ABC NORTE REDD PROJECT

Document Prepared by Ecológica Assessoria Ltda.

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1 PROJECT DETAILS

1.1 Summary Description of the Project

In Brazil, 58.39% of its entire 851,029,591.4 ha 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 primary objective of the ABC Norte REDD Project is to avoid the unplanned deforestation (AUD) of the 140,432.27 ha project area, consisting of 100% Amazon rainforest. The project area is located within a private property named “Fazenda Pacajá”, which is located between the municipalities of Portel and Bagre, in the State of Pará, Northeast Amazon.

The project proponent, ABC Agropecuária Brasil Norte SA Produção e Exportação, leased the area to a forestry company that carried out the sustainable forest management activities during almost 20 years. On 13-September-2017, despite a recurrent negative balance over the last years and an increasing deforestation pressure from external agents, the project proponent decided to maintain the Sustainable Forest Management Plan (SFMP) in Fazenda Pacajá through ceasing the contract with the former forestry company, and the investment in a certified reduced impact logging SFMP with other company combined with the expansion of social activities to local communities and enhanced surveillance in the project area. Carbon credits revenues are an important income source for making such activities feasible.

Thus, 13-September-2017 was defined as the project start date of the present project activity.

ABC Norte is the forestry company of Algar, a Brazilian family group with over 90 years of experience, and operations in the telecommunications, tourism and agribusiness sectors.

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

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[1] IBGE – Instituto Brasileiro de Geografia e Estatística. Brasil. 2021. Available at: <https://www.ibge.gov.br/cidades-e-estados>. Last visited on October 21st, 2021.

[2] FAO and UNEP. 2020. The State of the World’s Forests 2020. Forests, biodiversity and people. Rome. Available at: < https://www.fao.org/3/ca8642en/ca8642en.pdf>.

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

The present REDD project is estimated to avoid a predicted 82,994.27 ha of deforestation, equating to 30,138,794 tCO2e in emission reductions over the 30 year of project lifetime (13-September-2017 to 12-September-2047), with an annual average of 1,004,626 tCO2e.

The project is located in the State of Pará, in priority areas for conservation, according to the Ministry of Environment. The main deforestation and degradation agents acting within the reference region during the historical period were: cattle ranching, mainly producing beef cattle; and timber harvesters, acting both legally and illegally. 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.

The increased complexity and costs associated with the sustainable operation of the forest as well as other factors such as bureaucratic constraints and price fluctuations of certified timber prices make sustainable forest management less competitive than illegal logging. Thus, revenue from the sales of the Verified Carbon Units (VCUs) is essential for the project activity to compete with profitable alternative land use scenarios.

In addition to contributing to the long-term conservation of the region, the ABC Norte REDD Project also establishes a barrier against the advancement of deforestation, making it an important contribution to the conservation of Northeast Amazon biodiversity and also to climate regulation in Brazil and South America.

1.2 Sectoral Scope and Project Type

14. Agriculture, Forestry, Land Use (AFOLU)

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

This is not 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. Brazil endorses the

definition of forest adopted by FAO[4]. For this, the area was submitted to an analysis using MapBiomas mapping and classification. Thus, this assessment guarantees that the project area meets an internationally accepted definition of forest. Mapping is detailed in section 3.3;

- This project does not occur on wetlands and does not drain native ecosystems or degrade hydrological functions;
- Non-permanence risk will be analyzed in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool.

1.4 Project Design

This project has been designed as a single installation of an activity.

Eligibility Criteria

Not applicable. This is not a grouped project.

1.5 Project Proponent

Organization name	ABC Agropecuária Brasil Norte S.A. - Produção e Exportação (Primary PP)
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Telephone	Postal Code: 66.050-290
Email	Belém - PA, Brazil

Organization name	Ecológica Assessoria Ltda.
Contact person	Marcelo Hector Sabbagh Haddad

[4] Available at < https://snif.florestal.gov.br/pt-br/florestas-e-recursos-florestais/167-definicao-de-floresta>

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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 Cintia Donato Carolina Pendl Abinajm Heloisa Dorneles Moitinho Lyara Carolina Montone do Amaral Yara Fernandes da Silva
Title	Stefano Merlin – CEO Cintia Donato – Legal Coordinator Carolina Pendl Abinajm - Technical Analyst Heloisa Dorneles Moitinho - Technical Analyst Lyara Carolina Montone do Amaral - Technical Analyst Yara Fernandes da Silva - Technical Analyst

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Organization name	Uezu Planejamento Ambiental S/S LTDA
Role in the project	Geographic Information System – GIS
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1.7 Ownership

The project area of the ABC Norte REDD Project is owned by ABC Agropecuária Brasil Norte S.A. - Produção e Exportação. The legal documents proving the land title and ownership of the property will be made available to the auditors during the validation process.

In Brazil, the owner of the area is entitled to all the resources resulting from it. The owner has the right to use, enjoy and dispose of the property. The limitation on the right to property occurs in the case of underground research and mining (article 20, item IX and article 176 of the Federal Constitution[5] and article 1,230 of the Civil Code[6]).

[5] Brazilian Constitution available at <http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm>

[6] Brazilian Civil Code available at < http://www.planalto.gov.br/ccivil_03/leis/2002/l10406compilada.htm>

As far as carbon credits are concerned, they can be taken as the result of a property, so they belong to the owner. The legislation is expressed in this sense for the Permanent Preservation Areas and Legal Reserve, in art 41, § 4: "The maintenance activities of Permanent Preservation Areas, Legal Reserve and restricted use are eligible for any payments or incentives for services environmental issues, configuring additionality for the purposes of national and international markets for certified greenhouse gas emission reductions.[7]"

Therefore, as per section 3.6.1 of the VCS Standard, project ownership is arising under law for ABC Agropecuária Brasil Norte S.A. - Produção e Exportação. Ecológica Assessoria is also Project Proponent as, per contractual right, where both companies have defined a percentage of ownership of the credits.

1.8 Project Start Date

The Project Start Date is 13-September-2017. This was the date of signature of the contract with the new tenant, in order to conduct a more sustainable forest management with less environmental and social impact.

Despite a recurrent negative balance over the last years and an increasing deforestation pressure by external agents, ABC Norte (i.e., the primary project proponent) decided to maintain the Sustainable Forest Management Plan (SFMP) in Fazenda Pacajá through ceasing the contract with the former forestry company. Since the owner has owned the farm and has relationship with the communities since 1979, it was his personal desire to maintain the area and to search for a more sustainable administration, with environmental conservation and benefits for the community.

Thus, several alternatives for the use of Fazenda Pacajá were evaluated, including carrying out a Carbon Project. Furthermore, as from this first action, the project proponent also decided to invest in a certified reduced impact logging SFMP combined with the expansion of social activities to local communities and enhanced surveillance in the project area. As part of this new strategy, a contract between Madeireira J&Y and ABC Norte to lease of its farm for the purposes of carrying out the SFMP in a more sustainable manner.

The mentioned contract with J&Y has much more specific environmental restrictions and obligations than the previous contract, such as:

- specific assignment only for the management exploration area
- prohibition of exploitation of other natural resources in the property
- annual exploration restriction of 100,000 m^3
- contract renewal subject to an evaluation report and the evolution of the development of forestry, social, economic, and environmental activities
- mandatory investment in social programs for the local community and the surroundings of the farm and the ABC village
- mandatory recovery of degraded areas
- adoption of a chain of custody system to identify logs produced in the forest management

[7] Brazilian Forest Code: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

- SFMP management by a contracted third party, with access to all documents and information
- accountability to ABC Norte, upon submission of reports on forest production and environmental compliance.

Since the project start date, the project implemented socio-environmental responsibility and environmental education programs. Furthermore, the project started the forest management certification in 2017 and received the CERFLOR certification in 2020. The Sustainable Forest Management Plan was renewed in 2019, being valid until 2025, and, in addition, the Rural Activity License (RAL) was obtained, valid until 2025 as well.

In addition, the company also opted to maintain an internal team to take over the management in case there is any problem with the tenant, with a team formed by forest engineers, besides to already having all the monitoring control and verification of compliance with the SFMP.

This was initiated to ensure the forestry activity and the forest standing, as it is the company's main activity.

Therefore, on 13-September-2017 was conducted the main action of the company in terms of reducing GHG emissions and initiating the present REDD project and is thus the designated project start date.

Furthermore, project activity also increased the surveillance since the project start date, which helps to avoid unplanned deforestation or illegal logging within the project area by external agents.

1.9 Project Crediting Period

The project has a crediting period of 30 years, from 13-September-2017 until 12-September-2047.

1st baseline period: 13/09/2017 to 12/09/2027

2nd baseline period: 13/09/2027 to 12/09/2037

3rd baseline period: 13/09/2037 to 12/09/2047.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

Year	Estimated GHG emission reductions or removals (tCO_2e)
2017	-50,473
2018	-228,926

2019	-59,140
2020	5,960
2021	71,590
2022	217,872
2023	345,333
2024	422,448
2025	578,886
2026	726,399
2027	865,444
2028	943,132
2029	1,089,721
2030	1,126,413
2031	1,217,396
2032	1,318,778
2033	1,390,764
2034	1,405,947
2035	1,469,838
2036	1,504,888
2037	1,511,126
2038	1,524,629
2039	1,501,463
2040	1,489,615

2041	1,579,126
2042	1,477,421
2043	1,444,834
2044	1,437,588
2045	1,459,327
2046	1,398,863
2047	952,533
Total estimated ERs	**30,138,794**
Total number of crediting years	**30**
Average annual ERs	**1,004,626**

1.11 Description of the Project Activity

The main objective of the present REDD project is the conservation of 145,680.7882 ha of Amazon rainforest area within a private land named “Fazenda Pacajá”, which is described in section 1.9 of the present VCS PD. This will be achieved through avoidance of unplanned deforestation.

This project is located within the Para State jurisdiction which is not covered by a jurisdictional REDD+ program. The “Fazenda Pacajá” was acquired in 1979, starting the process of opening and occupation. From 1982 to 1999 the Sustainable Forest Management Plan (SFMP) took place, being leased to CKBV Florestal from 1999 to 2017. In 2014, Algar incorporated ABC Norte, and in 2017, CKBV ceased to be responsible for the Management Plan.

It is important to describe the context at the time of the project implementation. Before the project start date, the sustainable forest management plan was poorly conducted, and financial results were negative. For instance, in 2017, the accumulated loss was R$17 million. Given the loss, the company analyzed other land use alternatives for the property, such as agriculture (soy planting), deforestation for cattle raising, development of a carbon project, donating the area for the implementation of a National Protected Area, and even the sale of the property. A final feasibility report was sent to ABC Norte in January 2017.

However, although not being a favorable economic scenario, the landowner decided to maintain the property as a personal purpose for the forest conservation and life improvement for the local communities. Thus, the alternative was to continue with the forest management plan, but this time carrying out conservation activities and allocating part of the revenues to social and environmental actions. Considering the high accumulated negative balance at that time, this decision was based on the development of a carbon project in conjunction with the SFMP, thus generating carbon credits which would help paying the costs of the new SFMP operations and socioenvironmental activities.

A new tenant contract was developed with several additional conditions that required greater social and environmental commitment at Fazenda Pacajá and the surrounding communities. Thus, 13/September/2017 was defined as project start date, since the new contract included environmental and social restrictions and obligations to the new tenant, which increased the control and surveillance against illegal deforestation and led to the generation of GHG emission reductions or removals, together with changing to a reduced impact logging operation, and the implementation of management and protection plans. The contract was signed for a specified period of 5 years and has the exclusive purpose of exploiting forest products (wood, residual woody material from exploitation and non-wood products). It is important to note that this agreement has already been renewed for another 5 years, i.e., until 2027.

The table below shows a timeline of the main activities carried out since the project start date, both for the SFMP and REDD Project activities.

Year	SFMP	REDD Project
2017	23/01/2017 - Feasibility Report conducted by a Carbon Project Developer; 07/03/2017 – Board decision for the development of a Carbon Project together with the SFMP[8]; 13/09/2017 – New Tenant Contract (Madeireira J&Y); 14/09/2017 – Hiring of the new internal forest management team.	23/01/2017 - Feasibility Report conducted by a Carbon Project Developer, which included an action plan for the development of the carbon project; 07/03/2017 - Board decision for the development of a Carbon Project together with the SFMP; 24/08/2017 – Community survey and first meetings with community leaders; 13/09/2017 – New Tenant Contract (Madeireira J&Y), which included environmental and social restrictions and obligations to the new tenant, which increased the control and surveillance against illegal deforestation;

[8] In 2021, ABC Norte also elaborated an explanatory document to clarify about the decision made to initiate the carbon project in 2017, which also contains the preparatory measures that had to be carried out before the project start date and the confidentiality of the deliberations taken during the transition process in 2017.

2018	01/03/2018 – Hiring of a social environmental consultancy for conducting a better approach with the surrounding communities regarding the SFMP. May 2018 – The company starts to produce monthly environmental monitoring reports 12/09/2018 – Rural activity license on behalf of J&Y to conduct the new Sustainable Forest Management Plan, which includes several activities to mitigate impacts in the forest, besides the development of internal quality	Year of 2018 - The company followed the guidelines of the feasibility study, starting the necessary regularizations and updates, in addition to social responsibility actions; Year of 2018 – ABC Norte start building monitoring bases to expand the area's surveillance and control, together with the monitoring of the property boundaries; May 2018 – The company starts to produce monthly environmental monitoring reports 01/03/2018 – Hiring of a social environmental consultancy to implement socioenvironmental activities for the surrounding communities, which maintained the services during the following years. 12/09/2018 – Rural activity license on behalf of J&Y to conduct the new Sustainable Forest Management Plan, which includes several activities to mitigate impacts in the forest, besides the development of internal quality
2019	Year of 2019 – J&Y management activities begin at Fazenda Pacajá, under the new SFMP.	19/02/19 – Presentation of the Social Responsibility Program social program to the communities and state and municipal secretariats; 10/06/2019 – 1st proposal for the elaboration of the carbon project from another project developer; 21/08/2019 – Negotiation with the carbon project company and acceptance of the draft contract; 27/12/2019 - Completion of the update of the registrations in the responsible notary's office and SIGEF;
2020	15/05/2020 – CERFLOR certification for the SFMP	January/2020 – Socio-economic diagnosis of the communities;

		26/03/2020 - Acceptance of the project's economic model from the other project developer proposal; 02/06/2020 - Contract renegotiation with the carbon project developer; 06/07/2020 – First negotiations with Ecológica Assessoria for the development of the REDD Project; 27/11/2020 – Contract signature with Ecológica Assessoria.
2021		13/07/2021 – Project is published in the VCS Pipeline

Under the management of ABC Norte, and since the project start date, social activities began through environmental education and socio-environmental responsibility programs. Some communities are located inside the farm, with 13 communities nearby. Currently, the project serves 5 of them, and, with the carbon credit, it is planned that activities will be gradually expanded to all communities. Furthermore, the certification of the SFMP by CERFLOR also started after the project start date, and it was obtained in 2020.

In summary, activities implemented since the project start date, to improve the sustainable forest management plan and expand social and impact mitigation activities, are:

- Signing of a contract with a new tenant, with restrictive clauses and requiring environmental conservation and social responsibility;
- Structuring of a specialized internal team to monitor the conduct of the management plan and take over the activity, if necessary;
- Hiring a consultancy for the development of socio-economic diagnosis and activities with the communities. The Social Responsibility Program holds workshops, lectures and training for the "ribeirinhos", in order to promote the independence of communities from illegal deforestation, generating an alternative source of income. Activities such as: specialization in production systems (poultry, fish farming and agroforestry), craft workshops and biscuit production, environmental, financial and activity planning education, etc.
- Expansion of surveillance booths at strategic points on the Fazenda Pacajá;
- Certification of the Sustainable Forest Management Plan (CERFLOR).

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[9].

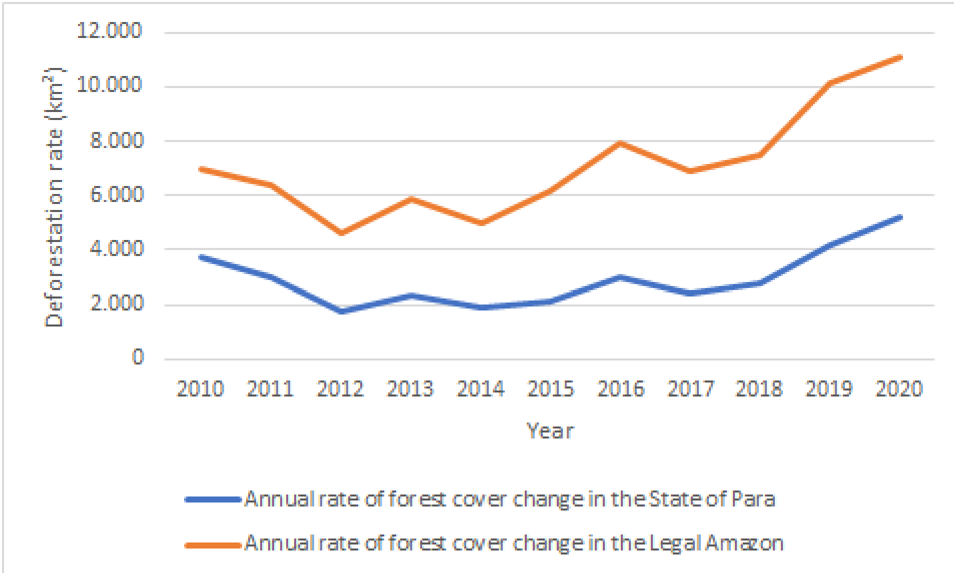
The main deforestation and degradation agents within the ABC Norte REDD project region are: cattle ranching, mainly producing beef, timber harvesters, acting both illegally, and infrastructure, such as the proximity to existing highways and the expected expansion and/or retrofit of such roads in the near future.

Furthermore, according to PRODES[10], the municipalities of Altamira and São Félix do Xingu are located next to Portel and Bagre (which contain the project area in its entirety) and were the municipalities that had the highest deforestation rated in recent years within the Amazon biome, a result of the disorganized occupation and the lack of economic alternatives for local communities and landowners. Moreover, the project area is located close to the Brazilian arc of deforestation, which is a region with high deforestation pressure and illegal logging.

According to PRODES[11], the rate of deforestation has been increasing since 2014, growing almost 3 times from 2017 until 2020, that is, during the same period that the ABC Norte project started. In 2017 deforestation in the state of Pará was 2,433 km², increasing to 5,192 km² in 2020. The figure below displays a comparison between the 2010 to 2020 annual deforestation rate in the State of Para and in the Legal Amazon region.

[9] 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.
[10] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite, Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates>. Last visited on 20-January-2021.
[11] PRODES. Monitoring of Deforestation in the Brazilian Amazon Forest by Satellite. Available at: http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes. Last visited on October 21st, 2021.

Figure 1. Comparison between the annual rate of forest cover change in the State of Para and in the Legal Amazon, for the 2010 - 2020 period



Through the present project activity, ABC Agropecuária Brasil Norte SA Produção e Exportação, committed to conserve the forest area, despite having more profitable land use alternatives. Therefore, the revenue from this REDD project is essential for the continued conservation of this native rainforest area. Conservation activities include increased monitoring to prevent invasion of illegal deforestation by outside agents and banning of unplanned logging and other unpermitted degradation within the project area. As mentioned in section 1.8, the new tenant is binded by contract to perform the sustainable management, invest in socioenvironmental activities and is responsible for any illegal conduct within Fazenda Pacajá. These clauses were specifically included in the new contract to avoid problems and ensure the forest preservation and a good relationship with communities, in addition to actions that minimize environmental impacts and the conduct of illegal activities.

Forest supervision is carried out by Aflora Engenharia, which monthly monitors aspects of Fazenda Pacajá, such as satellite images and cartographic data from official bodies as IBGE, IBAMA, INPE and SEMAS, themes related to vegetation cover, deforestation of the forest management production of the Fazenda Pacajá. This surveillance allows the management of the environmental situation of the property during the development of the forest exploration work, in addition to ensuring compliance with the requirements set out in the current legislation.

The objective of the temporal analysis is to verify possible changes in the vegetation cover of Fazenda Pacajá, through the identification of deforestation, hot spots, fires and anthropism, using geoprocessing and image processing techniques of satellite images, in order to promote the monthly update of the technical report of the area.

The ex ante estimate for the predicted avoided deforestation within the project area over the 30 years of project lifetime is 82,994.27 ha. The avoided emissions due to the ABC Norte REDD AUD Project are expected to be 26,454,119 tCO2e across the 30 years of the project crediting period (13-September-2017 to 12-September-2047), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

Besides forest conservation, the present project aims to improve and quantify its social and environmental benefits through the 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 indicators: Biodiversity; Natural; Financial; Human; Social and Carbon Resources and aims to deliver high-integrity benefits in each.

<u>Background on Sustainable Forest Management Plan within the ABC Norte REDD Project Area</u>

The Sustainable Forest Management Plan (PMFS) is a set of plans and techniques for forest extraction, adapted to the conditions of the forest. This concept will guide the exploitation of forest resources (wood, residual woody material from exploration and non-wood products), guaranteeing the supply of wood processing and processing units.

The management of the forest must occur in a sustainable manner, which ensures the use of available resources based on techniques such as the Reduced Impact Exploration (EIR) system, the conservation of the forest, preventing soil wear and erosion, in addition to protecting watersheds, reduce the risk of fire and allow the maintenance of natural regeneration and protection of biological diversity.

Therefore, there is a guarantee that the wood product comes from sustainable management, which makes its commercialization feasible. And the main products are roundwood and sawn wood, to serve the foreign and domestic markets. The companies involved in the ABC Norte project are committed to the norms and principles of sustainability of the forestry activity.

The Sustainable Forest Management Plan (PMFS) aims to produce forest resources in a sustainable manner in order to provide continuous supply to the company's industrial processing and value-added units. Its main products are wood, residual woody material from exploration and non-wood products, and seeks to add value to the products, in addition to enabling the supply of raw materials of safe and continuous origin to the consumer market.

Furthermore, the company has currently started the CERFLOR certification process and has acquired the recommendation for the acquisition of the “green seal”. With this, it is guaranteed that this project has to offer countless benefits for the sustainable development of the region, contributing to the conservation of local biodiversity, generation of knowledge and income for the local community.

In 2019, a sample forest inventory was developed within the SFMP area, based on the points of paths to be covered by opening between points, considering species with DBH greater than 30 cm, in a 50 m wide band, being 25 m to the right and 25 m to the left. This was necessary to assess the area’s forestry potential, plan the location of roads and access paths, and determine the actual area for sustainable forest management in order to design the SFMP. This area was divided into 35 large Annual Production Units (APUs), which constitute the forest areas to be managed for the next 35 years (operation cut cycles).

Although the total property area has 145,680.7882 ha, the area for forest harvest management is 121,632.3691 ha. In this area were excluded the permanent preservation areas and the absolute reserve area. According to the Brazilian Forest Code, permanent preservation areas (PPA) at the borders of waterways shall be comprehensively preserved. The Permanent Preservation Area of the property is 6,016.40 ha.

Therefore, 79.83% of total property area is subject to SFMP. The adopted rotation cycle is 35 years, thus each annual productive unit (APU) has around 3,521 hectares. Figures 2 and 3 below show the location of each APU and protection areas within the ABC Norte area.

Figure 2. APU Location

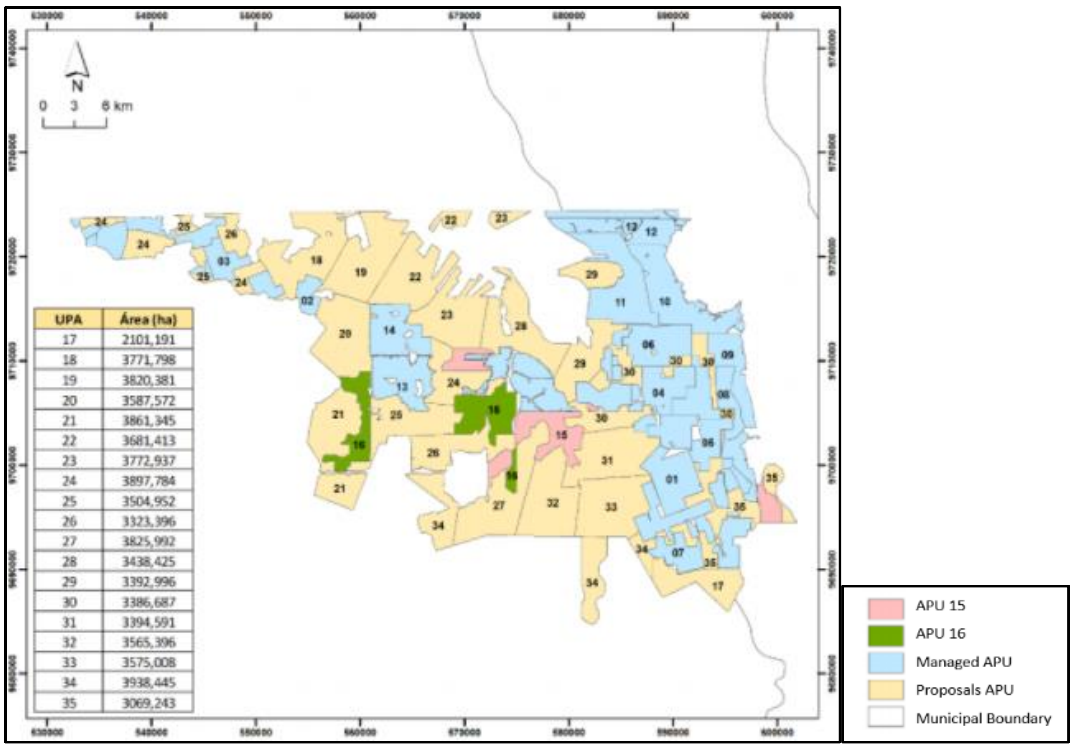
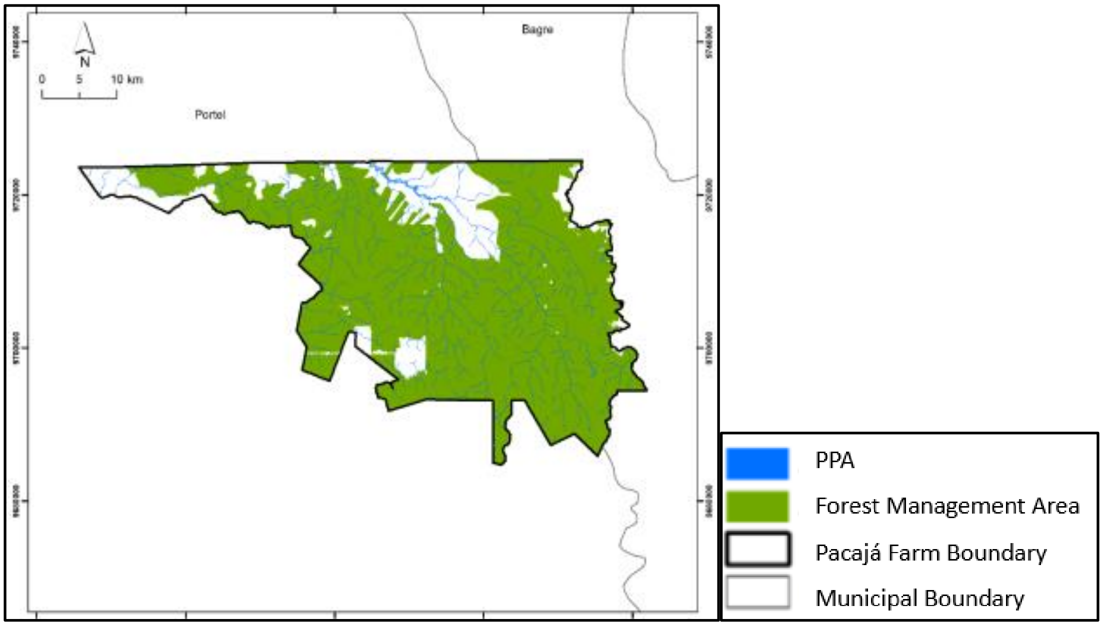


Figure 3. Management Area, Absolute Reserve and Permanent Preservation Area



To develop the assessment to the area's potential, data was sought through the Inventory Systematic Sampling, a methodology aimed at collecting information on species of interest, as well as biogeographic characteristics of interest in the field, where the execution had as reference base the waypoints to travel through the opening between points, considering species with DBH greater than 30 cm, in a 50 m wide strip, being 25 m to the right and 25 m to the left. After processing the collected data, the true potential of commercial species and volumetry of the asset was fetched using the most reliable estimate available.

The cutting cycle in this plan is 35 years. This cycle is based on an attempt to introduce new paradigms for forest management, in order to reduce the period for recovery of forest stocks. Forest monitoring will provide the growth data from the permanent plots installed in the Forest Management Unity, aiming to adjust the period initially foreseen. For this plan, it is proposed to harvest according to the concession contract 29.86 m^3 per hectare, despite the legislation authorizing a maximum of 30 m^3/ha.

The silvicultural system to be adopted is the polycyclic one, widely recommended for yields upland forests in the Brazilian Amazon. EMBRAPA named the referred system of the Brazilian System of Selective Management. In each cycle, mature trees are harvested in intermediate cuts. In the case of this management plan, a cycle will be initially adopted of 35 years.

The application of this system is due to the results of research carried out, which indicate this system as the most appropriate for the management of tropical forests. The sequence of operations of the system to be developed in the PMFS of Fazenda Pacajá is presented below.

Table 1. Main forestry measures and operations to be conducted by ABC Norte in the SFMP

Year	Operations
Y-1	● Demarcation of UPAs, UTs and trails or guidance trails; ● 100% inventory (forest census) and cutting of vines on trees to be harvested; ● Preparation of exploration maps; ● Establishment and measurement of permanent plots; ● Fauna inventory; ● Harvest; ● Planning and construction of permanent infrastructure (roads and storage yards);
Y	● Exploration of trees, observing the established guidelines for exploration with reduced impact; ● Exploitation of residues for charcoaling;
Y+1	● Remeasurement of permanent parcels; ● Post exploratory fauna inventory; ● Maintenance of permanent infrastructure; ● Survey of damage caused by exploration and waste; ● Data collection for volume equation; ● Silvicultural treatments;
Y+3	● Remeasurement of permanent parcels; ● Fauna inventory (post exploratory);
Y+4	● Inventory of forest residues;
Y+5	● Remeasurement of permanent parcels; ● Fauna inventory (post exploratory); ● Data collection for the volume equation; ● Adjustment of the volume equation;
Y+10	● Remeasurement of permanent parcels;

Y+20	● Remeasurement of permanent parcels;
Y+35	● Beginning of the new cycle.

The Sustainable Forest Management Plan (PMFS) aims to produce forest resources in a sustainable way in order to provide continuous supply of industrial units processing and adding value to the company. Its main products are wood, residual woody material from exploration and non-timber products, and seeks to add value products, in addition to enabling the offer of safe and continuous raw material for the consumer market.

Furthermore, the applied forestry management system has the following objectives:

- Employ Reduced Impact Exploration (EIR) techniques, in order to mitigate damage to remaining forest, regulating production in order to ensure a minimum cutting cycle of 35 years old;
- Implement a monitoring and control program for forest management activities, aiming to optimize productivity, reduce impacts and costs of operations, in order to guide the possible changes that may be necessary to the original management plan;
- Develop partnerships with research institutions for the development of studies that enhance the improvement of forest management techniques;
- Support forest certification in the management area, through compliance with the principles and criteria of onshore forest management;
- Value local products, whether timber or non-timber;
- Maximize the resources of the management area through the multiple use of the forest;
- Develop markets and secure existing markets with wood and non-wood products (resins, oils, seeds, etc.) of sustainable origin.

All actions that cause direct and indirect impacts on the environment must be monitored and the appropriate mitigating measures implemented. Likewise, it should be noted that both management and field teams must be properly trained to employ natural resource management methodologies in order to minimize impacts and costs, in addition to the use of reduced impact exploration techniques to minimize the damage caused to remaining species, to the soil, hydrography, air and fauna. In this aspect, the activities with the greatest impact will be identified and monitored, offering conditions for assessment and measurement directly in the field by the company's team.

With the management and exploration system employed, the environmental impacts are reduced. The selection method provides a stable habitat for plants and animals. Managed stands support more weeds, secondary vegetation and natural regeneration than unmanaged primitive stands. It increases the diversity and frequency of birds and nests with rapid recovery after exploration and has a reduced impact on the mammal community because of the maintenance of natural conditions important to their development.

The chain of custody is extremely important, as it ensures the tracking of the raw material, from production to the consumer. Tree identification starts at the forest inventory, through the plates that are placed on the tree stump after the cut. The log must also carry identification (UPA number, UT number, tree, section number, species code and log length) after unloading. Marking must be done on each section of the logs when tracing is needed.

For the tracking of wood in the various stages of management, some activities will be developed to ensure control of the entire wood chain, from the tree that will be harvested to the exit from the industrial processing unit.

The Company seeks to maintain the traditional local culture and insert communities into its production chain, generating jobs and regional development. The ABC Norte project also provides training for workers in reduced impact extraction, occupational safety, occupational health and safety, first aid and firefighting. Activities related to the Sustainable Forest Management Plan do not affect the food production of the communities. Social and environmental actions are carried out to introduce new forms of income and food for the community, such as raising chicken and fish.

Despite the importance of sustainable forest management for climate change adaptation and mitigation, its implementation is not considered common practice, primarily due to the shortage of human resources and funding required to implement the necessary measures.

Implementation of REDD and SOCIALCARBON mechanisms together with SFMP promotes sustainable forest use because it initiates forest conservation and storage of carbon stocks in forests while reducing pressure for timber from other conserved areas. In this way, biodiversity conservation and development of the local economy can be achieved simultaneously. Furthermore, REDD+ mechanisms in sustainably managed forests can provide a guarantee to purchasers of wood products that the product was produced in an environmentally responsible way, thus catering to the growing market demand.

1.12 Project Location

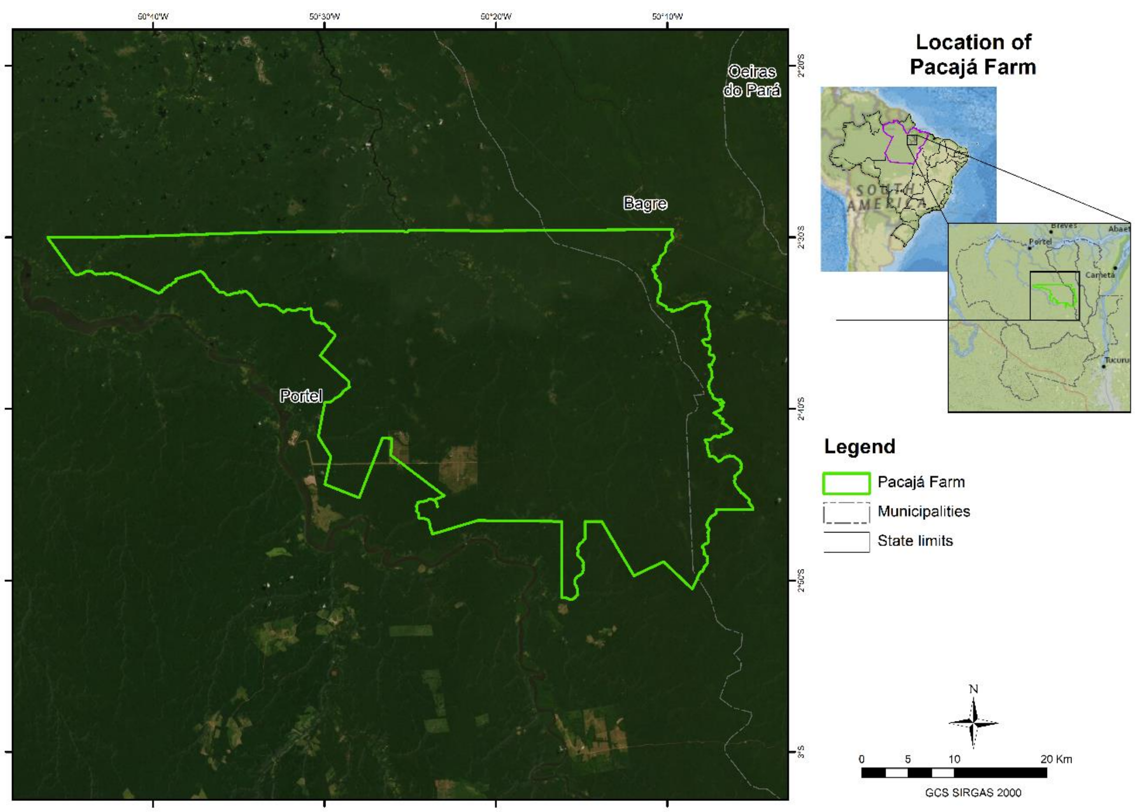
The ABC Norte REDD project is located in a private property named “Fazenda Pacajá” covered almost in its totality by native vegetation, totaling 145,680.7882 ha., which is situated between the municipality of Portel and Bagre, in the State of Pará, Northeast Amazon.

According to the logistical arrangement, Fazenda Pacajá can be accessed via a route, by river, leaving the city of Belém by the river Pará until the city of Portel at a distance of 304 kilometers. It follows the route, still by river via Pacajá River, from the city of Portel to Fazenda Pacajá, covering 180 kilometers. In total, it travels 484 km from the state capital to the farm.

In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, the project area may only include areas composed of "forest"[12] for a minimum of ten years prior to the project start date. Therefore, satellite images between 2007 and 2017, were analyzed and classified. The areas within the property that were defined as forest in 2017 and in 2007 were separated and utilized to compose the project area. In addition, some non-forest areas were also excluded, such as rivers, rocks, and non-forest vegetation.

As shown in Figure 4 below, the size of the areas that were considered "non-forest" (i.e. planned roads and non-forest vegetation or rock formations, as the area has never been deforested) within the project area was 5,247,73 ha. This was excluded from the initial area of 145,680 ha, resulting in 140,432.27 ha, which was then defined as project area.

Figure 4. ABC Norte REDD Project - Project area



1.13 Conditions Prior to Project Initiation

[12] Brazil adopts FAO forest definition: "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity in situ." Available at: < http://www.fao.org/3/x6896e/x6896e0e.htm >. Last visit on: August 06th, 2021.

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

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

The present project activity has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction. On the other hand, the project aims to combine REDD and SFMP activities, which will promote forest conservation combined with alternative income generation from sustainable practices, associated with a greater surveillance against deforestation agents. Furthermore, the SFMP has a minimal 30-years cutting cycle, ensuring the presence in the area, the natural regeneration of the forest, and the permanence of GHG emission reductions.

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

Climate

According to the Köppen classification, the project region has a dominant hot and humid climate, characteristic of Tropical Forests. Furthermore, the region maintains heavy rainfall rates (around 2,400 mm of rain), high average air temperature (26ºC) and relative humidity above 85%. The average annual temperature varies from 26º to 27ºC, highs between 31ºC and 33ºC and lows between 21ºC and 24ºC.

Regarding the pluviometric regime, the region has total annuals generally between 1800 mm and 2800 mm, but it is subject to important fluctuations during the time. The rains are not distributed equally during the year, being characterized by a sharp division in a period with heavy rains from January to July, and another with low rainfall from August to December.

Graphs below present the temperature and rainfall in 2007 and 2017[13]. It is possible to see that there were no major changes in the climate between these years. The period between June and November is the driest, and with the highest temperatures. From January to March the rainfalls are up to 400 mm per month, and temperatures between 26 to 27ºC. The graphs present data from Breves as it is the climate station closest to the project area.

[13] Data available at < https://bdmep.inmet.gov.br/> for Breves/Pará, conventional station.

Figure 5. Climograph from year 2007 in Breves

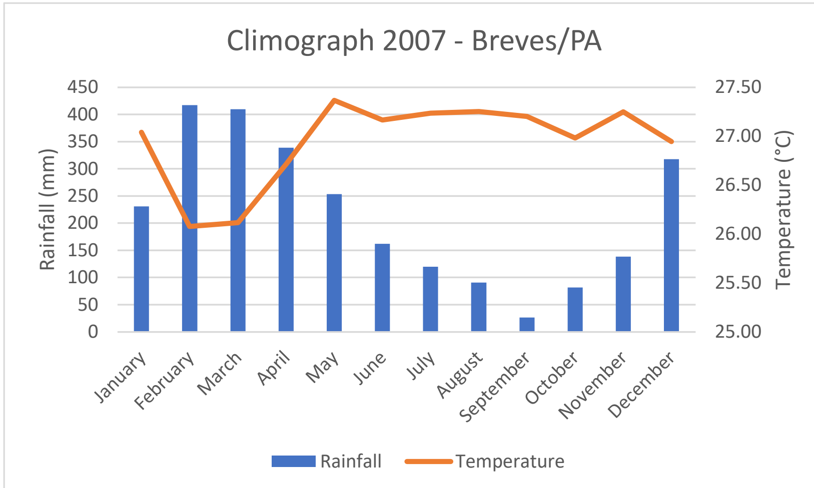
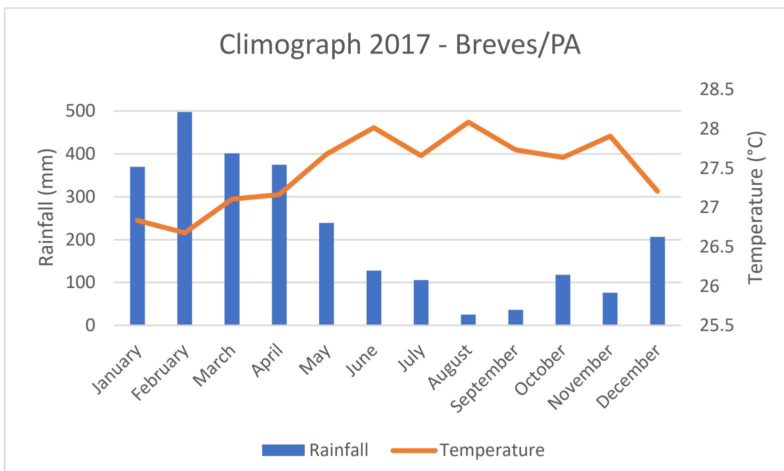


Figure 6. Climograph from year 2017 in Breves

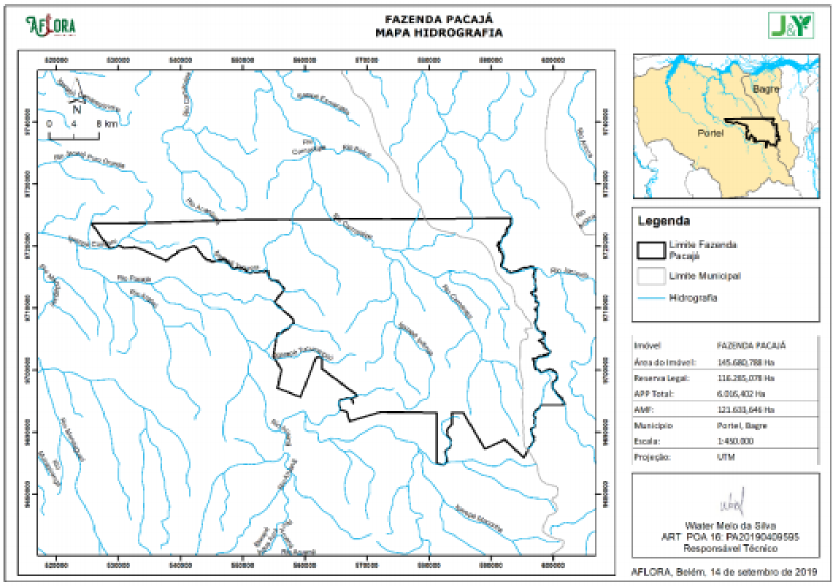


Hydrography

The municipality of Portel has a hydrography rich in rivers, however, with regard to the use of regional hydrography, the most prominent river is the Pacajá River.

According to the description of the RADAM-BRASIL project (1974), the management area is located in the region of the Lower Plateau of the Amazon (Baixo Amazonas), in the Portel hydrographic region - Marajó.

Figure 7. Hydrography of Fazenda Pacajá



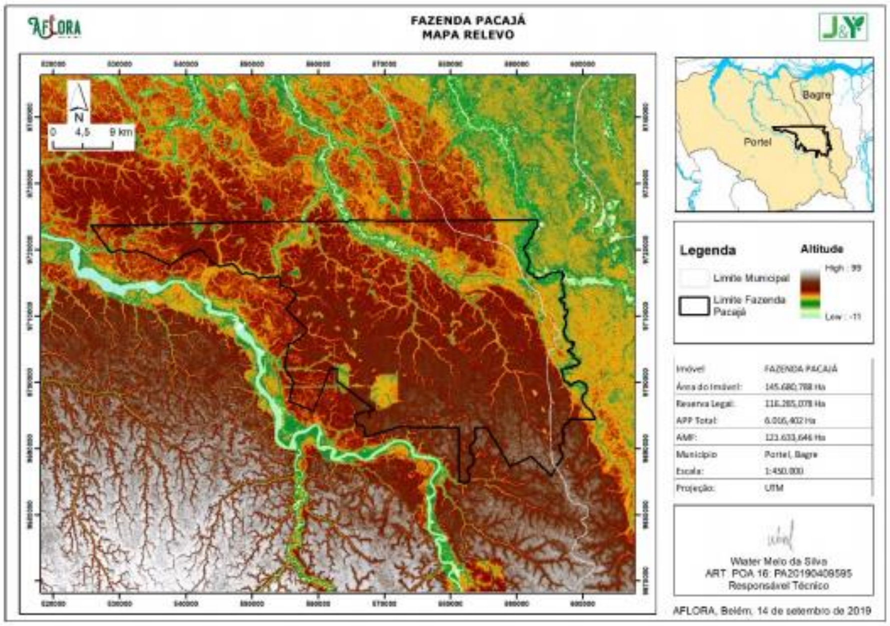
Within the managed forest area, there are the following main rivers: Pacajá Candirú, Raquerá, Camaraipi, Jacundá, Repartimento, Arraia and Castanha, in addition to many other small streams such as the Conderu Taquera and Ipitinga streams, and caves that will be demarcated in the surveys of field and submitted to a protection regime as Permanent Preservation Areas (APP) as established by the forest code.

Between 2007 and 2017 there were no constructions or dams that could alter the supply of water resources in the region or the natural regime of the rivers.

Geology, Topography and Soils

The lower plateau of the Amazon is the extensive surface of the Pleistocene Pediplano that borders the riverbanks with the Amazonian plain; to the south with the peripheral depression of southern Pará and to the north with the plateau of the sedimentary basin of Amazonas. In the region in question, the pediplane is preserved despite the dense forest cover, however Cametá has on the left bank Tocantins River where isolated, depressed areas appear with sandy deposits, subject to floods covered by undergrowth (RADAM, 1974).

Figure 8. Relief of Fazenda Pacajá



According to SUDAM (1974), the region to the north originates from the Quaternary period, with sand and clay sediments formed by rivers, or sometimes by the sea. To the south is Tertiary, with sediments mainly of clay, with sand and layers of sand stones.

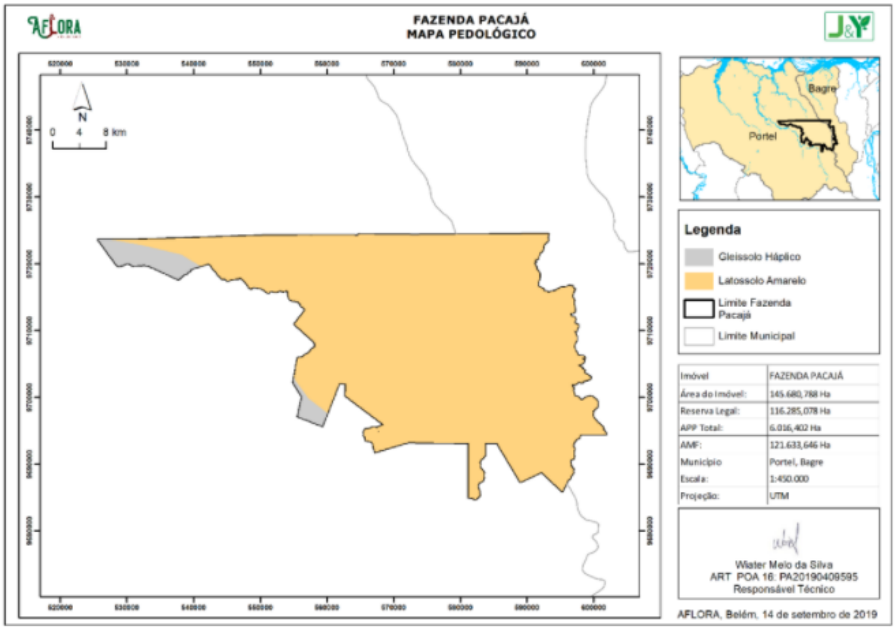
According to IBGE (1990) the rocks of the mesozoic sedimentary cover constitute the Alter do Chão formation of Cretaceous age and which represents the most widely distributed mapping unit in the plateau area of the Amazonian sedimentary basin. This formation supports the reliefs of the lowered plateau of the Amazon in which the area of the plan is inserted.

According to the Brazilian Soil Classification System (EMBRAPA, 2006), the municipality's soils are composed of the following types:

- Dystrophic Yellow Latosol;
- Dystrophic Yellow Latosol Concretionary;
- Dystrophic Yellow Argisol;
- Hydromorphic Carbic Spodosol;
- Ferrocarbic Spodosol;
- Quartzarenic Neosol.

In the area of Fazenda Pacajá there is a predominance of soil classified as Yellow Latosol, as show in figure below.

Figure 9. Soil map included in the SFMP



There were no changes in these conditions between 2007 and 2017. This classification was used in 2007 and it is still valid currently.

Socio-Economic Conditions

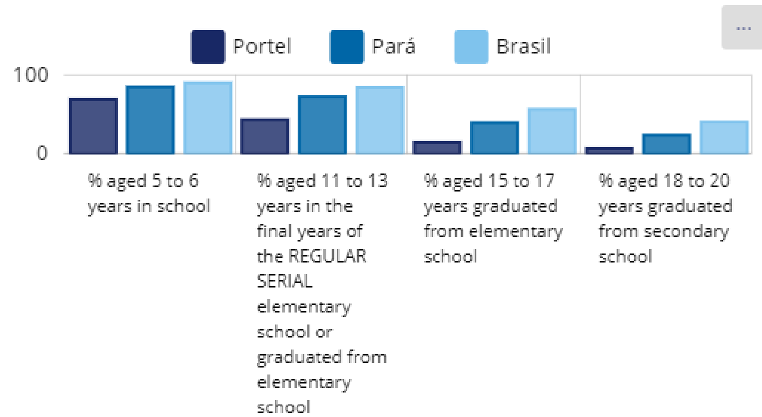
The municipality of Portel is located at 01º56'08'' south latitude and 50°49'16" west longitude, in the western region of Pará, in the Mesoregion of Marajó, in the micro-region of Portel and is located on the banks of the Pacajá River. It has an area of 25,384.779 km² and a distance of approximately 266 kilometers, in a straight line, from the state capital.

Portel has 62,043 inhabitants, according to estimates of the IBGE Census (2019) and is located in the state of Pará. Data from the Demographic Census shows that Portel's MHDI was 0.359, in 2000 and 0.483, in 2010. Meanwhile, in the state of Pará, the MHDI went from 0.359 to 0.483. In relative terms, the evolution of the index was 34,54% in the city.

According to estimates from 2017, the population of Portel was of 60,322 people, composed, on its majority, by men and black people. Between 2013 and 2017, the city registered an increase of 7.54%. In the same period, Pará registered an increase of 4.98%.

In the city, the share of children aged 5 to 6 years in school was 69.79%, in 2010. In the same year, the share of children aged 11 to 13 years attending the final years of elementary education was 43.95%. The share of young people aged 15 to 17 years graduated from elementary education was 14.97%; and the share of young people aged 18 to 20 years graduated from secondary education was 7.37%.

Figure 10. Education per age group in the city of Portel and the State of Pará - 2010



Analyzing the indicator years of study expectancy, in 2000 the expectancy was 3.86 years and 6.19 years in 2010, while the state reported 6.80 and 8.49 years, respectively.

In addition, according to the Atlas of Human Development, people are considered extremely poor, poor and vulnerable to poverty when their household per capita monthly income is below R$70.00, R$140.00 and R$255.00 (values from August 2010), respectively. Thus, in 2000, 42.43% of the city population were extremely poor, 69.01% were poor and 87.21% were vulnerable to poverty; in 2010, these shares were, respectively, 39.40%, 60.55% and 80.46%[14].

According to CadÚnico, data and information collection center that aims to identify all low-income families in the country for inclusion in social assistance and income redistribution programs, from Federal Government, the share of extremely poor registered after receiving the Bolsa Família social benefit went from 75.90%, in 2014, to 61.65%, in 2017. On the other hand, the share of poor people registered in the system after receiving the Bolsa Família benefit was of 88.91%, in 2014, and 92.98% in 2017. Finally, the share of people vulnerable to poverty was of 89.70%, in 2014, and 97.61%, in 2017[15].

The Gini index in Portel reduced from 0.66, in 2000, to 0.64, in 2010, indicating, therefore, a reduction in income inequality[16].

Historically, the region's main economic activity is the extraction of forest products, mainly from lowland forests. In addition, it is also characterized by the development of agriculture, timber industries and trade.

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[14] IBGE - Brazilian Institute of Geography and Statistics. Panorama of the City of Portel. Available on: <https://cidades.ibge.gov.br/brasil/pa/portel/panorama>. Last visit on: April 21st, 2021.

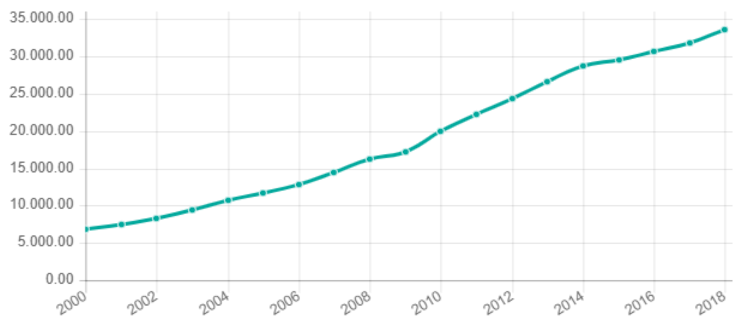
[15] IBGE - Brazilian Institute of Geography and Statistics. Panorama of the City of Portel. Available on: <https://cidades.ibge.gov.br/brasil/pa/portel/panorama>. Last visit on: April 21st, 2021.

[16] IBGE - Brazilian Institute of Geography and Statistics. Panorama of the City of Portel. Available on: <https://cidades.ibge.gov.br/brasil/pa/portel/panorama>. Last visit on: April 21st, 2021.

In 2010, of the employed people aged 18 or over in the municipality, 43.47% worked in the agricultural sector, 0.00% in the extractive industry, 8.36% in the processing industry, 3.67% in the construction, 0.66% in the public utility sectors, 9.51% in commerce and 26.71% in the services sector.

By the end of 2017, the municipality of Portel had 416 active companies, with its GDP as shown in Figure 8 below[17].

Figure 11. Portel's GDP evolution



Biodiversity

Brazil harbors the greatest concentration of biodiversity on the planet. It has a great abundance of life forms – which translates to over 20% of the total species on Earth – and raises Brazil to the main nation among the 17 countries with the highest biodiversity levels globally, containing over 70% of the planet's biodiversity[18].

Brazil has the greatest flora species richness in the world, with 46,392 species described. Furthermore, it contains over 8,700 known species of vertebrates consisting of 720 mammals, 986 amphibians, 759 reptiles, 1,924 birds and 4,388 fish species. It is estimated that around 93 thousand invertebrate species are known[19].

The number of known species in Brazil is estimated to range from 170 to 210 thousand, while the total number of species that the country harbors is approximately 1.8 million, putting the known proportion of biodiversity at a mere 11%. New species are described every day in Brazil[20]. It is also estimated then that approximately 10% of the entire planet's biodiversity is found in the project region, including many threatened species and those which exist only in Amazonia, or endemic species[21].

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[17] IBGE - Brazilian Institute of Geography and Statistics. Panorama of the City of Portel. Available on: <https://cidades.ibge.gov.br/brasil/pa/portel/panorama>. Last visit on: April 21st, 2021.

[18] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). The Brazilian Biodiversity. Available at: <https://www.gov.br/mma/pt-br/assuntos/biodiversidade>. Last visit on: October 21st, 2021.

[19] Information System about the Brazilian Biodiversity (SiBBr). Available at: <https://regions.sibbr.gov.br/regions/Biomas%20Brasileiros/Amaz%25C3%25B4nia#group=ALL_SPECIES&subgroup=&guid=&from=1850&to=2021&tab=speciesTab&fq=>. Last visit on: October 21st, 2021.

[20] Information System about the Brazilian Biodiversity (SiBBr). Available at: <https://regions.sibbr.gov.br/regions/Biomas%20Brasileiros/Amaz%25C3%25B4nia#group=ALL_SPECIES&subgroup=&guid=&from=1850&to=2021&tab=speciesTab&fq=>. Last visit on: October 21st, 2021.

[21] Protected Areas Program of the Amazon - ARPA (Brasil) (Org.). Arpa Biodiversidade. Amazonas: WWF - Brasil, 2010. 34 p.

The ecosystem of Pará presents the biodiversity characteristic of the Amazon region, where more than two thousand species of fish have been catalogued, about 950 species of birds, 300 species of mammals and about 10% of all plant species on Earth.

In the territory of Pará, this variety of animal and plant species is immense, mainly due to climatic conditions (location in the equatorial zone) and the size of the area covered by forests. Among the trees considered to be noble wood, which is why they are often cut down indiscriminately, are Angelim, Cedro and Mahogany. In the extractive sector, the most sought after species are rubber and Castanheira-do Pará.

The flora also features exotic species, such as the water lily and dozens of species of bromeliads. In the last decades, the concern with the future of the Amazonian ecosystem has been manifested inside and outside Brazil, by governmental and non-governmental institutions.

Several factors contribute to the destruction of flora and the accelerated process of extinction of animals in Pará territory. Among these factors, we highlight the selective exploitation of wood (which ends with natural reserves of hardwoods), extensive agriculture (responsible for cutting down the forest for transformation into pasture), the construction of hydroelectric plants (which alters the ecosystem of rivers and nearby areas), indiscriminate hunting aiming at the removal of leather for commercialization, overfishing and extraction of plants destined for the pharmaceutical industry.

In some areas, animals, such as the white-lipped peccary, the manatee, the pirarucu, the turtles and the curassows have already been greatly reduced.

The “Red book of Endangered Brazilian Fauna” was developed in 2008[22] and updated in 2018[23]. In 2008, the book reported that the Amazon biome presented 24 threatened species. On the 2018 update, of the total endangered species in Brazil, 15.3% are found in the Amazon, representing 180. Of this total, 124 species are endemic to this biome.

ABC Norte has also conducted a Fauna monitoring report in the project area. Information is available below:

The Project area presents a very rich biodiversity. Fauna surveys conducted on the Project area indicated the presence of 15 species of medium and large mammals. Of the 15 species, the tamarin (*S. sciureus*) is endemic to the Amazon Forest. None of the species are on official lists of extinction threats, but the fox (*Cerdocyon thous*) and the scent tamarin (*Saimiri sciureus*) are present in Appendix II of CITES (Convention on International Trade in Species of Wild Flora and Fauna in Endangered)[24].

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[22] Available at < https://biodiversitas.org.br/wp-content/uploads/2021/06/Livro-Vermelho-BR-Vol-I.pdf> Last visit on: October 13th, 2021.

[23] Available at < https://www.icmbio.gov.br/portal/images/stories/comunicacao/publicacoes/publicacoes-diversas/livro_vermelho_2018_vol1.pdf> Last visit on: October 13th, 2021.

[24] CITES - Convention on International Trade in Species of Wild Flora and Fauna in Endangered. **Appendices**. Available on: <https://cites.org/eng/app/appendices.php>.

Also, 48 species were sampled, including amphibians, lizards and snakes. None of the registered species are on official lists of extinction threats. Some species such as *Rhinella marina* and *Rhinella major* can adapt more easily to modified environments, are more tolerant to environmental changes and are commonly found in modified environments, such as urbanized areas.

On the other hand, species that use litter like *Adenomera andreae*, *Rhinella margaritifera*, *Rhinella proboscídea*, *Ranitomeya ventrimaculata* and *Allobates femoralis* were recorded during the sampling, corroborating the significant non-alteration of the environment, especially *R. ventrimaculata* and *A. femoralis* which are individuals who need microhabitats with specific characteristics of environmental quality to survive. The presence of *Anolis fuscoauratus* and *Plica umbra* demonstrates that the area provides the necessary support for species maintenance, since they are arboreal lizards and do not support drastic changes in the environment.

Seasonality proved to be very significant in the composition of herpetofaunistic communities, mainly due to the formation of new niches, and conditions that allow the occupation and reproduction of some species, such as the case of Pithecopus hypochondrialis and Callimedusa tomopterna. However, the methodology restrictions on time-limited demand (PLT) justify the collection efficiency values below the expected for the area, thus not meeting its maximum potential.

Figure 12. Animals registered at the Project Area

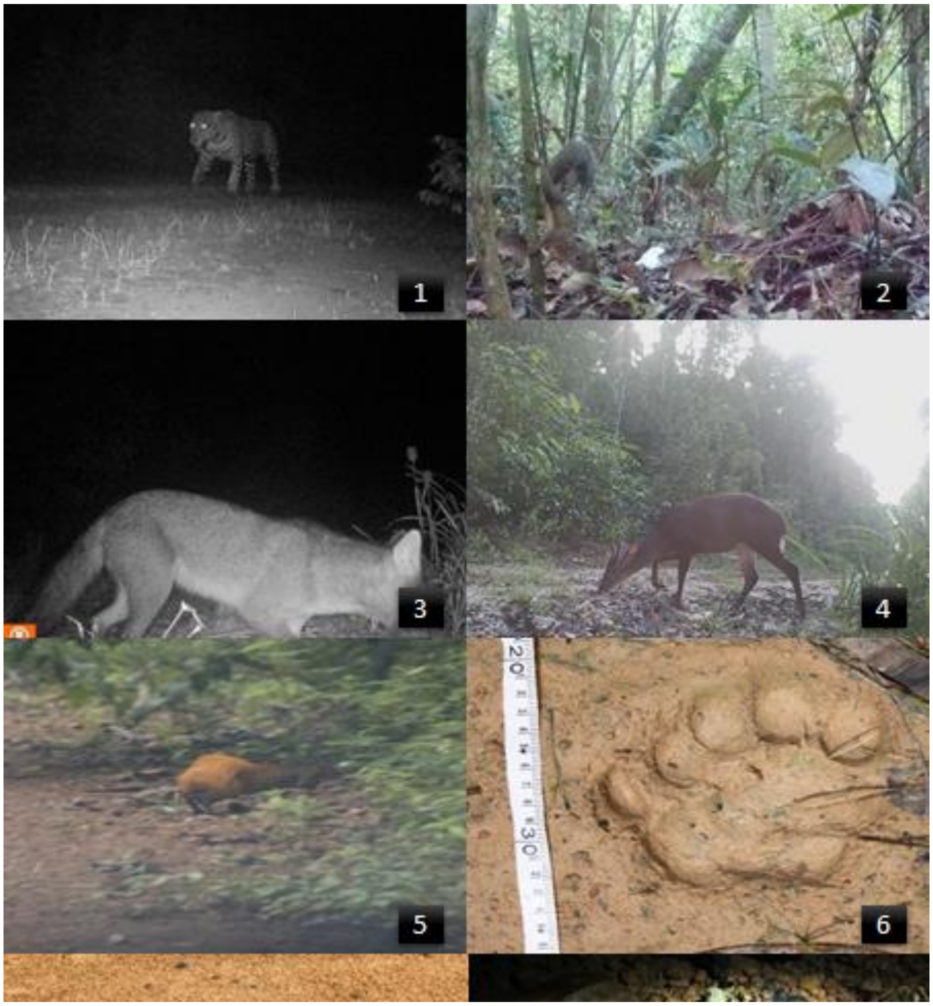


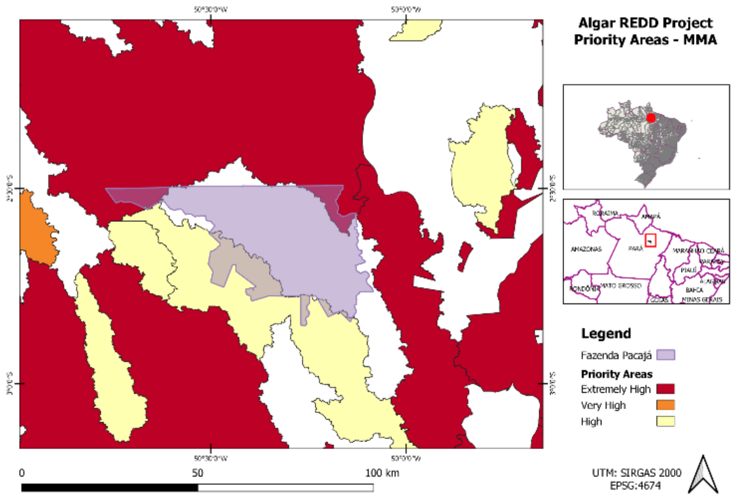
Figure 13. Animals registered at the Project Area

The Brazilian Government Ministry for the Environment classified the ABC Norte REDD project region in its 2018 survey of Brazil's priority areas for conservation[25]. The surroundings of the project area are mainly classified within the "very high" priority category, as detailed in figure below. This shows the importance of the present REDD project for the conservation of Brazilian biodiversity, creating an

[25] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). Brazilian priority areas for biodiversity conservation and sustainable use – 2nd update. Available at: <http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias>. Last visit on: October 8th, 2021.

ecological corridor for preservation of the fauna and flora species. Thus, the conservation of these private lands contributes to the Brazilian Government's conservation proposal.

Figure 14. Brazil's priority areas for conservation and the Project area



In terms of flora biodiversity, the vegetation within the project area itself was assessed by the Madeireira J&Y in a forest inventory[26]. To develop the evaluation of the potential of the area, data was sought through the Systematic Sample Inventory, a methodology that aims to collect information on species of interest, as well as biogeographic characteristics of interest in the field, where the execution was based on the points of paths to be traversed by opening between points, considering species with DBH greater than 30 cm, in a range of 50 m wide, being 25 m to the right and 25 m to the left.

Table 2 presents the list of the 20 main forest species found in the forest inventory, containing the common, scientific and family name.

However, the final analysis of the commercial class and which species will actually be harvested will be made in detail in each UPA and explained in the respective POAs because the current list does not contemplate future market variations or the company's work in the commercial development of lesser-known species.

Furthermore, as the forest inventory is sampled, during the census, some rare species may lose this status. On the other hand, some more abundant species may be rare in a given UPA.

The current species list should be considered as a reference and not as a final list of the number of species and their commercial class, as this process is dynamic.

[26] SILVA, Wiater Melo Melo da. Plano de Manejo Florestal Sustentável: Fazenda Pacajá. Belém: Aflora Engenharia, 2019. 106 p.

Table 2. Main forest species found in the forest inventory

Nome Vulgar	Nome Científico	Família
Acapú	*Vouacapoua americana* Aubl.	Fabaceae
Andiroba	*Carapa guianensis* Aubl.	Meliaceae
Angelim-Amargoso	*Vatairea fusca* (Ducke) Ducke.	Fabaceae
Angelim-Pedra	*Hymenolobium petraeum* Ducke.	Leguminosae
Angelim-Vermelho	*Dinizia excelsa* Ducke.	Leguminosae
Breu-Sucuruba	*Trattinickia burserifolia* (Mart.) Willd.	Burseraceae
Copaíba	*Copaifera langsdorfii*	Fabaceae
Cumarú	*Dipteryx odorata*	Fabaceae
Cupiúba	*Goupia glabra* Aubl.	Goupiaceae
Fava-bolota	*Parkia pendula* Benth. ex Walp	Leguminosae
Faveira	*Parkia decussata* Ducke.	Fabaceae
Guajará-bolacha	*Yzygiopsis oppositifolia* Ducke.	Sapotaceae
Jatobá	*Hymenaea courbaril* L.	Fabaceae
Jutaí	*Hymenaea coubarilL* (Hayne) Lee	Caesalpinaceae
Louro-Vermelho	*Nectandra rubra* (Mez) C. K. Allen	Lauraceae
Maçaranduba	*Manilkara huberi* (Ducke) Chevalier.	Sapotaceae
Mandioqueira-preta	*Ruizterania albiflora*, Marcano Bert.	Vochysiaceae
Maparajuba	*Manilkara bidentata*	Sapotaceae
Marupá	*Simarouba amara* Aubl.	Simaroubaceae
Matamatá-branco	*Eschweilera coriacea* (DC.) S.A.Mori	Lecythidaceae

Considering the current legislation for logging (IN 05 MMA, dated 11/12/2006), which allows logging of up to 30 m^3/ha, in a cutting cycle of 35 years and minimum cutting diameter (DMC) of 50 cm. The composition of the population, formed by important species for the timber sector, is also considered a good indication for this activity, where the frequency of species such as Maçaranduba (Manilkara huberi (Ducke) Chevalier), Cupiúba (Goupia glabra Aubl.) was recorded. Cracker Guajará (Yzygiopsis oppositifolia Ducke.) Sapucaia (Lecythis pisonis Cambess.) and Muiracatiara (Astronium gracilis Engl.) with good distribution, being present in practically all diameter classes, which favors management.
Therefore, the Northeast Amazon region has a great biological diversity and several environment types, in addition to the presence of endemic species of extreme importance to the conservation of Amazon biodiversity[27].

The ABC Norte REDD project therefore creates an important Northeast Amazon biodiversity corridor in a threatened and still unknown region. Preserving continuous forest environments is one way of ensuring continued gene flow of regional species and limiting the entrance of invasive species from other habitats.

Vegetation Cover

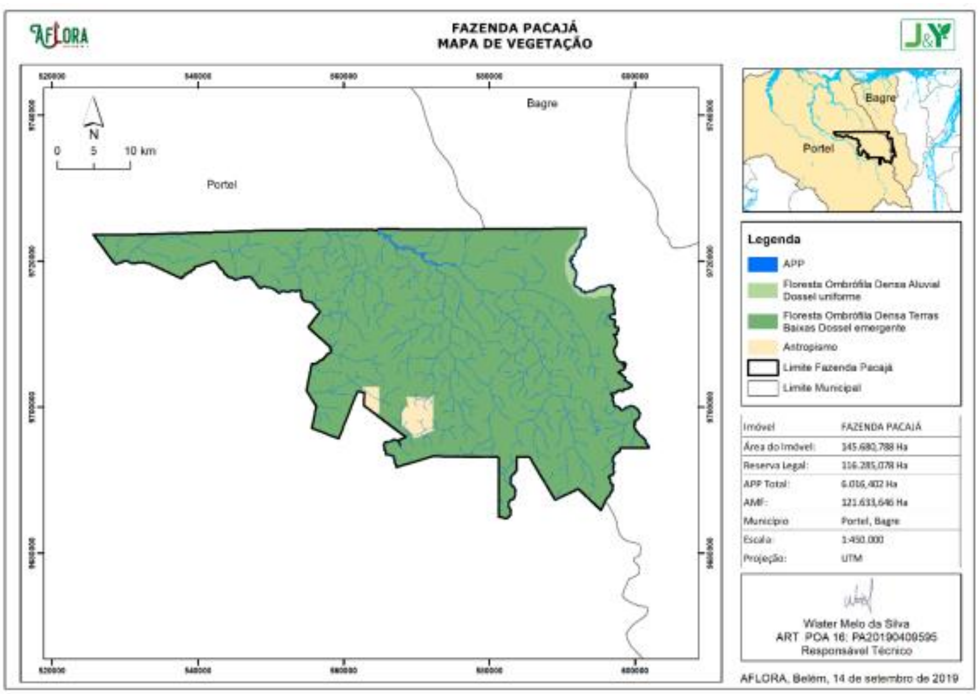
[27] Nelson, B.W. e A. A. Oliveira. 1999. Avaliação e Ações prioritárias para a Conservação do bioma Floresta Amazônia: Ações Prioritárias para a Conservação da Biodiversidade da Amazônia. Programa Nacional da Diversidade Biológica- PROBIO, MMA.

The project area is covered by native Amazonian vegetation, as per internationally accepted definition of forest. More information on the forest definition is available in section 3.3. The Region has several types of vegetation groups, which vary depending on the types of soils and water drainage.

The areas related to native vegetation are the most representative element in the region under study. They occur preferentially along the main hydrographic basins that cross the region. Thus, the regions of Portel and Bagre, comprise two large groups of forest cover, which are:

- Group 1 - Dense Ombrophilous Lowland Forest emergent canopy: Formation typical of the Amazon region is also known as rainy tropical forest. It is characterized by its large trees, usually with one or two species that protrude from the uniform tree layer, between 30 to 50 m height. It occurs in almost every area of Fazenda Pacajá.
- Group 2 - Alluvial Dense Ombrophilous Forest uniform canopy: The high floodplains have a greater diversity of species than the low floodplain and igapó. It has a low density of large trees. Most species have rapid growth. It has a good occurrence in the area covered by the Project, bordering rivers and streams.

Figure 15. Vegetation Cover of the Project Area



In general, the forest areas are of relevant interest to the economy of the municipalities, notably those related to the Dense Forest of Terra Firme, due to the presence of wood of high commercial value, such as tauari (*courati spp*), jarana (*Leeythis lucida*) and itaúba (M*ezilaurus itauba*), etc.

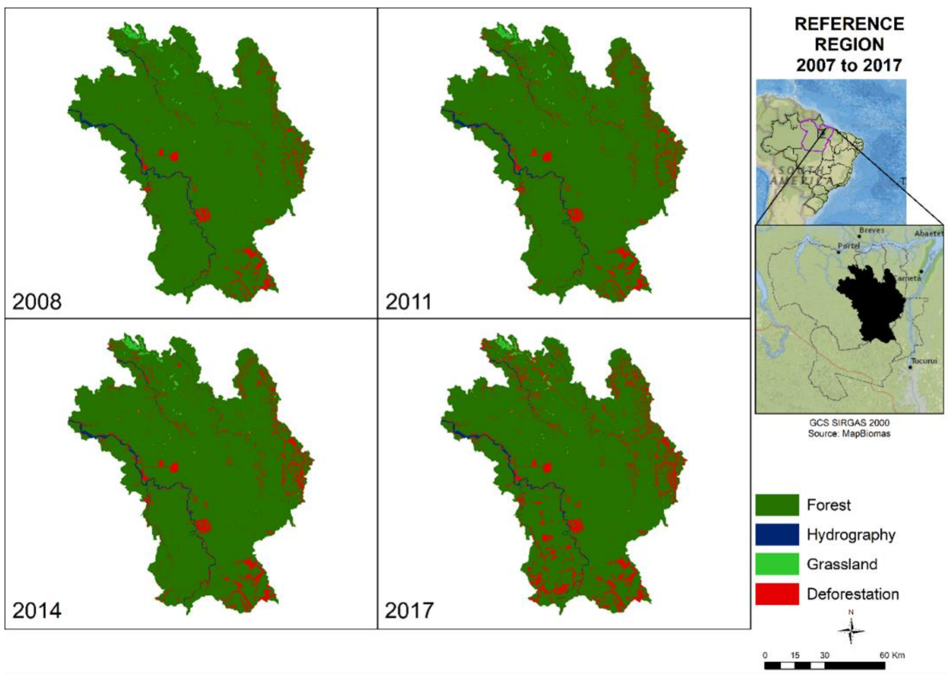
However, the final analysis of the commercial class and which species will actually be harvested will be done in detail in each UPA and explained in the respective POAs, as the current list does not include future market variations or the company's work in the commercial development of lesser-known species.

In addition, as the forest inventory is sampling, during the census, some rare species may lose this status. On the other hand, some more abundant species may be rare in a given UPA.

Therefore, the current species list should be considered as a reference and not as a final list of the number of species and their commercial class, as this process is dynamic.

Image below presents the comparison of deforestation and vegetation cover in the Reference Region during the historic period. It is possible to observe the advance of deforestation in the years prior to the project start date, indicating the land use change.

Figure 16. Deforestation in the Reference Region between 2007 and 2017



1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law Nº 12.651, 25/05/2012[28]), all rural estates located in forest zones shall 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, protecting the soil and ensuring the well-being of human populations

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

II - Legal Reserve: an area located within a rural property or possession which is required to be segregated, as well as the permanent preservation area, for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[29], eighty percent (80%) of a rural property should be preserved.

However, there is a clear disregard for legal conservation requirements in the region. Much of the deforestation occurs in areas that should be preserved.

One of the main ways to combat deforestation in Brazil is command and control mechanisms, such as effective monitoring, requiring compliance with environmental legislation along with a greater State presence. However, this does not seem to be implemented in most regions of the country, because of the government's tendency to disregard these responsibilities in comparison with other social goals and economic interests, which has put Brazil among the world's largest deforesters[30]. Given the approval of the new Forest Code (2012) and its general pardoning of those who deforested, a significant increase in annual deforestation rates has been observed[31].

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 commodity production and encourage land use for agricultural, bio energy and cattle breeding purposes have created a scenario of complete disregard for the mandatory provisions of the Forest Code. In addition, covering vast areas with low demographic density makes tracking of illegal activities and land surveillance very difficult for the authorities[32,33].

Moreover, according to PRODES, around 788,893 km² have been deforested until 2016, which is equivalent to 18.9% of the total Amazon biome area. Given the increasing deforestation trend observed in recent years, this data shows the non-compliance with the Legal Reserve requirement established by the Brazilian Forest Code.

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.

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[29] The concept of Legal Amazonia was originated in 1953 and its boundaries arise from the necessity of planning the economic development of the region. For this reason, Legal Amazonia's boundaries do not correspond to those of the Amazon biome. The former has an area of approximately 5 million km², distributed through the entirety or a proportion of 9 Brazilian states.
[30] FAO. **Global Forest Resource Assessment 2015**: Desk reference. Rome, 2015. 253 p.
[31] NOBRE, Antonio Donato. **O Futuro Climático da Amazônia.** São José dos Campos: Articulación Regional Amazônica (ARA), 2014. 42 p.
[32] 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.
[33] INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Reduções de Emissões do Desmatamento e Degradação Florestal (REDD+): Estudo de Oportunidades para a Região Sul do Amazonas. Manaus: Idesam, 2011. 45 p. (Relatórios Técnicos nº1).

As the project activity involves planned logging, it is important to describe compliance with applicable law.

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

The National Forest Code and Decree 5,975[34] also specifies the technical and scientific foundations of the PMFS (Article 31, 1st paragraph):

I. Characterization of physical and biological environment;
II. Determination of existent stock;
III. Exploitation intensity compatible with the forest's environmental support capacity;
IV. Cutting cycle compatible with the restoration time of the volume of product extracted from the forest;
V. Promotion of the natural regeneration of the forest;
VI. Adoption of adequate silvicultural system;
VII. Adoption adequate operating system;
VIII. Monitoring of the development of remaining forest;
IX. Adoption of mitigation measures for the social and environmental impacts.

In addition, the law also demands the fulfillment of obligations related to control and monitoring of the sustainable management. The company must submit an annual report to the environmental agency with information on the entire Sustainable Management Area and the description of the appliable activities and must be submitted to technical inspections to approve the operations and activities carried out in the management area.

The technical procedures for the preparation, presentation, execution and technical evaluation of sustainable forest management plans are regulated by IBAMA's Normative Instructions: 1, of 24/04/2007[35], 5, of 11/12/2006[36] and 2 – 27/06/2007[37]; in addition to CONAMA's Resolution 406, of 02/02/2009[38]

[34] Available at < http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm>
[35] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=113233>
[36] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=112909>
[37] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&force=1&legislacao=113306>
[38] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=114762>

The approval of the SFMP and expedition of environmental licenses is responsibility of the State Government, with law Nº6,462[39] and normative instructions IN 05[40], IN 08[41], IN 45[42] and IN 01[43]. After the SFMP approval, the company proceeds to the applicable Forest Management Licenses (AUTEX, in national level, and AUTEF, in Pará).

In this sense the preparation for REDD+ activities, programs and projects become essential for the Project Region, not only as a means to promote forest conservation, but also as a way to implement a new productive forest-based economy. This scenario needs to be reinforced because the areas in question hold incomparable biological and cultural diversity, with their traditional inhabitants marginalized from the process of economic development through capitalized livestock production.

Regarding other regulatory frameworks that exist in Brazil, on November 28th, 2019 occurred the approval of the Federal Decree 10,144/2019, which establishes the National Commission for Reducing Emissions of Greenhouse Gases from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+[44].

The development of this Project is not in conflict with such Decree. It is important to clarify the difference between Law and Decree in Brazil. The Brazilian Federal Constitution establishes the principle of legality for all the national territory, according to the text of article 5, item II "no one shall be obliged to do or not to do anything other than by virtue of law."

Law is an infra-constitutional (sub-constitutional) norm, it is a mandatory rule by the coercive force of the legislative power or of legitimate authority, which constitutes the rights and duties in a society. Law is different from Decree.

Decrees, on the other hand, are administrative acts, issued by the Chief Executive (president, governor or mayor), with the main objective of regulating and detailing a law, in order to grant it the necessary means for its faithful execution, without, however, being able to contradict any of its provisions or to innovate the Law.

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

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39 Available at <https://www.semas.pa.gov.br/legislacao/files/pdf/506.pdf> Last visit: 02/07/2021

40 Available at <https://www.semas.pa.gov.br/2015/09/11/in-05-de-10092015-publicada-no-doe-32969-de-11092015-paginas-de-37-57/> Last visit: 02/07/2021

41 Available at <https://www.sistemas.pa.gov.br/sisleis/legislacao/1306>

42 Available at <https://www.semas.pa.gov.br/2010/05/13/10968/>

43 Available at <https://www.semas.pa.gov.br/2014/01/14/in-0012014-de-10-de-janeiro-de-2014-publicada-no-doepa-no32563-de-14012014-caderno-5-paginas-6-7-8/> Last visit 02/07/2021

44 The Decree is available in Portuguese at: <http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm#art12> Last visited on August 6th, 2021.

Thus, Decree 10,144/2019[45] only limits the Federal Government's understanding of what shall be accounted for in order to comply with mitigation commitments of other countries to the United Nations Framework Convention on Climate Change. It does not impose a barrier or obstacles to the implementation of REDD projects and the commercialization of carbon assets generated from these projects. This consideration in the Decree does not affect or interfere with the voluntary or regulated carbon market, domestic or international.

There is no law in Brazil that does not allow or restrict the execution of REDD projects or that does not allow or restrict any commercial transaction of assets resulting from REDD projects. On the contrary, such transactions are valid and legally permitted. Thus, there is no contradiction or irregularity between the ABC Norte project and such Decree.

1.15 Participation under Other GHG Programs

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

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

1.15.2 Projects Rejected by Other GHG Programs

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

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project does not participate in any other trading program or other binding limits.

1.16.2 Other Forms of Environmental Credit

The project area has not created any other form of environmental credit. This project has not been registered in any other credited activity.
The project does not intend to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under this VCS project.

1.17 Additional Information Relevant to the Project

Leakage Management

[45] Available at <http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2019/decreto/D10144.htm>

The leakage management plan and a map of the leakage management area are located in section 3.3 - Project Boundaries, of the present VCS PD.

Besides forest conservation, the present project aims to improve and quantify its social and environmental benefits through application of the SOCIALCARBON® Methodology. In combination with the leakage management plan, it is expected that the social and environmental performance of the present project will have long-term effectiveness, thus reducing the leakage risk. The SOCIALCARBON methodology uses a set of analytical tools that assess the social, environmental and economic conditions of communities affected by the project and demonstrates the project's contribution to sustainable development through continuous monitoring.

Commercially Sensitive Information

No sensitive information has been excluded from the public version of this VCS PD.

Sustainable Development

The primary objective of the ABC Norte REDD Project is to avoid the unplanned deforestation (AUD) of the 140,432.27 ha project area, consisting of 100% Amazon rainforest. The Project also has the function of establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Amazon biodiversity and also to climate regulation in Brazil and South America.

These measures contribute to several nationally stated sustainable development priorities, such as the objectives from the Brazilian Government related to the UN Sustainable Development Goals (SDGs)[46] and the Nationally Determined Contribution (NDC).

In Brazil, the National Commission for Sustainable Development Objectives (CNODS) is responsible for internalizing, disseminating and providing transparency to the process of implementing the 2030 Agenda for Sustainable Development in Brazil[47]. The Commission is made up of eight government representatives (Government Secretariat of the Presidency of the Republic; Civil House of the Presidency of the Republic; Ministry of Foreign Affairs; Ministry of Citizenship; Ministry of Economy; Ministry of Environment; representative of the state/district levels; representative of the municipal level) and by eight representatives of civil society and the private sector. The monitoring of the country's advances in relation to the SDGs established as priorities is carried out by the Institute of Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE), which are also permanent technical advisory bodies.

There is no monitoring at the specific level of projects, and progress at the national level can be accompanied by the synthesis report carried out by IBGE [48] and by the IPEA reports[49]. In addition, in 2018

[46] UN's Sustainable Development Goals and targets available at: <https://sdgs.un.org/goals> Last visited on October 22nd, 2021.
[47] More information on the CNODS avaliable at < https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/comissao-nacional-para-os-objetivos-do-desenvolvimento-sustentavel-cnods> Last visited on November 22nd, 2021.
[48] Available at < https://odsbrasil.gov.br/relatorio/sintese> Last visited on November 22nd, 2021
[49] Available at < https://www.ipea.gov.br/ods/publicacoes.html> Last visited on November 22nd, 2021

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

The ABC Norte REDD Project main contributions to the Brazilian priority goals are listed below[50]. These contributions are monitored by the parameters defined by the REDD project, in addition to additional standards, such as CCB[51] and SOCIALCARBON. For more information, please consult the applicable social benefit report:

- SDG 1: No poverty.

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

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

- SDG 2: Zero hunger.

The project aims to expand training related to the management of non-timber forest products. The local community maintains a small production of cassava flour, copaiba oil and *açaí*, which is used for sale and exchanges for other supplies, non-timber forest products are used mainly for subsistence purposes. The project itself enhances better management of non-timber forest products as, through the carbon credits sales, qualifies investments in the local community training and capacity building programs.

[50] Available at < https://odsbrasil.gov.br/> Last visited November 22nd, 2021.
[51] CCB Standard will be applied in future monitoring periods

Likewise, strengthen ecosystem conservation and preservation. This SDG is monitored in the Financial resource (7. Alternative income source) and Biodiversity (13. Non-timber forest products (NTFPs) in the SOCIALCARBON Report. Guideline targets are:

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

- SDG 3: Good Health and Well-being.

The ABC Norte REDD Project maintains a partnership with the city hall for social assistance actions, donation of hypochlorite for water treatment in communities and visits together with a health professional for guidance. Beyond that, the project intends to implement an Occurrence Registration Form, to monitor and inform the local health center about the facts reported by the riverside communities and also offer sports-oriented activities, especially for children in the communities.

This SDG is monitored in the Social Resource (2. Expansion of community activities) and Human (5. Public health) in the SOCIALCARBON Report. Therefore, this project is aligned with the target below:

- 3.3 “By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases”.

- SDG 4: Quality education.

The project aims to invest in education for the communities affected by the project, such as basic education, professional training, environmental education, among others.
The carbon project encourages the local communities to participate in courses regarding technical skills, basic education, professional training, environmental education, among others. Moreover, the carbon project encourages the development of partnerships with educational entities striving for socioenvironmental scholarly initiatives. This SDG is monitored in the Social resource (2. Expansion of community activities), Human (6. Community education and training), Financial (11. Social and environmental investments), and Carbon (17. Stakeholder consultation) in the SOCIALCARBON Report. The targets determined by the UN that will act as a guideline for monitoring actions are:

- 4.1 “By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes”;
- 4.4 “By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship”;
- 4.5 “By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations”;
- 4.6 “By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy”;

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

- SDG 5: Gender equality.

The Socioenvironmental Responsibility Program developed by the project elaborates different activities with the communities, on which the majority public is made up of women. Although so far there are no specific activities on women's empowerment and independence, there are women in the leadership of all communities, so they are already integrated into the decisions. Furthermore, the project intends to develop a cycle of lectures and training aimed exclusively at the female audience, with themes on gender inequality, domestic violence, and encouraging actions that develop professional activities to generate income.
The carbon project expects a continuous improvement concerning women's inclusion, such as through sponsoring events and initiatives which promote a gender equality environment. This SDG is monitored in the Social resource (1. Women inclusion, 2. Expansion of community activities, 3. Associations and Cooperatives), in the SOCIALCARBON Report. Thus, the project may have initiatives that contribute to the following targets:

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

- SDG 6: Clean water and sanitation.

As aforementioned, the project maintains a partnership with the city hall for donation of hypochlorite for water treatment in communities. This SDG is monitored in the Human Resource(5. Public health) Therefore, the ABC Norte project directly contributes to the target:

- 6.1 “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”;

- SDG 8: Decent work and economic growth.

The project offers workshops, lectures and education for the local communities, as well as trainings for other alternative sources of income, such as pisciculture, agroforestry and poultry farming. Besides the training, they started the production, as well as the construction of the infrastructure necessary for each activity. The REDD project aims to offer training and income generation in the project region as a measure to conserve native forest standing and promote economic viability and growth in the local communities.

This SDG is monitored in the Social resource (3. Associations and Cooperatives), Human (6. Community education and training), Financial (7. Alternative income sources), Natural (11. Social and environmental investments), Biodiversity (Non-timber forest products (NTFPs)) in the SOCIALCARBON Report. Guideline targets are:

- 8.3 "Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services";
- 8.6 "By 2020, substantially reduce the proportion of youth not in employment, education or training";

- SDG 12: Ensure sustainable production and consumption patterns.

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

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

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

Another of the main objectives of the REDD project is to reduce greenhouse gas emissions through the conservation of standing forest. Thus, its activity is already an action to combat climate change and its effects. In addition, the project stimulates biodiversity monitoring initiatives in a measure to combat climate changes. This SDG is monitored in the Biodiversity (14. Biodiversity monitoring, 15. Impact on remaining flora) and Carbon (16. Buffer reduction, 18. Project performance) resources in the SOCIALCARBON Report. The targets and guidelines for this objective are:

13.2 "Integrate climate change measures into national policies, strategies and planning";

- 13.3 "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning";

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

The project is based on the conservation and restoration of forests in the Amazon biome, ensuring forest services, preservation of natural resources and biodiversity. This SDG is monitored in the Natural (11. Social and environmental investments) and Biodiversity (14. Biodiversity monitoring, 15.

Impact on remaining flora, 15. Impact on remaining flora) resources in the SOCIALCARBON Report. The targets and guidelines related to this objective are:

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

Reducing deforestation and promoting sustainable development in the Amazon is also a key component to Brazil’s Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, Ministério do Meio Ambiente), the implementation of REDD+ activities are an important component to meet the Country’s contribution under the United Nations Framework Convention on Climate Change while preserving natural forest resources[52].

The following components of the Brazilian commitments under the Convention are reinforced by the development of the ABC Norte REDD Project:

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

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

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

In addition, beyond the project's ecological and carbon benefits, the implementation of REDD and SOCIALCARBON mechanisms together with CERFLOR seal promotes sustainable forest use. Beyond the project's ecological and carbon benefits, a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project region, specifically contributing to improving deforestation control, and developing environmental education and other social activities.

SOCIALCARBON methodology will serve as a plan and guideline for carrying out activities and achieving goals, in addition to assessing progress in each monitoring period. In this way, the owners are committed and add value to the carbon project with each action taken, encouraging long-term sustainable development.

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

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

ABC Norte has conducted a social and economic impact assessment of the sustainable forest management carried out within the Project Area in 2020[53]. The diagnosis was developed by UPBIO Soluções Ambientais for ABC Norte, within the scope of the Social and Environmental Responsibility Program of Fazenda Pacajá. The assessment included consultations with local stakeholders, who were asked about their impressions on the expected impacts related to ABC Norte activities.

The diagnosis presents official data and primary information referring to the municipality of Portel and the riverside communities addressed by the Social and Environmental Responsibility Program at Fazenda Pacajá, in addition to a territorial socioeconomic trait.

There are 13 communities in the reference region, 5 of which were analyzed by this study. According to the study, those communities are distributed mainly on the banks of the Pacajá and Jacundá rivers. These 5 communities add up to approximately 99 families, with an estimated population of 495 people. With the income generated by the carbon project, ABC Norte will expand this socio-environmental diagnosis to the other 8 communities in its surroundings.

The table below provides details on the identified potential risks:

Table 3. Main social, economic and environmental impacts of the ABC Norte REDD Project

Activity	Aspect	Impact	Effect		Comments/ Observation
			Beneficial	Adverse	
REDD: Carbon credit project	Environmental - Conservation of Amazon Rainforest	Greenhouse Gas Emissions Reductions	X		Monitored by the Carbon resource: ● Project performance Monitored by the Natural resource: ● Quality control
REDD: Carbon credit project	Environmental - Conservation of Amazon Rainforest	Monitoring and supervision to avoid deforestation of forest within the project area.	X		Monitored by the Biodiversity resource: ● Impact on remaining flora Monitored by the Natural resource: ● Quality control
REDD: Carbon credit project	Social - Conservation of Amazon Rainforest	Conflict management with communities in the project area, due to banning of timber product extraction.		X	Monitored by the Carbon resource: ● Stakeholder consultation Monitored by the Human resource: ● Conflict management

REDD: Carbon credit project	Social/Economic - Empowerment	Increased independence of the communities in the project area.	X		Monitored by the Social resource: ● Associations and cooperatives ● Expansion of community activities ● Women inclusion Monitored by the Human resource: ● Community education and training Monitored by the Financial resource: ● Alternative income sources Monitored by the Natural resource: ● Social and environmental investments Monitored by the Biodiversity resource: ● Non timber forest products (NTFPs)
REDD: Carbon credit project	Social/economic - Application of the Social Carbon methodology	Encouragement and investment in social, economic and environmental aspects in the project region.	X		Monitored by the Social resource: ● Expansion of community activities Monitored by the Human resource: ● Community education and training Monitored by the Financial resource: ● Carbon credit benefits Monitored by the Natural resource: ● Social and environmental investments Monitored by the Carbon resource: ● Project performance

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

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

Table 4. Significant risks to the project

Activity	Aspect	Risk	SOCIALCARBON Indicators that will monitor the identified potential risks
REDD carbon project	Environmental - Uncertainties relating to standing forest in the future.	Non permanence of carbon: Time which carbon will remain stocked in live biomass, without being emitted into the atmosphere. Due to the uncertainties related to what will happen to the forest in future, there is a risk of non-permanence of forest carbon.	Monitored by the Carbon resource: • Buffer reduction
REDD carbon project	Environmental/Social - Land demarcation process	Risk of land invasion by deforestation agents	Monitored by the Natural resource: • Land Tenure Monitored by the Human resource: • Conflict management
REDD	Environmental - Sustainable forest management plan	Risk of non-performance of the sustainable forest management plan	Monitored by the Financial resource: • Alternative income sources Monitored by the Biodiversity resource: • Non timber forest products (NTFPs)

These risks will be monitored as part of the monitoring report described on the section Monitoring Plan of this VCS PD and also as part of the monitoring of the non-permanence risk, which shall be evaluated at each verification event. Nevertheless, this risk will also be assessed by the SOCIALCARBON Indicator described on the last column of the table above.

Negative environmental impact will be mitigated and assessed as described in section 2.3. Any social conflict regarding the project will be assessed following Algar and ABC's Code of Conduct, and the Security Procedures detailed in section 5.3 Monitoring Plan. ABC Norte works to resolve conflicts based on conversation and the promotion of basic and environmental education. In this way, the REDD project itself and the expansion of the Social Responsibility Program conducted by the company are ways of mitigating conflicts and maintaining good relationships with the communities.

2.2 Local Stakeholder Consultation

It is important to highlight that, despite the project start date is September 2017, the first formal consultation on the carbon project was held in 2021. However, one of the main activities carried out by ABC Norte, related to the development of the REDD project, was the rapprochement with the communities, and carrying out diagnoses, both for the evaluation of suggestions and comments on the conduct of the management plan, social management and illegal activities in the surroundings of Fazenda Pacajá, as well as to understand the needs and needs of the families. These consultations and technical visits started in 2017.

For the REDD Project consultation, the main stakeholders of this project are:

- The communities living within the Reference Region and Project Area
- ITERPA
- UP Bio
- Prefeitura de Portel
- J&Y
- JPR
- Secretaria Estadual de Meio ambiente e Sustentabilidade
- Secretaria Municipal de Meio Ambiente - Portel
- Secretaria de Educação de Portel
- Grupo Martins
- NBX Florestal
- AMPLA Consultoria
- M&D Advogados
- Instituto Nacional de Colonização e Reforma Agrária (INCRA)
- WWF – Brazil;
- Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais (IBAMA).
- Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio);

- Serviço Florestal Brasileiro
- Programa Municípios Verdes
- CEPAM
- Sysflor
- UFRA
- IFT Pará

Due to the worldwide Corona Virus pandemic that was established in 2020, security and protection measures had to be taken to carry out the consultation with stakeholders. To contain new cases and avoid agglomerations, stakeholder consultation was carried out remotely during this validation. Thus, the Stakeholder consultation was divided in two steps: an online meeting and a local consultation with the community within and near the project instance area, where the leakage management area was defined.

To stakeholders located in urban areas, mostly government agencies, an explanatory letter was sent, briefly presenting the project. Moreover, they were also invited to attend a remote conference, with an email as a reminder for the meeting. The invitation letter and e-mail are shown below.

Figure 17. Invitation letter to the remote consultation

Ecológica

CONVITE ÀS PARTES INTERESSADAS

Projeto Algar REDD Project

Assunto: Apresentação da Ecológica Assessoria Ltda. – Projeto Algar REDD Project

Prezado (a),

Vimos por meio desta informar V. Sa. sobre o desenvolvimento de um projeto de reduções de emissões de gases de efeito estufa por preservação da floresta amazônica. O projeto Algar REDD Project, localizado em Portel, município do estado do Pará, tem como principal objetivo evitar o desmatamento não planejado (REDD AUD) na área do projeto de 145.680,78 ha. O projeto está em consonância com as diretrizes e critérios de desenvolvimento sustentável do país.

Com esta iniciativa, a ABC Norte e Ecológica Assessoria Ltda. visam mitigar de forma voluntária os impactos ambientais provocados pelos gases liberados por meio do desmatamento da Floresta Amazônica, além de gerar benefícios socioambientais para a região do projeto com a aplicação da metodologia do Carbono Social, impactando positivamente o ecossistema local.

O Projeto encontra-se na fase de validação, para posteriormente ser apresentado ao standard sob o qual foi desenvolvido, Verified Carbon Standard (VCS/Verra), atendendo aos procedimentos estabelecidos pelo mesmo para a geração de créditos de carbono através da redução voluntária de emissões.

Assim, a ABC Norte e a Ecológica Assessoria Ltda. entram em contato com as partes interessadas para divulgação deste projeto e convidá-lo a participar de uma videoconferência no dia **13 de julho de 2021, às 16:00 horas (horário de Brasília).** A conferência será realizada através da Plataforma Google Meets, que poderá ser acessada neste dia e horário através do link: https://meet.google.com/mjs-soxa-syc. Informamos que também enviaremos o convite via e-mail.

A partir da data aqui proposta para a videoconferência, estará aberto o período para solicitações de informações e envio de comentários sobre o relatório técnico do Projeto Algar REDD Project. O prazo para comentários é de 30 dias a partir da realização da Apresentação do Projeto (até 14 de agosto de 2021). Para mais informações e solicitações, favor entrar em contato através de marcelo@ecologica.earth ou por correios para Rua Dr. Bacelar, 368, cj 23, CEP 04026-001, São Paulo-SP, Brasil.

Consulta às partes interessadas – Algar REDD Project

Terça-feira, 13 de julho · 16h até 17h (horário de Brasília)

Informações de participação do Google Meet

Link da videochamada: https://meet.google.com/mjs-soxa-syc

Ou disque: (BR) +55 11 4949-3179 PIN: 385 112 156#

Atenciosamente,

Stefano Merlin

Ecológica Assessoria Ltda.

Figure 18. Invitation e-mail to the remote consultation


ALGAR REDD PROJECT

Ecológica

ABC NORTE

Não se esqueça!

A Ecológica Assessoria Ltda. e a ABC Norte vem por meio deste lembrá-los que no dia 13 de julho, às 16h (horário de Brasília) ocorrerá a reunião para apresentação e consulta às partes interessadas do Projeto REDD Algar.

A conferência será realizada online na Plataforma Google Meet. Contamos com a sua presença, sua opinião será importante para desenvolver um projeto alinhado ao Desenvolvimento Sustentável.

Clique aqui para participar

A partir da data proposta, estará aberto o período para solicitações de informações e envio de comentários sobre o relatório técnico do Projeto Algar REDD Project. O prazo para comentários é de 40 dias a partir da realização da Apresentação do Projeto (22 de agosto de 2021). Para mais informações e solicitações, favor entrar em contato através de mh@ecologica.earth.

Atenciosamente,

Stefano Merlin
Ecológica Assessoria Ltda.

Furthermore, in general, these consultations also communicated:

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

During the Local Stakeholder Consultations, no comments or suggestions regarding the project design were made, and thus, no modifications were made in the PDD after the meetings.

A detailed description of each consultation is provided below:

<u>Local Stakeholder Consultation – Online consultation</u>

The online local stakeholders' consultation was held on 13-July-2021, at 4pm (Brasília time zone) on a Virtual Conference Platform.

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

The online meeting was attended by several actors, among them: Upbio Soluções Ambientais, Sustainable Carbon, Instituto Ecológica Palmas, Chico Mendes Institute for Biodiversity Conservation (ICMBio) and National Institute of Colonization and Agrarian Reform (INCRA). Stakeholders were very interested in the project, promoting a great discussion at the end of the presentation. No negative comments were made about the project.

The presentation described the main actions taken by ABC Norte to formulate the carbon project, such as certified forest management and social and environmental activities. In addition to the introduction of the company's activities, the carbon project development process, deforestation monitoring and projection methods, project area, reference region, leakage belt, etc. were also explained. The Social Carbon Standard, its co-benefits, monitoring methods and methodology were also explained, as well as the relationship with the UN's Sustainable Development Goals.

Comments received are summarized in table below:

Table 5. Summary of comments made during the remote Stakeholder Consultation

Stakeholder/actor	Comments
Environmental Analyst of DIMAN/ICMBio – Board of creation and management of protected areas. ICMBio is an autarchy created on August 28, 2007, by Law 11,516, and is linked to the Ministry of Environment and is part of the National Environment System (Sisnama)[54]. The Institute carries outactions of the National System of Conservation Units, and is able to propose, implement, manage, protect, inspect and monitor the Protected Areas established by the government. It is 57esponsible to foster and execute programs for research, protection, preservation and conservation of the biodiversity and exercise the power of environmental police to protect federal Conservation Units.	The environmental analyst explained his opinion on the importance of REDD+ projects and the voluntary carbon market. He pointed out that he only knew how the cutting cycle works, where an exploited area can be managed again only after the cycle is completed (in Fazenda Pacajá's case, 30 years). He asked about the calculation of the volume of avoided deforestation emissions and the sale of credits. It was explained that the Project is categorized as AUD (Avoided Unplanned deforestation), and that this category includes projects with or without sustainable forest management plan. The carbon calculation is performed from the deforestation reduction. The deforestation is projected for the entire duration of the project and compared with the actual deforestation during project monitoring. Emissions from the forest

[54] Available at < https://www.icmbio.gov.br/portal/oinstituto>

	management are discounted from emission reductions and are called project emissions. Ecológica Assessoria also added that there are about 20 REDD projects in Brazil, and 4 of them with forest management. Due to the greater valuation of carbon credits, there is a tendency to value standing forests instead of areas with forest management, with the carbon credit starting to have a valuation close to certified legal wood. The presentation material, with information about the project, was sent to ICMBio.

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

<u>Local Stakeholder Consultation – Communities consultation</u>

The consultation with stakeholders (riverside community) took place from 25 – 27 June 2021, visiting the 5 communities that are reached through the Socio environmental program. The meeting had a simplified presentation about the project, exposing the risks and benefits resulting from the project activities for the riverside population. The project's location, context of climate change and the threat of deforestation were discussed with the communities in an informal conversation, with the ribeirinhos sharing their perceptions and experiences on the subject. The report with the summary of the meeting and comments from the stakeholders will be made available to the VVB.

Table 6. Summary of meetings and inputs to the ABC Norte REDD Project

Date	Stakeholders/actor	Comments
25/Jun/2021	Cipoal Community	18 members of this community attended the meeting. They showed interest in knowing what was done in other projects, to have examples of actions that this type of project can carry out with the communities. The community already has a fish farming project, which is being very positive for the generation of income and training of the community. Their main demand is the renovation of the school and resumption of classes (ABC Norte has already committed to donating construction material). There were no comments against the project, they thought it was a good initiative by ABC Norte and

		they hope that the socio-environmental work with UPbio will grow even more.
25/Jun/2021	Nossa Senhora do Carmo Community	9 adults and 5 children attended the meeting. The community members demonstrated a lot of interest in the project and pointed out that the project's success will be positive to bring new activities to the community. They asked about what other projects can be developed to generate carbon credits, such as reforestation, agroforestry systems, etc.
26/Jun/2021	Divino Espírito Santo Community	After the project was presented, the eight meeting participants asked how the credit can help communities and how they can help secure this resource for them. It was answered that part of the sales of credits will be directed towards improvements in activities that are already developed with the communities, which can help with the work and maintenance of the forest, which will generate even more credits. The possibility of the community supplying seedlings for ABC Norte to carry out the reforestation of the areas, chocolate production, courses and training aimed at other productions, etc., was discussed. As the main demand, they commented on the lack of opportunities for young people and children, who have to leave the community to study and have better living conditions. They would like to be more organized as a community and expand the opportunities for these young people to come back and apply knowledge in the communities.
26/Jun/2021	Cristo Salvador Community	Those present commented that they had already heard about the greenhouse effect and global warming. They noticed differences in heat and working hours, because of the sun's heat. They pointed out that the deforestation from the communities is for sustenance and survival, but that they agree that there is aggression and impacts on nature. They liked the project's initiative and the possibility of expanding the company's actions with the communities. They would like the

		resources to collaborate to reduce the impacts generated by the communities, in addition to generating employment and more security.
26/Jun/2021	ABC Norte employees - Vila ABC	The employees asked about what benefits it could provide the village. They commented on the need for electricity and improvements in the health center, mainly. They were very interested in the project and looked for more folders to get in touch with the companies and find out more details.
27/Jun/2021	Monte Siao (Santa Terezinha) Community	The community confirmed that they feel a difference in the climate and the need to minimize impacts on nature. Currently, the community carries out aviculture activity. With the carbon resource, they hope to be able to start fish farming. As the main need, they asked for job creation in the ABC itself for the management.

In addition, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. During the visit, an informative folder was distributed, containing address, e-mail and telephone number of Ecológica Assessoria and ABC Norte. Thus, the channel is available for any comment, suggestion or criticism. These will be registered and forwarded to the responsible part. In addition, the communities also have contact with the Social Responsibility Program team through message app, besides the monthly visits held by the program.

It is important to state that all relevant laws and regulations covering workers' rights in Brazil are followed by ABC Norte and are communicated to each employee upon hiring[55].

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

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

[55] Applicable Brazilian legislation for workers' rights is available in Law nº 5,452 < http://www.planalto.gov.br/ccivil_03/decreto-lei/del5452.htm> and NR-31 from the Work Ministery < https://www.gov.br/trabalho-e-previdencia/pt-br/composicao/orgaos-especificos/secretaria-de-trabalho/inspecao/seguranca-e-saude-no-trabalho/normas-regulamentadoras/nr-31-atualizada-2022-retif.pdf>

2.3 Environmental Impact

ABC Norte has developed a sustainable forest management plan to define technical criteria and procedures for their forest operations on the Project Area. As part of this SFMP, the following environmental impacts and measures to mitigate them were identified:

1. Soil (erosion, compaction and drag)
    a. In inclined areas, do drainage modifications at the beginning of slope, especially in the rainy season, to avoid water running through the road and thus avoid erosion;
    b. Build trenches, passages and manholes in rainwater targeting for areas marginal to roads;
    c. Operational training of employees involved in operations;
    d. Use of equipment developed for forestry operations, characterized by undercarriage equipped with low pressure tires or mats;
    e. Avoid soil removal;
    f. Limit the number of trees dragged by extensions, minimizing soil compaction.
2. Obstruction of streams
    a. Observe if it is necessary to build bridges or manholes. When building bridges, special care should be taken to prevent damming water, erosion and damage to protection areas;
    b. Avoid pushing soil into the watercourse, cleaning the watercourse, removing any wood reside that may prevent passage of water;
    c. Build retaining walls to avoid clogging the watercourse;
    d. Utilize base map during planning, allowing better visualization of protection areas, risk areas and to avoid transposition
3. Environmental impacts on port area
    a. Training and lectures on environmental education and capacitation for employees and providers involved in operations;
    b. Repair in possible soil damage.
4. Damage to remnants, protected species and protection areas.
    a. Road planning with aid of the base map, visualizing location of species.
    b. Identify the remnants and the protected species on the cut and drag map;
    c. Special cut techniques;
    d. Plot the inventory microzoning on the cut and drag maps;
    e. Preserve nest trees, or that serve as reproduction for the fauna.
5. Impacts on the soil due to fuel and lubricant spills.
    a. Inspection and periodic maintenance of chainsaws
    b. In case of leakage, use soil to absorb the fuel.

c. Training for employees involved in operation.

All actions that cause direct and indirect impacts on the environment, must be monitored and addressed to the related mitigating measures. Similarly, it should be noted that teams, both management and field, should be properly trained to employ natural resource management methodologies to minimize impacts and costs, in addition to the use of low impact exploration techniques in order to minimize the damage caused to the remaining species, to the soil, hydrography, air and fauna. The diagnoses carried out and the data from the inventory and the permanent parcels will offer the primary data for later monitoring.

2.4 Public Comments

No negative input or comment was received during the public comment period. During the Local Stakeholder Consultations, no comments or suggestions regarding the project design were made, and thus, no modifications were made in the PDD after the meetings.

2.5 AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

According to the VCS Standard, version 4.0, the project proponent shall conduct a thorough assessment of the local stakeholders that will be impacted by the project, including:

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

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

According to the local social diagnosis, there are riverside communities directly affected by the project. It is important to note that environmental and social activities carried out by the project will try to benefit all families present in this area. It will be ensured that the project activity does not adversely affect their way of life.

The project and actions involving the community will be monitored by SOCIALCARBON indicators at each verification event, which will analyze the extent of alternative income generation sources and further programs and alternative income sources, besides the applied methods for local stakeholders' consultation.

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

ABC Norte recognizes the presence of the communities around the project area, and since 2017, takes efforts to maintain a healthy relationship with them. Since 2017, the company conducts a

Socio Environmental program to offer benefits and independence to these communities, mitigating illegal deforestation.

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

The Decree No. 6,040 of February 7, 2007[56], called National Policy for the Sustainable Development of Traditional People and Communities, has the specific objective of promoting the aforementioned "sustainable development" with an emphasis on the recognition, strengthening and guarantee of their territory, social rights, environment, economic and culture. It also advocates the respect and appreciation of the identity of traditional people and communities, as well as their forms of organization and their different institutions[57].

The Policy is structured around four strategic axes:

1. Access to Traditional Territories and Natural Resources
2. Infrastructure
3. Social Inclusion and
4. Promotion and Sustainable Production.

As previously described in section 1.17, these are also the objectives and guidelines of this REDD Project.

Article 215 of the Brazilian Constitution determines that the State will guarantee the full exercise of cultural rights. And as distinctive signs of the identity of the different groups that form Brazilian society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[58].

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

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

As stated in item 1, project stakeholders involve from government agencies to the resident community inside and outside the project area. Thus, by applying different forms of consultation,

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

it is considered that the project covers the social, economic and cultural diversity of the different stakeholders.

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

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

According to the Socio-economic report, it was identified that, among the estimated population of 495 people, divided into 99 families, there are 76% adults, 22% children and 2% of people with special needs (PNE). The communities were formed, in their majority, by matriarchs and patriarchs, each community being identified with the name of its patron Saint, in which 79% of the residents of the communities are catholic.

Each community has a leader, responsible for conducting religious services and local festivals. In each community there is a chapel for the celebration of worship, whether Catholic or Protestant and a community shack where meetings and religious parties are held.

The economic activities of riverside dwellers are characterized by the extraction of wood (billet), açaí (fruit and heart of palm), fishing and the production of agricultural products aimed mainly at family consumption (cassava, corn, manioc, fruit in general).

The predominant occupation of productive activity in the communities is farming, with emphasis on the production of manioc flour (51%), followed by family farming (30%) and artisanal fishing (13%). However, communities have a balance in various productive activities to generate family income, such as logging (14%), swidden (18%), hunting (16%), handling of açaí (19%), fishing (20 %) and others.

Most of the products produced in the communities (58%) are for the subsistence of families, 22% are sold in the community itself and 17% are sold to the headquarters of the municipality of Portel.

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

The socio-economic diagnosis is carried out every year to identify changes in the local communities. Any future significant changes will be informed in this section.

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

The risks and impacts of the project are analyzed in the SFMP, designing mitigation strategies for each impact observed. No alteration of the community area, methodology or way of life in general is predicted.

It is planned that the project's revenue will be invested in more socio-environmental programs to involve the local community and minimize damage to the environment and illegal deforestation. To this end, ABC Norte develops several programs, reports and analysis aimed at the optimization of processes, the sustainable use of natural resources and the good relationship with the local community.

Project planning is geared towards forest conservation and sustainable community development, using approved methodologies for monitoring these advances. Communities will be directly impacted since they will have actions aimed exclusively at them, which may be:

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

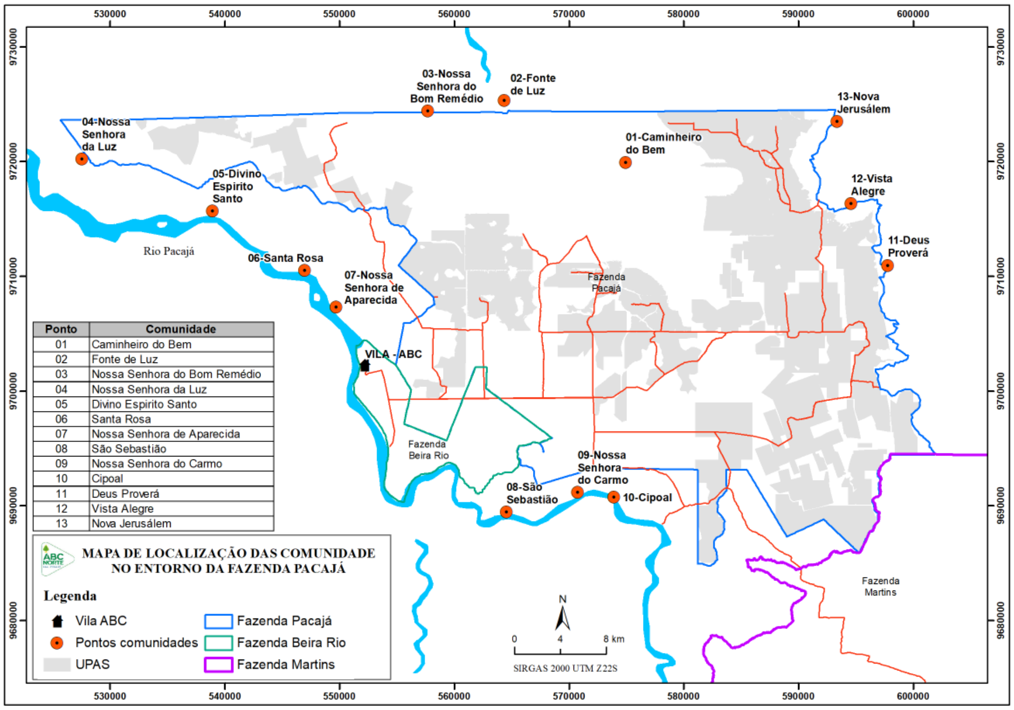
- Directing resources to expand education, health, professionalization, and environmental education actions;

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

More information is detailed in the section “Risks to Local Stakeholders” below.

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

Figure 19. Location of the communities around the Project Area



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

The area used by the communities is included on the Leakage Management Area.

Risks to Local Stakeholders

The project proponent understands that some risks are inherent to the project activity, and that others may arise from stakeholder's doubts. Considering this, the table below presents potential risks and impacts to local stakeholders and measures taken to mitigate those.

Table 7. Risks to Local Stakeholders

Aspect	Impact	Effect		Comments/ Observation
		Beneficial	Adverse	
Sustainable Forest Management Plan	Logging		X	ABC Norte works with the Sustainable Forest Management Plan, exploring a volume below the authorized by the Exploitation License. In addition, sustainable management certifications (FSC) are guarantees of a planned management that reduces impacts on the environment and communities. Monitored by the Biodiversity resource: ● Impact on remaining flora Monitored by the Natural resource: ● Quality Control
Sustainable Forest Management Plan	Reduced access to land due to expansion of exploration		X	The region where the communities live is not within the Management Plan, and therefore will not be affected by logging activities. In any case, the expansion of the exploration is not foreseen, and, if any, it will be communicated and carried out in order to avoid the displacement of residents or limitation of land access. Monitored by the Natural resource: ● Quality Control ● Land Tenure

Resources	Withdrawal of natural, economic and cultural resources (water, food, alternative income, cultural events, etc.) from families		X	The region where the communities live is not within the Management Plan, and therefore will not be affected by logging activities. The project's objective is to guarantee financial resources to maintain sustainable and certified wood management and also to expand the socio-environmental benefits for the communities within and around the Project Area. Thus, certifications and the use of Social Carbon are a guarantee that there will be no reduction in access and/or withdrawal of resources from impacted families. Monitored by the Biodiversity resource: ● Non-timber forest products (NTFPs) Monitored by the Carbon resource: ● Stakeholder consultation Monitored by the Financial Resource: ● Alternative income sources
Land access	Reduced access to traditional areas		X	The management plan area does not include communities' access regions, and therefore, they will not be affected by the maintenance of activities. There are no plans to expand the management area, and communities are guaranteed access to customary land. Monitored by the Natural resource: ● Quality Control ● Land Tenure

Land use	Displacement of families due to project activity		X	Families will not be removed from the area currently used. ABC Norte maintains a relationship with the families, and one of the objectives of the carbon project is to expand social and environmental benefits. ABC Norte recognizes the permanence and land use of the families in the project area, and any changes will be previously communicated. Monitored by the Human resource: ● Conflict management Monitored by the Natural resource: ● Land Tenure
Food Security	Withdrawal of land used for food production or income generation		X	The management plan area does not include communities' access regions, and therefore, they will not be affected by the maintenance of activities. The areas for planting / ranching for subsistence or for selling for income generation will not be included in the management plan and the removal of these lands is not planned. Monitored by the Biodiversity resource: ● Non-timber forest products (NTFPs) Monitored by the Natural resource: ● Land Tenure

Climate change adaptation	Adaptations and impacts related to the climate crisis	X		The main objective of the project is forest conservation, avoiding unplanned deforestation. The maintenance of the standing Forest is essential to mitigate the effects of the climate crisis and the maintenance of natural resources for the population. The project also contributes to achieving climate justice, since the groups that suffer most from climate change are the vulnerable and traditional communities. Monitored by the Financial resource: ● Carbon Credit Benefits Monitored by the Natural resource: ● Social and environmental investments Monitored by the Carbon resource: ● Project performance
Discrimination or sexual harassment	Involvement of project proponent or any other entity in any form of discrimination or sexual harassment		X	The project activity doesn't endorse any form of discrimination based on gender. Brazil has ratified ILO Conventions 45 (Underground Work (Women) Convention) and 111 (Discrimination (employment and occupation) Convention[59]. In addition, Algar/ABC has an internal code of conduct, including a supplier code of conduct to guide and guarantee the ethics and safety of its workers and activities.

[59] Available at < https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:102571>

Expertise and prior experience in Land Management and Carbon Project	Carbon project management and internal management and social activities	X		The team responsible for the development of the project, mapping and socio-environmental diagnosis has previous experience and technical knowledge to conduct the project. Ecológica Assessoria is responsible for the Carbon Project development; Ecológica Institute experience in forest projects dates back to 1998 with ten projects and contracts. In addition, the Ecológica Assessoria team has successfully validated and verified more than 50 voluntary emission reduction projects, over twelve years. ABC Norte has a dedicated forest management team to organize, monitor and conduct the Sustainable Forest Management Plan in Fazenda Pacajá.

Respect for Local Stakeholders Resources

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

ABC Norte has a stable relation with the communities, with activities in the region dating back to 1979. In 2017 the company took over the management of the area and the SMFP, also initiating social actions with the communities, with the Social and Environmental Responsibility Program. Although there are 13 communities identified in the region, service is currently provided in only 5 of them, due to difficulties in transportation and communication with the other communities. With the carbon project revenue, the program is expected to reach all communities.

ABC Norte is the legal owner of the project area, however, has a verbal agreement with the communities to maintain the current use of land, as long as they commit to forest preservation and leave no environmental liabilities. There is no legal agreement since all contacts with the community are made prioritizing conversation and good relationship. In addition, the company prevents the community from being required to sign any documents, in order to avoid embarrassment and misunderstandings. The SMFP does not include the region occupied by the communities.

No community member has been or will be removed from their land, on the contrary, communities will be supported through programs and incentives the project proponent will instigate. In addition, the project did not introduce any invasive species or allow an invasive species to thrive through project implementation. If the project implements any reforestation project with non-native species over native species in the future, the possible risks and adverse effects of exotic species will be justified and explained to communities.

<u>**Communication and Consultation**</u>

The project will take all appropriate measures to communicate and consult with local stakeholders in an ongoing process for the life of the project. As described above, the project intends to carry out an average of at least one local stakeholder consultation per year (to be held on site after the end of the pandemic), which will be monitored by SOCIALCARBON certification. Every consultation shall communicate:

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

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

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

Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All communities have an online message group with the team responsible for the socioenvironmental activities. In addition, they also received Ecológica and ABC Norte contacts during the Local Stakeholder Consultation. All comments received will be responded, and grievances will be resolved in a suitable time frame whenever possible, taking into account culturally appropriate conflict resolution methods.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

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.

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3.2 Applicability of Methodology

Table 8. Applicability conditions of the chosen methodology

VM0015	
Applicability Conditions	**Justification of Applicability**
a) Baseline activities may include planned or unplanned logging for timber, fuelwood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.	None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4.1. The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvesters, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure expansion, such as waterways and roads. In addition, the company that was operating the previous sustainable forest management plan had very low monitoring and control of people's access to the area, in addition to having evidence of logging above that permitted by forestry permits, which caused an increase in unplanned deforestation. In fact, the Environmental Agency of the State of Pará found around 100 ha of illegal deforestation caused by the previous leaseholder between 2009-2016, and another 1,135 ha of illegal logging areas, which were harvested above the legal limits, including the operation of an illegal sawmill

	within the property[60]. Furthermore, there were around 2 thousand hectares of illegal deforestation within Fazenda Pacajá during the historical reference period (2007-2017), mainly in the northern portion of the property along the rivers[61], which shows the lack of surveillance and control by the previous tenant. Therefore, in the baseline scenario, the project area would continue to be illegally deforested, both by the previous leaseholder and by other deforestation agents described above. Thus, 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 project activity falls within category B, “Avoided Deforestation with Logging in the Project Case”. The reason is that the project area contains 100% native vegetation, and a sustainable forest management plan is implemented in the project area. In addition, it is important to note that 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 agroforestry systems meeting the definition of “forest”.	The REDD project area is 100% made up of native Amazon Rain Forest. The area is considered forest as per the definition of forest adopted by FAO[62]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%,

[60] Technical analysis nº 15566 issued by the Environmental Agency of the State of Pará (SEMAS/PA) in 2020.
[61] Analysis carried out through Global Forest Watch, available at: <https://gfw.global/33zalIn>.
[62] Available at < https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses.>

	or trees able to reach these thresholds in situ. No deforested, degraded or areas otherwise modified by humans were included in the project area at Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The project area consisted of 100% tropical rainforest in 2007 – 10 years prior to the project start date – all of which conformed to the Brazilian definition of forest[63]. This was ascertained using satellite images, as described in the section 3.3 Project Boundary of the present VCS PD.
e) The project area can include forested wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	According to the Sustainable Forest Management Plan, the project area region is formed by soil types yellow latosol and haploid gleysol. The map is presented in section 1.13. Therefore, none of the project region grows on peat, satisfying this applicability criterion.
VT001	
AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced;	The activities in the proposed project boundary does not lead to violation of any applicable law even if the law is not enforced. The sustainable forest management plan is an activity authorized and endorsed in Brazil, and ABC Norte has all the environmental and legal authorizations necessary to conduct the activity.

[63] 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>.

The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario. Project proponent(s) proposing new baseline methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.	The methodology provides a stepwise approach to justify determination of the most plausible baseline scenario.

3.3 Project Boundary

SPATIAL BOUNDARIES

The Project Boundaries are located in 5 different municipalities. The project area extends to Portel and Bagre, while the Reference Region also reaches Baião, Oeiras do Norte and Pacajá. Leakage Belt is located in Bagre, Oeiras do Norte and Portel. Table below summarizes the areas in each municipality:

Municipality	Project Area	Reference Region
Portel	90.58%	61.75%
Bagre	9.42%	22.28%
Oeiras do Norte	-	13.17%
Pacajá	-	2.41%
Baião	-	0.39%

- **Project Area**

The project area is formed by a single property (Fazenda Pacajá) which has a total area of approximately 145,680 ha, covered almost in its totality by native vegetation. However, in order to satisfy the definitions of the methodology, which establish that the area must be forest for at least 10 years before the Project Start Date, some adjustments and discounts were made. The property 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 Table 8 below.

Table 9. Project Area, Reference Region and Leakage Belt

Name	Area (ha)
Project Area	140,432.27 ha
Leakage Belt	81.217,32 ha
Reference Region	976,850.1 ha

- <u>Reference Region</u>

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

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

The Reference Region must encompass the project area, the leakage belt and any other geographic area that is relevant to determine the baseline of the project area.

A geographic area with agents, drivers and overall deforestation patterns observed during the 10-year period preceding the start date, i.e. September-2007 to September-2017, was determined, representing a credible proxy for possible future deforestation patterns in the project area.

The RR was defined in accordance with two criteria:

- The methodology recommends that projects over 100,000 ha in size should have RRs 5 – 7 times bigger than the project area. Thus, it was calculated that the RR of the ABC Norte REDD Project has the size of 976,850.1 ha (6.94 times larger 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 principal means of human and product transportation in the region. As such, from the areas directly surrounding the project, the RR was expanded to meet the nearest main waterways and roads.

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

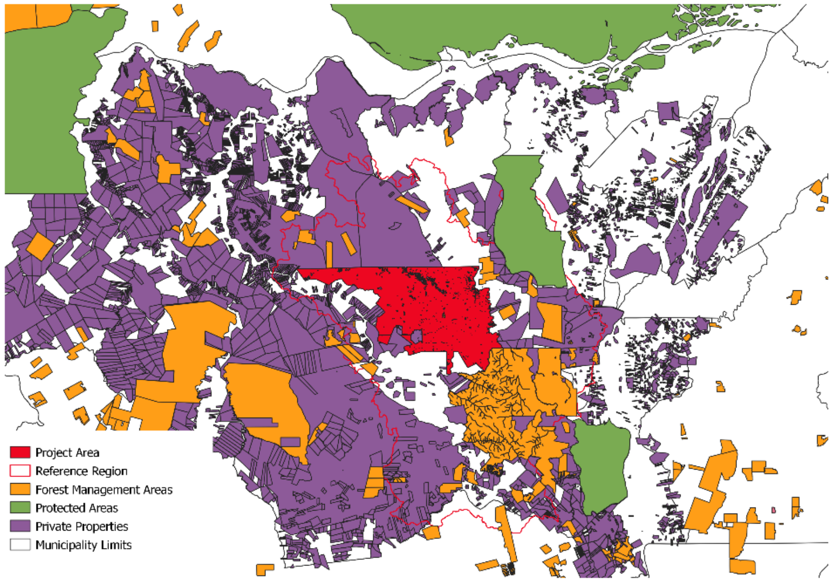
- **Agents and drivers of deforestation**: Timber logging (both legal and illegal) is an important economic activity within the reference region. Economic data sources between 2007 and 2017 show that timber stands out as having the highest values of annual production in the project area municipalities of Bagre and Portel. As detailed in section 1.13 and to be presented in section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats throughout the southern Amazon region. Thus, the analysis of the Reference Region definition includes these factors.

- **Socio-economic and cultural conditions:** The methodology implies that "The legal status of the land (private, forest concession, conservation concession, etc.) in the baseline case within the project area must exist elsewhere in the reference region. If the legal status of the project area is a unique case, demonstrate that legal status is not biasing the baseline of the project area." This is complied with the areas surrounding the Fazenda Pacajá that are not public or part of any protected area, such as project area. These conditions also comply with Land Use and Land Tenure items, once the conditions of the project area are found elsewhere in the reference region. The project area is governed by the same policies, legislation and regulations that apply elsewhere in the reference region. These policies are detailed in section 1.14. Figure below shows the areas surrounding the Project Area, specially the municipalities of Portel, Bagre, Pacajá, Oeiras do Pará and Baião. Data presented is the private areas available at Brazil's Environmental Rural Registration[64], National Protected Areas[65]:

[64] Available at < https://www.car.gov.br/publico/imoveis/index>

[65] Available at <http://mapas.mma.gov.br/i3geo/datadownload.htm>

Figure 20. Private and state areas surrounding Fazenda Pacajá



- **Landscape configuration and ecological conditions:** To define the Reference Region, hydrographic basins were used within an area of 22.23 million hectares around the project area, from the drainage network produced by the SRTM digital elevation model. For each of these basins, the average values of elevation, slope and precipitation and the percentages of different types of vegetation were determined. Based on these values, basins that presented values close to these parameters to the values of the project area were selected. Then, an attempt was made to select basins until reaching an extension of approximately seven times the size of the project area.

The RR sums to 976.850,1 ha and is distributed over the following municipalities: Portel, Bagre, Pacajá, Oeiras do Pará and Baião. Although the reference region is distributed across five municipalities, two of them sum to the majority of the reference region, Portal and Bagre. The other three, Oeiras do Pará, Baião and Pacajá, comprise a smaller percentage.

Maps below show some of the criteria that were taken into account in order to adjust the ABC Norte REDD Project's Reference Region.

Vegetation cover

As presented in graph below, similarity between Reference Region and Project Area vegetation cover is 97,75%. The main Project Area's vegetation type, Dense Lowland Tropical Rainforest, occupies 93% of the Reference Region.

Figure 21. Vegetation cover of the Reference Region. Source: Sivam

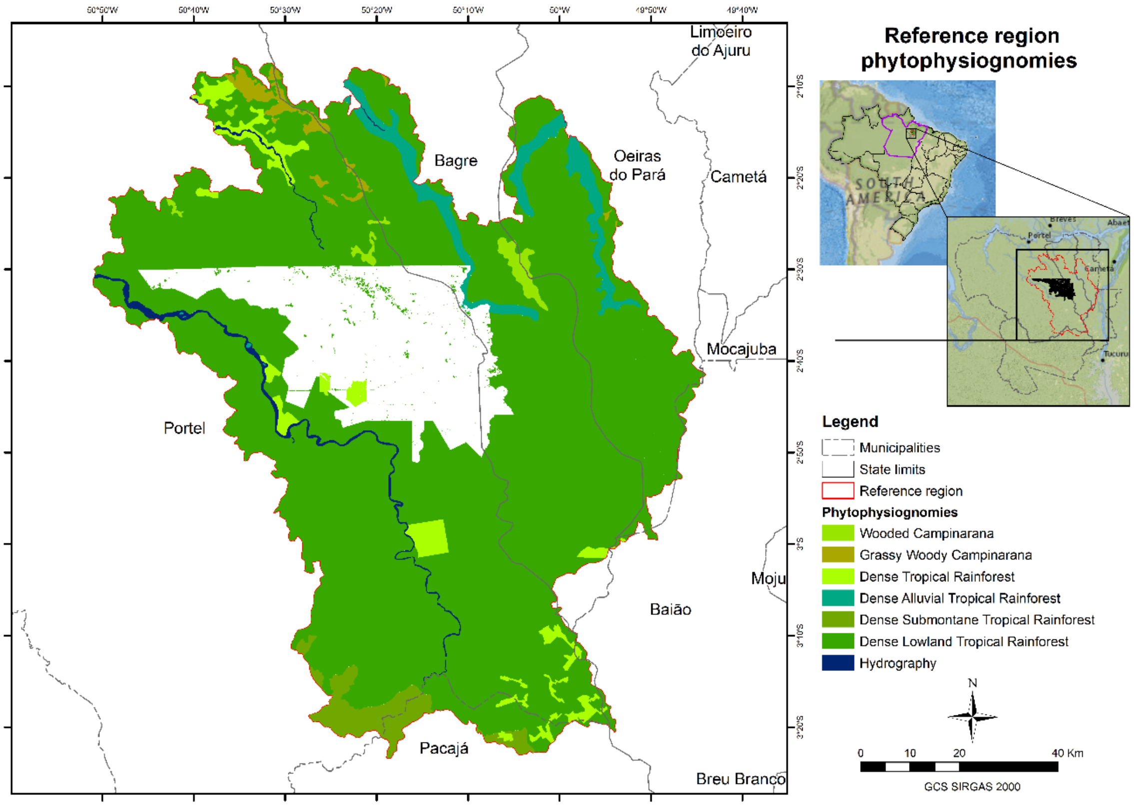
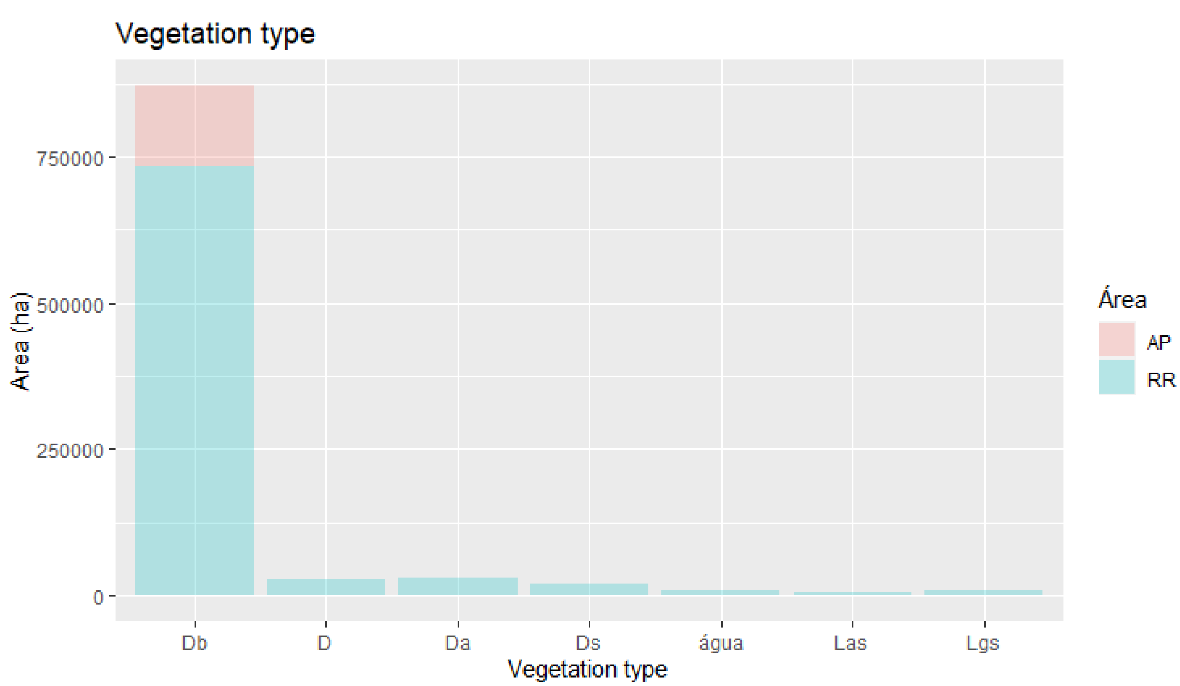


Figure 22. Distribution of phytophysiognomies, in area (ha), in the Reference Region and in the Project Area.



Altitude

The altitude in the project area ranges from 16 to 79 meters and these values are within 85.46% of the variation in the reference region, as shown in the Figures below.

Figure 23. Altitude variation in the Reference Region of the ABC Norte REDD Project. Source: SRTM

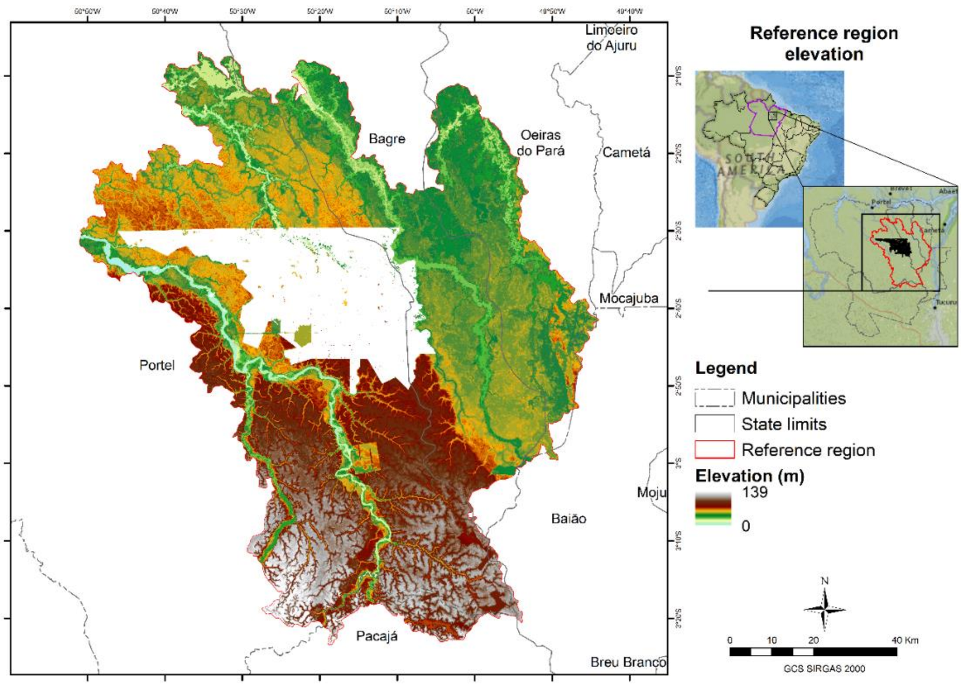
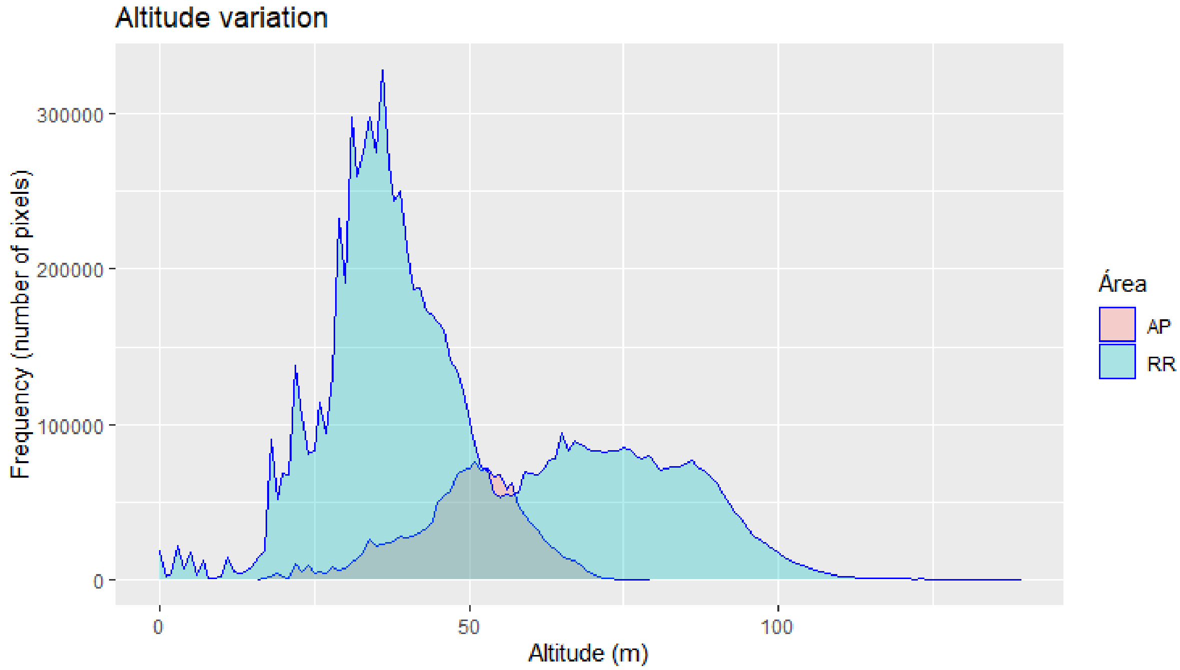


Figure 24. Altitude distribution (m), in number of pixels, in the Reference Region (RR) and in the Project



Slope

The average slope in the project area is 4.19%, while in the reference region it is 4.65%. Therefore, the average value of the project area is within the range of ± 10% of the average in this region, which is between 4.18% and 5.11%.

Figure 25. Slope variation in the ABC Norte REDD reference region. Altitude source: SRTM

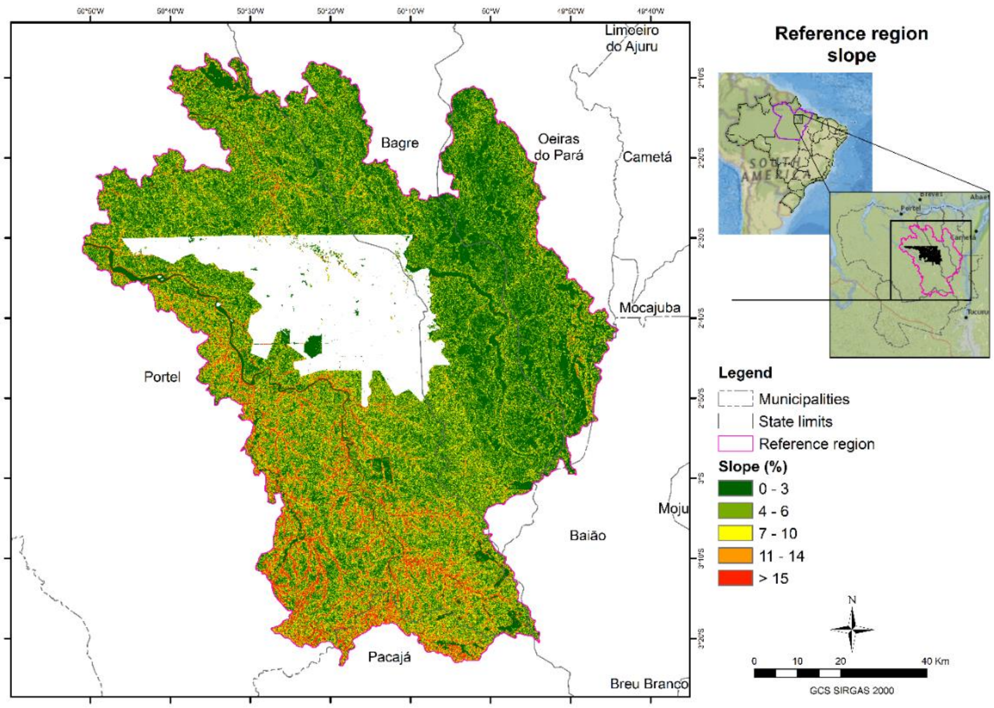
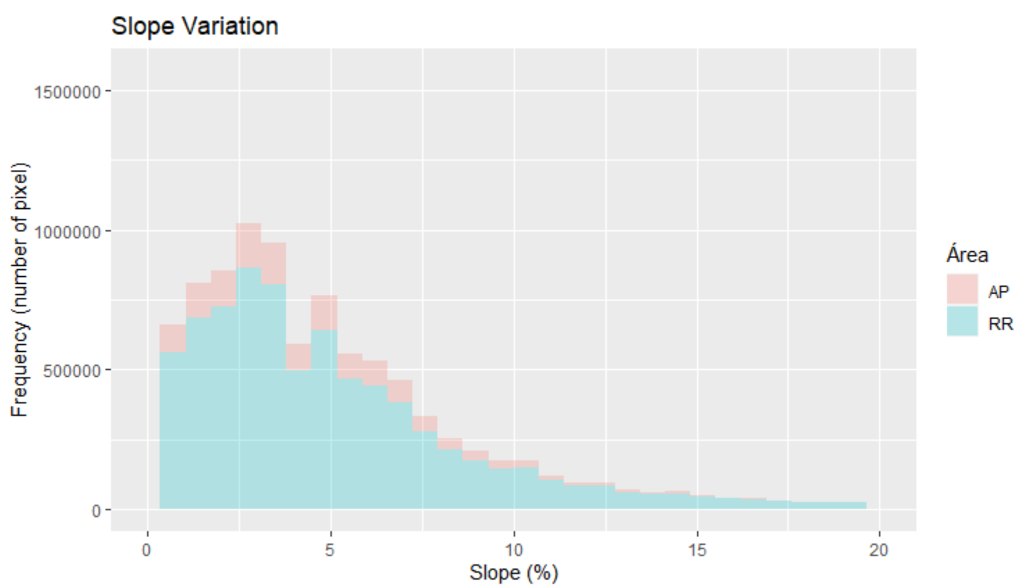


Figure 26. Slope distribution (degrees), in number of pixels, in the Reference Region and in the Project Area



Rainfall

The annual precipitation in the project area is, on average, 2,562.43 millimeters per year, while in the rest of the reference region it is 2,503.86 mm, thus, the amount of rain in the project area is within the range of ± 10% of 100% of the average of the rest of the reference region, which varies between 2,253.47 and 2,754.25 mm.

Figure 27. Variation of annual precipitation in the Reference Region[66]

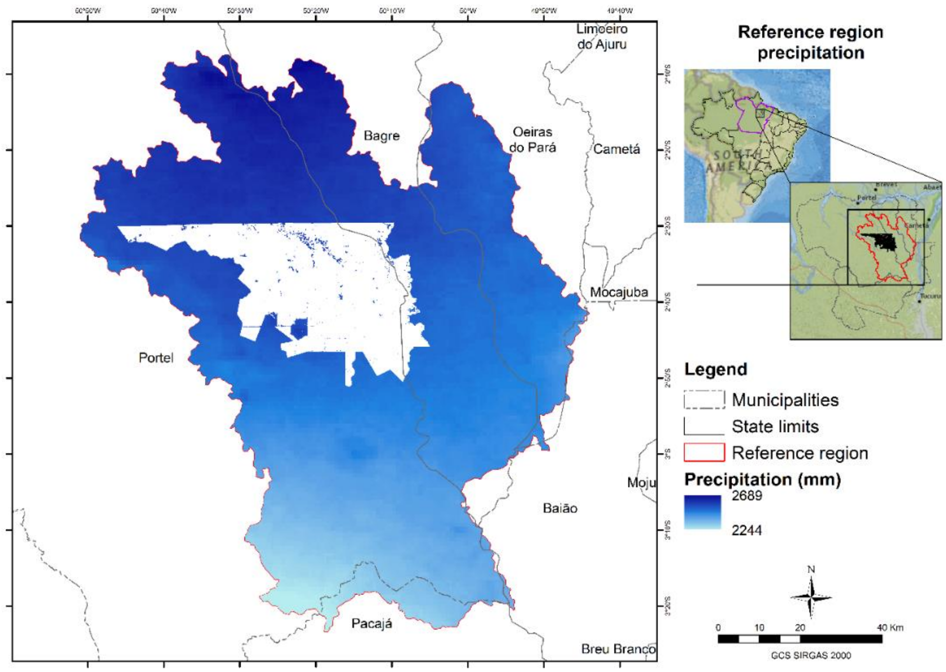
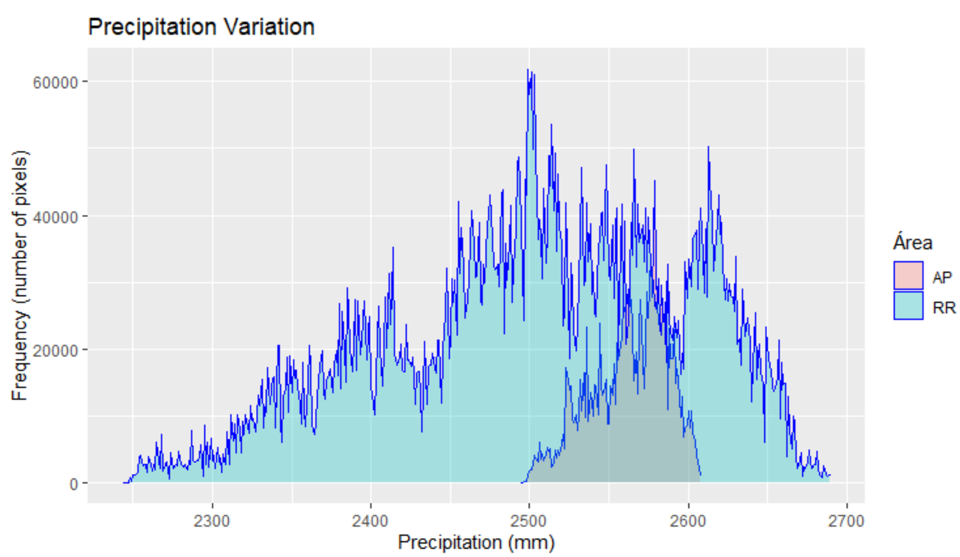


Figure 28. Distribution of annual precipitation (mm), in number of pixels, in the Reference Region (RR) and in the Project Area (PA)



- <u>Leakage Belt</u>

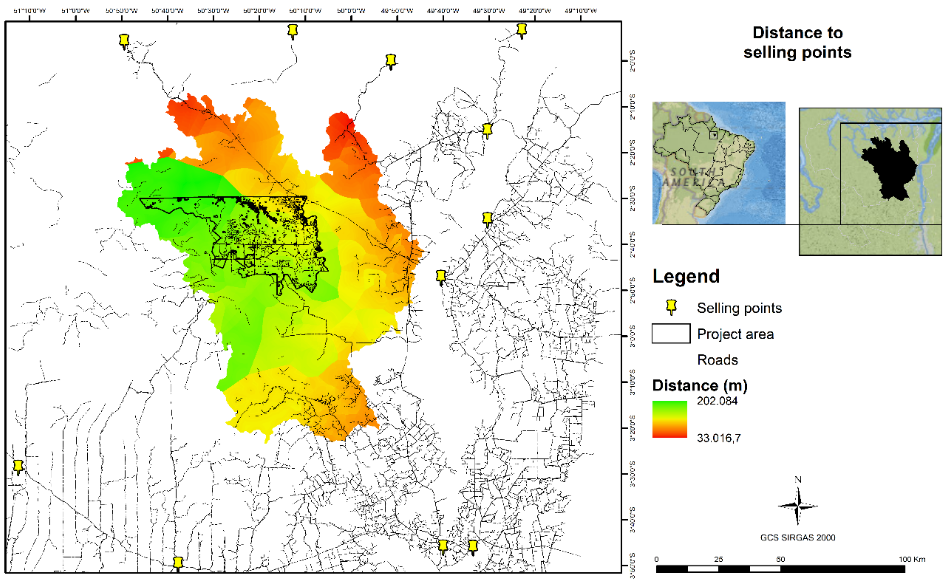
  To determine the leakage belt area, was carried out the methodology of opportunity cost. Therefore, the economic viability of livestock production was spatialized in the Reference Region

[66] Source: https://www.worldclim.org/data/worldclim21.html

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 traveled to the nearest commercial center (Portel or Bagre). Figure below represents the total distance in the reference region.

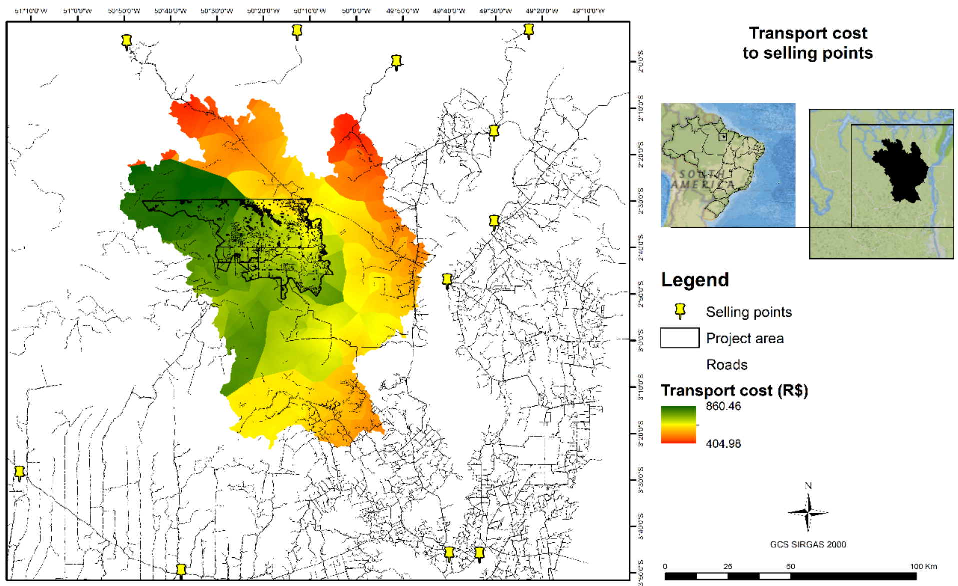
Figure 29. Surface distances (m) to the nearest commercial centers (Portel and Bagre) in the Reference Region (RR)



For monetary costs, the freight table for road transportation of cargo capacity[67] was considered. Each animal weighs an average of 13 *arrobas*[68] (unit of weight corresponding to 15 kilograms), so it was considered 1 3-axle truck carrying an average of 72 cattle heads at the price of R$ 2,6941/km + R$316.03 for loading and unloading. Figure below illustrates the freight values that would be paid at each point in the reference region.

[67] Freight table available in Resolution nº 5,890, of May 26th, 2020. Available in <https://www.in.gov.br/en/web/dou/-/resolucao-n-5.890-de-26-de-maio-de-2020-258705401>. Last visited on August 3rd, 2021.
[68] CARRERO, G.C; ALBUJA, G; FRIZO, P; HOFFMANN, E. K; ALVES, C; BEZERRA, C. S. A Cadeia Produtiva da Carne Bovina no Amazonas. IDESAM, 2015. Available in: <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>. Last visited on August 3rd, 2021.

Figure 30. Surface costs (R$) for road transportation to the nearest commercial centers in the Reference Region (RR) and in the Project Area (AP)



Combining these two data, the economically viable areas for livestock production would be where the sum of revenues minus total costs are positive. In the region, the costs per animal considering a productive area of 20 hectares and an extensive breeding system are on average approximately R$ 906.00[69]. The average price of the *arroba* varies between R$ 80 and R$ 92[70]. The analysis used the minimum value of R$ 80. Thus, for an average of 13 *arrobas* per animal, R$ 1,040.00.

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

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

Where:

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

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

[69] The costs of animal production are described in <https://idesam.org/publicacao/relatorio-viabilidade-pecuaria.pdf>. The value of R$906.00 is accounted considering these costs, and is available in table 7 of <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>.

[70] CARRERO, G.C; ALBUJA, G; FRIZO, P; HOFFMANN, E. K; ALVES, C; BEZERRA, C. S. A Cadeia Produtiva da Carne Bovina no Amazonas. IDESAM, 2015. Available in: <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>. Last visited on August 3rd, 2021.

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

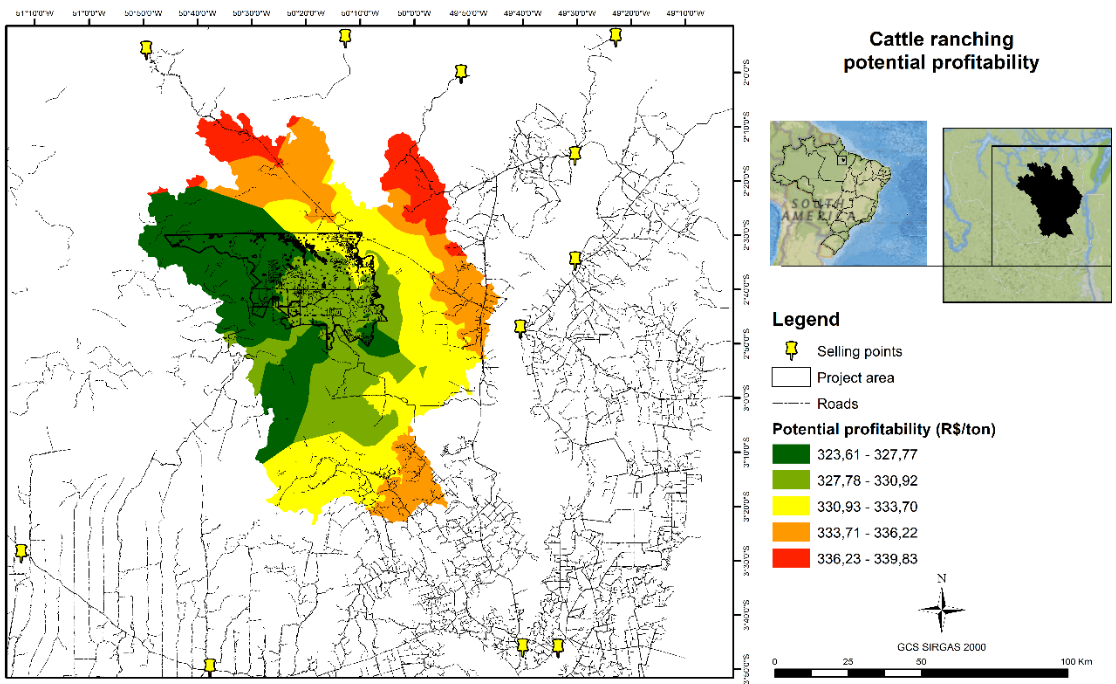
TDv: Transport distance on land, river or road of type v; km

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

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

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

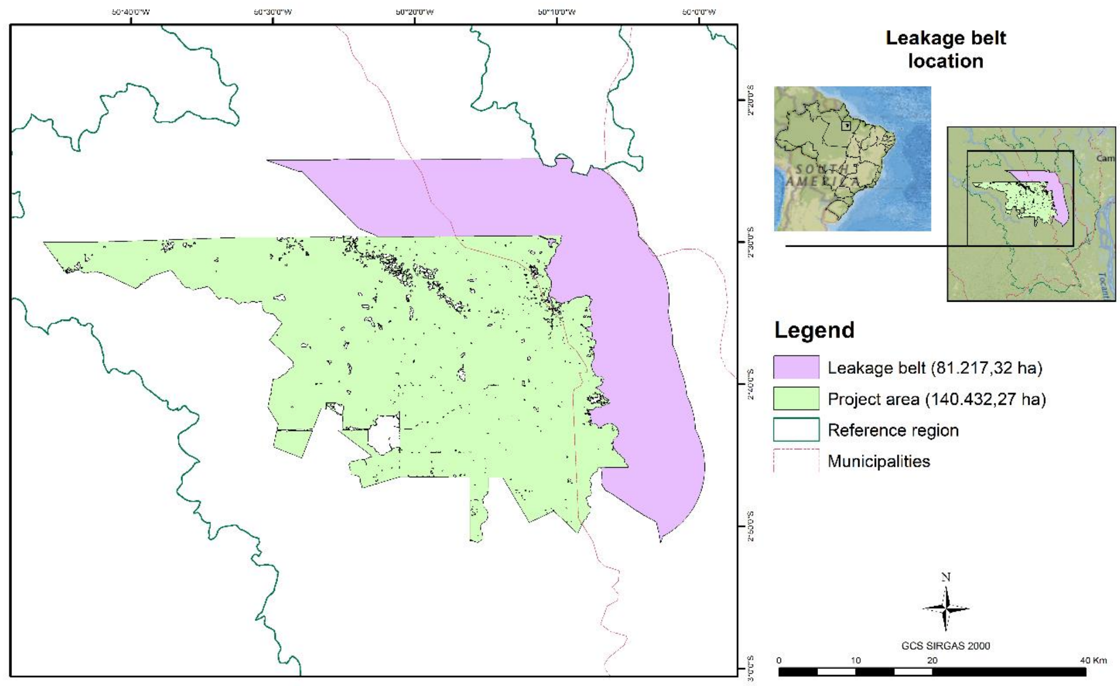
Figure 31. Potential profitability areas for cattle ranching within the Reference Region (RR) and the Project Area (PA)



From this analysis, it is taken into consideration that areas with a higher profitability value should be more attractive for cattle ranching. Thus, classification by natural breaks was made based on the profitability values, highlighting the values from the 3rd class. In addition, it is considered that adjacent viable areas to the project area, according to the opportunity cost analysis within a 10km radius[71], would be where deforestation could occur directly due to the project's activity. In more distant areas, the increase in deforestation, as it is already happening, is probably associated with the proximity to rivers and roads. Thus, based on an overlap of both information, it's considered that the area to the east of the project area, even though it has 2nd class profitability values due to natural breaks, as it is very close to the project area and areas of greater commercial value, it would also have potential of leakage. Thus, the area of the leakage belt was defined, comprising an area of 81,217.32 ha. The Figure below illustrates its location.

[71] Available at https://www.researchgate.net/publication/339796935_Reconstrucao_e_asfaltamento_da_Rodovia_BR-319_Efeito_domino_pode_elevar_as_taxas_de_desmatamento_no_Sul_do_Estado_de_Roraima Last visit on: October 14th, 2021.

Figure 32. Location of the Leakage Belt



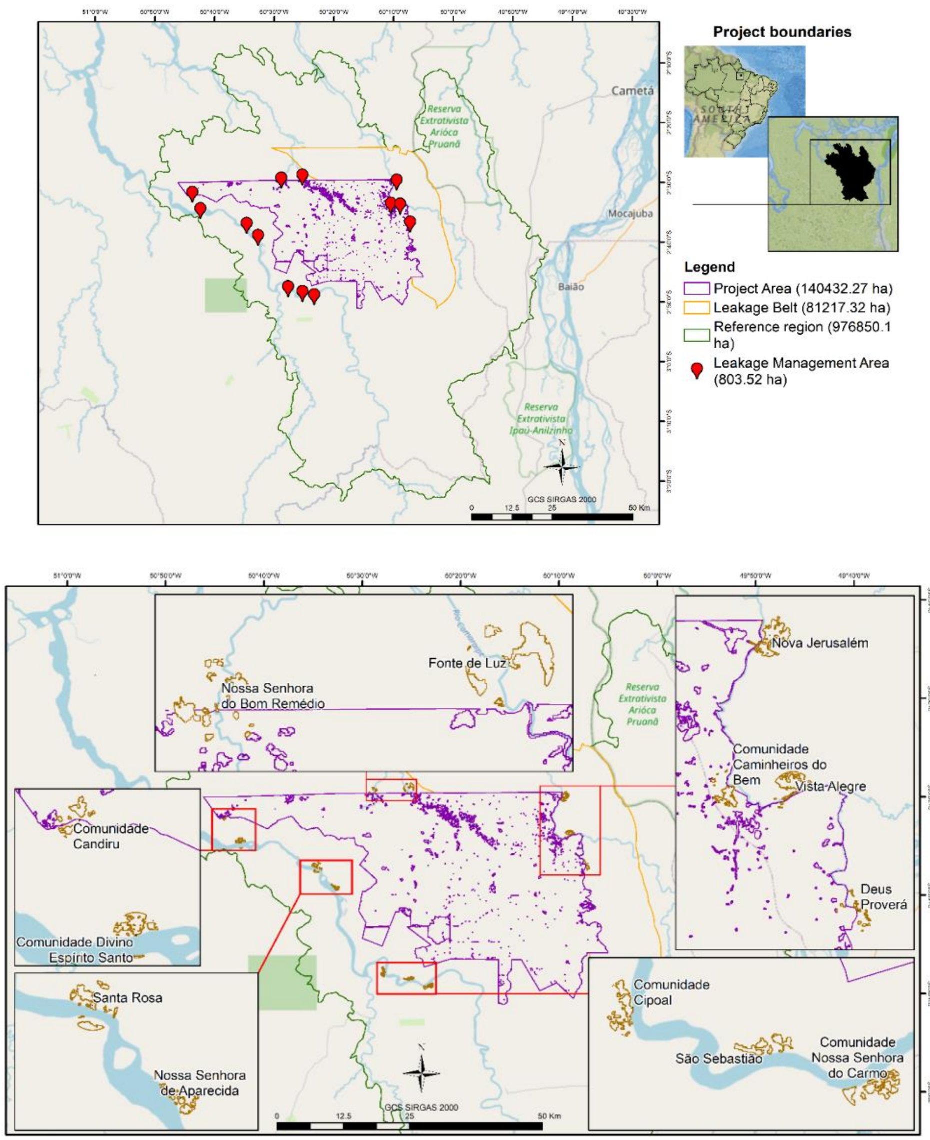
- <u>Leakage Management Area</u>

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

To define the Leakage Management Area, a radius of 1 kilometer around the 13 communities was used. Then, the non-forest areas were cut in September 2017. The leakage management area was delimited in 803.52 ha.

The map of the project boundary including the locations of Project area, Reference Region and Leakage Belt it's shown at the Figure below.

Figure 33. Project boundaries



Leakage Management Plan

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

Since 2017, ABC Norte develops activities to generate alternative income, training and education to the communities surrounding the project area. The 13 communities are included in the Leakage Management Area, however, until 2021, only 5 of them receive the Social Environmental Responsibility

Program, due to difficulties in transport and communication. It is expected that, with the revenues of the carbon credit sale, all communities will be covered by the program.

Actions implemented since 2017:

- Socio-economic diagnosis of the communities
- Construction of monitoring stations throughout the Fazenda Pacajá area
- Ação Social da Fazenda Pacajá (2019) – Actions in partnership with the government, to provide health and social services
- Lectures and environmental education
- Training on production systems – pisciculture, poultry farming and agroforestry.

All the activities are developed with the communities, according to their culture, technical skills and interests. They are planned through the year, and there is a visit from the social team once a month.

In addition to the activities already developed by ABC Norte, and the project's ecological and carbon benefits, the implementation of REDD and SOCIALCARBON mechanisms promote benefit sharing. SOCIALCARBON methodology will serve as a plan and guideline for carrying out activities and achieving goals, in addition to assessing progress in each monitoring period. In this way, the owners are committed and add value to the carbon project with each action taken, encouraging long-term sustainable development.

The area's conservation plan involves increasing satellite monitoring, overflight and/or in person, with monitoring posts in the area, as well as socio-environmental education and community insertion in the project activity through the generation of jobs, such as monitoring agents, as the main way to mitigate illegal actions in the area. No afforestation, reforestation or enhanced crop and grazing land management is planned in the Leakage Management Plan. This plan will be based on the monitoring parameters, in addition to being verified in every SOCIALCARBON Report. The SOCIALCARBON methodology drives continuous improvement in the local community through prospects (at least one per resource, totaling 6 improvement actions), in which the project owner undertakes to implement them until the next monitoring period.

Planned perspectives include:

- Lectures and training aimed at the female audience;
- Formal monitoring of the community's health issues;
- Construction of a library and implementation of tutoring classes;
- Expand the income generation activities developed with the communities

- Expand training related to the management of non-timber forest products

The plan and activities held by ABC Norte in the monitoring period are detailed in the Social Carbon Report Point 0. The plan's monitoring is carried out together with the monitoring report and may undergo changes that shall be justified at each verification, which should be updated at each point/monitoring period, in order to reflect the region's sustainable development goals.

To guarantee the evolution of the socio environmental scenario in the region, SOCIALCARBON Standard requires that at least 50% of the actions suggested in the previous Point must be implemented, under the risk of losing the Standard. The monitoring period for SOCIALCARBON should be the same as the monitoring period for the Carbon Accounting Standard.

<u>Forest</u>

According to the Brazilian Forests at a Glance 2019[72], the Brazilian Forest Service considers as forests the lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE), updated by the SIVAM project[73]. Brazil endorses the definition of forest adopted by FAO: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.

For the Project Area definition, as described previously in this section, only areas considered as forest were accounted. For this, the area was submitted to an analysis using MapBiomas mapping and classification. MapBiomas applies a hierarchical system with a combination of LULC classes in accordance with national definition[74]. Thus, this assessment guarantees that the project area meets an internationally accepted definition of forest .

In addition, as per VM0015 methodology, the Minimum Mapping Unit (MMU) size of the LULC maps created using RS imagery shall not be more than one hectare irrespective of forest definition. Thus, the 30 m resolution LANDSAT images used for mapping have the minimum mapping unit defined at 30x30 m (0.09 ha), therefore falling easily to the methodology requirement. Details on data and image processing can be verified in Appendix II.

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[72] Available at <https://www.florestal.gov.br/documentos/publicacoes/4262-brazilian-forests-at-a-glance-2019/file>. Last visited on August 3rd, 2021

[73] As of 1996, through a contract signed between the Implementation Commission of the Airspace Control System - Ciscea, and its Amazon's Surveillance System Project - Sivam, and IBGE, updated the information that make up the Legal Amazon, attending, at the same time, the Systematization of Information on Natural Resources project. Information available at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf; SIVAM Project: https://www.camara.leg.br/noticias/55929-o-que-e-o-sivam/

[74] A cross-reference of the MapBiomas LCLU classes with classes from other classification systems such as FAO, IBGE and National Inventory is available at Annex III of MapBiomas general handbook. Available at < https://mapbiomas-br-site.s3.amazonaws.com/Metodologia/ATBD_Collection_6_v1_January_2022.pdf>

TEMPORAL BOUNDARIES

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

The adopted historical reference period is September 2007 to September 2017.

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

The project has a crediting period of 30 years, from 13-September-2017 until 12-September-2047.

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

The first baseline period is from 13-September-2017 to 12-September-2027.

- **Monitoring period**

The first monitoring period included in this Joint PD is 13-September-2017 to 31-December-2020. The next monitoring periods will comply with the criteria established in the applied methodology, which states that the minimum duration of a monitoring period is one year, and the maximum duration is one fixed baseline period.

CARBON POOLS

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

Table 10. Carbon pools included or excluded within the boundary of the proposed AUD project activity

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Carbon stock change in this pool is always significant
	Non-Tree: Excluded	No existence of perennial crops as final class
Below-ground	Included	Stock change in this pool is significant
Dead wood	Excluded	Excluded for simplification. In the baseline scenario, dead wood is not removed and/or used before the deforestation, as it is often in the process of decomposition in the forest, being left to burn in the baseline case. Therefore, not accounting for this carbon pool is conservative, as it does not consider GHG emissions from deforestation and burning in the baseline.
Harvested wood products	Excluded	Stock change in this pool was not considered in the baseline or project scenarios. This exclusion is conservative.

Litter	Excluded	Excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the AUD project activity. This exclusion is conservative.
Soil organic carbon	Excluded	Recommended when forests are converted to cropland. Not to be measured in conversions to pasture grasses and perennial crop according to VCS Methodology Requirements, 4.0.

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

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

- Amount of harvested timber in baseline x project scenarios: The amount of timber harvested in the baseline scenario is lower than the project scenario, which includes legalized and sustainable forest management conducted by ABC Norte. According to the most common species harvested by illegal agents in the project region[75], relating the species with the highest commercial value and their presence within the project area (according to local forest inventory), it can be concluded that the potential volume of wood harvested by illegal loggers during the baseline would be of 17 m^3/ha. On the other hand, the authorized sustainable management of ABC Norte during the project scenario presents logging volume of 30 m^3/ha.

In addition, logging in the baseline case occurred through planned and unplanned activities. In both cases, harvesting targeted the most commercially valuable species[76], without the use of proper machinery and planning, i.e., the same species were harvested using low efficiency methods without any criteria regarding the number of remaining trees per species.

In addition, in both scenarios, after harvesting the most valuable species, the area was abandoned for illegal deforestation. On the other hand, in the project scenario, a larger number of species are harvested under a certified sustainable forest management plan, avoiding the overexploitation and extinction of a single species, in a proper way for the forest management be sustainable and balanced.

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

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

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

- Carbon stored in wood products - The analysis of the most valuable timber species in the region[77] and the forest inventory conducted by ABC Norte allows to conclude that the species harvested in the baseline are also contemplated under the sustainable forest management in the project scenario. Thus, it can be concluded that the final use as wood products of both scenarios is the same, i.e., medium to long-lived wood products[78].

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

This analysis was conducted for baseline logging activities (both planned and unplanned), and it was found that the sum of decreases in carbon pools and increases in emissions represents less than 5% of the total decrease in carbon pools and increase in emissions (1.07%) and less than 5% of net anthropogenic removals by sinks (2.90%).

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

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

In addition, the Methodology considers the two sources of GHG emissions listed in the Table below. Their inclusion or exclusion within the boundary of the proposed AUD project activity, as well as the respective justification/explanation, are described in the Table below.

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[77] Information available at Apprehension Report by SEMA-PA – 2019 and EXPLORAÇÃO E VALORAÇÃO EM TORA DE 10 ESPÉCIES FLORESTAIS NO BAIXO AMAZONAS, ESTADO DO PARÁ, ENTRE 2006 – 2016 <https://periodicoscientificos.ufmt.br/ojs/index.php/biodiversidade/article/view/9999 >

[78] According to the applied methodology it is conservative to assume that 100% of the carbon stock in wood products in the baseline scenario is long-lived

Table 11. Sources and GHG included or excluded within the boundary of the proposed AUD project activity

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

3.4 Baseline Scenario

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

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

As detailed throughout the PD, the area is vulnerable to encroachments and illegal deforestation, as it has been happening throughout the historical and current period. Although the sustainable forest management plan is effective as a way of mitigating deforestation, it is necessary to have a greater control of its activities, in addition to investments in socio-environmental activities, surveillance and internal management to maintain na activity with low environmental impact and control effective illegal deforestation. This would envolve higher costs, increasing the current loss of the company with the area.

The sale of the property was not considered a viable alternative due to the owner's history with the area, having a personal commitment even before the carbon project was set to happen, even though the area was giving him several losses and the company's recommendation was to sell it. Thus, considering that ABC Norte is an Agricultural company and, therefore, would have the conditions and expertise to conduct the change of activity in the area, in addition to being the most economically profitable activity, it is assumed that the baseline scenario would be the clear cutting of the area for conduction of cattle ranching.

The assessment of alternative land use and definition of the most probable baseline scenario was made according to the" VT0001 Tool for the demonstration and assessment of additionality in VCS agriculture, forestry and other land use (AFOLU) project activities", Version 3.0, STEP 1:

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

Sub-step 1a. Identify credible land use scenarios to the proposed VCS AFOLU project activity

Credible alternative land use scenarios to the present AFOLU project activity are:

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

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

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

Many scientific articles conclude that sustainable forest management plans (SFMP), namely those certified, can be considered a tool for forest conservation, maintenance of forest carbon stocks, and decrease of deforestation rates in the region where they are implemented. This mainly occurs due to the use of reduced impact logging techniques, reduced social and environmental operational impacts, greater surveillance in the area, and generation of economic value for forests. On the other hand, there is a belief that forest is a non-productive natural resource and needs replacing with productive activities, such as livestock farming and agriculture, primarily in areas that require social and economic development[79],[80],[81],[82],[83].

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

Therefore, despite the contribution to forest preservation and carbon stock maintenance, SFMP areas are subject to unplanned deforestation and loss of carbon stock due to external agents, however expected to be in a lower intensity than in other areas without forest management. In addition, there are incentives for the local population to perform activities that result in unplanned deforestation, such as the expansion of low productivity agricultural activities, resulting in an ongoing necessity of cutting down the forest to maintain production.

There are many challenges to guarantee the consolidation of these areas and their effective social and environmental protection. Many conservation areas located in the Amazon still don't have an approved management plan, and a large amount does not have a management team. Furthermore, the number of Government agents assigned to these areas is greatly lacking and insufficient to carry out effective surveillance. The result is intense deforestation and pressure on protected areas in the legal Amazon,

[79] BRASIL. Ministério do Meio Ambiente (MMA). Plano de ação para prevenção e controle do desmatamento na Amazônia. Brasília, 2012.
[80] SCHULZE, M., GROGAN, J., & VIDAL, E. 2008. O manejo florestal como estratégia de conservação e desenvolvimento socioeconômico na Amazônia: quanto separa os sistemas de exploração madeireira atuais do conceito de manejo florestal sustentável? In N. Bensusan & G. Armstrong (Eds.), O Manejo da Paisagem e a Paisagem do Manejo (1ª ed., pp. 161-213). Brasil: IEB
[81] VIEIRA, I. C. G.; SILVA, J. M. C.; TOLEDO, P. M. Estratégias para evitar a perda de biodiversidade na Amazônia. Estud. av., São Paulo , v. 19, n. 54, Aug. 2005 .
[82] HOLMES, T.P. el al. Custos e benefícios financeiros da exploração de impacto reduzido em comparação à exploração florestal convencional na Amazônia Oriental. Belém: Fundação Floresta Tropical, 2002, 66p, 2nd edition.
[83] VERWEIJ, P. *et al*. Keeping the Amazon Forests standing: a matter of values. Zeist: WWF, 2009. 72p.

primarily because of wood harvesting activities, agriculture, road construction and mining[84],[85].

II. **Implementation of a sustainable forest management plan, combined with the implementation of additional activities:** In this scenario, the Project activity would be carried out on the land within the project boundary, nevertheless performed without being registered as the VCS REDD project. This scenario would include avoiding deforestation through conducting sustainable forest management activities, with the addition of certifications such as CERFLOR or FSC.

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

III. **Cattle ranching:** In this scenario, ABC Norte would change its activity from forest management to cattle ranching. This is a plausible scenario since cattle is one of Brazil's main economic activities, as previously described in section above. Furthermore, it is one of the core activities of the holding company, named Algar Group. Therefore, the long-therm experience of the Group in this activity makes cattle ranching a very likely scenario to be developed in the property.

According to the 2017's report[86], the State of Pará has the main cattle herd in Northern Region of Brazil, making Pará livestock an important segment for the state's economy. The relevance of livestock in the Pará economic matrix is expressed in its participation of 26% of the GDP of the primary sector. During the historic period (2007 to 2016), the state's herd grew above the national average, with a growth of 33.36%. This is also the most profitable and common practice in the region.

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

[84] VERÍSSIMO, A. *et al* (Org.). **Áreas Protegidas na Amazônia brasileira:** avanços e desafios. Belém : Imazon ; São Paulo : Instituto Socioambiental, 2011. 90 p.

[85] PORTAL AMAZONIA.COM. Unidades de Conservação do Amazonas ainda sofrem com crimes ambientais. 2013. Available at: <http://www.portalamazonia.com.br/editoria/meio-ambiente/unidades-de-conservacao-do-amazonas-ainda-sofrem-com-crimes-ambientais/>. Last visit on: March 12th, 2015

[86] Available at http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716 Last visit on: October 19th, 2021.

Scenario I and II - The application of a sustainable forest management plan is regulated in Brazil by the laws Nº 12,651[87], decree Nº 5,975[88], in addition to Pará legislation, with law Nº6,462[89] and normative instructions IN 05[90] and Nº 001/2014[91]. Despite the requirement to mitigate social impacts, social and environmental activities for the communities surrounding the management plan area are not required by law. According to Ribeiro[92], the main obstacles related to the approval of the sustainable forest management plan in the Amazon are: a) low investment capacity, financial and fiscal incentives, b) bureaucracy and lack of control in the SFMP approval procedure and c) lack of participation of traditional communities in the process of elaboration of the SFMP, when they are involved. Thus, it is common to see the exclusion of the surrounding community from management activities in private areas.

As it does not contain social and environmental activities to control deforestation coming from communities surrounding the property, scenario I may contain activities that are illegal or of uncertain legal status, not being enforced namely due to the lack of control[93] and government capacity. This type of illegal deforestation, apart from planned deforestation, occurs mainly due to social pressure and low HDI in the Amazon regions. Although not being in compliance with applicable mandatory laws and regulations, this scenario results from systematic lack of enforcement of applicable laws and regulations. One of the goals of the present REDD project is to contribute to a solution to this problem by promoting the sustainable management of forest resources through increased monitoring and surveillance to avoid unplanned, illegal deforestation.

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

One way to avoid increased accessibility and illegal exploitation of protected areas would be to increase the effectiveness of sanctions in cases of environmental malpractice.

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[87] Available at <https://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12651.htm> Last visit: 02/07/2021

[88] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm> Last visit: 02/07/2021

[89] Available at <https://www.semas.pa.gov.br/legislacao/files/pdf/506.pdf> Last visit: 02/07/2021

[90] Available at <https://www.semas.pa.gov.br/2015/09/11/in-05-de-10092015-publicada-no-doe-32969-de-11092015-paginas-de-37-57/> Last visit: 02/07/2021

[91] Available at <https://www.semas.pa.gov.br/2014/01/14/in-0012014-de-10-de-janeiro-de-2014-publicada-no-doepa-no32563-de-14012014-caderno-5-paginas-6-7-8/> Last visit 02/07/2021

[92] RIBEIRO, A.C.F. et al. O PLANO DE MANEJO FLORESTAL COMO INSTRUMENTO DE DESENVOLVIMENTO SUSTENTÁVEL NA AMAZÔNIA. Direito & Desenvolvimento, ISSN 2236-0859, 2020. Available at <https://periodicos.unipe.br/index.php/direitoedesenvolvimento/article/download/875/715/#:~:text=O%20Plano%20de%20Manejo%20Florestal%20Sustent%C3%A1vel%20%2D%20PMFS%20est%C3%A1%20intimamente%20relacionado,forma%20alcan%C3%A7armos%20um%20desenvolvimento%20ambiental>.

[93] 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.

The creation of protected areas is proven to be one of the most effective tools in forest conservation and the fight against deforestation. However, without management and investment, these important reserves do not attain their sustainable development goals, leaving them vulnerable to criminal activity such as land squatting, illegal wood harvesting and deforestation. This underlines the importance of REDD+ projects for forest conservation, despite being located in protected areas, because they are capable of contributing to the improvement of deforestation monitoring and control, promoting social, economic and environmental benefits in the region.

As Scenario II is the implementation of the SFMP with the addition of social environmental activities, as presented above, it is also in compliance with all applicable legal and regulatory requirements. Thus, there are no restrictions for SFMP within the areas where the ABC Norte REDD project's property is located.

Scenario III - Cattle raising in the Amazon Forest is legal as long as the owner follows the 80% Legal Reserve and Permanent Preservation Areas restriction described in the Brazilian legislation. The landowner must also provide a deforestation authorization for clearing the area for pasture. This authorization is provided by the State's government, and in Pará, is regulated by Normative Instruction nº 2, from July 6th, 2015[94], in addition to the National Forest Code (Law 12,651) and Decree 5,975.

Sub-step 1c. Selection of the baseline scenario

Based on the scenarios presented and the scenario of the ABC Norte operations in the period, the damage caused by the poor administration and execution of the previous management plan and the accumulated loss, it is possible to conclude that the baseline scenario is Scenario III.

Cattle ranching is the most profitable alternative land use, and thus, the most plausible scenario at the time. This is reinforced by the fact that it is already a company activity, and therefore it would be an acceptable change, even more so with the estimated financial return.

3.5 Additionality

For the purpose of the present analysis, the VCS Tool for the Demonstration and Assessment of Additionality in VCS Agricultural, Forestry and Other Land Use (AFOLU) Project Activities - VT0001 version 3.0[95] was applied. Following the STEP 1 described in section 3.4 above, this section describes STEPS 2 to 4.

STEP 2. Investment Analysis

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[94] https://www.semas.pa.gov.br/2015/07/08/instrucao-normativa-no-02-de-06-de-julho-de-2015-publicada-no-doepa-32923-de-06072015-in-022015-paginas-123-124/

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

Sub-step 2a. Determine appropriate analysis method

The ABC Norte REDD Project generates financial benefits other than the revenue from the sale of VCUs, primarily through the commercialization of timber, as a result of the sustainable forest management plan. Thus, two investment analysis comparison (Option II) will be carried out in order to determine the project's additionality, i.e, whether the proposed project activity, without the revenue from the sale of GHG credits, is economically or financially less attractive than the other land use scenarios.

Sub-step 2b. - Option II. Apply investment comparison analysis

An investment comparison analysis was performed to demonstrate which of the scenarios identified above is more financially attractive. For such analysis, the Net Present Value was considered the most appropriate financial indicator. Many articles on profitability of alternative land uses in areas under similar conditions to the project region applied the Net Present Value (NPV) for financial analysis, such as Amaral et al. (1998)[96], Barreto et al. (1998)[97], Schneider (2000)[98], Razera (2005)[99], Young et al. (2007)[100] and IDESAM (2014)[101].

Sub-step 2c. - Calculation and comparison of financial indicators

The following scenarios were analyzed as part of the investment analysis:

1. The implementation of a sustainable forest management plan within the project boundaries of the proposed VCS REDD project, however without carrying out additional social and environmental activities, as well as activities to reduce unplanned deforestation.
2. Implementation of a sustainable forest management plan, combined with the implementation of additional activities to reduce deforestation.
3. Land use change to cattle ranching.

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[97] BARRETO, P. et al. Custos e Benefícios do Manejo Florestal para Produção de Madeira na Amazônia Oriental. Série Amazônia N°10 - Belém: Imazon, 1998.

[98] SCHNEIDER, R. R. et al. Amazônia sustentável: limitantes e oportunidades para o desenvolvimento. Belém: Instituto do Homem e Meio Ambiente da Amazônia (IMAZON), 2000. 58 p.

[99] 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.

[100] ARIMA, E.; BARRETO, P.; BRITO, M. Pecuária na Amazônia: tendências e implicações para a conservação ambiental. Belém: Instituto do Homem e Meio Ambiente da Amazônia (IMAZON), 2005. 76 p.
173 YOUNG, C. E. F. et al. Rentabilidade da pecuária e custo de oportunidade privado da conservação no estado do Amazonas. 2007.

[101] INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Viabilidade econômica da pecuária semi-intensiva no sul do Amazonas: uma oportunidade para reduzir o avanço do desmatamento. Manaus: IDESAM, 2014. 48 p.

Under Scenario I, expenses are mostly related to sustainable forest management plan, while revenues derive from the commercialization of timber. Under scenario II, the same revenues and expenses are expected. However, scenario II involves additional expenses to reduce deforestation, such as the cost of monitoring the Project Area and promoting social and environmental activities with local communities. In Scenario III, expenses are related to the implementation of the livestock infrastructure, including animal purchase and clearing of the forest area. Revenues include not only animal selling, but also the sale of commercial wood removed during the clearing of the area. The key parameters considered on each scenario are described on the Table below.

Table 12. Main parameters used for the investment comparison analysis

Parameter	Scenario		
	Scenario I (in Brazilian Reais)	Scenario II (in Brazilian Reais)	Scenario III (in Brazilian Reais)
TOTAL REVENUES	**R$ 240,516,952.05**	**R$ 240,516,952.05**	**R$ 840,378,043.64**
Timber	R$ 240,516,952.05	R$ 240,516,952.05	R$ 251,856,329.51
Other (cattle ranching)	R$ 0.00	R$ 0.00	R$ 588,521,714.14
TOTAL EXPENSES	**-R$ 123,944,247.66**	**-R$ 177,747,920**	**-R$ 236,988,138.12**
SFMP costs	-R$ 123,944,247.66	-R$ 123,944,247.66	R$ 0.00
Forest conservation and socio environmental activities	R$ 0.00	-R$ 53,803,672.87	R$ 0.00
Other (cattle ranching)	R$ 0.00	R$ 0.00	-R$ 236,988,138.12

The Table below provides the results of the investment comparison analysis.

Table 13. Results from the investment analysis comparison between scenarios[102]

Investment Analysis Comparison - 30 years project lifetime (Brazilian Reais)			
Land use scenarios Variables	I - Sustainable Forest Management Plan (SFMP)	II – SFMP combined with the implementation of additional activities to reduce deforestation	III – Cattle Ranching
Total costs	-123,944,247.66	-177,747,920.53	–236,988,138.12
Total Revenues	240,516,952.05	240,516,952.05	840,378,043.64
Accumulated cashflow	116,572,704.40	62,769,031.53	599,364,382.40
NPV	32,435,252.98	17,928,606.53	252,783,883.50

Through this analysis, it can be concluded that scenarios I and III would have a higher Net Present Value than what was calculated for scenario II. The implementation of the present VCS AFOLU project over the project lifetime (30 years) would represent a decrease on the expected NPV that would be generated by the sustainable forest management activity alone.

This represents a significant barrier for adopting additional deforestation reduction practices. Scenario I, where no REDD activities are undertaken together with the SFMP, is a more economically attractive scenario than the measures proposed by the project activity. Considering an activity change, Scenario III presents a much higher profit, although having higher costs.

Therefore, all the additional costs to monitor and reduce deforestation would not be needed if the REDD project did not occur, thus making the proposed VCS AFOLU project without the financial benefits from VCUs substantially less attractive when comparing to other land use scenarios.

Sub-step 2d. - Sensitivity analysis

The objective of this sub-step is to demonstrate that the conclusion regarding the financial attractiveness of the project is robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument in favor of additionality only if it consistently supports the conclusion that the proposed VCS AFOLU project without the financial benefits from carbon credits is unlikely to be financially attractive.

To carry out the sensitivity analysis, the following variables were subject to reasonable variation:

[102] An eletronic spreadsheet with a detailed calculation of financial indicators and the comparison of both scenarios was made available for the auditing team.

● Cost of SFM activities, including the SFM Plan, Yearly operational Plan and other documents (Brazilian Reais/year);

● Cost for forest conservation measures and social and environmental activities required by the REDD Project (Brazilian Reais/year);

And, for the Scenario III, two analysis were developed:

- Analysis 1 – Cattle Ranching
  - Arroba value (Brazilian Reais/year)
  - Production costs (Brazilian Reais/year)
- Analysis 2 – Timber harvesting
  - m^3 value (Brazilian Reais/year)
  - Production costs (Brazilian Reais/year)

Revenues from SFMP will not be subjected to variations in this analysis, as the land owner has a leasing agreement with a Third Party. Such agreement establishes a fixed annual revenue from the leasing of harvesting activities on the Project Area.

The sensitivity analysis demonstrates that Scenario II would not be more feasible than Scenario I even if a variation of ±10% on the SFMP occurs. It is important to consider that any foreseeable change in these costs would likely occur in both scenarios, i.e., both scenarios would be impacted by changes in project operational costs. In addition, this indicates that forest conservation costs would need to be completely eliminated or be combined with a significant reduction in the cost of SFM activities to be comparable with the Scenario I's NPV.

In Scenario III case, the sensitivity analysis shows that even with a variation of 10% in the arroba value and production costs, cattle ranching would still be more economically feasible than the project activity. The same is observed with the timber harvesting analysis.

Figures below show the sensitivity analysis described above.

Figure 34. Sensitivity analysis for SFMP

			Variation on cost of forest conservation measures																				
			-10%	-9%	-8%	-7%	-6%	-5%	-4%	-3%	-2%	-1%	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
		R$ 17,928,607	R$ 1,761,924	R$ 1,781,501	R$ 1,801,078	R$ 1,820,655	R$ 1,840,232	R$ 1,859,809	R$ 1,879,386	R$ 1,898,962	R$ 1,918,539	R$ 1,938,116	R$ 1,957,693	R$ 1,977,270	R$ 1,996,847	R$ 2,016,424	R$ 2,036,001	R$ 2,055,578	R$ 2,075,155	R$ 2,094,732	R$ 2,114,309	R$ 2,133,886	R$ 2,153,463
Variation on costs of Sustainable forest management plan	-10%	R$3,851,801	R$ 21,828,360	R$ 21,705,962	R$ 21,583,565	R$ 21,461,167	R$ 21,338,769	R$ 21,216,372	R$ 21,093,974	R$ 20,971,576	R$ 20,849,178	R$ 20,726,781	R$ 20,604,383	R$ 20,481,985	R$ 20,359,588	R$ 20,237,190	R$ 20,114,792	R$ 19,992,395	R$ 19,869,997	R$ 19,747,599	R$ 19,625,202	R$ 19,502,804	R$ 19,380,406
	-9%	R$3,894,599	R$ 21,560,782	R$ 21,438,385	R$ 21,315,987	R$ 21,193,589	R$ 21,071,192	R$ 20,948,794	R$ 20,826,396	R$ 20,703,998	R$ 20,581,601	R$ 20,459,203	R$ 20,336,805	R$ 20,214,408	R$ 20,092,010	R$ 19,969,612	R$ 19,847,215	R$ 19,724,817	R$ 19,602,419	R$ 19,480,022	R$ 19,357,624	R$ 19,235,226	R$ 19,112,829
	-8%	R$3,937,396	R$ 21,293,205	R$ 21,170,807	R$ 21,048,409	R$ 20,926,012	R$ 20,803,614	R$ 20,681,216	R$ 20,558,819	R$ 20,436,421	R$ 20,314,023	R$ 20,191,625	R$ 20,069,228	R$ 19,946,830	R$ 19,824,432	R$ 19,702,035	R$ 19,579,637	R$ 19,457,239	R$ 19,334,842	R$ 19,212,444	R$ 19,090,046	R$ 18,967,649	R$ 18,845,251
	-7%	R$3,980,194	R$ 21,025,627	R$ 20,903,229	R$ 20,780,832	R$ 20,658,434	R$ 20,536,036	R$ 20,413,639	R$ 20,291,241	R$ 20,168,843	R$ 20,046,445	R$ 19,924,048	R$ 19,801,650	R$ 19,679,252	R$ 19,556,855	R$ 19,434,457	R$ 19,312,059	R$ 19,189,662	R$ 19,067,264	R$ 18,944,866	R$ 18,822,469	R$ 18,700,071	R$ 18,577,673
	-6%	R$4,022,992	R$ 20,758,049	R$ 20,635,652	R$ 20,513,254	R$ 20,390,856	R$ 20,268,459	R$ 20,146,061	R$ 20,023,663	R$ 19,901,266	R$ 19,778,868	R$ 19,656,470	R$ 19,534,072	R$ 19,411,675	R$ 19,289,277	R$ 19,166,879	R$ 19,044,482	R$ 18,922,084	R$ 18,799,686	R$ 18,677,289	R$ 18,554,891	R$ 18,432,493	R$ 18,310,096
	-5%	R$4,065,790	R$ 20,490,472	R$ 20,368,074	R$ 20,245,676	R$ 20,123,279	R$ 20,000,881	R$ 19,878,483	R$ 19,756,086	R$ 19,633,688	R$ 19,511,290	R$ 19,388,893	R$ 19,266,495	R$ 19,144,097	R$ 19,021,699	R$ 18,899,302	R$ 18,776,904	R$ 18,654,506	R$ 18,532,109	R$ 18,409,711	R$ 18,287,313	R$ 18,164,916	R$ 18,042,518
	-4%	R$4,108,588	R$ 20,222,894	R$ 20,100,496	R$ 19,978,099	R$ 19,855,701	R$ 19,733,303	R$ 19,610,906	R$ 19,488,508	R$ 19,366,110	R$ 19,243,713	R$ 19,121,315	R$ 18,998,917	R$ 18,876,519	R$ 18,754,122	R$ 18,631,724	R$ 18,509,326	R$ 18,386,929	R$ 18,264,531	R$ 18,142,133	R$ 18,019,736	R$ 17,897,338	R$ 17,774,940
	-3%	R$4,151,385	R$ 19,955,316	R$ 19,832,919	R$ 19,710,521	R$ 19,588,123	R$ 19,465,726	R$ 19,343,328	R$ 19,220,930	R$ 19,098,533	R$ 18,976,135	R$ 18,853,737	R$ 18,731,340	R$ 18,608,942	R$ 18,486,544	R$ 18,364,146	R$ 18,241,749	R$ 18,119,351	R$ 17,996,953	R$ 17,874,556	R$ 17,752,158	R$ 17,629,760	R$ 17,507,363
	-2%	R$4,194,183	R$ 19,687,739	R$ 19,565,341	R$ 19,442,943	R$ 19,320,546	R$ 19,198,148	R$ 19,075,750	R$ 18,953,353	R$ 18,830,955	R$ 18,708,557	R$ 18,586,160	R$ 18,463,762	R$ 18,341,364	R$ 18,218,966	R$ 18,096,569	R$ 17,974,171	R$ 17,851,773	R$ 17,729,376	R$ 17,606,978	R$ 17,484,580	R$ 17,362,183	R$ 17,239,785
	-1%	R$4,236,981	R$ 19,420,161	R$ 19,297,763	R$ 19,175,366	R$ 19,052,968	R$ 18,930,570	R$ 18,808,173	R$ 18,685,775	R$ 18,563,377	R$ 18,440,980	R$ 18,318,582	R$ 18,196,184	R$ 18,073,787	R$ 17,951,389	R$ 17,828,991	R$ 17,706,593	R$ 17,584,196	R$ 17,461,798	R$ 17,339,400	R$ 17,217,003	R$ 17,094,605	R$ 16,972,207
	0%	R$4,279,779	R$ 19,152,583	R$ 19,030,186	R$ 18,907,788	R$ 18,785,390	R$ 18,662,993	R$ 18,540,595	R$ 18,418,197	R$ 18,295,800	R$ 18,173,402	R$ 18,051,004	R$ 17,928,607	R$ 17,806,209	R$ 17,683,811	R$ 17,561,413	R$ 17,439,016	R$ 17,316,618	R$ 17,194,220	R$ 17,071,823	R$ 16,949,425	R$ 16,827,027	R$ 16,704,630
	1%	R$4,322,577	R$ 18,885,006	R$ 18,762,608	R$ 18,640,210	R$ 18,517,813	R$ 18,395,415	R$ 18,273,017	R$ 18,150,620	R$ 18,028,222	R$ 17,905,824	R$ 17,783,427	R$ 17,661,029	R$ 17,538,631	R$ 17,416,234	R$ 17,293,836	R$ 17,171,438	R$ 17,049,040	R$ 16,926,643	R$ 16,804,245	R$ 16,681,847	R$ 16,559,450	R$ 16,437,052
	2%	R$4,365,374	R$ 18,617,428	R$ 18,495,030	R$ 18,372,633	R$ 18,250,235	R$ 18,127,837	R$ 18,005,440	R$ 17,883,042	R$ 17,760,644	R$ 17,638,247	R$ 17,515,849	R$ 17,393,451	R$ 17,271,054	R$ 17,148,656	R$ 17,026,258	R$ 16,903,860	R$ 16,781,463	R$ 16,659,065	R$ 16,536,667	R$ 16,414,270	R$ 16,291,872	R$ 16,169,474
	3%	R$4,408,172	R$ 18,349,850	R$ 18,227,453	R$ 18,105,055	R$ 17,982,657	R$ 17,860,260	R$ 17,737,862	R$ 17,615,464	R$ 17,493,067	R$ 17,370,669	R$ 17,248,271	R$ 17,125,874	R$ 17,003,476	R$ 16,881,078	R$ 16,758,681	R$ 16,636,283	R$ 16,513,885	R$ 16,391,487	R$ 16,269,090	R$ 16,146,692	R$ 16,024,294	R$ 15,901,897
	4%	R$4,450,970	R$ 18,082,273	R$ 17,959,875	R$ 17,837,477	R$ 17,715,080	R$ 17,592,682	R$ 17,470,284	R$ 17,347,887	R$ 17,225,489	R$ 17,103,091	R$ 16,980,694	R$ 16,858,296	R$ 16,735,898	R$ 16,613,501	R$ 16,491,103	R$ 16,368,705	R$ 16,246,307	R$ 16,123,910	R$ 16,001,512	R$ 15,879,114	R$ 15,756,717	R$ 15,634,319
	5%	R$4,493,768	R$ 17,814,695	R$ 17,692,297	R$ 17,569,900	R$ 17,447,502	R$ 17,325,104	R$ 17,202,707	R$ 17,080,309	R$ 16,957,911	R$ 16,835,514	R$ 16,713,116	R$ 16,590,718	R$ 16,468,321	R$ 16,345,923	R$ 16,223,525	R$ 16,101,128	R$ 15,978,730	R$ 15,856,332	R$ 15,733,934	R$ 15,611,537	R$ 15,489,139	R$ 15,366,741
	6%	R$4,536,565	R$ 17,547,117	R$ 17,424,720	R$ 17,302,322	R$ 17,179,924	R$ 17,057,527	R$ 16,935,129	R$ 16,812,731	R$ 16,690,334	R$ 16,567,936	R$ 16,445,538	R$ 16,323,141	R$ 16,200,743	R$ 16,078,345	R$ 15,955,948	R$ 15,833,550	R$ 15,711,152	R$ 15,588,755	R$ 15,466,357	R$ 15,343,959	R$ 15,221,561	R$ 15,099,164
	7%	R$4,579,363	R$ 17,279,540	R$ 17,157,142	R$ 17,034,744	R$ 16,912,347	R$ 16,789,949	R$ 16,667,551	R$ 16,545,154	R$ 16,422,756	R$ 16,300,358	R$ 16,177,961	R$ 16,055,563	R$ 15,933,165	R$ 15,810,768	R$ 15,688,370	R$ 15,565,972	R$ 15,443,575	R$ 15,321,177	R$ 15,198,779	R$ 15,076,381	R$ 14,953,984	R$ 14,831,586
	8%	R$4,622,161	R$ 17,011,962	R$ 16,889,564	R$ 16,767,167	R$ 16,644,769	R$ 16,522,371	R$ 16,399,974	R$ 16,277,576	R$ 16,155,178	R$ 16,032,781	R$ 15,910,383	R$ 15,787,985	R$ 15,665,588	R$ 15,543,190	R$ 15,420,792	R$ 15,298,395	R$ 15,175,997	R$ 15,053,599	R$ 14,931,202	R$ 14,808,804	R$ 14,686,406	R$ 14,564,008
	9%	R$4,664,959	R$ 16,744,384	R$ 16,621,987	R$ 16,499,589	R$ 16,377,191	R$ 16,254,794	R$ 16,132,396	R$ 16,009,998	R$ 15,887,601	R$ 15,765,203	R$ 15,642,805	R$ 15,520,408	R$ 15,398,010	R$ 15,275,612	R$ 15,153,215	R$ 15,030,817	R$ 14,908,419	R$ 14,786,022	R$ 14,663,624	R$ 14,541,226	R$ 14,418,828	R$ 14,296,431
	10%	R$4,707,757	R$ 16,476,807	R$ 16,354,409	R$ 16,232,011	R$ 16,109,614	R$ 15,987,216	R$ 15,864,818	R$ 15,742,421	R$ 15,620,023	R$ 15,497,625	R$ 15,375,228	R$ 15,252,830	R$ 15,130,432	R$ 15,008,035	R$ 14,885,637	R$ 14,763,239	R$ 14,640,842	R$ 14,518,444	R$ 14,396,046	R$ 14,273,649	R$ 14,151,251	R$ 14,028,853

Figure 35. Sensitivity analysis for cattle ranching

ching			Variation on production costs						
			-10%	-9%	-8%	-7%	-6%	-5%	-4%
		R$ 252,783,884	R$ 294	R$ 297	R$ 301	R$ 304	R$ 307	R$ 311	R$ 314
Variation on arroba value	-10%	R$106	R$ 241,902,402	R$ 241,442,294	R$ 240,982,187	R$ 240,522,080	R$ 240,061,972	R$ 239,601,865	R$ 239,141,757
	-9%	R$107	R$ 243,450,657	R$ 242,990,550	R$ 242,530,443	R$ 242,070,335	R$ 241,610,228	R$ 241,150,120	R$ 240,690,013
	-8%	R$109	R$ 244,998,913	R$ 244,538,805	R$ 244,078,698	R$ 243,618,591	R$ 243,158,483	R$ 242,698,376	R$ 242,238,269
	-7%	R$110	R$ 246,547,168	R$ 246,087,061	R$ 245,626,954	R$ 245,166,846	R$ 244,706,739	R$ 244,246,631	R$ 243,786,524
	-6%	R$111	R$ 248,095,424	R$ 247,635,317	R$ 247,175,209	R$ 246,715,102	R$ 246,254,994	R$ 245,794,887	R$ 245,334,780
	-5%	R$112	R$ 249,643,680	R$ 249,183,572	R$ 248,723,465	R$ 248,263,357	R$ 247,803,250	R$ 247,343,143	R$ 246,883,035
	-4%	R$113	R$ 251,191,935	R$ 250,731,828	R$ 250,271,720	R$ 249,811,613	R$ 249,351,506	R$ 248,891,398	R$ 248,431,291
	-3%	R$114	R$ 252,740,191	R$ 252,280,083	R$ 251,819,976	R$ 251,359,868	R$ 250,899,761	R$ 250,439,654	R$ 249,979,546
	-2%	R$116	R$ 254,288,446	R$ 253,828,339	R$ 253,368,231	R$ 252,908,124	R$ 252,448,017	R$ 251,987,909	R$ 251,527,802
	-1%	R$117	R$ 255,836,702	R$ 255,376,594	R$ 254,916,487	R$ 254,456,380	R$ 253,996,272	R$ 253,536,165	R$ 253,076,057
	0%	R$118	R$ 257,384,957	R$ 256,924,850	R$ 256,464,743	R$ 256,004,635	R$ 255,544,528	R$ 255,084,420	R$ 254,624,313
	1%	R$119	R$ 258,933,213	R$ 258,473,105	R$ 258,012,998	R$ 257,552,891	R$ 257,092,783	R$ 256,632,676	R$ 256,172,569
	2%	R$120	R$ 260,481,468	R$ 260,021,361	R$ 259,561,254	R$ 259,101,146	R$ 258,641,039	R$ 258,180,932	R$ 257,720,824
	3%	R$122	R$ 262,029,724	R$ 261,569,617	R$ 261,109,509	R$ 260,649,402	R$ 260,189,294	R$ 259,729,187	R$ 259,269,080
	4%	R$123	R$ 263,577,980	R$ 263,117,872	R$ 262,657,765	R$ 262,197,657	R$ 261,737,550	R$ 261,277,443	R$ 260,817,335
	5%	R$124	R$ 265,126,235	R$ 264,666,128	R$ 264,206,020	R$ 263,745,913	R$ 263,285,806	R$ 262,825,698	R$ 262,365,591
	6%	R$125	R$ 266,674,491	R$ 266,214,383	R$ 265,754,276	R$ 265,294,169	R$ 264,834,061	R$ 264,373,954	R$ 263,913,846
	7%	R$126	R$ 268,222,746	R$ 267,762,639	R$ 267,302,531	R$ 266,842,424	R$ 266,382,317	R$ 265,922,209	R$ 265,462,102
	8%	R$127	R$ 269,771,002	R$ 269,310,894	R$ 268,850,787	R$ 268,390,680	R$ 267,930,572	R$ 267,470,465	R$ 267,010,358
	9%	R$129	R$ 271,319,257	R$ 270,859,150	R$ 270,399,043	R$ 269,938,935	R$ 269,478,828	R$ 269,018,720	R$ 268,558,613
	10%	R$130	R$ 272,867,513	R$ 272,407,406	R$ 271,947,298	R$ 271,487,191	R$ 271,027,083	R$ 270,566,976	R$ 270,106,869

		-3%	-2%	-1%	0%	1%	2%	3%
	R$ 252,783,884	R$ 317	R$ 320	R$ 324	R$ 327	R$ 330	R$ 333	R$ 337
-10%	R$106	R$ 238,681,650	R$ 238,221,543	R$ 237,761,435	R$ 237,301,328	R$ 236,841,221	R$ 236,381,113	R$ 235,921,006
-9%	R$107	R$ 240,229,906	R$ 239,769,798	R$ 239,309,691	R$ 238,849,583	R$ 238,389,476	R$ 237,929,369	R$ 237,469,261
-8%	R$109	R$ 241,778,161	R$ 241,318,054	R$ 240,857,946	R$ 240,397,839	R$ 239,937,732	R$ 239,477,624	R$ 239,017,517
-7%	R$110	R$ 243,326,417	R$ 242,866,309	R$ 242,406,202	R$ 241,946,095	R$ 241,485,987	R$ 241,025,880	R$ 240,565,772
-6%	R$111	R$ 244,874,672	R$ 244,414,565	R$ 243,954,458	R$ 243,494,350	R$ 243,034,243	R$ 242,574,135	R$ 242,114,028
-5%	R$112	R$ 246,422,928	R$ 245,962,820	R$ 245,502,713	R$ 245,042,606	R$ 244,582,498	R$ 244,122,391	R$ 243,662,284
-4%	R$113	R$ 247,971,183	R$ 247,511,076	R$ 247,050,969	R$ 246,590,861	R$ 246,130,754	R$ 245,670,646	R$ 245,210,539
-3%	R$114	R$ 249,519,439	R$ 249,059,332	R$ 248,599,224	R$ 248,139,117	R$ 247,679,009	R$ 247,218,902	R$ 246,758,795
-2%	R$116	R$ 251,067,695	R$ 250,607,587	R$ 250,147,480	R$ 249,687,372	R$ 249,227,265	R$ 248,767,158	R$ 248,307,050
-1%	R$117	R$ 252,615,950	R$ 252,155,843	R$ 251,695,735	R$ 251,235,628	R$ 250,775,521	R$ 250,315,413	R$ 249,855,306
0%	R$118	R$ 254,164,206	R$ 253,704,098	R$ 253,243,991	R$ 252,783,884	R$ 252,323,776	R$ 251,863,669	R$ 251,403,561
1%	R$119	R$ 255,712,461	R$ 255,252,354	R$ 254,792,246	R$ 254,332,139	R$ 253,872,032	R$ 253,411,924	R$ 252,951,817
2%	R$120	R$ 257,260,717	R$ 256,800,609	R$ 256,340,502	R$ 255,880,395	R$ 255,420,287	R$ 254,960,180	R$ 254,500,072
3%	R$122	R$ 258,808,972	R$ 258,348,865	R$ 257,888,758	R$ 257,428,650	R$ 256,968,543	R$ 256,508,435	R$ 256,048,328
4%	R$123	R$ 260,357,228	R$ 259,897,121	R$ 259,437,013	R$ 258,976,906	R$ 258,516,798	R$ 258,056,691	R$ 257,596,584
5%	R$124	R$ 261,905,483	R$ 261,445,376	R$ 260,985,269	R$ 260,525,161	R$ 260,065,054	R$ 259,604,947	R$ 259,144,839
6%	R$125	R$ 263,453,739	R$ 262,993,632	R$ 262,533,524	R$ 262,073,417	R$ 261,613,309	R$ 261,153,202	R$ 260,693,095
7%	R$126	R$ 265,001,995	R$ 264,541,887	R$ 264,081,780	R$ 263,621,672	R$ 263,161,565	R$ 262,701,458	R$ 262,241,350
8%	R$127	R$ 266,550,250	R$ 266,090,143	R$ 265,630,035	R$ 265,169,928	R$ 264,709,821	R$ 264,249,713	R$ 263,789,606
9%	R$129	R$ 268,098,506	R$ 267,638,398	R$ 267,178,291	R$ 266,718,184	R$ 266,258,076	R$ 265,797,969	R$ 265,337,861
10%	R$130	R$ 269,646,761	R$ 269,186,654	R$ 268,726,546	R$ 268,266,439	R$ 267,806,332	R$ 267,346,224	R$ 266,886,117

		4%	5%	6%	7%	8%	9%	10%
	R$ 252,783,884	R$ 340	R$ 343	R$ 346	R$ 350	R$ 353	R$ 356	R$ 360
-10%	R$106	R$ 235,460,898	R$ 235,000,791	R$ 234,540,684	R$ 234,080,576	R$ 233,620,469	R$ 233,160,361	R$ 232,700,254
-9%	R$107	R$ 237,009,154	R$ 236,549,047	R$ 236,088,939	R$ 235,628,832	R$ 235,168,724	R$ 234,708,617	R$ 234,248,510
-8%	R$109	R$ 238,557,409	R$ 238,097,302	R$ 237,637,195	R$ 237,177,087	R$ 236,716,980	R$ 236,256,873	R$ 235,796,765
-7%	R$110	R$ 240,105,665	R$ 239,645,558	R$ 239,185,450	R$ 238,725,343	R$ 238,265,236	R$ 237,805,128	R$ 237,345,021
-6%	R$111	R$ 241,653,921	R$ 241,193,813	R$ 240,733,706	R$ 240,273,598	R$ 239,813,491	R$ 239,353,384	R$ 238,893,276
-5%	R$112	R$ 243,202,176	R$ 242,742,069	R$ 242,281,961	R$ 241,821,854	R$ 241,361,747	R$ 240,901,639	R$ 240,441,532
-4%	R$113	R$ 244,750,432	R$ 244,290,324	R$ 243,830,217	R$ 243,370,110	R$ 242,910,002	R$ 242,449,895	R$ 241,989,787
-3%	R$114	R$ 246,298,687	R$ 245,838,580	R$ 245,378,473	R$ 244,918,365	R$ 244,458,258	R$ 243,998,150	R$ 243,538,043
-2%	R$116	R$ 247,846,943	R$ 247,386,835	R$ 246,926,728	R$ 246,466,621	R$ 246,006,513	R$ 245,546,406	R$ 245,086,299
-1%	R$117	R$ 249,395,198	R$ 248,935,091	R$ 248,474,984	R$ 248,014,876	R$ 247,554,769	R$ 247,094,662	R$ 246,634,554
0%	R$118	R$ 250,943,454	R$ 250,483,347	R$ 250,023,239	R$ 249,563,132	R$ 249,103,024	R$ 248,642,917	R$ 248,182,810
1%	R$119	R$ 252,491,710	R$ 252,031,602	R$ 251,571,495	R$ 251,111,387	R$ 250,651,280	R$ 250,191,173	R$ 249,731,065
2%	R$120	R$ 254,039,965	R$ 253,579,858	R$ 253,119,750	R$ 252,659,643	R$ 252,199,536	R$ 251,739,428	R$ 251,279,321
3%	R$122	R$ 255,588,221	R$ 255,128,113	R$ 254,668,006	R$ 254,207,899	R$ 253,747,791	R$ 253,287,684	R$ 252,827,576
4%	R$123	R$ 257,136,476	R$ 256,676,369	R$ 256,216,261	R$ 255,756,154	R$ 255,296,047	R$ 254,835,939	R$ 254,375,832
5%	R$124	R$ 258,684,732	R$ 258,224,624	R$ 257,764,517	R$ 257,304,410	R$ 256,844,302	R$ 256,384,195	R$ 255,924,087
6%	R$125	R$ 260,232,987	R$ 259,772,880	R$ 259,312,773	R$ 258,852,665	R$ 258,392,558	R$ 257,932,450	R$ 257,472,343
7%	R$126	R$ 261,781,243	R$ 261,321,136	R$ 260,861,028	R$ 260,400,921	R$ 259,940,813	R$ 259,480,706	R$ 259,020,599
8%	R$127	R$ 263,329,498	R$ 262,869,391	R$ 262,409,284	R$ 261,949,176	R$ 261,489,069	R$ 261,028,962	R$ 260,568,854
9%	R$129	R$ 264,877,754	R$ 264,417,647	R$ 263,957,539	R$ 263,497,432	R$ 263,037,324	R$ 262,577,217	R$ 262,117,110
10%	R$130	R$ 266,426,010	R$ 265,965,902	R$ 265,505,795	R$ 265,045,687	R$ 264,585,580	R$ 264,125,473	R$ 263,665,365

Figure 36. Sensitivity analysis for timber harvesting in cattle ranch scenario

			-10%	-9%	-8%	-7%	-6%	-5%	-4%
		R$ 252,783,884	R$ 2,780	R$ 2,811	R$ 2,841	R$ 2,872	R$ 2,903	R$ 2,934	R$ 2,965
Variation on m³ value	-10%	R$198	R$ 236,568,042	R$ 236,089,401	R$ 235,610,760	R$ 235,132,118	R$ 234,653,477	R$ 234,174,836	R$ 233,696,195
	-9%	R$200	R$ 238,668,267	R$ 238,189,626	R$ 237,710,985	R$ 237,232,344	R$ 236,753,703	R$ 236,275,061	R$ 235,796,420
	-8%	R$202	R$ 240,768,493	R$ 240,289,852	R$ 239,811,210	R$ 239,332,569	R$ 238,853,928	R$ 238,375,287	R$ 237,896,645
	-7%	R$205	R$ 242,868,718	R$ 242,390,077	R$ 241,911,436	R$ 241,432,795	R$ 240,954,153	R$ 240,475,512	R$ 239,996,871
	-6%	R$207	R$ 244,968,944	R$ 244,490,302	R$ 244,011,661	R$ 243,533,020	R$ 243,054,379	R$ 242,575,737	R$ 242,097,096
	-5%	R$209	R$ 247,069,169	R$ 246,590,528	R$ 246,111,887	R$ 245,633,245	R$ 245,154,604	R$ 244,675,963	R$ 244,197,322
	-4%	R$211	R$ 249,169,394	R$ 248,690,753	R$ 248,212,112	R$ 247,733,471	R$ 247,254,829	R$ 246,776,188	R$ 246,297,547
	-3%	R$213	R$ 251,269,620	R$ 250,790,979	R$ 250,312,337	R$ 249,833,696	R$ 249,355,055	R$ 248,876,414	R$ 248,397,772
	-2%	R$216	R$ 253,369,845	R$ 252,891,204	R$ 252,412,563	R$ 251,933,921	R$ 251,455,280	R$ 250,976,639	R$ 250,497,998
	-1%	R$218	R$ 255,470,071	R$ 254,991,429	R$ 254,512,788	R$ 254,034,147	R$ 253,555,506	R$ 253,076,864	R$ 252,598,223
	0%	R$220	R$ 257,570,296	R$ 257,091,655	R$ 256,613,013	R$ 256,134,372	R$ 255,655,731	R$ 255,177,090	R$ 254,698,448
	1%	R$222	R$ 259,670,521	R$ 259,191,880	R$ 258,713,239	R$ 258,234,598	R$ 257,755,956	R$ 257,277,315	R$ 256,798,674
	2%	R$224	R$ 261,770,747	R$ 261,292,105	R$ 260,813,464	R$ 260,334,823	R$ 259,856,182	R$ 259,377,540	R$ 258,898,899
	3%	R$227	R$ 263,870,972	R$ 263,392,331	R$ 262,913,690	R$ 262,435,048	R$ 261,956,407	R$ 261,477,766	R$ 260,999,125
	4%	R$229	R$ 265,971,197	R$ 265,492,556	R$ 265,013,915	R$ 264,535,274	R$ 264,056,632	R$ 263,577,991	R$ 263,099,350
	5%	R$231	R$ 268,071,423	R$ 267,592,782	R$ 267,114,140	R$ 266,635,499	R$ 266,156,858	R$ 265,678,217	R$ 265,199,575
	6%	R$233	R$ 270,171,648	R$ 269,693,007	R$ 269,214,366	R$ 268,735,724	R$ 268,257,083	R$ 267,778,442	R$ 267,299,801
	7%	R$235	R$ 272,271,874	R$ 271,793,232	R$ 271,314,591	R$ 270,835,950	R$ 270,357,309	R$ 269,878,667	R$ 269,400,026
	8%	R$238	R$ 274,372,099	R$ 273,893,458	R$ 273,414,816	R$ 272,936,175	R$ 272,457,534	R$ 271,978,893	R$ 271,500,251
	9%	R$240	R$ 276,472,324	R$ 275,993,683	R$ 275,515,042	R$ 275,036,401	R$ 274,557,759	R$ 274,079,118	R$ 273,600,477
	10%	R$242	R$ 278,572,550	R$ 278,093,908	R$ 277,615,267	R$ 277,136,626	R$ 276,657,985	R$ 276,179,343	R$ 275,700,702

		-3%	-2%	-1%	0%	1%	2%	3%
	R$ 252,783,884	R$ 2,996	R$ 3,027	R$ 3,058	R$ 3,089	R$ 3,119	R$ 3,150	R$ 3,181
-10%	R$198	R$ 233,217,553	R$ 232,738,912	R$ 232,260,271	R$ 231,781,630	R$ 231,302,988	R$ 230,824,347	R$ 230,345,706
-9%	R$200	R$ 235,317,779	R$ 234,839,138	R$ 234,360,496	R$ 233,881,855	R$ 233,403,214	R$ 232,924,573	R$ 232,445,931
-8%	R$202	R$ 237,418,004	R$ 236,939,363	R$ 236,460,722	R$ 235,982,080	R$ 235,503,439	R$ 235,024,798	R$ 234,546,157
-7%	R$205	R$ 239,518,230	R$ 239,039,588	R$ 238,560,947	R$ 238,082,306	R$ 237,603,665	R$ 237,125,023	R$ 236,646,382
-6%	R$207	R$ 241,618,455	R$ 241,139,814	R$ 240,661,172	R$ 240,182,531	R$ 239,703,890	R$ 239,225,249	R$ 238,746,608
-5%	R$209	R$ 243,718,680	R$ 243,240,039	R$ 242,761,398	R$ 242,282,757	R$ 241,804,115	R$ 241,325,474	R$ 240,846,833
-4%	R$211	R$ 245,818,906	R$ 245,340,264	R$ 244,861,623	R$ 244,382,982	R$ 243,904,341	R$ 243,425,700	R$ 242,947,058
-3%	R$213	R$ 247,919,131	R$ 247,440,490	R$ 246,961,849	R$ 246,483,207	R$ 246,004,566	R$ 245,525,925	R$ 245,047,284
-2%	R$216	R$ 250,019,356	R$ 249,540,715	R$ 249,062,074	R$ 248,583,433	R$ 248,104,792	R$ 247,626,150	R$ 247,147,509
-1%	R$218	R$ 252,119,582	R$ 251,640,941	R$ 251,162,299	R$ 250,683,658	R$ 250,205,017	R$ 249,726,376	R$ 249,247,734
0%	R$220	R$ 254,219,807	R$ 253,741,166	R$ 253,262,525	R$ 252,783,884	R$ 252,305,242	R$ 251,826,601	R$ 251,347,960
1%	R$222	R$ 256,320,033	R$ 255,841,391	R$ 255,362,750	R$ 254,884,109	R$ 254,405,468	R$ 253,926,826	R$ 253,448,185
2%	R$224	R$ 258,420,258	R$ 257,941,617	R$ 257,462,975	R$ 256,984,334	R$ 256,505,693	R$ 256,027,052	R$ 255,548,411
3%	R$227	R$ 260,520,483	R$ 260,041,842	R$ 259,563,201	R$ 259,084,560	R$ 258,605,918	R$ 258,127,277	R$ 257,648,636
4%	R$229	R$ 262,620,709	R$ 262,142,067	R$ 261,663,426	R$ 261,184,785	R$ 260,706,144	R$ 260,227,503	R$ 259,748,861
5%	R$231	R$ 264,720,934	R$ 264,242,293	R$ 263,763,652	R$ 263,285,010	R$ 262,806,369	R$ 262,327,728	R$ 261,849,087
6%	R$233	R$ 266,821,159	R$ 266,342,518	R$ 265,863,877	R$ 265,385,236	R$ 264,906,595	R$ 264,427,953	R$ 263,949,312
7%	R$235	R$ 268,921,385	R$ 268,442,744	R$ 267,964,102	R$ 267,485,461	R$ 267,006,820	R$ 266,528,179	R$ 266,049,537
8%	R$238	R$ 271,021,610	R$ 270,542,969	R$ 270,064,328	R$ 269,585,687	R$ 269,107,045	R$ 268,628,404	R$ 268,149,763
9%	R$240	R$ 273,121,836	R$ 272,643,194	R$ 272,164,553	R$ 271,685,912	R$ 271,207,271	R$ 270,728,629	R$ 270,249,988
10%	R$242	R$ 275,222,061	R$ 274,743,420	R$ 274,264,779	R$ 273,786,137	R$ 273,307,496	R$ 272,828,855	R$ 272,350,214

		4%	5%	6%	7%	8%	9%	10%
	R$ 252,783,884	R$ 3,212	R$ 3,243	R$ 3,274	R$ 3,305	R$ 3,336	R$ 3,366	R$ 3,397
-10%	R$198	R$ 229,867,065	R$ 229,388,424	R$ 228,909,782	R$ 228,431,141	R$ 227,952,500	R$ 227,473,859	R$ 226,995,217
-9%	R$200	R$ 231,967,290	R$ 231,488,649	R$ 231,010,008	R$ 230,531,366	R$ 230,052,725	R$ 229,574,084	R$ 229,095,443
-8%	R$202	R$ 234,067,516	R$ 233,588,874	R$ 233,110,233	R$ 232,631,592	R$ 232,152,951	R$ 231,674,309	R$ 231,195,668
-7%	R$205	R$ 236,167,741	R$ 235,689,100	R$ 235,210,458	R$ 234,731,817	R$ 234,253,176	R$ 233,774,535	R$ 233,295,893
-6%	R$207	R$ 238,267,966	R$ 237,789,325	R$ 237,310,684	R$ 236,832,043	R$ 236,353,401	R$ 235,874,760	R$ 235,396,119
-5%	R$209	R$ 240,368,192	R$ 239,889,550	R$ 239,410,909	R$ 238,932,268	R$ 238,453,627	R$ 237,974,985	R$ 237,496,344
-4%	R$211	R$ 242,468,417	R$ 241,989,776	R$ 241,511,135	R$ 241,032,493	R$ 240,553,852	R$ 240,075,211	R$ 239,596,570
-3%	R$213	R$ 244,568,642	R$ 244,090,001	R$ 243,611,360	R$ 243,132,719	R$ 242,654,077	R$ 242,175,436	R$ 241,696,795
-2%	R$216	R$ 246,668,868	R$ 246,190,227	R$ 245,711,585	R$ 245,232,944	R$ 244,754,303	R$ 244,275,662	R$ 243,797,020
-1%	R$218	R$ 248,769,093	R$ 248,290,452	R$ 247,811,811	R$ 247,333,169	R$ 246,854,528	R$ 246,375,887	R$ 245,897,246
0%	R$220	R$ 250,869,319	R$ 250,390,677	R$ 249,912,036	R$ 249,433,395	R$ 248,954,754	R$ 248,476,112	R$ 247,997,471
1%	R$222	R$ 252,969,544	R$ 252,490,903	R$ 252,012,261	R$ 251,533,620	R$ 251,054,979	R$ 250,576,338	R$ 250,097,696
2%	R$224	R$ 255,069,769	R$ 254,591,128	R$ 254,112,487	R$ 253,633,846	R$ 253,155,204	R$ 252,676,563	R$ 252,197,922
3%	R$227	R$ 257,169,995	R$ 256,691,353	R$ 256,212,712	R$ 255,734,071	R$ 255,255,430	R$ 254,776,788	R$ 254,298,147
4%	R$229	R$ 259,270,220	R$ 258,791,579	R$ 258,312,938	R$ 257,834,296	R$ 257,355,655	R$ 256,877,014	R$ 256,398,373
5%	R$231	R$ 261,370,445	R$ 260,891,804	R$ 260,413,163	R$ 259,934,522	R$ 259,455,880	R$ 258,977,239	R$ 258,498,598
6%	R$233	R$ 263,470,671	R$ 262,992,030	R$ 262,513,388	R$ 262,034,747	R$ 261,556,106	R$ 261,077,465	R$ 260,598,823
7%	R$235	R$ 265,570,896	R$ 265,092,255	R$ 264,613,614	R$ 264,134,972	R$ 263,656,331	R$ 263,177,690	R$ 262,699,049
8%	R$238	R$ 267,671,122	R$ 267,192,480	R$ 266,713,839	R$ 266,235,198	R$ 265,756,557	R$ 265,277,915	R$ 264,799,274
9%	R$240	R$ 269,771,347	R$ 269,292,706	R$ 268,814,064	R$ 268,335,423	R$ 267,856,782	R$ 267,378,141	R$ 266,899,500
10%	R$242	R$ 271,871,572	R$ 271,392,931	R$ 270,914,290	R$ 270,435,649	R$ 269,957,007	R$ 269,478,366	R$ 268,999,725

It is not expected that any large variation of project costs will occur, as the average inflation during 2007-2017 period was 6%/year[103]. Preventing deforestation is a complex and resource demanding activity, which involves personnel, technology and the engagement with local communities in an area with more than 120,000 hectares. Therefore, the magnitude of these costs is a reflection of the complexity of developing an AFOLU REDD Project and maintaining measures to prevent deforestation and degradation. Such activities need to be performed either by for-profit organizations (such as consultancy companies) or by internal staff, that must be compensated for their services.

The conditions to allow Scenario II to be more financially attractive than Scenario I and III are considered unlikely by the Project Proponents. Hence, the land owner would hardly invest in activities to prevent deforestation beyond what is required by the appliable legislation in the absence of the REDD project.

Since the sensitivity analysis allows determining the VCS AFOLU project without the financial benefits from the VCS is unlikely to be financially attractive, a common practice analysis will be demonstrated next.

STEP 4. Common practice analysis

The previous steps shall be complemented with an analysis of the extent to which similar activities have already diffused in the geographical area of the ABC Norte REDD project activity. Similar activities to the proposed REDD project, i.e., that are of similar scale, take place in a comparable environment, inter alia,

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103 Annual inflation (IPCA), cumulative value per year. Available at: <https://www.inflation.eu/pt/taxas-de-inflacao/brasil/inflacao-historica/ipc-inflacao-brasil.aspx>.

with respect to the regulatory framework and are undertaken in the relevant geographical area, shall be analyzed. Other registered VCS AFOLU Project activities shall not be included in this analysis.

As shown in the previous sections, logging is an important economic agent in the state of Pará, especially in the municipality of Portel and Bagre, municipalities in the project area.

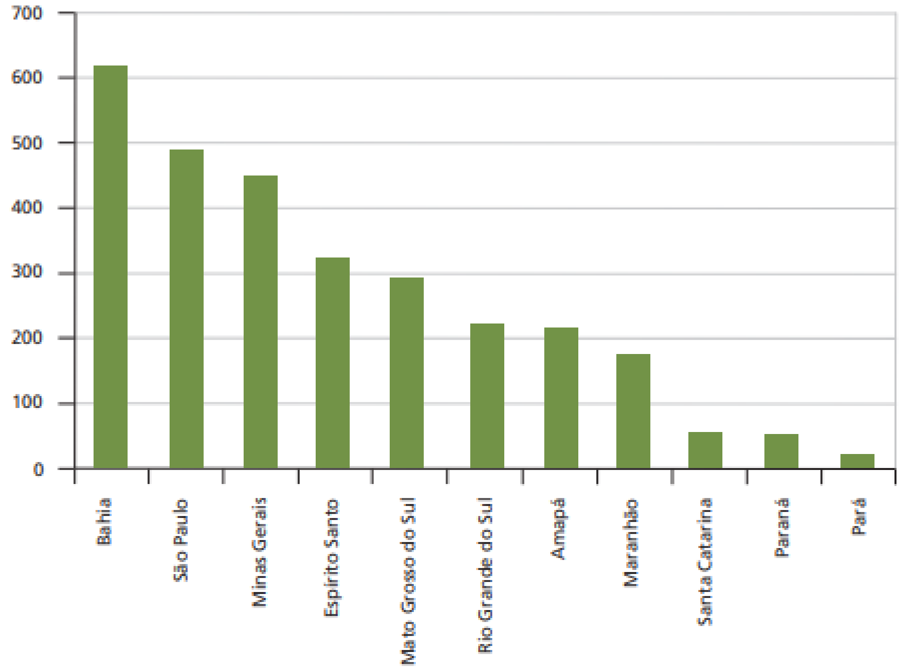
In an analysis carried out with information from Secretaria do Meio Ambiente do Pará[104] (Pará Department of Environment), there are currently 1,241 establishments with a Sustainable Forest Management Plan registered in the State of Pará. Of these, 44 are located in the municipalities of Portel and Bagre. In addition to Fazenda Pacajá, 2 others have areas above 50 thousand hectares, which are owned by the same company. These areas don't have CERFLOR or FSC certifications. In Baião, municipality next to Portel, there is one area with over 100 thousand hectares, and it makes frontier with Fazenda Pacajá. This area is owned by other company, and it has FSC Certification since 2015

- **CERFLOR/PEFC certification**

According to information of the National System of Forest Information[105], in 2017, there were 3,072,628 ha of CERFLOR certified forest area. In 2016, 22 sustainable forest management plans were certified, totaling 2,905,578.69 ha[106]. Figure below presents the number of certified hectares for each state:

[104] Available at <https://www.semas.pa.gov.br/analisecar/geoprocessamento.php>
[105] Available at <https://snif.florestal.gov.br/pt-br/certificacao-florestal/322-certificacao-cerflor>
[106] Data available at <http://repositorio.ipea.gov.br/bitstream/11058/9233/1/Contribui%C3%A7%C3%A3o%20da%20certifica%C3%A7%C3%A3o.pdf>

Figure 37. CERFLOR certified area, per state (data from 2016, in thousand ha)[107]



Thus, it can be stated that Pará state does not have a significant share in certificated areas in Brazil.

In 2021, 117 companies with CERFLOR/PEFC certification were identified throughout Brazil with valid and active certificates, 18 of which in the same category as Fazenda Pacajá[108]. 3 of them, in addition to Fazenda Pacajá, are located in Pará. Of the 18, only 3 are categorized as Productive Forest (that is, management of native species and non-planted forest): Fazenda Pacajá, another area located in Pará, and one in Amapá. The other 15 are pine and eucalyptus plantation areas.

Of the two other areas with certificated native productive forest, it was noted that one of them develops a REDD Project, thus, it won't be included in this common practice analysis. Therefore, only one area has a similar project activity, located in Amapá State. After the assessment of the SFMP, however, it was possible to conclude that the management area is in a public forest under a Forest Concession Contract, where the government allows the use of the forest resources in state, municipal and union public forests. In addition, the proposed project area is 140,432.27 ha, while the Amapá area is 67.434,7874 ha, less than half of the proposed area.

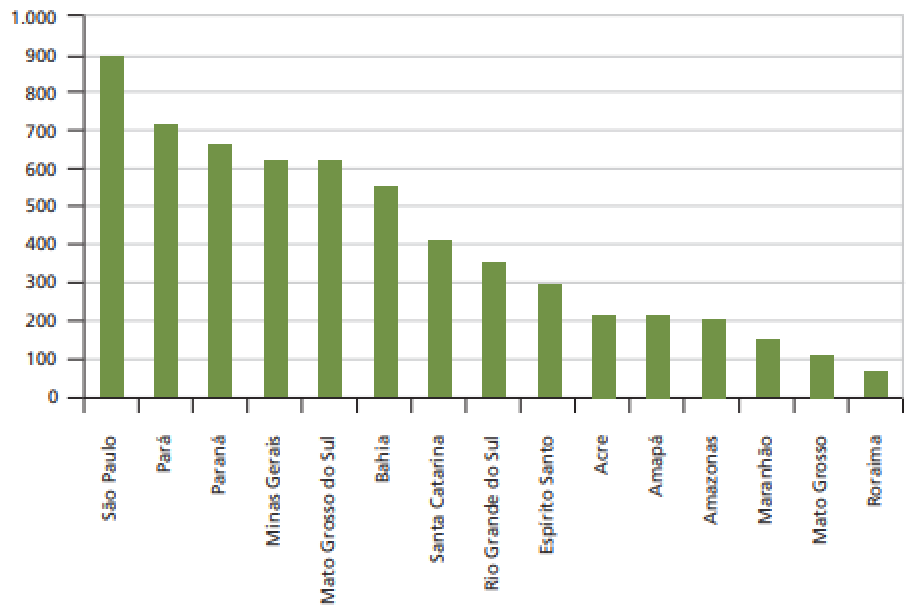
Therefore, it may be concluded that as Fazenda Pacajá is a private area, without any benefit from the public power, or concession area, the proposed project activity is not common practice in the region or in the country, being differentiated even from similar activities.

[107] Available at <http://repositorio.ipea.gov.br/bitstream/11058/9233/1/Contribui%C3%A7%C3%A3o%20da%20certifica%C3%A7%C3%A3o.pdf>
[108] This assessment included Forest Management certificate types for Wood manufacturers products in Brazil. Information available at: https://www.pefc.org/find-certified. Data from 2021.

- FSC

Data from 2016 shows that Brazil has 6.035.377,86 ha certified in the forest management category, in 106 management units. Of this, 1.244.497,18 ha are from native forest and 4.798.880,68 ha from planted forests[109]. There are 37 certified entities in Pará State, 11 of them for their forest management[110]. Figure below presents the certified hectares in each state:

Figure 38. FSC certified area, per state (data from 2016, in thousand ha)



It is possible to conclude that certified sustainable forest management plan is not a common practice in the Amazon Rainforest, and, according to the presented data, are concentrated in areas in the center-south and southeast of the country, generally associated with paper companies.

Therefore, the proposed project activity is not considered a common practice in the region. Thus, the proposed VCS AFOLU project is not the baseline scenario and, hence, it is additional.

3.6 Methodology Deviations

This project activity does not apply any methodology deviations.

[109] http://repositorio.ipea.gov.br/bitstream/11058/9233/1/Contribui%C3%A7%C3%A3o%20da%20certifica%C3%A7%C3%A3o.pdf
[110] https://br.fsc.org/preview.o-liberal-fsc-brasil-garante-certificao-no-par-por-brenda-pantoja.a-992.pdf

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Analysis of historical land-use and land-cover change

- Collection of appropriate data sources

GIS MAPPING, REMOTE SENSING TECHNIQUES

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

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

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

In order to compose the entire reference region, three Landsat scenes per year (orbit/point: 225/62, 225/61 and 224/62) from the reference period were required (Table 11). The final mapping resolution was 30 m pixel.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[111] 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

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

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

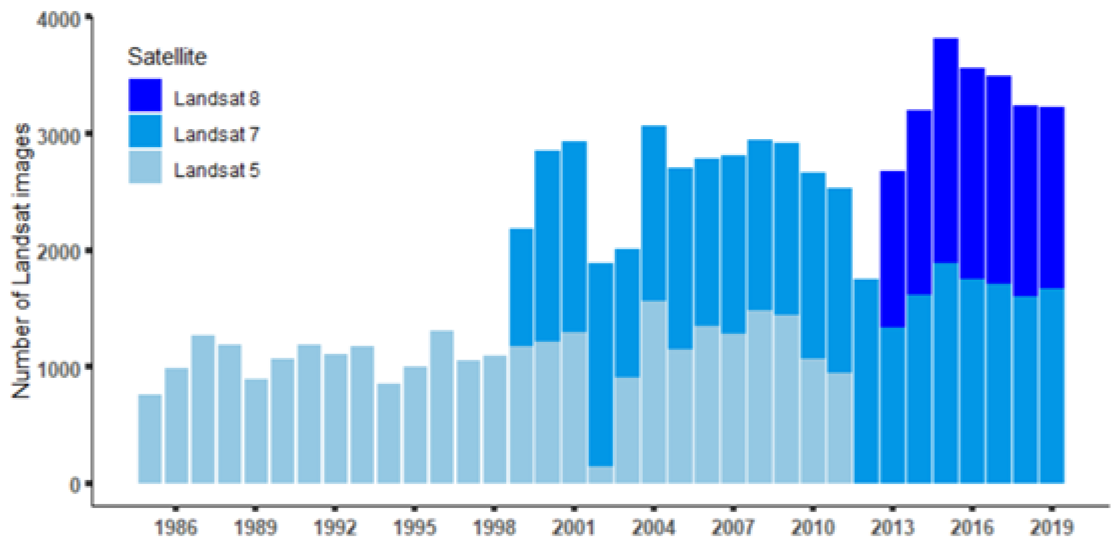
The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomas series and direct collection by visual interpretation of Landsat images to classify as a single map per class. This classification then goes through the stages of the spatial filter, applying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

For the supervised classification of September 2017, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomas methodology. In order to obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 5% cloud cover limit were collected within the Reference Region and an average of these images was generated. Training samples were generated for each land use class (forest, water and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. Then the spatial filter with the Majority Filter tool from ArcGIS was applied using an 8-pixel neighborhood. This filter is used in MapBiomas in order to avoid unwanted modifications on the edges of pixel groups (blobs).

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

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(km²)	DD/MM/YYYear	Path	Row
Satellite	Landsat TM	30	0.45-2.35	34,225	2007 - 2017	225	62
Satellite	Landsat TM	30	0.45-2.35	34,225	2007 - 2017	225	61
Satellite	Landsat TM	30	0.45-2.35	34,225	2007-2017	224	62

Figure 39. Number of Landsat images for mapping the Amazon. Source: MapBiomas



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

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

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

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

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

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

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

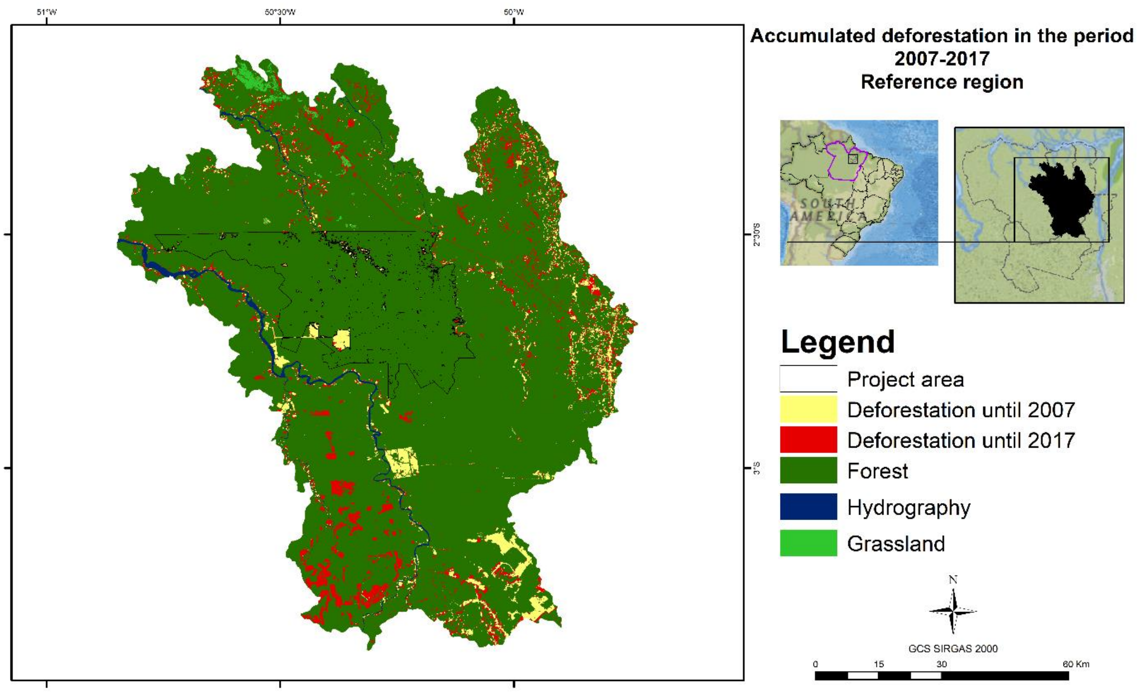
Table 15. Vegetation types found in the project boundaries.

Forest class	Presence in the RR (%)	Presence in the PA (%)	Presence in the LB (%)
Dense Lowland Tropical Rainforest	93%	99%	89%
Dense Alluvial Tropical Rainforest	3%	1%	5%
Dense Tropical Rainforest	1%	0.32%	-
Dense Submontane Tropical Rainforest	2%	-	-
Wooded Campinarana	1%	0.0%	6%
Grassy Woody Campinarama	0.41%	-	-

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

Satellite images were used to generate the land-use and land-cover map in 2017 shown in the figure below.

Figure 40. Land use and land cover map comparing 2007 and 2017



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

Table 16. List of land use and land cover change categories

Class identifier		Trend in carbon stock[1]	Presence in[2]	Baseline activity[3]			Description (including criteria for unambiguous boundary definition)
IDcl	Name			LG	FW	CP	
1	Forest	constant	RR, PA, LK	yes	no	no	According to official classification of the types of vegetation of Brazil (SIVAM) and the high representativeness of the main forest type within the project area, no stratification in different forest classes was conducted. In addition, carbon density is not expected to undergo significant changes due to degradation in the baseline case. According to the significance test, carbon stock change due to logging activities in the baseline case is considered insignificant and therefore, trend in carbon stock could be deemed as constant.
2	No forest	constant	RR, PA, LK	no	no	no	Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification.
3	Hydrography	constant	RR, PA, LK	no	no	no	Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA.

An analysis in the Amazon region[112] between 2009-2016 shows that there is no trend in degradation, although it affects an area larger than deforestation. It was concluded that degradation can serve as a warning that the region will soon be the target of deforestation practices. As the degradation has low local recurrence over the years, i.e., on average the same area is classified as degraded only once during the analyzed period, it is very unusual that the same area will suffer another degradation, since the valuable woods have already been harvested. Thus, it is very likely that carbon stocks after degradation might increase. Therefore, it is conservatively assumed that the trend in carbon stocks in the baseline case is constant.

The main forest type present in RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[113]:

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

Figure 41. Dense Tropical Rainforest profile

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

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

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

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

It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map comparing 2007 with 2017. It is important to note that while the latter shows only deforestation from 2007–2017, the Tables below display deforestation across the whole crediting period.

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

Table 17. Land use change matrix in the reference region between 2007 and 2017

	IDcl	Initial LU/LC class: Forest	Initial LU/LC class: No forest
Final Class	Forest	I1/F1	0
Final Class	No forest	I1/F2	I2/F2

BASELINE SCENARIO

PA	IDcl	Initial LU/LC class: Forest	Initial LU/LC class: Non Forest in the PA
Final Class	Forest	57,438.00	0.00
Final Class	Non Forest in the PA	82,994.27	0.00

LB	IDcl	Initial LU/LC class: Forest	Initial LU/LC class: Non Forest in the LK
Final Class	Forest	50,758.22	0.00
Final Class	Non Forest in the LK	26,254.72	3,688.35

PROJECT SCENARIO

PA	IDcl	Initial LU/LC class: Forest	Initial LU/LC class: Non Forest in the PA
Final Class	Forest	135,891.55	0.00
Final Class	Non Forest in the PA	4,540.72	0.00

LB	IDcl	Initial LU/LC class: Forest	Initial LU/LC class: Non Forest in the LK
Final Class	Forest	38,309.08	0.00
Final Class	Non Forest in the LK	38,703.86	3,688.35

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

Table 18. List of land use and land cover change categories

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

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

Figure 42. Deforestation dynamics, between the years 2007 and 2017, in the reference region and project area. Source: MapBiomas and IPE data

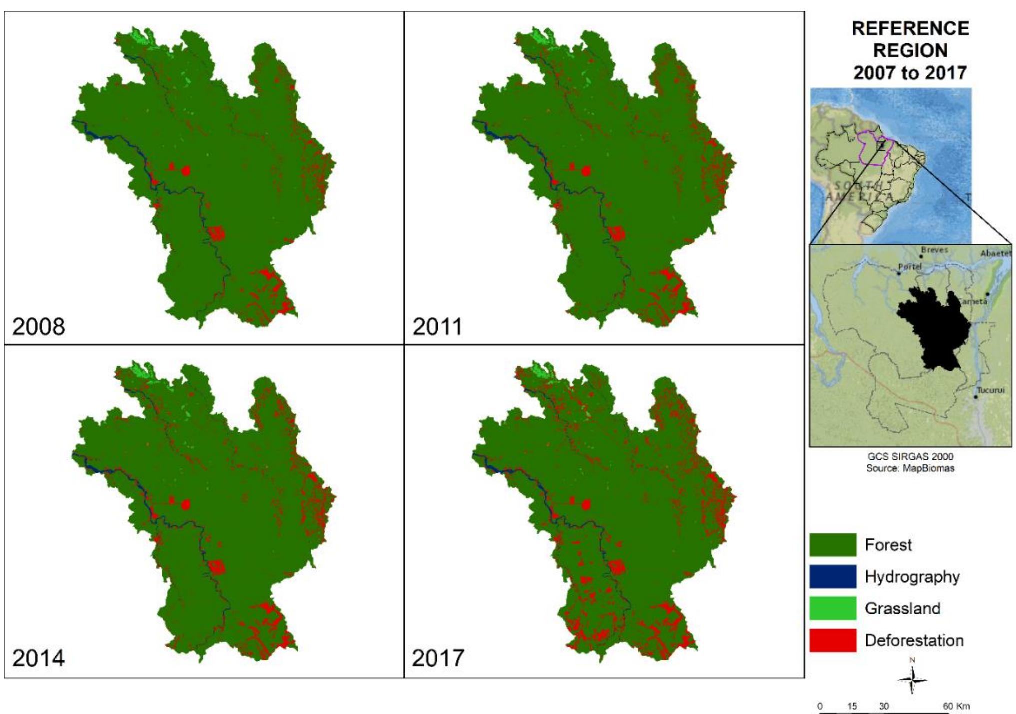


Table 19. Annual deforestation in the Reference Region between 2007-2017 (September-2007 to September-2017)

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2008	38,706.75	5,126.13
2009	42,927.30	4,220.55
2010	47,697.93	4,770.63
2011	51,611.76	3,913.83
2012	54,702.36	3,090.60
2013	56,956.05	2,253.69
2014	59,755.32	2,799.27
2015	64,048.41	4,293.09
2016	78,415.74	14,367.33
2017	88698.24	10,282.50

Table 20. Annual deforestation in the Leakage Belt between 2007-2017 (September-2007 to September-2017)

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2008	373.65	373.65
2009	545.00	171.35
2010	790.06	245.06
2011	1,240.54	450.48
2012	1,421.51	180.98
2013	1,538.08	116.56
2014	1,637.47	99.39
2015	1,729.11	91.65

2016	2,383.60	654.48
2017	2,643.75	260.15

- Map accuracy assessment

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

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

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

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

Table 21. Summary of confusion matrices from the evaluation of MapBiomas from 2007 to 2017

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

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

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[114].

- **Identification of agents of deforestation**

In the past few years, the project region has been the subject of news and studies, mainly due to the advancement of the arc of deforestation in the Amazon biome. This pressure is expected to continue, given the globalization of markets in the amazon region and international development policies planned for the region[115].

Of the ten cities that most deforested in 2016, five are located in Pará. The city of Portel remains in the ranking of the ten municipalities that have lead deforestation in the Brazilian Amazon at least for five years[116,117].

The main deforestation agents identified in the region are timber harvesting, acting both legally and illegally;

a) **Timber harvesting**

As aforementioned in section 1 above, timber logging (both legal and illegal) is an important economic activity within the reference region. The large-scale commercial logging for timber which occurs on Marajó Island is sold on local, national and international markets[118]. Logging in the Portel region peaked in the 1970s and 2000s and was marked by a strong connection between communities and companies[119].

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[114] VM0015: STEP 3: Analysis Of Agents, Drivers And Underlying Causes Of Deforestation And Their Likely Future Development, page 37. Available at: <https://verra.org/wp-content/uploads/2018/03/VM0015-Methodology-for-Avoided-Unplanned-Deforestation-v1.1.pdf>.

[115] 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

[116] Available in: <https://agenciabrasil.ebc.com.br/geral/noticia/2017-01/amazonia-perde-7989-km2-de-floresta-maior-desmatamento-desde-2008>. Last visited on 14/05/2021.

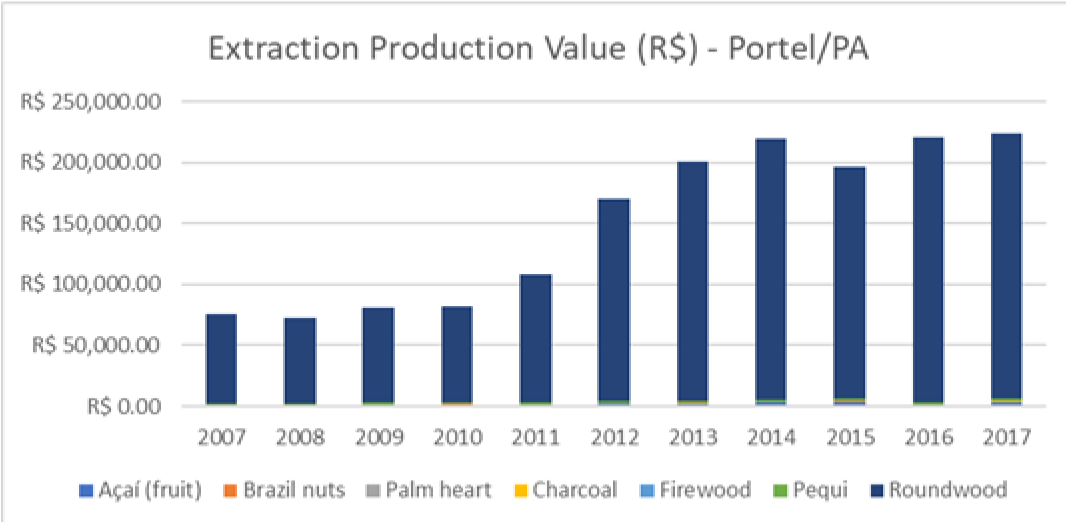
[117] IPAM. Overview Of Amazon Deforestation 2016. Available at: <http://aliancaamazonia.org.br/wp-content/uploads/2017/05/Overview-of-Amazon-deforestation-2016_IPAM.pdf> . Last visited: 14/05/2021.

[118] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico SócioEconômico'.

[119] D'Arace, L. M. B. et al. Wood production in log and firewood in northern Brazil and the state of Pará. Brazilian Journal. of Development, Curitiba, v. 5, n. 9, p. 16885-16896, September 2019.

Economic data sources between 2007 and 2017 show that timber is the largest contributor to the value of annual production when compared to all extractivism products in the project area and in the main reference region municipality.

Figure 43. Extraction Production Value (R$) – Portel/PA



Portel had the highest production values for roundwood. It is possible to see that the value of wood raised in 2011, following the deforestation pattern in the historical reference period and in the amazon biome.

However, beyond the high production level shown in official data, the production of timber continues to be conducted illegally: studies, estimate that 36% of Brazil's timber production is legal[120]. By comparing official data from the Portel microregion (which includes the municipalities of Bagre, Gurupá, Melgaço and Portel) it is possible to note the proportion of logs illegally extracted and traded through the incompatible data between the sources[121]. Illegal wood harvesting is known to take place within the reference region and project area, being transported to the sawmills by riverboat.

Usually, timber logging is the first deforestation agent that reaches previously inaccessible forest lands, using existing roads or creating illegal ones, followed by land speculators or farmers in search of cheap land.

[120] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras".
[121] SANTANA, A. C. SANTOS, M. A. S. OLIVEIRA, C. M. Preço Da Madeira Em Pé, Valor Econômico E Mercado De Madeira Nos Contratos De Transição Do Estado Do Pará. Research Report from the Federal Rural University of the Amazon. Belém, Pará, 2010.

The Figures below show the annual quantity of timber logging produced, separated in firewood and roundwood, in the municipalities of the project area. The municipality of Portel was the main responsible for the expansion of this activity.

Figure 44. Roundwood - Produced quantity[122,123]

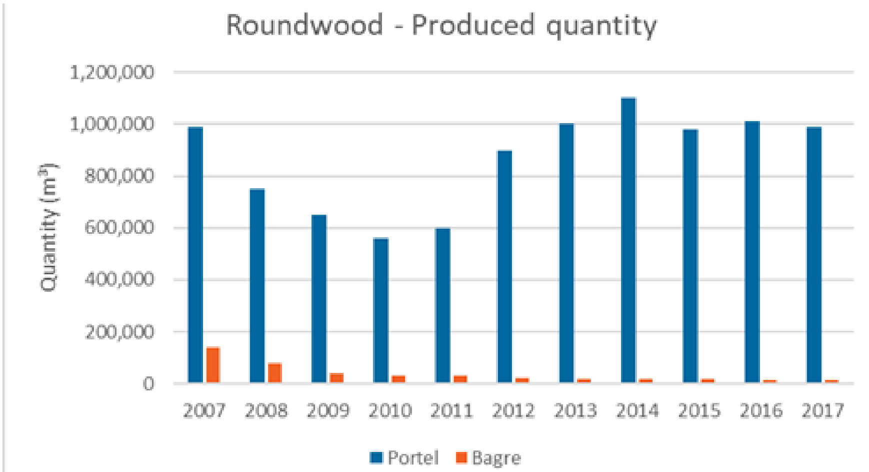
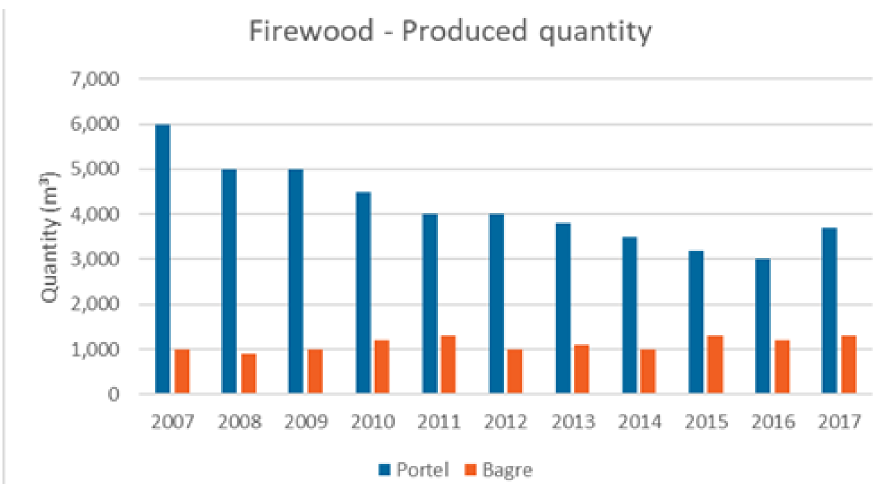


Figure 45. Firewood - Produced quantity



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

122 IBGE Cidades – Extração vegetal e silvicultura – Portel. Available at: https://cidades.ibge.gov.br/brasil/pa/portel/pesquisa/16/12705. Last visited on July 05th, 2021.
123 IBGE Cidades – Extração vegetal e silvicultura - Bagre. Available at: https://cidades.ibge.gov.br/brasil/pa/bagre/pesquisa/16/12705. Last visited on July 05th, 2021

b) Cattle ranching

According to Razera (2005)[124], the lack of economic alternatives has created the conditions for livestock farming to establish itself as the main economic activity causing settlement of deforested areas in Amazonia.

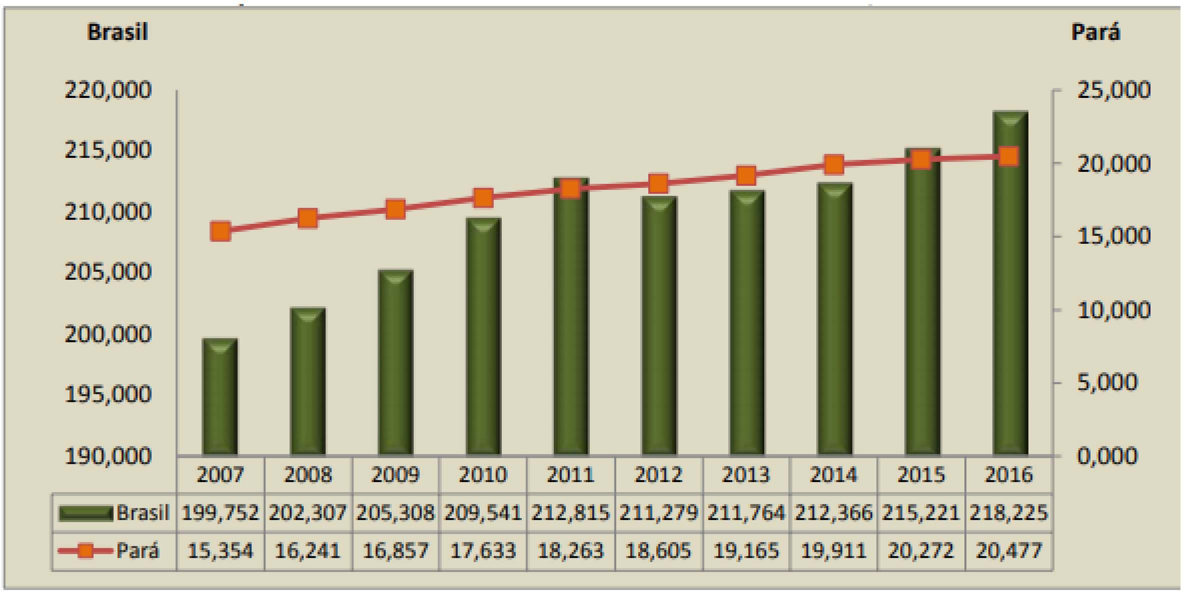
Cattle farming in the Amazon region is primarily due to low land prices combined with adequate rainfall levels[125]. The Amazon region attends to national and regional demand. Analysis of supply and demand show that livestock farming could expand even more to attend to the majority of global demand. 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[126]. In this way, the predominance of the free market (with no legal restrictions) will lead to the expansion of cattle farming, especially of the type based upon indiscriminate deforestation.

The State of Pará has the 4th largest cattle herd in Brazil - and the largest in the northern region, with more than 20 million heads - and is constantly growing, with a beef cattle industry based on cultivated pastures with good productivity[127,128]. The evolution of livestock between (2007 and 2016) shows that the cattle herd in Pará grew above the Brazilian average. While the national herd obtained a variation of 9.25%, Pará's had a growth of 33.36% (superior result even when compared to the states with the largest effective cattle herd: Mato Grosso, Minas Gerais and Goiás)[129].

[124] RAZERA, A. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005.
[125] BRANDÃO, F. Tendências para o consumo de carne bovina no Brasil. 2013. 102 f. Thesis (Doctor grade) - Curso de Agronegócio, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013
[126] RAZERA, A. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005
[127] NETO, J. F. T; COSTA, N. A. Criação de Bovinos de Corte no Estado do Pará. EMBRAPA. Available at:
[128] Available at: https://cidades.ibge.gov.br/brasil/pa/pesquisa/18/16459. Last visited on August 6th, 2021.
[129] FAPESPA. Boletim Agropecuário do Estado do Pará (2017). Available At: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716. Last visited on August 6th, 2021.

Figure 46. Evolution of the cattle herd in the state of Pará and Brazil, 2007-2016[130]



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brasil	199,752	202,307	205,308	209,541	212,815	211,279	211,764	212,366	215,221	218,225
Pará	15,354	16,241	16,857	17,633	18,263	18,605	19,165	19,911	20,272	20,477

In Pará State, livestock represents 51% of the land use, equivalent to 14,523,938 ha. Until 2018, there were 281,699 agricultural establishments in the State[131].

In addition, the competitive evolution of livestock in Pará is linked to natural, economic and technological variables, such as governance structure that establishes conditions for the applicability of the bovine activity; the availability of land at lower prices compared to others regions in Brazil; the favorable weather for pastures, ideal for the development of grass and forage; the quality of the meat produced - due to feeding exclusively on pasture (green cattle); and the Aftosa Free Area International Certification. These characteristics favors the cattle raising in the State and allows producers from Pará access national and international markets[132].

Pastureland (either planted, natural or degraded) represents the main land use after forest (natural and protected areas) in the main municipalities of the reference region, which also shows that this is the main economic activity in the region[133,134].

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[130] FAPESPA. Boletim Agropecuário do Estado do Pará (2017). Available At: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716. Last visited on August 6th, 2021.

[130] Available at: Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/estabelecimentos.html?localidade=15>. Last visited on August 4th, 2021.

[131] Available at: Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/estabelecimentos.html?localidade=15>. Last visited on August 4th, 2021.

[132] FAPESPA. Boletim Agropecuário do Estado do Pará (2017). Available At: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716. Last visited on August 6th, 2021.

[133] Brazilian Institute for Geography and Statistics (IBGE): <http://www.ibge.gov.br/home/>.

[134] Available at: <https://cidades.ibge.gov.br/brasil/pa/portel/pesquisa/24/76693?localidade1=150110&localidade2=150520>.

Figure 47. Land Use - Portel and Bagre, respectively (%)

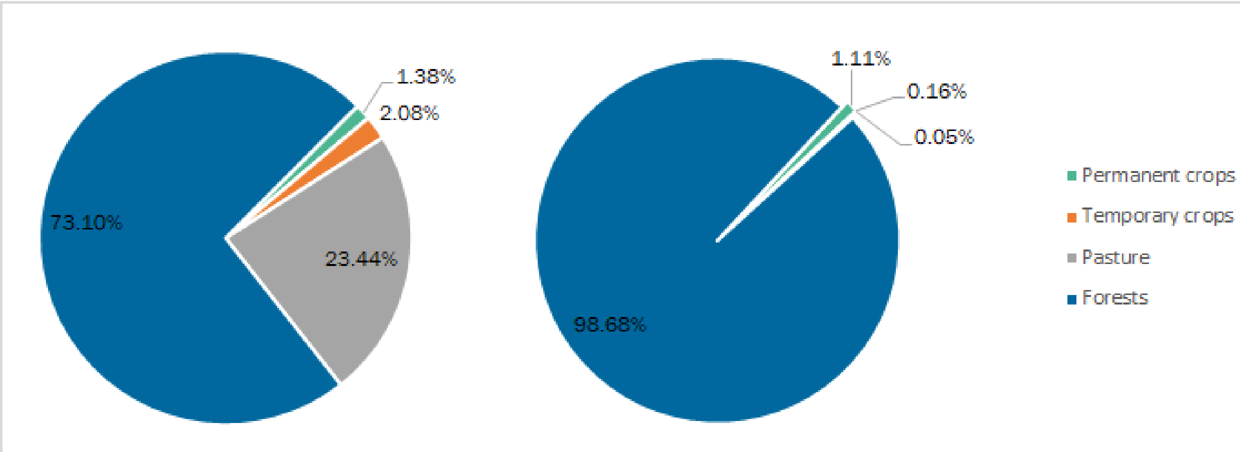
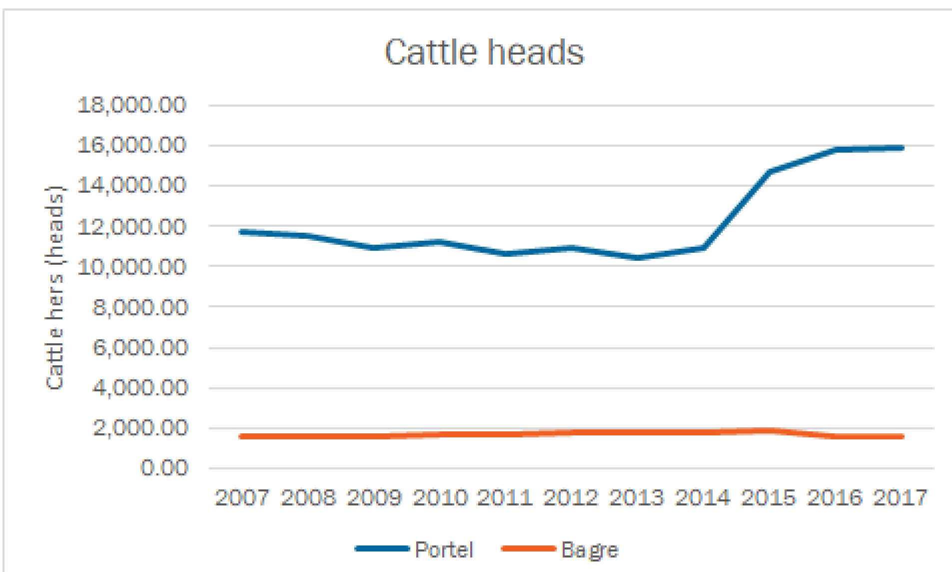


Figure below shows the increase of the cattle herd in the main municipality of the reference region across the period 2007-2017. It is possible to note that the total number increased around 30.88% over this period. Considering the stocking rate in the region (1.2 animals/ha), this would mean that cattle ranching alone was responsible for the deforestation of around 300 thousand hectares of Amazon rainforest in the analyzed municipalities.

Figure 48. Annual livestock in the two main municipalities of the reference region, in heads of cattle[135]



Furthermore, according to the figure above, the municipality of Bagre does not have a strong tradition in cattle raising as an economic activity when compared to Portel. The city of Bagre once belonged to the territory of Oeiras do Pará and later of Portel, becoming an independent

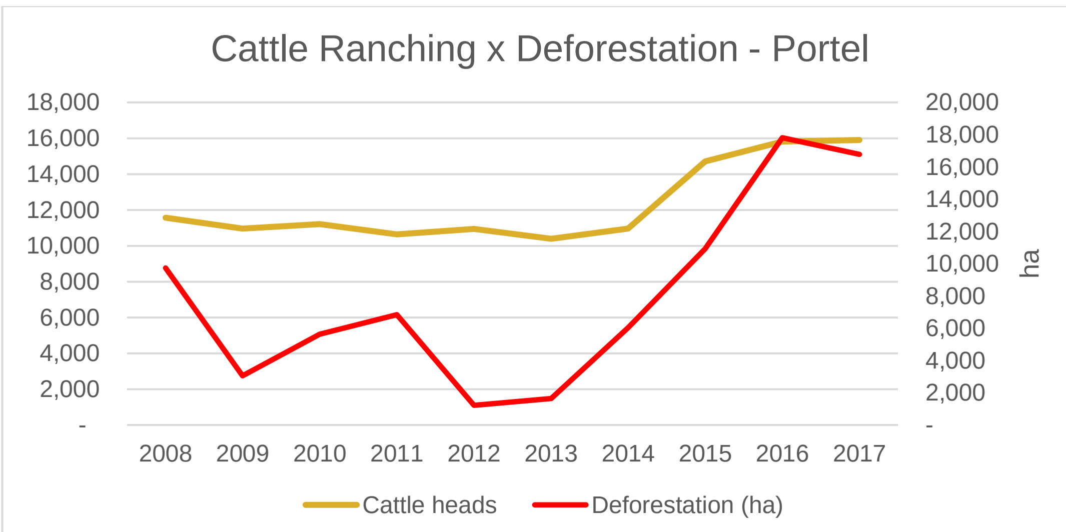
135 Available at: <https://cidades.ibge.gov.br/brasil/pa/portel/pesquisa/24/76693?localidade1=150110&localidade2=150520>.

municipality only about 50 years ago[136]. The municipality follows the economic activities of the larger cities that once belonged but it does not dominate the market in this sector. Therefore, the greatest economic impact comes from Portel, as almost the entire Project area and a large part of the Reference Region is in it.

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

The Graphs below relate deforestation numbers with cattle herd in the region. According to PRODES satellite data[137], it can be noticed that in Portel, where the largest portion of the Project Area and the Reference Region are located, the increase in deforestation follows the trend of an increase in the cattle herd.

Figure 49. Deforestation areas with cattle herd in Portel (PA), in hectares



Furthermore, the cattle ranching analysis below shows a clear breakpoint in 2014, where it starts to increase after some decrease during the 2008-2013 period.

Thus, considering all evidence that has been presented, cattle ranching activity will most likely continue to increase in the future due to:

- Increasing population growth rate;
- Increasing prices of meat;

[136] FAPESPA. Bagre - Estatística municipal. Available at: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/328.pdf?id=1456690457. Last visited on August 6th, 2021.
[137] Available in < http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates>.

- Low prices of forested lands, which makes it profitable to deforest the area and sell it at higher prices with pasturelands.

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

Some of the factors that characterize, and drive deforestation and subsequent cattle ranching are the low cost of the forested area; soil fertility and favorable weather; well-structured soil and mainly flat conditions of the area; tradition of farming existing in the municipalities and the meat market of the region[138].

Key driver variables are detailed in the section below.

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

1) Population growth:

Several studies for the Amazon biome[139,140,141] mention that deforestation rates may increase because of population growth and the need for more land for food, fuelwood, timber, or other forest products. The number of people and their socio-economic conditions both have a significant impact on deforestation. As agriculturally based population density increases in and near forested areas, the strongest relationship between population growth and deforestation occurs, as local people and young migrant families arrive at the forest frontier and clear land to provide more area for subsistence farming. Therefore, besides addressing the population numbers, policies that impact the socio-economic conditions of the people are needed if deforestation is to be delayed or forests are to be sustained.

As detailed in previous sections and in the description of deforestation agents above, timber prices have much higher value than other products exploited in the region. Roundwood production in the region represented a higher value when compared to other PFNM produced in the municipalities. Prices vary between 560,000 and 1,100,000 reais per m^3. In 2016, non-timber forest products were responsible for moving around 2.8 billion reais, while the forestry industry generated more than 13.7 billion reais[142].

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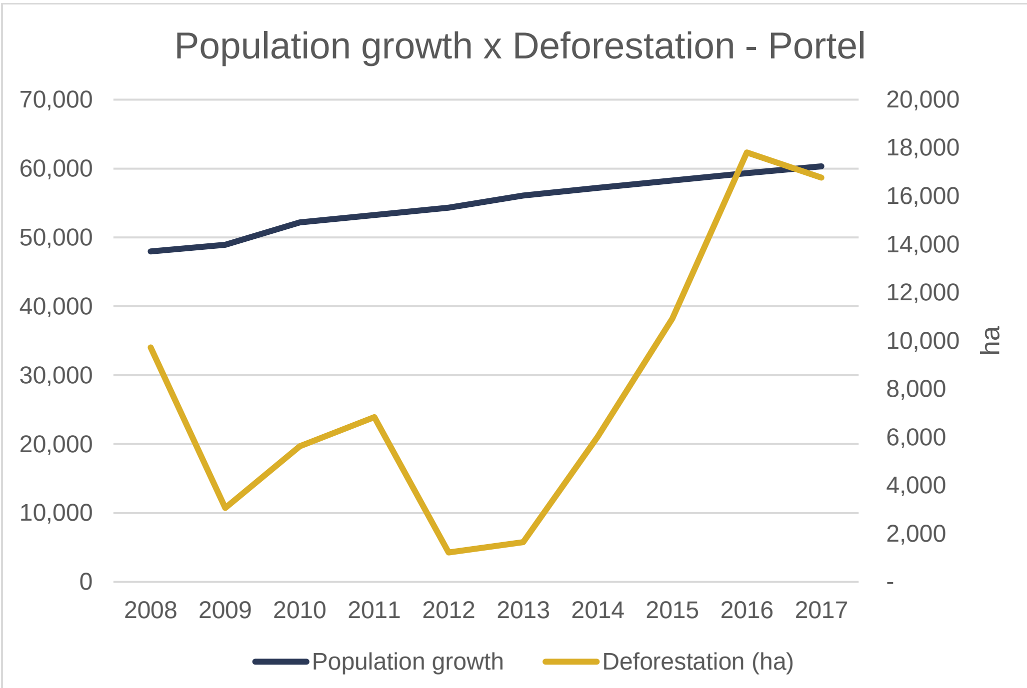
[138] FAPESPA. Boletim Agropecuário do Estado do Pará (2017). Available At: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716. Last visited on August 6th, 2021.
[139] ANGELSEN; KAIMOWITZ. Rethinking the Causes of Deforestation: Lessons from Economic Models. The World Bank Research Observer, vol. 14, no. 1 (February 1999), pp. 73–98.
[140] ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997
[141] MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003
[142] SNIF. Boletim 2017 sobre Recursos Florestais no Brasil. Available at: https://www.florestal.gov.br/documentos/publicacoes/3230-boletim-snif-2017-ed1-final/file. Last visited on July 7th, 2021.

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[143]. Thus, this disparity promotes the purchase of new forested areas, deforestation, and further creation of new pasturelands.

Considering Portel, the main urban center in the region, there is a correlation of 0.53 between deforestation and population growth. Between 2007 and 2017, the population of Portel increased by 33%, reaching 63,831 inhabitants[144].

Figure 50. Population growth in Portel-PA



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

As previously described above, the prices of timber logs and *arroba* (livestock) are the main reason why the cattle herd increased in the period, reaching more than 500 thousand animals in the two main municipalities composing the reference region. In addition, during the same period, the timber logging also increased, being one of the main produced products in the two municipalities.

[143] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. Economia Verde: Desafios e Oportunidades, Campinas, v. 8, p.143-155, jun. 2011. Available at: <https://web.archive.org/web/20171031104223/ttp://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: July 7th, 2021.

[144] Population estimation available at < https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html?=&t=downloads>

It is important to note that timber stands out as having the highest values among the total annual production in the project area municipalities[145]. In addition, according to Razera (2005) , given the large increase in pastureland property values, creation of new areas for livestock raising has been stimulated and intensified, raising cattle numbers and, consequently, increasing deforestation.

Research developed to determine leakage belt accounted for approximately R$1040,00 per animal in the region, on an average of R$80,00 per *arroba*. Considering data of 2017, that indicated 15,900 animals in Portel and 1,596 in Bagre, the amount of money produced by the activity in the region would surpass 18 million reais per year.

Furthermore, forested property values are almost 6 times cheaper than established pasturelands. Thus, this disparity promotes the purchase of new forested areas, deforestation and further creation of new pasturelands[146]. Thus, partly due to the expansion of globalization, deforestation rates in Amazonia appear to be linked to the growth of the international market, especially of beef[147].

b) Driver variables explaining the location of deforestation:

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

1) <u>Distance from deforested areas</u>

The presence of "non-forest" is a driver variable predicting quantity and location of future deforestation. Forested areas are influenced by their proximity to areas that have already been deforested. The distance from previously deforested areas is one of the major causes of forest degradation in the Amazon biome and their spatio-temporal dynamics are highly influenced by annual deforestation patterns. In addition, forest fragmentation results from deforestation and disturbance, with subsequent edge effects extending deep into remaining forest areas[148,149].

2) <u>Roads, highways, access roads and navigable rivers</u>

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

[145] IBGE Cidades – Extração vegetal e silvicultura – Portel e Bagre. Available at: https://cidades.ibge.gov.br/brasil/pa/portel/pesquisa/16/12705?localidade1=150110. Last visited on July 05th, 2021.
[146] The Brazilian Institute for Geography and Statistics (IBGE): <http://www.ibge.gov.br/home/>.
[147] Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. Conservation Biology 19(3):680-688.

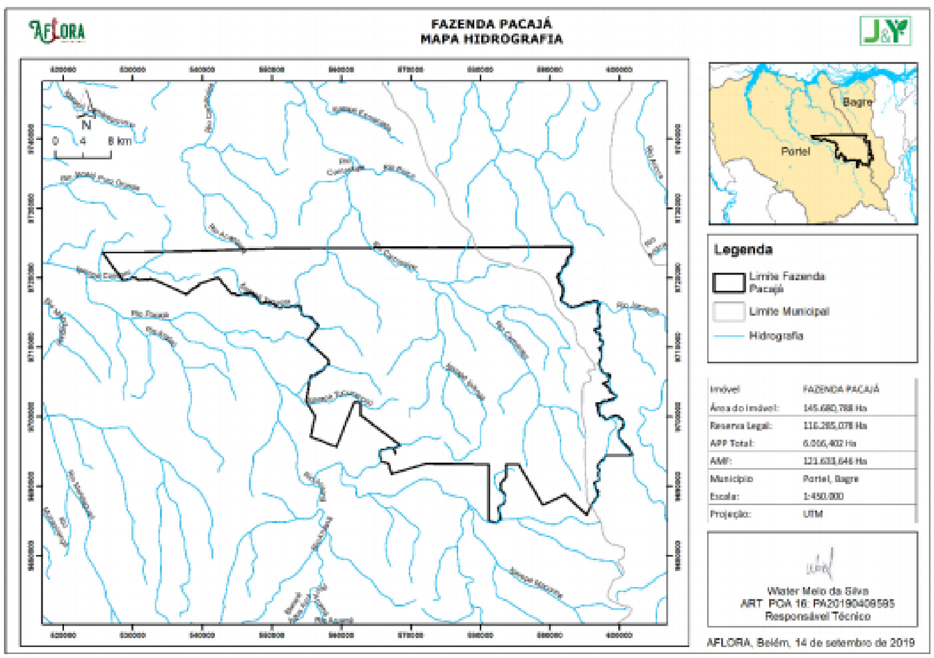
[148] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757
[149] IMAZON. Carbon emissions from deforestation and forest fragmentation in the Brazilian Amazon. 2011. Available at: <http://imazon.org.br/publicacoes/carbon-emissions-from-deforestation-and-forest-fragmentation-in-the-brazilian-amazon/?lang=en>. Last visit on: August 6th, 2021.

the region, increases anthropogenic pressure and, consequently, the intensity of deforestation[150,151,152].

Waterways remain the overwhelmingly predominant means of transport and access to forest products. The reference region is located in one of Brazil's richest areas in terms of waterways, which historically determined the locations of settlements in relation to extraction of non-timber forest products (NTFPs)

and timber. Waterways remain the overwhelmingly predominant means of transport and access to forest products. Furthermore, the small sawmills to which timber is taken for processing are located on riverbanks. For these reasons, the great majority of the regional population is located in small settlements on the banks of the rivers[153].

Figure 51. Hidrography of the Project Area



3) <u>Extreme poverty</u>

Poverty and government abandonment, which does not develop welfare public policies aimed at the sustainable development of the region, encourages illegal activities associated with the lack

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

151 GENELETTI, D. Biodiversity Impact Assessment of roads: an approach based on ecosystem rarity. Environmental Impact Assessment Review, v.23, n.3, p.343-365, 2003

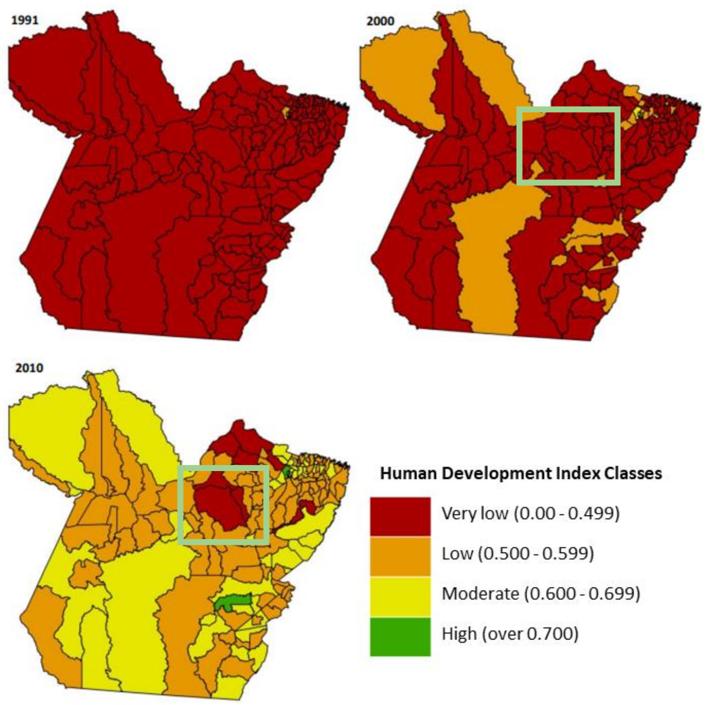
152 Fearnside, P.M. e P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the Potential Impact of Linking the Arc of Deforestation to Central Amazonia. Environmental Management 38:705-716

153 Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano De Desenvolvimento Territorial Sustentável Do Arquipélago Do Marajó".

of economic options and the need to generate income. Logging in the Portel region is marked by a strong connection between communities and companies. This connection was mainly based on the need to generate income for these families, who sell wood logs from their land at extremely low prices, clandestinely, without any planning of use or notion of the value of the forest[154].

The cities of Portel and Bagre have one of the worst averages of the Human Development Index (HDI) in Brazil, reaching only 0.483[155] and 0.471[156], respectively.

Figure 52. Historical analysis of the HDI in the state of Pará (Portel and Bagre are highlighted by the rectangle)[157]



Despite the evolution in the HDI of almost all municipalities in the State of Pará between 1991 and 2010, The figure above allows to observe that the cities of Portel and Bagre continue in the range of worst socioeconomic situations, being in 5,553rd and 5,558th places in the Brazil

[154] D'Arace, L. M. B. et al. Wood production in log and firewood in northern Brazil and the state of Pará. Brazilian Journal. of Development, Curitiba, v. 5, n. 9, p. 16885-16896, september 2019.
[155] Available at: https://www.ibge.gov.br/cidades-e-estados/pa/portel.html. Last visited on July 8th, 2021.
[156] Available at: https://www.ibge.gov.br/cidades-e-estados/pa/bagre.html. Last visited on July 8th, 2021
[157] IDESP. Síntese do Índice De Desenvolvimento Humano Municipal – IDHM Para o Estado do Pará. Available at: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/234.pdf?id=1479216410. Last visited on July 7th, 2021

ranking (which has 5,568 municipalities as a whole). Beyond that, the average monthly income of the inhabitants of these cities is around 2.3 basic wage (around 2,155 reais in 2017), however, only 7.2% of the population has formal jobs, making the population socio-economically vulnerable.

The analysis of the HDI was carried out based on values collected in 2010, since there is no updated data at the municipal level. The last HDI data by municipality available in Brazil is from 2010, as there was no 2020 census due to the pandemic[158]. Figure below presents the last available data:

Figure 53. HDI data available for the municipalities of Brazil[159]

BAIXAR TABELA

Territorialidades	IDHM Censo 2010	IDHM PNAD 2012	IDHM PNAD 2013	IDHM PNAD 2014	IDHM PNAD 2015	IDHM PNAD 2016	IDHM PNAD 2017
Brasil	0,727	-	-	-	-	0,776	0,778
Bagre (PA)	0,471	-	-	-	-	-	-
Portel (PA)	0,483	-	-	-	-	-	-

Exibindo 10 resultados de 2 (1 a 2).

Elaboração: Atlas do Desenvolvimento Humano no Brasil. Pnud Brasil, Ipea e FJP, 2020.

Fontes: dados do IBGE e de registros administrativos, conforme especificados nos metadados disponíveis aqui.

Many *ribeirinhos* that live around the project area sell timber illegally to smugglers along the Pacajá River, as a way to generate a small income for subsistence, as these families often do not have another source of income. The absence of the State, the limitations due to lack of income and distance create a favorable scenario for illegal deforestation. For 19 years, Pacajá farm was under the ownership of a company that did not play a supporting role for the surrounding communities, increasing incidents of social conflicts and discomfort in the municipality of Portel related to illegal logging.

When ABC Norte leased Pacajá Farm, it started to develop a socio-environmental study on communities as a way of understanding the local deforestation dynamics and promoting improvements in the livelihood, a reduction in the rate of illegal deforestation was observed, since the communities joined the preservation activities.

The goal of the ABC Norte REDD Project, beyond the conservation and enhancement of the standing forest, is also to use social and environmental indicators to monitor and drive improvements for communities in the region, through the SOCIALCARBON Standard. In the absence of the project and socio-environmental monitoring carried out by ABC Norte, the deforestation scenario would be more accentuated.

[158] The last HDI census is available at <http://www.atlasbrasil.org.br/> Last visited on December 14th, 2021

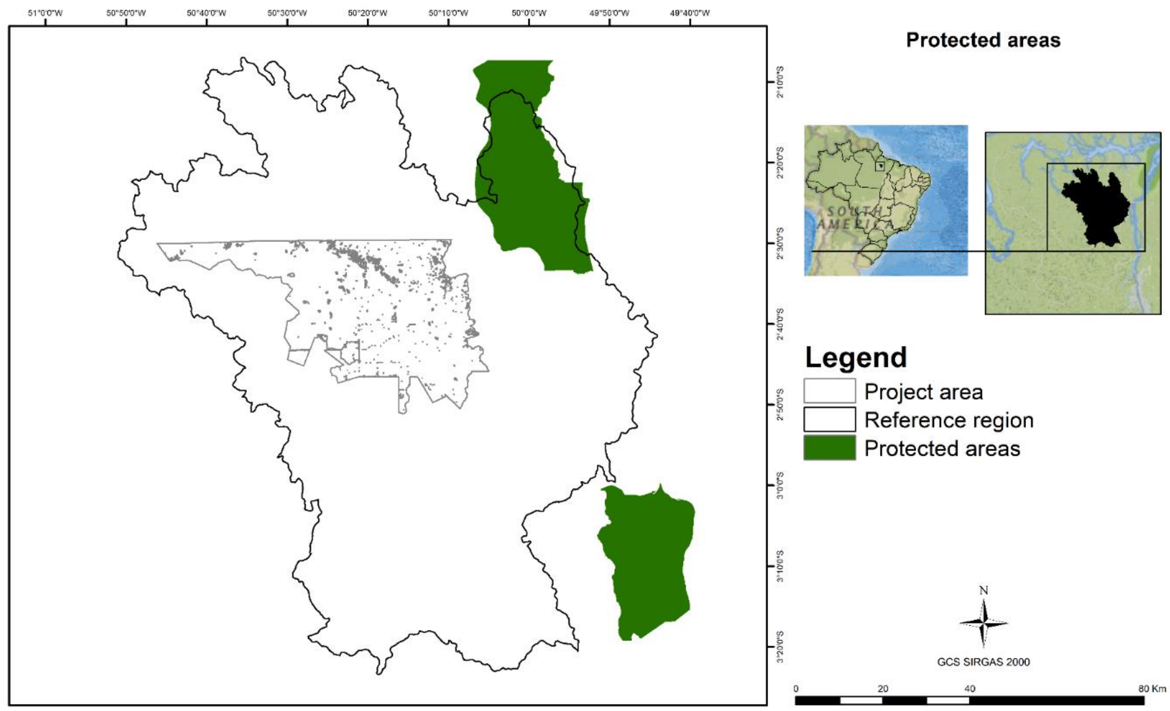
[159] The last HDI census is available at <http://www.atlasbrasil.org.br/> Last visited on December 14th, 2021

4) Presence of protected areas and settlements

The reference region is surrounded by two Conservation Units, one within the Reference Region, listed below:

- Arióca Pruanã Extractive Reserve
- Ipaú-Anilzinho Extractive Reserve

Figure 54. Protected Areas in the Reference Region



The presence of protected areas in the surroundings of the project area would in theory decrease the likelihood of deforestation, affecting the location of future deforestation. However, between 2012 and 2015, 237.3 thousand hectares were deforested within Conservation Units (UCs) in the Amazon. In that period, the occupants may have obtained a gross income of R $ 300 million from the sale of timber illegally harvested from the PAs, which created an enormous investment potential in deforestation, with logging being the main agent of deforestation[160]. Deforestation has increased within some protected areas and the percentage share of deforestation in conservation units in the total deforested in the Legal Amazon doubled from 6% to 12% between 2008 and 2015. In 2015, deforestation within conservation units was 79% higher than in 2012. In the last 4 years, the area of devastated forest in conservation units in the Legal Amazon rose 80%, against 35% of deforestation in general.

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

The political scenario is intrinsically related to the upward trend. For more than a decade, Brazil has elected a series of governments that are little concerned or completely averse to the country's environmental agenda.

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

It is also important to highlight that these protected areas are also mapped as Settlements by the Brazilian Government. The analysis of the contribution of settlements to deforestation in the Amazon was carried out from the 2016 reference[163], due to the lack of in-depth literature updated until 2018.

Agrarian reform settlements have emerged as one of the main focuses of deforestation in the Amazon between 2007 and 2014. The analysis indicates that deforestation seems to be closely linked to some of the main categories of existing settlement projects in the Amazon, as these classifications group together modalities with specific objectives, established to promote, either agricultural-based, or forest-based and extractive land uses[164].

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

This pattern indicates that the processes that affect the dynamics of forest clearing outside the settlements have repercussions within them, and that the strategies to encourage the reduction of deforestation in these settlements cannot be treated in isolation and distant from the local context of the territory in the which are inserted. It should be considered, however, that punitive strategies must be treated cautiously and in a surgical and educational manner within them, taking into account the impact that these sanctions may have on the food security of the real beneficiaries of agrarian reform. Thus, the importance of the carbon project and the socio-environmental actions to be applied as a way of mitigating deforestation is highlighted. The

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

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

strategy is to detach the need for illegal deforestation to generate income in these communities, creating alternative sources of production and income.

In conclusion, in 2014, few settlements were responsible for a large part of deforestation in this land category, with deforestation in these settlements occurring mainly through large continuous blocks. These two results indicate that deforestation in Amazonian settlements is localized and possibly results from a process of land reconcentration.

Thus, the deforestation that occurs within the settlements is not carried out solely by land reform clients. The analysis show that it is common to find consolidated farms consolidated in the settlements. Entrepreneurs, traders and other segments of local society, not clients of the agrarian reform, have acquired lots within the settlements, following a strategy that begins with the commercialization of the remaining wood in the forests of the lots, followed by the deforestation of the same, and the establishment of pasture to cattle ranching.

Identification of underlying causes of deforestation

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

Analyzing the deforestation graph for the historical period within the reference region of ABC Norte REDD Project, it is possible to notice two different trends forming two subperiods: a low-decreasing trend between 2008 and 2013, and a clear increase trend between 2014 and 2017. This trend is also similar to the deforestation pattern of the entire Amazon biome.

It is also important to highlight that of the ten cities that most deforested in 2016, pre project, five are located in Pará. The city of Portel, where more than 90% of the project area is located, remains in the ranking of the ten municipalities that have lead deforestation in the Brazilian Amazon at least for five years[165,166].

Since there are two different trends during the historical reference period (2008 - 2017), the two subperiods were separately analyzed in order to conclude which would be the most representative deforestation rate for the project's modeling and projection.

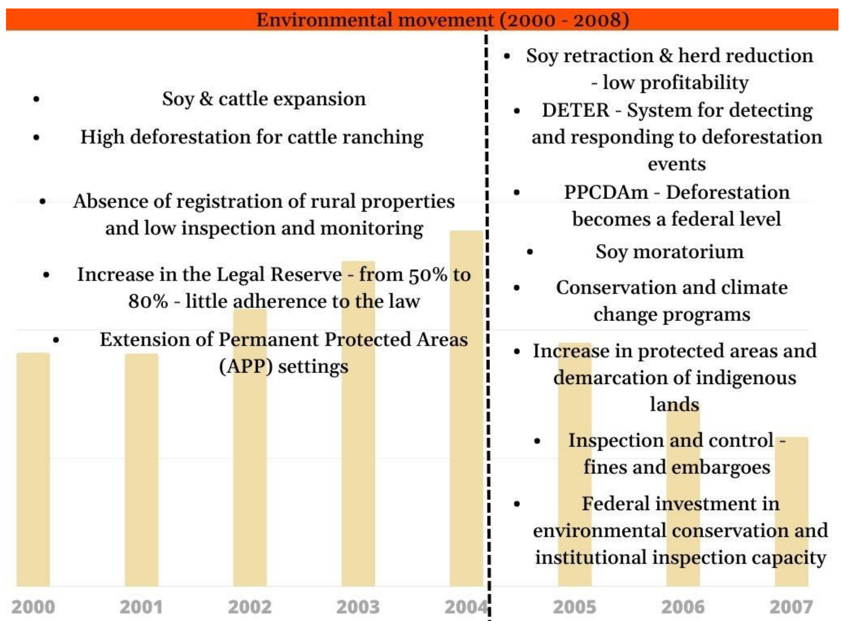
[165] Available in: <https://agenciabrasil.ebc.com.br/geral/noticia/2017-01/amazonia-perde-7989-km2-de-floresta-maior-desmatamento-desde-2008>. Last visited on 14/05/2021.

[166] IPAM. Overview Of Amazon Deforestation 2016. Available at: <http://aliancaamazonia.org.br/wp-content/uploads/2017/05/Overview-of-Amazon-deforestation-2016_IPAM.pdf>

Thus, this section will present a timeline of the Brazilian political scenario and its influence on deforestation in the Amazon, comparing it with the annual deforestation rate. The analysis is based on deforestation information from PRODES[167], and Nepstad and Rajão articles[168].

Environmental governance in Brazil can be divided into three major periods: 2000 - 2008, where the main improvements in environmental governance were established, 2009 – 2012, period of main decrease in deforestation and the start of the weakening of the Forest Code; and after 2012, when governance suffered a gradual erosion with the large amnesty granted to past illegal deforesters in the revision of the Forest Code and a return of deforestation rates to the peak levels of the last decade.

2000 to 2008 - Environmental movement



In summary, the period between the end of the 1990s and 2008 showed a highly variable dynamics in deforestation, with a peak in 2004 and a decline thereafter, reaching the lowest deforestation rates since the beginning of the decade. The variation in cattle and soy prices, and the lack of inspection and adherence to environmental legislation influenced the increase in deforestation at the beginning of the period. From 2000, actions such as the reinforcement of the forest code (with the increase of the Legal Reserve in the Amazon, from 50% to 80% and

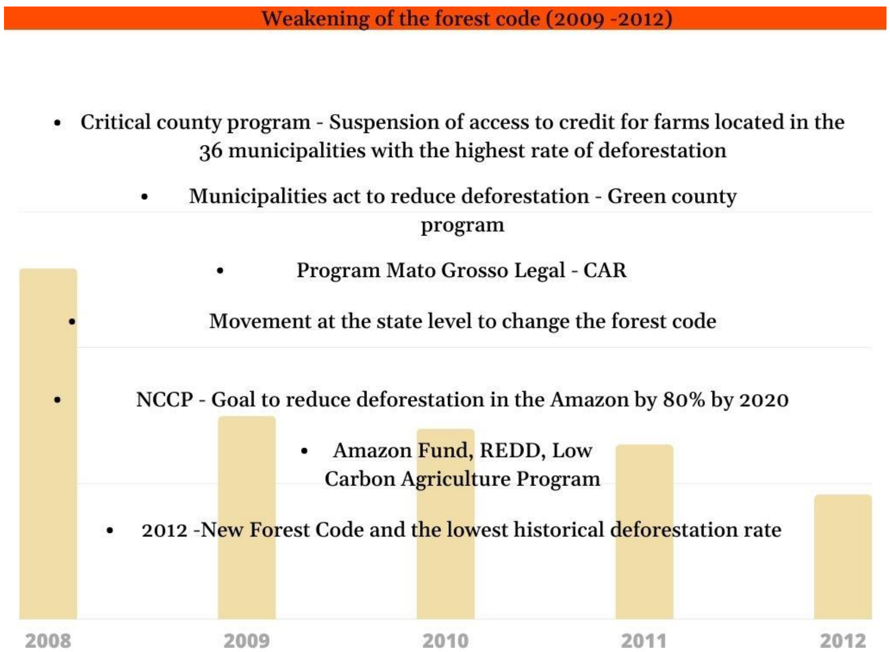
167 Available at < http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates> and < http://www.dpi.inpe.br/prodesdigital/prodesmunicipal.php>

168 Available at < https://www.science.org/doi/10.1126/science.1248525> and < https://observatorioflorestal.org.br/wp-content/uploads/2021/05/LIVRO_LEGISLACAO_FLORESTAL.pdf>

expansion of the protection of the APPs), creation of the SNUC[169] (and the increase of protected areas and land demarcation indigenous peoples), greater punishment and embargoes (Environmental Crimes Law[170], Soy Moratorium[171]) represented the pinnacle of advances in environmental legislation.

This was reflected in the reduction of deforestation from 2004 onwards.

2009 to 2012 – Weakening of the Forest Code



The Amazon graph shows a deforestation increase between 2007 and 2008, followed by a large decrease in deforestation between 2009 and 2012. This demonstrates the rapid and, above all, effective action taken by the government.

The measures taken in the previous period continued to have an effect and were complemented with the Critical County Program (Municípios prioritários[172]), suspending access to agricultural credit for those farms and ranches located in the 36 counties with the highest deforestation rates. The program stimulated collective action to reduce deforestation, with programs mainly in Pará and Mato Grosso to facilitate producers' compliance with legislation.

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[169] National System of Protected Areas (Sistena Nacional de Unidades de Conservação da Natureza) Available at < https://www.planalto.gov.br/ccivil_03/leis/l9985.htm>

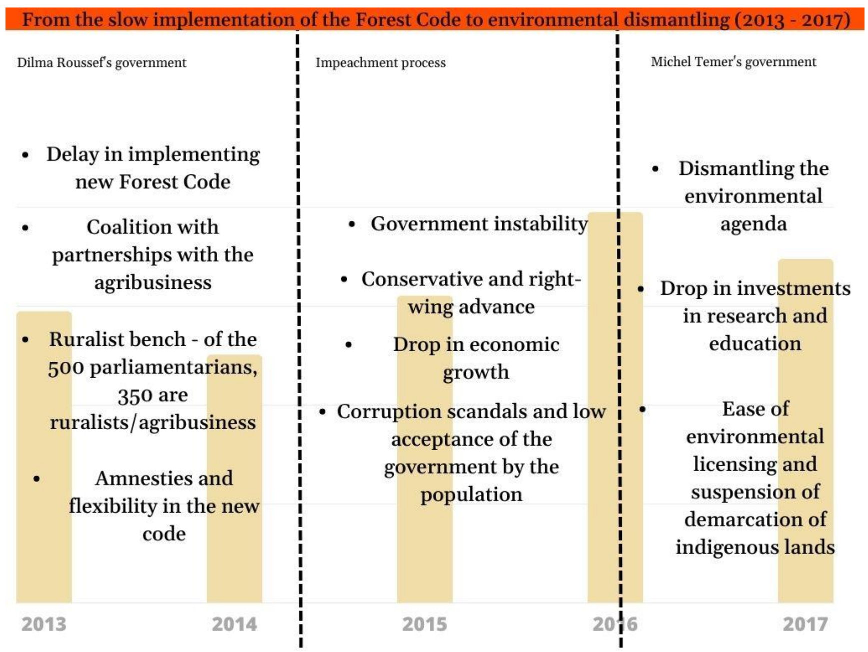
[170] Available at < https://www.planalto.gov.br/ccivil_03/leis/l9605.htm>

[171] Available at < https://www.science.org/doi/10.1126/science.aaa0181>

[172] Available at https://www.gov.br/mma/pt-br/assuntos/servicosambientais/controle-de-desmatamento-e-incendios-florestais/municipios-prioritarios

The strong environmental and inspection pressure and anti-deforestation actions made a powerful faction of the agribusiness lobby sought revisions in the code. Thus, government mobilization began to demand changes the 1965 Forest Code, with the agricultural sector claiming that it was impossible to achieve the goals established in the law, requiring an update and suspension of command and control actions in favor of a program of "environmental regularization" that would make it possible for producers to leave illegality. Thus, in 2012, the New Forest Code was approved, with several topics criticized by the environmentalists, and, at the same time, the lowest historical deforestation rate in Brazil, a reflection of the actions and intense inspection of previous years.

<u>2013 – 2017 - From the slow implementation of the Forest Code to environmental dismantling</u>



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.

The deforestation rates in the country, which had been declining since 2005, increased again in the Brazilian Amazon[173]. The impact of the change in the country's ideology after the alteration of the forest code, and mainly evidenced after the impeachment (which began with the governmental stagnation in 2014 and was concluded in 2016) can be seen in the national, state,

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

municipal and reference region deforestation charts. The large increase in deforestation from 2014 is strongly linked to the political scenario and attempts to make Brazilian environmental legislation more flexible.

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

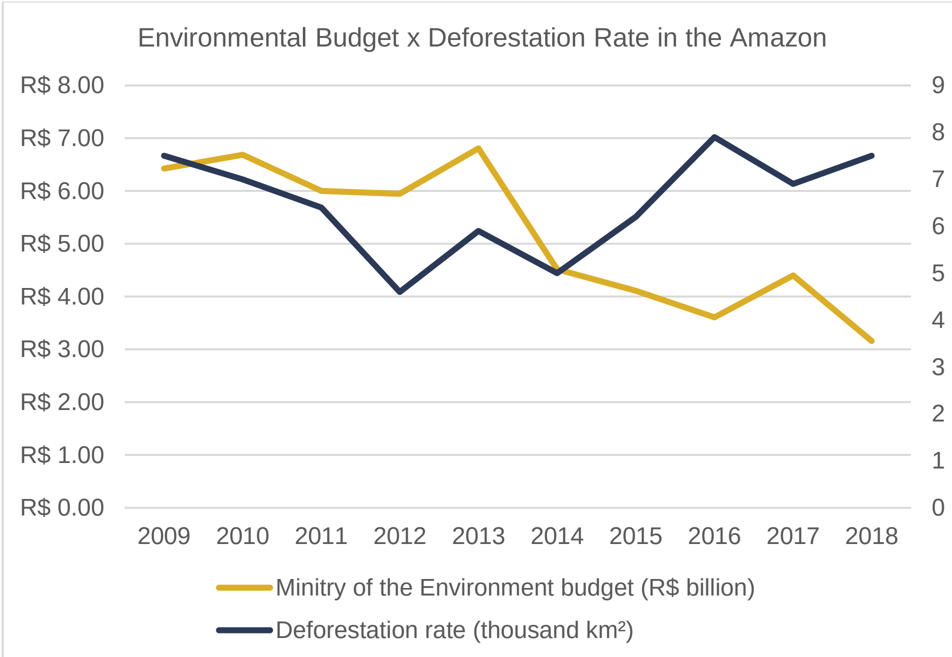
In 2013, before the breakpoint observed in the statistical analysis, environmental agencies warned of the scenario of increased deforestation, for the same reasons and agents evaluated above[174]. This differs, for example, of pre-2012 studies, which analyzed the success of the country's actions to reduce deforestation[175]. Evidence of the upward trend is that, after this new increase in deforestation, there was no government response as in 2008/2009.

In addition, analyzing the 2008-2017 period, there was a great reduction of budget of the Brazilian Ministry of Environment after 2014, which is responsible for deforestation control. During the 2014-2017 period, there was a decrease of 35% in the budget[176], which turned it even more difficult to expand the deforestation control in the Amazon.

Figure 55. Environmental budget and deforestation between 2009 and 2018

[174] Available at < https://ipam.org.br/wp-content/uploads/2013/08/The-Increase-in-Deforestation-in-the-Amazon-in-2013.pdf>
[175] Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. Available at < https://www.science.org/doi/10.1126/science.1248525>

[176] Available at < https://portaldatransparencia.gov.br/orgaos-superiores/44000?ano=2022>



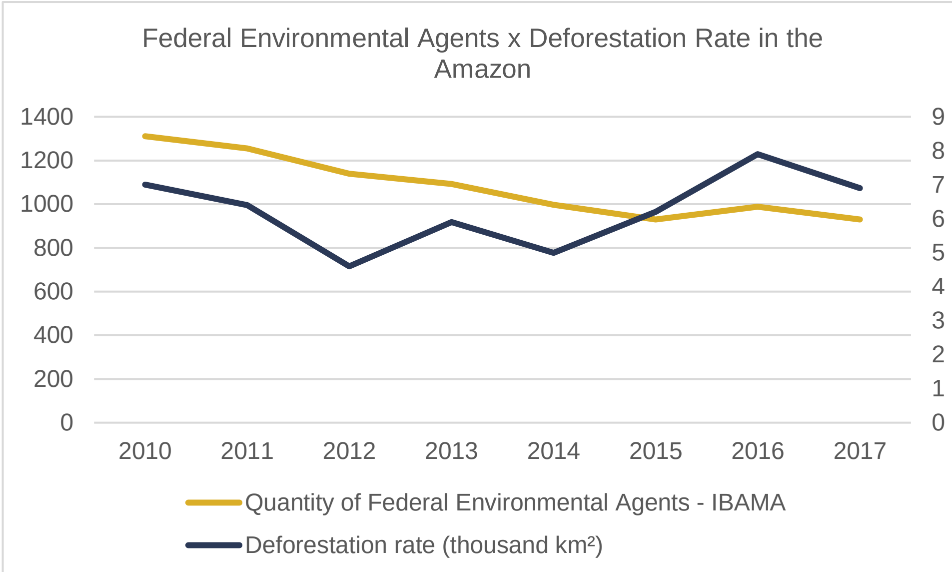
The post impeachment period wide opened the dismantling policy of the environmental agenda created by the new government (*Michel Temer, May 12, 2016 to December 31, 2018*) to gain the support of the ruralist party, constituted by a coalition of parliamentarians of the Brazilian National Congress with common interests, such as the advance of the livestock and agribusiness barrier in Brazil – and, consequently, reduce the environmental policies that prevent it from occur.

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

During this period, Brazil was the stage for a series of acts against the environmental area, such as cutting budgets for protected areas monitoring, reducing the protection of more than 600,000 ha of Amazon and Atlantic Forest biomes[177] reduction of federal agents responsible for tackling deforestation.

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

Figure 56. Federal Environmental Agents and Deforestation Rate



Therefore, after the impeachment of Dilma Roussef in 2016, the Temer's Government clearly opened the threat of political bargaining to forest conservation in order to attract the rural party in the Congress. In exchange of political support, the government offered landholders to increase deforestation, and the signature of 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[178].

Therefore, the analysis of the chain events above, in the sub-period starting from the revision of the Forest Code in 2012 to the Temer's rural-based Government in 2017 shows the main reasons why deforestation increased during the 2014-2017 period and moreover, that it will most likely continue in the future.

Analysis of chain of events leading to deforestation

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

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

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

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

It is possible to relate the deforestation curve to the increase in livestock and wood production in the region, all of which are growing. Those two land-use changes (timber harvesting and cattle ranching) are the main deforestation agents in the region. The profit from both products is also considerably higher than the production of other common forest products in the region, such as Brazil nuts and *açaí*. Furthermore, deforestation will probably increase due to setbacks in environmental legislation and deforestation control occurred in in the period after 2012, namely reduction in control programs to reduce deforestation in the Amazon, reduction of protected areas and the amnesty to deforesters.

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

The historic of polemics and anti-environmentalism of the last Brazilian governments, in addition to not tackling the direct causes, minimizing monitoring and restrictions in critical environmental areas and no investments in sustainable management and farming methods end up influencing and even motivating deforestation, illegal occupation and non-compliance with environmental laws. There is no strong environmental policy, and even with good advances, Brazilian laws have gaps that allows to be taken advantage of by landowners, or the inspection mechanisms suffer dismantling by the interest parties, making the conservation of the extensive Brazilian biomes even more difficult.

Conclusion

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

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

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

Projection of Future Deforestation

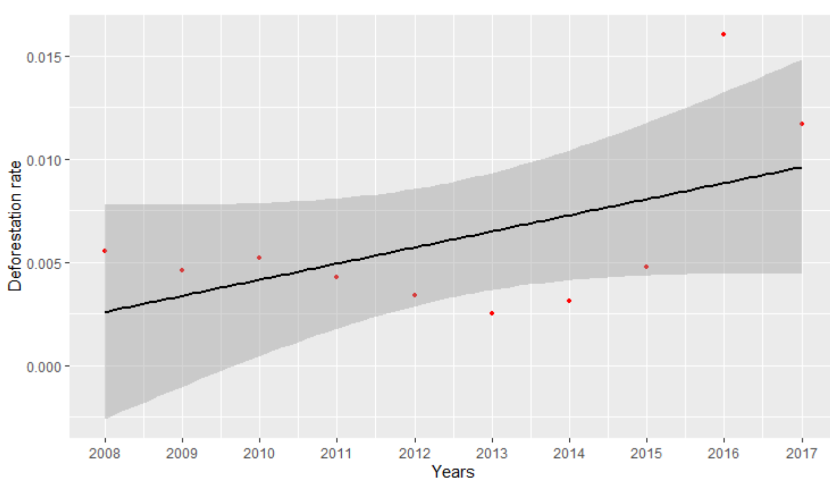
As the Methodology stipulates, the aim of this step is to locate in space and time the baseline deforestation in the project area, reference region and leakage belt.

Selection of Baseline Approach

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

According to the GIS analysis, between 2007 and 2017, there was a deforestation of 55,117.62 ha within the reference region, with an average oscillation of approximately 5,511.76 ha/year. The results of simple linear regression analysis demonstrated that the variation of the rates of deforestation, between 2008 and 2017 has a low increasing trend. This conclusion is based on a simple linear regression analysis, which results in a non-significative p-value of 0.1014 and a low R-squared (0.2122). According to the graphic below, the rates of deforestation are constant until 2013 and, then it starts to increase.

Figure 57. Variation in the deforestation rate in the reference region between the years 2007 and 2017. Source: MapBiomas



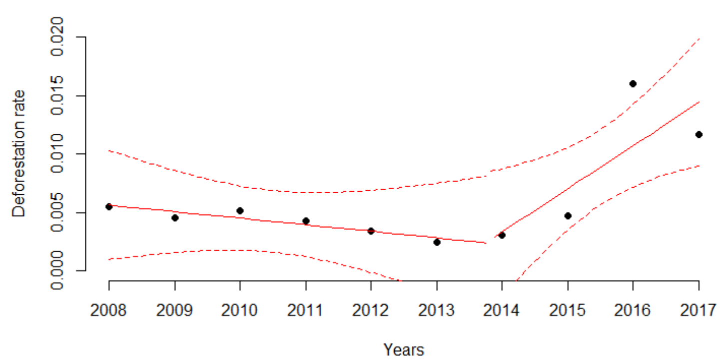
The conclusive evidence from the analysis conducted during the historical reference period shows that there is an increasing trend in deforestation rates observed during 2013-2017, and it was considered that only this historical sub-period is representative of what is likely to happen in the future, which is an increase in deforestation. Therefore, the time function approach was chosen.

As the linear regression is not a proper approach for this case, a Piecewise regression model was applied. When this model was adjusted using a piecewise linear regression, it was found that the coefficient of determination R^2 rises to 0.62 and the comparison becomes significant (p=0.027), indicating that this model has a good result.

This analysis is widely recognized and used among mathematical functions. For example, Tom and Lesperance published a paper in Ecology, in 2003, the most respected journal in the field of Ecology, where they demonstrated the use of piecewise regression as a statistical technique to model ecological thresholds.[180]

The R package "Segmented" was utilized for this analysis[181]. The functions "segmented" and "pscore.test" were used to verify the existence of a breakpoint and estimate the model parameters. The analysis revealed a breakpoint value of 2013.75, with a p-value of 0.0266 and an R-squared of 0.6245. These results demonstrated the existence of a breakpoint, with a very low probability for this result to be randomly created, allowing us to confirm a change in the rate of deforestation along the analyzed period. These results can be observed in the graphic below.

Figure 58. Variation in the deforestation rate in the reference region between 2007 and 2017, using the Piecewise linear regression model. Source: MapBiomas



Additionally, an extra analysis of model selection Based on AIC (Akaike Information Criterion) was conducted to compare the linear regression and piecewise regression model. As presented in the table below, the Piecewise Regression Model is the best one to model the rate of deforestation

[180] [Tom, JD and Lesperance, ML. 2003. Piecewise regression: a tool for identifying ecological thresholds, Ecology, 84: 2034-2041, number of citation: 631].

[181] Muggeo VMR. Segmented: an R package to fit regression models with broken-line relationships. RNews. 2008; 8:20–5 number of citation: 1897. This paper has been cited by more than 1000 scientific articles, confirming that this technique is widely used in Science.

along the time, as it presents a delta AIC of zero and the linear model a delta AIC of 56.84. A model can be selected when the Delta AIC presents a value below 2.0[182].

Model	AIC	Delta AIC
Linear	-28.61	56.84
Piecewise	-85.45	0.00

The analysis for the whole period (2008-2017) resulted in the following equation:

$$F(x) = \{1.1337293 - 0.0005618x, for\ x < 2014$$

$$and - 7.438121 + 0.00369490x, for\ x > 2014$$

From this equation, the deforestation for the next 30 years was projected, from the project start date. It is important to mention that this equation was generated based on the analysis of the entire historical period, from 2008 to 2017.

In the graphic below, the black line indicates the projection according to the function generated from the piecewise regression model. And, the blue line, represents the projection according to the lower boundary of the confidence interval (95% of confidence). In order to be conservative, this minimum slope was used for the deforestation projection.

[182] We can find a similar approach of model selection in Ewers and Laurance (2006) [Ewers R. and Laurance W. 2006. Scale-dependent patterns of deforestation in the Brazilian Amazon. Environmental Conservation 33 (3): 203–211]. In this study, a piecewise model was also the selected one.

Figure 59. Boundaries for the projection of deforestation

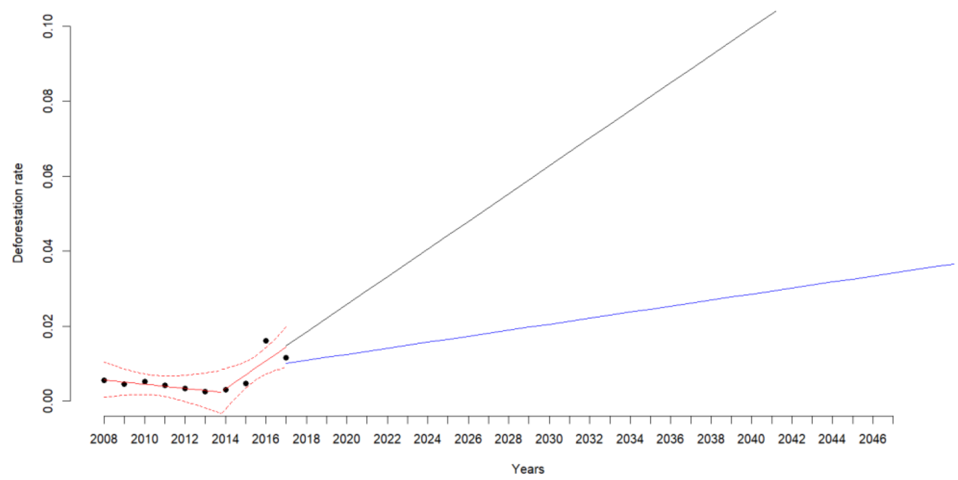
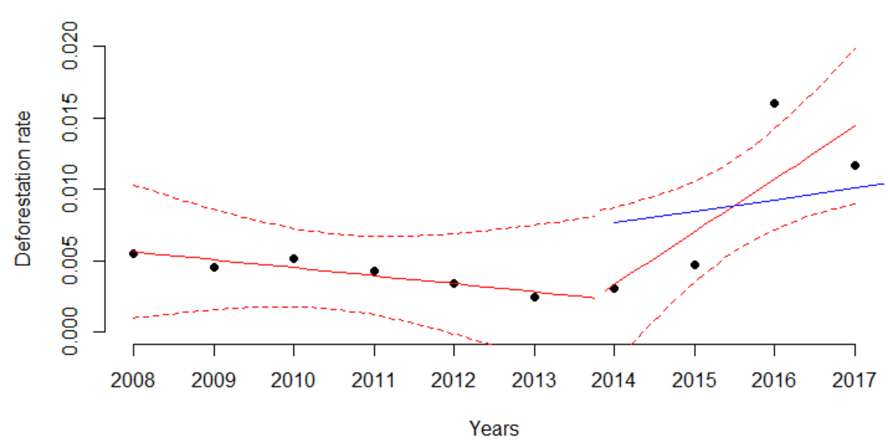


Figure below represents the procedures aforementioned. The blue line represents the model used to project the deforestation rate until 2047, which considered the lowest value of the confidence interval line's slope for the period 2014-2017 of the Piecewise model:

Figure 60. Variation in the deforestation rate in the reference region between 2007 and September 2017, using the Piecewise linear regression model.



This approach was made according to the VM0015 methodology, that states that "the rate of baseline deforestation is estimated by extrapolating the historical trend observed within the reference region as a function of time using either linear regression, logistic regression, or any other statistically sound regression technique.

The equation applied in the analysis is described below:

$$F(x) = \begin{cases} 1.3827 - 0.00068424x, for\ x < 7.3436 \\ \\ -3.4381 + 0.00170730x, for\ x > 7.3436 \end{cases}$$

The coefficient of determination of this model was 0.9242 and the value of p = 0.00372, showing a good fit of the data to the predictive model. Thus, it may be concluded that this approach is a statistically sound regression technique, and its use is in compliance with the methodology.

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

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

Table 22. Annual areas of baseline deforestation in the reference region

Project year t	Stratum i in the reference region (ha)	Total (ha)	
	ABSLRR	annual $ABSLRR_t$	cumulative ABSLRR
2017	2,199.32	2,199.32	2,199.32
2018	7,297.75	7,297.75	9,497.07
2019	10,085.85	10,085.85	19,582.92
2020	10,651.77	10,651.77	30,234.69
2021	11,194.20	11,194.20	41,428.89
2022	11,711.70	11,711.70	53,140.59
2023	12,203.55	12,203.55	65,344.14
2024	12,668.94	12,668.94	78,013.08
2025	13,106.97	13,106.97	91,120.05
2026	13,517.10	13,517.10	104,637.15
2027	13,898.70	13,898.70	118,535.85
2028	14,251.50	14,251.50	132,787.35
2029	14,574.87	14,574.87	147,362.22
2030	14,868.90	14,868.90	162,231.12
2031	15,133.05	15,133.05	177,364.17
2032	15,367.50	15,367.50	192,731.67
2033	15,572.34	15,572.34	208,304.01
2034	15,747.75	15,747.75	224,051.76
2035	15,893.64	15,893.64	239,945.40
2036	16,010.55	16,010.55	255,955.95
2037	16,099.02	16,099.02	272,054.97
2038	16,159.32	16,159.32	288,214.29
2039	16,192.08	16,192.08	304,406.37
2040	16,198.02	16,198.02	320,604.39
2041	16,177.68	16,177.68	336,782.07
2042	16,132.05	16,132.05	352,914.12
2043	16,061.85	16,061.85	368,975.97
2044	15,967.89	15,967.89	384,943.86
2045	15,851.25	15,851.25	400,795.11
2046	15,712.83	15,712.83	416,507.94
2047	15,553.80	15,553.80	432,061.74

Table 23. Annual areas of baseline deforestation in the project area

Project year t	Stratum i in the project area (ha)	Total (ha)	
	ABSLPA	annual $ABSLPA_t$	cumulative ABSLPA
2017	145.32	145.32	145.32
2018	482.20	482.20	627.52
2019	821.10	821.10	1,448.62
2020	942.03	942.03	2,390.65
2021	1,062.34	1,062.34	3,452.99
2022	1,345.17	1,345.17	4,798.16
2023	1,585.67	1,585.67	6,383.83
2024	1,720.26	1,720.26	8,104.09
2025	2,014.46	2,014.46	10,118.55
2026	2,286.32	2,286.32	12,404.86
2027	2,540.36	2,540.36	14,945.23
2028	2,672.25	2,672.25	17,617.48
2029	2,947.38	2,947.38	20,564.86
2030	2,994.73	2,994.73	23,559.59
2031	3,153.66	3,153.66	26,713.25
2032	3,336.87	3,336.87	30,050.12
2033	3,460.69	3,460.69	33,510.81
2034	3,468.10	3,468.10	36,978.91
2035	3,580.09	3,580.09	40,559.01
2036	3,635.43	3,635.43	44,194.44
2037	3,634.77	3,634.77	47,829.21
2038	3,649.75	3,649.75	51,478.96
2039	3,594.94	3,594.94	55,073.90
2040	3,562.72	3,562.72	58,636.62
2041	3,740.53	3,740.53	62,377.15
2042	3,529.26	3,529.26	65,906.41
2043	3,462.97	3,462.97	69,369.38
2044	3,448.35	3,448.35	72,817.73
2045	3,495.42	3,495.42	76,313.16
2046	3,374.75	3,374.75	79,687.90
2047	3,306.37	3,306.37	82,994.27

Table 24. Annual areas of baseline deforestation in the leakage belt

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	ABSLLK	annual $ABSLLK_t$	cumulative ABSLLK
2017	76.39	76.39	76.39
2018	253.46	253.46	329.85
2019	330.73	330.73	660.58
2020	379.41	379.41	1,039.99
2021	353.38	353.38	1,393.36
2022	432.21	432.21	1,825.58
2023	432.28	432.28	2,257.86
2024	484.57	484.57	2,742.43
2025	514.93	514.93	3,257.36
2026	524.40	524.40	3,781.76
2027	586.52	586.52	4,368.28
2028	627.96	627.96	4,996.24
2029	628.17	628.17	5,624.42
2030	695.97	695.97	6,320.39
2031	803.50	803.50	7,123.88
2032	792.76	792.76	7,916.65
2033	914.64	914.64	8,831.28
2034	950.14	950.14	9,781.43
2035	1,010.91	1,010.91	10,792.33
2036	1,049.76	1,049.76	11,842.10
2037	1,130.15	1,130.15	12,972.25
2038	1,169.77	1,169.77	14,142.02
2039	1,207.82	1,207.82	15,349.84
2040	1,311.61	1,311.61	16,661.46
2041	1,300.53	1,300.53	17,961.99
2042	1,303.35	1,303.35	19,265.34
2043	1,356.95	1,356.95	20,622.29
2044	1,400.71	1,400.71	22,023.01
2045	1,406.75	1,406.75	23,429.75
2046	1,408.68	1,408.68	24,838.43
2047	1,416.28	1,416.28	26,254.72

Projection of the location of future deforestation

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

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

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

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

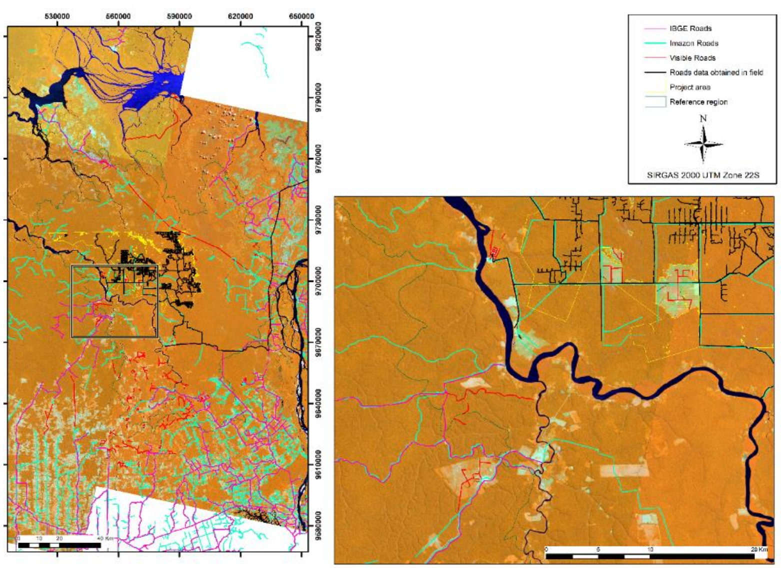
(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2008 to 2017) through the Business-as-usual scenario.

Assigning weightings to change agents

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

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

Figure 61. Access roads in the reference region by Landsat images



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

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

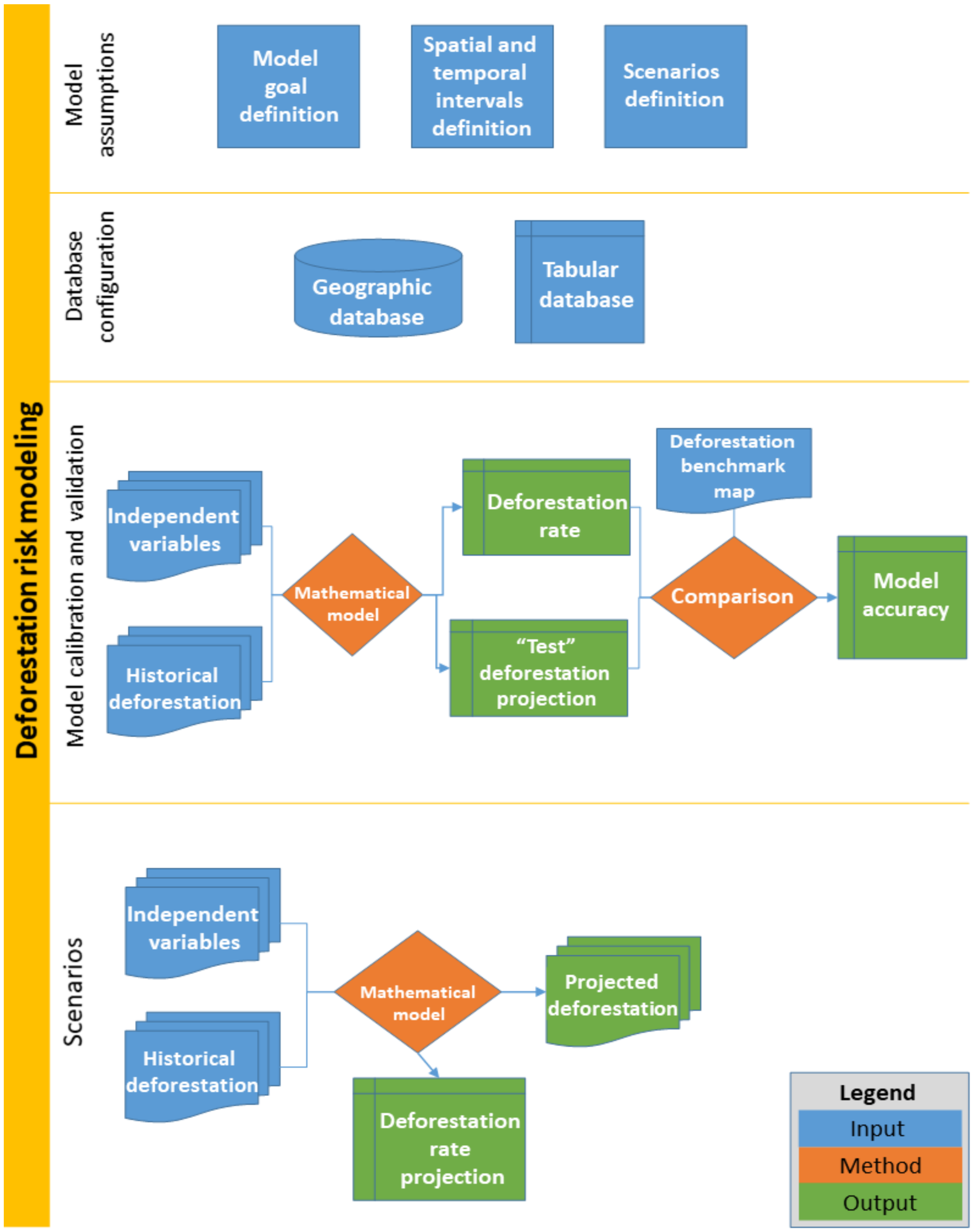
Dinamica EGO is an environmental platform for land use change modeling. Dinamica EGO allows the design of a model by simply dragging and connecting operators that perform calculations upon various types of data, such as constants, matrices, tables and raster maps. In this way, it is possible to set up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

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

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

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

Figure 62. Modelling steps focusing on the creation of the deforestation risk map and the projection of future deforestation



The spatial variables that most likely represent the patterns of baseline deforestation in the reference region were identified, and the digital maps representing the spatial features of each variable were created. The list of variables, maps and factor maps is presented below:

Table 25. List of variables, maps and factor maps

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

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

Based on the weights of the evidence, the transition probability of each forest pixel to become other types of anthropic use is calculated. This probability is calculated based on the sum of all the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps[187].

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

Table 26. Variation of the weights of evidence according to deforestation distance ranges

Deforestation distance ranges		Weight of evidence
0	100	1.97
100	200	1.05
200	300	0.63
300	400	0.32
400	500	0.08
500	600	-0.10
600	800	-0.29
800	1000	-0.41
1000	1200	-0.49
1200	1400	-0.60
1400	1600	-0.69
1600	1900	-0.77
1900	2200	-0.92
2200	2500	-1.03
2500	2900	-1.02
2900	3400	-0.91
3400	3700	-0.69

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

3700	3900	-0.50
3900	4100	-0.27
4100	4700	-0.08
4700	5900	-0.26
5900	6600	-0.46
6600	6700	-2.80
6700	9100	-5.26

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

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

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

Distance from rivers		Weight of evidence
0	100	0.25
100	300	0.47
300	600	0.58
600	900	0.36
900	1200	0.17
1200	1400	-0.01
1400	1700	-0.16
1700	2000	-0.24
2000	2300	-0.23
2300	2600	-0.23
2600	3000	-0.26
3000	3400	-0.29
3400	3800	-0.31
3800	4100	-0.13
4100	4600	0.00
4600	5200	0.09
5200	5800	-0.05
5800	5900	-0.26
5900	6400	-0.07
6400	6700	0.11
6700	7900	-0.06
7900	8000	-0.45
8000	8800	-0.23
8800	8900	0.11
8900	10300	-0.10
10300	10400	-5.29

10400	11400	-5.36

Distance from large rivers		Weight of evidence
0	100	0.24
100	200	0.77
200	700	0.83
700	800	0.60
800	1200	0.40
1200	1500	0.21
1500	1900	0.09
1900	2300	0.02
2300	2700	0.04
2700	3100	0.06
3100	3600	0.00
3600	4100	-0.03
4100	4600	-0.16
4600	5100	-0.10
5100	5700	-0.22
5700	6300	-0.12
6300	6400	0.07
6400	7100	0.05
7100	7700	-0.13
7700	8600	-0.18
8600	9700	-0.28
9700	9800	-1.28
9800	11800	-1.48
11800	13700	-1.93
13700	17200	-2.35

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

Slope		Weight of evidence
0	2	-0.19
2	3	-0.18
3	4	-0.16
4	5	-0.13
5	6	-0.06
6	7	-0.01
7	8	0.07
8	10	0.17
10	13	0.36
13	22	0.57
22	98	0.67
12	13	-0.21
13	15	-0.22
15	18	-0.19
18	55	-0.35

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

Altitude		Weight of evidence
0	2	0.88
2	3	-1.76
3	4	-1.22
4	6	-0.95
6	8	-0.46
8	10	0.01
10	11	0.20
11	12	0.48
12	13	0.91

Altitude		Weight of evidence
40	41	-0.25
41	43	-0.43
43	44	-0.65
44	45	-0.93
45	47	-1.19
47	50	-1.50
50	54	-1.51
54	59	-1.25
59	60	-0.93

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

Table 31. Variation of the weights of evidence according to Protected Areas categories

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

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

Table 32. Variation of the weights of evidence according to the presence of settlements[188]

Settlements	Weight of evidence
Outside settlements	-0.34
Within settlements	0.97

Table 33. Variation of the weights of evidence according to distance from urban areas

Distance from urban areas		Weight of evidence
0	11000	1.00
11000	13000	1.50

Distance from urban areas		Weight of evidence
48500	49500	-0.17
49500	50000	-0.42

[188] The agrarian reform settlement is a set of agricultural units installed by INCRA on a rural property. Each of these units, called plots or lots, is intended for a family of agriculturist or rural worker without economic conditions to acquire a rural property. The benefited family must reside and explore the lot, with the development of various productive activities. More information on < https://www.gov.br/incra/pt-br/assuntos/reforma-agraria/assentamentos>

13000	13500	2.08	50000	53000	-0.44
13500	17500	1.44	53000	54500	-0.65
17500	18000	0.89	54500	55000	-1.04
18000	18500	0.46	55000	55500	-0.74
18500	19000	0.69	55500	56500	-1.00
19000	19500	0.05	56500	57000	-1.35
19500	21000	0.18	57000	57500	-0.90
21000	21500	0.68	57500	60500	-0.82
21500	22000	1.03	60500	61000	-0.53
22000	22500	0.77	61000	63500	-0.46
22500	23000	0.55	63500	64000	-0.68
23000	23500	0.22	64000	65000	-0.94
23500	24000	0.37	65000	68000	-0.86
24000	26000	0.15	68000	68500	-0.39
26000	28500	-0.03	68500	71500	-0.22
28500	29000	-0.31	71500	75000	-0.11
29000	29500	-0.68	75000	78500	-0.21
29500	30000	-0.90	78500	79000	-0.01
30000	31500	-0.74	79000	81500	0.23
31500	32000	-0.08	81500	82000	0.72
32000	32500	0.11	82000	85000	0.48
32500	33000	0.33	85000	85500	-0.23
33000	33500	0.14	85500	86500	-0.02
33500	36500	0.32	86500	87500	0.27
36500	41000	0.22	87500	88000	0.70
41000	45000	0.19	88000	92500	0.83
45000	48500	0.03	92500	101500	0.73

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

Figure 63.Distance from roads risk map

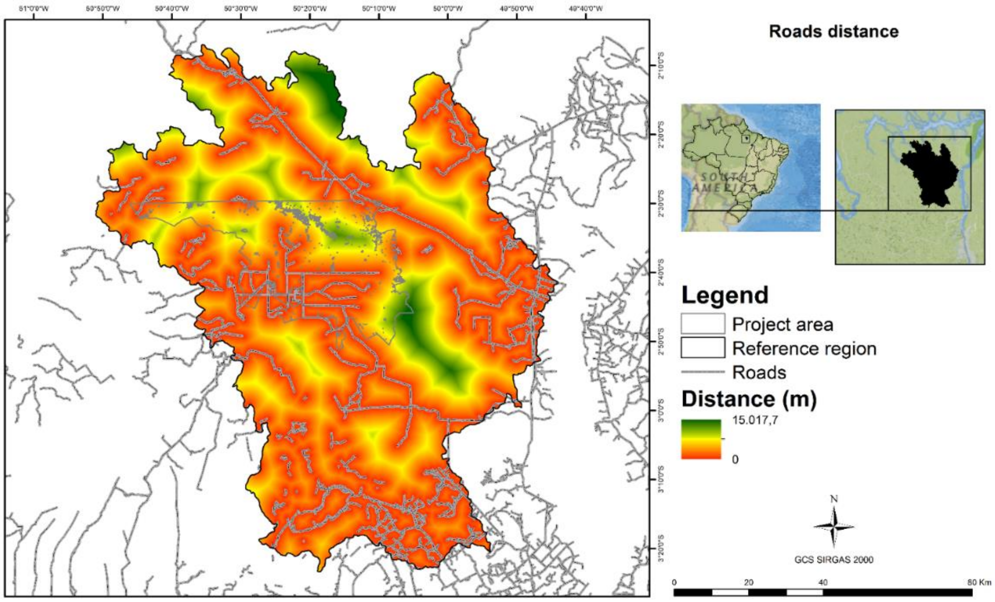


Figure 64. Distance from urban areas risk map

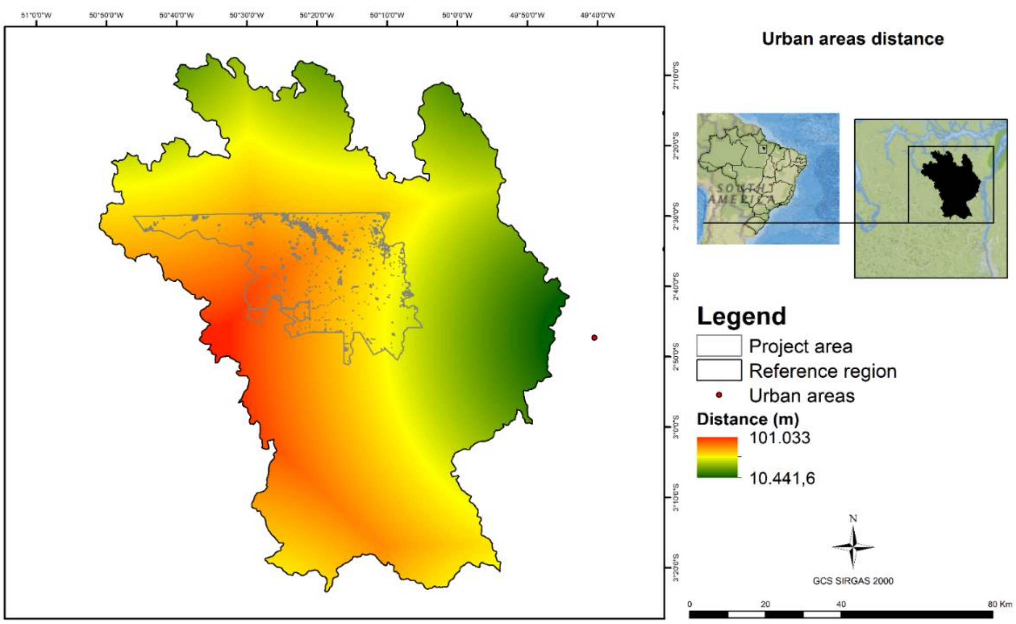


Figure 65. Presence of settlements (baseline)

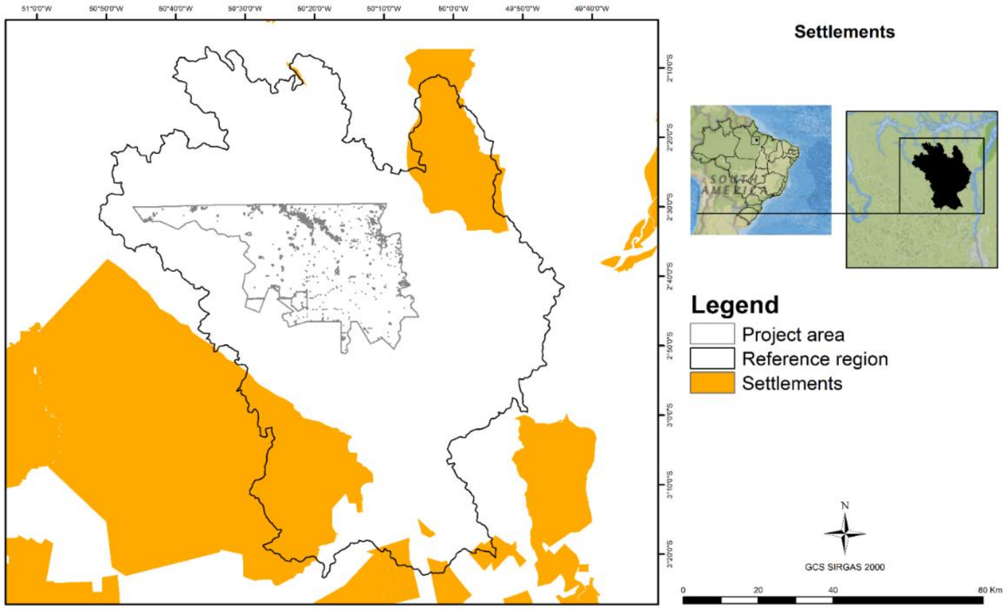
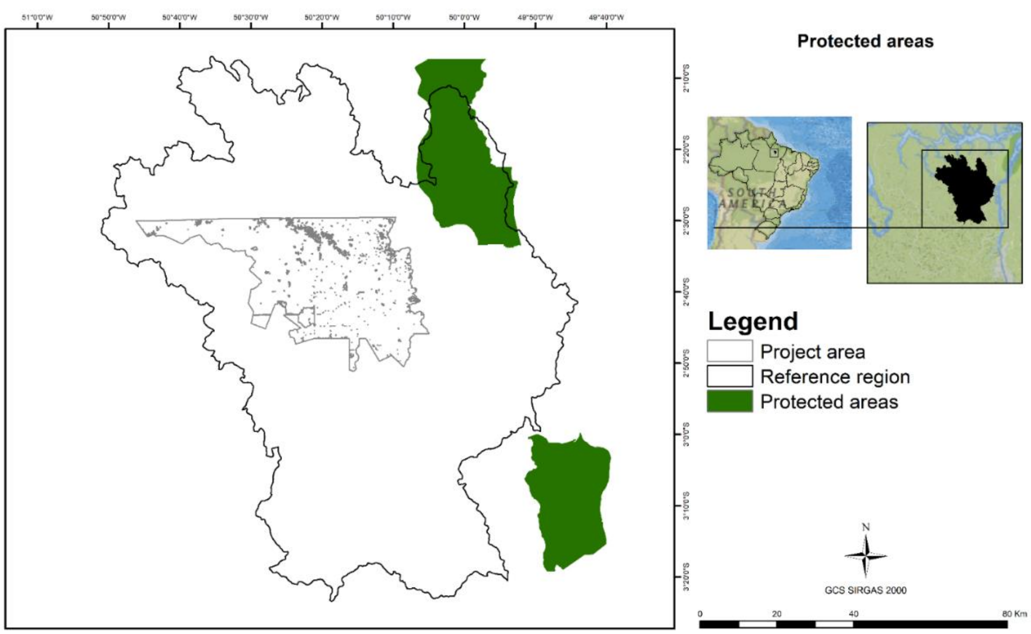


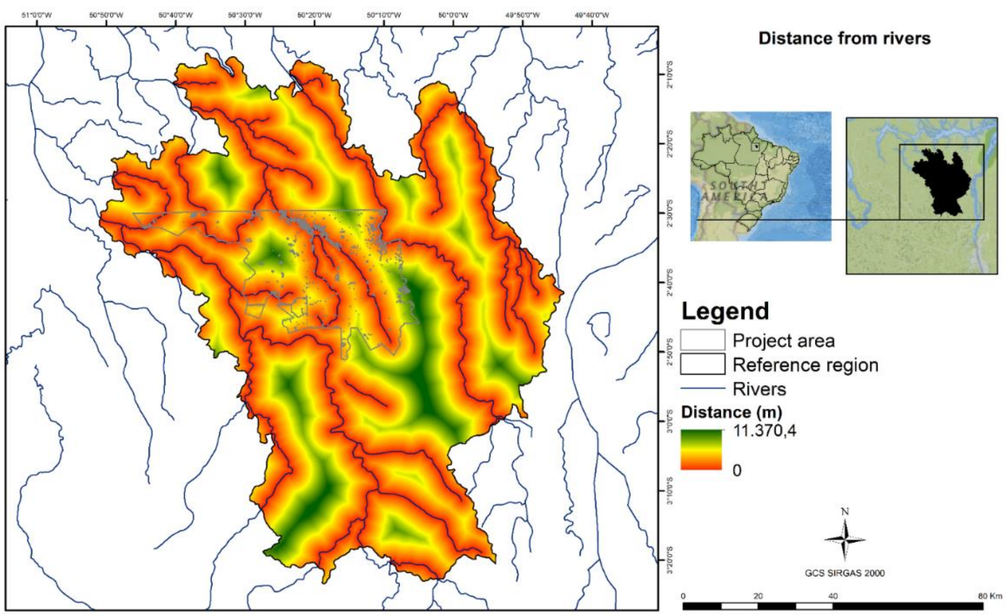
Figure 66. Proximity to conservation units



The Protected Areas Arióca Pruanã Extractive Reserve and Ipaú-Anilzinho Extractive Reserve are areas used by traditional extractivist populations, whose subsistence is based on extractivism and, in addition, on subsistence agriculture and the raising of small animals, and whose basic objectives are to protect the livelihoods and culture of these populations and ensure the sustainable use of the unit's natural resources[189]. In this way, this type of conservation unit usually also has a settlement associated with it, as is the case[190].

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

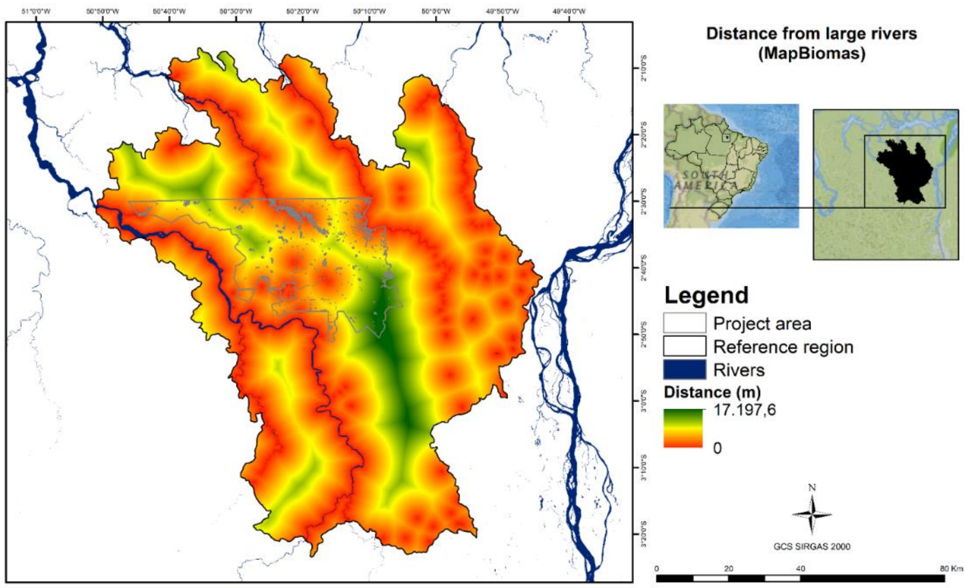
Figure 67. Proximity to rivers



[189] Available at < https://www.planalto.gov.br/ccivil_03/leis/l9985.htm>

[190] The areas of Extractive Reserves (Resex) are recognized by INCRA as Settlement Projects, enabling the access of the communities that live there to the basic rights established for the Agrarian Reform Program. Available at < https://www.gov.br/incra/pt-br/assuntos/reforma-agraria/assentamentos>

Figure 68.Proximity to large rivers mapped by MapBiomas



Two rivers databased are used as variables: rivers and large rivers. The proximity of rivers (areas of water that offer access by swimming or small boats) and larger rivers (here considering navigable rivers, which facilitate the traffic of ferries and larger boats) have different weights since they have different probabilities of driving deforestation. Thus, similar to protected areas, both variables are weighted and analysed according to its vulnerability to deforestation.

Selection of most accurate deforestation risk map

According to the methodology, "The Prediction Map with the best fit is the map that best reproduced actual deforestation in the confirmation period. The best fit must be assessed using appropriate statistical techniques. Most peerreviewed modeling tools, such as Geomod, Idrisi Taiga, Land Use Change Modeler, and Dinamica Ego, include in the software package appropriate assessment techniques, which can be used under this methodology. Preference should be given to techniques that assess the accuracy of the prediction at the polygon level, such as the predicted quantity of total deforestation within the project area as compared to the observed one."

Thus, in the ABC Norte REDD Project case, the exponential decay function was used to calculate the similarity between real and projected scenarios, which is a method indicated in the Dinamica Ego software, software recommended by the methodology[191].

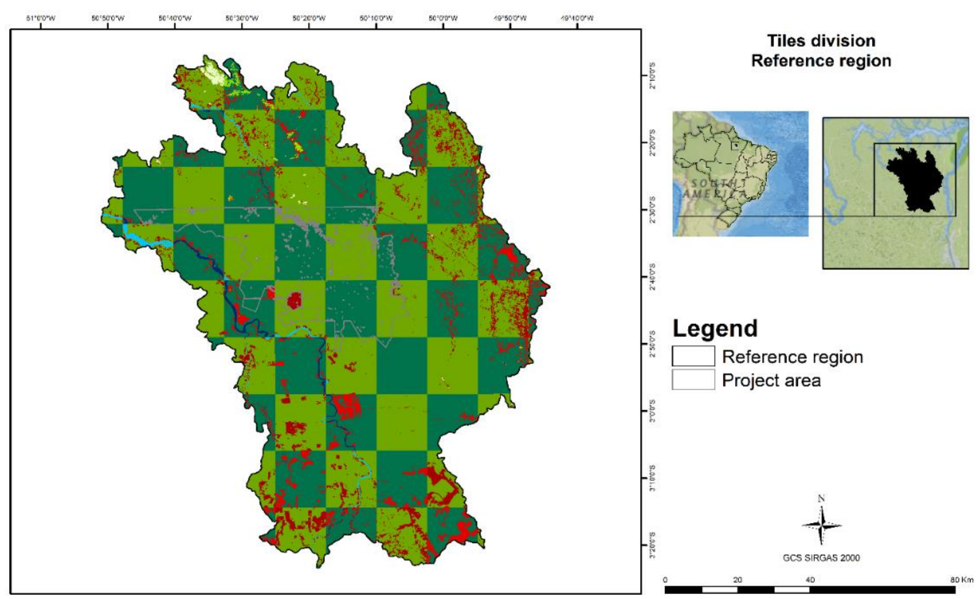
[191] An example of application is presented in the following article:
https://www.sciencedirect.com/science/article/pii/S1364815213000236?casa_token=iq5Q228fEYEAAAAA:JaWqxV1H_61NGSYMXo5XbHyXw3Atv1P1f2ioAJtwg6Idm8F8W7BUm7rCIyArnHIKRlyCNkXwfdI

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.

As guided in section 4.3.2 of the methodology, the selection of the most accurate deforestation risk map was conducted following option B) (*Where only one historical sub-period is representative of what is likely to happen in the future, divide the reference region in tiles and randomly select half of the tiles for the calibration data set and the other half for the confirmation set.*), as the sub-period of 2014-2017 is the most representative of the deforestation pattern in the region.

For this, the reference region was divided in a grid ("tiles") with approximately 14 x 15 km cells. The grid was systematically divided into two types, following the pattern of a chessboard. A part of this grid was selected to adjust and calibrate the model, relating the explanatory variables (factors) to the deforested areas, and the other part was used to project 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 2007 to September 2017.

Figure 69. Reference Region divided into tiles, where half of the area was used to calibrate the models and the other half for validation



For validation, the simulated scenarios for September 2017 were compared with the actual deforestation that happened in the area, using the method of similarity degree with exponential decay due to distance. This index ranges from 0 (no overlapping) to 1 (completely overlapped), and the closer to 1, the more similar is the simulated scenario in relation to the real. Two values are calculated for the indices, the comparison of the simulated map in relation to the real deforestation map and, the opposite, the real map in relation to the simulated map. Thus, to define the most accurate map, the average of these two values was used.

The results of this analysis are shown in table below, indicating that model 10 was the most accurate. The selected variables in this model are: Settlements and Distance to roads. The other variables were not considered, as presented below.

Figure 70. Best deforestation projection models from 2007 to September 2017. Each line corresponds to a model and was evaluated by the degree of similarity

Model	Similarity 01	Similarity 02	Average	Settlement	Distance to roads	Distance to rivers	Distances to large rivers	Distance from urban areas	Slope	Altitude	Protected Areas
m00	0.382	0.433	0.4076	1	1	1	1	1	1	1	1
m01	0.339	0.419	0.3789	0	1	1	1	1	1	1	1
m02	0.312	0.379	0.3454	1	0	1	1	1	1	1	1
m03	0.395	0.437	0.4160	1	1	0	1	1	1	1	1
m04	0.397	0.438	0.4174	1	1	1	0	1	1	1	1
m05	0.371	0.422	0.3964	1	1	1	1	0	1	1	1
m06	0.377	0.436	0.4065	1	1	1	1	1	0	1	1
m07	0.347	0.422	0.3847	1	1	1	1	1	1	0	1
m08	0.390	0.437	0.4136	1	1	1	1	1	1	1	0
m09	0.341	0.423	0.3820	0	1	0	0	0	0	0	0
m10	0.403	0.449	0.4258	1	1	0	0	0	0	0	0
m11	0.411	0.439	0.4247	1	1	0	0	0	0	1	0
m12	0.403	0.442	0.4226	1	1	0	0	1	0	1	0
m13	0.412	0.439	0.4257	1	1	0	0	1	1	1	0
m14	0.404	0.435	0.4193	1	1	0	0	1	1	1	1

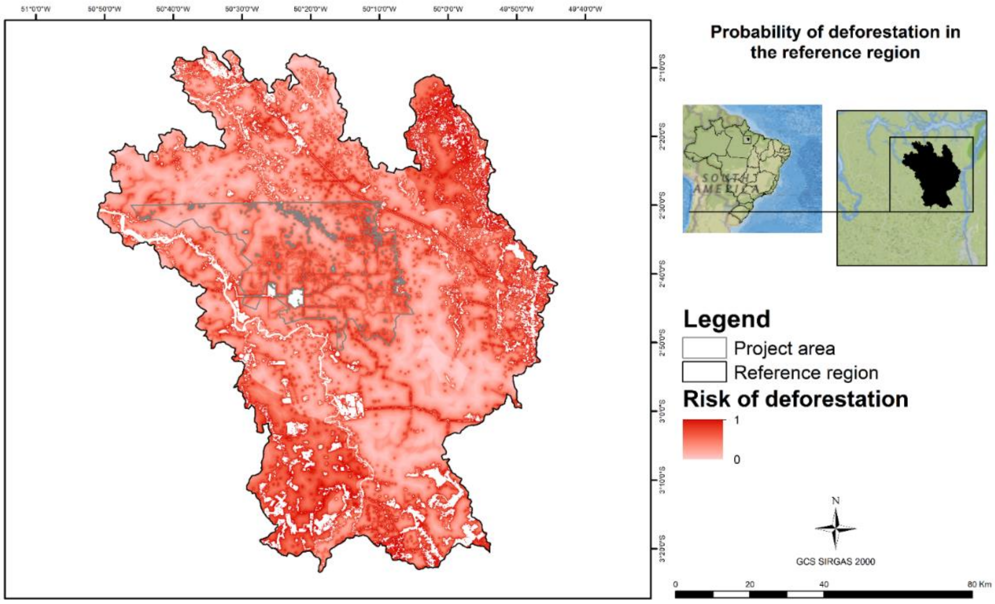
Additionally, for the most accurate model, a similarity analysis with multiple growing windows was used, in which it observes a window in the surroundings for each pixel and compares the degree of accuracy between the simulated map and the map with real deforestation. Therefore, the larger the window, the greater the chance of success. According to Barni[192], a degree of correctness above 50% is considered satisfactory, which happens when the window is 9x9 in size.

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

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

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

Figure 71. Potential risk map for the occurrence of deforestation in the reference region, using Dinamica Ego Software



Mapping of locations of future deforestation

The mapping of the location of future deforestation until 2048 was carried out through Dinamica Ego. Figures below show the results in the reference region, project area and leakage belt.

Figure 72. Projection of deforestation in the reference region, using Dinamica EGO

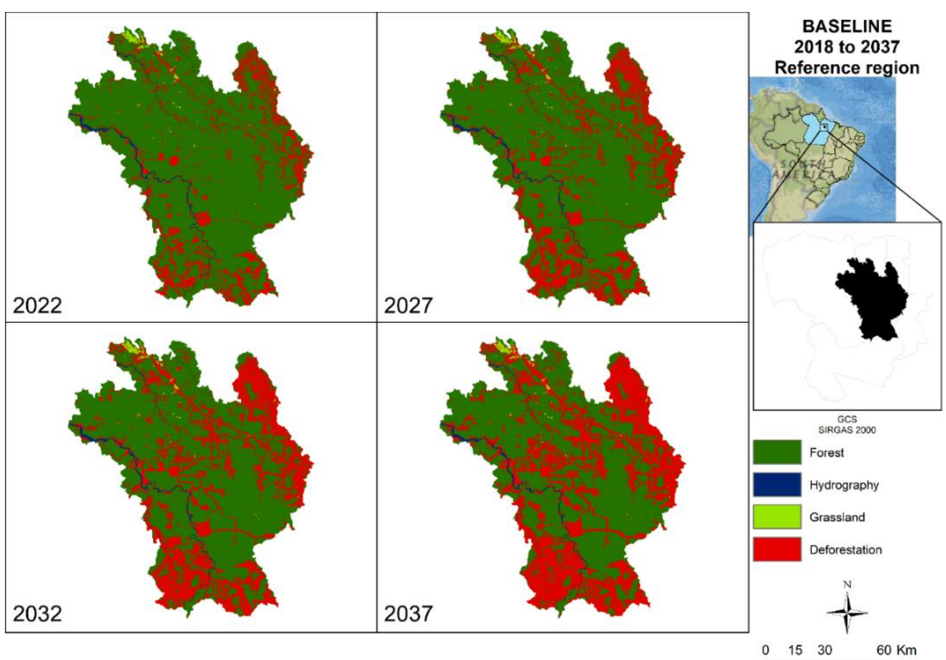


Figure 73. Projection of deforestation in the reference region, using Dinamica EGO

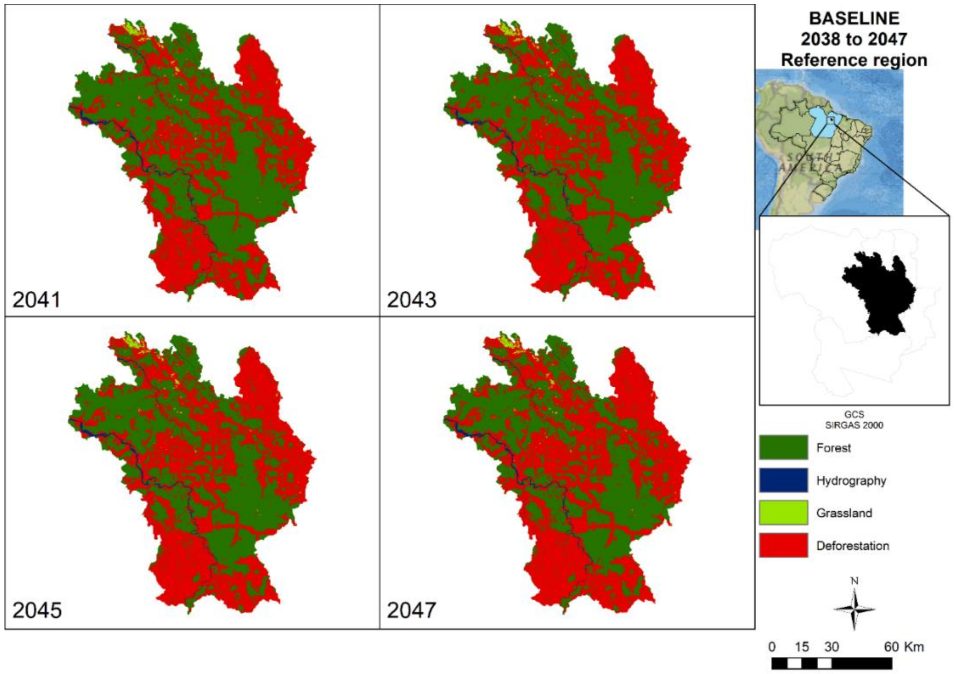


Figure 74. Projection of deforestation in the Project Area, using Dinamica EGO

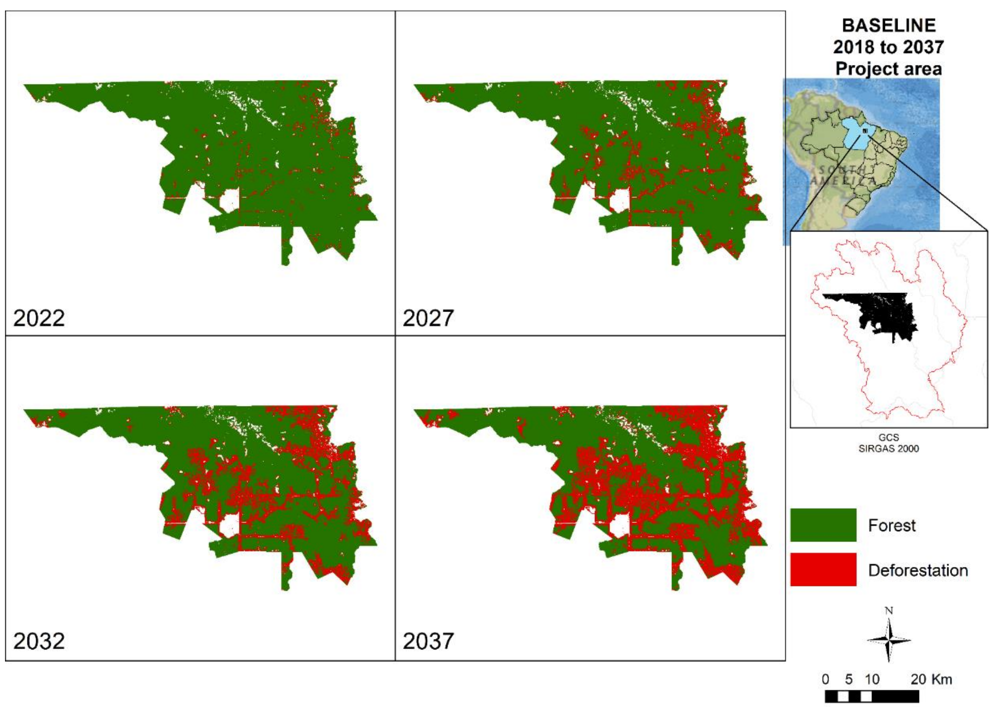


Figure 75. Projection of deforestation in the project area, using Dinamica EGO

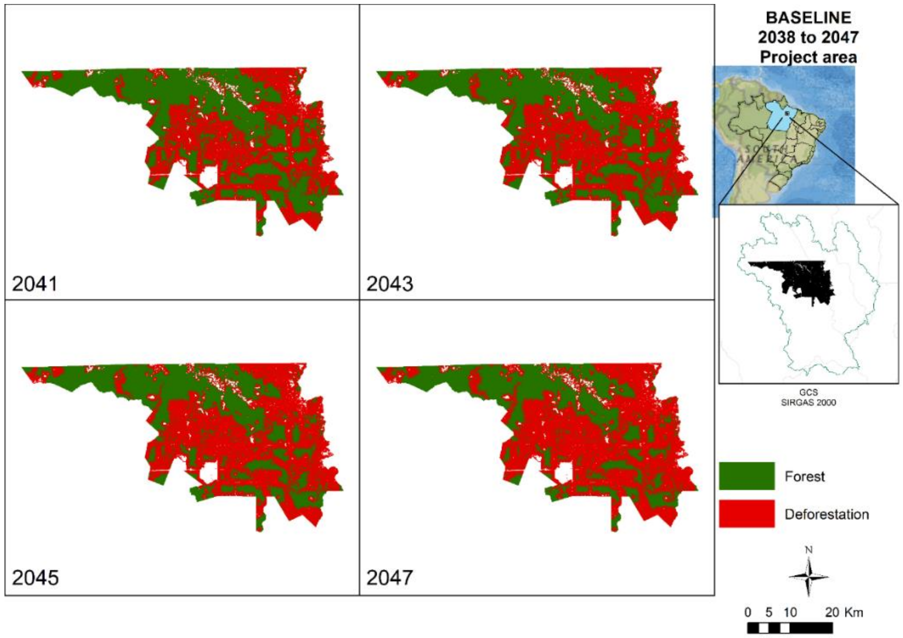


Figure 76. Projection of deforestation in the leakage belt, using Dinâmica EGO

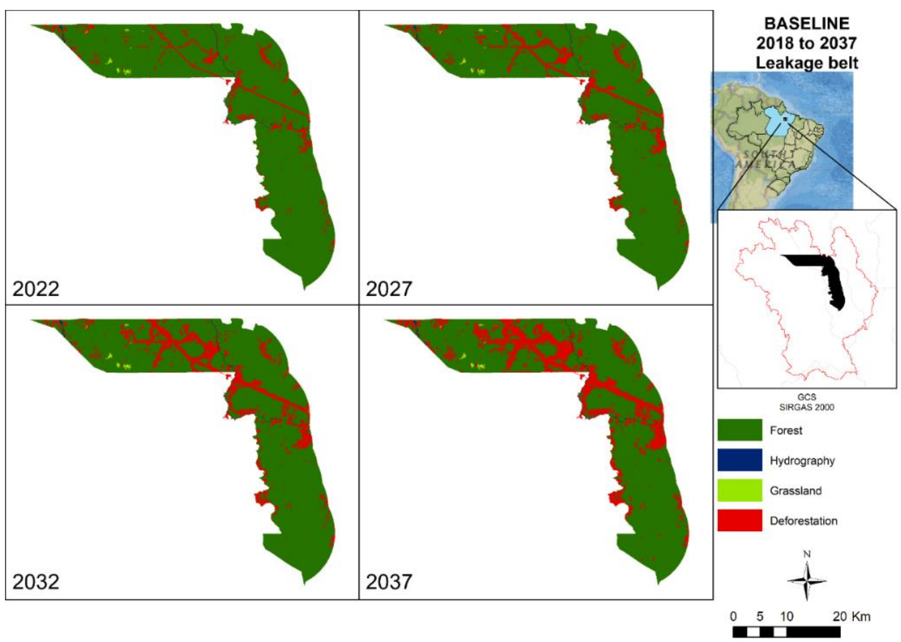


Figure 77. Projection of deforestation in the leakage belt, using Dinâmica EGO

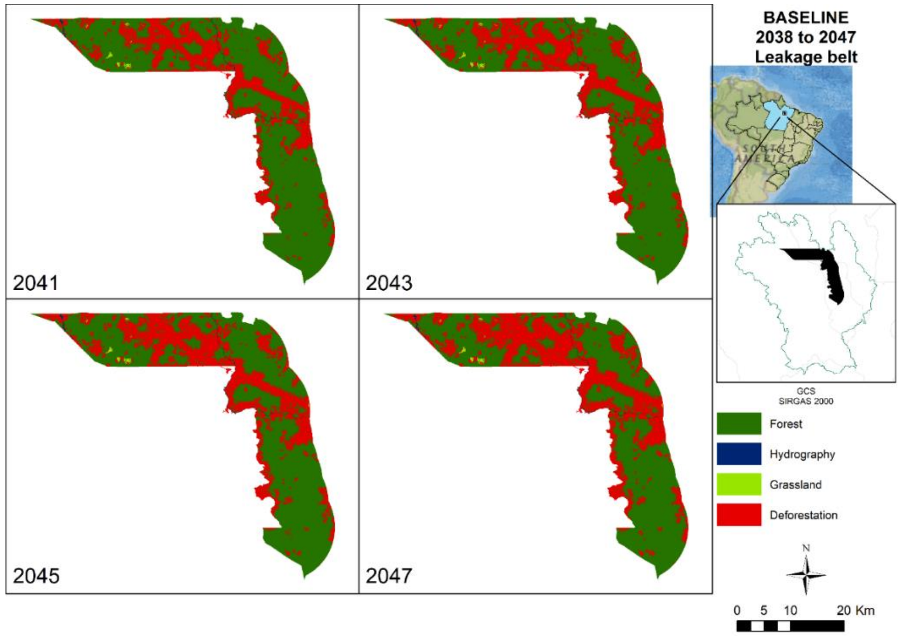


Figure 78. Deforestation projection in the reference region, year by year (2018-2027)

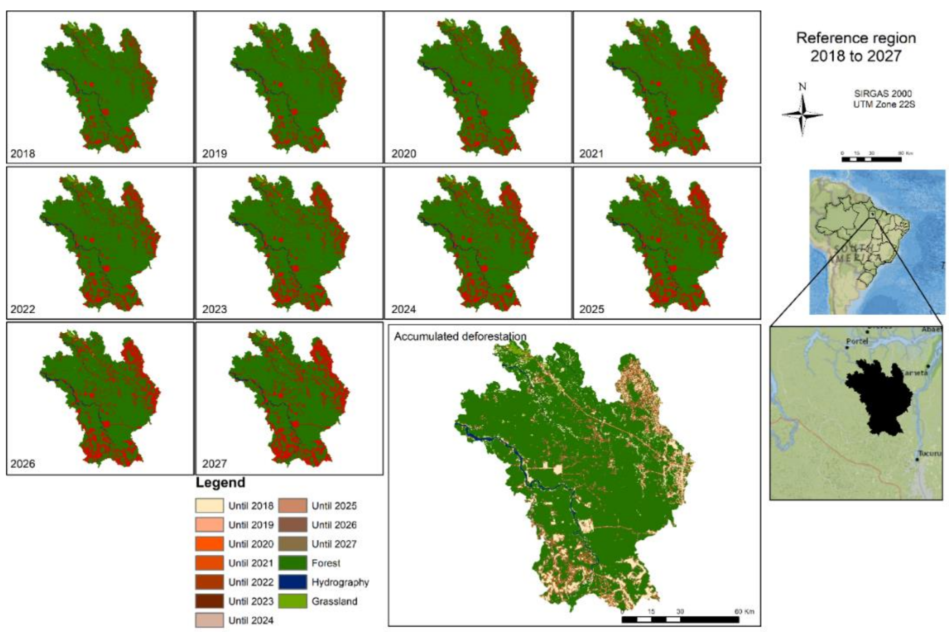


Figure 79. Deforestation projection in the reference region, year by year (2028-2037)

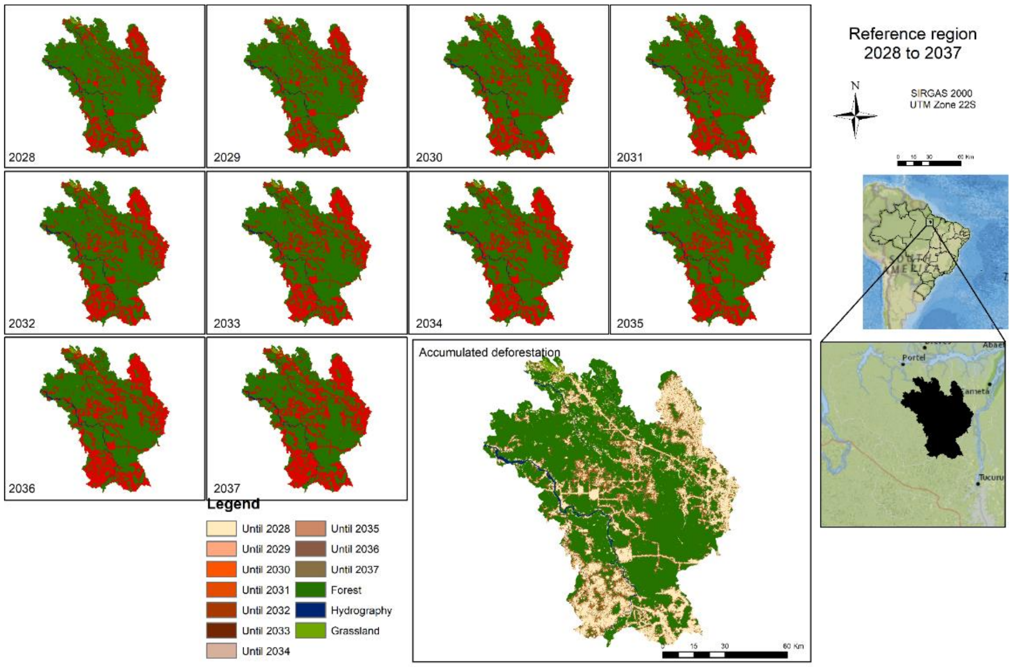


Figure 80. Deforestation projection in the reference region, year by year (2038-2047)

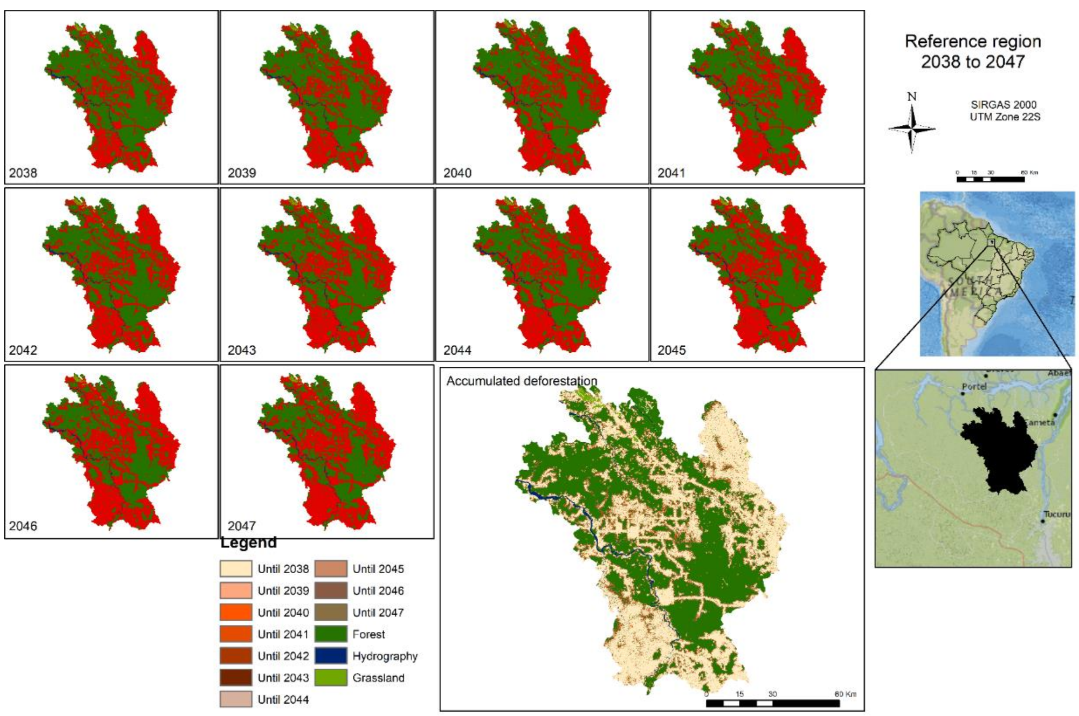


Figure 81. Deforestation projection in the project area, year by year (2018-2027)

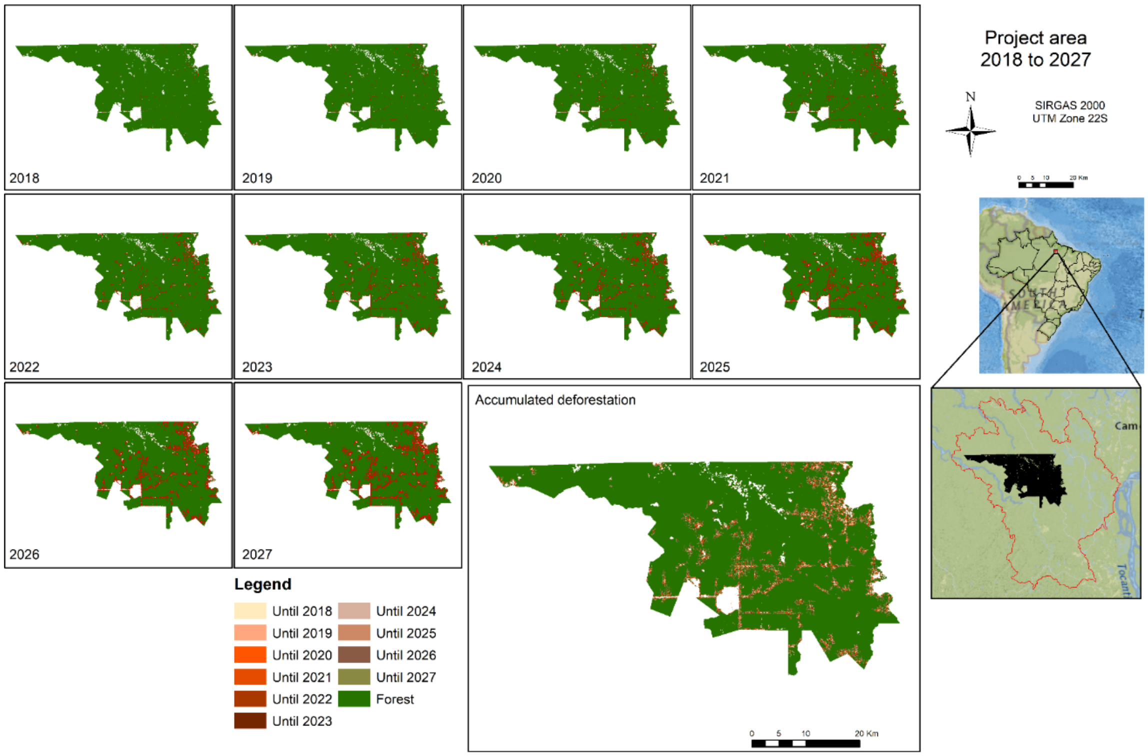


Figure 82. Deforestation projection in the project area, year by year (2028-2037)

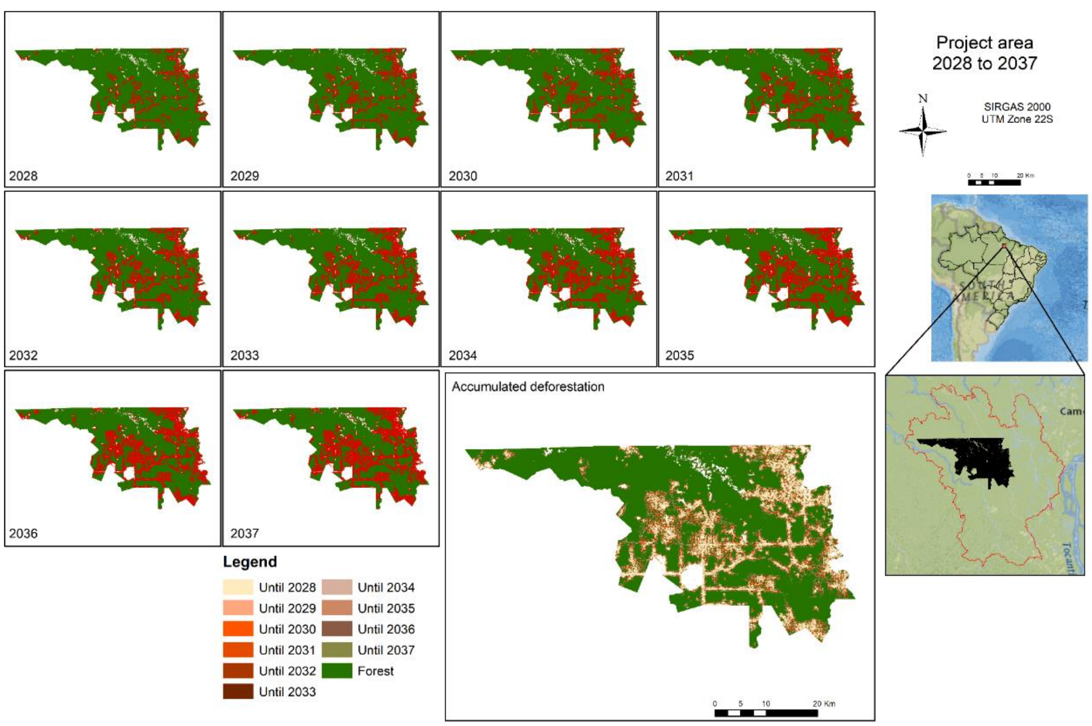


Figure 83. Deforestation projection in the project area, year by year (2038-2047)

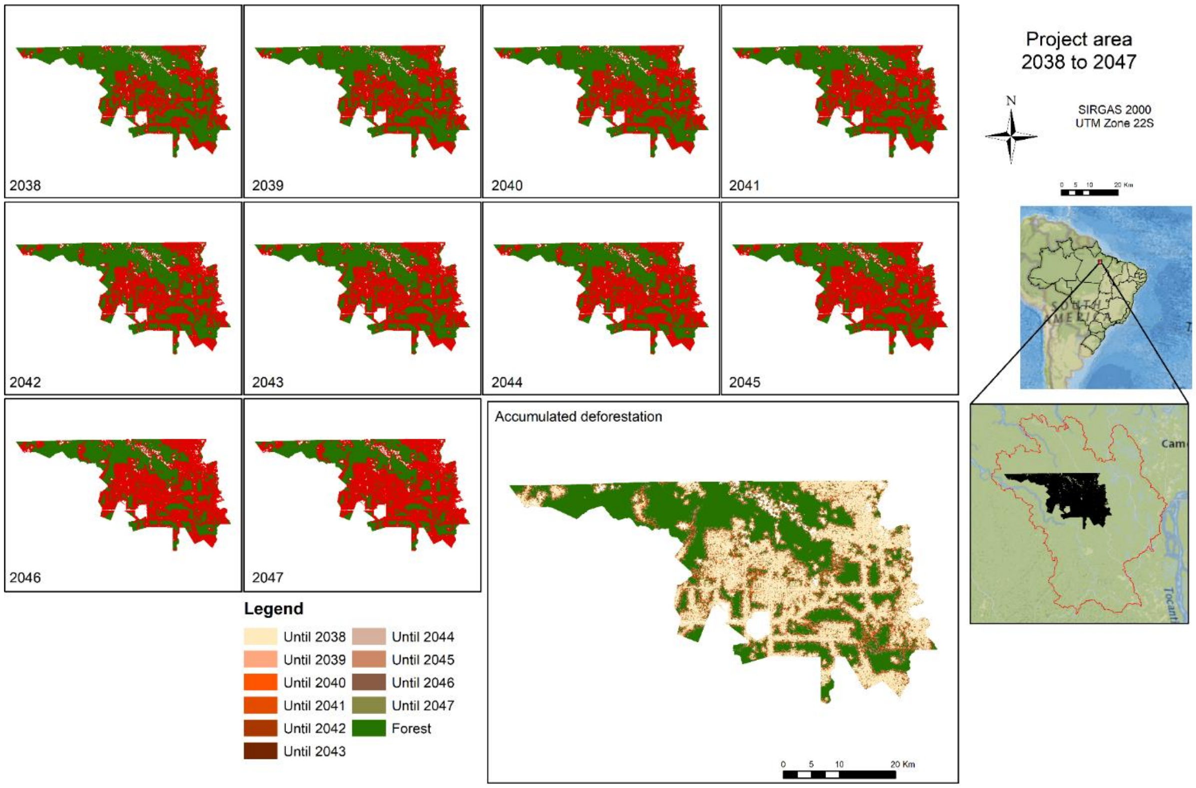


Figure 84. Deforestation projection in the leakage belt, year by year (2018 - 2027)

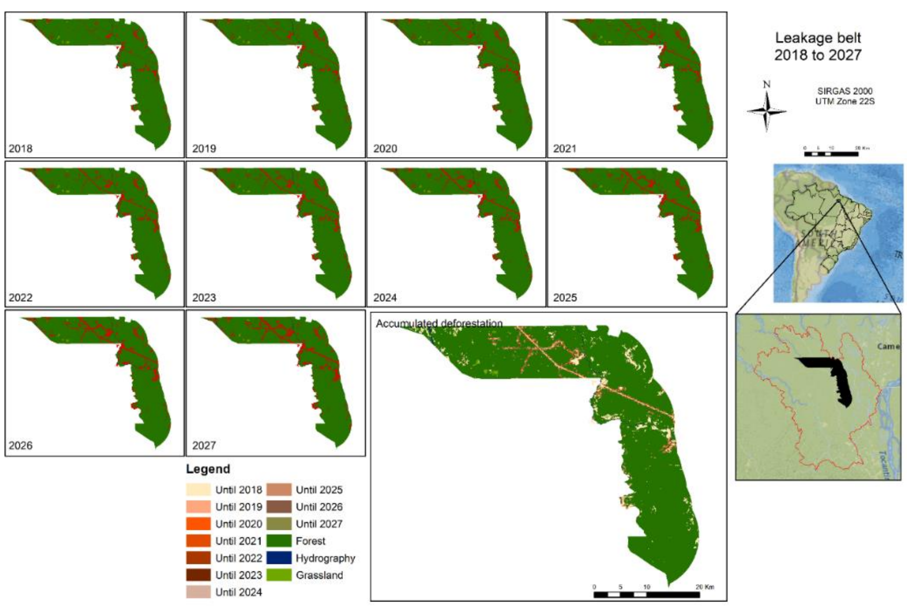


Figure 85. Deforestation projection in the leakage belt, year by year (2028-2037)

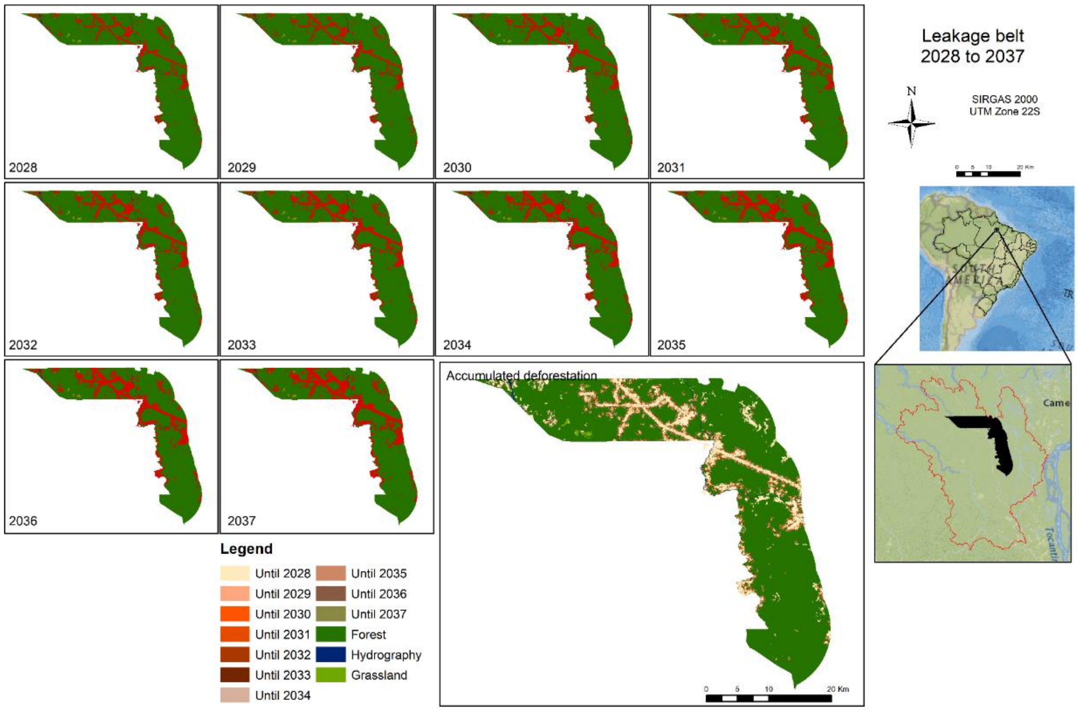
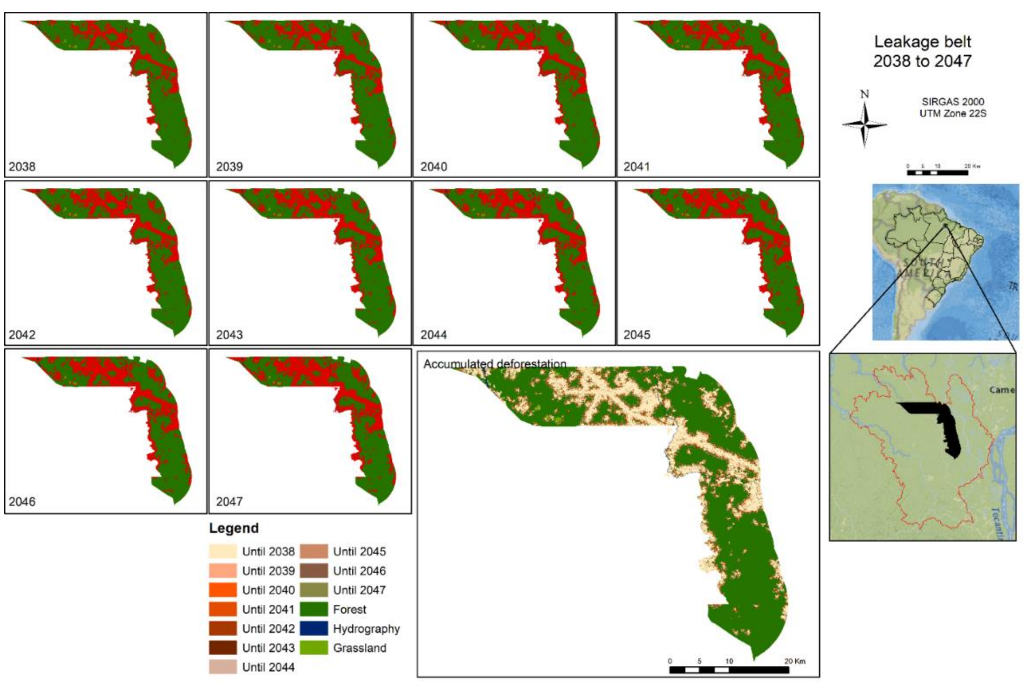


Figure 86. Deforestation projection in the leakage belt, year by year (2038-2047)



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

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

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

Calculation of baseline activity data per forest class

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

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

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

Area deforested per florest class *icl* within the reference region		Total baseline deforestation in the reference region	
IDicl	1	annual ABSLRRt (ha)	ABSLRR cumulative (ha)
Name	Forest		
Project year *t*	ha		
2017	2,199.32	2,199.32	2,199.32
2018	7,297.75	7,297.75	9,497.07
2019	10,085.85	10,085.85	19,582.92
2020	10,651.77	10,651.77	30,234.69
2021	11,194.20	11,194.20	41,428.89
2022	11,711.70	11,711.70	53,140.59
2023	12,203.55	12,203.55	65,344.14
2024	12,668.94	12,668.94	78,013.08
2025	13,106.97	13,106.97	91,120.05
2026	13,517.10	13,517.10	104,637.15
2027	13,898.70	13,898.70	118,535.85
2028	14,251.50	14,251.50	132,787.35
2029	14,574.87	14,574.87	147,362.22
2030	14,868.90	14,868.90	162,231.12
2031	15,133.05	15,133.05	177,364.17
2032	15,367.50	15,367.50	192,731.67
2033	15,572.34	15,572.34	208,304.01
2034	15,747.75	15,747.75	224,051.76
2035	15,893.64	15,893.64	239,945.40
2036	16,010.55	16,010.55	255,955.95
2037	16,099.02	16,099.02	272,054.97
2038	16,159.32	16,159.32	288,214.29
2039	16,192.08	16,192.08	304,406.37
2040	16,198.02	16,198.02	320,604.39
2041	16,177.68	16,177.68	336,782.07
2042	16,132.05	16,132.05	352,914.12
2043	16,061.85	16,061.85	368,975.97
2044	15,967.89	15,967.89	384,943.86
2045	15,851.25	15,851.25	400,795.11
2046	15,712.83	15,712.83	416,507.94
2047	15,553.80	15,553.80	432,061.74

Table 35. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)

Area deforested per florest class icl within the project area		Total baseline deforestation in the project area	
IDicl	1	annual ABSLPAt (ha)	ABSLPA cumulative (ha)
Name	Forest		
Project year *t*	ha		
2017	145.32	145.32	145.32
2018	482.20	482.20	627.52
2019	821.10	821.10	1,448.62
2020	942.03	942.03	2,390.65
2021	1,062.34	1,062.34	3,452.99
2022	1,345.17	1,345.17	4,798.16
2023	1,585.67	1,585.67	6,383.83
2024	1,720.26	1,720.26	8,104.09
2025	2,014.46	2,014.46	10,118.55
2026	2,286.32	2,286.32	12,404.86
2027	2,540.36	2,540.36	14,945.23
2028	2,672.25	2,672.25	17,617.48
2029	2,947.38	2,947.38	20,564.86
2030	2,994.73	2,994.73	23,559.59
2031	3,153.66	3,153.66	26,713.25
2032	3,336.87	3,336.87	30,050.12
2033	3,460.69	3,460.69	33,510.81
2034	3,468.10	3,468.10	36,978.91
2035	3,580.09	3,580.09	40,559.01
2036	3,635.43	3,635.43	44,194.44
2037	3,634.77	3,634.77	47,829.21
2038	3,649.75	3,649.75	51,478.96
2039	3,594.94	3,594.94	55,073.90
2040	3,562.72	3,562.72	58,636.62
2041	3,740.53	3,740.53	62,377.15
2042	3,529.26	3,529.26	65,906.41
2043	3,462.97	3,462.97	69,369.38
2044	3,448.35	3,448.35	72,817.73
2045	3,495.42	3,495.42	76,313.16
2046	3,374.75	3,374.75	79,687.90
2047	3,306.37	3,306.37	82,994.27

Table 36. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

Area deforested per florest class icl within the leakage belt		Total baseline deforestation in the leakage belt	
IDicl	1	annual ABSLLKt (ha)	ABSLLK cumulative (ha)
Name	Forest		
Project year *t*	ha		
2017	76.39	76.39	76.39
2018	253.46	253.46	329.85
2019	330.73	330.73	660.58
2020	379.41	379.41	1,039.99
2021	353.38	353.38	1,393.36
2022	432.21	432.21	1,825.58
2023	432.28	432.28	2,257.86
2024	484.57	484.57	2,742.43
2025	514.93	514.93	3,257.36
2026	524.40	524.40	3,781.76
2027	586.52	586.52	4,368.28
2028	627.96	627.96	4,996.24
2029	628.17	628.17	5,624.42
2030	695.97	695.97	6,320.39
2031	803.50	803.50	7,123.88
2032	792.76	792.76	7,916.65
2033	914.64	914.64	8,831.28
2034	950.14	950.14	9,781.43
2035	1,010.91	1,010.91	10,792.33
2036	1,049.76	1,049.76	11,842.10
2037	1,130.15	1,130.15	12,972.25
2038	1,169.77	1,169.77	14,142.02
2039	1,207.82	1,207.82	15,349.84
2040	1,311.61	1,311.61	16,661.46
2041	1,300.53	1,300.53	17,961.99
2042	1,303.35	1,303.35	19,265.34
2043	1,356.95	1,356.95	20,622.29
2044	1,400.71	1,400.71	22,023.01
2045	1,406.75	1,406.75	23,429.75
2046	1,408.68	1,408.68	24,838.43
2047	1,416.28	1,416.28	26,254.72

Calculation of baseline activity data per post-deforestation forest class

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

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

Table 37. Zone of the reference region encompassing potential post-deforestation LU/LC class

Zone		Name		Total area of each zone	
		Non-forest			
		ID_{fcl}	1		
		Area	% of zone	Area	% of zone
IDz	Name	ha	%	ha	%
1	Reference region	432,061.74	45%	432,061.74	45%
Total area of each class *fcl*		432,061.74	45%	432,061.74	45%

Tables below depict the annual areas deforested in each zone in the baseline case within the reference region, project area and leakage belt, respectively:

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

Area established after deforestation per zone within the reference region		Total baseline deforestation in the reference region	
ID_{fcl}	1	*$ABSLRR_t$*	*ABSLRR*
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2017	2,199.32	2,199.32	2,199.32
2018	7,297.75	7,297.75	9,497.07
2019	10,085.85	10,085.85	19,582.92
2020	10,651.77	10,651.77	30,234.69
2021	11,194.20	11,194.20	41,428.89
2022	11,711.70	11,711.70	53,140.59
2023	12,203.55	12,203.55	65,344.14
2024	12,668.94	12,668.94	78,013.08
2025	13,106.97	13,106.97	91,120.05
2026	13,517.10	13,517.10	104,637.15
2027	13,898.70	13,898.70	118,535.85
2028	14,251.50	14,251.50	132,787.35
2029	14,574.87	14,574.87	147,362.22
2030	14,868.90	14,868.90	162,231.12
2031	15,133.05	15,133.05	177,364.17
2032	15,367.50	15,367.50	192,731.67
2033	15,572.34	15,572.34	208,304.01
2034	15,747.75	15,747.75	224,051.76
2035	15,893.64	15,893.64	239,945.40
2036	16,010.55	16,010.55	255,955.95
2037	16,099.02	16,099.02	272,054.97
2038	16,159.32	16,159.32	288,214.29
2039	16,192.08	16,192.08	304,406.37
2040	16,198.02	16,198.02	320,604.39
2041	16,177.68	16,177.68	336,782.07
2042	16,132.05	16,132.05	352,914.12
2043	16,061.85	16,061.85	368,975.97
2044	15,967.89	15,967.89	384,943.86
2045	15,851.25	15,851.25	400,795.11
2046	15,712.83	15,712.83	416,507.94
2047	15,553.80	15,553.80	432,061.74

Table 39. Annual areas deforested in each zone within the project area in the baseline case (baseline activity data per zone)

Area established after deforestation per zone within the project area		Total baseline deforestation in the project area	
ID_{fcl}	1	$ABSLPA_t$	*ABSLPA*
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2017	145.32	145.32	145.32
2018	482.20	482.20	627.52
2019	821.10	821.10	1,448.62
2020	942.03	942.03	2,390.65
2021	1,062.34	1,062.34	3,452.99
2022	1,345.17	1,345.17	4,798.16
2023	1,585.67	1,585.67	6,383.83
2024	1,720.26	1,720.26	8,104.09
2025	2,014.46	2,014.46	10,118.55
2026	2,286.32	2,286.32	12,404.86
2027	2,540.36	2,540.36	14,945.23
2028	2,672.25	2,672.25	17,617.48
2029	2,947.38	2,947.38	20,564.86
2030	2,994.73	2,994.73	23,559.59
2031	3,153.66	3,153.66	26,713.25
2032	3,336.87	3,336.87	30,050.12
2033	3,460.69	3,460.69	33,510.81
2034	3,468.10	3,468.10	36,978.91
2035	3,580.09	3,580.09	40,559.01
2036	3,635.43	3,635.43	44,194.44
2037	3,634.77	3,634.77	47,829.21
2038	3,649.75	3,649.75	51,478.96
2039	3,594.94	3,594.94	55,073.90
2040	3,562.72	3,562.72	58,636.62
2041	3,740.53	3,740.53	62,377.15
2042	3,529.26	3,529.26	65,906.41
2043	3,462.97	3,462.97	69,369.38
2044	3,448.35	3,448.35	72,817.73
2045	3,495.42	3,495.42	76,313.16
2046	3,374.75	3,374.75	79,687.90
2047	3,306.37	3,306.37	82,994.27

Table 40. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

Leakage Belt			
Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	$ABSLLK_t$	*ABSLLK*
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2017	76.39	76.39	76.39
2018	253.46	253.46	329.85
2019	330.73	330.73	660.58
2020	379.41	379.41	1,039.99
2021	353.38	353.38	1,393.36
2022	432.21	432.21	1,825.58
2023	432.28	432.28	2,257.86
2024	484.57	484.57	2,742.43
2025	514.93	514.93	3,257.36
2026	524.40	524.40	3,781.76
2027	586.52	586.52	4,368.28
2028	627.96	627.96	4,996.24
2029	628.17	628.17	5,624.42
2030	695.97	695.97	6,320.39
2031	803.50	803.50	7,123.88
2032	792.76	792.76	7,916.65
2033	914.64	914.64	8,831.28
2034	950.14	950.14	9,781.43
2035	1,010.91	1,010.91	10,792.33
2036	1,049.76	1,049.76	11,842.10
2037	1,130.15	1,130.15	12,972.25
2038	1,169.77	1,169.77	14,142.02
2039	1,207.82	1,207.82	15,349.84
2040	1,311.61	1,311.61	16,661.46
2041	1,300.53	1,300.53	17,961.99
2042	1,303.35	1,303.35	19,265.34
2043	1,356.95	1,356.95	20,622.29
2044	1,400.71	1,400.71	22,023.01
2045	1,406.75	1,406.75	23,429.75
2046	1,408.68	1,408.68	24,838.43
2047	1,416.28	1,416.28	26,254.72

Calculation of Baseline Emissions

The total average biomass stock per hectare (Mg ha^{-1}) was converted to tCO_2e using the following equations:

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

Where,

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

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

Where,

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

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

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

Where,

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

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

Where,

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

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

Where,

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

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

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

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

As previously described, the Dense Lowland Tropical Rainforest is the main forest type present within the project area, with around 99% of the total forest cover. In addition, the mean carbon stock within the project area calculated through weighed average with other forest classes showed a similarity of around 99.96% to the Dense Lowland Tropical Rainforest carbon stocks. Thus, due to the high representativeness of this forest type within the project area, and the very high similarity in terms of carbon stocks in relation to the mean, the forest class was not stratified, i.e., the "Forest" class includes just one strata due to the low difference in average carbon stocks within the project area. The estimation of the average carbon stocks for Dense Lowland Tropical Rainforest is described below.

- **Dense Lowland Tropical Rainforest (code "*Db*"):** According to Fearnside et al. (2013)[193], this forest type has 394 $t.ha^{-1}$ of total biomass. Barni et al. (2016)[194], in turn, point to a 419.0 $t.ha^{-1}$ total biomass for this type of forest. The Ministry of Science, Technology and Innovation (2015)[195], adopts a value of 421,87 $t.ha^{-1}$ in national official greenhouse gas emission estimations. According to Higuchi (2015)[196], this type of vegetation holds 327.40 $t.ha^{-1}$ of aboveground biomass, or 405.98 $t.ha^{-1}$ for total biomass[197].

  However, in order to obtain local biomass data for "*Db*" vegetation, the project proponent promoted a forest inventory campaign at Fazenda Pacajá (Portel/PA) in 2021, involving the measurement of 21 plots. The allocation of the permanent plots prioritized areas not previously managed for timber products. Each plot has dimensions of 50 x 50 m (0.25 hectares), randomly distributed. The permanent plots were demarcated at the four corners, with wooden pickets, in order to facilitate their location later on, and their geographical coordinates were recorded. DBH was measured at 1.30 m above ground level, involving trees with DBH > 10 cm (measuring tape). The total height of the trees was obtained in an estimated manner (visual) or using a Blume-Leiss device (hypsometer), when possible. Data were collected from a total sample area of 5.25 ha, involving the measurement of 2,345 individuals.

  The estimation of tree volumes involved the application of allometric equation from Colpini et al. (2009)[198]. The Colpini et al. (2009) Schumacher-Hall model showed the best performance for volumes with bark, being therefore used in this biomass quantification. The allometric equation was applied for estimating the merchantable volume of trees. This equation has been derived using DBH based on datasets that comprise more than 30 trees (i.e. 91 trees). This equation was based on statistically significant regression and has an R^2 that is higher than 0.8 (i.e. $R^2 = 0.966$). The allometric equation has been obtained for individuals with DBH ranging from 15 cm to 135 cm. Considering that Colpini's Schumacher-Hall model was derived from a data set of more than 30 sample trees, and the value of coefficient of determination (R^2) obtained was not less than 0.85,

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[193] https://revista.ufrr.br/agroambiente/article/view/971/1026
[194] http://philip.inpa.gov.br/publ_livres/mss%20and%20in%20press/Barni_et_al-biomassa_florestal_em_Roraima_PORTUGUES_2016.07.19.pdf
[195] http://redd.mma.gov.br/images/FREL/RR_LULUCF_Mudana-de-Uso-e-Floresta.pdf
[196] https://acervodigital.ufpr.br/bitstream/handle/1884/41822/R%20-%20T%20-%20FRANCISCO%20GASPARETTO%20HIGUCHI.pdf?sequence=1&isAllowed=y)
[197] Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha; and 0.20 for below 125 tons/ha.
[198] https://www.scielo.br/j/aa/a/BXPkWdfz4h869TrBzpKRWGh/?lang=pt

thus it meets all the necessary criteria prescribed in the tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities"[199]. The results of merchantable tree volume obtained with the equation below were then converted to dry biomass using the 0.701 t/m^3 wood basic density, according to Nogueira (2008)[200] for this same forest type in the State of Pará. A 1.66 Biomass Expansion Factor (BEF) was applied for conversion of merchantable volume to total aboveground tree biomass, according to Brown et al. (1989)[201]. A 0.24 root-shoot ratio was applied for estimating the belowground tree biomass (according to VM0015, Appendix 3, Table 2. Root to shoot ratios).

$$Ln(Volume) = -9,1892 + 1,9693 \times ln(DBH) + 0,837 \times ln(Height)$$

The local biomass inventory results are summarized in table below. Given that the error level (E%) of estimates are under 10% (i.e., 7.67%), thus the average value of 392.3 t dm ha^{-1} has been used, corresponding to 719.2 tCO_2 ha^{-1}.

[199] https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-17-v1.pdf

[200] http://philip.inpa.gov.br/publ_livres/Teses%20e%20dissertacoes%20orientadas/Nogueira_E%20M%202008_WOOD_DENSITY_ALLOMETRY_AND_CARBON_IN_BRAZILIAN_AMAZONIA_THESIS_ingles.pdf (Table 3, accessed in 06/08/2021)

[201] Brown, S., A. J. R. Gillespie, and A. E. Lugo, 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. Forest Science, 35:881-902. (Table 4; pg. 890; minimum value deducted from lowest limit.: 1.743 - 0.083 = 1.66)

Table 41. Summary of local biomass inventory, corresponding to "Db" classification

Permanent plot	Aboveground biomass (t dm ha^{-1})	Belowground biomass (t dm ha^{-1})	Total biomass (t dm ha^{-1})	Carbon stock (t CO_2 ha^{-1})
6	430.5	103.3	533.8	978.6
9	338.5	81.2	419.7	769.4
10	374.7	89.9	464.6	851.8
14	287.5	69.0	356.5	653.5
15	417.7	100.3	518.0	949.7
24	316.2	75.9	392.1	718.9
25	394.5	94.7	489.2	896.9
26	308.5	74.0	382.5	701.2
79	311.4	74.7	386.2	708.0
7	217.3	52.1	269.4	493.9
2	265.1	63.6	328.7	602.6
4	257.3	61.8	319.1	585.0
6203	279.7	67.1	346.8	635.8
6204	283.8	68.1	351.9	645.1
6097	298.6	71.7	370.2	678.7
6796	319.6	76.7	396.3	726.6
5397	373.6	89.7	463.2	849.2
6102	256.3	61.5	317.8	582.7
7195	308.6	74.1	382.7	701.5
7094	347.3	83.3	430.6	789.5
7193	256.9	61.7	318.6	584.0
Average	316.35	75.92	392.28	719.18
Average				719.2
Standard deviation				128.9
E%				7.67

Therefore, the table below shows a comparison of the results obtained from the local forest inventory and the literature values for vegetation type dense lowland tropical rainforest. Given that a local forest inventory has been conducted in the Project Area in 2021 and uncertainty levels are within methodology tolerances, local estimates were used in calculations. Moreover, the local inventory has the most conservative value among the other literatures cited above.

Table 42. Total carbon stocked per hectare in Dense Tropical Rainforest (code "Db"), according to the literature and comparison to the local forest inventory.

Dense lowland tropical rainforest Above and below ground biomass	
Source	$tCO_2\ ha^{-1}$
Fearnside et al. (2013)	722.3
Barni et al. (2016)	768.2
Ministry of Science, Technology and Innovation (2015)	773.4
Higuchi (2015)	744.3
Local forest inventory in Fazenda Pacajá (2021)	719.2

In order to be conservative, the weighted average carbon stocks will be used instead of the value for dense lowland tropical rainforest. It is also important to note that the local forest inventory conducted for the dense lowland tropical rainforest has a lower uncertainty when compared to the literature values for other forest types within the project area. Therefore, using the value for dense lowland tropical rainforest is more accurate. Furthermore, using the weighed average carbon stocks within the project area is more conservative.

Table 43. Comparison between literature and forest inventory carbon stock

PROJECT AREA										
Forest class	% of the PA	Aboveground*			Belowground**			TOTAL		
		Biomass (Mg ha-1)	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha-1)	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha-1)	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Lowland Tropical Rainforest	99%	316.35	158.18	579.98	75.92	37.96	139.19	392.27	196.14	719.17
Dense Alluvial Tropical Rainforest[202]	1%	299.26	149.63	548.64	71.82	35.91	131.67	371.08	185.54	680.32
Dense Tropical Rainforest[203]	0%	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Wooded Campinarana[204]	0%	42.09	21.05	77.17	8.42	4.21	15.43	50.51	25.25	92.60
Weighted average		**316.22**	**158.11**	**579.74**	**75.89**	**37.95**	**139.14**	**392.11**	**196.06**	**718.87**

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

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

Table 44. Biomass to CO2 conversion factors[205]

Conversion Factors	
Biomass to Carbon	0.5
C to CO_2	3.6667

[202] NOGUEIRA, E.M., Yanai, A. M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. Global Change Biology 21: 1271-1292. Available at: <http://philip.inpa.gov.br/publ_livres/Preprints/2015/Nogueira_et_al_Carbon_stock_Loss_through_2013-GCB-Preprint.pdf>.
[203] HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015. Available at: https://acervodigital.ufpr.br/bitstream/handle/1884/41822/R%20-%20T%20-%20FRANCISCO%20GASPARETTO%20HIGUCHI.pdf?sequence=1&isAllowed=y.
[204] NOGUEIRA, E.M., Yanai, A. M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. Global Change Biology 21: 1271-1292. Available at: <http://philip.inpa.gov.br/publ_livres/Preprints/2015/Nogueira_et_al_Carbon_stock_Loss_through_2013-GCB-Preprint.pdf>.
[205] IPCC, 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Table 45. Biomass values used for the "forest" class within the reference region, project area and leakage belt

Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} ($tCO2$/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} ($tCO2$/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Lowland Tropical Rainforest (weighted average)	316.22	158.11	579.74	75.89	37.95	139.14	392.11	196.06	718.87

Average carbon stocks of post-deforestation classes

The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomas, which is detailed below:

Land Use	Area (%)
Pasturelands	66.18%
Secondary forests	33.66%
Agriculture	0.09%
Rivers, lakes and reservatory	0.06%
Urban area	0.01%

Therefore, almost two-thirds of the post-deforestation land uses within the reference region is composed by pasturelands.

In order to estimate the post-deforestation carbon stocks, the average carbon stocks of pasturelands, agriculture and other land uses were taken from the National GHG Emissions Communication of Brazil to the UNFCCC (2019)[206].

For secondary forests, a regional study was conducted. Most secondary forests in the Brazilian Amazon are young. In 2017, 65% of secondary forests was ≤10 years old. On average, 35% of annual land abandonment to secondary forests was re-cleared within 5 years, and 57% within 10 years[207]. The half-life of secondary forests is 8 years, on average, which is also the same value

[206] Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf>

[207] Sâmia Nunes *et al* 2020 *Environ. Res. Lett.* **15** 034057. Available at: <https://iopscience.iop.org/article/10.1088/1748-9326/ab76db>

found by other study that concludes that more than 50% of the secondary forests in the Amazon biome have less than 8 years old[208].

According to a study conducted in the State of Pará that analyzed the carbon stocks of a secondary forest with 14 years old, the average carbon stock in above ground biomass is around 19 tC/ha[209]. Below ground biomass was estimated through the root-to-shoot ratio from the applied methodology. Therefore, the average value for secondary forests is around 22,8 tC/ha.

Therefore, the weighted average carbon stocks was calculated through the data below.

Land Use	Area (%)	Carbon stocks (tC/ha)
Pasturelands	66,18%	7.57
Secondary forests	33,66%	22.8
Agriculture	0,09%	21
Rivers, lakes and reservatory	0,06%	0
Urban area	0,01%	0
Weighted average of post-deforestation carbon stocks		12.70

Table 46. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Post deforestation class *fcl*	
Name	Non forest
ID_{fcl}	1
Average carbon stock per hectare ±90% CI	
$Ctot_{fcl}$	
tCO_2e/ha	
46.58	

<u>Uncertainty assessment</u>

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

[208] Silva Junior, C.H.L., Heinrich, V.H.A., Freire, A.T.G. *et al.* Benchmark maps of 33 years of secondary forest age for Brazil. *Sci Data* **7**, 269 (2020). Available at: <https://doi.org/10.1038/s41597-020-00600-4>

[209] Pereira, Izaura Cristina Nunes. Estoque de biomassa e carbono florestal em unidades de paisagem na Amazônia: uma análise a partir da abordagem metodológica. Universidade Federal do Pará, , Belém, 2013. Available at: <https://ppgdstu.propesp.ufpa.br/ARQUIVOS/teses/TESES/2013/IZAURA%20CRISTINA%20NUNES%20PEREIRA.pdf>

the leakage belt, and the higher boundary of the 90% confidence interval if the class is an initial forest class in the leakage belt or a final non-forest class in the project area.

The local forest inventory – for the Dense lowland tropical rainforest - was conducted at a 95% confidence interval and present an uncertainty level less than 10% of the average carbon stock value.

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

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

Initial forest class *icl*						
Boundaries	Average carbon stock 90% CI					
	Name	Forest - Dense Lowland Tropical Rainforest				
	ID_{icl}	1				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI
	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
Project Area	579.74	37.32	139.14	8.96	718.87	46.27
Leakage Belt	579.74	37.32	139.14	8.96	718.87	46.27

Table 48. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties

<table>
<tr><td></td><td colspan="7">Initial forest class icl</td></tr>
<tr><td></td><td rowspan="6">Boundaries</td><td colspan="6">Average carbon stock 90% CI</td></tr>
<tr><td></td><td>Name</td><td colspan="5">Forest - Dense Lowland Tropical Rainforest</td></tr>
<tr><td></td><td>ID_{icl}</td><td colspan="5">1</td></tr>
<tr><td></td><td colspan="2">Cab_{icl}</td><td colspan="2">Cbb_{icl}</td><td colspan="2">Ctot_{icl}</td></tr>
<tr><td></td><td>C stock</td><td>C stock change</td><td>C stock</td><td>C stock change</td><td>C stock</td><td>C stock change</td></tr>
<tr><td></td><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td></tr>
<tr><td>Initial forest class</td><td rowspan="2">Project Area</td><td>579.74</td><td>579.74</td><td>139.14</td><td>139.14</td><td>718.87</td><td>718.87</td></tr>
<tr><td>Final forest class</td><td>579.74</td><td>579.74</td><td>139.14</td><td>139.14</td><td>718.87</td><td>718.87</td></tr>
<tr><td>Initial forest class</td><td rowspan="2">Leakage Belt</td><td>579.74</td><td>579.74</td><td>139.14</td><td>139.14</td><td>718.87</td><td>718.87</td></tr>
<tr><td>Final forest class</td><td>579.74</td><td>579.74</td><td>139.14</td><td>139.14</td><td>718.87</td><td>718.87</td></tr>
</table>

<u>Carbon stock change factors</u>

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

a) Above-ground biomass:

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

b) Below-ground biomass:

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

the 10 years period following deforestation (i.e. 1/10th of the final carbon stock is accumulated each year).

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

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

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-579.98	-13.92
2	t*+1	0	-13.92
3	t*+2	0	-13.92
4	t*+3	0	-13.92
5	t*+4	0	-13.92
6	t*+5	0	-13.92
7	t*+6	0	-13.92
8	t*+7	0	-13.92
9	t*+8	0	-13.92
10	t*+9	0	-13.92
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20…	0	0

Table 50. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-579.74	-13.91
2	t*+1	0	-13.91
3	t*+2	0	-13.91
4	t*+3	0	-13.91
5	t*+4	0	-13.91
6	t*+5	0	-13.91
7	t*+6	0	-13.91
8	t*+7	0	-13.91
9	t*+8	0	-13.91
10	t*+9	0	-13.91
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20…	0	0

Table 51. Carbon stock change factors for initial forest classes (icl) in the Leakage Belt (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-579.74	-13.91
2	t*+1	0	-13.91
3	t*+2	0	-13.91
4	t*+3	0	-13.91
5	t*+4	0	-13.91
6	t*+5	0	-13.91
7	t*+6	0	-13.91
8	t*+7	0	-13.91
9	t*+8	0	-13.91
10	t*+9	0	-13.91
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Table 52. Carbon stock change factors for final classes fcl or zones z (Method 1)

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/ha)
1	t*	0.00
2	t*+1	5.18
3	t*+2	5.18
4	t*+3	5.18
5	t*+4	5.18
6	t*+5	5.18
7	t*+6	5.18
8	t*+7	5.18
9	t*+8	5.18
10	t*+9	5.18
11	t*+10	0
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0
16	t*+15	0
17	t*+16	0
18	t*+17	0
19	t*+18	0
20	t*+19	0
21-T	t*+20…	0

Calculation of baseline carbon stock changes

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

Table 53. Baseline carbon stock change in the Reference Region

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the reference region	
ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e
2017	1,275,553	1,275,553	1,275,553
2018	4,232,510	4,232,510	5,508,063
2019	5,849,541	5,849,541	11,357,604
2020	6,177,760	6,177,760	17,535,364
2021	6,492,356	6,492,356	24,027,720
2022	6,792,493	6,792,493	30,820,214
2023	7,077,754	7,077,754	37,897,968
2024	7,347,668	7,347,668	45,245,636
2025	7,601,715	7,601,715	52,847,351
2026	7,839,580	7,839,580	60,686,931
2027	8,060,899	8,060,899	68,747,830
2028	8,265,514	8,265,514	77,013,343
2029	8,453,060	8,453,060	85,466,404
2030	8,623,590	8,623,590	94,089,994
2031	8,776,791	8,776,791	102,866,784
2032	8,912,766	8,912,766	111,779,550
2033	9,031,568	9,031,568	120,811,118
2034	9,133,301	9,133,301	129,944,420
2035	9,217,914	9,217,914	139,162,333
2036	9,285,719	9,285,719	148,448,052
2037	9,337,029	9,337,029	157,785,081
2038	9,372,002	9,372,002	167,157,083
2039	9,391,002	9,391,002	176,548,084
2040	9,394,447	9,394,447	185,942,531
2041	9,382,650	9,382,650	195,325,181
2042	9,356,186	9,356,186	204,681,367
2043	9,315,471	9,315,471	213,996,838
2044	9,260,977	9,260,977	223,257,815
2045	9,193,329	9,193,329	232,451,144
2046	9,113,049	9,113,049	241,564,192
2047	9,020,815	9,020,815	250,585,008

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e
2017	30,613	30,613	30,613
2018	132,194	132,194	162,807
2019	272,582	272,582	435,389
2020	420,849	420,849	856,238
2021	576,665	576,665	1,432,903
2022	739,685	739,685	2,172,588
2023	909,551	909,551	3,082,140
2024	1,085,895	1,085,895	4,168,035
2025	1,268,336	1,268,336	5,436,371
2026	1,456,486	1,456,486	6,892,858
2027	1,619,335	1,619,335	8,512,192
2028	1,716,127	1,716,127	10,228,319
2029	1,778,611	1,778,611	12,006,930
2030	1,837,311	1,837,311	13,844,241
2031	1,892,138	1,892,138	15,736,379
2032	1,943,024	1,943,024	17,679,403
2033	1,989,916	1,989,916	19,669,319
2034	2,032,771	2,032,771	21,702,089
2035	2,071,560	2,071,560	23,773,649
2036	2,106,267	2,106,267	25,879,916
2037	2,136,894	2,136,894	28,016,810
2038	2,163,450	2,163,450	30,180,260
2039	2,185,960	2,185,960	32,366,220
2040	2,204,461	2,204,461	34,570,681
2041	2,219,002	2,219,002	36,789,682
2042	2,229,644	2,229,644	39,019,326
2043	2,236,457	2,236,457	41,255,783
2044	2,239,521	2,239,521	43,495,305
2045	2,238,931	2,238,931	45,734,236
2046	2,234,787	2,234,787	47,969,024
2047	2,227,198	2,227,198	50,196,222

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region	
ID_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e
2017	0	0	0
2018	11,382	11,382	11,382
2019	49,151	49,151	60,533
2020	101,349	101,349	161,882
2021	156,476	156,476	318,358
2022	214,410	214,410	532,769
2023	275,023	275,023	807,791
2024	338,181	338,181	1,145,972
2025	403,747	403,747	1,549,719
2026	471,581	471,581	2,021,300
2027	541,537	541,537	2,562,837
2028	602,086	602,086	3,164,923
2029	638,074	638,074	3,802,997
2030	661,306	661,306	4,464,304
2031	683,132	683,132	5,147,435
2032	703,517	703,517	5,850,952
2033	722,437	722,437	6,573,389
2034	739,872	739,872	7,313,261
2035	755,806	755,806	8,069,067
2036	770,228	770,228	8,839,294
2037	783,132	783,132	9,622,427
2038	794,520	794,520	10,416,946
2039	804,394	804,394	11,221,340
2040	812,763	812,763	12,034,103
2041	819,642	819,642	12,853,745
2042	825,048	825,048	13,678,793
2043	829,005	829,005	14,507,798
2044	831,538	831,538	15,339,337
2045	832,678	832,678	16,172,015
2046	832,458	832,458	17,004,473
2047	830,918	830,918	17,835,391

Total net carbon stock change in the reference region	
$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
annual	cumulative
tCO$_2$e	tCO$_2$e
1,306,166	1,306,166
4,353,322	5,659,488
6,072,972	11,732,460
6,497,260	18,229,720
6,912,545	25,142,265
7,317,768	32,460,034
7,712,282	40,172,316
8,095,383	48,267,699
8,466,304	56,734,003
8,824,486	65,558,488
9,138,696	74,697,185
9,379,555	84,076,739
9,593,597	93,670,337
9,799,595	103,469,931
9,985,796	113,455,728
10,152,273	123,608,001
10,299,047	133,907,048
10,426,200	144,333,248
10,533,668	154,866,916
10,621,758	165,488,674
10,690,791	176,179,465
10,740,932	186,920,396
10,772,568	197,692,965
10,786,144	208,479,109
10,782,010	219,261,118
10,760,781	230,021,900
10,722,924	240,744,823
10,668,960	251,413,783
10,599,582	262,013,366
10,515,378	272,528,743
10,417,096	282,945,839

Table 54. Baseline carbon stock change in the Project Area

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the project area		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area		Total net carbon stock change in the project area	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$	ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$	ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$	$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	84,248	84,248	84,248	2017	2,022	2,022	2,022	2017	0	0	0	86,270	86,270
2018	279,550	279,550	363,797	2018	8,731	8,731	10,753	2018	752	752	752	287,529	373,798
2019	476,020	476,020	839,818	2019	20,156	20,156	30,909	2019	3,248	3,248	4,000	492,928	866,727
2020	546,133	546,133	1,385,951	2020	33,263	33,263	64,172	2020	7,497	7,497	11,497	571,899	1,438,626
2021	615,879	615,879	2,001,830	2021	48,044	48,044	112,215	2021	12,373	12,373	23,869	651,551	2,090,176
2022	779,845	779,845	2,781,675	2022	66,760	66,760	178,976	2022	17,871	17,871	41,740	828,735	2,918,911
2023	919,274	919,274	3,700,949	2023	88,823	88,823	267,798	2023	24,832	24,832	66,572	983,265	3,902,176
2024	997,298	997,298	4,698,248	2024	112,758	112,758	380,556	2024	33,039	33,039	99,611	1,077,017	4,979,193
2025	1,167,856	1,167,856	5,866,103	2025	140,786	140,786	521,343	2025	41,942	41,942	141,553	1,266,701	6,245,894
2026	1,325,464	1,325,464	7,191,568	2026	172,598	172,598	693,940	2026	52,367	52,367	193,920	1,445,695	7,691,588
2027	1,472,745	1,472,745	8,664,313	2027	205,922	205,922	899,862	2027	64,200	64,200	258,120	1,614,467	9,306,055
2028	1,549,205	1,549,205	10,213,518	2028	236,393	236,393	1,136,255	2028	76,595	76,595	334,715	1,709,003	11,015,058
2029	1,708,710	1,708,710	11,922,228	2029	265,978	265,978	1,402,233	2029	87,929	87,929	422,645	1,886,759	12,901,817
2030	1,736,160	1,736,160	13,658,388	2030	294,538	294,538	1,696,772	2030	98,934	98,934	521,578	1,931,765	14,833,582
2031	1,828,295	1,828,295	15,486,683	2031	323,636	323,636	2,020,408	2031	109,557	109,557	631,136	2,042,374	16,875,956
2032	1,934,511	1,934,511	17,421,194	2032	351,348	351,348	2,371,757	2032	120,381	120,381	751,516	2,165,478	19,041,434
2033	2,006,291	2,006,291	19,427,485	2033	377,437	377,437	2,749,193	2033	130,689	130,689	882,205	2,253,039	21,294,474
2034	2,010,590	2,010,590	21,438,075	2034	401,756	401,756	3,150,949	2034	140,392	140,392	1,022,597	2,271,953	23,566,427
2035	2,075,515	2,075,515	23,513,590	2035	423,540	423,540	3,574,489	2035	149,438	149,438	1,172,036	2,349,617	25,916,043
2036	2,107,598	2,107,598	25,621,188	2036	442,311	442,311	4,016,800	2036	157,541	157,541	1,329,577	2,392,368	28,308,411
2037	2,107,213	2,107,213	27,728,401	2037	457,538	457,538	4,474,338	2037	164,523	164,523	1,494,100	2,400,228	30,708,639
2038	2,115,897	2,115,897	29,844,298	2038	471,139	471,139	4,945,477	2038	170,187	170,187	1,664,287	2,416,849	33,125,488
2039	2,084,125	2,084,125	31,928,423	2039	480,149	480,149	5,425,625	2039	175,246	175,246	1,839,533	2,389,027	35,514,515
2040	2,065,445	2,065,445	33,993,867	2040	488,051	488,051	5,913,677	2040	178,597	178,597	2,018,130	2,374,899	37,889,414
2041	2,168,526	2,168,526	36,162,393	2041	496,217	496,217	6,409,894	2041	181,537	181,537	2,199,667	2,483,206	40,372,620
2042	2,046,045	2,046,045	38,208,438	2042	498,894	498,894	6,908,788	2042	184,574	184,574	2,384,241	2,360,365	42,732,985
2043	2,007,617	2,007,617	40,216,055	2043	498,926	498,926	7,407,713	2043	185,570	185,570	2,569,811	2,320,973	45,053,957
2044	1,999,141	1,999,141	42,215,196	2044	498,651	498,651	7,906,364	2044	185,582	185,582	2,755,393	2,312,210	47,366,167
2045	2,026,428	2,026,428	44,241,624	2045	497,473	497,473	8,403,837	2045	185,480	185,480	2,940,873	2,338,421	49,704,589
2046	1,956,469	1,956,469	46,198,093	2046	493,846	493,846	8,897,683	2046	185,041	185,041	3,125,914	2,265,273	51,969,862
2047	1,916,826	1,916,826	48,114,919	2047	489,276	489,276	9,386,959	2047	183,692	183,692	3,309,606	2,222,410	54,192,272

Table 55. Baseline carbon stock change in the Leakage Belt

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	44,284	44,284	44,284
2018	146,943	146,943	191,227
2019	191,736	191,736	382,963
2020	219,958	219,958	602,921
2021	204,865	204,865	807,786
2022	250,571	250,571	1,058,357
2023	250,610	250,610	1,308,966
2024	280,924	280,924	1,589,891
2025	298,525	298,525	1,888,416
2026	304,015	304,015	2,192,430
2027	340,029	340,029	2,532,460
2028	364,051	364,051	2,896,510
2029	364,177	364,177	3,260,687
2030	403,480	403,480	3,664,167
2031	465,819	465,819	4,129,985
2032	459,595	459,595	4,589,580
2033	530,249	530,249	5,119,829
2034	550,834	550,834	5,670,663
2035	586,062	586,062	6,256,725
2036	608,586	608,586	6,865,311
2037	655,193	655,193	7,520,504
2038	678,158	678,158	8,198,662
2039	700,221	700,221	8,898,884
2040	760,393	760,393	9,659,276
2041	753,969	753,969	10,413,245
2042	755,601	755,601	11,168,847
2043	786,677	786,677	11,955,524
2044	812,047	812,047	12,767,571
2045	815,544	815,544	13,583,114
2046	816,665	816,665	14,399,779
2047	821,073	821,073	15,220,853

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	1,063	1,063	1,063
2018	4,589	4,589	5,652
2019	9,191	9,191	14,843
2020	14,470	14,470	29,313
2021	19,387	19,387	48,700
2022	25,401	25,401	74,101
2023	31,415	31,415	105,516
2024	38,157	38,157	143,673
2025	45,322	45,322	188,995
2026	52,618	52,618	241,614
2027	59,716	59,716	301,330
2028	64,927	64,927	366,257
2029	69,065	69,065	435,322
2030	73,470	73,470	508,792
2031	79,733	79,733	588,525
2032	84,749	84,749	673,274
2033	91,461	91,461	764,735
2034	97,939	97,939	862,673
2035	104,839	104,839	967,513
2036	112,149	112,149	1,079,662
2037	119,713	119,713	1,199,375
2038	127,252	127,252	1,326,627
2039	135,317	135,317	1,461,943
2040	143,883	143,883	1,605,826
2041	150,798	150,798	1,756,624
2042	157,902	157,902	1,914,527
2043	164,057	164,057	2,078,583
2044	170,326	170,326	2,248,909
2045	175,833	175,833	2,424,742
2046	180,827	180,827	2,605,570
2047	184,808	184,808	2,790,378

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt	
ID_{iz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	0	0	0
2018	395	395	395
2019	1,707	1,707	2,102
2020	3,419	3,419	5,521
2021	5,382	5,382	10,904
2022	7,211	7,211	18,115
2023	9,448	9,448	27,563
2024	11,685	11,685	39,248
2025	14,193	14,193	53,441
2026	16,858	16,858	70,299
2027	19,572	19,572	89,871
2028	22,212	22,212	112,084
2029	24,150	24,150	136,234
2030	25,690	25,690	161,924
2031	27,328	27,328	189,252
2032	29,658	29,658	218,909
2033	31,524	31,524	250,433
2034	34,020	34,020	284,453
2035	36,429	36,429	320,882
2036	38,996	38,996	359,879
2037	41,715	41,715	401,594
2038	44,529	44,529	446,123
2039	47,333	47,333	493,456
2040	50,333	50,333	543,788
2041	53,519	53,519	597,307
2042	56,091	56,091	653,399
2043	58,734	58,734	712,132
2044	61,023	61,023	773,155
2045	63,355	63,355	836,510
2046	65,403	65,403	901,914
2047	67,261	67,261	969,175

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulative
tCO_2e	tCO_2e
45,347	45,347
151,137	196,484
199,221	395,704
231,009	626,713
218,869	845,583
268,760	1,114,343
272,577	1,386,920
307,396	1,694,316
329,654	2,023,970
339,775	2,363,745
380,173	2,743,918
406,766	3,150,684
409,092	3,559,775
451,260	4,011,035
518,223	4,529,258
514,687	5,043,945
590,186	5,634,131
614,753	6,248,884
654,472	6,903,355
681,739	7,585,094
733,191	8,318,285
760,881	9,079,166
788,205	9,867,372
853,942	10,721,314
851,248	11,572,562
857,412	12,429,975
892,000	13,321,974
921,350	14,243,324
928,022	15,171,347
932,089	16,103,435
938,621	17,042,056

Baseline non-CO2 emissions from forest fires

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

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

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

Where,

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

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

Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
NCR	Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
ER_{N2O}	Emission ratio for N_2O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N_2O (IPCC default value)[212]

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

Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
ER_{CH4}	Emission ratio for CH_4 (IPCC default value = 0.012)

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

GWP_{CH4} Global Warming Potential for CH_4 (IPCC default value) [213]

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

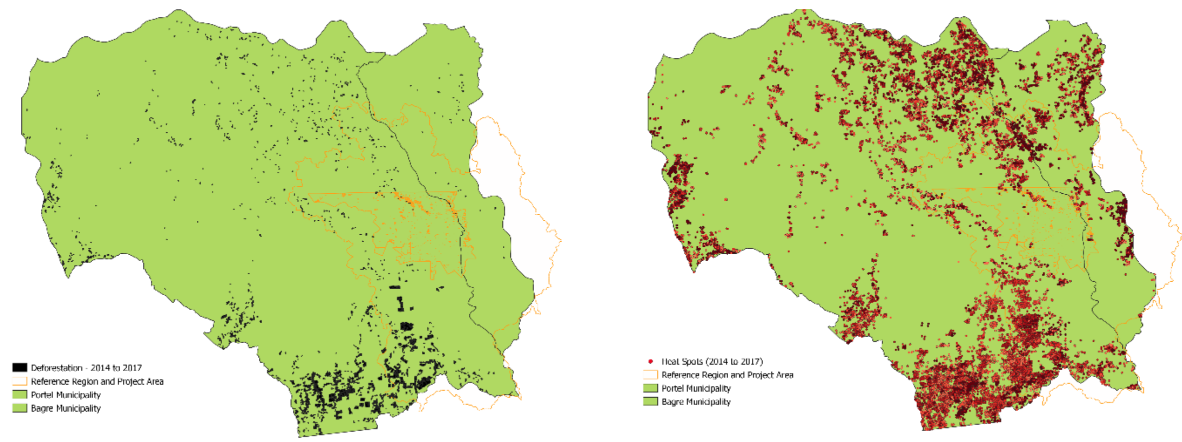
Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in the forest class icl at year t; tCO_2e/ha
$Fburnt_{icl}$	Proportion of forest area burned during the historical reference period in the forest class icl; %
$C_{picl,t}$	Average carbon stock per hectare in the carbon pool p burnt in the forest class icl at year t; tCO_2e/ha
$Pburnt_{p,icl}$	Average proportion of mass burnt in the carbon pool p in the forest class icl; %
$CE_{p,icl}$	Average combustion efficiency of the carbon pool p in the forest class icl; dimensionless (IPCC default of 0.5)
p	Carbon pool that could burn, above-ground biomass

The Fburnt analysis was carried out on the municipalities of Portel and Bagre, as it is where the Project Area is fully inserted in, as well as most of the Reference Region. Hot spots were considered during the period from 2014 to 2017 (prior to 2014, the data has no fire risk classification, and therefore, was not taken into account). For the assessed years, the fire risk predicted for the day of detection of the outbreak was considered, contemplating only outbreaks with a fire risk of >= 0.5 as, according to INPE's methodology, fire risk higher than 0.4 is considered as medium to critical (=1). By overlapping these fire outbreaks with the deforestation mapping of the same time period, it was possible to verify the tendency of fire outbreaks being directly related to areas with recent and/or consolidated deforestation. This can also be verified by the proximity of deforestation detection dates by satellite and the close or overlapping heat spots. Thus, it is possible to assume that these outbreaks are related to anthropic actions to open pastures/crops. Thereby, there was an overlap of 89.44% of the pixels analysed during the reference period in Portel and Bagre, where the project is located. This can also be seen analysing the maps below:

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

Figure 87. Comparison of the deforestation and the heat spots in Portel and Bagre between 2014 and 2017



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

However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation.

The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.

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

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

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

Where,

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

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

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

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

Table 56. Parameters used to calculate non-CO2 emissions from forest fires

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

Table 57. Baseline non-CO2 emissions from forest fires in the project area

	Project year *t*	Emissions of non-CO_2 gasses from baseline forest fires		Total baseline non-CO_2 emissions from forest fires in the project area	
		ID_{cl} = 1 Forest		annual	cumulative
		$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	EBBBSLPA
		ha	tCO_2e/ha	tCO_2e	tCO_2e
First baseline period	2017	145.32	23.87	3,468.74	3,468.74
	2018	482.20	23.87	11,509.94	14,978.68
	2019	821.10	23.87	19,599.25	34,577.93
	2020	942.03	23.87	22,486.02	57,063.96
	2021	1,062.34	23.87	25,357.68	82,421.63
	2022	1,345.17	23.87	32,108.67	114,530.31
	2023	1,585.67	23.87	37,849.40	152,379.71
	2024	1,720.26	23.87	41,061.90	193,441.62
	2025	2,014.46	23.87	48,084.29	241,525.91
	2026	2,286.32	23.87	54,573.53	296,099.43
Second baseline period	2027	2,540.36	23.87	60,637.53	356,736.96
	2028	2,672.25	23.87	63,785.65	420,522.61
	2029	2,947.38	23.87	70,352.98	490,875.59
	2030	2,994.73	23.87	71,483.16	562,358.75
	2031	3,153.66	23.87	75,276.64	637,635.40
	2032	3,336.87	23.87	79,649.88	717,285.28
	2033	3,460.69	23.87	82,605.30	799,890.58
	2034	3,468.10	23.87	82,782.30	882,672.88
	2035	3,580.09	23.87	85,455.48	968,128.36
	2036	3,635.43	23.87	86,776.44	1,054,904.79
Third baseline period	2037	3,634.77	23.87	86,760.57	1,141,665.36
	2038	3,649.75	23.87	87,118.14	1,228,783.50
	2039	3,594.94	23.87	85,809.95	1,314,593.45
	2040	3,562.72	23.87	85,040.85	1,399,634.30
	2041	3,740.53	23.87	89,285.03	1,488,919.33
	2042	3,529.26	23.87	84,242.10	1,573,161.42
	2043	3,462.97	23.87	82,659.89	1,655,821.31
	2044	3,448.35	23.87	82,310.91	1,738,132.23
	2045	3,495.42	23.87	83,434.40	1,821,566.63
	2046	3,374.75	23.87	80,553.97	1,902,120.60
	2047	3,306.37	23.87	78,921.75	1,981,042.35

4.2 Project Emissions

The CERFLOR-certified sustainable forest management plan implemented by ABC Norte in 2017 within the project area aims to harvest forest products/by-products in a manner consistent with the conservation of the local ecosystem. This type of economic activity enables the harvesting of an economically feasible volume of forest products, however allowing the regeneration of the natural stock in accordance with the growth and recovery rates of the biome.

Therefore, the present REDD project includes planned deforestation and planned logging activities within the project area. These carbon stock changes are estimated ex ante and shall be measured ex post.

Planned deforestation mainly includes implementation of infrastructure, such as opening of main and secondary roads, skidding trails[214], and timber yards in each annual production unit – APU (Unidade de Produção Anual, in portuguese) within the project area, estimated to be around 2.5% of each APU. According to the sustainable forest management plan, 121,632.37 ha are subject to SFMP. The adopted rotation cycle is 35 years, thus each annual productive unit (APU) has around 3,345 hectares.

Table 61 below presents an *ex ante* estimated carbon stock decrease due to planned deforestation in the project area. The location of annual planned deforestation areas was proportionally divided among the forest classes existing within the project area. The *ex ante* estimated carbon stock decrease due to planned deforestation in the project area was calculated using the following equation:

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

Where,

$\Delta CPDdPA_t$	Total decrease in carbon stock due to planned deforestation at year t in the project area; tCO_2e
$APDPA_{icl,t}$	Areas of planned deforestation in forest class icl at year t in the project area; ha
$\Delta Ctot_{icl}$	Average carbon stock change of all accounted carbon pools in forest class icl at time t; tCO_2e/ha

[214] According to the SFMP implemented by ABC Norte, all skidding trails are planned to minimize damages to the forest, extracting trees from the felling site without damaging other trees, only affecting sub-forest areas using low impact techniques. According to Holmes et al. (2002) less than 10% of skidding trails from reduced impact logging (RIL) forest management systems caused soil degradation and consequently clearings in the forest, while 100% of trails in conventional management areas are affected. It is expected that the certified SFMP implemented by ABC Norte would reduce this damage in a more significant way when compared to simple RIL-forest management.
HOLMES, T.P.; BLATE, G.M.; ZWEEDE, J.C.; PEREIRA JUNIOR, R.L BARRETO, P.; BOLTZ, F. Custos e benefícios financeiros da exploração de impacto reduzido em comparação à exploração florestal convencional na Amazônia Oriental. Belém: Fundação Floresta Tropical, 2002, 66p., 2ª edição.

Table 58. Ex ante estimated actual carbon stock decrease due to planned deforestation in the project area

Project year *t*	Areas of planned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned deforestation	
	ID_{cl} = 1 Forest		annual	cumulative
	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2017	0.00	718.87	0.00	0.00
2018	86.88	718.87	62,456.04	62,456.04
2019	86.88	718.87	62,456.04	124,912.08
2020	86.88	718.87	62,456.04	187,368.13
2021	86.88	718.87	62,456.04	249,824.17
2022	86.88	718.87	62,456.04	312,280.21
2023	86.88	718.87	62,456.04	374,736.25
2024	86.88	718.87	62,456.04	437,192.30
2025	86.88	718.87	62,456.04	499,648.34
2026	86.88	718.87	62,456.04	562,104.38
2027	86.88	718.87	62,456.04	624,560.42
2028	86.88	718.87	62,456.04	687,016.47
2029	86.88	718.87	62,456.04	749,472.51
2030	86.88	718.87	62,456.04	811,928.55
2031	86.88	718.87	62,456.04	874,384.59
2032	86.88	718.87	62,456.04	936,840.63
2033	86.88	718.87	62,456.04	999,296.68
2034	86.88	718.87	62,456.04	1,061,752.72
2035	86.88	718.87	62,456.04	1,124,208.76
2036	86.88	718.87	62,456.04	1,186,664.80
2037	86.88	718.87	62,456.04	1,249,120.85
2038	86.88	718.87	62,456.04	1,311,576.89
2039	86.88	718.87	62,456.04	1,374,032.93
2040	86.88	718.87	62,456.04	1,436,488.97
2041	86.88	718.87	62,456.04	1,498,945.02
2042	86.88	718.87	62,456.04	1,561,401.06
2043	86.88	718.87	62,456.04	1,623,857.10
2044	86.88	718.87	62,456.04	1,686,313.14
2045	86.88	718.87	62,456.04	1,748,769.18
2046	86.88	718.87	62,456.04	1,811,225.23
2047	86.88	718.87	62,456.04	1,873,681.27

Planned logging operations are carried out following a Reduced Impact Logging (RIL) system combined with other improved forest management techniques, including: planning of management activities, selection of best locations for infrastructure construction, directional felling, utilization of advanced technologies, tracking record of wood logs, reforestation activities, among others; which are essential practices to minimize the damage caused to the forest.

In the project scenario, emissions due to planned logging activities results from timber harvesting and also from damages to vegetation during the directional tree felling, which generate forest residues (branches, remains of logs and other damaged trees during the tree felling). According to Feldpausch et al (2005), the mean Coarse woody debris returned to the soil as necromass following logging and damage in: (1) tree felling gap formation (trees killed by tree-fall), (2) residual canopy from the felled tree, (3) road, (4) deck construction (whole trees plowed to the ground) and (5) skid maneuvering during logging, is about 6.9 Mg C/ha. According to section 4.3 (pg 212) from this same study, this represents 2.4 times the carbon taken off site in logs. However, the MR already takes into account as planned deforestation the roads and decks constructions, which represent around 16% of the total damage. Therefore, the LDF is 2.4 * (1-0,159) = 2.0174.

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

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

Where,

$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class *icl* at time *t*; tCO_2e/ha
$HI_{icl,t}$	Harvesting intensity of timber in forest class *icl* at year *t* in the project area due to planned logging activities (i.e., sustainable forest management plan); m^3/ha
LDF	Logging damage factor; m^3/m^3
D_m	Mean wood density; g/cm^3
CF	Default value of carbon fraction in biomass; tC t-1 d.m.
44/12	Ratio of molecular weight of CO_2 to carbon; dimensionless

Harvested wood products were not accounted as a carbon pool, thus, $\Delta Cwp_t = 0$. Therefore, the *ex ante* estimated carbon stock decrease due to planned logging activities in the project area was calculated using the following equation:

$$\Delta CPLdPA_t = (APLPA_{icl,t} \times \Delta CLd_{icl,t}) - (APLPA_{icl,t}) \times \Delta Cwp_t$$

Where,

$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities at year *t* in the project area; tCO_2e
$APLPA_{icl,t}$	Areas of planned logging activities in forest class *icl* at year *t* in the project area; ha
$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class *icl* at time *t*; tCO_2e/ha
ΔCwp_t	Average carbon stock per hectare in the harvested wood products carbon pool at time *t*; tCO_2e/ha

Thus, Table below presents an *ex ante* estimated carbon stock decrease due to planned logging activities in the project area.

Table 59. Ex ante estimated actual carbon stock decrease due to planned logging activities in the project area

Project year *t*	Areas of planned logging activities x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned logging activities	
	ID_{cl} = 1 Forest		annual	cumulative
	$APLPA_{icl,t}$	$\Delta CLd_{icl,t}$	$\Delta CPLdPA_t$	$\Delta CPLdPA$
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2017	1,047.32	116.34	121,841.30	121,841.30
2018	3,475.21	116.34	404,291.60	526,132.90
2019	3,475.21	116.34	404,291.60	930,424.50
2020	3,475.21	116.34	404,291.60	1,334,716.09
2021	3,475.21	116.34	404,291.60	1,739,007.69
2022	3,475.21	116.34	404,291.60	2,143,299.29
2023	3,475.21	116.34	404,291.60	2,547,590.88
2024	3,475.21	116.34	404,291.60	2,951,882.48
2025	3,475.21	116.34	404,291.60	3,356,174.08
2026	3,475.21	116.34	404,291.60	3,760,465.67
2027	3,475.21	116.34	404,291.60	4,164,757.27
2028	3,475.21	116.34	404,291.60	4,569,048.87
2029	3,475.21	116.34	404,291.60	4,973,340.46
2030	3,475.21	116.34	404,291.60	5,377,632.06
2031	3,475.21	116.34	404,291.60	5,781,923.66
2032	3,475.21	116.34	404,291.60	6,186,215.25
2033	3,475.21	116.34	404,291.60	6,590,506.85
2034	3,475.21	116.34	404,291.60	6,994,798.45
2035	3,475.21	116.34	404,291.60	7,399,090.04
2036	3,475.21	116.34	404,291.60	7,803,381.64
2037	3,475.21	116.34	404,291.60	8,207,673.24
2038	3,475.21	116.34	404,291.60	8,611,964.84
2039	3,475.21	116.34	404,291.60	9,016,256.43
2040	3,475.21	116.34	404,291.60	9,420,548.03
2041	3,475.21	116.34	404,291.60	9,824,839.63
2042	3,475.21	116.34	404,291.60	10,229,131.22
2043	3,475.21	116.34	404,291.60	10,633,422.82
2044	3,475.21	116.34	404,291.60	11,037,714.42
2045	3,475.21	116.34	404,291.60	11,442,006.01
2046	3,475.21	116.34	404,291.60	11,846,297.61
2047	3,475.21	116.34	404,291.60	12,250,589.21

Fossil fuel emissions from sustainable forest management activities are likely to be less than 5% of the total GHG emissions reductions benefits generated by the present project. Considering that emissions from deforestation and forest degradation would be much higher than those associated with timber harvesting, the emissions from fossil fuel during transport and machinery use can be considered *de-minimis*. In addition, according to VCS AFOLU Requirements, fossil fuel emissions from transport and machinery use in REDD project activities can be considered *de minimis*.

No production of fuel wood or charcoal is expected to occur within the project area under the project scenario. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out. According to the applied methodology, if the project activity generates a significant decrease in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

Thus, Table below presents an *ex ante* estimated carbon stock decrease due to planned activities in the project area.

Table 60. Total ex ante carbon stock decrease due to planned activities in the project area

Project year *t*	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuel-wood and charcoal activities		Total carbon stock decrease due to planned activities	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$\Delta CPLdPA_t$	$\Delta CPLdPA$	$\Delta CPFdPA_t$	$\Delta CPFdPA$	$\Delta CPAdPA_t$	$\Delta CPAdPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	121,841.30	121,841.30	0.00	0.00	121,841.30	121,841.30
2018	62,456.04	62,456.04	404,291.60	526,132.90	0.00	0.00	466,747.64	588,588.94
2019	62,456.04	124,912.08	404,291.60	930,424.50	0.00	0.00	466,747.64	1,055,336.58
2020	62,456.04	187,368.13	404,291.60	1,334,716.09	0.00	0.00	466,747.64	1,522,084.22
2021	62,456.04	249,824.17	404,291.60	1,739,007.69	0.00	0.00	466,747.64	1,988,831.86
2022	62,456.04	312,280.21	404,291.60	2,143,299.29	0.00	0.00	466,747.64	2,455,579.50
2023	62,456.04	374,736.25	404,291.60	2,547,590.88	0.00	0.00	466,747.64	2,922,327.14
2024	62,456.04	437,192.30	404,291.60	2,951,882.48	0.00	0.00	466,747.64	3,389,074.78
2025	62,456.04	499,648.34	404,291.60	3,356,174.08	0.00	0.00	466,747.64	3,855,822.42
2026	62,456.04	562,104.38	404,291.60	3,760,465.67	0.00	0.00	466,747.64	4,322,570.05
2027	62,456.04	624,560.42	404,291.60	4,164,757.27	0.00	0.00	466,747.64	4,789,317.69
2028	62,456.04	687,016.47	404,291.60	4,569,048.87	0.00	0.00	466,747.64	5,256,065.33
2029	62,456.04	749,472.51	404,291.60	4,973,340.46	0.00	0.00	466,747.64	5,722,812.97
2030	62,456.04	811,928.55	404,291.60	5,377,632.06	0.00	0.00	466,747.64	6,189,560.61
2031	62,456.04	874,384.59	404,291.60	5,781,923.66	0.00	0.00	466,747.64	6,656,308.25
2032	62,456.04	936,840.63	404,291.60	6,186,215.25	0.00	0.00	466,747.64	7,123,055.89
2033	62,456.04	999,296.68	404,291.60	6,590,506.85	0.00	0.00	466,747.64	7,589,803.53
2034	62,456.04	1,061,752.72	404,291.60	6,994,798.45	0.00	0.00	466,747.64	8,056,551.17
2035	62,456.04	1,124,208.76	404,291.60	7,399,090.04	0.00	0.00	466,747.64	8,523,298.81
2036	62,456.04	1,186,664.80	404,291.60	7,803,381.64	0.00	0.00	466,747.64	8,990,046.45
2037	62,456.04	1,249,120.85	404,291.60	8,207,673.24	0.00	0.00	466,747.64	9,456,794.08
2038	62,456.04	1,311,576.89	404,291.60	8,611,964.84	0.00	0.00	466,747.64	9,923,541.72
2039	62,456.04	1,374,032.93	404,291.60	9,016,256.43	0.00	0.00	466,747.64	10,390,289.36
2040	62,456.04	1,436,488.97	404,291.60	9,420,548.03	0.00	0.00	466,747.64	10,857,037.00
2041	62,456.04	1,498,945.02	404,291.60	9,824,839.63	0.00	0.00	466,747.64	11,323,784.64
2042	62,456.04	1,561,401.06	404,291.60	10,229,131.22	0.00	0.00	466,747.64	11,790,532.28
2043	62,456.04	1,623,857.10	404,291.60	10,633,422.82	0.00	0.00	466,747.64	12,257,279.92
2044	62,456.04	1,686,313.14	404,291.60	11,037,714.42	0.00	0.00	466,747.64	12,724,027.56
2045	62,456.04	1,748,769.18	404,291.60	11,442,006.01	0.00	0.00	466,747.64	13,190,775.20
2046	62,456.04	1,811,225.23	404,291.60	11,846,297.61	0.00	0.00	466,747.64	13,657,522.84
2047	62,456.04	1,873,681.27	404,291.60	12,250,589.21	0.00	0.00	466,747.64	14,124,270.47

Due to the management plan, no carbon stock increase due to planned activities was considered. No planned protection of secondary/degraded forests without harvest are expected to occur within the project area under the project scenario. Thus, carbon stock increase due to growth without harvest or will not be monitored. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out. According to the applied methodology, if the project activity generates a significant change in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

No significant unavoidable unplanned deforestation is expected in the project scenario, due to the present conservation measures and sustainable forest management practices adopted by ABC Norte. Nevertheless, some unplanned deforestation may happen in the project area despite the implemented REDD project activity. The level at which deforestation will actually be reduced in the project case depends on the effectiveness of the proposed activities, which cannot be measured *ex ante*. *Ex post* measurements of the project results will be important to determine actual emission reductions.

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

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

Where,

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

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

Where,

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

Due to the importance of project activities, which is expected to generate improvements in the local economy and employment generation, the Effectiveness Index (EI) was conservatively assumed as

95.52%. This percentage was calculated based on verified reports of similar REDD projects located in Brazil.

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

As forest fires were included in the baseline scenario, non-CO_2 emissions from biomass burning should also be included in the project scenario. This is done by multiplying the baseline emissions by the factor (1 – EI), as follows.

$$EBBPSPA_t = EBBBSPA_t * (1 - EI)$$

Where,

$EBBPSPA_t$	Total *ex ante* actual non-CO_2 emissions from forest fire due to unavoided unplanned deforestationat at year t in the project area; tCO_2e/ha
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
EI	*Ex ante* estimated Effectiveness Index; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

Table 61. Ex ante estimated net carbon stock change in the project area under the project scenario

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	121,841.30	121,841.30	0.00	0.00	4,719.92	4,719.92	126,561.22	126,561.22
2018	466,747.64	588,588.94	0.00	0.00	15,731.04	20,450.96	482,478.68	609,039.91
2019	466,747.64	1,055,336.58	0.00	0.00	26,968.70	47,419.67	493,716.34	1,102,756.25
2020	466,747.64	1,522,084.22	0.00	0.00	31,289.28	78,708.95	498,036.92	1,600,793.17
2021	466,747.64	1,988,831.86	0.00	0.00	35,647.12	114,356.07	502,394.76	2,103,187.93
2022	466,747.64	2,455,579.50	0.00	0.00	45,341.08	159,697.15	512,088.72	2,615,276.65
2023	466,747.64	2,922,327.14	0.00	0.00	53,795.60	213,492.75	520,543.24	3,135,819.89
2024	466,747.64	3,389,074.78	0.00	0.00	58,924.93	272,417.68	525,672.57	3,661,492.46
2025	466,747.64	3,855,822.42	0.00	0.00	69,302.72	341,720.40	536,050.36	4,197,542.81
2026	466,747.64	4,322,570.05	0.00	0.00	79,095.70	420,816.10	545,843.34	4,743,386.15
2027	466,747.64	4,789,317.69	0.00	0.00	88,329.42	509,145.51	555,077.06	5,298,463.21
2028	466,747.64	5,256,065.33	0.00	0.00	93,501.65	602,647.16	560,249.29	5,858,712.50
2029	466,747.64	5,722,812.97	0.00	0.00	103,226.86	705,874.02	569,974.50	6,428,686.99
2030	466,747.64	6,189,560.61	0.00	0.00	105,689.19	811,563.21	572,436.83	7,001,123.82
2031	466,747.64	6,656,308.25	0.00	0.00	111,740.76	923,303.97	578,488.39	7,579,612.22
2032	466,747.64	7,123,055.89	0.00	0.00	118,475.94	1,041,779.91	585,223.58	8,164,835.80
2033	466,747.64	7,589,803.53	0.00	0.00	123,266.51	1,165,046.42	590,014.15	8,754,849.95
2034	466,747.64	8,056,551.17	0.00	0.00	124,301.31	1,289,347.73	591,048.95	9,345,898.90
2035	466,747.64	8,523,298.81	0.00	0.00	128,550.37	1,417,898.10	595,298.01	9,941,196.91
2036	466,747.64	8,990,046.45	0.00	0.00	130,889.35	1,548,787.46	597,636.99	10,538,833.90
2037	466,747.64	9,456,794.08	0.00	0.00	131,319.37	1,680,106.82	598,067.00	11,136,900.90
2038	466,747.64	9,923,541.72	0.00	0.00	132,228.73	1,812,335.55	598,976.37	11,735,877.27
2039	466,747.64	10,390,289.36	0.00	0.00	130,706.57	1,943,042.12	597,454.21	12,333,331.48
2040	466,747.64	10,857,037.00	0.00	0.00	129,933.59	2,072,975.71	596,681.23	12,930,012.71
2041	466,747.64	11,323,784.64	0.00	0.00	135,859.21	2,208,834.92	602,606.85	13,532,619.56
2042	466,747.64	11,790,532.28	0.00	0.00	129,138.40	2,337,973.32	595,886.04	14,128,505.60
2043	466,747.64	12,257,279.92	0.00	0.00	126,983.22	2,464,956.54	593,730.86	14,722,236.46
2044	466,747.64	12,724,027.56	0.00	0.00	126,503.81	2,591,460.36	593,251.45	15,315,487.91
2045	466,747.64	13,190,775.20	0.00	0.00	127,937.86	2,719,398.21	594,685.49	15,910,173.41
2046	466,747.64	13,657,522.84	0.00	0.00	123,935.85	2,843,334.06	590,683.49	16,500,856.90
2047	466,747.64	14,124,270.47	0.00	0.00	121,590.76	2,964,924.82	588,338.40	17,089,195.29

Furthermore, it is conservatively assumed that all unplanned deforestation within the project area will involve fire and all above ground biomass will be burnt. It is worth mentioning that the effect of fire on CO2 emissions is counted in the estimation of carbon stock changes in the parameter ΔCUDdPAt; therefore, CO2 emissions from forest fires should be ignored to avoid double counting.

Table 62. Total ex ante estimated actual emissions of non-CO2 gases due to forest fires in the project area

Project year *t*	Total ex ante estimated actual non-CO_2 emissions from forest fires in the Project area	
	$EBBPSPA_t$	EBBPSPA
	annual	cumulative
	tCO_2e	tCO_2e
2017	189.78	189.78
2018	629.72	819.50
2019	1,072.30	1,891.80
2020	1,230.24	3,122.04
2021	1,387.35	4,509.39
2022	1,756.70	6,266.09
2023	2,070.79	8,336.88
2024	2,246.55	10,583.42
2025	2,630.75	13,214.17
2026	2,985.78	16,199.96
2027	3,317.55	19,517.51
2028	3,489.79	23,007.30
2029	3,849.10	26,856.40
2030	3,910.93	30,767.33
2031	4,118.48	34,885.80
2032	4,357.74	39,243.55
2033	4,519.44	43,762.98
2034	4,529.12	48,292.10
2035	4,675.37	52,967.47
2036	4,747.64	57,715.12
2037	4,746.78	62,461.89
2038	4,766.34	67,228.23
2039	4,694.77	71,923.00
2040	4,652.69	76,575.69
2041	4,884.89	81,460.58
2042	4,608.99	86,069.57
2043	4,522.42	90,591.99
2044	4,503.33	95,095.32
2045	4,564.80	99,660.12
2046	4,407.21	104,067.32
2047	4,317.90	108,385.23

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

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

Table 63. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area

Project year *t*	Total *ex ante* carbon stock decrease due to planned activities		Total *ex ante* carbon stock increase due to planned activities		Total *ex ante* carbon stock decrease due to unavoided unplanned deforestation		Total *ex ante* carbon stock change		Total *ex ante* estimated actual non-CO_2 emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	121,841.30	121,841.30	0.00	0.00	4,719.92	4,719.92	126,561.22	126,561.22	189.78	189.78
2018	466,747.64	588,588.94	0.00	0.00	15,731.04	20,450.96	482,478.68	609,039.91	629.72	819.50
2019	466,747.64	1,055,336.58	0.00	0.00	26,968.70	47,419.67	493,716.34	1,102,756.25	1,072.30	1,891.80
2020	466,747.64	1,522,084.22	0.00	0.00	31,289.28	78,708.95	498,036.92	1,600,793.17	1,230.24	3,122.04
2021	466,747.64	1,988,831.86	0.00	0.00	35,647.12	114,356.07	502,394.76	2,103,187.93	1,387.35	4,509.39
2022	466,747.64	2,455,579.50	0.00	0.00	45,341.08	159,697.15	512,088.72	2,615,276.65	1,756.70	6,266.09
2023	466,747.64	2,922,327.14	0.00	0.00	53,795.60	213,492.75	520,543.24	3,135,819.89	2,070.79	8,336.88
2024	466,747.64	3,389,074.78	0.00	0.00	58,924.93	272,417.68	525,672.57	3,661,492.46	2,246.55	10,583.42
2025	466,747.64	3,855,822.42	0.00	0.00	69,302.72	341,720.40	536,050.36	4,197,542.81	2,630.75	13,214.17
2026	466,747.64	4,322,570.05	0.00	0.00	79,095.70	420,816.10	545,843.34	4,743,386.15	2,985.78	16,199.96
2027	466,747.64	4,789,317.69	0.00	0.00	88,329.42	509,145.51	555,077.06	5,298,463.21	3,317.55	19,517.51
2028	466,747.64	5,256,065.33	0.00	0.00	93,501.65	602,647.16	560,249.29	5,858,712.50	3,489.79	23,007.30
2029	466,747.64	5,722,812.97	0.00	0.00	103,226.86	705,874.02	569,974.50	6,428,686.99	3,849.10	26,856.40
2030	466,747.64	6,189,560.61	0.00	0.00	105,689.19	811,563.21	572,436.83	7,001,123.82	3,910.93	30,767.33
2031	466,747.64	6,656,308.25	0.00	0.00	111,740.76	923,303.97	578,488.39	7,579,612.22	4,118.48	34,885.80
2032	466,747.64	7,123,055.89	0.00	0.00	118,475.94	1,041,779.91	585,223.58	8,164,835.80	4,357.74	39,243.55
2033	466,747.64	7,589,803.53	0.00	0.00	123,266.51	1,165,046.42	590,014.15	8,754,849.95	4,519.44	43,762.98
2034	466,747.64	8,056,551.17	0.00	0.00	124,301.31	1,289,347.73	591,048.95	9,345,898.90	4,529.12	48,292.10
2035	466,747.64	8,523,298.81	0.00	0.00	128,550.37	1,417,898.10	595,298.01	9,941,196.91	4,675.37	52,967.47
2036	466,747.64	8,990,046.45	0.00	0.00	130,889.35	1,548,787.46	597,636.99	10,538,833.90	4,747.64	57,715.12
2037	466,747.64	9,456,794.08	0.00	0.00	131,319.37	1,680,106.82	598,067.00	11,136,900.90	4,746.78	62,461.89
2038	466,747.64	9,923,541.72	0.00	0.00	132,228.73	1,812,335.55	598,976.37	11,735,877.27	4,766.34	67,228.23
2039	466,747.64	10,390,289.36	0.00	0.00	130,706.57	1,943,042.12	597,454.21	12,333,331.48	4,694.77	71,923.00
2040	466,747.64	10,857,037.00	0.00	0.00	129,933.59	2,072,975.71	596,681.23	12,930,012.71	4,652.69	76,575.69
2041	466,747.64	11,323,784.64	0.00	0.00	135,859.21	2,208,834.92	602,606.85	13,532,619.56	4,884.89	81,460.58
2042	466,747.64	11,790,532.28	0.00	0.00	129,138.40	2,337,973.32	595,886.04	14,128,505.60	4,608.99	86,069.57
2043	466,747.64	12,257,279.92	0.00	0.00	126,983.22	2,464,956.54	593,730.86	14,722,236.46	4,522.42	90,591.99
2044	466,747.64	12,724,027.56	0.00	0.00	126,503.81	2,591,460.36	593,251.45	15,315,487.91	4,503.33	95,095.32
2045	466,747.64	13,190,775.20	0.00	0.00	127,937.86	2,719,398.21	594,685.49	15,910,173.41	4,564.80	99,660.12
2046	466,747.64	13,657,522.84	0.00	0.00	123,935.85	2,843,334.06	590,683.49	16,500,856.90	4,407.21	104,067.32
2047	466,747.64	14,124,270.47	0.00	0.00	121,590.76	2,964,924.82	588,338.40	17,089,195.29	4,317.90	108,385.23

4.3 Leakage

This step provides an *ex ante* estimate of the possible decrease in carbon stock and increase in GHG emissions (other than carbon stock change) due to leakage. According to the applied methodology, two sources of leakage are considered: a) decrease in carbon stocks and increase in GHG emissions associated with leakage prevention measures; and b) decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage.

Ex ante **estimation of decrease in carbon stocks and increase in GHG emissions due to leakage prevention measures**

To reduce the risk of activity displacement leakage, baseline deforestation agents could participate in activities within the project area and leakage management area that together will replace baseline income, product generation and livelihood of the agents as much as possible, so that deforestation will be reduced and the risk of displacement minimized. As such, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. If this decrease in carbon stock or increase in GHG emission is significant, it must be accounted, and ex post monitoring will be required.

Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. In order to calculate the net carbon stock changes that the planned leakage prevention measures are expected to occasion during the project crediting period, the projected carbon stocks shall be estimated in the leakage management area under the baseline case and project scenario.

The following activities in leakage management areas could occasion a decrease in carbon stocks or an increase in GHG emissions:

- Carbon stock changes due to activities implemented in leakage management areas;
- Methane (CH_4) and nitrous oxide (N_2O) emissions from livestock intensification (involving a change in the animal diet and/or animal numbers).

$$\Delta CLPMLKt = \Delta CBSLLKt - \Delta CPSLKt$$

Where,

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

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

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

ECH_4ferm_t CH_4 emissions from enteric fermentation in leakage management areas at year t; tCO_2e/year

ECH_4man_t CH_4 emissions from manure management in leakage management areas year t; tCO_2e/year

EN_2Oman_t N_2O emissions from manure management in leakage management areas at year t; tCO_2e/year

t 1, 2, 3, … T years of the project crediting period; dimensionless

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

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

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

Table 64. Ex ante estimated net carbon stock change in leakage management areas

Project year	Total carbon stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual	cumulatve	annual	cumulatve	annual	cumulatve
	$\Delta CBSLLK_t$	$\Delta CBSLLK$	$\Delta CPSLK_t$	$\Delta CPSLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00

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

Table 65. Ex ante estimated total emissions above the baseline from leakage prevention activities

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total *ex ante* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00

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

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

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

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

Where,

$\Delta CADLKt$	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
DLF	Displacement leakage factor; %

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

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

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

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

$EADLKt_t$	Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_2e
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
DLF	Displacement leakage factor; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

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

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

Table 66. Ex ante estimated leakage due to activity displacement

Project year	Total ex ante estimated decrease in carbon stocks due to displaced deforestation		Total ex ante estimated increase in GHG emissions due to displaced forest fires	
	annual	cumulative	annual	cumulative
	$\Delta CADLK_t$	$\Delta CADLK$	$EADLK_t$	$EADLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	12,940.45	12,940.45	520.31	520.31
2018	43,129.31	56,069.76	1,726.49	2,246.80
2019	73,939.24	130,009.01	2,939.89	5,186.69
2020	85,784.84	215,793.85	3,372.90	8,559.59
2021	97,732.58	313,526.43	3,803.65	12,363.25
2022	124,310.22	437,836.64	4,816.30	17,179.55
2023	147,489.69	585,326.34	5,677.41	22,856.96
2024	161,552.62	746,878.96	6,159.29	29,016.24
2025	190,005.08	936,884.04	7,212.64	36,228.89
2026	216,854.18	1,153,738.22	8,186.03	44,414.91
2027	242,169.98	1,395,908.20	9,095.63	53,510.54
2028	256,350.52	1,652,258.71	9,567.85	63,078.39
2029	283,013.83	1,935,272.54	10,552.95	73,631.34
2030	289,764.71	2,225,037.26	10,722.47	84,353.81
2031	306,356.11	2,531,393.36	11,291.50	95,645.31
2032	324,821.76	2,856,215.12	11,947.48	107,592.79
2033	337,955.91	3,194,171.03	12,390.80	119,983.59
2034	340,792.97	3,534,964.00	12,417.34	132,400.93
2035	352,442.50	3,887,406.50	12,818.32	145,219.25
2036	358,855.21	4,246,261.71	13,016.47	158,235.72
2037	360,034.16	4,606,295.87	13,014.09	171,249.80
2038	362,527.33	4,968,823.20	13,067.72	184,317.52
2039	358,354.08	5,327,177.28	12,871.49	197,189.02
2040	356,234.82	5,683,412.10	12,756.13	209,945.14
2041	372,480.92	6,055,893.02	13,392.75	223,337.90
2042	354,054.69	6,409,947.71	12,636.31	235,974.21
2043	348,145.89	6,758,093.60	12,398.98	248,373.20
2044	346,831.51	7,104,925.11	12,346.64	260,719.83
2045	350,763.18	7,455,688.29	12,515.16	273,234.99
2046	339,791.01	7,795,479.30	12,083.10	285,318.09
2047	333,361.54	8,128,840.84	11,838.26	297,156.35

Ex ante estimation of total leakage

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

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

Where,

ΔCLKt	Total decrease in carbon stocks within the leakage belt at year t; tCO_2e
ΔCADLKt	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
ΔCLPMLKt	Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

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

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

$$ELK_t = EgLK_t + EADLK_t$$

Where,

ELK_t	Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_2e
$EgLK_t$	Emissions from grazing animals in leakage management areas at year t; tCO_2e
$EADLK_t$	Total *ex ante* increase in GHG emissions due to displaced forest fires at year t; tCO_2e

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

Table 67. Ex ante estimated total leakage

Project year	Total ex ante GHG emissions from increased grazing activities		Total ex ante increase in GHG emissions due to displaced forest fires		Total ex ante decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	$EgLK$	$EADLK_t$	$EADLK$	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	520.31	520.31	12,940.45	12,940.45	0.00	0.00	12,940.45	12,940.45	520.31	520.31
2018	0.00	0.00	1,726.49	2,246.80	43,129.31	56,069.76	0.00	0.00	43,129.31	56,069.76	1,726.49	2,246.80
2019	0.00	0.00	2,939.89	5,186.69	73,939.24	130,009.01	0.00	0.00	73,939.24	130,009.01	2,939.89	5,186.69
2020	0.00	0.00	3,372.90	8,559.59	85,784.84	215,793.85	0.00	0.00	85,784.84	215,793.85	3,372.90	8,559.59
2021	0.00	0.00	3,803.65	12,363.25	97,732.58	313,526.43	0.00	0.00	97,732.58	313,526.43	3,803.65	12,363.25
2022	0.00	0.00	4,816.30	17,179.55	124,310.22	437,836.64	0.00	0.00	124,310.22	437,836.64	4,816.30	17,179.55
2023	0.00	0.00	5,677.41	22,856.96	147,489.69	585,326.34	0.00	0.00	147,489.69	585,326.34	5,677.41	22,856.96
2024	0.00	0.00	6,159.29	29,016.24	161,552.62	746,878.96	0.00	0.00	161,552.62	746,878.96	6,159.29	29,016.24
2025	0.00	0.00	7,212.64	36,228.89	190,005.08	936,884.04	0.00	0.00	190,005.08	936,884.04	7,212.64	36,228.89
2026	0.00	0.00	8,186.03	44,414.91	216,854.18	1,153,738.22	0.00	0.00	216,854.18	1,153,738.22	8,186.03	44,414.91
2027	0.00	0.00	9,095.63	53,510.54	242,169.98	1,395,908.20	0.00	0.00	242,169.98	1,395,908.20	9,095.63	53,510.54
2028	0.00	0.00	9,567.85	63,078.39	256,350.52	1,652,258.71	0.00	0.00	256,350.52	1,652,258.71	9,567.85	63,078.39
2029	0.00	0.00	10,552.95	73,631.34	283,013.83	1,935,272.54	0.00	0.00	283,013.83	1,935,272.54	10,552.95	73,631.34
2030	0.00	0.00	10,722.47	84,353.81	289,764.71	2,225,037.26	0.00	0.00	289,764.71	2,225,037.26	10,722.47	84,353.81
2031	0.00	0.00	11,291.50	95,645.31	306,356.11	2,531,393.36	0.00	0.00	306,356.11	2,531,393.36	11,291.50	95,645.31
2032	0.00	0.00	11,947.48	107,592.79	324,821.76	2,856,215.12	0.00	0.00	324,821.76	2,856,215.12	11,947.48	107,592.79
2033	0.00	0.00	12,390.80	119,983.59	337,955.91	3,194,171.03	0.00	0.00	337,955.91	3,194,171.03	12,390.80	119,983.59
2034	0.00	0.00	12,417.34	132,400.93	340,792.97	3,534,964.00	0.00	0.00	340,792.97	3,534,964.00	12,417.34	132,400.93
2035	0.00	0.00	12,818.32	145,219.25	352,442.50	3,887,406.50	0.00	0.00	352,442.50	3,887,406.50	12,818.32	145,219.25
2036	0.00	0.00	13,016.47	158,235.72	358,855.21	4,246,261.71	0.00	0.00	358,855.21	4,246,261.71	13,016.47	158,235.72
2037	0.00	0.00	13,014.09	171,249.80	360,034.16	4,606,295.87	0.00	0.00	360,034.16	4,606,295.87	13,014.09	171,249.80
2038	0.00	0.00	13,067.72	184,317.52	362,527.33	4,968,823.20	0.00	0.00	362,527.33	4,968,823.20	13,067.72	184,317.52
2039	0.00	0.00	12,871.49	197,189.02	358,354.08	5,327,177.28	0.00	0.00	358,354.08	5,327,177.28	12,871.49	197,189.02
2040	0.00	0.00	12,756.13	209,945.14	356,234.82	5,683,412.10	0.00	0.00	356,234.82	5,683,412.10	12,756.13	209,945.14
2041	0.00	0.00	13,392.75	223,337.90	372,480.92	6,055,893.02	0.00	0.00	372,480.92	6,055,893.02	13,392.75	223,337.90
2042	0.00	0.00	12,636.31	235,974.21	354,054.69	6,409,947.71	0.00	0.00	354,054.69	6,409,947.71	12,636.31	235,974.21
2043	0.00	0.00	12,398.98	248,373.20	348,145.89	6,758,093.60	0.00	0.00	348,145.89	6,758,093.60	12,398.98	248,373.20
2044	0.00	0.00	12,346.64	260,719.83	346,831.51	7,104,925.11	0.00	0.00	346,831.51	7,104,925.11	12,346.64	260,719.83
2045	0.00	0.00	12,515.16	273,234.99	350,763.18	7,455,688.29	0.00	0.00	350,763.18	7,455,688.29	12,515.16	273,234.99
2046	0.00	0.00	12,083.10	285,318.09	339,791.01	7,795,479.30	0.00	0.00	339,791.01	7,795,479.30	12,083.10	285,318.09
2047	0.00	0.00	11,838.26	297,156.35	333,361.54	8,128,840.84	0.00	0.00	333,361.54	8,128,840.84	11,838.26	297,156.35

4.4 Estimated Net GHG Emission Reductions and Removals

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

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

Where:

ΔREDDt Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e

ΔCBSLPAt Sum of baseline carbon stock changes in the project area at year t; tCO2e

EBBBSLPAt Sum of baseline emissions from biomass burning in the project area at year t; tCO2e

ΔCPSPAt Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e

Note: If ΔCPSPAt represents a net increase in carbon stocks, a negative sign before the absolute value of ΔCPSPAt shall be used. If ΔCPSPAt represents a net decrease, the positive sign shall be used.

EBBPSPAt Sum of (ex ante estimated) actual emissions from biomass burning in the project area at year t; tCO2e

ΔCLKt Sum of ex ante estimated leakage net carbon stock changes at year t; tCO2e

Note: If the cumulative sum of ΔCLKt within a fixed baseline period is > 0, ΔCLKt shall be set to zero.

ELKt Sum of ex ante estimated leakage emissions at year t; tCO2e

t 1, 2, 3 … t, a year of the proposed project crediting period; dimensionless.

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

$$VCUt = \Delta REDDt - VBCt$$

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

Where:

VCUt Number of Verified Carbon Units that can be traded at time t; t CO2e

ΔREDDt Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e

VBCt Number of Buffer Credits deposited in the VCS Buffer at time t; t CO2e

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

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

The net GHG emission reductions and removals by the project activity of ABC Norte REDD project are summarized in the table below.

Table 68. Summary of net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	*Ex ante* buffer credits (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2017	89,738	126,751	13,461	0	0
2018	299,039	483,108	44,856	0	0
2019	512,528	494,789	76,879	0	0
2020	594,385	499,267	89,158	7,386	0
2021	676,908	503,782	101,536	14,916	0
2022	860,843	513,845	129,127	31,665	0
2023	1,021,114	522,614	153,167	46,272	201,977
2024	1,118,079	527,919	167,712	55,134	367,313
2025	1,314,785	538,681	197,218	73,065	505,820
2026	1,500,268	548,829	225,040	89,985	636,413
2027	1,675,104	558,395	251,266	105,939	759,504
2028	1,772,789	563,739	265,918	114,875	828,256
2029	1,957,112	573,824	293,567	131,678	958,043
2030	2,003,248	576,348	300,487	135,933	990,480
2031	2,117,651	582,607	317,648	146,389	1,071,007
2032	2,245,128	589,581	336,769	158,025	1,160,752
2033	2,335,645	594,534	350,347	166,303	1,224,461
2034	2,354,735	595,578	353,210	168,090	1,237,856
2035	2,435,072	599,973	365,261	175,432	1,294,406
2036	2,479,145	602,385	371,872	179,473	1,325,415
2037	2,486,988	602,814	373,048	180,216	1,330,910
2038	2,503,967	603,743	375,595	181,787	1,342,842
2039	2,474,837	602,149	371,226	179,157	1,322,305
2040	2,459,940	601,334	368,991	177,822	1,311,793
2041	2,572,491	607,492	385,874	188,060	1,391,065
2042	2,444,607	600,495	366,691	176,448	1,300,972
2043	2,403,632	598,253	360,545	172,724	1,272,110
2044	2,394,521	597,755	359,178	171,896	1,265,692
2045	2,421,856	599,250	363,278	174,374	1,284,953
2046	2,345,827	595,091	351,874	167,459	1,231,403
2047	1,607,780	414,048	241,199	114,161	838,371
Total	**55,479,763**	**17,018,972**	**8,321,997**	**3,684,665**	**26,454,119**

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

Table 69. Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and verified carbon units (VCUt)

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex ante project carbon stock changes		Ex ante project GHG emissions from biomass burning		Ex ante leakage carbon stock changes		Ex ante leakage GHG emissions		Ex ante net anthropogenic GHG emission reductions		Ex ante VCUs tradable		Ex ante buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	EBBBSLPA	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	EBBPSPA	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017 (13/09/2017 to 31/12/2017)	86,270	86,270	3,469	3,469	126,561	126,561	190	190	12,940	12,940	520	520	-50,473	-50,473	0	0	0	0
2018	287,529	373,798	11,510	14,979	482,479	609,040	630	820	43,129	56,070	1,726	2,247	-228,926	-279,399	0	0	0	0
2019	492,928	866,727	19,599	34,578	493,716	1,102,756	1,072	1,892	73,939	130,009	2,940	5,187	-59,140	-338,539	0	0	0	0
2020	571,899	1,438,626	22,486	57,064	498,037	1,600,793	1,230	3,122	85,785	215,794	3,373	8,560	5,960	-332,579	0	0	7,386	7,386
2021	651,551	2,090,176	25,358	82,422	502,395	2,103,188	1,387	4,509	97,733	313,526	3,804	12,363	71,590	-260,989	0	0	14,916	22,302
2022	828,735	2,918,911	32,109	114,530	512,089	2,615,277	1,757	6,266	124,310	437,837	4,816	17,180	217,872	-43,118	0	0	31,665	53,966
2023	983,265	3,902,176	37,849	152,380	520,543	3,135,820	2,071	8,337	147,490	585,326	5,677	22,857	345,333	302,215	201,977	201,977	46,272	100,239
2024	1,077,017	4,979,193	41,062	193,442	525,673	3,661,492	2,247	10,583	161,553	746,879	6,159	29,016	422,448	724,664	367,313	569,290	55,134	155,373
2025	1,266,701	6,245,894	48,084	241,526	536,050	4,197,543	2,631	13,214	190,005	936,884	7,213	36,229	578,886	1,303,550	505,820	1,075,110	73,065	228,438
2026	1,445,695	7,691,588	54,574	296,099	545,843	4,743,386	2,986	16,200	216,854	1,153,738	8,186	44,415	726,399	2,029,948	636,413	1,711,523	89,985	318,423
2027	1,614,467	9,306,055	60,638	356,737	555,077	5,298,463	3,318	19,518	242,170	1,395,908	9,096	53,511	865,444	2,895,392	759,504	2,471,027	105,939	424,362
2028	1,709,003	11,015,058	63,786	420,523	560,249	5,858,712	3,490	23,007	256,351	1,652,259	9,568	63,078	943,132	3,838,524	828,256	3,299,283	114,875	539,238
2029	1,886,759	12,901,817	70,353	490,876	569,974	6,428,687	3,849	26,856	283,014	1,935,273	10,553	73,631	1,089,721	4,928,245	958,043	4,257,326	131,678	670,916
2030	1,931,765	14,833,582	71,483	562,359	572,437	7,001,124	3,911	30,767	289,765	2,225,037	10,722	84,354	1,126,413	6,054,658	990,480	5,247,806	135,933	806,849
2031	2,042,374	16,875,956	75,277	637,635	578,488	7,579,612	4,118	34,886	306,356	2,531,393	11,291	95,645	1,217,396	7,272,054	1,071,007	6,318,813	146,389	953,237
2032	2,165,478	19,041,434	79,650	717,285	585,224	8,164,836	4,358	39,244	324,822	2,856,215	11,947	107,593	1,318,778	8,590,832	1,160,752	7,479,565	158,025	1,111,263
2033	2,253,039	21,294,474	82,605	799,891	590,014	8,754,850	4,519	43,763	337,956	3,194,171	12,391	119,984	1,390,764	9,981,597	1,224,461	8,704,026	166,303	1,277,565
2034	2,271,953	23,566,427	82,782	882,673	591,049	9,345,899	4,529	48,292	340,793	3,534,964	12,417	132,401	1,405,947	11,387,544	1,237,856	9,941,882	168,090	1,445,656
2035	2,349,617	25,916,043	85,455	968,128	595,298	9,941,197	4,675	52,967	352,442	3,887,406	12,818	145,219	1,469,838	12,857,382	1,294,406	11,236,288	175,432	1,621,088
2036	2,392,368	28,308,411	86,776	1,054,905	597,637	10,538,834	4,748	57,715	358,855	4,246,262	13,016	158,236	1,504,888	14,362,270	1,325,415	12,561,703	179,473	1,800,561
2037	2,400,228	30,708,639	86,761	1,141,665	598,067	11,136,901	4,747	62,462	360,034	4,606,296	13,014	171,250	1,511,126	15,873,396	1,330,910	13,892,613	180,216	1,980,777
2038	2,416,849	33,125,488	87,118	1,228,783	598,976	11,735,877	4,766	67,228	362,527	4,968,823	13,068	184,318	1,524,629	17,398,025	1,342,842	15,235,455	181,787	2,162,564
2039	2,389,027	35,514,515	85,810	1,314,593	597,454	12,333,331	4,695	71,923	358,354	5,327,177	12,871	197,189	1,501,463	18,899,488	1,322,305	16,557,760	179,157	2,341,721
2040	2,374,899	37,889,414	85,041	1,399,634	596,681	12,930,013	4,653	76,576	356,235	5,683,412	12,756	209,945	1,489,615	20,389,103	1,311,793	17,869,553	177,822	2,519,543
2041	2,483,206	40,372,620	89,285	1,488,919	602,607	13,532,620	4,885	81,461	372,481	6,055,893	13,393	223,338	1,579,126	21,968,228	1,391,065	19,260,618	188,060	2,707,603
2042	2,360,365	42,732,985	84,242	1,573,161	595,886	14,128,506	4,609	86,070	354,055	6,409,948	12,636	235,974	1,477,421	23,445,649	1,300,972	20,561,590	176,448	2,884,051
2043	2,320,973	45,053,957	82,660	1,655,821	593,731	14,722,236	4,522	90,592	348,146	6,758,094	12,399	248,373	1,444,834	24,890,483	1,272,110	21,833,700	172,724	3,056,775
2044	2,312,210	47,366,167	82,311	1,738,132	593,251	15,315,488	4,503	95,095	346,832	7,104,925	12,347	260,720	1,437,588	26,328,071	1,265,692	23,099,392	171,896	3,228,671
2045	2,338,421	49,704,589	83,434	1,821,567	594,685	15,910,173	4,565	99,660	350,763	7,455,688	12,515	273,235	1,459,327	27,787,398	1,284,953	24,384,345	174,374	3,403,044
2046	2,265,273	51,969,862	80,554	1,902,121	590,683	16,500,857	4,407	104,067	339,791	7,795,479	12,083	285,318	1,398,863	29,186,261	1,231,403	25,615,748	167,459	3,570,503
2047 (01/01/2047 to 12/09/2047	1,552,643	53,522,505	55,137	1,957,258	411,031	16,911,888	3,017	107,084	232,896	8,028,376	8,303	293,621	952,533	30,138,794	838,371	26,454,119	114,161	3,684,665

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	BEF
Data unit	Dimensionless
Description	Biomass expansion factor
Source of data	Brown, S., A. J. R. Gillespie, and A. E. Lugo, 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. Forest Science, 35:881-902. Data available in Table 4, pg. 890 of the referred study. The minimum value was utilized, which was then deducted from lowest limit.: 1.743 - 0.083 = 1.66.
Value applied	1.66
Justification of choice of data or description of measurement methods and procedures applied	The biomass volume was estimated through a local forest inventory considering only the merchantable or commercial volume, i.e., the main tree trunk. For estimating carbon stocks, all the above-ground biomass including twigs, branches and even leaves needs to be estimated. To convert merchantable tree volume into total biomass, biomass expansion factor (BEF) is used. Furthermore, the allometric equation for estimating the aboveground merchantable volume of trees was obtained from Colpini et al. (2009)[215], according to: Ln(Volume) = -9.1892 + 1.9693×ln(DBH) + 0.837×ln(Height) Where: DBH: Diameter at Breast Height H: Height The BEF was used to convert the merchantable volume obtained from the local forest inventory to total aboveground tree biomass.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions in the baseline and project scenarios. Provides

[215] COLPINI, Chirle *et al*. Determinação do volume, do fator de forma e da porcentagem de casca de árvores individuais em uma Floresta Ombrófila Aberta na região noroeste de Mato Grosso. **Acta Amazonica**, [*s. l*], v. 39, n. 1, p. 97-104, 2009. Available at: <https://www.scielo.br/j/aa/a/BXPkWdfz4h869TrBzpKRWGh/?format=pdf>. Acesso em: 06 ago. 2021.

	the conversion of merchantable volume obtained from the local forest inventory to total aboveground tree biomass.
Comments	If new and more accurate data become available, these can be used to estimate the biomass expansion factor of the subsequent fixed baseline period.

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

Data / Parameter	$Ctot_{fcl}$
Data unit	tCO_2e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in tCO_2e/ha

Source of data	The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomas. Average carbon stocks of pastureland, agriculture and other land uses – National GHG Emissions Communication of Brazil to the UNFCCC (2019) - Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf Secondary Forest average carbon stocks - Pereira, Izaura Cristina Nunes. Estoque de biomassa e carbono florestal em unidades de paisagem na Amazônia: uma análise a partir da abordagem metodológica. Universidade Federal do Pará, , Belém, 2013. Available at: https://ppgdstu.propesp.ufpa.br/ARQUIVOS/teses/TESES/2013/IZAURA%20CRISTINA%20NUNES%20PEREIRA.pdf Belowground biomass – Root to shoot ratio available at VM0015. A weighted average of the post-deforestation carbon stocks was done, considering the % of area for each land use.
Value applied	46.58
Justification of choice of data or description of measurement methods and procedures applied	Almost two-thirds of the post-deforestation land uses within the reference region is composed by pasturelands.In order to estimate the post-deforestation carbon stocks, the average carbon stocks of pasturelands, agriculture and other land uses were taken from the National GHG Emissions Communication of Brazil to the UNFCCC (2019)[216]. For secondary forests, a regional study was conducted. Most secondary forests in the Brazilian Amazon are young. In 2017, 65% of secondary forests was ≤10 years old. On average, 35% of annual land abandonment to secondary forests was re-cleared within 5 years, and 57% within 10 years[217]. The half-life of secondary forests is 8 years, on average, which is also the same value found by other study that concludes that more than 50% of

[216] Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf>

[217] Sâmia Nunes *et al* 2020 *Environ. Res. Lett.* **15** 034057. Available at: <https://iopscience.iop.org/article/10.1088/1748-9326/ab76db>

	the secondary forests in the Amazon biome have less than 8 years old[218]. According to the referenced study, conducted in the State of Pará, that analyzed the carbon stocks of a secondary forest with 14 years old, the average carbon stock in above ground biomass is around 19 tC/ha. Below ground biomass was estimated through the root-to-shoot ratio from the applied methodology. Therefore, the average value for secondary forests is around 22,8 tC/ha. The applied value was obtained with the weighted average of the carbon stock and land use.
Purpose of Data	This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	VCS Standard
Value applied	15%
Justification of choice of data or description of measurement methods and procedures applied	DLF was adopted as the default activity-shifting leakage deduction as per VCS Standard.
Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the

[218] Silva Junior, C.H.L., Heinrich, V.H.A., Freire, A.T.G. *et al.* Benchmark maps of 33 years of secondary forest age for Brazil. *Sci Data* **7**, 269 (2020). Available at: <https://doi.org/10.1038/s41597-020-00600-4>

	project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	Dm
Data unit	g/cm³
Description	Mean wood density
Source of data	NOGUEIRA, E. M. Densidade de Madeira e Alometria de Árvores em Florestas do 'Arco do Desmatamento': Implicações para Biomassa e Emissão de Carbono a partir de Mudanças de Uso da Terra na Amazônia Brasileira (Wood Density and Tree Allometry in 'Arc of Deforestation' Forests: Implications for Biomass and Carbon Emissions from Land Use Change in the Brazilian Amazon). 2008. 151 pages. Doctor Thesis - Tropical Rainforest Science Course, INPA, Manaus, 2008.
Value applied:	0.701
Justification of choice of data or description of measurement methods and procedures applied	The mean wood density presented in Nogueira (2008) was obtained from the Brazilian Amazon, where the project region is located. The value is for the Lowland Dense Tropical Rainforest in the State of Pará (Table 3 of the referred study), vegetation type that is logged through SFMP.
Purpose of Data	This parameter is used to calculate baseline, project and leakage emissions through the conversion from m³ to tons for estimating above-ground biomass from local forest inventories, specifically for the main forest type within the project area - Dense Lowland Tropical Rainforest – composing 99% of the project area.
Comments	Furthermore, it is also used to calculate project emissions from logging activities occurred in the project scenario due to sustainable forest management. Carbon stock decrease due to planned logging activities were calculated through multiplying the harvested volume by the mean wood density. Carbon stock increase due to natural regeneration after periodical harvest cycle

	can be calculated through multiplying the mean annual increment by the mean wood density.

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

Data / Parameter	$EBBBSLPA_t$
Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO2 emissions from forest fire at year t in the project area
Source of data	Remote sensing data and GIS, supervisor reports.
Value applied	63,137 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Justification of choice of data or description of	Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation

measurement methods and procedures applied	within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. Non-CO_2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t).
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an ex-ante estimation.
Comments	Ex post monitoring of forest fires and non-CO_2 emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$Fburnt_{icl}$
Data unit	%
Description	Proportion of forest area burned during the historical reference period in the forest class.
Source of data	Measured or estimated from literature. *Fburnt data source:* - Heat spots: Data from 2014 to 2017 for Portel and Bagre municipalities, all satellites. <https://queimadas.dgi.inpe.br/queimadas/bdqueimadas> - Deforestation: <http://terrabrasilis.dpi.inpe.br/downloads/>

Value applied	89.94
Justification of choice of data or description of measurement methods and procedures applied	The Fburnt analysis was carried out on the municipalities of Portel and Bagre, as it is where the Project Area is fully inserted in, as well as most of the Reference Region. Heat spots were considered during the period from 2014 to 2017 (prior to 2014, the data has no fire risk classification, and therefore, was not taken into account). For the assessed years, the fire risk predicted for the day of detection of the outbreak was considered, contemplating only outbreaks with a fire risk of >= 0.5 as, according to INPE's methodology, fire risk higher than 0.4 is considered as medium to critical (=1). By overlapping these fire outbreaks with the deforestation mapping of the same time period, it was possible to verify the tendency of fire outbreaks being directly related to areas with recent and/or consolidated deforestation. This can also be verified by the proximity of deforestation detection dates by satellite and the close or overlapping heat spots. Thus, it is possible to assume that these outbreaks are related to anthropic actions to open pastures/crops. Thereby, there was an overlap of 89.94% of the pixels analysed during the reference period in the municipalities.
Purpose of data	This parameter is the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	$Pburnt_{p,icl}$
Data unit	%
Description	Average proportion of mass burnt in the carbon pool in the forest class
Source of data	Measured or estimated from literature. *Pburnt data source:* Anderson LO, Aragão LE, Gloor M, et al. **Disentangling the contribution of multiple land covers to fire-mediated carbon emissions in Amazonia during the 2010 drought.** Global Biogeochem Cycles. 2015; 29 (10):1739-1753. Doi: 10.1002/2014GB005008. Available at

	<https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014GB005008>. Last visited on September 2021.
Value applied	78
Justification of choice of data or description of measurement methods and procedures applied	Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m^3/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%. However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation. The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%. It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.
Purpose of data	This parameter is the average of biomass that has commercial value, and could be removed prior to clear cutting and burning, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	Estimate from project proponent based on verified reports of similar REDD projects verified by Ecologica Assessoria Ltda. and by other project proponents in Brazil up to date. Available in VERRA database.
Value applied	94.53%

Justification of choice of data or description of measurement methods and procedures applied	Based on the comparison between *ex post* and *ex ante* deforestation of similar REDD projects developed by Ecologica Assessoria Ltda. and by other project proponents in Brazil, available in verified reports in VERRA database up to date.
Purpose of Data	This parameter is used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation.
Comments	*Ex post* monitoring of the project area will be done to determine deforestation rate and the project emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	Logging damage factor (LDF)
Data unit	m^3/m^3 of harvested timber
Description	The logging damage factor (LDF) is a representation of the quantity of emissions that will ultimately arise per unit of extracted timber (m^3). These emissions arise from the non-commercial portion of the felled trees (the branched and stump) and trees incidentally killed during felling.
Source of data	SFMP related documentation, such as forestry inventory, harvesting management plans and post-harvest assessment reports. Feldpausch et al. When big trees fall: Damage and carbon export by reduced impact logging in southern Amazonia. Forest Ecology and Management 219 (2005) 199–215
Value applied:	2.0174
Justification of choice of data or description of measurement methods and procedures applied	This parameter is added to the harvested timber volume intensity in order to calculate carbon stock decrease from planned logging activities at each forest class. The emissions resulting directly from logging are calculated by estimating the emissions resulting from dead wood created in each logging gap measured divided by the volume of wood created, adding skidder trails damage. According to Feldpausch et al. (2005), Table 6 pag 209, the mean Coarse woody debris returned to the soil as necromass following logging and damage

	in: (1) tree felling gap formation (trees killed by tree-fall), (2) residual canopy from the felled tree, (3) road, (4) deck construction (whole trees plowed to the ground) and (5) skid maneuvering during logging, is about 6.9 Mg C/ha. According to section 4.3 (pg 212) from this same study, this represents 2.4 times the carbon taken off site in logs. However, the MR already takes into account as planned deforestation the roads and decks constructions, which represent around 16% of the total damage. Therefore, the LDF is 2.4 * (1-0,159) = 2.0174.
Purpose of data	This parameter is used to calculate project emissions from logging activities occurred in the project scenario due to sustainable forest management, specifically for the calculation of the carbon stock decrease due to planned logging activities in the project area.
Comments	If no monitoring data is available, SFMP data shall be used. If new and more accurate harvest intensity data become available, these can be used to estimate project emissions.

5.2 Data and Parameters Monitored

Data / Parameter	ab_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the above-ground biomass were taken from the local forest inventory conducted at Fazenda Pacajá in 2021, for the forest type Lowland Dense Tropical Rainforest.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	Above-ground biomass ab_{icl} (Mg/ha)

	<table><tr><th>Vegetation</th><th>Reference Region</th><th>Project Area</th><th>Leakage Belt</th></tr><tr><td>Forest (Dense Lowland Tropical Rainforest)</td><td>316.35</td><td>316.22</td><td>316.22</td></tr></table>
Monitoring equipment	To obtain local biomass data, the project proponent promoted a forest inventory campaign at Fazenda Pacajá (Portel/PA), involving the measurement of several plots. The allocation of the permanent plots prioritized areas not previously managed for timber products. Each plot had dimensions of 50x50 m (0.25 hectares), randomly distributed. The permanent plots were demarcated at the four corners, with wooden pickets, in order to facilitate their location later on, and their geographical coordinates were recorded through GPS. The Diameter at Breast Height (DBH) was measured using a measuring tape at 1.30 m above ground level, involving trees with DBH>10 cm, and in a sub-plot of 10x10m, DBH>5 cm. The total height of the trees was obtained through an estimated manner (visual), or using a Blume-Leiss device (hypsometer), when possible.
QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements
Purpose of data	This parameter is used to calculate baseline emissions, project emissions and leakage emissions in both baseline and project scenarios.
Calculation method	Regarding the main forest type within the project area - Dense Lowland Tropical Rainforest – composing more than 95% of the project area, this parameter was estimated through a local forest inventory.
Comments	The values will be reassessed every 10 years or when data is more than 10 years old, whichever occurs first.

Data / Parameter	bb_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground

	biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	(see table below)
Monitoring equipment	No monitoring equipment is used to determine this parameter.
QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements
Purpose of data	This parameter is used to calculate baseline, project and leakage emissions in the baseline and project scenarios.
Calculation method	Calculation according to the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Comments	The values will be reassessed every 10 years or when data is more than 10 years old, whichever occurs first.

Below-ground biomass			
bb_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Forest (Dense Lowland Tropical Rainforest)	75.92	75.89	75.89

Data / Parameter	$ACPA_t$
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.
Source of data	- Remote sensing data and GIS, - ABC Norte management team and other field data.
Description of measurement methods	In addition to field data from the management team, he following sources will also be monitored:

and procedures to be applied	- INMET[219] - INPE[220]
Frequency of monitoring/recording	At each time a catastrophic event occurs.
Value applied	The value will be calculated *ex-post* at each time a catastrophic event occurs, when significant.
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Field data from the management team
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an *ex post* estimation of the area affected by catastrophic events within the project area.
Calculation method	Remote sensing and GIS
Comments	Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$ABSLLK_t$
Data unit	Ha
Description	Annual area of deforestation within the leakage belt at year t.
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.

[219] INMET. Instituto Nacional de Meteorologia. Available at: <https://portal.inmet.gov.br/>. Last visited on 06/08/2021.
[220] INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://www.inpe.br/>. Last visited on 06/08/2021.

Frequency of monitoring/recording	Annually
Value applied	The table below shows the annual average deforestation projected in the leakage belt during the crediting period Vegetation type | $ABSLLK_t$ (ha) Forest | 846.93
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	$ABSLPA_t$
Data unit	Ha
Description	Annual area of deforestation in the project area at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	The table below shows the annual average projected deforestation in the project area during the crediting period. Vegetation type | $ABSLPA_t$ (ha) Forest | 2,677.23

Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$ABSLRR_t$
Data unit	Ha
Description	Annual area of deforestation in the reference region at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the reference region.
Frequency of monitoring/recording	Annually
Value applied	The table below shows the annual average projected deforestation within the reference region during the crediting period. Vegetation type: Forest; $ABSLRR_t$ (ha): 13,937.48
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the reference region.

Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	APDPAicl,t
Data unit	Hectare
Description	Areas of planned deforestation in forest class icl at year t in the project area
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.
Description of measurement methods and procedures applied	The planned deforestation activities in the project area that result in carbon stock decrease will be subject to monitoring. The ABC Norte management team records such information according to procedures established in its sustainable forest management plan.
Frequency of monitoring/recording	Annually
Value applied:	The table below shows the annual average planned deforestation expected to occur within the project area during the crediting period. Vegetation type: Forest; $APDPA_{icl,t}$ (ha): 86.88
Monitoring equipment	- Remote sensing and GIS - ABC Norte Management team, based on the Sustainable Forest Management Plan for Fazenda Pacajá
QA/QC procedures applied	- Best practices in remote sensing. - Internal audit of the SFMP. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to planned deforestation in the project area.

Calculation method	Emissions from deforestation at each forest class are quantified by multiplying the detected area of forest loss by the average forest carbon stock per unit area. For an *ex ante* estimation, it was considered that 2.5% of each annual production unit will be deforested for the implementation of SFMP infrastructure.
Comments	Planned deforestation mainly includes implementation of the forest management infrastructure, such as opening of main and secondary roads, skidding trails, and timber yards in each annual production unit within the project area.

Data / Parameter	APLPAicl,t
Data unit	Hectare
Description	Areas of planned logging activities in forest class icl at year t in the project area
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.
Description of measurement methods and procedures applied	The planned logging activities in the project area that resulted in carbon stock increase or decrease shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied:	The table below shows the annual average planned logging areas expected to occur within the project area during the crediting period. Vegetation type: Forest — $APLPA_{icl,t}$ (ha): 3,396.89
Monitoring equipment	- Remote sensing and GIS - ABC Norte Management team, based on the Sustainable Forest Management Plan for Fazenda Pacajá
QA/QC procedures applied	- Best practices in remote sensing. - Internal audit of the SFMP. - Internal procedures required by the SFMP and forest certification.

Vegetation type	$APLPA_{icl,t}$ (ha)
Forest	3,396.89

Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the increase or decrease in carbon stocks due to planned logging activities in the project area.
Calculation method	Carbon stock decrease from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the harvested timber volume intensity, and then by the mean wood density. Carbon stock increase from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the mean annual increment due to natural regeneration of managed forests, and then by the mean wood density.
Comments	According to the sustainable forest management plan, 121,632.37 ha are subject to sustainable forest management plan (SFMP). The adopted rotation cycle is 35 years, thus each annual productive unit (APU) has around 3,475.21 hectares. The SFMP provides guidance to the management team in order to harvest forest products/by-products in a consistent manner with the conservation of the local ecosystem.

Data / Parameter	AUDPAicl,t
Data unit	Hectare
Description	Areas of unplanned deforestation in forest class icl at year t in the project area
Source of data	- Remote sensing and GIS. - Field reports
Description of measurement methods and procedures applied	The unplanned deforestation within the project area that result in carbon stock decrease will be subject to monitoring.
Frequency of monitoring/recording	Annually
Value applied:	The table below shows the annual average unplanned deforestation expected to occur within the project area during the crediting period.

	<table><tr><th>Vegetation type</th><th>AUDPA$_{icl,t}$ (ha)</th></tr><tr><td>Forest</td><td>151.36</td></tr></table>
Monitoring equipment	- Remote sensing and GIS - Field report prepared by ABC Norte Management team Pacajá
QA/QC procedures applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to unplanned deforestation in the project area.
Calculation method	Emissions from deforestation at each forest class are quantified by multiplying the detected area of forest loss by the average forest carbon stock per unit area. For an ex ante estimation, it was considered that around 5.47% of the projected deforestation (ABSLPAt) would occur within the project area, according to the Effectiveness Index parameter.
Comments	N/A

Data / Parameter	APFPAicl,t
Data unit	Hectare
Description	Areas of planned fuel-wood collection and charcoal production activities in forest class icl at year t in the project area
Source of data	- Authorization for the Use of Forest Raw Material document
Description of measurement methods and procedures applied	No production of fuel wood or charcoal is expected to occur within the project area during the crediting period.
Frequency of monitoring/recording	Annually
Value applied:	0 (no production of fuel wood or charcoal is expected to occur)
Monitoring equipment	- Remote sensing and GIS - Planned interventions proposed by the project proponent

QA/QC procedures applied	Best practices in remote sensing. Internal audit of the SFMP.
Purpose of data	This parameter was used to calculate project emissions in the project scenario. Provides the ex post value of the increase or decrease in carbon stocks due to planned fuel-wood collection and charcoal production activities in the project area.
Calculation method	Emissions at each forest class are quantified by multiplying the detected area subject to fuel wood collection or charcoal production by the harvested volume intensity, and then by the mean wood density.
Comments	N/A

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	262,220.67 (Annual average projected decrease in carbon stocks due to displaced deforestation in the leakage belt during the crediting period)
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.

Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	$\Delta CPAdPA_t$
Data unit	tCO2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Source of data	Documents, remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	455,621.63 (Annual average decrease in carbon stocks due to all planned activities within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS SFMP reports, including the post-harvesting annual report.
QA/QC procedures to be applied	- Best practices in remote sensing. - Internal audit of the SFMP. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
Source of data	- Activities report related to leakage prevention measures - SOCIALCARBON report - Field assessment - Remote sensing and GIS
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area

Source of data	- Remote sensing and GIS - Field reports.
Description of measurement methods and procedures to be applied	Forest cover change due to unplanned deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	95,642.74 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project area.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	N/A

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex post* increase in GHG emissions due to displaced forest fires at year t.
Source of data	Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	Forest fires in the leakage belt area may be considered activity displacement leakage. GHG emissions due displaced forest fires will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually

Value applied	9,585.69 (Annual average for the project crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate leakage emissions in the baseline and project scenario. Provides the *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt.
Calculation method	GHG emissions from deforestation are estimated by multiplying the detected area of forest loss in the leakage belt times the average forest carbon stock per unit area.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) of actual non-CO_2 emissions from forest fire at year t in the project area
Source of data	- Remote sensing data and GIS, - ABC Norte management team and field data.
Description of measurement methods and procedures to be applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, the ABC Norte management team could also confirm the obtained data. No forest fire will be used by ABC Norte for conducting planned deforestation or timber harvesting activities. However, it is expected that some unplanned deforestation within the project area will occur during the crediting period, which conversion of forest to non-forest may involve fire. The effect of fire on carbon emissions is counted in the estimation of carbon stock changes in the parameter $\Delta CUDdPA_t$; therefore CO_2 emissions from forest fires were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest

	fires must be counted in the project scenario, when they are significant. In order to be conservative, it will be assumed that all unplanned deforestation within the project area will involve fire. Therefore, non-CO_2 emissions from forest fires will be quantified and deducted from emission reductions.
Frequency of monitoring/recording	Annually
Value applied	3,454 (annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate *non-CO_2* emissions due to forest fires within the project area in the project scenario, providing an estimate of the *ex post* value for each vegetation type.
Calculation method	If forest fires occur, *non-CO_2* emissions from biomass burning will calculated according to requirements of methodology VM0015 v1.1. Therefore, this parameter will be calculated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the project scenario times the total GHG emission from biomass burning in initial forest classes ($EBBtot_{icl,t}$), when significant.
Comments	N/A

Data / Parameter	$EBBtot_{icl,t}$
Data unit	tCO2e/ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Source of data	Calculated according to methodology VM0015 v1.1.
Description of measurement methods and procedures to be applied	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial

	value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. These average percentage values are assumed to remain the same in the future, according to the applied methodology
Frequency of monitoring/recording	Annually
Value applied	<table><tr><th colspan="2">Initial Forest Class</th><th rowspan="2">$EBBtot_{icl}$ tCO_2e/ha</th></tr><tr><th>IDcl</th><th>Name</th></tr><tr><td>1</td><td>Forest</td><td>23.87</td></tr></table>
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter is used to calculate the baseline, project and leakage non-CO_2 emissions from biomass burning occurred in the baseline and project scenarios
Calculation method	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology.
Comments	GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing data and GIS.

Description of measurement methods and procedures to be applied	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS Field assessment data
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	The community living within the leakage management area does not practice any grazing activities. However, this shall be monitored during the crediting period. GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	Hlicl,t
Data unit	m^3/ha
Description	Harvesting intensity of timber in forest class icl at year t in the project area due to planned logging activities (i.e., sustainable forest management plan).
Source of data	Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report.
Description of measurement methods and procedures to be applied	Forest inventory and measurements of wood logs by ABC Norte management team. ABC Norte controls all the harvested timber from the forest management area. Harvesting intensity followed procedures described in the Sustainable Forest Management Plan for Fazenda Pacajá.
Frequency of monitoring/recording	Annually

Value applied	30
Monitoring equipment	The same equipment applied in the forest inventory. Each harvested timber log is measured by ABC Norte management team and stored in a collector, which is linked to the SFMP data control.
QA/QC procedures to be applied	Control procedures applied to forest inventory. Forest management Certification. SFMP internal audit. Logging authorization from the Brazilian Environmental Agency[221].
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the harvested timber volume due to planned logging activities in the project area.
Calculation method	This parameter was calculated through the annual timber inventory, which is carried out before harvesting and contains the timber volume from each Annual Productive Unit (APU). After harvesting operations, each harvested timber log is measured (diameter and height) by ABC Norte employees and stored in a collector, which automatically calculate the timber volume through the following equation: $V (m^3) = 0.00008912 \times (DBH^2 \times H)^{0.948}$ Where, DBH = Diameter at Breast Height H = Height Carbon stock decrease from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the harvested timber volume intensity (added to logging damage factor), and then by the mean wood density.
Comments	N/A

Data / Parameter	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report – ABC Norte REDD Project; - Remote sensing data and GIS;

[221] The responsible environmental agency in this case is the Environmental Agency of the State of Pará (SEMA - Pará).

	- SFMP data; - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	10
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event.
Purpose of data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors described in the VCS Non-Permanence Risk Report will be assessed.
Comments	N/A

5.3 Monitoring Plan

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

Organizational structure

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

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

Thus, ABC Norte is responsible, from the signing of the contract, for:

- Alignment meetings between the parties to define the SOCIALCARBON Standard indicators;
- Hiring a team to carry out the Social and Environmental Diagnosis and activities to recognize the communities that live in the vicinity of the project area;
- Regularization of documentation for proof of ownership;
- Sending documentation and questionnaires to the team responsible for preparing the Project Document, referring to:
  - Project activity;
  - Non-permanence report (Buffer Report);
  - SOCIALCARBON Report.
- The conservation of the area, through monitoring and combating threats and agents related to:
  - Encroachment;
  - Deforestation and degradation;
  - fire;
  - illegal hunting and fishing;
  - illegal roads, without previous government authorization.
- Therefore, it is necessary to carry out the monitoring of the area by means such as (not limited to):
  - Overflight of the area
  - Image monitoring through satellite or drones;
  - Recruitment of the monitoring team;
  - Construction of monitoring posts at strategic points on the property.
- Employees training related to:
  - Fire brigade;
  - Security;
  - Environmental education;
  - First aid.

The team that will deliver such training must have proven experience, or proof of other training.

- The owners are also responsible for ensuring the entire on-site monitoring infrastructure, such as:
  - Construction of monitoring posts at strategic points on the property;
  - Acquisition of vehicles, motorcycles or boats for monitoring by land or water;
  - Installation and acquisition of communication equipment (radio, antenna, etc.).
- According to perspectives listed and verified by the SOCIALCARBON Standard, and REDD+ methodology, the Contractor is also responsible for socio-environmental actions that ensure the sharing of benefits from the sale of carbon credits. Among the actions:
  - Creation of alternative sources of income, aimed at minimizing illegal deforestation and facilitators of invasions, such as:
    - Associations and cooperatives of typical fruits, seeds and oils;
    - Hiring and training of a monitoring team;
    - Professional training for women;
    - Incentive to crafts and handiwork.
  - Incentive and investment in local education:
    - Creation of a community center for youth and adult education;
    - Partnership with city hall and education centers for school construction;
    - Partnership with education centers to offer training and lecture cycles.
  - Ensuring food security for the local community, allowing the use of the private area for subsistence planting, among other alternative income activities.
  - Installation of infrastructure to reduce the isolation of families, such as:
    - Electricity;
    - Communication network;
    - Transportation;
    - Assistance in issuing documents and registering residents in government services

These actions will be defined and monitored as the project progresses and carbon credits are sold. The owner is responsible for establishing prospects in each Social Carbon report, as well as complying with at least 50% of the proposed actions, under penalty of losing the Social Carbon standard.

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

- **Revision of the baseline**

The current baseline is valid for 10 years, i.e. through 13/September/2027. The baseline will be reassessed every 10 years, and it will be validated at the same time as the subsequent verification.

Technical description of the monitoring task

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

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

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

Data to be collected

Data will be collected to comply with the parameters used in VM0015 version 1.1, listed in Appendix 5, or the most recent.

Overview of data collection procedures

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

Quality control and quality assurance procedures

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

Data archiving

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

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

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

Organization and responsibilities of the parties involved in all the above

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

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

Uezu Planejamento Ambiental is responsible for all GIS related information.

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

ABC Norte is responsible for the implementation of the project activity. The monitoring of the sustainable management plan is carried out by the municipal and state secretariats. In addition, as it is a CEFLOR certification holder, Fazenda Pacajá has its management plan and activities audited internally by the certifier annually.

To keep track of the impact of project activities, ABC Norte produces reports on:

- Fauna and Flora
- Environmental monitoring
- Post Exploratory
- Socioenvironmental diagnosis
- Permanent plots

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

Updating Forest Carbon Stocks Estimates

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

Sampling approaches for forest inventory

Sampling and carbon stocks estimate shall be conducted according to Appendix III – Methods to estimate carbon stocks. The sampling and execution of the forest inventory is the responsibility of ABC Norte. Future monitoring and collections must follow the procedure conducted during this PD, as informed in section 4:

The forest inventory campaign involved the measurement of 21 plots. The allocation of the permanent plots shall prioritize areas not previously managed for timber products.

Each plot has dimensions of 50 x 50 m (0.25 hectares), randomly distributed. The permanent plots were demarcated at the four corners, with wooden pickets, in order to facilitate their location later on, and their geographical coordinates were recorded. DBH was measured at 1.30 m above ground level, involving trees with DBH > 10 cm (measuring tape).

The total height of the trees was obtained in an estimated manner (visual) or using a Blume-Leiss device (hypsometer), when possible. Data was collected from a total sample area of 5.25 ha.

The estimation of tree volumes must involve the application of allometric equation from adequate literature.

The forest inventory data must be summarized into a table, including aboveground biomass, belowground biomass, total biomass, and total carbon stock. A spreadsheet including target precision levels, sample sizes, sample site locations and stratification must be presented to Ecológica and the VVB. If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction, provided that these data are in accordance with the requirements established by the applied methodology VM0015. Data shall be updated every baseline reassessment.

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

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

Ecológica Assessoria Ltda. Will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the subsequent baseline reports and monitoring periods.

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

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

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

Quality Assurance/Quality Control

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

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

The implementation of the project activity will be monitored by continuous monitoring activities using remote sensing techniques. Additionally, field studies will also be used. The land-use monitoring will be carried out with remote sensing methods, using images generated by Mapbiomas, INPE (PRODES)[222] and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

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

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

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

[222] Available at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes> Last visited on 10/03/2021.

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

Procedures for handling internal auditing and non-conformities

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

A project information quality management system will be implemented, the main purpose of which is to minimize the risk of error, obtaining reliable data on which to base the monitoring results, and thus, minimizing non-conformities. It includes the training of general staff in the different roles to play within the framework of the ABC Norte Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and; review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of Ecológica Assessoria Ltda.

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

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

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

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

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

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

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

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

Other applied methodologies for monitoring of deforestation are listed below:

Monitoring bases

The bases are positioned in strategic points within the Fazenda Pacajá. Figure below presents the current and planned monitoring bases:

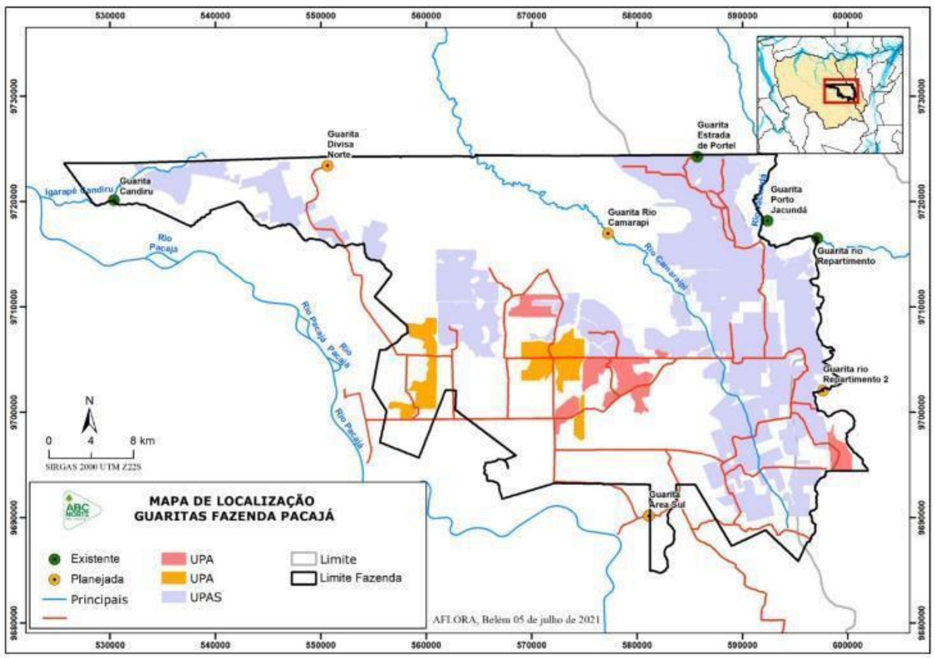


Figure 88. Current and planned monitoring bases at Fazenda Pacajá

According to Figure above, the green dots represent the bases already established by the project owner as monitoring bases. Yellow dots are the planned points that will be constructed with the carbon credits revenues. All the bases have radio communication and are equipped with vehicles to move to other areas if necessary.

Satellite images and remote sensing monitoring

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

All reliable data collected and documented will be used as a technical support tool for decision making in order to improve project outcomes, and to adapt the project according to the current needs and reality. These decisions will be made during periodic meetings to review the Action

Plan – that will be developed as part of the SocialCarbon Methodology. On these occasions, the design of the Monitoring Plan will be analyzed according to its efficiency in generating reliable feedback and all the necessary information. If any changes in the Monitoring Plan or management actions are identified, a corrective action will be designed and implemented.

The collected data is compiled in an annual environmental report, that gathers information on deforestation, heat spots and anthropism occupation.

Security procedures

- In order to ensure the internal and patrimonial security of Fazenda Pacajá and its natural heritage, the employees follow formalized guidance when there is any internal change in the Forest area of the property.
- It is noteworthy that the first step is to try to communicate and increase the scope of the Socio-Environmental Program, as a way of approaching the extremes of the area and the communities, in order to guide and have an active voice with those who act irregularly within Fazenda Pacajá.
- A satellite image report may be issued monthly, containing the information of deforestation and forest degradation within the project area. In addition, from now on, all ABC Norte employees shall observe any irregularity in the project area.
- Upon verification of any irregularity, the person must inform the office in Vila ABC. With this, the responsible team will go to the field and try to contact the deforestation agents.
- Upon confirmation, the area should be photographed, and the local coordinates recorded, in order to facilitate the registration of the occurrence at the Portel Forest Police. In possession of the registration, the environmental secretariats are called to request action.

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

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

- **Monitoring of carbon stock changes and non-CO2 emissions from fires**

In addition to the mentioned above, ABC Norte is responsible for training monitoring, management, safety and health personnel. This includes periodic fire brigade training, including first aid, fire procedures, training of new monitoring personnel and those responsible for management during harvests.

If forest fires occur, these non-CO2 emissions will be subject to monitoring and accounting, when significant.

- **Monitoring of impacts of natural disturbances and other catastrophic events**

The monitoring of natural impacts and other catastrophic events is responsibility of ABC Norte. The company must notify Ecológica Assessoria so that it can include the related impacts in the carbon project reports, updating the related parameters, including the buffer report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

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

- **Monitoring of Leakage**

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

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

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

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

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

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

- **Organizational structure, responsibilities and competencies**

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

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

Oversight and accountability of monitoring activities

ABC Norte and Ecológica shall mutually account for the monitoring and execution of activities under their responsibility. The development of the project will be linked to the quality and veracity of the data sent, which will be audited by a third party during each validation and verification. The frequency of monitoring and accountability will be, at most, at each verification, and may vary according to each activity.

Table 70. Type of Monitoring and Party Responsible for Monitoring

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Ecologica Assessoria and external institutions qualified for the GIS analysis and monitoring	Every 10 years
Monitoring Deforestation and Project Emissions	Project proponent together with Ecologica Assessoria and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Project proponent together with Ecologia Assessoria and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring Leakage emissions	Project proponent together with Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of Natural Disturbance and catastrophic events	Project proponent	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Project proponent	At least, every 10 years, only if necessary.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	ab_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.
Value applied:	(see table below)
Comments	N/A.

Above-ground biomass ab_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Forest (Dense Lowland Tropical Rainforest)	316.35	316.22	316.22

Data / Parameter	bb_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.
Value applied:	(see table below)
Comments	N/A.

Below-ground biomass bb_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Forest (Dense Lowland Tropical Rainforest)	75.92	75.89	75.89

Data / Parameter	$ACPA_t$
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.
Value applied:	0
Comments	Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$ABSLLK_t$
Data unit	Ha
Description	Annual area of deforestation within the leakage belt at year t.
Value applied:	(see table below)
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Year	$ABSLLK_t$ (ha)	
	Forest	Cumulative
2017	100.23	100.23
2018	332.58	432.81
2019	315.30	748.11
2020	222.91	971.02
Total	971.02	-

Data / Parameter	$ABSLPA_t$
Data unit	Ha
Description	Annual area of deforestation in the project area at year t
Value applied:	(see table below)
Comments	N/A

Year	$ABSLPA_{icl,t}$ (ha)	
	Forest	TOTAL
2017	48.14	48.14
2018	159.72	207.86
2019	256.14	464.00
2020	109.74	573.73
Total	573.73	-

Data / Parameter	$ABSLRR_t$
Data unit	Ha
Description	Annual area of deforestation in the reference region at year t
Value applied:	(see table below)

Year	$ABSLRR_{icl,t}$ (ha)	
	Forest	TOTAL
2017	3,614.09	3,614.09
2018	11,992.19	15,606.28
2019	10,408.78	26,015.06
2020	5,126.42	31,141.48
Total	31,141	-

Comments	N/A

Data / Parameter	$APDPA_{icl,t}$
Data unit	Hectare
Description	Areas of planned deforestation in forest class *icl* at year *t* in the project area
Value applied:	see table below
Comments	N/A

Year	$APDPA_{icl,t}$ (ha)
	Forest
2017	0.00
2018	0.00
2019	111.82
2020	58.73
Total	170.54

Data / Parameter	$APLPA_{icl,t}$
Data unit	Hectare
Description	Areas of planned logging activities in forest class *icl* at year *t* in the project area
Value applied:	see table below

Year	$APLPA_{icl,t}$ (ha)
	Forest
2017	3,494.44
2018	3,494.44
2019	7,114.12

	2020: 3,556.27 Total: 17,659.27
Comments	N/A

Data / Parameter	$AUDPA_{icl,t}$
Data unit	Hectare
Description	Areas of unplanned deforestation in forest class *icl* at year *t* in the project area
Value applied:	see table below
Comments	N/A

Year	$AUDPA_{icl,t}$ (ha)
	Forest
2017	48.14
2018	159.72
2019	144.32
2020	51.01
Total	403.19

Data / Parameter	$APFPA_{icl,t}$
Data unit	Hectare
Description	Areas of planned fuel-wood collection and charcoal production activities in forest class *icl* at year *t* in the project area
Value applied:	see table below

Year	$APFPA_{icl,t}$ (ha)
	Forest
2017	0
2018	0

	2019	0
	2020	0
	Total	0
Comments	N/A	

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Value applied:	
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Year	$\Delta CADLK_t$ (tCO_2e)
2017	0.00
2018	0.00
2019	0.00
2020	0.00
Total	0.00

Data / Parameter	$\Delta CPAdPA_t$
Data unit	tCO2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Value applied:	

Year	$\Delta CPAdPA_t$ (tCO_2e)
2017	51,224.16
2018	113,158.82
2019	356,387.11

	2020	212,192.09
	Total	732,962.18
Comments	N/A	

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
Value applied:	

Year	$\Delta CPSLK_t$ (tCO_2e)
2017	2.83
2018	40.58
2019	68.25
2020	72.20
Total	183.87

Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area. However, there were some deforestation of regenerated areas within the leakage management area, which should be accounted as leakage emissions.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Value applied:	

Year	$\Delta CUDdPA_t$ (tCO_2e)

	2017	34,603.76
	2018	114,821.58
	2019	103,748.03
	2020	36,669.81
	Total	289,843.18
Comments	N/A	

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex post* increase in GHG emissions due to displaced forest fires at year t.
Value applied:	<table><tr><th>Year</th><th>EADLK_t (tCO2e)</th></tr><tr><td>2017</td><td>0.00</td></tr><tr><td>2018</td><td>0.00</td></tr><tr><td>2019</td><td>0.00</td></tr><tr><td>2020</td><td>0.00</td></tr><tr><td>Total</td><td>0.00</td></tr></table>
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	$EBBBSLPA_t$
Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO_2 emissions from forest fire at year t in the project area

Value applied:	<table><tr><th>Year</th><th>EBBBSLPA_t (tCO2e)</th></tr><tr><td>2017</td><td>3,469</td></tr><tr><td>2018</td><td>11,510</td></tr><tr><td>2019</td><td>19,599</td></tr><tr><td>2020</td><td>22,486</td></tr><tr><td>Total</td><td>57,064</td></tr></table>
Comments	N/A

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) actual non-CO_2 emissions from forest fire at year t in the project area
Value applied:	<table><tr><th>Year</th><th>EBBPSPA_t (tCO2e)</th></tr><tr><td>2017</td><td>1,148.99</td></tr><tr><td>2018</td><td>3,812.55</td></tr><tr><td>2019</td><td>3,444.86</td></tr><tr><td>2020</td><td>1,217.59</td></tr><tr><td>Total</td><td>9,624.00</td></tr></table>
Comments	N/A

Data / Parameter	$EBBtot_{icl,t}$
Data unit	tCO_2e/ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Value applied:	<table><tr><th>Initial Forest Class</th><th>EBBtot_{icl} tCO2e/ha</th></tr></table>

	<table><tr><th>IDcl</th><th>Name</th><th>Baseline case</th><th>Project case</th></tr><tr><td>1</td><td>Forest (Dense Lowland Tropical Rainforest)</td><td>23.87</td><td>23.87</td></tr></table>
Comments	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. These average percentage values are assumed to remain the same in the future, according to the applied methodology

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Value applied:	<table><tr><th>Year</th><th>$EgLK_t$ (tCO_2e)</th></tr><tr><td>2017</td><td>0</td></tr><tr><td>2018</td><td>0</td></tr><tr><td>2019</td><td>0</td></tr><tr><td>2020</td><td>0</td></tr><tr><td>Total</td><td>0</td></tr></table>
Comments	There were no activities in the leakage management area that resulted in GHG emissions during the monitoring period. In addition, the community living within the leakage management area does not practice any grazing activities.

Data / Parameter	$HI_{icl,t}$
Data unit	m^3/ha

Description	Harvesting intensity of timber in forest class *icl* at year *t* in the project area due to planned logging activities (i.e., sustainable forest management plan).
Value applied:	11.11 (Average harvesting intensity)
Comments	N/A

Data / Parameter	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Value applied:	10
Comments	N/A

6.2 Baseline Emissions

The total average biomass stock per hectare (Mg ha^{-1}) was converted to tCO_2e using the following equations:

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

Where,

Cab_{icl} — Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class *icl*; $tCO_2e\ ha^{-1}$

ab — Average biomass stock per hectare in the above-ground biomass pool of initial forest class *icl*; Mg ha^{-1}

CF — Default value of carbon fraction in biomass

44/12 — Ratio converting C to CO_2e

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

Where,

Cbb_{icl} — Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class *icl*; $tCO_2e\ ha^{-1}$

bb Average biomass stock per hectare in the below-ground biomass pool of initial forest class *icl*; Mg ha^{-1}

CF Default value of carbon fraction in biomass

44/12 Ratio converting C to CO_2e

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

$$\Delta \boldsymbol{CBSLPAt} = \Delta \boldsymbol{CabBSLPAicl,t} + \Delta \boldsymbol{CbbBSLPAicl,t}$$

Where,

$\Delta CBSLPAt$ Total baseline carbon stock changes in the project area at year *t*; tCO_2e

$\Delta CabBSLPA_{icl,t}$ Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e

$\Delta CbbBSLPA_{icl,t}$ Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e

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

Where,

$\Delta CabBSLPA_{icl,t}$ Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e

$ABSLPA_{icl,t}$ Area of initial forest class *icl* deforested at time *t* within the project area in the baseline case; ha

ΔCab_{icl} Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class *icl*; tCO_2e ha^{-1}

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

Where,

$\Delta CbbBSLPA_{icl,t}$ Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e

$ABSLPA_{icl,t}$ Area of initial forest class *icl* deforested at time *t* within the project area in the baseline case; ha

ΔCbb_{icl} Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category *icl*; tCO_2e ha^{-1}

Project carbon stocks were calculated as presented in section 4.1.

Average carbon stocks of post-deforestation classes

The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomas, which is detailed below:

Land Use	Area (%)
Pasturelands	66.18%
Secondary forests	33.66%
Agriculture	0.09%
Rivers, lakes and reservatory	0.06%
Urban area	0.01%

Therefore, almost two-thirds of the post-deforestation land uses within the reference region is composed by pasturelands.

In order to estimate the post-deforestation carbon stocks, the average carbon stocks of pasturelands, agriculture and other land uses were taken from the National GHG Emissions Communication of Brazil to the UNFCCC (2019)[223].

For secondary forests, a regional study was conducted. Most secondary forests in the Brazilian Amazon are young. In 2017, 65% of secondary forests was ≤10 years old. On average, 35% of annual land abandonment to secondary forests was re-cleared within 5 years, and 57% within 10 years[224]. The half-life of secondary forests is 8 years, on average, which is also the same value found by other study that concludes that more than 50% of the secondary forests in the Amazon biome have less than 8 years old[225].

According to a study conducted in the State of Pará that analyzed the carbon stocks of a secondary forest with 14 years old, the average carbon stock in above ground biomass is around 19 tC/ha[226]. Below ground biomass was estimated through the root-to-shoot ratio from the applied methodology. Therefore, the average value for secondary forests is around 22,8 tC/ha.

Therefore, the weighted average carbon stocks was calculated through the data below.

[223] Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf>

[224] Sâmia Nunes *et al* 2020 *Environ. Res. Lett.* 15 034057. Available at: <https://iopscience.iop.org/article/10.1088/1748-9326/ab76db>

[225] Silva Junior, C.H.L., Heinrich, V.H.A., Freire, A.T.G. *et al.* Benchmark maps of 33 years of secondary forest age for Brazil. *Sci Data* 7, 269 (2020). Available at: <https://doi.org/10.1038/s41597-020-00600-4>

[226] Pereira, Izaura Cristina Nunes. Estoque de biomassa e carbono florestal em unidades de paisagem na Amazônia: uma análise a partir da abordagem metodológica. Universidade Federal do Pará, , Belém, 2013. Available at: <https://ppgdstu.propesp.ufpa.br/ARQUIVOS/teses/TESES/2013/IZAURA%20CRISTINA%20NUNES%20PEREIRA.pdf>

Land Use	Area (%)	Carbon stocks (tC/ha)
Pasturelands	66,18%	7.57
Secondary forests	33,66%	22.8
Agriculture	0,09%	21
Rivers, lakes and reservatory	0,06%	0
Urban area	0,01%	0
Weighted average of post-deforestation carbon stocks		12.70

Table 71. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Post deforestation class *fcl*	
Name	Non forest
ID_{fcl}	1
Average carbon stock per hectare ±90% CI	
$Ctot_{fcl}$	
tCO_2e/ha	
46.58	

Calculation of baseline carbon stock changes

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

Table 72. Baseline carbon stock change in the reference region

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the reference region	
ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	2,096,079	2,096,079	2,096,079
2018	6,955,173	6,955,173	9,051,252
2019	6,036,832	6,036,832	15,088,084
2020	2,973,195	2,973,195	18,061,280

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	50,306	50,306	50,306
2018	217,230	217,230	267,536
2019	362,114	362,114	629,650
2020	433,471	433,471	1,063,121

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region	
ID_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	0	0	0
2018	62,064	62,064	62,064
2019	115,934	115,934	177,998
2020	142,465	142,465	320,462

Total net carbon stock change in the reference region	
$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
annual	cumulative
tCO_2e	tCO_2e
2,146,385	2,146,385
7,110,339	9,256,724
6,283,013	15,539,737
3,264,201	18,803,938

Table 73. Baseline carbon stock change in the project area

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the project area	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	27,906	27,906	27,906
2018	92,598	92,598	120,504
2019	148,491	148,491	268,996
2020	63,618	63,618	332,614

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area	
ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	670	670	670
2018	2,892	2,892	3,562
2019	6,456	6,456	10,018
2020	7,983	7,983	18,000

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area	
ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	0	0	0
2018	249	249	0
2019	1,076	1,076	1,076
2020	2,401	2,401	3,477

Total net carbon stock change in the project area	
$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
annual	cumulative
tCO_2e	tCO_2e
28,576	28,576
95,241	123,817
153,872	277,689
69,200	346,888

Table 74. Baseline carbon stock change in the leakage belt

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	58,107	58,107	58,107
2018	192,809	192,809	250,916
2019	182,791	182,791	433,708
2020	129,229	129,229	562,937

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	1,395	1,395	1,395
2018	6,022	6,022	7,417
2019	10,409	10,409	17,826
2020	13,510	13,510	31,336

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt	
ID_{iz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2017	0	0	0
2018	519	519	519
2019	2,240	2,240	2,759
2020	3,872	3,872	6,630

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulative
tCO_2e	tCO_2e
59,502	59,502
198,313	257,814
190,960	448,775
138,868	587,643

6.3 Project Emissions

As detailed in section 5.4 above, the CERFLOR-certified sustainable forest management plan implemented by ABC Norte in 2017 within the project area aims to harvest forest products/by-products in a manner consistent with the conservation of the local ecosystem. This type of economic activity enables the harvesting of an economically feasible volume of forest products, however allowing the regeneration of the natural stock in accordance with the growth and recovery rates of the biome.

As previously described, almost all deforestation occurred within the project area resulted from planned deforestation activities. During the current monitoring period, four APUs were harvested, according to Table below.

Annual Productive Unit (APU)	m³	ha	m³/ha
APU 14	42,390.11	3,494.44	12.13
APU 15	51,887.92	3,491.46	14.86
APU 16	19,286.80	3,622.64	5.32
APU 17	43,832.20	3,556.27	12.33

The *ex post* carbon stock decrease due to planned deforestation in the project area was calculated using the following equation:

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

Where,

$\Delta CPDdPA_t$ Total decrease in carbon stock due to planned deforestation at year *t* in the project area; tCO_2e

$APDPA_{icl,t}$ Areas of planned deforestation in forest class *icl* at year *t* in the project area; ha

$\Delta Ctot_{icl}$ Average carbon stock change of all accounted carbon pools in forest class *icl* at time *t*; tCO_2e/ha

In addition, some unplanned deforestation occurred in the southern border of the project area, corresponding to a total of 403.19 ha during the monitoring period. The *ex post* carbon stock decrease due to unplanned deforestation in the project area was calculated using the following equation:

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

Where,

$\Delta CPUdPA_t$ Total *ex post* actual carbon stock change due to unavoidable unplanned deforestation at year *t* in the project area; tCO_2e

$AUDPA_{icl,t}$ Areas of unplanned deforestation in forest class *icl* at year *t* in the project area; ha

$\Delta Ctot_{icl}$	Average carbon stock change of all accounted carbon pools in forest class *icl* at time *t*; tCO_2e/ha

Therefore, the total carbon stock decreases due to planned and unplanned deforestation in the project area could be calculated, as depicted in Table below.

Table 75. Ex post carbon stock decrease due to planned and unplanned deforestation in the project area

Project year *t*	Total carbon stock decrease due to planned deforestation				Areas of unplanned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to unplanned deforestation		Total carbon stock decrease due to planned and unplanned deforestation in the project area	
	ID_{cl} = 1 Forest		annual	cumulative	ID_{cl} = 1 Forest		annual	cumulative	annual	cumulative
	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$AUDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CUDdPA_t$	$\Delta CUDdPA$		
	ha	tCO_2e/ha	tCO_2e	tCO_2e	ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	718.87	0.00	0.00	48.14	718.87	34,603.76	34,603.76	34,603.76	34,603.76
2018	0.00	718.87	0.00	0.00	159.72	718.87	114,821.58	149,425.34	114,821.58	149,425.34
2019	111.82	718.87	80,381.34	80,381.34	144.32	718.87	103,748.03	253,173.37	184,129.37	333,554.71
2020	58.73	718.87	42,216.86	122,598.20	51.01	718.87	36,669.81	289,843.18	78,886.67	412,441.38

Planned logging operations are carried out following a Reduced Impact Logging (RIL) system combined with other improved forest management techniques, including: planning of management activities, selection of best locations for infrastructure construction, directional felling, utilization of advanced technologies, tracking record of wood logs, reforestation activities, among others; which are essential practices to minimize the damage caused to the forest.

In the project scenario, emissions due to planned logging activities results from timber harvesting and also from damages to vegetation during the directional tree felling, which generate forest residues (branches, remains of logs and other damaged trees during the tree felling). According to Feldpausch et al (2005), the mean Coarse woody debris returned to the soil as necromass following logging and damage in: (1) tree felling gap formation (trees killed by tree-fall), (2) residual canopy from the felled tree, (3) road, (4) deck construction (whole trees plowed to the ground) and (5) skid maneuvering during logging, is about 6.9 Mg C/ha. According to section 4.3 (pg 212) from this same study, this represents 2.4 times the carbon taken off site in logs. However, the MR already takes into account as planned deforestation the roads and decks constructions, which represent around 16% of the total damage. Therefore, the LDF is 2.4 * (1-0,159) = 2.0174.

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

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

Where,

$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class *icl* at time *t*; tCO_2e/ha
$HI_{icl,t}$	Harvesting intensity of timber in forest class *icl* at year *t* in the project area due to planned logging activities (i.e., sustainable forest management plan); m^3/ha
LDF	Logging damage factor; m^3/ha
D_m	Mean wood density; g/cm^3
CF	Default value of carbon fraction in biomass; tC t-1 d.m.
44/12	Ratio of molecular weight of CO_2 to carbon; dimensionless

Harvested wood products were not accounted as carbon pool. Therefore, the *ex post* carbon stock decrease due to planned logging activities in the project area was calculated using the following equation:

$$\Delta CPLdPA_t = \sum_{icl=1}^{icl} (APLPA_{icl,t} \times \Delta CLd_{icl,t}) - \left(\sum_{icl=1}^{icl} APLPA_{icl,t} \right) \times \Delta Cwp_t$$

Where,

$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities at year *t* in the project area; tCO_2e

$APLPA_{icl,t}$	Areas of planned logging activities in forest class *icl* at year *t* in the project area; ha
$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class *icl* at time *t*; tCO_2e/ha
ΔCwp_t	Average carbon stock per hectare in the harvested wood products carbon pool at time *t*; tCO_2e/ha

Thus, Table below presents the *ex post* carbon stock decrease due to planned logging activities in the project area.

Table 76. **Ex post actual carbon stock decrease due to planned logging activities in the project area**

Project year *t*	Areas of planned logging activities x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned logging activities	
	ID_{cl} = 1 Forest		annual	cumulative
	$APLPA_{icl,t}$	$\Delta CLd_{icl,t}$	$\Delta CPLdPA_t$	$\Delta CPLdPA$
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2017	3,494.44	14.66	51,224.16	51,224.16
2018	3,494.44	32.38	113,158.82	164,382.98
2019	7,114.12	38.80	276,005.78	440,388.75
2020	3,556.27	47.80	169,975.22	610,363.97

Fossil fuel emissions from sustainable forest management activities are likely to be less than 5% of the total GHG emissions reductions benefits generated by the present project. Considering that emissions from deforestation and forest degradation would be much higher than those associated with timber harvesting, the emissions from fossil fuel during transport and machinery use can be considered *de-minimis*. In addition, according to VCS AFOLU Requirements, fossil fuel emissions from transport and machinery use in REDD project activities can be considered *de minimis*.

No production of fuel wood or charcoal occurred within the project area during the monitoring period.

Thus, Table below presents the total *ex post* carbon stock decrease due to planned activities in the project area.

Table 77. Total ex post carbon stock decrease due to planned activities in the project area

Project year *t*	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuel-wood and charcoal activities		Total carbon stock decrease due to planned activities	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$\Delta CPLdPA_t$	$\Delta CPLdPA$	$\Delta CPFdPA_t$	$\Delta CPFdPA$	$\Delta CPAdPA_t$	$\Delta CPAdPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	51,224.16	51,224.16	0.00	0.00	51,224.16	51,224.16
2018	0.00	0.00	113,158.82	164,382.98	0.00	0.00	113,158.82	164,382.98
2019	80,381.34	80,381.34	276,005.78	440,388.75	0.00	0.00	356,387.11	520,770.09
2020	42,216.86	122,598.20	169,975.22	610,363.97	0.00	0.00	212,192.09	732,962.18

Neither planned protection of secondary/degraded forests without harvest nor production of fuel-wood and charcoal are expected to occur within the project area under the project scenario. Thus, carbon stock increase due to growth without harvest or due to planned fuel-wood and charcoal activities were not monitored. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out. According to the applied methodology, if the project activity generates a significant change in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

The calculation of the *ex post* net carbon stock change in the project area under the project scenario ($\Delta CPSPA_t$) is described as follows.

$$\Delta \boldsymbol{CPSPA_t} = \Delta \boldsymbol{CPAdPA_t} + \Delta \boldsymbol{CUDdPA_t} - \Delta \boldsymbol{CPAiPA_t}$$

Where,

$\Delta CPSPA_t$ Sum of ex post actual carbon stock changes in the project area at year t; tCO_2e

$\Delta CPAdPA_t$ Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_2e

$\Delta CUDdPA_t$ Total ex post actual carbon stock change due to unavoidable unplanned deforestation at year t in the project area; tCO_2e

$\Delta CPAiPA_t$ Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

Ex post carbon stock change in the project area under the project scenario is shown below.

Table 78. Ex post net carbon stock change in the project area under the project scenario

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	51,224.16	51,224.16	0.00	0.00	34,603.76	34,603.76	85,827.92	85,827.92
2018	113,158.82	164,382.98	0.00	0.00	114,821.58	149,425.34	227,980.40	313,808.32
2019	356,387.11	520,770.09	0.00	0.00	103,748.03	253,173.37	460,135.14	773,943.46
2020	212,192.09	732,962.18	0.00	0.00	36,669.81	289,843.18	248,861.90	1,022,805.36

No forest fire was used by ABC Norte for carrying out planned deforestation or timber harvesting activities. However, there were around 403.19 ha of unplanned deforestation within the project area during the monitored period, which conversion of forest to non-forest could have involved fires.

The effect of fire on carbon emissions is counted in the estimation of carbon stock changes in the parameter $\Delta CUDdPA_t$; therefore CO_2 emissions from forest fires were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest fires must be counted in the project scenario, when they are significant.

It was conservatively assumed that all unplanned deforestation within the project area involved fire and all above ground biomass was burnt. Therefore, non-CO_2 emissions from forest fires were quantified and deducted from emission reductions, as follows:

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

Where,

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

$EBBN_2O_{icl,t}$ N_2O emission from biomass burning in forest class *icl* at year *t*; tCO_2e/ha

$EBBCH_{4icl,t}$ CH_4 emission from biomass burning in forest class *icl* at year *t*; tCO_2e/ha

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

Where,

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

NCR Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless

ER_{N2O} Emission ratio for N_2O (IPCC default value = 0.007)

GWP_{N2O} Global Warming Potential for N_2O[228]

$$EBBCH4_{icl,t} = EBBCO2_{icl,t} * 12/44 * ER_{CH4} * 16/12 * GWP_{CH4}$$

Where,

$EBBCO2_{icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class *icl* at year *t*; tCO_2e/ha
ER_{CH4}	Emission ratio for CH_4 (IPCC default value = 0.012)
GWP_{CH4}	Global Warming Potential for CH_4[229]

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

Where,

$EBBCO2_{icl,t}$	Per hectare CO_2 emission from biomass burning in the forest class *icl* at year *t*; tCO_2e/ha
$Fburnt_{icl}$	Proportion of forest area burned during the historical reference period in the forest class *icl*; %
$C_{picl,t}$	Average carbon stock per hectare in the carbon pool *p* burnt in the forest class *icl* at year *t*; tCO_2e/ha
$Pburnt_{p,icl}$	Average proportion of mass burnt in the carbon pool *p* in the forest class *icl*; % (conservatively assumed as 100%)
$CE_{p,icl}$	Average combustion efficiency of the carbon pool *p* in the forest class *icl*; dimensionless (IPCC default of 0.5 was used)
p	Carbon pool that could burn, in the project case, above-ground biomass

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

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

Where,

[228] According to the VCS Standard v4, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report. GWP for N_2O = 298. Available at: <https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html>. Last visited on: 18/June/2020.

[229] According to the VCS Standard v4, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report. GWP for CH_4 = 25. Available at: <https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html>. Last visited on: 18/June/2020.

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

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

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

Table 79. Total ex post emissions of GHG due to forest fires in the project area

Project year *t*	Emissions of non-CO_2 gases from forest fires in the project area		Total ex post emissions of GHG due to forest fires in the project area	
	ID_{cl} = 1 Forest		annual	cumulative
	$AUDPA_{icl,t}$	$EBBPSPA_{icl,t}$	$EBBPSPA_t$	EBBPSPA
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2017	48.14	23.87	1,148.99	1,148.99
2018	159.72	23.87	3,812.55	4,961.54
2019	144.32	23.87	3,444.86	8,406.41
2020	51.01	23.87	1,217.59	9,624.00

<u>Total *ex post* project emissions for the project area</u>

The *ex post* carbon stock changes and non-CO_2 emissions in the Project area during the monitoring period is summarized in Table below.

Table 80. Total ex post estimated actual net changes in carbon stocks and emissions of GHG gases in the project area

Project year *t*	Total *ex post* carbon stock decrease due to planned activities		Total *ex post* carbon stock increase due to planned activities		Total *ex post* carbon stock decrease due to unavoided unplanned deforestation		Total *ex post* carbon stock change		Total *ex post* estimated actual non-CO_2 emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAiPA_t$	ΔCPAiPA	$\Delta CUDdPA_t$	ΔCUDdPA	$\Delta CPSPA_t$	ΔCPSPA	$EBBPSPA_t$	EBBPSPA
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	51,224.16	51,224.16	0.00	0.00	34,603.76	34,603.76	85,827.92	85,827.92	1,148.99	1,148.99
2018	113,158.82	164,382.98	0.00	0.00	114,821.58	149,425.34	227,980.40	313,808.32	3,812.55	4,961.54
2019	356,387.11	520,770.09	0.00	0.00	103,748.03	253,173.37	460,135.14	773,943.46	3,444.86	8,406.41
2020	212,192.09	732,962.18	0.00	0.00	36,669.81	289,843.18	248,861.90	1,022,805.36	1,217.59	9,624.00

6.4 Leakage

According to the applied methodology, two sources of leakage are considered: a) decrease in carbon stocks and increase in GHG emissions associated with leakage prevention measures; and b) decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage.

***Ex post* estimation of decrease in carbon stocks and increase in GHG emissions due to leakage prevention measures**

To reduce the risk of activity displacement leakage, baseline deforestation agents could participate in activities within the project area and leakage management area that together will replace baseline income, product generation and livelihood of the agents as much as possible, so that deforestation will be reduced, and the risk of displacement minimized. As such, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. If this decrease in carbon stock or increase in GHG emission is significant, it must be accounted, and *ex post* monitoring will be required.

In order to calculate the net carbon stock changes that the planned leakage prevention measures are expected to occasion during the monitoring period, the projected carbon stocks shall be estimated in the leakage management area under the baseline case and project scenario.

$$\Delta CLPMLK_t = \Delta CPSLK_t - \Delta CBSLLK_t$$

Where,

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

$\Delta CBSLLK_t$ Annual carbon stock changes in leakage management areas in the baseline case at year t; tCO_2e

$\Delta CPSLK_t$ Annual carbon stock change in leakage management areas in the project case; tCO_2e

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

According to the planned interventions carried out by ABC Norte REDD Project in the baseline case, no decrease in carbon stocks due to activities implemented in the leakage management area were identified, thus $\Delta CBSLLK = 0$. However, during the current monitoring period, there were carbon stock changes within the leakage management area due to deforestation of regenerated forests. Therefore, the *ex post* carbon stock change in leakage management areas in the project case ($\Delta CPSLK_t$) was calculated as follows. The annual values are detailed in the Table below.

$$\Delta CPSLK_t = APSLK_{fcl,t} * \Delta Ctot_{cl}$$

Where,

$\Delta CPSLK_t$ Annual carbon stock change in leakage management areas in the project case; tCO_2e

$APSLK_{fcl,t}$ Annual area of class fcl with decreasing carbon stock in leakage management areas in the project case at year t; ha

$\Delta Ctot_{icl}$ Average carbon stock change of all accounted carbon pools in forest class icl at time t; tCO_2e/ha

Table 81. Ex post carbon stock change in leakage management areas in the project case

Project year	Carbon stock changes in leakage management area in the project case			
	ID_{fcl}	1	annual	cumulative
	APSLKfcl,t	$Ctot_{fcl,t}$	ΔCPSLK t	ΔCPSLK
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2017	0.54	5.23	2.83	2.83
2018	1.80	22.57	40.58	43.42
2019	1.71	39.91	68.25	111.67
2020	1.26	57.30	72.20	183.87

The Table below shows that the net sum of carbon stock changes within the leakage management area during the current monitoring period is less than zero, i.e., leakage prevention measures are causing carbon stock decrease and therefore, are included as leakage emissions.

Table 82. Ex post estimated net carbon stock change in leakage management areas

Project year	Total carbon stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLLK_t$	ΔCBSLLK	$\Delta CPSLK_t$	ΔCPSLK	$\Delta CLPMLK_t$	ΔCLPMLK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	2.83	2.83	2.83	2.83
2018	0.00	0.00	40.58	43.42	40.58	43.42
2019	0.00	0.00	68.25	111.67	68.25	111.67
2019	0.00	0.00	72.20	183.87	72.20	183.87

Furthermore, leakage prevention measures carried out by the present project during the current monitoring period did not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. As the project will not involve grazing animals or crop plantations in the leakage management area, actions to avoid leakage involves containing the displacement leakage risk. Thus, the main plan for mitigating leakage is to involve the community in monitoring and inspecting deforestation, training, alternative income generation and other actions described in the Social Carbon and Conservation Plan. Therefore, emissions from grazing animals in leakage management areas ($EgLK_t$), which calculation is detailed below, equals to zero.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

ECH_4ferm_t CH_4 emissions from enteric fermentation in leakage management areas at year t; tCO_2e/year

ECH_4man_t CH_4 emissions from manure management in leakage management areas year t; tCO_2e/year

EN_2Oman_t N_2O emissions from manure management in leakage management areas at year t; tCO_2e/year

t 1, 2, 3, … T years of the project crediting period; dimensionless

Therefore, the total *ex post* estimated carbon stock changes and increases in GHG emissions due to leakage prevention measures during this monitoring period is calculated as follows. These emissions were also zero.

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

Table 83. Ex post estimated total emissions above the baseline from leakage prevention activities

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex post* GHG emissions from increased grazing activities		Total *ex post* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	2.83	2.83	0.00	0.00	2.83	2.83
2018	40.58	43.42	0.00	0.00	40.58	43.42
2019	68.25	111.67	0.00	0.00	68.25	111.67
2020	72.20	183.87	0.00	0.00	72.20	183.87

<u>Ex post decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage</u>

Activities that cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted ex ante would indicate displacement of deforestation activities due to the project.

It is important to note that activity data for the leakage belt area was determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage due to displacement activity was monitored by mapping forest cover change in the leakage belt.

As defined in the VCS Methodology VM0015 v1.1, if carbon stocks in the leakage belt area decrease more during project implementation than projected in the baseline case, this will be an indication that leakage due to displacement of baseline activities has occurred. Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and considered leakage.

Thus, leakage emissions due to activity displacement is calculated as the difference between the ex ante and the ex post assessments, as detailed in the Table below.

Table 84. Total net carbon stock change in the leakage belt

Project year	Total ex ante net baseline carbon stock change		Total ex post net actual carbon stock change		Total ex post leakage	
	ΔCBSLLKt	ΔCBSLLK	ΔCBSLLKt	ΔCBSLLK	ΔCBSLLKt	ΔCBSLLK
	annual	cumulative	annual	cumulative	annual	cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	45,347	45,347	59,502	59,502	0	0
2018	151,137	196,484	198,313	257,814	0	0
2019	199,221	395,704	190,960	448,775	0	0
2020	231,009	626,713	138,868	587,643	0	0

Furthermore, the monitoring of increases in GHG emissions within leakage belt ($EADLK_t$) was also carried out. However, as could be observed in the table above, no increase in GHG emissions within the leakage belt happened, thus non-CO2 emissions from biomass burning in the leakage belt were not associated with the project activity.

<u>Ex post estimation of total leakage</u>

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

$$\Delta CLK_t = \Delta CLPMLK_t + \Delta CADLK_t$$

Where:

ΔCLK_t Total decrease in carbon stocks within the leakage belt at year t; tCO_2e

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

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

$$ELK_t = EgLK_t + EADLK_t$$

Where:

ELK_t Sum of *ex post* leakage emissions at year t; tCO_2e

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

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

The results of all ex post estimations of leakage are summarized in the table below.

Table 85. Ex post estimated total leakage

Project year	Total ex post GHG emissions from increased grazing activities		Total ex post increase in GHG emissions due to displaced forest fires		Total ex post decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	$EgLK$	$EADLK_t$	$EADLK$	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	0.00	0.00	0.00	0.00	2.83	2.83	2.83	2.83	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00	40.58	43.42	40.58	43.42	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	68.25	111.67	68.25	111.67	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	72.20	183.87	72.20	183.87	0.00	0.00

6.5 Net GHG Emission Reductions and Removals

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

$$\Delta REDD_t = (\Delta CBSLPA_t + EBBBSLPA_t) - (\Delta CPSPA_t + EBBPSPA_t) - (\Delta CLK_t + ELK_t)$$

Where:

$\Delta REDD_t$ *Ex post* net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year *t*; tCO_2e

$\Delta CBSLPA_t$ Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e

$EBBBSLPA_t$ Sum of baseline emissions from biomass burning in the project area at year *t*; tCO_2e

$\Delta CPSPA_t$ Sum of *ex post* estimated actual carbon stock changes in the project area at year *t*; tCO_2e

Note: If ΔCPSPAt represents a net increase in carbon stocks, a negative sign before the absolute value of ΔCPSPAt shall be used. If ΔCPSPAt represents a net decrease, the positive sign shall be used.

$EBBPSPA_t$ Sum of actual emissions from biomass burning in the project area at year *t*; tCO_2e

ΔCLK_t Sum of *ex post* estimated leakage net carbon stock changes at year *t*; tCO_2e

Note: If the cumulative sum of ΔCLK_t within a fixed baseline period is > *0,* ΔCLK_t shall be set to zero.

ELK_t Sum of *ex post* estimated leakage emissions at year *t*; tCO_2e

t 1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

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

$$VCU_t = \Delta REDD_t - VBC_t$$

$$VBC_t = (\Delta CBSLPA_t - \Delta CPSPA_t) \times RF_t$$

Where:

VCU_t Number of Verified Carbon Units that can be traded at time *t*; tCO_2e

Note: If VCUt < 0 no credits (VCUs) will be awarded to the proponents of the AUD project activity.

$\Delta REDD_t$ *Ex post* estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year *t*; tCO_2e

VBC_t Number of Buffer Credits deposited in the VCS Buffer at time *t*; tCO_2e

$\Delta CBSLPA_t$ Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e

$\Delta CPSPA_t$ Sum of *ex post* carbon stock changes in the project area at year *t*; $tCO_2e\ ha^{-1}$

RF_t Risk factor used to calculate VCS buffer credits; %

t 1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

The RF_t was estimated using the most recent version of the *VCS-approved AFOLU Non-Permanence Risk Tool* and the resulting value of RF_t for the present REDD project during the current monitoring period was 10%.

The specific summary of GHG reductions and removals in the ABC Norte REDD project during the current monitoring period is included in Table below. The latter table includes estimates of GHG emissions reduction ($REDD_t$), calculations of buffer and leakage, and the resulting calculation of tradable Verified Carbon Units (VCU_t).

Table 86. Ex post estimated net anthropogenic GHG emissions reductions and VCU

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex post project carbon stock changes		Ex post project GHG emissions from biomass burning		Ex post leakage carbon stock changes		Ex post leakage GHG emissions		Ex post net anthropogenic GHG emission reductions		Ex post VCUs tradable		Ex post buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017 (13/09/2017 to 31/12/2017)	86,270	86,270	3,469	3,469	85,828	85,828	1,149	1,149	3	3	0	0	2,759	2,759	2,714	2,714	44	44
2018	287,529	373,798	11,510	14,979	227,980	313,808	3,813	4,962	41	43	0	0	67,205	69,964	61,254	63,968	5,951	5,995
2019	492,928	866,727	19,599	34,578	460,135	773,943	3,445	8,406	68	112	0	0	48,879	118,843	45,606	109,574	3,272	9,267
2020	571,899	1,438,626	22,486	57,064	248,862	1,022,805	1,218	9,624	72	184	0	0	344,233	463,076	311,936	421,510	32,296	41,564

In addition, the net GHG emission reductions and removals in the ABC Norte REDD Project are summarized in the Table below.

Table 87. Net GHG emissions reductions and removals in the ABC Norte REDD Project

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO2e)	Buffer pool allocation	VCUs eligible for issuance
2017	89,738	86,977	3	2,759	44	2,714
2018	299,039	231,793	41	67,205	5,951	61,254
2019	512,528	463,580	68	48,879	3,272	45,606
2020	594,385	250,079	72	344,233	32,296	311,936
Total	1,495,690	1,032,429	184	463,076	41,564	421,510
Total number of monitoring years	3.3	3.3	3.3	3.3	3.3	3.3
Average annual ERs	452,676	312,468	56	140,152	12,579	127,571

APPENDIX I: PROJECT AREA CONTOUR COORDINATES

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1	593249.3	9724502	26	593160.3	9723495	51	592540.7	9723495	76	592720.7	9723105	101	592360.7	9722115
2	593230.7	9724436	27	593110.7	9723495	52	592540.7	9723465	77	592660.7	9723105	102	592360.7	9722055
3	593230.7	9724455	28	593050.7	9723495	53	592600.7	9723465	78	592660.7	9723075	103	592330.7	9722055
4	593200.7	9724455	29	593050.7	9723405	54	592600.7	9723435	79	592630.7	9723075	104	592330.7	9722006
5	593200.7	9724335	30	593050.7	9723375	55	592690.7	9723435	80	592630.7	9723045	105	592322.3	9721995
6	593202.5	9724335	31	593020.7	9723375	56	592690.7	9723405	81	592600.7	9723045	106	592300.7	9721995
7	593195.3	9724309	32	593020.7	9723345	57	592720.7	9723405	82	592600.7	9723015	107	592300.7	9721968
8	593143.7	9724125	33	592990.7	9723345	58	592720.7	9723375	83	592570.7	9723015	108	592298.7	9721965
9	593140.7	9724125	34	592990.7	9723375	59	592840.7	9723375	84	592570.7	9722955	109	592270.7	9721965
10	593140.7	9724115	35	592870.7	9723375	60	592840.7	9723345	85	592540.7	9722955	110	592270.7	9721935
11	593135.3	9724095	36	592870.7	9723405	61	592900.7	9723345	86	592540.7	9722865	111	592240.7	9721935
12	593110.7	9724095	37	592810.7	9723405	62	592900.7	9723315	87	592510.7	9722865	112	592240.7	9721891
13	593110.7	9724035	38	592810.7	9723435	63	592960.7	9723315	88	592510.7	9722805	113	592228.1	9721875
14	593080.7	9724035	39	592750.7	9723435	64	592960.7	9723285	89	592480.7	9722805	114	592210.7	9721875
15	593080.7	9723855	40	592750.7	9723465	65	592930.7	9723285	90	592480.7	9722745	115	592210.7	9721855
16	593110.7	9723855	41	592690.7	9723465	66	592930.7	9723255	91	592450.7	9722745	116	592198.3	9721845
17	593110.7	9723735	42	592690.7	9723495	67	592870.7	9723255	92	592450.7	9722655	117	592180.7	9721845
18	593140.7	9723735	43	592660.7	9723495	68	592870.7	9723225	93	592420.7	9722655	118	592180.7	9721831
19	593140.7	9723705	44	592660.7	9723525	69	592840.7	9723225	94	592420.7	9722475	119	592160	9721815
20	593170.7	9723705	45	592630.7	9723525	70	592840.7	9723195	95	592450.7	9722475	120	592150.7	9721815
21	593170.7	9723675	46	592630.7	9723495	71	592780.7	9723195	96	592450.7	9722325	121	592150.7	9721808
22	593200.7	9723675	47	592600.7	9723495	72	592780.7	9723165	97	592420.7	9722325	122	592121.8	9721785
23	593200.7	9723555	48	592600.7	9723525	73	592750.7	9723165	98	592420.7	9722205	123	592120.7	9721785
24	593170.7	9723555	49	592480.7	9723525	74	592750.7	9723135	99	592390.7	9722205	124	592120.7	9721784
25	593170.7	9723508	50	592480.7	9723495	75	592720.7	9723135	100	592390.7	9722115	125	592007	9721695

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
126	592000.7	9721695	151	591610.7	9720885	176	591100.7	9720585	201	591010.7	9720255	226	591250.7	9719745
127	592000.7	9721690	152	591670.7	9720885	177	591100.7	9720525	202	591010.7	9720195	227	591279.5	9719745
128	591968.7	9721665	153	591670.7	9720826	178	591130.7	9720525	203	590980.7	9720195	228	591280.7	9719740
129	591940.7	9721665	154	591661.1	9720795	179	591130.7	9720465	204	590980.7	9720105	229	591280.7	9719565
130	591940.7	9721643	155	591640.7	9720795	180	591160.7	9720465	205	590950.7	9720105	230	591310.7	9719565
131	591930.5	9721635	156	591640.7	9720765	181	591160.7	9720435	206	590950.7	9720135	231	591310.7	9719535
132	591880.7	9721635	157	591610.7	9720765	182	591190.7	9720435	207	590920.7	9720135	232	591327.7	9719535
133	591880.7	9721575	158	591610.7	9720745	183	591190.7	9720405	208	590920.7	9720105	233	591332.5	9719514
134	591850.7	9721575	159	591591.8	9720735	184	591245.5	9720405	209	590950.7	9720105	234	591340.7	9719513
135	591850.7	9721515	160	591550.7	9720735	185	591250.7	9720398	210	590950.7	9720045	235	591340.7	9719505
136	591820.7	9721515	161	591550.7	9720715	186	591250.7	9720375	211	591010.7	9720045	236	591387.4	9719505
137	591820.7	9721425	162	591531.8	9720705	187	591268.5	9720375	212	591010.7	9720075	237	591430.7	9719498
138	591790.7	9721425	163	591490.7	9720705	188	591280.7	9720359	213	591040.7	9720075	238	591430.7	9719475
139	591790.7	9721275	164	591490.7	9720685	189	591280.7	9720315	214	591040.7	9720015	239	591400.7	9719475
140	591760.7	9721275	165	591472.6	9720676	190	591310.7	9720315	215	591070.7	9720015	240	591400.7	9719445
141	591760.7	9721185	166	591291.8	9720585	191	591310.7	9720285	216	591070.7	9719925	241	591340.7	9719445
142	591730.7	9721185	167	591250.7	9720585	192	591337.3	9720285	217	591100.7	9719925	242	591340.7	9719385
143	591730.7	9721125	168	591250.7	9720615	193	591340.7	9720281	218	591100.7	9719895	243	591310.7	9719385
144	591700.7	9721125	169	591220.7	9720615	194	591340.7	9720260	219	591130.7	9719895	244	591310.7	9719295
145	591700.7	9721035	170	591220.7	9720585	195	591319.2	9720255	220	591130.7	9719865	245	591340.7	9719295
146	591670.7	9721035	171	591160.7	9720585	196	591310.7	9720255	221	591160.7	9719865	246	591340.7	9719290
147	591670.7	9720945	172	591100.7	9720585	197	591310.7	9720253	222	591160.7	9719835	247	591339.8	9719289
148	591640.7	9720945	173	591100.7	9720615	198	591191.3	9720225	223	591220.7	9719835	248	591340.7	9719288
149	591640.7	9720975	174	591070.7	9720615	199	591130.7	9720225	224	591220.7	9719805	249	591340.7	9719265
150	591610.7	9720975	175	591070.7	9720585	200	591130.7	9720255	225	591250.7	9719805	250	591362.9	9719265

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
251	591370.7	9719257	276	591760.7	9718755	301	591700.7	9717285	326	591610.7	9716625	351	591400.7	9716145
252	591370.7	9719235	277	591760.7	9718725	302	591700.7	9717255	327	591610.7	9716685	352	591250.7	9716145
253	591392.4	9719235	278	591811.5	9718725	303	591670.7	9717255	328	591550.7	9716685	353	591250.7	9716175
254	591480.1	9719146	279	591820.7	9718710	304	591670.7	9717225	329	591550.7	9716655	354	591190.7	9716175
255	591520.7	9719105	280	591820.7	9718695	305	591640.7	9717225	330	591520.7	9716655	355	591190.7	9716145
256	591520.7	9719085	281	591829.9	9718695	306	591640.7	9717195	331	591520.7	9716595	356	591160.7	9716145
257	591540.1	9719085	282	591880.7	9718613	307	591610.7	9717195	332	591490.7	9716595	357	591160.7	9716235
258	591550.7	9719074	283	591880.7	9718515	308	591610.7	9717165	333	591490.7	9716565	358	591100.7	9716235
259	591550.7	9719055	284	591850.7	9718515	309	591580.7	9717165	334	591400.7	9716565	359	591100.7	9716205
260	591569.6	9719055	285	591850.7	9717915	310	591580.7	9717105	335	591400.7	9716535	360	591040.7	9716205
261	591580.7	9719044	286	591880.7	9717915	311	591550.7	9717105	336	591310.7	9716535	361	591040.7	9716235
262	591580.7	9719025	287	591880.7	9717859	312	591550.7	9716865	337	591310.7	9716505	362	590980.7	9716235
263	591599.1	9719025	288	591860.4	9717795	313	591520.7	9716865	338	591280.7	9716505	363	590980.7	9716175
264	591610.7	9719013	289	591850.7	9717795	314	591520.7	9716805	339	591280.7	9716475	364	590860.7	9716175
265	591610.7	9718995	290	591850.7	9717765	315	591550.7	9716805	340	591310.7	9716475	365	590860.7	9716115
266	591628.7	9718995	291	591838.4	9717726	316	591550.7	9716745	341	591310.7	9716445	366	591040.7	9716115
267	591640.7	9718983	292	591765.5	9717495	317	591580.7	9716745	342	591340.7	9716445	367	591040.7	9716085
268	591640.7	9718965	293	591760.7	9717495	318	591580.7	9716715	343	591340.7	9716415	368	591010.7	9716085
269	591658.2	9718965	294	591760.7	9717480	319	591626.1	9716715	344	591370.7	9716415	369	591010.7	9716055
270	591670.7	9718952	295	591736.3	9717403	320	591640.7	9716701	345	591370.7	9716355	370	591100.7	9716055
271	591670.7	9718815	296	591736.4	9717402	321	591640.7	9716685	346	591430.7	9716355	371	591100.7	9716085
272	591700.7	9718815	297	591742.6	9717375	322	591657.3	9716685	347	591430.7	9716295	372	591130.7	9716085
273	591700.7	9718785	298	591730.7	9717375	323	591688.6	9716655	348	591370.7	9716295	373	591130.7	9716025
274	591730.7	9718785	299	591730.7	9717292	324	591670.7	9716655	349	591370.7	9716235	374	591070.7	9716025
275	591730.7	9718755	300	591725	9717285	325	591670.7	9716625	350	591400.7	9716235	375	591070.7	9715995

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
376	591010.7	9715995	401	591190.7	9715965	426	591580.7	9715935	451	592000.7	9715785	476	591790.7	9716265
377	591010.7	9715965	402	591160.7	9715965	427	591580.7	9715905	452	591970.7	9715785	477	591790.7	9716295
378	590980.7	9715965	403	591160.7	9715935	428	591640.7	9715905	453	591970.7	9715815	478	591820.7	9716295
379	590980.7	9715935	404	591130.7	9715935	429	591640.7	9715935	454	592000.7	9715815	479	591820.7	9716325
380	590920.7	9715935	405	591130.7	9715995	430	591610.7	9715935	455	592000.7	9715875	480	591790.7	9716325
381	590920.7	9715905	406	591190.7	9715995	431	591610.7	9715965	456	592060.7	9715875	481	591790.7	9716385
382	590890.7	9715905	407	591190.7	9716025	432	591640.7	9715965	457	592060.7	9715905	482	591760.7	9716385
383	590890.7	9715845	408	591220.7	9716025	433	591640.7	9716025	458	592030.7	9715905	483	591760.7	9716415
384	590860.7	9715845	409	591220.7	9716055	434	591670.7	9716025	459	592030.7	9715935	484	591820.7	9716415
385	590860.7	9715815	410	591280.7	9716055	435	591670.7	9715965	460	592000.7	9715935	485	591820.7	9716475
386	590830.7	9715815	411	591280.7	9716025	436	591700.7	9715965	461	592000.7	9715965	486	591850.7	9716475
387	590830.7	9715785	412	591310.7	9716025	437	591700.7	9715905	462	591970.7	9715965	487	591850.7	9716505
388	590860.7	9715785	413	591310.7	9715995	438	591670.7	9715905	463	591970.7	9715995	488	591880.7	9716505
389	590860.7	9715815	414	591340.7	9715995	439	591670.7	9715845	464	591940.7	9715995	489	591880.7	9716541
390	590920.7	9715815	415	591340.7	9716025	440	591610.7	9715845	465	591940.7	9716025	490	591897.7	9716532
391	590920.7	9715875	416	591310.7	9716025	441	591610.7	9715755	466	591910.7	9716025	491	591899	9716531
392	590980.7	9715875	417	591310.7	9716085	442	591700.7	9715755	467	591910.7	9716055	492	592074.9	9716439
393	590980.7	9715905	418	591460.7	9716085	443	591700.7	9715875	468	591880.7	9716055	493	592076.3	9716439
394	591040.7	9715905	419	591460.7	9716055	444	591790.7	9715875	469	591880.7	9716085	494	592252.2	9716347
395	591040.7	9715935	420	591490.7	9716055	445	591790.7	9715815	470	591910.7	9716085	495	592253.5	9716346
396	591130.7	9715935	421	591490.7	9716085	446	591820.7	9715815	471	591910.7	9716145	496	592450.7	9716243
397	591130.7	9715905	422	591520.7	9716085	447	591820.7	9715755	472	591880.7	9716145	497	592450.7	9716235
398	591220.7	9715905	423	591520.7	9716055	448	591880.7	9715755	473	591880.7	9716175	498	592465.4	9716235
399	591220.7	9715935	424	591550.7	9716055	449	591880.7	9715725	474	591850.7	9716175	499	592480.7	9716227
400	591190.7	9715935	425	591550.7	9715935	450	592000.7	9715725	475	591850.7	9716265	500	592480.7	9716205

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
501	592510.7	9716205	526	592660.7	9715785	551	593080.7	9715545	576	593230.7	9715635	601	593711.4	9715875
502	592510.7	9716055	527	592660.7	9715815	552	593080.7	9715515	577	593290.7	9715635	602	593890.7	9715875
503	592480.7	9716055	528	592690.7	9715815	553	593050.7	9715515	578	593290.7	9715665	603	593890.7	9715905
504	592480.7	9715995	529	592690.7	9715845	554	593050.7	9715545	579	593350.7	9715665	604	593950.7	9715905
505	592510.7	9715995	530	592720.7	9715845	555	592990.7	9715545	580	593350.7	9715695	605	593950.7	9715920
506	592510.7	9715935	531	592750.7	9715845	556	592990.7	9715575	581	593380.7	9715695	606	594214.9	9715965
507	592595.8	9715935	532	592750.7	9715815	557	592900.7	9715575	582	593380.7	9715725	607	594220.7	9715965
508	592600.7	9715933	533	592930.7	9715815	558	592900.7	9715515	583	593410.7	9715725	608	594220.7	9715935
509	592600.7	9715905	534	592930.7	9715845	559	592870.7	9715515	584	593410.7	9715755	609	594250.7	9715935
510	592570.7	9715905	535	592960.7	9715845	560	592870.7	9715455	585	593470.7	9715755	610	594250.7	9715965
511	592570.7	9715875	536	592960.7	9715875	561	592900.7	9715455	586	593470.7	9715779	611	594280.7	9715965
512	592540.7	9715875	537	592990.7	9715875	562	592900.7	9715425	587	593485.6	9715785	612	594280.7	9715994
513	592540.7	9715845	538	592990.7	9715882	563	592930.7	9715425	588	593530.7	9715785	613	594283.1	9715995
514	592510.7	9715845	539	593050.7	9715891	564	592930.7	9715395	589	593560.7	9715785	614	594340.7	9715995
515	592510.7	9715875	540	593050.7	9715695	565	593050.7	9715395	590	593560.7	9715725	615	594340.7	9716025
516	592450.7	9715875	541	593080.7	9715695	566	593050.7	9715455	591	593590.7	9715725	616	594370.7	9716025
517	592450.7	9715755	542	593080.7	9715665	567	593080.7	9715455	592	593590.7	9715755	617	594370.7	9716053
518	592480.7	9715755	543	593110.7	9715665	568	593080.7	9715485	593	593620.7	9715755	618	594374	9716055
519	592480.7	9715725	544	593110.7	9715635	569	593140.7	9715485	594	593620.7	9715785	619	594430.7	9716055
520	592510.7	9715725	545	593050.7	9715635	570	593140.7	9715515	595	593590.7	9715785	620	594430.7	9716085
521	592510.7	9715695	546	593050.7	9715605	571	593110.7	9715515	596	593590.7	9715815	621	594460.7	9716085
522	592570.7	9715695	547	593080.7	9715605	572	593110.7	9715545	597	593560.9	9715815	622	594460.7	9716112
523	592570.7	9715725	548	593080.7	9715575	573	593170.7	9715545	598	593636.1	9715845	623	594465	9716115
524	592600.7	9715725	549	593110.7	9715575	574	593170.7	9715605	599	593650.7	9715845	624	594490.7	9716115
525	592600.7	9715785	550	593110.7	9715545	575	593230.7	9715605	600	593650.7	9715851	625	594490.7	9716132

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
626	594510.4	9716145	651	596050.7	9716595	676	596800.7	9716663	701	597179.4	9712842	726	597177.5	9709756
627	594520.7	9716145	652	596050.7	9716625	677	596849.4	9716685	702	597117.8	9712728	727	597280.5	9709555
628	594520.7	9716152	653	596110.7	9716625	678	596874.2	9716685	703	596920	9712698	728	597364.8	9709374
629	594601.4	9716205	654	596110.7	9716653	679	596890.7	9716612	704	596624.4	9712653	729	597449.3	9709192
630	594610.7	9716205	655	596118	9716655	680	596890.7	9716475	705	596432.6	9712532	730	597457.7	9708992
631	594610.7	9716211	656	596170.7	9716655	681	596890.7	9716445	706	596532.9	9712359	731	597466.2	9708792
632	594647.4	9716236	657	596170.7	9716673	682	596897.4	9716445	707	596638.2	9712177	732	597475.1	9708582
633	594829.2	9716319	658	596207.8	9716685	683	596876.2	9716344	708	596751.3	9712068	733	597371.5	9708411
634	595011	9716402	659	596260.7	9716685	684	597239.3	9716216	709	597121.8	9712045	734	597201.9	9708131
635	595170.4	9716475	660	596260.7	9716703	685	597019.6	9716049	710	597250.7	9711810	735	597151.5	9707937
636	595180.7	9716475	661	596277.5	9716709	686	597107.5	9715939	711	597250.7	9711765	736	597069.3	9707622
637	595180.7	9716480	662	596501.4	9716715	687	596962.2	9715912	712	597259.8	9711765	737	597158.1	9707399
638	595218.6	9716497	663	596560.7	9716715	688	596994.1	9715751	713	597245.7	9711623	738	597207.7	9707205
639	595390.7	9716503	664	596560.7	9716685	689	596905.7	9715572	714	597150.9	9711253	739	597269.3	9706965
640	595390.7	9716475	665	596590.7	9716685	690	596803	9715364	715	597180.1	9711049	740	597460.7	9706782
641	595420.7	9716475	666	596590.7	9716655	691	596812	9715072	716	597375.6	9711007	741	597460.7	9706755
642	595420.7	9716504	667	596620.7	9716655	692	596934.5	9714817	717	597640.7	9710950	742	597475.3	9706755
643	595446.8	9716505	668	596620.7	9716625	693	597061.1	9714619	718	597640.7	9710925	743	597490.7	9706710
644	595750.7	9716505	669	596690.2	9716625	694	597052.8	9714419	719	597654.7	9710925	744	597490.7	9706695
645	595750.7	9716532	670	596700.8	9716617	695	597042.2	9714162	720	597714	9710634	745	597495.6	9706695
646	595759.1	9716535	671	596718.9	9716625	696	597018.1	9713997	721	597616.3	9710390	746	597533	9706585
647	595870.7	9716535	672	596770.7	9716625	697	597073.9	9713805	722	597501.8	9710255	747	597602.2	9706381
648	595870.7	9716565	673	596770.7	9716649	698	597132.2	9713605	723	597448.2	9709953	748	597780.5	9706290
649	595990.7	9716565	674	596784.2	9716655	699	597153.6	9713454	724	597412.6	9709932	749	598047.9	9706155
650	595990.7	9716595	675	596800.7	9716655	700	597229.2	9713229	725	597086.3	9709934	750	598247.4	9706169

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
751	598469.7	9706185	776	598936.1	9703479	801	596990.3	9701406	826	597820.7	9699915	851	598098.6	9699615
752	598648	9705969	777	599243.3	9703277	802	596910.7	9701048	827	597840.8	9699915	852	598120.7	9699596
753	598743.5	9705866	778	599343.6	9703153	803	597036.8	9700717	828	597850.7	9699900	853	598120.7	9699585
754	598643.4	9705814	779	599440	9703102	804	597100.7	9700485	829	597850.7	9699885	854	598133.9	9699585
755	598450.7	9705846	780	599564.1	9703089	805	597100.7	9700455	830	597860.8	9699885	855	598144.7	9699576
756	598450.7	9705855	781	599549.8	9702893	806	597070.7	9700455	831	597880.7	9699855	856	598240.7	9699607
757	598420.7	9705855	782	599412	9702722	807	597070.7	9700365	832	597880.7	9699855	857	598240.7	9699585
758	598420.7	9705851	783	599155.9	9702662	808	597040.7	9700365	833	597880.9	9699855	858	598270.7	9699585
759	598301.6	9705871	784	599075.5	9702558	809	597040.7	9700275	834	597965.5	9699728	859	598270.7	9699555
760	598364.2	9705658	785	598906.7	9702563	810	597070.7	9700275	835	598030.7	9699673	860	598210.7	9699555
761	598623	9705518	786	598696.7	9702453	811	597070.7	9700245	836	598030.7	9699645	861	598210.7	9699525
762	598530.2	9705341	787	598469.8	9702504	812	597100.7	9700245	837	598000.7	9699645	862	598240.7	9699525
763	598416.1	9705123	788	598307.5	9702161	813	597100.7	9700275	838	598000.7	9699585	863	598240.7	9699495
764	598231.8	9705045	789	598159.3	9702235	814	597144	9700275	839	597970.7	9699585	864	598300.7	9699495
765	598047.6	9704967	790	598066.4	9702191	815	597169.4	9700119	840	597970.7	9699555	865	598300.7	9699525
766	597863.4	9704889	791	597955.5	9702319	816	597414.9	9700139	841	597940.7	9699555	866	598360.7	9699525
767	597642.9	9704796	792	597915.8	9702326	817	597700.7	9700048	842	597940.7	9699525	867	598360.7	9699555
768	597815.4	9704694	793	597668.3	9702247	818	597700.7	9700035	843	598030.7	9699525	868	598450.7	9699555
769	597987.9	9704593	794	597561.1	9702166	819	597730.7	9700035	844	598030.7	9699555	869	598450.7	9699615
770	598306	9704407	795	597448.4	9702052	820	597730.7	9700005	845	598090.7	9699555	870	598420.7	9699615
771	598266.6	9704285	796	597287.6	9701926	821	597760.7	9700005	846	598090.7	9699585	871	598420.7	9699645
772	598444.1	9704193	797	597087.9	9701916	822	597760.7	9699975	847	598060.7	9699585	872	598390.7	9699645
773	598694.5	9704063	798	596707.9	9701896	823	597790.7	9699975	848	598060.7	9699647	873	598390.7	9699656
774	598563.6	9703687	799	596770.9	9701668	824	597790.7	9699945	849	598090.7	9699622	874	598543	9699784
775	598738.3	9703589	800	596784.7	9701618	825	597820.7	9699945	850	598090.7	9699615	875	598630.7	9699858

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
876	598630.7	9699855	901	600552.8	9698583	926	601240.1	9695677	951	600669.5	9694422	976	597636.2	9693823
877	598660.7	9699855	902	600414.9	9698405	927	601294.4	9695638	952	600469.5	9694422	977	597565.3	9693785
878	598660.7	9699884	903	600258.6	9698325	928	601327.3	9695614	953	600269.5	9694422	978	597505.1	9693773
879	598662.4	9699885	904	600226.1	9698308	929	601397	9695551	954	600069.5	9694422	979	597414.3	9693684
880	598690.7	9699885	905	600022.9	9698065	930	601456.3	9695437	955	599869.5	9694422	980	597360.2	9693673
881	598690.7	9699909	906	599865.7	9697978	931	601456.3	9695339	956	599669.5	9694421	981	597322.5	9693624
882	598698	9699915	907	599968.3	9697699	932	601428.4	9695242	957	599363	9694421	982	597298.1	9693533
883	598780.7	9699915	908	599904.3	9697592	933	601424.9	9695148	958	599163	9694421	983	597248.8	9693454
884	598780.7	9699945	909	599834.7	9697517	934	601480.7	9695075	959	598963	9694421	984	597192.2	9693451
885	598810.7	9699945	910	599884.2	9697317	935	601550.4	9695051	960	598763	9694421	985	597120	9693325
886	598810.7	9699991	911	599961.8	9697043	936	601592.2	9694992	961	598563	9694420	986	597113.6	9693317
887	598965.7	9700040	912	600080.4	9696882	937	601609.6	9694932	962	598363	9694420	987	597030.5	9693221
888	599156.5	9700100	913	600246	9696657	938	601679.3	9694846	963	598163	9694420	988	597037.5	9693143
889	599365.4	9700166	914	600401.5	9696482	939	601724.6	9694790	964	597935.8	9694420	989	597017	9693088
890	599564.1	9700143	915	600486.1	9696387	940	601766.5	9694755	965	597928.5	9694389	990	596970	9693079
891	599797.7	9700117	916	600530.2	9696236	941	601801.3	9694703	966	597966.7	9694363	991	596941.2	9693043
892	599957.1	9699996	917	600708.8	9696149	942	601850.1	9694637	967	597977.2	9694334	992	596933.3	9693033
893	600182.5	9699825	918	600872.3	9696078	943	601871	9694574	968	597908.4	9694223	993	596960.8	9692988
894	600339	9699705	919	600880.9	9695966	944	601874.5	9694484	969	597914.8	9694089	994	596947.3	9692973
895	600441.2	9699626	920	600940.2	9695955	945	601869.5	9694424	970	597918.4	9694053	995	596914	9692920
896	600524.3	9699445	921	600967.9	9695921	946	601669.5	9694423	971	597867.9	9694001	996	596908.3	9692899
897	600646.9	9699176	922	600985.6	9695899	947	601469.5	9694423	972	597806.1	9693941	997	596944.2	9692879
898	600573.1	9698946	923	601062.3	9695847	948	601269.5	9694423	973	597807.5	9693879	998	596940.7	9692869
899	600584.2	9698907	924	601107.6	9695788	949	601069.5	9694423	974	597740.2	9693848	999	596919.1	9692841
900	600622	9698778	925	601166.9	9695725	950	600869.5	9694423	975	597668.2	9693850	1000	596896.2	9692801

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1001	596892.1	9692787	1026	597003.3	9691860	1051	596406.5	9690439	1076	596872.1	9689394	1101	596783.7	9688439
1002	596888.3	9692774	1027	597020.8	9691773	1052	596403.5	9690364	1077	596878	9689385	1102	596653.7	9688312
1003	596903.1	9692763	1028	597037	9691724	1053	596407	9690339	1078	596941.6	9689354	1103	596635.9	9688300
1004	596910.4	9692753	1029	597045.4	9691665	1054	596480.8	9690272	1079	596950.5	9689339	1104	596595	9688250
1005	596897.1	9692735	1030	597041.1	9691638	1055	596490.7	9690267	1080	596974.4	9689259	1105	596581	9688225
1006	596905.7	9692725	1031	596996.8	9691496	1056	596521.1	9690187	1081	596960.8	9689236	1106	596536.6	9688076
1007	596904.7	9692684	1032	597024.4	9691386	1057	596539.6	9690155	1082	596923.6	9689177	1107	596530.8	9688061
1008	596901.4	9692665	1033	597041.3	9691359	1058	596568.6	9690125	1083	596916.4	9689167	1108	596517.5	9687999
1009	596907.5	9692640	1034	597068.1	9691228	1059	596566.9	9690086	1084	596902.9	9689086	1109	596517.9	9687988
1010	596904.9	9692610	1035	597074.7	9691210	1060	596582.3	9690030	1085	596909.8	9689050	1110	596456.7	9687913
1011	596921.9	9692571	1036	597063.1	9691152	1061	596581.6	9689983	1086	596920	9689034	1111	596446.9	9687894
1012	596938	9692543	1037	597063.5	9691140	1062	596604.2	9689875	1087	596921.9	9689003	1112	596441.1	9687857
1013	597031.4	9692479	1038	597038.7	9690934	1063	596615	9689860	1088	596912.9	9688909	1113	596439.3	9687847
1014	597055.9	9692470	1039	597033.3	9690929	1064	596609.4	9689730	1089	596907.7	9688893	1114	596428.6	9687811
1015	597064	9692420	1040	596934.5	9690764	1065	596605	9689695	1090	596932.1	9688819	1115	596421.8	9687784
1016	597074.4	9692400	1041	596931.2	9690758	1066	596617.7	9689670	1091	596937.4	9688793	1116	596403.7	9687736
1017	597100.4	9692349	1042	596838.8	9690738	1067	596614.3	9689647	1092	596934.5	9688761	1117	596386.8	9687721
1018	597108.6	9692311	1043	596824.5	9690741	1068	596593.1	9689612	1093	596937.3	9688733	1118	596369.4	9687718
1019	597129.6	9692241	1044	596788.4	9690718	1069	596596.8	9689604	1094	596904.1	9688619	1119	596338.6	9687719
1020	597120.4	9692207	1045	596775.4	9690715	1070	596662	9689601	1095	596900.1	9688602	1120	596267.4	9687714
1021	597107.4	9692159	1046	596737.1	9690718	1071	596674.1	9689600	1096	596902.3	9688594	1121	596254.5	9687709
1022	597096.4	9692142	1047	596724.7	9690716	1072	596694.7	9689540	1097	596895.1	9688581	1122	596189.9	9687679
1023	597013.5	9691978	1048	596531.8	9690608	1073	596696.2	9689532	1098	596865.8	9688540	1123	596178.5	9687668
1024	597003.1	9691954	1049	596519.6	9690600	1074	596789.4	9689438	1099	596837.3	9688513	1124	596117.1	9687594
1025	596999	9691897	1050	596410.7	9690472	1075	596799.4	9689434	1100	596800.8	9688465	1125	596032.3	9687413

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1126	595947.6	9687232	1151	594436.1	9686689	1176	591835	9688637	1201	588283.5	9688506	1226	586134.1	9692114
1127	595870.7	9687068	1152	594290.8	9686827	1177	591796.5	9688619	1202	588181.2	9688678	1227	586031.7	9692286
1128	595870.7	9687105	1153	594145.5	9686964	1178	591654	9688552	1203	588078.8	9688850	1228	585929.3	9692458
1129	595840.7	9687105	1154	594000.2	9687102	1179	591615.5	9688534	1204	587976.5	9689022	1229	585827	9692630
1130	595840.7	9687135	1155	593854.9	9687239	1180	591579.3	9688517	1205	587874.1	9689193	1230	585724.6	9692802
1131	595810.7	9687135	1156	593709.6	9687377	1181	591473.1	9688467	1206	587771.7	9689365	1231	585524.5	9693138
1132	595810.7	9687105	1157	593647.8	9687435	1182	591292.1	9688382	1207	587669.4	9689537	1232	585472.5	9693138
1133	595750.7	9687105	1158	593564.3	9687514	1183	591111.1	9688296	1208	587567	9689709	1233	585472.5	9693138
1134	595750.7	9687015	1159	593419	9687651	1184	590930.1	9688211	1209	587491.8	9689835	1234	585470.2	9693138
1135	595810.7	9687015	1160	593273.7	9687789	1185	590749.1	9688126	1210	587500.7	9689835	1235	585324.5	9693138
1136	595810.7	9687075	1161	593128.4	9687926	1186	590568.2	9688041	1211	587500.7	9689895	1236	585270.2	9693138
1137	595840.7	9687075	1162	592983.1	9688064	1187	590387.2	9687956	1212	587456	9689895	1237	585124.5	9693138
1138	595840.7	9687045	1163	592837.8	9688201	1188	590206.2	9687871	1213	587362.3	9690052	1238	585070.2	9693138
1139	595860.2	9687045	1164	592692.5	9688339	1189	590025.2	9687786	1214	587260	9690224	1239	584924.5	9693138
1140	595778	9686870	1165	592690.7	9688340	1190	589844.3	9687700	1215	587157.6	9690396	1240	584870.2	9693138
1141	595693.3	9686688	1166	592690.7	9688365	1191	589663.3	9687615	1216	587055.3	9690568	1241	584724.5	9693138
1142	595608.5	9686507	1167	592720.7	9688365	1192	589482.3	9687530	1217	586952.9	9690740	1242	584670.2	9693138
1143	595523.8	9686326	1168	592720.7	9688395	1193	589301.3	9687445	1218	586850.5	9690912	1243	584524.5	9693138
1144	595439	9686145	1169	592632.6	9688395	1194	589000	9687303	1219	586748.2	9691083	1244	584470.2	9693138
1145	595308	9685865	1170	592547.2	9688476	1195	588897.7	9687475	1220	586645.8	9691255	1245	584324.5	9693139
1146	595162.7	9686002	1171	592401.9	9688613	1196	588795.3	9687647	1221	586607.3	9691320	1246	584270.2	9693139
1147	595017.4	9686140	1172	592197	9688807	1197	588692.9	9687819	1222	586543.5	9691427	1247	584124.5	9693139
1148	594872.1	9686277	1173	592158.4	9688789	1198	588590.6	9687991	1223	586441.1	9691599	1248	584070.2	9693139
1149	594726.8	9686415	1174	592016	9688722	1199	588488.2	9688162	1224	586338.8	9691771	1249	583924.5	9693139
1150	594581.4	9686552	1175	591977.5	9688704	1200	588385.9	9688334	1225	586236.4	9691943	1250	583705.6	9693139

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1251	583706	9693088	1276	583067.5	9690573	1301	583499.8	9688438	1326	582679.2	9686304	1351	582269.6	9684746
1252	583707.2	9692939	1277	583023.1	9690484	1302	583510.9	9688306	1327	582745.8	9686270	1352	582211.8	9684749
1253	583707.7	9692888	1278	582956.5	9690363	1303	583510.9	9688184	1328	582790.1	9686193	1353	582151.1	9684761
1254	583708.9	9692739	1279	582889.9	9690274	1304	583533.1	9688029	1329	582801.2	9686093	1354	582104.9	9684772
1255	583709.3	9692688	1280	582878.8	9690186	1305	583533.1	9687896	1330	582856.7	9686005	1355	582041.3	9684789
1256	583710.5	9692539	1281	582956.5	9690119	1306	583488.7	9687830	1331	582867.8	9685917	1356	581974.8	9684804
1257	583710.9	9692488	1282	582967.5	9690031	1307	583444.3	9687719	1332	582867.8	9685760	1357	581919.9	9684827
1258	583712.2	9692339	1283	582967.5	9689909	1308	583444.3	9687620	1333	582878.9	9685693	1358	581859.2	9684841
1259	583712.6	9692288	1284	582956.4	9689821	1309	583388.9	9687553	1334	582912.2	9685538	1359	581778.3	9684876
1260	583713.3	9692193	1285	582923.1	9689710	1310	583344.5	9687487	1335	582914.2	9685458	1360	581691.6	9684922
1261	583713.8	9692139	1286	582931.8	9689603	1311	583244.7	9687443	1336	582917.2	9685372	1361	581610.6	9684934
1262	583715.4	9691939	1287	582923	9689478	1312	583200.4	9687388	1337	582930.3	9685274	1362	581590.7	9684938
1263	583717.1	9691739	1288	583000.7	9689401	1313	583133.8	9687343	1338	582896.7	9685242	1363	581590.7	9684945
1264	583718.7	9691539	1289	583067.2	9689345	1314	583022.9	9687288	1339	582830.3	9685213	1364	581560.7	9684945
1265	583720.5	9691314	1290	583112.7	9689271	1315	582945.3	9687266	1340	582789.8	9685176	1365	581560.7	9684944
1266	583688.7	9691247	1291	583167	9689246	1316	582878.8	9687233	1341	582755.1	9685112	1366	581538.4	9684948
1267	583633.2	9691203	1292	583233.6	9689179	1317	582812.3	9687166	1342	582729.1	9685063	1367	581470.7	9684948
1268	583577.7	9691148	1293	583300.1	9689091	1318	582774	9687083	1343	582708.9	9685032	1368	581470.7	9685065
1269	583533.4	9691059	1294	583355.6	9689013	1319	582712.5	9687023	1344	582677.1	9684991	1369	581440.7	9685065
1270	583477.9	9690982	1295	583433.2	9688936	1320	582657	9686934	1345	582558.6	9684887	1370	581440.7	9685035
1271	583422.4	9690916	1296	583477.6	9688836	1321	582612.7	9686812	1346	582500.8	9684885	1371	581410.7	9685035
1272	583333.7	9690849	1297	583533.1	9688737	1322	582612.7	9686702	1347	582451.7	9684861	1372	581410.7	9685065
1273	583222.8	9690783	1298	583588.5	9688682	1323	582618.7	9686606	1348	582422.8	9684821	1373	581350.7	9685065
1274	583123	9690717	1299	583566.3	9688604	1324	582623.8	9686492	1349	582379.5	9684784	1374	581350.7	9685035
1275	583100.8	9690650	1300	583544.2	9688538	1325	582634.8	9686403	1350	582315.9	9684752	1375	581320.7	9685035

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1376	581320.7	9685005	1401	581225.9	9685745	1426	581225.1	9690745	1451	578824.9	9693171	1476	575380.7	9693255
1377	581350.7	9685005	1402	581225.9	9685945	1427	581225.1	9690945	1452	578624.9	9693174	1477	575380.7	9693225
1378	581350.7	9684975	1403	581225.8	9686145	1428	581225	9691145	1453	578424.9	9693176	1478	575440.7	9693225
1379	581380.7	9684975	1404	581225.8	9686345	1429	581225	9691345	1454	578225	9693179	1479	575440.7	9693214
1380	581380.7	9685005	1405	581225.8	9686545	1430	581225	9691545	1455	578025	9693182	1480	575425.2	9693215
1381	581410.7	9685005	1406	581225.7	9686745	1431	581224.9	9691745	1456	577825	9693184	1481	575225.2	9693217
1382	581410.7	9684947	1407	581225.7	9686945	1432	581224.9	9691900	1457	577625	9693187	1482	575025.2	9693220
1383	581356.3	9684942	1408	581225.7	9687145	1433	581224.9	9691945	1458	577425	9693189	1483	574825.2	9693222
1384	581298.5	9684942	1409	581225.6	9687345	1434	581224.9	9692145	1459	577225	9693192	1484	574625.2	9693225
1385	581226	9684945	1410	581225.6	9687545	1435	581224.8	9692345	1460	577025	9693194	1485	574425.3	9693227
1386	581226	9685005	1411	581225.6	9687745	1436	581224.8	9692545	1461	576825.1	9693197	1486	574225.3	9693230
1387	581230.7	9685005	1412	581225.5	9687945	1437	581224.8	9692745	1462	576820.7	9693197	1487	574025.3	9693232
1388	581230.7	9685035	1413	581225.5	9688145	1438	581224.7	9693140	1463	576820.7	9693225	1488	573825.3	9693235
1389	581226	9685035	1414	581225.5	9688345	1439	581224.7	9693141	1464	576790.7	9693225	1489	573625.3	9693238
1390	581226	9685065	1415	581225.4	9688545	1440	581024.7	9693143	1465	576790.7	9693197	1490	573425.3	9693240
1391	581230.7	9685065	1416	581225.4	9688745	1441	580824.7	9693146	1466	576625.1	9693199	1491	573225.4	9693243
1392	581230.7	9685095	1417	581225.4	9688945	1442	580624.8	9693148	1467	576425.1	9693202	1492	573025.4	9693245
1393	581290.7	9685095	1418	581225.4	9689145	1443	580424.8	9693151	1468	576225.1	9693204	1493	572825.4	9693248
1394	581290.7	9685125	1419	581225.3	9689345	1444	580224.8	9693153	1469	576025.1	9693207	1494	572625.4	9693250
1395	581230.7	9685125	1420	581225.3	9689545	1445	580024.8	9693156	1470	575825.1	9693210	1495	572425.4	9693253
1396	581230.7	9685095	1421	581225.3	9689745	1446	579824.8	9693159	1471	575625.2	9693212	1496	572148	9693256
1397	581226	9685095	1422	581225.2	9689945	1447	579624.8	9693161	1472	575470.7	9693214	1497	571956.4	9693199
1398	581226	9685145	1423	581225.2	9690145	1448	579424.9	9693164	1473	575470.7	9693225	1498	571764.9	9693141
1399	581226	9685345	1424	581225.2	9690345	1449	579224.9	9693166	1474	575560.7	9693225	1499	571573.3	9693084
1400	581225.9	9685545	1425	581225.1	9690545	1450	579024.9	9693169	1475	575560.7	9693255	1500	571381.8	9693026

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1501	571190.2	9692969	1526	566944.3	9692742	1551	567681	9695083	1576	567082.2	9696985	1601	564160.7	9699285
1502	570998.6	9692911	1527	566921	9693036	1552	567720.1	9694916	1577	566922.4	9697106	1602	564280.7	9699285
1503	570807.1	9692854	1528	566755.6	9693302	1553	567745.8	9694806	1578	566762.6	9697226	1603	564280.7	9699255
1504	570615.5	9692796	1529	566568.5	9693373	1554	567770.6	9694700	1579	566602.8	9697346	1604	564370.7	9699255
1505	570424	9692739	1530	566321.1	9693466	1555	567767.5	9694806	1580	566442.9	9697466	1605	564370.7	9699285
1506	570232.4	9692682	1531	566121.4	9693477	1556	567734.6	9694919	1581	566283.1	9697586	1606	564460.7	9699285
1507	570040.9	9692624	1532	565882.6	9693490	1557	567695.1	9695087	1582	566123.3	9697707	1607	564460.7	9699255
1508	569849.3	9692567	1533	565769.1	9693536	1558	567592.1	9695269	1583	565963.5	9697827	1608	564610.7	9699255
1509	569657.7	9692509	1534	565761.6	9693759	1559	567465	9695414	1584	565803.7	9697947	1609	564610.7	9699285
1510	569466.2	9692452	1535	565743.9	9694028	1560	567479.8	9695485	1585	565643.8	9698067	1610	564640.7	9699285
1511	569274.6	9692394	1536	565498.7	9694238	1561	567772.4	9695609	1586	565484	9698188	1611	564640.7	9699315
1512	569083.1	9692337	1537	565583.4	9694447	1562	567872	9695638	1587	565324.2	9698308	1612	564760.7	9699315
1513	568891.5	9692279	1538	565485.6	9694792	1563	568095.9	9695706	1588	565164.4	9698428	1613	564760.7	9699345
1514	568699.9	9692222	1539	565579.2	9694916	1564	568221.4	9695815	1589	565004.6	9698548	1614	565600.7	9699345
1515	568508.4	9692164	1540	565641.6	9695210	1565	568352.1	9695815	1590	564844.7	9698669	1615	565600.7	9699315
1516	568413.5	9692136	1541	565840.6	9695230	1566	568520.6	9695903	1591	564684.9	9698789	1616	565630.7	9699315
1517	568316.8	9692107	1542	566123.2	9695259	1567	568360.8	9696023	1592	564525.1	9698909	1617	565630.7	9699285
1518	568125.3	9692049	1543	566318.3	9695303	1568	568201	9696144	1593	564365.3	9699029	1618	565660.7	9699285
1519	567933.7	9691992	1544	566654.9	9695379	1569	568041.2	9696264	1594	564205.5	9699150	1619	565660.7	9699255
1520	567742.1	9691934	1545	566806.5	9695535	1570	567881.3	9696384	1595	564065.1	9699255	1620	565720.7	9699255
1521	567550.6	9691877	1546	567006.1	9695522	1571	567721.5	9696504	1596	564070.7	9699255	1621	565720.7	9699225
1522	567216	9691776	1547	567239.3	9695507	1572	567561.7	9696625	1597	564070.7	9699285	1622	565900.7	9699225
1523	567134.3	9692140	1548	567279.2	9695504	1573	567466.2	9696696	1598	564100.7	9699285	1623	565900.7	9699255
1524	567054.8	9692324	1549	567455.9	9695407	1574	567401.9	9696745	1599	564100.7	9699255	1624	565930.7	9699255
1525	566960	9692542	1550	567576.3	9695271	1575	567242	9696865	1600	564160.7	9699255	1625	565930.7	9699285

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1626	565990.7	9699285	1651	567220.7	9699375	1676	566410.7	9699435	1701	565540.7	9699615	1726	565420.7	9699495
1627	565990.7	9699315	1652	567250.7	9699375	1677	566410.7	9699465	1702	565480.7	9699615	1727	565420.7	9699465
1628	566020.7	9699315	1653	567250.7	9699405	1678	566380.7	9699465	1703	565480.7	9699585	1728	565540.7	9699465
1629	566020.7	9699345	1654	567220.7	9699405	1679	566380.7	9699525	1704	565450.7	9699585	1729	565540.7	9699435
1630	566260.7	9699345	1655	567220.7	9699465	1680	566260.7	9699525	1705	565450.7	9699555	1730	565510.7	9699435
1631	566260.7	9699315	1656	567190.7	9699465	1681	566260.7	9699555	1706	565390.7	9699555	1731	565510.7	9699405
1632	566290.7	9699315	1657	567190.7	9699435	1682	566200.7	9699555	1707	565390.7	9699525	1732	565360.7	9699405
1633	566290.7	9699285	1658	567100.7	9699435	1683	566200.7	9699585	1708	565330.7	9699525	1733	565360.7	9699435
1634	566320.7	9699285	1659	567100.7	9699405	1684	566110.7	9699585	1709	565330.7	9699555	1734	565270.7	9699435
1635	566320.7	9699255	1660	566950.7	9699405	1685	566110.7	9699555	1710	565300.7	9699555	1735	565270.7	9699405
1636	566380.7	9699255	1661	566950.7	9699435	1686	565960.7	9699555	1711	565300.7	9699615	1736	565150.7	9699405
1637	566380.7	9699285	1662	566740.7	9699435	1687	565960.7	9699675	1712	565270.7	9699615	1737	565150.7	9699435
1638	566410.7	9699285	1663	566740.7	9699465	1688	565930.7	9699675	1713	565270.7	9699645	1738	565060.7	9699435
1639	566410.7	9699315	1664	566680.7	9699465	1689	565930.7	9699705	1714	565240.7	9699645	1739	565060.7	9699405
1640	566440.7	9699315	1665	566680.7	9699495	1690	565840.7	9699705	1715	565240.7	9699675	1740	564820.7	9699405
1641	566440.7	9699345	1666	566650.7	9699495	1691	565840.7	9699735	1716	565090.7	9699675	1741	564820.7	9699435
1642	566500.7	9699345	1667	566650.7	9699525	1692	565720.7	9699735	1717	565090.7	9699615	1742	564760.7	9699435
1643	566500.7	9699315	1668	566620.7	9699525	1693	565720.7	9699765	1718	565060.7	9699615	1743	564760.7	9699465
1644	566680.7	9699315	1669	566620.7	9699555	1694	565690.7	9699765	1719	565060.7	9699525	1744	564730.7	9699465
1645	566680.7	9699345	1670	566590.7	9699555	1695	565690.7	9699705	1720	565150.7	9699525	1745	564730.7	9699495
1646	566950.7	9699345	1671	566590.7	9699525	1696	565660.7	9699705	1721	565150.7	9699495	1746	564700.7	9699495
1647	566950.7	9699375	1672	566560.7	9699525	1697	565660.7	9699675	1722	565330.7	9699495	1747	564700.7	9700455
1648	566980.7	9699375	1673	566560.7	9699465	1698	565600.7	9699675	1723	565330.7	9699465	1748	564670.7	9700455
1649	566980.7	9699345	1674	566500.7	9699465	1699	565600.7	9699645	1724	565360.7	9699465	1749	564670.7	9700485
1650	567220.7	9699345	1675	566500.7	9699435	1700	565540.7	9699645	1725	565360.7	9699495	1750	564700.7	9700485

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1751	564700.7	9700575	1776	563860.7	9701445	1801	563200.7	9702015	1826	562630.7	9702465	1851	561179.9	9700421
1752	564670.7	9700575	1777	563860.7	9701475	1802	563170.7	9702015	1827	562630.7	9702495	1852	561106.6	9700234
1753	564670.7	9700635	1778	563830.7	9701475	1803	563170.7	9702045	1828	562600.7	9702495	1853	561033.2	9700048
1754	564700.7	9700635	1779	563830.7	9701505	1804	563140.7	9702045	1829	562600.7	9702525	1854	560959.9	9699862
1755	564700.7	9700695	1780	563800.7	9701505	1805	563140.7	9702075	1830	562570.7	9702525	1855	560886.6	9699676
1756	564670.7	9700695	1781	563800.7	9701535	1806	563080.7	9702075	1831	562570.7	9702585	1856	560815.2	9699495
1757	564670.7	9701025	1782	563710.7	9701535	1807	563080.7	9702105	1832	562510.7	9702585	1857	560740.7	9699495
1758	564640.7	9701025	1783	563710.7	9701565	1808	563050.7	9702105	1833	562510.7	9702225	1858	560740.7	9699465
1759	564640.7	9701205	1784	563680.7	9701565	1809	563050.7	9702135	1834	562480.7	9702225	1859	560560.7	9699465
1760	564610.7	9701205	1785	563680.7	9701685	1810	563020.7	9702135	1835	562480.7	9702075	1860	560560.7	9699435
1761	564610.7	9701235	1786	563650.7	9701685	1811	563020.7	9702225	1836	562510.7	9702075	1861	560500.7	9699435
1762	564280.7	9701235	1787	563650.7	9701715	1812	562990.7	9702225	1837	562510.7	9702074	1862	560500.7	9699465
1763	564280.7	9701265	1788	563590.7	9701715	1813	562990.7	9702285	1838	562422.6	9702077	1863	560440.7	9699465
1764	564250.7	9701265	1789	563590.7	9701745	1814	562960.7	9702285	1839	562420.7	9702077	1864	560440.7	9699435
1765	564250.7	9701295	1790	563440.7	9701745	1815	562960.7	9702315	1840	562222.7	9702083	1865	560380.7	9699435
1766	563980.7	9701295	1791	563440.7	9701835	1816	562900.7	9702315	1841	562220.8	9702083	1866	560380.7	9699405
1767	563980.7	9701325	1792	563410.7	9701835	1817	562900.7	9702345	1842	561839.9	9702095	1867	560350.7	9699405
1768	564010.7	9701325	1793	563410.7	9701865	1818	562840.7	9702345	1843	561766.5	9701909	1868	560350.7	9699375
1769	564010.7	9701355	1794	563350.7	9701865	1819	562840.7	9702375	1844	561693.2	9701723	1869	560140.7	9699375
1770	563980.7	9701355	1795	563350.7	9701895	1820	562750.7	9702375	1845	561619.9	9701537	1870	560140.7	9699345
1771	563980.7	9701385	1796	563260.7	9701895	1821	562750.7	9702405	1846	561546.6	9701351	1871	559990.7	9699345
1772	563950.7	9701385	1797	563260.7	9701925	1822	562690.7	9702405	1847	561473.2	9701165	1872	559990.7	9699375
1773	563950.7	9701415	1798	563230.7	9701925	1823	562690.7	9702435	1848	561399.9	9700979	1873	559720.7	9699375
1774	563920.7	9701415	1799	563230.7	9701955	1824	562660.7	9702435	1849	561326.6	9700793	1874	559720.7	9699345
1775	563920.7	9701445	1800	563200.7	9701955	1825	562660.7	9702465	1850	561253.2	9700607	1875	559630.7	9699345

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1876	559630.7	9699375	1901	556600.7	9699315	1926	556540.7	9699225	1951	559420.7	9699255	1976	560680.7	9699225
1877	559360.7	9699375	1902	556600.7	9699345	1927	556570.7	9699225	1952	559420.7	9699225	1977	560708.8	9699225
1878	559360.7	9699405	1903	556570.7	9699345	1928	556570.7	9699195	1953	559540.7	9699225	1978	560666.6	9699118
1879	558850.7	9699405	1904	556570.7	9699315	1929	556690.7	9699195	1954	559540.7	9699195	1979	560593.3	9698932
1880	558850.7	9699375	1905	556510.7	9699315	1930	556690.7	9699165	1955	559570.7	9699195	1980	560519.9	9698746
1881	558760.7	9699375	1906	556510.7	9699285	1931	557350.7	9699165	1956	559570.7	9699225	1981	560446.6	9698560
1882	558760.7	9699405	1907	556480.7	9699285	1932	557350.7	9699135	1957	559630.7	9699225	1982	560373.3	9698374
1883	558670.7	9699405	1908	556480.7	9699315	1933	557380.7	9699135	1958	559630.7	9699255	1983	560299.9	9698188
1884	558670.7	9699375	1909	556330.7	9699315	1934	557380.7	9699105	1959	559780.7	9699255	1984	560226.6	9698002
1885	558610.7	9699375	1910	556330.7	9699255	1935	557440.7	9699105	1960	559780.7	9699225	1985	560153.3	9697816
1886	558610.7	9699345	1911	556360.7	9699255	1936	557440.7	9699135	1961	560020.7	9699225	1986	560079.9	9697629
1887	557740.7	9699345	1912	556360.7	9699195	1937	557470.7	9699135	1962	560020.7	9699255	1987	560006.6	9697443
1888	557740.7	9699375	1913	556330.7	9699195	1938	557470.7	9699165	1963	560110.7	9699255	1988	559933.3	9697257
1889	557650.7	9699375	1914	556330.7	9699165	1939	557650.7	9699165	1964	560110.7	9699225	1989	559859.9	9697071
1890	557650.7	9699345	1915	556360.7	9699165	1940	557650.7	9699225	1965	560200.7	9699225	1990	559786.6	9696885
1891	557530.7	9699345	1916	556360.7	9699195	1941	557620.7	9699225	1966	560200.7	9699195	1991	559713.3	9696699
1892	557530.7	9699315	1917	556450.7	9699195	1942	557620.7	9699255	1967	560260.7	9699195	1992	559640	9696513
1893	557440.7	9699315	1918	556450.7	9699165	1943	557680.7	9699255	1968	560260.7	9699225	1993	559566.6	9696327
1894	557440.7	9699285	1919	556480.7	9699165	1944	557680.7	9699225	1969	560470.7	9699225	1994	559493.3	9696141
1895	557290.7	9699285	1920	556480.7	9699195	1945	558580.7	9699225	1970	560470.7	9699195	1995	559420	9695955
1896	557290.7	9699315	1921	556450.7	9699195	1946	558580.7	9699255	1971	560530.7	9699195	1996	559314.5	9695687
1897	557020.7	9699315	1922	556450.7	9699255	1947	558610.7	9699255	1972	560530.7	9699225	1997	559128.3	9695760
1898	557020.7	9699345	1923	556510.7	9699255	1948	558610.7	9699225	1973	560650.7	9699225	1998	558942	9695833
1899	556660.7	9699345	1924	556510.7	9699285	1949	559390.7	9699225	1974	560650.7	9699195	1999	558755.8	9695906
1900	556660.7	9699315	1925	556540.7	9699285	1950	559390.7	9699255	1975	560680.7	9699195	2000	558569.5	9695979

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2001	558383.2	9696052	2026	556055.3	9699195	2051	554905.6	9702266	2076	555284.9	9704265	2101	557110.8	9706571
2002	558197	9696124	2027	556240.7	9699195	2052	554905.6	9702266	2077	555315.7	9704427	2102	557166.8	9706594
2003	558010.7	9696197	2028	556240.7	9699255	2053	554942.8	9702462	2078	555352.9	9704624	2103	557237.5	9706648
2004	557824.4	9696270	2029	556270.7	9699255	2054	554980.1	9702659	2079	555390.2	9704820	2104	557311	9706730
2005	557638.2	9696343	2030	556270.7	9699315	2055	555017.4	9702855	2080	555427.5	9705017	2105	557373.1	9706812
2006	557451.9	9696416	2031	556240.7	9699315	2056	555054.7	9703052	2081	555464.8	9705213	2106	557413.7	9706874
2007	557265.6	9696489	2032	556240.7	9699345	2057	555092	9703248	2082	555502.1	9705410	2107	557502.2	9706923
2008	557079.4	9696561	2033	556210.7	9699345	2058	555129.3	9703445	2083	555539.4	9705606	2108	557556.7	9707021
2009	556893.1	9696634	2034	556210.7	9699375	2059	555166.5	9703641	2084	555598.8	9705920	2109	557584.7	9707094
2010	556706.8	9696707	2035	556094.1	9699375	2060	555203.8	9703838	2085	555798.6	9705929	2110	557642.6	9707158
2011	556520.6	9696780	2036	556117	9699482	2061	555222.3	9703935	2086	555998.4	9705938	2111	557772.8	9707257
2012	556334.3	9696853	2037	556159.2	9699677	2062	555250.7	9703935	2087	556030.2	9705939	2112	557872.3	9707314
2013	556148.1	9696926	2038	556201.3	9699873	2063	555250.7	9703965	2088	556213.3	9705948	2113	557971.8	9707370
2014	555961.8	9696998	2039	556249.4	9700096	2064	555310.7	9703965	2089	556233	9706012	2114	558054	9707424
2015	555611.4	9697135	2040	556144.1	9700266	2065	555310.7	9703995	2090	556270.1	9706048	2115	558152.3	9707492
2016	555653.5	9697331	2041	556038.8	9700436	2066	555340.7	9703995	2091	556310.1	9706078	2116	558236.2	9707529
2017	555695.7	9697527	2042	555933.5	9700606	2067	555340.7	9704085	2092	556442.1	9706116	2117	558290.6	9707569
2018	555737.8	9697722	2043	555828.2	9700776	2068	555370.7	9704085	2093	556501.8	9706164	2118	558244.1	9707616
2019	555779.9	9697918	2044	555722.9	9700946	2069	555370.7	9704145	2094	556534.4	9706212	2119	558226.5	9707641
2020	555822.1	9698113	2045	555617.6	9701116	2070	555400.7	9704145	2095	556590.2	9706269	2120	558209	9707698
2021	555864.2	9698309	2046	555512.3	9701286	2071	555400.7	9704205	2096	556668.4	9706319	2121	558209	9707756
2022	555906.4	9698504	2047	555407.1	9701456	2072	555370.7	9704205	2097	556761.2	9706411	2122	558220.5	9707843
2023	555948.5	9698700	2048	555301.8	9701626	2073	555370.7	9704235	2098	556854	9706452	2123	558197.9	9707898
2024	555990.6	9698895	2049	555196.5	9701796	2074	555310.7	9704235	2099	556935.3	9706481	2124	558182.3	9707969
2025	556032.8	9699091	2050	555091.2	9701966	2075	555310.7	9704265	2100	557016.5	9706521	2125	558188.7	9708024

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2126	558191.1	9708092	2151	555479.8	9711430	2176	555868.6	9714099	2201	554291.8	9714862	2226	552540.1	9715807
2127	558176.5	9708159	2152	555600.9	9711590	2177	555808.1	9714143	2202	554300	9714930	2227	552356	9715771
2128	558127.4	9708248	2153	555721.9	9711749	2178	555773.6	9714203	2203	554298.6	9714934	2228	552105.4	9715812
2129	557978.6	9708382	2154	555843	9711908	2179	555743.4	9714268	2204	554268.2	9715026	2229	551890.7	9715858
2130	557829.8	9708516	2155	555964	9712067	2180	555665.7	9714302	2205	554215.9	9715098	2230	551716.8	9715925
2131	557681	9708649	2156	556085.1	9712226	2181	555631.1	9714350	2206	554189.7	9715130	2231	551497	9715899
2132	557532.2	9708783	2157	556206.1	9712386	2182	555600.9	9714384	2207	554175.2	9715188	2232	551389.6	9715761
2133	557383.4	9708917	2158	556327.2	9712545	2183	555536.1	9714384	2208	554165.6	9715281	2233	551281	9715664
2134	557234.6	9709050	2159	556448.3	9712704	2184	555451.1	9714375	2209	554183.7	9715380	2234	551112.3	9715649
2135	557085.8	9709184	2160	556665	9712989	2185	555364.8	9714362	2210	554157.7	9715473	2235	550795.3	9715828
2136	556937.1	9709318	2161	556695.1	9713051	2186	555252.5	9714388	2211	554154.8	9715577	2236	550645.1	9716026
2137	556788.3	9709451	2162	556714.6	9713124	2187	555218	9714418	2212	554128.7	9715665	2237	550329.7	9716229
2138	556639.5	9709585	2163	556675.8	9713219	2188	555131.7	9714457	2213	554141.3	9715785	2238	550142.2	9716298
2139	556490.7	9709719	2164	556619.7	9713305	2189	555032.4	9714461	2214	554151.9	9715847	2239	549900.1	9716388
2140	556341.9	9709852	2165	556563.6	9713370	2190	554935.1	9714461	2215	554090.9	9715917	2240	549528	9716406
2141	556193.1	9709986	2166	556438.4	9713456	2191	554853	9714448	2216	554061.8	9715990	2241	549232.6	9716489
2142	556044.3	9710120	2167	556343.4	9713525	2192	554796.9	9714461	2217	554052.3	9716039	2242	548915.4	9716479
2143	555895.5	9710253	2168	556257.1	9713568	2193	554727.8	9714491	2218	553930.9	9715940	2243	548790.5	9716419
2144	555746.7	9710387	2169	556170.8	9713641	2194	554676	9714539	2219	553853.2	9715949	2244	548680.7	9716317
2145	555598	9710521	2170	556110.3	9713728	2195	554611.3	9714560	2220	553721.2	9715965	2245	548515.8	9716317
2146	555449.2	9710654	2171	556062.9	9713771	2196	554555.1	9714578	2221	553562.7	9715863	2246	548282.9	9716499
2147	555300.4	9710788	2172	556058.5	9713849	2197	554499	9714621	2222	553348	9715858	2247	548166.4	9716700
2148	555116.6	9710953	2173	556041.3	9713940	2198	554425.6	9714690	2223	553169	9715960	2248	548027.4	9716860
2149	555237.7	9711112	2174	555976.5	9714000	2199	554369.5	9714759	2224	552990	9715991	2249	547890.2	9717057
2150	555358.7	9711271	2175	555929	9714069	2200	554322	9714802	2225	552662.8	9715925	2250	547778.8	9717223

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2051	554905.6	9702266	2076	555284.9	9704265	2101	557110.8	9706571	2126	558191.1	9708092	2151	555479.8	9711430
2052	554905.6	9702266	2077	555315.7	9704427	2102	557166.8	9706594	2127	558176.5	9708159	2152	555600.9	9711590
2053	554942.8	9702462	2078	555352.9	9704624	2103	557237.5	9706648	2128	558127.4	9708248	2153	555721.9	9711749
2054	554980.1	9702659	2079	555390.2	9704820	2104	557311	9706730	2129	557978.6	9708382	2154	555843	9711908
2055	555017.4	9702855	2080	555427.5	9705017	2105	557373.1	9706812	2130	557829.8	9708516	2155	555964	9712067
2056	555054.7	9703052	2081	555464.8	9705213	2106	557413.7	9706874	2131	557681	9708649	2156	556085.1	9712226
2057	555092	9703248	2082	555502.1	9705410	2107	557502.2	9706923	2132	557532.2	9708783	2157	556206.1	9712386
2058	555129.3	9703445	2083	555539.4	9705606	2108	557556.7	9707021	2133	557383.4	9708917	2158	556327.2	9712545
2059	555166.5	9703641	2084	555598.8	9705920	2109	557584.7	9707094	2134	557234.6	9709050	2159	556448.3	9712704
2060	555203.8	9703838	2085	555798.6	9705929	2110	557642.6	9707158	2135	557085.8	9709184	2160	556665	9712989
2061	555222.3	9703935	2086	555998.4	9705938	2111	557772.8	9707257	2136	556937.1	9709318	2161	556695.1	9713051
2062	555250.7	9703935	2087	556030.2	9705939	2112	557872.3	9707314	2137	556788.3	9709451	2162	556714.6	9713124
2063	555250.7	9703965	2088	556213.3	9705948	2113	557971.8	9707370	2138	556639.5	9709585	2163	556675.8	9713219
2064	555310.7	9703965	2089	556233	9706012	2114	558054	9707424	2139	556490.7	9709719	2164	556619.7	9713305
2065	555310.7	9703995	2090	556270.1	9706048	2115	558152.3	9707492	2140	556341.9	9709852	2165	556563.6	9713370
2066	555340.7	9703995	2091	556310.1	9706078	2116	558236.2	9707529	2141	556193.1	9709986	2166	556438.4	9713456
2067	555340.7	9704085	2092	556442.1	9706116	2117	558290.6	9707569	2142	556044.3	9710120	2167	556343.4	9713525
2068	555370.7	9704085	2093	556501.8	9706164	2118	558244.1	9707616	2143	555895.5	9710253	2168	556257.1	9713568
2069	555370.7	9704145	2094	556534.4	9706212	2119	558226.5	9707641	2144	555746.7	9710387	2169	556170.8	9713641
2070	555400.7	9704145	2095	556590.2	9706269	2120	558209	9707698	2145	555598	9710521	2170	556110.3	9713728
2071	555400.7	9704205	2096	556668.4	9706319	2121	558209	9707756	2146	555449.2	9710654	2171	556062.9	9713771
2072	555370.7	9704205	2097	556761.2	9706411	2122	558220.5	9707843	2147	555300.4	9710788	2172	556058.5	9713849
2073	555370.7	9704235	2098	556854	9706452	2123	558197.9	9707898	2148	555116.6	9710953	2173	556041.3	9713940
2074	555310.7	9704235	2099	556935.3	9706481	2124	558182.3	9707969	2149	555237.7	9711112	2174	555976.5	9714000
2075	555310.7	9704265	2100	557016.5	9706521	2125	558188.7	9708024	2150	555358.7	9711271	2175	555929	9714069

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2176	555868.6	9714099	2201	554291.8	9714862	2226	552540.1	9715807	2251	547653.8	9717409	2276	542670.8	9719659
2177	555808.1	9714143	2202	554300	9714930	2227	552356	9715771	2252	547463.3	9717561	2277	542522.7	9719793
2178	555773.6	9714203	2203	554298.6	9714934	2228	552105.4	9715812	2253	547225.9	9717781	2278	542352.8	9719948
2179	555743.4	9714268	2204	554268.2	9715026	2229	551890.7	9715858	2254	547042.3	9717894	2279	542144.4	9720017
2180	555665.7	9714302	2205	554215.9	9715098	2230	551716.8	9715925	2255	546795.1	9717869	2280	542092.5	9720001
2181	555631.1	9714350	2206	554189.7	9715130	2231	551497	9715899	2256	546660.9	9717739	2281	541953.9	9719956
2182	555600.9	9714384	2207	554175.2	9715188	2232	551389.6	9715761	2257	546526.7	9717732	2282	541763.5	9719895
2183	555536.1	9714384	2208	554165.6	9715281	2233	551281	9715664	2258	546419.2	9717842	2283	541573	9719834
2184	555451.1	9714375	2209	554183.7	9715380	2234	551112.3	9715649	2259	546369.2	9717806	2284	541382.5	9719773
2185	555364.8	9714362	2210	554157.7	9715473	2235	550795.3	9715828	2260	546205.7	9717690	2285	541192	9719712
2186	555252.5	9714388	2211	554154.8	9715577	2236	550645.1	9716026	2261	545951.7	9717707	2286	541001.6	9719651
2187	555218	9714418	2212	554128.7	9715665	2237	550329.7	9716229	2262	545584.9	9717577	2287	540811.1	9719590
2188	555131.7	9714457	2213	554141.3	9715785	2238	550142.2	9716298	2263	545234.9	9717465	2288	540620.6	9719529
2189	555032.4	9714461	2214	554151.9	9715847	2239	549900.1	9716388	2264	545009.1	9717493	2289	540430.1	9719468
2190	554935.1	9714461	2215	554090.9	9715917	2240	549528	9716406	2265	544858.2	9717624	2290	540239.7	9719407
2191	554853	9714448	2216	554061.8	9715990	2241	549232.6	9716489	2266	544704.3	9717758	2291	540049.2	9719347
2192	554796.9	9714461	2217	554052.3	9716039	2242	548915.4	9716479	2267	544446.8	9717738	2292	539858.7	9719286
2193	554727.8	9714491	2218	553930.9	9715940	2243	548790.5	9716419	2268	544188.9	9717800	2293	539502.3	9719171
2194	554676	9714539	2219	553853.2	9715949	2244	548680.7	9716317	2269	543962.1	9718071	2294	539541.5	9719049
2195	554611.3	9714560	2220	553721.2	9715965	2245	548515.8	9716317	2270	543801.7	9718191	2295	539497.6	9718918
2196	554555.1	9714578	2221	553562.7	9715863	2246	548282.9	9716499	2271	543628.5	9718320	2296	539363.1	9718841
2197	554499	9714621	2222	553348	9715858	2247	548166.4	9716700	2272	543499.5	9718653	2297	539187.7	9718784
2198	554425.6	9714690	2223	553169	9715960	2248	548027.4	9716860	2273	543308.5	9718828	2298	539074.4	9718666
2199	554369.5	9714759	2224	552990	9715991	2249	547890.2	9717057	2274	543048.9	9719072	2299	538971	9718518
2200	554322	9714802	2225	552662.8	9715925	2250	547778.8	9717223	2275	542863.5	9719349	2300	538836	9718489

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2301	538687.9	9718496	2326	535152.3	9718829	2351	531960.3	9719764	2376	530419.1	9719993	2401	528970.7	9719715
2302	538588.4	9718402	2327	534971.1	9718913	2352	531823	9719795	2377	530234.8	9720042	2402	528970.7	9719685
2303	538551.6	9718301	2328	534789.9	9718998	2353	531748.2	9719792	2378	530052.6	9720072	2403	528940.7	9719685
2304	538456.9	9718236	2329	534608.7	9719083	2354	531626.5	9719761	2379	529881.2	9720044	2404	528940.7	9719655
2305	538299.2	9718221	2330	534427.5	9719168	2355	531532.9	9719727	2380	529718.3	9719946	2405	528820.7	9719655
2306	538253.1	9718066	2331	534246.3	9719252	2356	531333.2	9719711	2381	529460.2	9719811	2406	528820.7	9719625
2307	538080.7	9718006	2332	533994.2	9719370	2357	531220.9	9719749	2382	529450.7	9719807	2407	528810.2	9719625
2308	538037	9717889	2333	533829.9	9719395	2358	531033.7	9719736	2383	529450.7	9719835	2408	528658.7	9719640
2309	537991.2	9717799	2334	533719	9719429	2359	530943.2	9719689	2384	529480.7	9719835	2409	528530.1	9719751
2310	537804.7	9717765	2335	533641.8	9719482	2360	530867.9	9719690	2385	529480.7	9719865	2410	528430.7	9719846
2311	537688.9	9717643	2336	533586.3	9719534	2361	530830.7	9719711	2386	529450.7	9719865	2411	528430.7	9719895
2312	537636.8	9717667	2337	533521	9719585	2362	530830.7	9719715	2387	529450.7	9719835	2412	528370.7	9719895
2313	537507.7	9717728	2338	533447.7	9719629	2363	530823	9719715	2388	529420.7	9719835	2413	528370.7	9719891
2314	537326.5	9717813	2339	533353.4	9719667	2364	530817.9	9719718	2389	529360.7	9719835	2414	528280.8	9719952
2315	537145.3	9717897	2340	533231.1	9719692	2365	530800.7	9719727	2390	529360.7	9719805	2415	528261.9	9720064
2316	536964.1	9717982	2341	533118.9	9719690	2366	530800.7	9719745	2391	529300.7	9719805	2416	528190.7	9720162
2317	536782.9	9718067	2342	532994.1	9719710	2367	530770.7	9719745	2392	529300.7	9719775	2417	528190.7	9720165
2318	536601.7	9718151	2343	532839.4	9719750	2368	530770.7	9719775	2393	529270.7	9719775	2418	528220.7	9720165
2319	536420.6	9718236	2344	532722.1	9719799	2369	530714	9719775	2394	529270.7	9719767	2419	528220.7	9720195
2320	536239.4	9718321	2345	532632.3	9719834	2370	530710.7	9719777	2395	529210.7	9719770	2420	528190.7	9720195
2321	536058.2	9718405	2346	532550	9719859	2371	530710.7	9719805	2396	529210.7	9719775	2421	528190.7	9720255
2322	535877	9718490	2347	532470.1	9719859	2372	530680.7	9719805	2397	529060.7	9719775	2422	528220.7	9720255
2323	535695.8	9718575	2348	532360.4	9719814	2373	530680.7	9719793	2398	529060.7	9719745	2423	528220.7	9720315
2324	535514.6	9718659	2349	532242.6	9719767	2374	530616.3	9719828	2399	529000.7	9719745	2424	528250.7	9720315
2325	535333.4	9718744	2350	532110.3	9719752	2375	530532.7	9719905	2400	529000.7	9719715	2425	528250.7	9720345

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2426	528220.7	9720345	2451	527084.3	9721681	2476	528247	9723649	2501	533071.1	9723706	2526	537986.7	9723843
2427	528220.7	9720405	2452	526966.6	9721842	2477	528447	9723649	2502	533271.1	9723711	2527	538186.6	9723849
2428	528160.7	9720405	2453	526848.8	9722004	2478	528647	9723649	2503	533471	9723717	2528	538386.5	9723856
2429	528160.7	9720375	2454	526731.1	9722165	2479	528847	9723648	2504	533670.9	9723722	2529	538586.4	9723862
2430	528130.7	9720375	2455	526613.3	9722327	2480	529047	9723648	2505	533870.8	9723728	2530	538786.3	9723868
2431	528130.7	9720345	2456	526495.5	9722489	2481	529247	9723648	2506	534070.8	9723733	2531	538986.2	9723875
2432	528100.7	9720345	2457	526377.8	9722650	2482	529447	9723647	2507	534270.7	9723739	2532	539186.1	9723881
2433	528100.7	9720315	2458	526260	9722812	2483	529647	9723647	2508	534470.6	9723744	2533	539386	9723887
2434	528078.9	9720315	2459	526142.3	9722974	2484	529847	9723647	2509	534670.5	9723750	2534	539585.9	9723894
2435	528026.4	9720387	2460	526024.5	9723135	2485	530047	9723646	2510	534870.5	9723755	2535	539785.8	9723900
2436	527908.7	9720549	2461	525906.7	9723297	2486	530247	9723646	2511	535070.4	9723761	2536	539985.7	9723907
2437	527790.9	9720711	2462	525789	9723459	2487	530447	9723646	2512	535270.3	9723766	2537	540130.7	9723911
2438	527673.1	9720872	2463	525647	9723654	2488	530647	9723645	2513	535470.2	9723772	2538	540130.7	9723885
2439	527555.4	9721034	2464	525847	9723653	2489	530819.5	9723645	2514	535670.1	9723778	2539	540190.7	9723885
2440	527500.7	9721109	2465	526047	9723653	2490	530872	9723645	2515	535870.1	9723783	2540	540190.7	9723913
2441	527500.7	9721425	2466	526247	9723653	2491	531071.9	9723651	2516	536070	9723789	2541	540220.7	9723914
2442	527470.7	9721425	2467	526447	9723652	2492	531271.8	9723656	2517	536269.9	9723794	2542	540220.7	9723885
2443	527470.7	9721455	2468	526647	9723652	2493	531471.7	9723662	2518	536469.8	9723800	2543	540250.7	9723885
2444	527500.7	9721455	2469	526847	9723652	2494	531671.7	9723667	2519	536669.8	9723805	2544	540250.7	9723855
2445	527500.7	9721485	2470	527047	9723651	2495	531871.6	9723673	2520	536869.7	9723811	2545	540220.7	9723855
2446	527440.7	9721485	2471	527247	9723651	2496	532071.5	9723678	2521	537069.6	9723816	2546	540220.7	9723825
2447	527440.7	9721191	2472	527447	9723651	2497	532271.4	9723684	2522	537269.5	9723822	2547	540250.7	9723825
2448	527437.6	9721196	2473	527647	9723650	2498	532471.4	9723689	2523	537537.5	9723829	2548	540250.7	9723795
2449	527319.9	9721357	2474	527847	9723650	2499	532671.3	9723695	2524	537586.9	9723830	2549	540280.7	9723795
2450	527202.1	9721519	2475	528047	9723650	2500	532871.2	9723700	2525	537786.8	9723837	2550	540280.7	9723825

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2551	540250.7	9723825	2576	541840.7	9723585	2601	541990.7	9723255	2626	541570.7	9723225	2651	541240.7	9723225
2552	540250.7	9723855	2577	541840.7	9723555	2602	541930.7	9723255	2627	541600.7	9723225	2652	541240.7	9723195
2553	540280.7	9723855	2578	541900.7	9723555	2603	541930.7	9723285	2628	541600.7	9723255	2653	541270.7	9723195
2554	540280.7	9723885	2579	541900.7	9723525	2604	541900.7	9723285	2629	541540.7	9723255	2654	541270.7	9723165
2555	540250.7	9723885	2580	541870.7	9723525	2605	541900.7	9723315	2630	541540.7	9723285	2655	541270.7	9723135
2556	540250.7	9723915	2581	541870.7	9723495	2606	541870.7	9723315	2631	541450.7	9723285	2656	541300.7	9723135
2557	540385.5	9723919	2582	541840.7	9723495	2607	541870.7	9723255	2632	541450.7	9723315	2657	541300.7	9723015
2558	540585.4	9723926	2583	541840.7	9723525	2608	541840.7	9723255	2633	541420.7	9723315	2658	541330.7	9723015
2559	540785.3	9723932	2584	541780.7	9723525	2609	541840.7	9723165	2634	541420.7	9723345	2659	541330.7	9722925
2560	540985.2	9723938	2585	541780.7	9723555	2610	541810.7	9723165	2635	541390.7	9723345	2660	541300.7	9722925
2561	541185.1	9723945	2586	541750.7	9723555	2611	541810.7	9723135	2636	541390.7	9723375	2661	541300.7	9722865
2562	541385	9723951	2587	541750.7	9723495	2612	541810.7	9723045	2637	541360.7	9723375	2662	541360.7	9722865
2563	541584.9	9723957	2588	541780.7	9723495	2613	541780.7	9723045	2638	541360.7	9723405	2663	541360.7	9722745
2564	541750.7	9723963	2589	541780.7	9723465	2614	541780.7	9723015	2639	541330.7	9723405	2664	541330.7	9722745
2565	541750.7	9723945	2590	541810.7	9723465	2615	541630.7	9723015	2640	541330.7	9723435	2665	541330.7	9722775
2566	541720.7	9723945	2591	541810.7	9723435	2616	541630.7	9723075	2641	541150.7	9723435	2666	541210.7	9722775
2567	541720.7	9723825	2592	541840.7	9723435	2617	541570.7	9723075	2642	541150.7	9723375	2667	541210.7	9722805
2568	541690.7	9723825	2593	541840.7	9723405	2618	541570.7	9723105	2643	541120.7	9723375	2668	541180.7	9722805
2569	541690.7	9723765	2594	541870.7	9723405	2619	541510.7	9723105	2644	541120.7	9723345	2669	541180.7	9722775
2570	541720.7	9723765	2595	541870.7	9723375	2620	541510.7	9723135	2645	541180.7	9723345	2670	541210.7	9722775
2571	541720.7	9723675	2596	541930.7	9723375	2621	541480.7	9723135	2646	541180.7	9723285	2671	541210.7	9722745
2572	541750.7	9723675	2597	541930.7	9723345	2622	541480.7	9723165	2647	541210.7	9723285	2672	541240.7	9722745
2573	541750.7	9723615	2598	542050.7	9723345	2623	541510.7	9723165	2648	541210.7	9723255	2673	541240.7	9722715
2574	541780.7	9723615	2599	542050.7	9723285	2624	541510.7	9723195	2649	541180.7	9723255	2674	541450.7	9722715
2575	541780.7	9723585	2600	541990.7	9723285	2625	541570.7	9723195	2650	541180.7	9723225	2675	541450.7	9722745

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2676	541480.7	9722745	2701	541810.7	9722715	2726	542050.7	9722625	2751	542410.7	9722955	2776	542680.7	9723435
2677	541480.7	9722685	2702	541870.7	9722715	2727	542050.7	9722685	2752	542380.7	9722955	2777	542680.7	9723495
2678	541450.7	9722685	2703	541870.7	9722775	2728	542140.7	9722685	2753	542380.7	9722925	2778	542650.7	9723495
2679	541450.7	9722535	2704	541900.7	9722775	2729	542140.7	9722715	2754	542410.7	9722925	2779	542650.7	9723615
2680	541480.7	9722535	2705	541900.7	9722805	2730	542080.7	9722715	2755	542410.7	9722895	2780	542620.7	9723615
2681	541480.7	9722385	2706	541930.7	9722805	2731	542080.7	9722745	2756	542530.7	9722895	2781	542620.7	9723705
2682	541510.7	9722385	2707	541930.7	9722835	2732	542110.7	9722745	2757	542530.7	9722925	2782	542590.7	9723705
2683	541510.7	9722355	2708	541960.7	9722835	2733	542110.7	9722775	2758	542500.7	9722925	2783	542590.7	9723735
2684	541480.7	9722355	2709	541960.7	9722865	2734	542170.7	9722775	2759	542500.7	9722955	2784	542560.7	9723735
2685	541480.7	9722325	2710	542020.7	9722865	2735	542170.7	9722745	2760	542470.7	9722955	2785	542560.7	9723705
2686	541510.7	9722325	2711	542020.7	9722835	2736	542290.7	9722745	2761	542470.7	9722985	2786	542530.7	9723705
2687	541510.7	9722295	2712	542050.7	9722835	2737	542290.7	9722805	2762	542500.7	9722985	2787	542530.7	9723675
2688	541540.7	9722295	2713	542050.7	9722805	2738	542170.7	9722805	2763	542500.7	9723015	2788	542500.7	9723675
2689	541540.7	9722325	2714	542020.7	9722805	2739	542170.7	9722835	2764	542530.7	9723015	2789	542500.7	9723645
2690	541570.7	9722325	2715	542020.7	9722775	2740	542140.7	9722835	2765	542530.7	9723075	2790	542410.7	9723645
2691	541570.7	9722445	2716	542020.7	9722745	2741	542140.7	9722925	2766	542470.7	9723075	2791	542410.7	9723705
2692	541630.7	9722445	2717	541990.7	9722745	2742	542170.7	9722925	2767	542470.7	9723135	2792	542350.7	9723705
2693	541630.7	9722505	2718	541990.7	9722715	2743	542170.7	9722955	2768	542500.7	9723135	2793	542350.7	9723645
2694	541660.7	9722505	2719	541990.7	9722685	2744	542200.7	9722955	2769	542500.7	9723285	2794	542380.7	9723645
2695	541660.7	9722535	2720	541960.7	9722685	2745	542200.7	9722985	2770	542560.7	9723285	2795	542380.7	9723615
2696	541720.7	9722535	2721	541960.7	9722625	2746	542230.7	9722985	2771	542560.7	9723345	2796	542350.7	9723615
2697	541720.7	9722565	2722	541990.7	9722625	2747	542230.7	9723015	2772	542620.7	9723345	2797	542350.7	9723585
2698	541750.7	9722565	2723	541990.7	9722655	2748	542290.7	9723015	2773	542620.7	9723405	2798	542320.7	9723585
2699	541750.7	9722625	2724	542020.7	9722655	2749	542290.7	9722985	2774	542650.7	9723405	2799	542320.7	9723555
2700	541810.7	9722625	2725	542020.7	9722625	2750	542410.7	9722985	2775	542650.7	9723435	2800	542290.7	9723555

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2801	542290.7	9723465	2826	541990.7	9723825	2851	546155.6	9724109	2876	551365.5	9724262	2901	555164.5	9724274
2802	542260.7	9723465	2827	541990.7	9723915	2852	546455.6	9724119	2877	551565.5	9724263	2902	555354.4	9724275
2803	542260.7	9723435	2828	542020.7	9723915	2853	546655.5	9724126	2878	551765.5	9724263	2903	555364.5	9724275
2804	542290.7	9723435	2829	542020.7	9723971	2854	546855.4	9724132	2879	551965.5	9724264	2904	555554.4	9724276
2805	542290.7	9723345	2830	542107.4	9723974	2855	547055.3	9724139	2880	552165.4	9724264	2905	555564.5	9724276
2806	542260.7	9723345	2831	542157.9	9723975	2856	547255.1	9724145	2881	552365.4	9724265	2906	555754.4	9724277
2807	542260.7	9723405	2832	542357.8	9723982	2857	547455	9724152	2882	552565.4	9724266	2907	555764.5	9724277
2808	542230.7	9723405	2833	542557.7	9723989	2858	547654.9	9724158	2883	552765.4	9724266	2908	555954.4	9724277
2809	542230.7	9723465	2834	542757.5	9723995	2859	547854.8	9724165	2884	552965.4	9724267	2909	555964.5	9724277
2810	542200.7	9723465	2835	542957.4	9724002	2860	548054.7	9724171	2885	553165.4	9724267	2910	556120.7	9724278
2811	542200.7	9723525	2836	543157.3	9724009	2861	548254.6	9724178	2886	553365.4	9724268	2911	556120.7	9724185
2812	542170.7	9723525	2837	543357.2	9724016	2862	548454.5	9724185	2887	553565.4	9724269	2912	556090.7	9724185
2813	542170.7	9723555	2838	543557.1	9724022	2863	548654.4	9724191	2888	553765.4	9724269	2913	556090.7	9724095
2814	542140.7	9723555	2839	543757	9724029	2864	548854.3	9724198	2889	554154.4	9724270	2914	556120.7	9724095
2815	542140.7	9723585	2840	543956.9	9724036	2865	549054.2	9724204	2890	554154.4	9724270	2915	556120.7	9724065
2816	542050.7	9723585	2841	544156.8	9724042	2866	549254.1	9724211	2891	554164.5	9724270	2916	556090.7	9724065
2817	542050.7	9723615	2842	544356.7	9724049	2867	549454	9724217	2892	554354.4	9724271	2917	556090.7	9724035
2818	542020.7	9723615	2843	544556.5	9724056	2868	549653.9	9724224	2893	554364.5	9724271	2918	556120.7	9724035
2819	542020.7	9723645	2844	544756.4	9724062	2869	549853.8	9724230	2894	554554.4	9724272	2919	556120.7	9723975
2820	541960.7	9723645	2845	544956.3	9724069	2870	550053.6	9724237	2895	554564.5	9724272	2920	556150.7	9723975
2821	541960.7	9723705	2846	545156.2	9724076	2871	550253.5	9724243	2896	554754.4	9724273	2921	556150.7	9723945
2822	541930.7	9723705	2847	545356.1	9724082	2872	550453.4	9724250	2897	554764.5	9724273	2922	556180.7	9723945
2823	541930.7	9723795	2848	545556	9724089	2873	550765.5	9724260	2898	554954.4	9724274	2923	556180.7	9723915
2824	541960.7	9723795	2849	545755.9	9724096	2874	550965.5	9724261	2899	554964.5	9724274	2924	556210.7	9723915
2825	541960.7	9723825	2850	545955.8	9724102	2875	551165.5	9724261	2900	555154.4	9724274	2925	556210.7	9723885

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
2926	556300.7	9723885	2951	556630.7	9723765	2976	556720.7	9723945	3001	557050.7	9724035	3026	557500.7	9724245
2927	556300.7	9723795	2952	556600.7	9723765	2977	556720.7	9723975	3002	557080.7	9724035	3027	557500.7	9724275
2928	556330.7	9723795	2953	556600.7	9723735	2978	556690.7	9723975	3003	557080.7	9724065	3028	557528.7	9724275
2929	556330.7	9723825	2954	556570.7	9723735	2979	556690.7	9724005	3004	557140.7	9724065	3029	557542	9724245
2930	556420.7	9723825	2955	556570.7	9723765	2980	556720.7	9724005	3005	557140.7	9724125	3030	557530.7	9724245
2931	556420.7	9723795	2956	556510.7	9723765	2981	556720.7	9724065	3006	557170.7	9724125	3031	557530.7	9724215
2932	556450.7	9723795	2957	556510.7	9723795	2982	556660.7	9724065	3007	557170.7	9724155	3032	557500.7	9724215
2933	556450.7	9723765	2958	556480.7	9723795	2983	556660.7	9724095	3008	557200.7	9724155	3033	557500.7	9724185
2934	556480.7	9723765	2959	556480.7	9723855	2984	556600.7	9724095	3009	557200.7	9724065	3034	557470.7	9724185
2935	556480.7	9723735	2960	556510.7	9723855	2985	556600.7	9724185	3010	557230.7	9724065	3035	557470.7	9724155
2936	556510.7	9723735	2961	556510.7	9723885	2986	556720.7	9724185	3011	557230.7	9724035	3036	557410.7	9724155
2937	556510.7	9723705	2962	556540.7	9723885	2987	556720.7	9724215	3012	557350.7	9724035	3037	557410.7	9724035
2938	556630.7	9723705	2963	556540.7	9723915	2988	556810.7	9724215	3013	557350.7	9724155	3038	557440.7	9724035
2939	556630.7	9723735	2964	556510.7	9723915	2989	556810.7	9724185	3014	557260.7	9724155	3039	557440.7	9724005
2940	556690.7	9723735	2965	556510.7	9723975	2990	556840.7	9724185	3015	557260.7	9724185	3040	557410.7	9724005
2941	556690.7	9723765	2966	556480.7	9723975	2991	556840.7	9724125	3016	557230.7	9724185	3041	557410.7	9723945
2942	556720.7	9723765	2967	556480.7	9724005	2992	556900.7	9724125	3017	557230.7	9724275	3042	557440.7	9723945
2943	556720.7	9723795	2968	556510.7	9724005	2993	556900.7	9724095	3018	557200.7	9724275	3043	557440.7	9723915
2944	556750.7	9723795	2969	556510.7	9724035	2994	556930.7	9724095	3019	557200.7	9724282	3044	557530.7	9723915
2945	556750.7	9723855	2970	556600.7	9724035	2995	556930.7	9724065	3020	557410.7	9724283	3045	557530.7	9723945
2946	556690.7	9723855	2971	556600.7	9724005	2996	556960.7	9724065	3021	557410.7	9724245	3046	557560.7	9723945
2947	556690.7	9723825	2972	556630.7	9724005	2997	556960.7	9724035	3022	557440.7	9724245	3047	557560.7	9723975
2948	556660.7	9723825	2973	556630.7	9723975	2998	556990.7	9724035	3023	557440.7	9724215	3048	557590.7	9723975
2949	556660.7	9723795	2974	556660.7	9723975	2999	556990.7	9724005	3024	557470.7	9724215	3049	557590.7	9724035
2950	556630.7	9723795	2975	556660.7	9723945	3000	557050.7	9724005	3025	557470.7	9724245	3050	557560.7	9724035

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
3051	557560.7	9724125	3076	560499.9	9724296	3101	563590.7	9724215	3126	564609.4	9724266	3151	565000.7	9724395
3052	557590.7	9724125	3077	560699.9	9724297	3102	563620.7	9724215	3127	564699.4	9724416	3152	564970.7	9724395
3053	557590.7	9724155	3078	560899.9	9724298	3103	563620.7	9724185	3128	564707.8	9724422	3153	564970.7	9724406
3054	557530.7	9724155	3079	561099.9	9724299	3104	563830.7	9724185	3129	564712.1	9724425	3154	565061.7	9724405
3055	557530.7	9724215	3080	561299.9	9724300	3105	563830.7	9724215	3130	564730.7	9724425	3155	565261.7	9724403
3056	557560.7	9724215	3081	561499.9	9724301	3106	563860.7	9724215	3131	564730.7	9724395	3156	565461.7	9724402
3057	557560.7	9724222	3082	561699.9	9724302	3107	563860.7	9724275	3132	564760.7	9724395	3157	565661.7	9724401
3058	557700	9724282	3083	561899.9	9724303	3108	563830.7	9724275	3133	564760.7	9724305	3158	565750.7	9724400
3059	557710.7	9724282	3084	562099.9	9724304	3109	563830.7	9724303	3134	564790.7	9724305	3159	565750.7	9724395
3060	557710.7	9724245	3085	562299.9	9724305	3110	563942.3	9724302	3135	564790.7	9724215	3160	565720.7	9724395
3061	557770.7	9724245	3086	562499.9	9724306	3111	563946.9	9724302	3136	564820.7	9724215	3161	565720.7	9724365
3062	557770.7	9724282	3087	562699.9	9724307	3112	564040.7	9724302	3137	564820.7	9724305	3162	565690.7	9724365
3063	557900	9724283	3088	562942.3	9724309	3113	564040.7	9724275	3138	564820.7	9724335	3163	565690.7	9724335
3064	558100	9724284	3089	562946.9	9724308	3114	564070.7	9724275	3139	564790.7	9724335	3164	565660.7	9724335
3065	558300	9724285	3090	563142.3	9724307	3115	564070.7	9724245	3140	564790.7	9724452	3165	565660.7	9724245
3066	558500	9724286	3091	563146.9	9724307	3116	564130.7	9724245	3141	564815.2	9724447	3166	565630.7	9724245
3067	558700	9724287	3092	563342.3	9724306	3117	564130.7	9724215	3142	564850.7	9724416	3167	565630.7	9724275
3068	558900	9724288	3093	563346.9	9724306	3118	564160.7	9724215	3143	564850.7	9724395	3168	565570.7	9724275
3069	559100	9724289	3094	563542.3	9724305	3119	564160.7	9724185	3144	564880.7	9724395	3169	565570.7	9724245
3070	559300	9724290	3095	563546.9	9724305	3120	564250.7	9724185	3145	564880.7	9724275	3170	565510.7	9724245
3071	559500	9724291	3096	563680.7	9724304	3121	564250.7	9724245	3146	564940.7	9724275	3171	565510.7	9724185
3072	559700	9724292	3097	563680.7	9724275	3122	564220.7	9724245	3147	564940.7	9724335	3172	565450.7	9724185
3073	559900	9724293	3098	563620.7	9724275	3123	564220.7	9724269	3148	564970.7	9724335	3173	565450.7	9724155
3074	560100	9724294	3099	563620.7	9724245	3124	564298.9	9724214	3149	564970.7	9724365	3174	565330.7	9724155
3075	560299.9	9724295	3100	563590.7	9724245	3125	564438.6	9724205	3150	565000.7	9724365	3175	565330.7	9724095

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
3176	565360.7	9724095	3201	566110.7	9723975	3226	566110.7	9723795	3251	566620.7	9724005	3276	567700.7	9724275
3177	565360.7	9724065	3202	566080.7	9723975	3227	566110.7	9723765	3252	566590.7	9724005	3277	567700.7	9724305
3178	565390.7	9724065	3203	566080.7	9724005	3228	566140.7	9723765	3253	566590.7	9724065	3278	567730.7	9724305
3179	565390.7	9724095	3204	566050.7	9724005	3229	566140.7	9723675	3254	566620.7	9724065	3279	567730.7	9724386
3180	565540.7	9724095	3205	566050.7	9723975	3230	566290.7	9723675	3255	566620.7	9724185	3280	567861.7	9724385
3181	565540.7	9724125	3206	566020.7	9723975	3231	566290.7	9723705	3256	566650.7	9724185	3281	568061.6	9724384
3182	565570.7	9724125	3207	566020.7	9723915	3232	566320.7	9723705	3257	566650.7	9724275	3282	568261.6	9724383
3183	565570.7	9724095	3208	566050.7	9723915	3233	566320.7	9723735	3258	566590.7	9724275	3283	568461.6	9724381
3184	565660.7	9724095	3209	566050.7	9723855	3234	566350.7	9723735	3259	566590.7	9724305	3284	568661.6	9724380
3185	565660.7	9724125	3210	566020.7	9723855	3235	566350.7	9723765	3260	566560.7	9724305	3285	568861.6	9724378
3186	565690.7	9724125	3211	566020.7	9723825	3236	566470.7	9723765	3261	566560.7	9724335	3286	569061.6	9724377
3187	565690.7	9724215	3212	566050.7	9723825	3237	566470.7	9723735	3262	566590.7	9724335	3287	569261.6	9724376
3188	565720.7	9724215	3213	566050.7	9723795	3238	566500.7	9723735	3263	566590.7	9724365	3288	569461.6	9724374
3189	565720.7	9724185	3214	566020.7	9723795	3239	566500.7	9723765	3264	566650.7	9724365	3289	569661.6	9724373
3190	565870.7	9724185	3215	566020.7	9723735	3240	566530.7	9723765	3265	566650.7	9724394	3290	569861.6	9724371
3191	565870.7	9724155	3216	565990.7	9723735	3241	566530.7	9723795	3266	566661.7	9724394	3291	570061.6	9724370
3192	565960.7	9724155	3217	565990.7	9723765	3242	566500.7	9723795	3267	566861.7	9724392	3292	570261.6	9724369
3193	565960.7	9724125	3218	565930.7	9723765	3243	566500.7	9723825	3268	567061.7	9724391	3293	570461.6	9724367
3194	566020.7	9724125	3219	565930.7	9723735	3244	566530.7	9723825	3269	567261.7	9724390	3294	570661.6	9724366
3195	566020.7	9724095	3220	565960.7	9723735	3245	566530.7	9723855	3270	567461.7	9724388	3295	570861.6	9724364
3196	566050.7	9724095	3221	565960.7	9723705	3246	566560.7	9723855	3271	567661.7	9724387	3296	571061.6	9724363
3197	566050.7	9724065	3222	566110.7	9723705	3247	566560.7	9723885	3272	567700.7	9724386	3297	571261.6	9724362
3198	566080.7	9724065	3223	566110.7	9723735	3248	566590.7	9723885	3273	567700.7	9724305	3298	571461.6	9724360
3199	566080.7	9724035	3224	566050.7	9723735	3249	566590.7	9723975	3274	567670.7	9724305	3299	571661.6	9724359
3200	566110.7	9724035	3225	566050.7	9723795	3250	566620.7	9723975	3275	567670.7	9724275	3300	571861.6	9724357

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
3301	572061.6	9724356	3326	577028.7	9724374	3351	580939.1	9724405	3376	585514.9	9724436	3401	588975.6	9724465
3302	572261.5	9724355	3327	577228.7	9724375	3352	581139.1	9724406	3377	585714.9	9724438	3402	589175.6	9724467
3303	572461.5	9724353	3328	577300.7	9724376	3353	581339.1	9724408	3378	585914.9	9724439	3403	589375.6	9724468
3304	572661.5	9724352	3329	577300.7	9724365	3354	581650.7	9724411	3379	586090.7	9724440	3404	589575.6	9724470
3305	572861.5	9724351	3330	577360.7	9724365	3355	581650.7	9724395	3380	586090.7	9724425	3405	589775.6	9724472
3306	573224.8	9724348	3331	577360.7	9724376	3356	581740.7	9724395	3381	586210.7	9724425	3406	589975.6	9724474
3307	573228.8	9724348	3332	577428.7	9724377	3357	581740.7	9724411	3382	586210.7	9724441	3407	590175.6	9724475
3308	573428.8	9724349	3333	577628.7	9724378	3358	581915	9724412	3383	586375.7	9724442	3408	590260.7	9724476
3309	573628.8	9724351	3334	577828.7	9724379	3359	582115	9724414	3384	586575.7	9724444	3409	590260.7	9724455
3310	573828.8	9724352	3335	578028.7	9724381	3360	582315	9724415	3385	586775.7	9724446	3410	590350.7	9724455
3311	574028.8	9724353	3336	578336.8	9724383	3361	582515	9724416	3386	586975.7	9724448	3411	590350.7	9724425
3312	574228.8	9724355	3337	578338.5	9724383	3362	582715	9724418	3387	587170.7	9724449	3412	590410.7	9724425
3313	574428.8	9724356	3338	578339.2	9724383	3363	582915	9724419	3388	587170.7	9724395	3413	590410.7	9724395
3314	574628.8	9724357	3339	578539.2	9724384	3364	583115	9724420	3389	587290.7	9724395	3414	590440.7	9724395
3315	574828.7	9724359	3340	578739.2	9724386	3365	583315	9724422	3390	587290.7	9724425	3415	590440.7	9724365
3316	575028.7	9724360	3341	578939.1	9724388	3366	583515	9724423	3391	587230.7	9724425	3416	590470.7	9724365
3317	575228.7	9724362	3342	579139.1	9724389	3367	583715	9724424	3392	587230.7	9724450	3417	590470.7	9724335
3318	575428.7	9724363	3343	579339.1	9724391	3368	583915	9724426	3393	587375.7	9724451	3418	590560.7	9724335
3319	575628.7	9724364	3344	579539.1	9724393	3369	584115	9724427	3394	587575.7	9724453	3419	590560.7	9724305
3320	575828.7	9724366	3345	579739.1	9724394	3370	584315	9724428	3395	587775.7	9724455	3420	590620.7	9724305
3321	576028.7	9724367	3346	579939.1	9724396	3371	584515	9724430	3396	587975.6	9724456	3421	590620.7	9724275
3322	576228.7	9724368	3347	580139.1	9724398	3372	584715	9724431	3397	588175.6	9724458	3422	590710.7	9724275
3323	576428.7	9724370	3348	580339.1	9724400	3373	584915	9724432	3398	588375.6	9724460	3423	590710.7	9724245
3324	576628.7	9724371	3349	580539.1	9724401	3374	585115	9724434	3399	588575.6	9724461	3424	590770.7	9724245
3325	576828.7	9724372	3350	580739.1	9724403	3375	585315	9724435	3400	588775.6	9724463	3425	590770.7	9724215

Project Area Contour Coordinates														
UTM 22S, Datum SIRGAS 2000														
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
3426	590830.7	9724215	3451	591550.7	9723645	3476	591610.7	9723195	3501	591910.7	9723285	3526	592360.7	9723675
3427	590830.7	9724185	3452	591610.7	9723645	3477	591610.7	9723135	3502	591940.7	9723285	3527	592360.7	9723705
3428	590890.7	9724185	3453	591610.7	9723675	3478	591640.7	9723135	3503	591940.7	9723345	3528	592390.7	9723705
3429	590890.7	9724155	3454	591640.7	9723675	3479	591640.7	9723105	3504	591910.7	9723345	3529	592390.7	9723735
3430	590950.7	9724155	3455	591640.7	9723645	3480	591610.7	9723105	3505	591910.7	9723435	3530	592420.7	9723735
3431	590950.7	9724125	3456	591670.7	9723645	3481	591610.7	9723075	3506	591940.7	9723435	3531	592420.7	9723765
3432	591070.7	9724125	3457	591670.7	9723585	3482	591640.7	9723075	3507	591940.7	9723465	3532	592450.7	9723765
3433	591070.7	9724095	3458	591640.7	9723585	3483	591640.7	9723045	3508	592000.7	9723465	3533	592450.7	9723795
3434	591160.7	9724095	3459	591640.7	9723555	3484	591670.7	9723045	3509	592000.7	9723495	3534	592480.7	9723795
3435	591160.7	9724065	3460	591580.7	9723555	3485	591670.7	9723015	3510	591970.7	9723495	3535	592480.7	9723915
3436	591190.7	9724065	3461	591580.7	9723525	3486	591760.7	9723015	3511	591970.7	9723525	3536	592450.7	9723915
3437	591190.7	9724035	3462	591550.7	9723525	3487	591760.7	9723045	3512	592000.7	9723525	3537	592450.7	9723975
3438	591280.7	9724035	3463	591550.7	9723495	3488	591790.7	9723045	3513	592000.7	9723585	3538	592390.7	9723975
3439	591280.7	9724005	3464	591520.7	9723495	3489	591790.7	9723075	3514	592030.7	9723585	3539	592390.7	9724005
3440	591370.7	9724005	3465	591520.7	9723465	3490	591820.7	9723075	3515	592030.7	9723615	3540	592300.7	9724005
3441	591370.7	9723975	3466	591460.7	9723465	3491	591820.7	9723135	3516	592060.7	9723615	3541	592300.7	9723975
3442	591430.7	9723975	3467	591460.7	9723405	3492	591850.7	9723135	3517	592060.7	9723645	3542	592240.7	9723975
3443	591430.7	9723945	3468	591490.7	9723405	3493	591850.7	9723165	3518	592180.7	9723645	3543	592240.7	9724005
3444	591460.7	9723945	3469	591490.7	9723375	3494	591820.7	9723165	3519	592180.7	9723615	3544	592120.7	9724005
3445	591460.7	9723795	3470	591520.7	9723375	3495	591820.7	9723195	3520	592300.7	9723615	3545	592120.7	9724095
3446	591490.7	9723795	3471	591520.7	9723315	3496	591850.7	9723195	3521	592300.7	9723585	3546	592000.7	9724095
3447	591490.7	9723765	3472	591550.7	9723315	3497	591850.7	9723225	3522	592330.7	9723585	3547	592000.7	9724065
3448	591520.7	9723765	3473	591550.7	9723255	3498	591880.7	9723225	3523	592330.7	9723645	3548	591910.7	9724065
3449	591520.7	9723705	3474	591580.7	9723255	3499	591880.7	9723255	3524	592300.7	9723645	3549	591910.7	9724095
3450	591550.7	9723705	3475	591580.7	9723195	3500	591910.7	9723255	3525	592300.7	9723675	3550	591880.7	9724095

Project Area Contour Coordinates					
UTM 22S, Datum SIRGAS 2000					
Point	X	Y	Point	X	Y
3551	591880.7	9724065	3578	590830.7	9724275
3552	591820.7	9724065	3579	590830.7	9724305
3553	591820.7	9724095	3580	590770.7	9724305
3554	591790.7	9724095	3581	590770.7	9724335
3555	591790.7	9724125	3582	590710.7	9724335
3556	591760.7	9724125	3583	590710.7	9724365
3557	591760.7	9724155	3584	590620.7	9724365
3558	591670.7	9724155	3585	590620.7	9724395
3559	591670.7	9724065	3586	590560.7	9724395
3560	591520.7	9724065	3587	590560.7	9724425
3561	591520.7	9724035	3588	590500.7	9724425
3562	591430.7	9724035	3589	590500.7	9724455
3563	591430.7	9724065	3590	590440.7	9724455
3564	591340.7	9724065	3591	590440.7	9724478
3565	591340.7	9724095	3592	590575.5	9724479
3566	591220.7	9724095	3593	590775.5	9724480
3567	591220.7	9724125	3594	590975.5	9724482
3568	591130.7	9724125	3595	591175.5	9724484
3569	591130.7	9724155	3596	591375.5	9724486
3570	591100.7	9724155	3597	591575.5	9724487
3571	591100.7	9724185	3598	591775.5	9724489
3572	590980.7	9724185	3599	591975.5	9724491
3573	590980.7	9724215	3600	592175.5	9724493
3574	590920.7	9724215	3601	592375.5	9724494
3575	590920.7	9724245	3602	592575.5	9724496
3576	590890.7	9724245	3603	592775.5	9724498
3577	590890.7	9724275	3604	592975.5	9724499

APPENDIX II: METHODOLOGICAL PROCEDURES FOR LU/LC CHANGE ANALYSIS

According to the applied methodology, in order to achieve a consistent time-series of LU/LC-change data over the crediting period, the detailed methodological procedures used in pre-processing, classification, post classification processing, and accuracy assessment of the remotely sensed data shall be carefully documented in the VCS PD. Therefore, the information below describes the methodological procedures applied during the current monitored period.

Data sources and pre-processing

The historic deforestation of the reference region should be analyzed through maps from MapBiomas (version 5.0, which was the last available version), available in raster format, which can be downloaded from the *http://mapbiomas.org/* website. MapBiomas is a multi-institutional initiative of the Greenhouse Gas Emissions Estimation System (SEEG - http://seeg.eco.br/en/) promoted by the Climate Observatory. MapBiomas co-creation involves NGO's, universities and technology companies.

Table 88. Source of the remotely sense data used for historical reference period

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	2007 to 2017	Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2009 - 2019	225	62
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2009 - 2019	225	61
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2009 - 2019	224	62

The forest dynamics data, the deforestation vectors and other base data from the studied region, which were used for the project's baseline construction, should be organized in a spatialized database. For this purpose, the software used in this baseline reassessment was the File Geodatabase format from ArcGIS 10.6. The files are stored in vector and matrix format (raster). In order to standardize spatial references, all data has been projected for the UTM and Datum WGS84, Zone 22S projection.

The MapBiomas methodology for land use classification uses 105 input variables, including the original Landsat bands, indexes, fractional and textural information derived from these bands, which are detailed in the table below:

Figure 89. List, description and reference of bands, fractions and indexes available in the feature space

			Reducer						
	band or index name	formula	median	median_dry	median_wet	amplitude	std Dev	min	Reference
bands	blue	B1 (L5 e L7); B2 (L8)							
	green	B2 (L5 e L7); B3 (L8)							
	red	B3 (L5 e L7); B4 (L8)							
	nir	B4 (L5 e L7); B5 (L8)							
	swir1	B5 (L5 e L7); B6 (L8)							
	swir2	B7 (L5); B8 (L7); B7 (L8)							
	temp	B6 (L5 e L7); B10 (L8)							
index	ndvi	(nir - red)/(nir + red)							
	evi2	(2.5 * (nir - red)/(nir + 2.4 * red + 1)							
	cai	(swir2 / swir1)							
	ndwi	(nir - swir1)/(nir + swir1)							
	gcvi	(nir / green - 1)							
	hall_cover	(-red*0.017 - nir*0.007 - swir2*0.079 + 5.22)							
	pri	(blue - green)/(blue + green)							
	savi	(1 + L) * (nir - red)/(nir + red + 0,5)							
	textG	('median_green') .entropy(ee.Kernel .square({radius: 5}))							
fraction	gv	fractional abundance of green vegetation within the pixel							
	npv	fractional abundance of non-photosynthetic vegetation within the pixel							
	soil	fractional abundance of soil within the pixel							
	cloud	fractional abundance of cloud within the pixel							
	shade	100 - (gv + npv + soil + cloud)							
MEM index	gvs	gv / (gv + npv + soil + cloud)							
	ndfi	(gvs - (npv + soil))/(gvs + (npv + soil))							
	sefi	(gv+npv_s - soil)/(gv+npv_s + soil)							
	wefi	((gv+npv) - (soil+shade)) /((gv+npv) + (soil+shade))							
	fns	((gv+shade) - soil) / ((gv+shade) + soil)							
slope		ALOS DSM: Global 30m							

Where,

Median - Median of the pixel values of the best mapping period defined by each biome.

Median_dry = median of the quartile of the lowest pixel NDVI values.

Median_wet = median of the quartile of the highest pixel NDVI values.

Amplitude = amplitude of variation of the index considering all the images of each year.

stdDev = standard deviation of all pixel values of all images of each year.

Min = lower annual value of the pixels of each band.

In addition, Landsat Images used in MapBiomas were accessible via Google Earth Engine, and most of them are composed by the Collection 1 Tier 1 from USGS. This is the highest quality Level-1 products suitable for pixel-level time series analysis. These images are radiometrically calibrated and orthorectified using ground control points (GCPs) and digital elevation model (DEM) data to correct for relief displacement.

Data classification and post-processing

The LU/LC classes defined for this project activity were: Forest, Non-Forest and Hydrography. In addition, the established LU/LC-change categories were:

a) Forested areas that remains as forested areas (Conservation);

b) Forest that are converted to non-forested areas (Deforestation); or

c) Non-forested areas that remains as non-forested areas.

The image classification methodology for each year involves all Landsat images available for each period (Landsat 5 [L5], Landsat 7 [L7] and Landsat 8 [L8]) or other sensor available) with a cloud cover less than or equal to 50%, and in accordance with its 30m resolution, the minimum mapping unit was defined at 30x30m (0.09ha), therefore falling easily to the methodology requirement that the MMU cannot be larger than 1ha. Thus, a representative mosaic of each year could be generated, selecting cloud free pixels from the available images. Metrics should be extracted for each pixel that describes its behavior during the year and could contain up to 105 layers of information. The mapping should be done with an artificial intelligence classifier, such as the Randon Forest. The Landsat images acquisition could be made through Google Earth Engine, with data from NASA and USGS (U.S. Geological Survey).

The algorithm may use samples obtained by reference maps, stable collections from previous MapBiomas series and/or direct collection by visual interpretation of Landsat images in order to classify a single map per class. This classification should then go through spatial filter, applying neighborhood rules and temporal filters to reduce spatial and temporal inconsistencies. The software used in this baseline reassessment was the ArcGIS 10.6. In addition, high resolution images from Google Earth software (https://earth.google.com/) were also utilized to perform some LU/LC-change analysis.

Due to the pixel-based classification method and the long temporal series, the MapBiomas applies a chain of post-classification filters. The first post-classification action involves the application of temporal filters. Then, a spatial filter was applied followed by a gap fill filter. The application of these filters removes classification noises. These post-classification procedures were implemented in the Google Earth Engine platform and are described below:

Gap Fill

The Gap fill is a temporal filter used to fill possible no-data values. In a long time series of severely cloud-affected regions, it is expected that no-data values may populate some of the resultant median composite pixels. In this filter, no-data values ("gaps") are theoretically not allowed and are replaced by the temporally nearest valid classification

Spatial Filter

Spatial filter was applied to avoid unwanted modifications to the edges of the pixel groups (blobs), a spatial filter was built based on the "connectedPixelCount" function. This function locates connected components (neighbours) that share the same pixel value.

Temporal Filter

The temporal filter uses sequential classifications in a three-to-five-years unidirectional moving window to identify temporally non-permitted transitions. Based on generic rules (GR), the temporal filter inspects the central positions of three to five consecutive years, and if the extremities of the consecutive years are identical but the centre position is not, then the central pixels are reclassified to match its temporal neighbour class.

Frequency Filter

This filter takes into consideration the occurrence frequency throughout the entire time series. Thus, all class occurrence with less than given percentage of temporal persistence (eg. 3 years or fewer out of 33) are filtered out. This mechanism decreasing the number of false positives and preserving consolidated trajectories.

Incident Filter

An incident filter was applied to remove pixels that changed too many times in the 34 years of time spam. All pixels that changed more than eight times and are connected to less than 6 pixels were replaced by the MODE value of that given pixel position in the stack of years.

Classification accuracy assessment

The MapBiomas results go through an accuracy evaluation, which remains 95% for the entire Amazon Biome. However, to meet the particularities of the project's region, an independent evaluation was carried out for the reference region.

Thus, in order to assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated calculating the percentages of user and producer correctness, as well as omission and commission errors.

A total of 300 random points was drawn on the reference region (100 points for each land use class – Forest, Non-Forest and Hydrography) and the degree of correctness of the classification was verified. High resolution images from Google Earth should also be used as reference, in which land use was visually possible at the drawn points.

The table below shows the final accuracy analysis carried out for each year and each land use class during the analyzed monitoring period.

Table 89. Summary of confusion matrices from the evaluation of MapBiomas from 2007 to 2017

	Producer Accuracy				User Accuracy			
Year	Forest	Hydrography	Country Formation	Deforestation	Forest	Hydrography	Country Formation	Deforestation
2007	97.96%	97.96%	94.00%	92.31%	96.00%	96.00%	94.00%	96.00%
2008	97.78%	100.00%	94.23%	88.68%	88.00%	100.00%	98.00%	94.00%
2009	95.74%	98.04%	88.89%	89.58%	90.00%	100.00%	96.00%	86.00%
2010	97.62%	96.15%	90.38%	87.04%	82.00%	100.00%	94.00%	94.00%
2011	97.83%	98.04%	95.74%	85.71%	90.00%	100.00%	90.00%	96.00%
2012	91.67%	92.31%	85.45%	88.89%	88.00%	96.00%	94.00%	80.00%
2013	95.24%	96.15%	88.68%	81.13%	80.00%	100.00%	94.00%	86.00%
2014	93.88%	96.00%	96.08%	92.00%	92.00%	96.00%	98.00%	92.00%
2015	88.00%	92.45%	95.65%	86.27%	88.00%	98.00%	88.00%	88.00%
2016	97.62%	98.00%	85.71%	80.77%	82.00%	98.00%	96.00%	84.00%
2017	98.77%	95.15%		86.21%	80.00%	98.00%		100.00%

APPENDIX III – METHODS TO ESTIMATE CARBON STOCKS

Sampling framework

The sampling framework, including sample size, plot size, plot shape and plot location should be specified in the PD. Areas to be sampled in forest classes should be at locations expected to be deforested according to the baseline projections. The sampling areas for non-forest classes should be selected within the reference region at locations that represent a chrono-sequence of 10 to 30 years since the deforestation date.

Temporary or permanent plots

Plots can be temporary or permanent depending on the specific project circumstances, interests and needs, but in general temporary plots should be sufficient. Where changes in carbon stocks are to be monitored, permanent sampling plots are recommended. Permanent sample plots are generally regarded as statistically efficient in estimating changes in forest carbon stocks because typically there is high covariance between observations at successive sampling events. However, it should be ensured that the plots are treated in the same way as other lands within the project boundary, e.g., during logging operations, and should not be destroyed over the monitoring interval. Ideally, staff involved in forest management activities should not be aware of the location of monitoring plots. Where local markers are used, these should not be visible. If trees markers are required (e.g. if plots are also used for ecological or structural monitoring), these should be as unconspicous as possible and no bias in the treatment of plots compared to the surrounding forest must be granted.

Permanent plots may also be considered to reduce the uncertainty of the average carbon density of a forest class undergoing carbon stock changes due to management and to detect changes in carbon stocks induced by climate change or large-scale natural disturbances.

Definition of the sample size and allocation among LU/LC-classes

The number of sample plots is estimated as dependent on accuracy, variability of the parameter to estimate in each class and costs. The sample size calculation also corresponds to the method of samples drawn without replacement. Where at the beginning of a REDD project activity accurate data for sample size estimation and allocation are not available, the sampling size can initially be estimated by using a desired level of accuracy (10% of sampling error at 90% confidence level), and by allocating the estimated sample size proportionally to the area of each class, using respectively equations 1, and 2. Then, once data on carbon stock variability within each class become available, the sample size and allocation is recalculated using the methodology described by Wenger (1984), which also accounts for the cost of sampling (see equations 3 and 4).

Equation 1 was chosen because it works with percentages rather than absolute units (biomass, carbon, or CO2), and coefficient variation data could be easier to find in the literature at the beginning of a project activity. The initial allocation of the sample plots shall be proportional to the area of the LU/LC- classes, but with minimum of 5 plots per class. The t-student for a 95% confidence level is approximately equal to 2 when the number of sample plot is over 30. As the first step, use 2 as the t –student value, and if the resulting “n” is less than 30, use the new “n” to get a new t-student value and conduct the new estimation of the sample size. This process can be repeated until the calculated n is stabilized.

$$n = \frac{t_{st}^2 \cdot (CV\%)^2}{(E\%)^2 + \frac{t_{st}^2 \cdot (CV\%)^2}{N}}$$

Where:

cl = 1, 2, 3, …. Cl LU/LC classes

Cl = Total number of LU/LC classes

tst = t-student value for a 90% confidence level (initial value t = 2)

n = total number of sample units to be measured (in all LU/LC classes)

E% = allowable sample error in percentage (±10%)

CV% = the highest coefficient of variation (%) reported in the literature from different volume or biomass forest inventories in forest plantations, natural forests, agroforestry and/or silvo-pastoral systems.

ni = number of samples units to be measured in LU/LC class cl that is allocated proportional to the size of the class. If estimated ncl < 3, set ncl = 3.

Ni = maximum number of possible sample units for LU/LC class cl, calculated by dividing the area of class cl by the measurement plot area.

N = population size or maximum number of possible sample units (all LU/LC classes)