AGROCORTEX REDD PROJECT

GHG EMISSION REDUCTIONS FROM AVOIDED UNPLANNED DEFORESTATION

Document Prepared By Ecológica Assesoria Ltda.

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1 PROJECT DETAILS

1.1 Summary Description of the Project

Brazil has more than 490 million hectares of forest, covering 59% of its entire territory, putting it in second place for nations with most forest area worldwide[1]. Brazil has at times also been the country with the highest levels of forest loss in the world, for example 53,167,000ha were deforested from 1990 to 2015 at an average rate of 0.4%/year[2]. The expansion of the agricultural frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization have 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 Agrocortex REDD Project is to avoid the unplanned deforestation (AUD) of the 186,219.06 ha project area, consisting of 100% Amazon rainforest. The project area is located within a private property named "Fazenda Seringal Novo Macapá", which is situated in the municipalities of Manoel Urbano, Pauini and Boca do Acre, in the States of Acre and Amazonas, South-western Amazon.

The project proponent is Agrocortex Madeiras do Acre Agroflorestal Ltda., a Brazilian private company responsible for the operations of Agrocortex Florestas do Brasil S.A – the holding. The latter also holds Agrocortex Florestas Tropicais Ltda., which owns another private company named Batisflor Florestal Ltda. – the landowner of Fazenda Seringal Novo Macapá.

In March/2014, the Agrocortex holding company and Batisflor Florestal Ltda. established an agreement to harvest forest products/by-products and non-timber forest products (NTFPs) in the Project Area, in a manner that is consistent with local ecosystem conservation, granting rights of 1) timber harvesting, 2) NTFPs extraction and 3) carbon credits to Agrocortex Madeiras do Acre Agroflorestal Ltda. (hereafter, "Agrocortex" or "the company"). Agrocortex is a sustainable development company engaged in conserving the environment through sustainable forest and NTFP management, generating greenhouse gases (GHG) emission reductions, and NTFPs. Agrocortex started the sustainable forest management operations in June/2014, which defines the project start date because the activity resulted in reduced GHG emissions.

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 projects 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.

The present REDD project is estimated to avoid a predicted 30,006 ha of deforestation, equating to 14,507,808 tCO_2e in emissions reductions over the 30 year project lifetime (01-July-2014 to 30-June-2044).

The project is located in the border between the States of Acre and Amazonas, within the agricultural expansion frontier region, around 25km south of the BR-364, the main highway

[1] FAO. **Global Forest Resource Assessment 2015**: Desk reference. Rome, 2015. 253 p. Available at: <http://www.fao.org/3/a-i4808e.pdf>. Last visited on: 21-March-2017.
[2] FAO. **Global Forest Resources Assessment 2015 Country Reports**: Brazil. Rome, 2014. 148 p. Available at: <http://www.fao.org/3/a-az172e.pdf>. Last visited on: 21-March-2017.

that crosses the State of Acre. 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.

Agrocortex developed a sustainable forest management plan (SFMP) that is certified by the Forest Stewardship Council (FSC), and is considered a tool for forest conservation, maintenance of forest carbon stocks, and decreasing deforestation rates in the project region. These benefits are mainly due to the following:

a) the use of reduced impact logging techniques;
b) reduced social and environmental operational impacts;
c) increased surveillance in the area; and
d) increased economic value from forest resources.

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 Agrocortex REDD Project also establishes a barrier against the advancement of deforestation, making it an important contribution to the conservation of South-western 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 Proponent

Organization name	Agrocortex Madeiras do Acre Agroflorestal Ltda.
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1.4 Other Entities Involved in the Project

Organization name	Ecológica Assessoria Ltda.
Role in the project	Project developer. As the authorized project contract, Ecológica was given the responsibility of developing the present Project Document.
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Role in the project	Project development
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1.5 Project Start Date

The Project Start Date is 02-June-2014. “Fazenda Seringal Novo Macapá” is a private land owned by Batisflor Florestal Ltda, a Brazilian company owned by Agrocortex Florestas

Tropicais Ltda. On 17/March/2014, an agreement was established between the Agrocortex holding company and Batisflor Florestal Ltda., granting rights of timber harvesting, NTFPs extraction and carbon credits to Agrocortex Madeiras do Acre Agroflorestal Ltda. (i.e., the project proponent).

Agrocortex obtained the logging authorization from the Brazilian Environmental Agency[3] for operating the area on 02-June-2014. From this date, the first Annual Production Unit (APU) was harvested through sustainable forest management plan (SFMP) and reduced impact logging techniques. This was 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, the greater presence in the area increased the surveillance, which helps to avoid unplanned deforestation or illegal logging within the project area by external agents.

1.6 Project Crediting Period

The project has a crediting period of 30 years, from 01-July-2014 until 30-June-2044.

1st baseline period : 01/07/2014 to 30/06/2024

2nd baseline period: 01/07/2024 to 30/06/2034

3rd baseline period: 01/07/2034 to 30/06/2044

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Table 1. Indication of the scale of the project

The estimated annual GHG emission reductions or removals for the project crediting period are presented in Table 2 below.

[3] The responsible environmental agency in this case is the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* - IBAMA.

Year	Estimated GHG emission reductions or removals (tCO_2e)
2014 (01-July to 31-December)	51,183
2015	363,852
2016	370,512
2017	376,485
2018	491,423
2019	435,685
2020	390,596
2021	489,483
2022	449,249
2023	505,007
2024	338,555
2025	468,707
2026	476,088
2027	487,839
2028	520,151
2029	509,435
2030	521,492
2031	503,951
2032	510,272
2033	476,462
2034	568,356
2035	558,976
2036	483,932
2037	606,539
2038	572,771
2039	561,932
2040	535,709
2041	487,387
2042	491,965
2043	661,943
2044 (01-January to 30-June)	241,872
Total estimated ERs	14,507,808
Total number of crediting years	30
Average annual ERs	483,594

Table 2. Estimated total and average annual GHG emission reductions

1.8 Description of the Project Activity

The main objective of the present REDD project is the conservation of 186,219.06 ha of Amazon rainforest area within a private land named “Fazenda Seringal Novo Macapá”, 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 with the biggest part of its area (±97%) within the Amazon State jurisdiction which is not covered by a jurisdictional REDD+ program. However, a small part of the project area (±3%) is located within the State of Acre, where there is a proprietary and voluntary nested REDD program which is not validated by the VCS or other Carbon Standard[4].

Agrocortex Madeiras do Acre Agroflorestal Ltda. (i.e., the project proponent) is the company responsible for operations in Brazil, being part of a Brazilian holding company named Agrocortex Florestas do Brasil S.A. The latter also holds Agrocortex Florestas Tropicais Ltda., which owns Batisflor Florestal Ltda., the landowner of Fazenda Seringal Novo Macapá (where the project area is located). Figure 1 below shows the company organization chart.

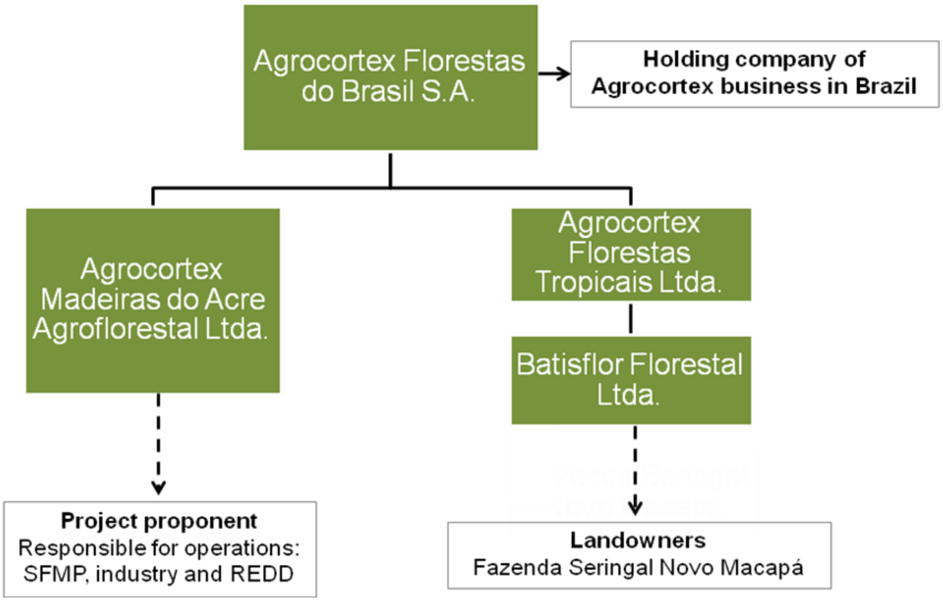


Figure 1. Agrocortex company organization chart

In March/2014, the Agrocortex holding company and Batisflor Florestal Ltda. established an agreement to harvest forest products/by-products and NTFPs in a manner consistent with the conservation of the local ecosystem, granting rights of timber harvesting, NTFPs extraction and carbon credits to Agrocortex Madeiras do Acre Agroflorestal Ltda. Since June/2014, Agrocortex has been harvesting timber according to the sustainable forest management plan using reduced impact logging techniques. The FSC-certification for the sustainable forest management plan was obtained in July/2015.

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

[4] The ISA Carbon Program of Acre is the Jurisdictional REDD+ Program of the State of ACRE. More information on the ISA Carbon Program of Acre is available at: <https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000005599>. Last visited on April 12th, 2017.

of markets in the Amazon region and international development policies planned for the region[5].

The main deforestation and degradation agents within the Agrocortex REDD project region are: cattle ranching, mainly producing beef; timber harvesters, acting both legally and 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[6], the municipalities of Manoel Urbano, Pauini and Boca do Acre (which contain the project area in its entirety) were among the municipalities with the highest accumulated deforestation in the States of Acre and Amazonas up until 2014, a result of the disorganized occupation and the lack of economic alternatives for local communities and land owners. 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, the rate of deforestation has been decreasing since 2003, reaching an average annual value over the 2010-2013 period of 0.04%/year (550 km²/year) in the State of Amazonas, and 0.18%/year (265 km²/year) in the State of Acre. However, the annual deforestation rate within the Agrocortex project's reference region was higher, reaching an average of 0.21%/year in the same period. The figure below displays a comparison between the 2000 to 2013 annual deforestation rate in the States of Acre and Amazonas and also in the project reference region.

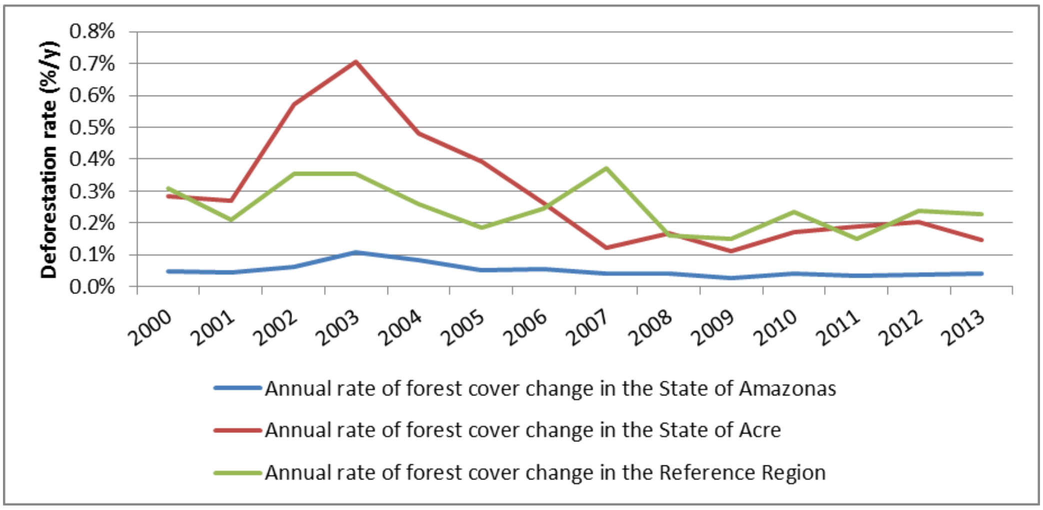


Figure 2. Comparison between the annual rate of forest cover change in the project reference region and in the States of Acre and Amazonas, for the 2000 – 2013 period[7]

Through the present project activity, Agrocortex Madeiras do Acre Agroflorestal Ltda. 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 the prevent invasion of illegal deforestation by outside agents and banning of unplanned logging and other unpermitted degradation within the project area.

[5] 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.
[6] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on 28-March-2017.
[7] The annual deforestation rate was calculates through Puyravaud, J.-P. (2003), "Standardizing the calculation of the annual rate of deforestation." Forest Ecology and Management, 177: 593-596

Forest supervision is carried out by a supervision team from within the project region, who live in the project area and also in the neighboring city of Manoel Urbano. The supervision team also monitors the area through satellite images, however, authorized personnel are always present at the main access point to the project area, which is located in the South of the project area. Access to the project area is restricted, and can only be entered by the main entrance or by the harbour entrance on the Purus River.

Agrocortex provides boats, motorcycles and cars (pickup trucks) for the use of the supervision team. In the case of identifying any deforestation/degradation risks, enforcement actions are taken immediately following an established action plan, which may include overflights to the identified areas.

Other measures used to avoid deforestation are:

- Forest fire prevention and fire fighting training. All management personnel are required to participate in the training session. Training session invitation are also sent to stakeholders within the local community;

- Training of fire brigades, periodic maintenance of fire extinguishers, periodic maintenance of forest machinery,

- Utilization of signs indicating the area of forest management, prohibition of fire, and periodic monitoring by satellite images of the entire project area.

Only reduced impact logging activities have been carried out within the project area because the main objective of the project owner is forest conservation combined with sustainable forest management, along with other activities related to the collection of non-timber forest products (NTFPs).

Thus, the greater presence of Agrocortex in the area mainly due to sustainable forest management activities increased the surveillance and control, which helped to avoid unplanned deforestation, illegal logging or invasions within the project area by external agents.

The *ex ante* estimate for the predicted avoided deforestation within the project area over the 30 years project lifetime is 30,006 ha. The avoided emissions due to the Agrocortex REDD AUD Project are expected to be 12,196,848 tCO_2e across the project crediting period (01-July-2014 to 30-June-2044), 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.

Background on Sustainable Forest Management Plans within the Agrocortex REDD Project Area

The project proponent developed a sustainable forest management plan (SFMP) that was certified by FSC. The use of the forest under SFMPs depend on prior authorization by the responsible environmental agency, which in this case is the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* - IBAMA. The procedures and guidelines for forest management of the area are described below, aiming to achieve economic, social and environmental benefits.

According to environmental experts, SFMP is an advantageous and productive method to save the Amazon forests from the deforestation agents and drivers. The forest resource must be used in a sustainable way, meaning that economic value must be extracted in a renewable manner If there is no alternative way to utilize natural resources of the region in a sustainable way, there will be a predominance of illegal economic options for forest use with no gains for the local population[8].

In July/2015, Forest Stewardship Council (FSC) Certification for Forest Management (FSC-C121950) and Chain of Custody (FSC-C127203) were applied to the project region. FSC equates sustainable forest use to low-impact harvest systems associated with forest longevity, continued ecological balance, socio-environmental responsibility and financial efficiency.

The Project Proponent is the only authorized company in Brazil to harvest Mahogany (*Swietenia macrophylla King*). In order to receive the sustainable logging authorization, the project proponent did extensive work with the local communities and environmental institutions to assess if the harvesting of Mahogany had negative repercussions on the local biodiversity.

The level of exploitation of this species has led to the exhaustion of supplies particularly in the Amazon. Regeneration of the species is stochastic, depending in nature on large-scale disturbance. This ecological strategy makes Mahogany vulnerable to logging regimes. There is, at present, little economic incentive to manage natural stands sustainably. Mahogany was classified within the vulnerable category, according to the International Union for Conservation of Nature – IUCN.

Having a reddish-brown color, high durability and easy handling for different types of industry, Mahogany conquered the world in the 1980s and 1990s. At that time, Brazilian Amazon was attacked by loggers and invaders, who stole wood for taking them to be processed in clandestine sawmills[9].

The predatory exploitation of Mahogany in Brazil made IBAMA prohibit any sale of the product in the country. In 2003, Mahogany entered to the list of prohibited species in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

[8] GRISOTTO, R. Exploração do Mogno pode trazer vantagens para a Amazônia. **Época Negócios**, 08/06/2016. Editora Globo. Available at: <http://epocanegocios.globo.com/Brasil/noticia/2016/06/nova-fronteira-do-mogno.html>. Last visited on: 08-April-2017.

[9] GRISOTTO, R. Exploração do Mogno pode trazer vantagens para a Amazônia. **Época Negócios**, 08/06/2016. Editora Globo. Available at: <http://epocanegocios.globo.com/Brasil/noticia/2016/06/nova-fronteira-do-mogno.html>. Last visited on: 08-April-2017.

In order to regulate the sustainable exploitation of Mahogany, the Brazilian government created in 2006 specific guidelines on how to catalog trees in the forest, organize cutting and track production. According to Brazilian legislation for sustainable forest management located in the Amazon biome:

- A minimal cutting cycle of 25 years must be applied; and

- The maximum cutting level is 30 m^3/ha (4 – 6 trees/ha) in reduced impact plans, provided that the trees have minimum diameter of 50cm for felling for all species for which specific felling diameters have not yet been specified; and

- At least 10% of the remaining trees per species in the effective exploration area are guaranteed, respecting the minimum limit of preservation of at least 3 trees per species per 100 ha, in each subdivision of the plot. For vulnerable species, those figures are stricter: 15% of the remaining trees per species in the effective exploration area shall be guaranteed, and at least 4 trees per species per 100 ha shall be preserved; and

- The annual productivity of the managed forest area is 0.86 m^3/ha/year, such that at the end of 35 years, the maximum cutting level allowed (30 m^3) could be recovered, thus completing one cycle[10,11,12,13].

- Legal reserve areas established by the Brazilian Forest Code[14] can be harvested for production of goods and services, subject to the approval of the SFMP by the relevant environmental body.

In 2000, a sample forest inventory within the SFMP area consisting of 144 plots of 1 hectare each was developed. 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 30 large Annual Production Units (APUs), which constitute the forest areas to be managed for the next 30 years (operation cut cycles). In this way, APU1 which was harvested in 2012 (before Agrocortex), will be harvested next in 2042, and again in 2072, which ensures the regeneration and preservation of the ecosystem.

Although the total property area has 190,210 ha, the forest management area equates to 186,000 ha (97.8%). According to the Brazilian Forest Code, permanent preservation areas (PPA) at the borders of waterways shall be comprehensively preserved. An additional 5%

[10] SERVIÇO FLORESTAL BRASILEIRO (SFB). **Florestas do Brasil em resumo - 2010:** dados de 2005-2010. Brasília, 2010. 152 p.

[11] BRASIL. Conselho Nacional do Meio Ambiente (CONAMA). Estabelece parâmetros técnicos a serem adotados na elaboração, apresentação, avaliação técnica e execução de Plano de Manejo Florestal Sustentável - PMFS com fins madeireiros, para florestas nativas e suas formas de sucessão no bioma Amazônia. Resolução nº. 406, 02 February 2009. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 06 Feb. 2009.

[12] BRASIL. Ministério do Meio Ambiente. Dispõe sobre procedimentos técnicos para elaboração, apresentação, execução e avaliação técnica de Planos de Manejo Florestal Sustentável-PMFSs nas florestas primitivas e suas formas de sucessão na Amazônia Legal, e dá outras providências. Instrução Normativa nº. 5, 11 December 2006. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 13 Dec. 2006.

[13] BRASIL. Ministério do Meio Ambiente. A aprovação de Planos de Manejo Florestal Sustentável – PMFS e seus respectivos Planos Operacionais Anuais – POA, quando envolver a exploração de espécies constantes na "Lista Nacional Oficial de Espécies da Flora Ameaçadas de Extinção" – Lista, classificadas na categoria Vulnerável – VU, no bioma amazônico, deverá considerar os seguintes critérios. Instrução Normativa nº. 1, 12 February 2015. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 13 Feb. 2015.

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

was designed as protection area from FSC-certified sustainable forest management. Moreover, some area was considered to be inaccessible or unusable due to the natural conditions of the area (presence of slope or swamps).

Therefore, 175,707.55 ha (92.4% of total property area) are subject to SFMP. The adopted rotation cycle is 30 years, thus each annual productive unit (APU) has around 5,856.9 hectares. Figure 3 below shows the location of each APU and protection areas within the Agrocortex area.

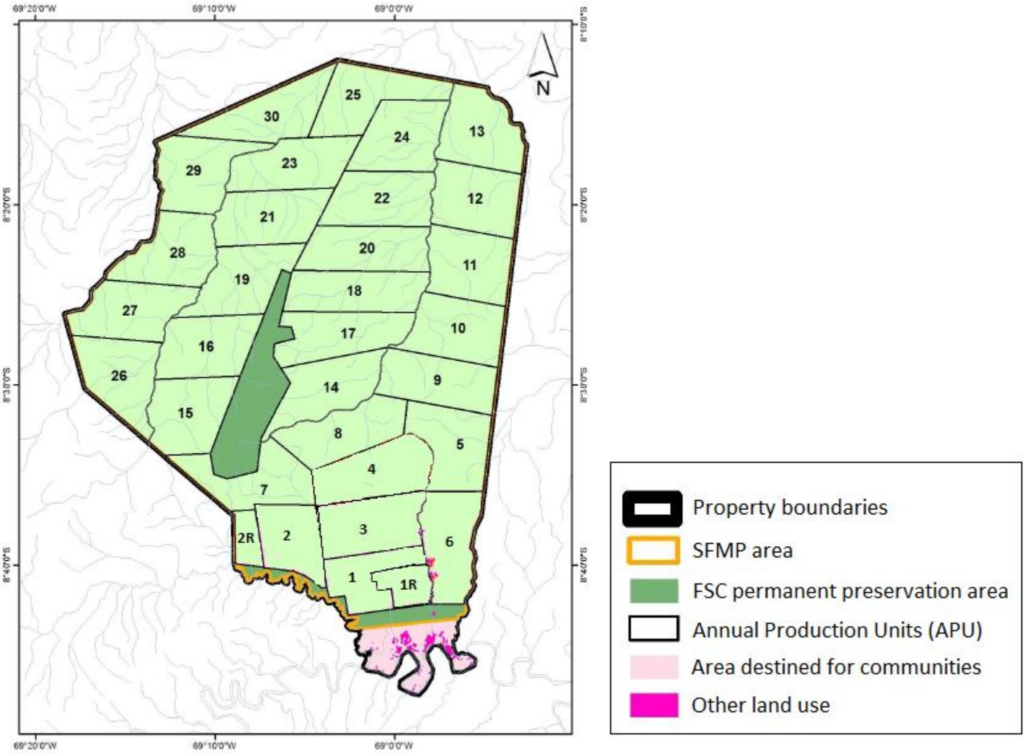


Figure 3. Location of each APU within the Sustainable Forest Management Plan area

Before starting an annual harvesting cycle, a 100% forest inventory of each APU shall be carried out, considering a Diameter at Breast Height (DBH) ≥ 30 cm for commercial species and ≥ 10 cm for Mahogany. The geographic coordinates of all measured trees are collected through a GPS. Furthermore, tree selection is conducted according to technical and ecological criteria to promote regeneration of managed tree species, soil preservation and quality of remaining forest.

A Light Detection and Ranging (LIDAR) tool, which has a high-resolution of 1.5m, is used to establish an aerial map of the area as well as identify the protection areas and design the roads and trails for the SFMP. This data also allows the generation of the Digital Terrain Model and the Digital Drainage Model. From these models, it is possible to generate level curves and to identify PPAs according to legislation. With the aforementioned models and the spatial distribution of the selected trees for cutting, Agrocortex precisely plans the infrastructure construction in each APU, such as opening of main and secondary roads, skidding trails[15], and timber yards, estimated to be around 1% of each APU.

[15] Skidders are tractors which extract the tree from the felling site by lifting the butt end up from the ground and pulling the tree with the crown dragging along the ground to the timber yard.

The construction of the infrastructure is carried out in accordance with techniques provided by the Tropical Forest Institute (*Instituto Floresta Tropical* - IFT), an NGO that promotes the adoption of good practices in sustainable forest management, ensuring the conservation of natural resources and improvement of life quality of the population[16].

Finally, an Annual Harvesting Operational Plan shall be developed, which also depends on prior authorization by IBAMA. This Plan details all forestry measures that will be adopted for each APU, such as harvesting techniques, construction of secondary roads and decks (taking into consideration permanent preservation areas - PPA), liana cutting, and installation of permanent preservation plots. Figure 4 below shows an example of the planning of activities and infrastructure construction within the Agrocortex SFMP, taking into consideration the location of selected trees for cutting and PPAs.

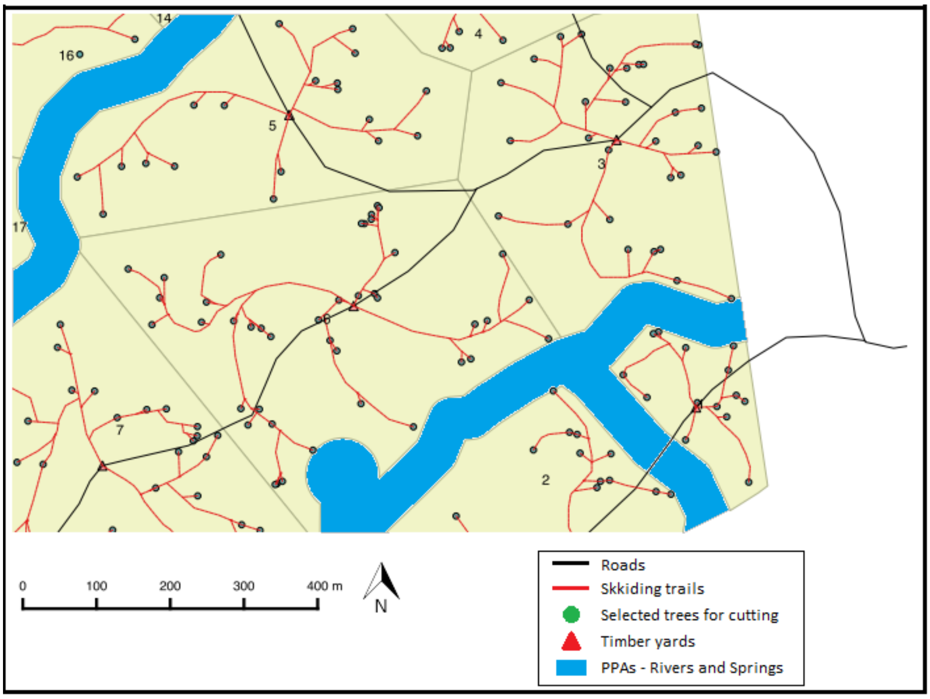


Figure 4. Planning of SFMP activities

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.

The maximum cutting level adopted by Agrocortex is 25.8 m^3/ha, which is 14% lower than the legal harvesting volume allowed by Law. However, due to conservation measures, the actual logging intensity carried out by Agrocortex is around 9 m^3/ha, which is far below the legal harvesting limit.

According to specific legislation, Mahogany trees shall have minimum diameter of 60cm for felling. At least 20% of the remaining Mahogany trees in the effective exploration area shall

[16] Available at: <http://ift.org.br/>. Last visited on: April 26th, 2017

be preserved, respecting the minimum limit of preservation of at least 5 trees per 100 ha, in each subdivision of the plot[17].

After each annual harvesting cycle, each APU shall be monitored in an established frequency, evaluating the natural regeneration and increment rates within permanent plots, damages and wastes, and planting of some native species (including Mahogany).

Permanent plots are installed annually at each APU in order to analyze the development of the managed forest, which are monitored at each five years. During the process of selecting and preserving trees for cutting, trees of all species are preserved, ensuring the perpetuity and diversification of the forest.

Table below describes each phase of the SFMP[18].

Year	Operations
Initial procedures	• Sample forest inventory in the complete forest management area; • Macro-zoning; • Location of main roads and access paths.
Y-1	• Delineation of the Annual Production Unit (APU); • 100% forest inventory, considering a DBH ≥ 30 cm for commercial species and DBH ≥ 10 cm for Mahogany; • Selection of trees for logging, for conservation (seeds or prohibited for harvesting) or for future logging (after 30 years); • Cutting of lianas and vines of all trees selected to be logged; • Micro-zoning (waterways, topography, etc); • Construction of roads and access paths; • Permanent plots implementation; • Forestry planning and submission of the Annual Harvesting Operational Plan to IBAMA.
Y0	• Construction of infrastructure (secondary roads and decks); • Training of all employees in reduced impact logging techniques; • Harvesting operations following reduced impact logging; • Planning of skid trails and utilization of skidders; • Chain of custody control; • Transportation of logs; • Seeds collection.
Y+1	• Identification of forest clearings for enrichment planting; • Planting of Mahogany and other native species; • Evaluation of damages and wastes during the harvesting; • Measurement of remaining Mahogany trees;

[17] BRASIL. Ministério do Meio Ambiente. Dispõe sobre a necessidade de adequar os procedimentos relativos às atividades de Plano de Manejo Florestal Sustentável que contemplem a exploração da espécie Mogno (*Swietenia macrophylla King*). Instrução Normativa nº. 7, 22 August 2003. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 26 Aug. 2003.

[18] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

	• Maintenances of permanent infrastructure, natural regeneration and enrichment planting.
Y+2 to Y+5	• Monitoring of permanent plots; • Measurement of planted trees in order to analyze growth and survival; • Maintenance of natural regeneration and enrichment planting; • Measurement of remaining Mahogany trees.
Y+10	• Monitoring of permanent plots; • Measurement of planted trees in order to analyze growth and survival; • Maintenance of natural regeneration and enrichment planting; • Measurement of remaining Mahogany trees.
Y+15 to Y+20	• Monitoring of permanent plots at each 5 years; • Maintenance of natural regeneration and enrichment plantings; • Measurement of remaining Mahogany trees at each 5 years.
Y+30	• Beginning of the second cutting cycle.

Table 3. Main forestry measures and operations to be conducted by Agrocortex in the SFMP

The applied forestry management system is based on the following fundamental steps to seek long-term sustainability:

1. Careful planning for sustainable forest harvesting, with the purpose of reducing damages to the remaining forest stock and increase productivity;

2. Apply Reduced Impact Logging (RIL) techniques and maintain the SFMP certification in order to conserve the forest and the biodiversity;

3. Application of post-harvest forestry treatments allowing for a better regeneration and growth for the next cycle;

4. Monitoring growth, mortality and natural regeneration of the forest to assist technical and administrative decisions.

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

a. Achieve a constant and economically satisfactory production with minimal impact to the residual forest;

b. Conduct natural regeneration, inducing advanced regeneration for higher diameter tree classes;

c. Increase forest productivity through enrichment planting of Mahogany intercropped with other forest species in clearings and maintenance during the cutting cycle;

d. Reduce and control the population of bamboos, lianas and vines.

The industrial complex of Agrocortex is located in the city of Manoel Urbano/AC, on the banks of the Purus River, outside the property area. It consists of 10 sawmills, as well as 20 greenhouses for drying and storage sheds. The company supplies its products to clients in Brazil, Asia, Europe and United States.

The main purpose of the Chain of Custody is to guarantee the origin of each tree and its respective logs, i.e., it certifies that a given tree has been exactly explored from a known area, making it possible to return to the stump if necessary. The control begins during the forest inventory, where a tag is nailed to all inventoried trees, containing data and GPS coordinates that allow their tracking. After harvesting the selected trees, the inventory tag is attached to the stump of the tree and to the wood log, which will be identified during the whole process until reaching its final client.

The Company seeks to maintain local traditional culture and to insert communities in its production chain, generating employment and regional development. Agrocortex also promotes training to workers in reduced impact logging, safety at work, occupational health and safety, first aid and firefighting. The reduced impact logging conserves the forest structure, not impacting the subsistence hunting and fishing for local communities.

It is estimated that the forest management and industrialization carried out by Agrocortex results in roughly 400 direct jobs and 300 indirect jobs, totaling around 700 employment opportunities, causing a great positive impact on the local economy. It is more than 8% of the 8 thousand inhabitants of Manoel Urbano. Currently, from all Agrocortex workers employed in management and industrial activities, 70% come from local communities - Boca do Acre and Manoel Urbano municipalities, and 15% from the capital of the State of Acre - Rio Branco.

All employees are trained in partnership with the National Industry Service (*Serviço Nacional de Aprendizagem Industrial* - SENAI) or the Tropical Forest Institute (IFT) in order to perform different roles – reduced impact logging, chainsaw operators, truck and machines drivers, as well as factory operations. New jobs may be created with the construction of a power plant with a capacity of 5 megawatts, which will operate with wood residues generated from industrial processing - enough to supply energy for the entire city of Manoel Urbano, including Agrocortex operations.

In addition to the generation of jobs, Agrocortex stimulates local commerce through the purchase of products from local sources, generating income and development for local residents. This includes, for example, a sewing workshop that maintains and recycles workers' uniforms.

Despite the importance of sustainable forest management for climate change adaptation and mitigation, their implementation is not considered common practice, primarily due to the shortage of human resources and funding required to implement the necessary measures[19].

Implementation of REDD and SOCIALCARBON mechanisms together with FSC-certified 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

[19] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO). 10. **Forest management and climate change:** a literature review. Rome, 2012. 53 p.

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[20].

1.9 Project Location

The Agrocortex REDD Project is situated in three municipalities within the South-western Amazon region: Manoel Urbano in the State of Acre (AC), and Pauini and Boca do Acre, in the State of Amazonas (AM). The project area is composed of one single property (in Portuguese: *Fazenda*) covered almost in its totality by native vegetation: Fazenda Seringal Novo Macapá, totaling 190,210 ha.

There are two transport options to reach the project area. The main one leaves from Sena Madureira, in the State of Acre. This city is located around 145 km from the Acre State capital, Rio Branco. From this city, it is about 70 km by car: it is necessary to take the BR-364 towards the municipality of Manoel Urbano (approximately 45 km), and then take a municipal road northwards to the main base of the project area (around 26km). The second option is by boat, two hours down the Purus River northwards. This option is only available during the rainy season (from October to April), making it difficult to reach the area by boat during the dry season.

Project Area

In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, the project area may only include areas composed of “forest”[21] for a minimum of ten years prior to the project start date. Satellite images from 2003 and 2013 were analyzed and classified. Images from those years were chosen due to the lack of availability of images for the first semester of 2014 (before the Project Start Date).

A portion of land measuring 3,690.22 ha located on the south border of Fazenda Seringal Novo Macapá was excluded from the Project Area, as it is expected that the ownership of this area will be transferred to the local community in the near future. The remaining areas within Fazenda Seringal Novo Macapá that were defined as forest in 2013 and in 2003 were identified 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 5 below, the size of the areas that were considered “non-forest” (i.e. deforested areas, non-forest vegetation, hydrography or rock formations) within the project area at the project start date was 300.72 ha. This was excluded from the initial area of 190,210 ha, resulting in 186,219.06 ha, which was then defined as project area. The full contour coordinates of the project area are found in Appendix I.

[20] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO). 10. **Forest management and climate change:** a literature review. Rome, 2012. 53 p.

[21] Brazilian Forestry Service. Brazil adopts FAO forest definition: “Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity *in situ*.” Available at: <http://www.florestal.gov.br/snif/recursos-florestais/index.php?option=com_k2&view=item&layout=item&catid=14&id=158>. Last visited on: 24-March-2017.

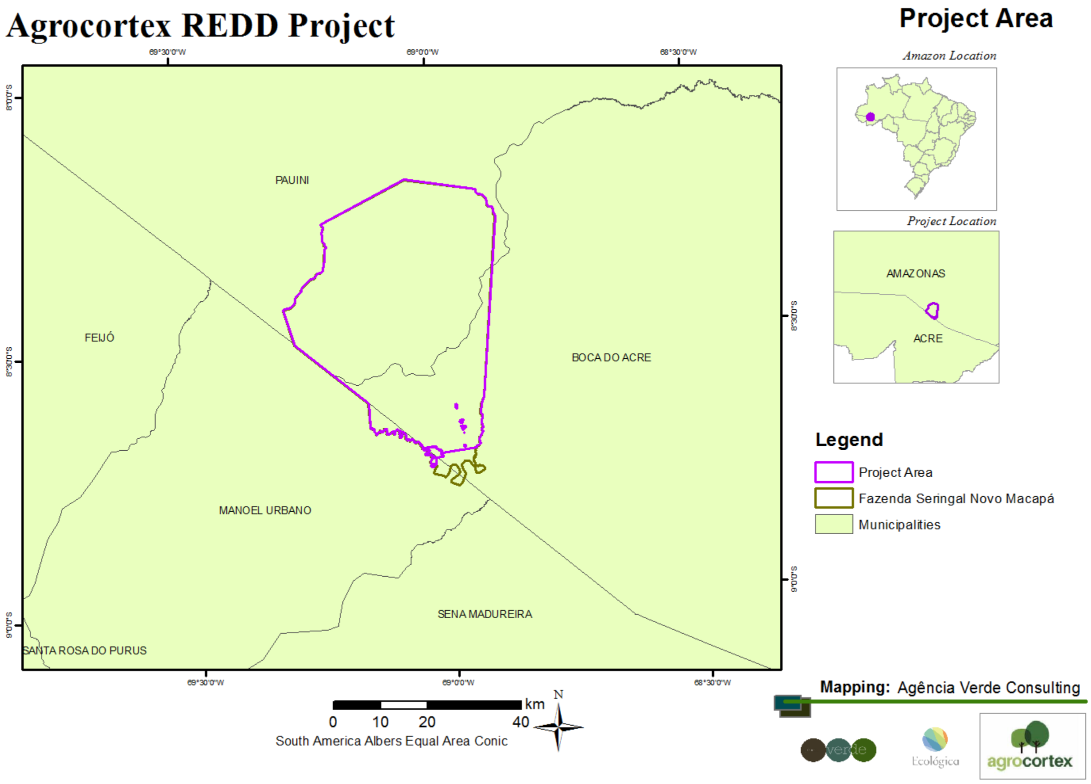


Figure 5. Agrocortex REDD project area

- Definition of the property boundaries

The project area borders used in the Agrocortex REDD Project were extracted from technical appraisals (Portuguese: *laudos*) registered at an official notary and at INCRA[22]. Vectorization – which is the process of converting the appraisal documents into digital shapefiles and polygons, being formats compatible with GIS software – was conducted using ArcGIS and ArcCatalog software.

The technical appraisals were double checked against the descriptive memorandum of the property, which shows the property limits through geographic coordinates. In addition, the hydrographic limits were also utilized because the rivers delineate the property in some locations.

- Historical reference period

The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. In accordance with the methodology, this period must not exceed 10 – 15 years in span and end as close as possible to the REDD project start date (≤2 years). The project start date is 02-June-2014 and the historical reference period comprised analysis of images from 1999 to 2013. Sufficient satellite images covering the reference region referring to this period were available, with low presence of cloud cover.

[22] Instituto Nacional de Colonização e Reforma Agrária (INCRA): http://www.incra.gov.br/

- Image classification

For the image classification of the reference region, satellite images from Landsat 5 (Thematic Mapper (TM) sensor), images from Landsat 7 (Enhanced Thematic Mapper (ETM) sensor), and images from ResourceSat 1 (LISS3 sensor) were found for the 1999-2013 period (Table 4 below). Images from 2013 were also used for the calibration of the projection model, as described in section 2.4 below. Two images were necessary to cover the whole Reference Region, being the following orbit-points respectively: 002/066 and 003/-066. A total of 31 satellite images were necessary to compose the reference region during the historical reference period. These images were downloaded from U.S. Geological Survey (USGS)[23].

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	DD/MM/YY	Path/ Latitude	Row/ Longitude
Landsat 5	TM	30	0.45 - 12.5	31,820	08/07/1999	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	20/04/1999	002	066
Landsat7	ETM	30	0.45 - 12.5	31,820	07/07/2000	003	066
Landsat7	ETM	30	0.45 - 12.5	31,820	20/08/2000	002	066
Landsat 7	ETM	30	0.45 - 12.5	31,820	29/07/2001	003	066
Landsat 7	ETM	30	0.45 - 12.5	31,820	07/08/2001	002	066
Landsat 7	ETM	30	0.45 - 12.5	31,820	04/10/2002	003	066
Landsat 7	ETM	30	0.45 - 12.5	31,820	10/08/2002	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	15/10/2003	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	09/10/2003	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	15/09/2204	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	08/09/2004	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	01/08/2005	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	10/08/2005	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	05/09/2006	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	17/09/2006	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	24/09/2007	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	31/07/2007	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	12/10/2008	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	18/08/2008	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	13/09/2009	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	06/09/2009	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	16/09/2010	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	25/09/2010	002	066
Landsat 5	TM	30	0.45 - 12.5	31,820	18/08/2011	003	066
Landsat 5	TM	30	0.45 - 12.5	31,820	30/10/2011	002	066
ResourceSat 1	LISS3	23.5	0.62 - 1.70	141	01/09/2012	306	082
ResourceSat 1	LISS3	23.5	0.62 - 1.70	141	20/07/2012	307	082
ResourceSat 1	LISS3	23.5	0.62 - 1.70	141	08/08/2012	306	083
Landsat 8	OLI	30	0.64 - 1.65	185	08/09/2013	003	066
Landsat 8	OLI	30	0.64 - 1.65	185	01/09/2013	002	066

Table 4. Data used for historical reference period

As mentioned above, all the images from 1999 to 2013 could be obtained. All the images were then processed through a band composition method (bands 1 – 5), since this composition enabled the mapping analysis in both real and false colours. The following bands and wave-lengths were utilized:

[23] U.S. Geological Survey. Available at: <http://www.usgs.gov/>. Last visit on: February 03rd, 2015.

- Band 1 – Visible (0.45 – 0.52 µm) = blue
- Band 2 – Visible (0.52 – 0.60 µm) = green
- Band 3 – Visible (0.63 – 0.69 µm) = red
- Band 4 – Near infrared (0.76 – 0.90 µm)
- Band 5 – Mid infrared (1.55 – 1.75 µm)

The first step of the automatic classification of land-use in the reference area was done on MultiSpec software [24], using images from the Landsat 5, Landsat 7, Landsat 8, and ResourceSat satellites, and in accordance with their minimal 30m resolution – the minimum mapping unit (MMU) was defined at 30x30m (0.09ha), therefore easily meeting the methodology requirement that the MMU cannot be larger than 1ha.

Tests were carried out using unsupervised classification with the *cluster* method of the Idrisi software, which identifies land uses by grouping histogram values into their most common values. However, these tests yielded poor quality results in terms of high variation of pixel colour for a single land use, and poor distinction between different land-uses, indicating low correlation with the real scenario.

Thus, tests using supervised classification with the maximum likelihood classifier tool were carried out. This classification required a specialist to identify land-use classes in the region, following which the software utilized those classes as a reference to carry out the automatic classification of the whole image. These tests yielded good quality results in terms of distinction between different land-use classes.

Nevertheless, before carrying out all the images classification, some samples were subjected to a consistency and quality analysis through the Kappa index check, which is recommended to be above 80% in order to show a significant correlation with the reality[25].

The supervised classification utilized the following three land use classes:

1- Forest;
2- Non-forest (exposed soil, agricultural lands, pasturelands, fires, cities or population clusters, etc);
3- Hydrography.

After this classification, a high general performance was obtained, almost all of them having a Kappa index value above 93%. Therefore, there was a high correlation with the reality, and few pixels remained in other non-categorized classes.

A post-classification refinement process within the reference region was necessary, which involved manual adjustment to improve cloud obstruction of images, comparing images with previous and subsequent years to determine whether obscured areas were forest or not. This was also necessary to remove "debris", or isolated pixels, left behind by the supervised classification method.

[24] Developed by Pardue University in partnership with NASA, School of Electrical and Computer Engineering, ITaP and LARS for the multispectral and hyper spectral analysis of satellite images. Available at: <https://engineering.purdue.edu/~biehl/MultiSpec/description.html>. Last visit on: December 15th, 2014.

[25] The kappa statistic (or kappa coefficient) is the most commonly used statistic for measuring the agreement between two or more interpretations. A kappa of 1 indicates perfect agreement, whereas a kappa of 0 indicates agreement equivalent to chance. A commonly cited scale (Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-74.) used for many interpretation analysis establishes that the agreement range between 0.81–0.99 corresponds to an almost perfect agreement. According to: VIERA, Anthony J.; GARRETT, Joanne M.. Understanding Interobserver Agreement: The Kappa Statistic. **Family Medicine,** North Caroline, v. 37, n. 5, p.360-363, May 2005.

The year 2003 was then utilized to exclude forests that are less than 10 years old at the project start date from the project area. Finally, the "hydrography" class was defined as constants throughout the historical reference period, and the same class was applied for each mapped year, as those values did not significantly vary across the analyzed period.

For the present project, the process of accumulating "Non Forest" areas was adopted, in such a way that areas classified as "Non Forest" in one year were necessarily included in the same category in the following year.

The project area contains only areas which were defined as "forest" in 2003 (more than 10 years prior to the project start date), as depicted in the forest cover benchmark maps in Figure 6 below.

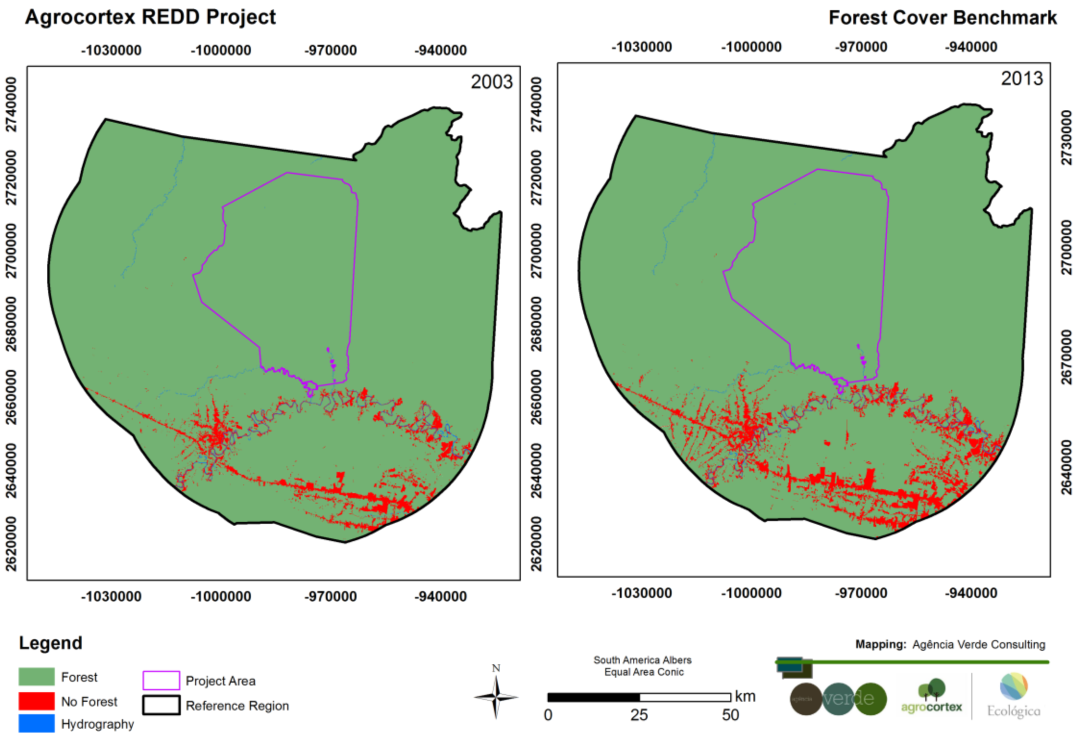


Figure 6. Forest cover benchmark maps, comparison between 2003 and 2013

Classification was first conducted for the whole Reference Region and subsequently cropped to the Leakage Belt and Project Area. The classification of the images was carried out in accordance with the VM0015 methodology. The classified images of the reference region, project area and leakage belt by year follow in Section 2.4 – Baseline Scenario below.

<u>The 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.

The RR was defined in accordance with two criteria:

- The methodology recommendation that projects over 100,000 ha in size should have RRs 5 to 7 times bigger than the project area.
- The conditions determining the likelihood of deforestation within the project area being similar or expected to become similar to those found within the reference region,

depending on: the landscape configuration and ecological conditions (elevation, slope, vegetation, and rainfall), socio-economic and cultural conditions, and agents and drivers of deforestation (agent groups, infrastructure or other drivers). The latter condition was the most important for adjusting the RR in order for it to more accurately represent the land-use dynamics. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the main means of human and product transportation in the region.

As detailed above, the majority of the project area is located in the south of the State of Amazonas, in municipalities that are in the list of regions with increasing land conflict, expansion of livestock and history of increase of deforestation rate. A small part of the project area is located in the State of Acre, in the municipality that is in progressive development due to the construction of roads linking other important municipalities of Acre.

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

The municipalities are within the South-Western Amazon region and belong to the Purus River Basin. In this basin the Tropical rainforest with bamboo and Tropical rainforest with palm trees are predominant. This is a region of medium to high vulnerability according to existing natural resources. The Purus Sub-region is known for integrating the States of Acre, Amazonas and Rondônia through the navigability of the rivers, mainly the Purus River, where exists the flow of agricultural production and also extractive products to Manaus/AM or Porto Velho/RO. In addition to navigable hydrography, other modes such as roads and openings of new accesses for the transportation of products of the region were considered for defining the Reference Region.

Thus, based on the project area definition, the Reference Region was delimited encompassing the leakage belt. The criterion of the minimum area was adopted as mentioned in the applied methodology. A concentric buffer was developed around the Project Area with a size 7 times greater than the project area. As the project area totals 186,219.06 ha, the reference area would need to have a limit of up to 1,300,000 ha. After this first delimitation, adjustments were made based on:

- Agents and drivers of deforestation expected to cause deforestation within the project area in absence of the proposed REDD project activity (i.e., cattle ranching and agriculture) caused deforestation in the reference region during the historical reference period;
- History of deforestation and economic growth of the region, expansion of the agricultural frontier, limits of the arc of deforestation, land conflicts, land structure in the region (presence of conservation units, indigenous lands and agrarian reform settlements);
- Existing infrastructure with the presence of navigable rivers, roads and highways and their respective production outflow routes;

- Socioeconomic characteristics of the municipalities involved, such as Gross Domestic Product (GDP), concentration of population in urban or rural areas and main economic products;
- The legal status of the land and the land tenure system found within the project area, i.e. private land, is also found in the reference region;
- Current and projected land use within the project area are found in the reference region;
- The project area is governed by the same policies, legislation and regulations that apply in the reference region;
- Elevation, Slope, Climate and Forest Classes characteristics in the Project Region: at least 90% of the project area have landscape configurations and ecological conditions that exist in at least 90% of the rest of the reference region.

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

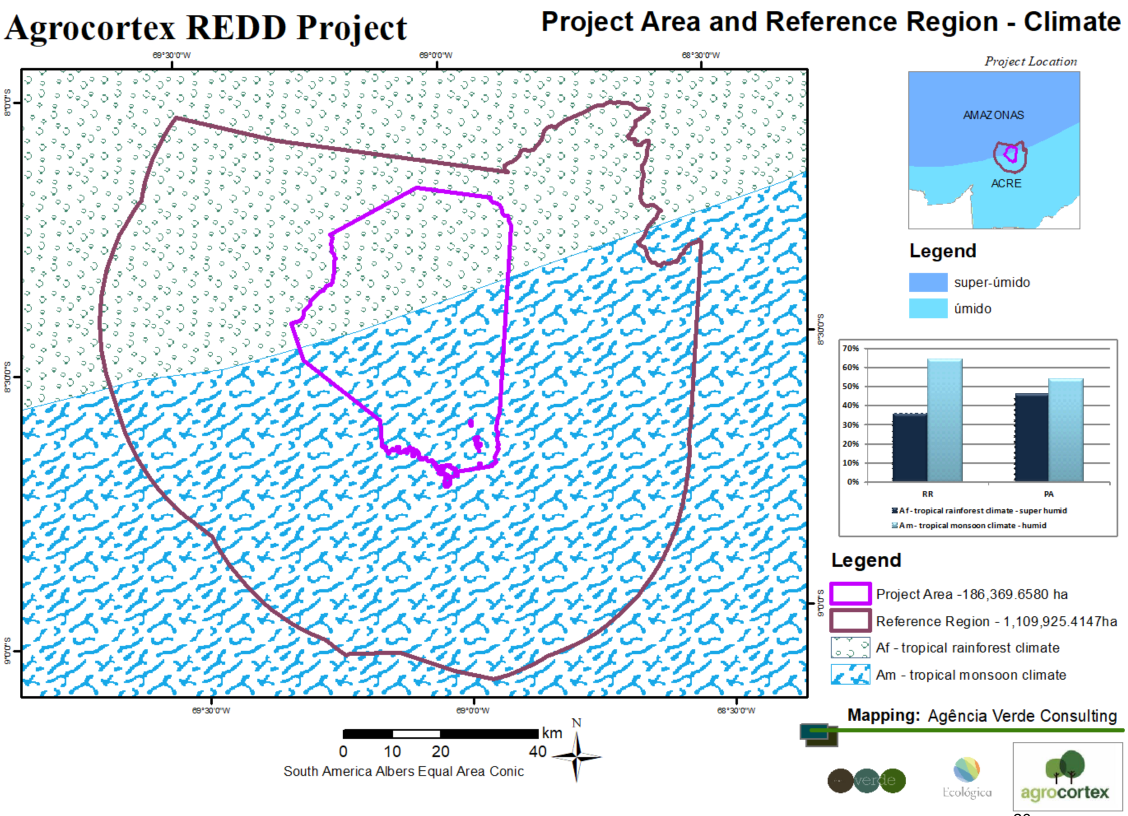


Figure 7. Climate conditions in the project region according to the Köppen climate classification[26], detail to the Project Area location (in yellow), showing similar climate conditions in the project region

[26] The climate of the Amazon region is predominantly tropical and has little regional variations during drought periods in certain months of the year. According to the Köppen-Geiger Climate Classification, there are two climatic typologies for the Reference Region, Af and Am. This classification is based on phytosociology and local ecology. Both Reference Region and Project Area encompass the general classification "A", first letter, which indicates that the climate is tropical. The second letter of the classification refers to precipitation, so the typology "f" indicates equatorial precipitation, which means that it is a super humid region, warm and with average temperature above 18°C all year. The typology "m", indicates that the climate is tropical monsoon, which is humid, with average temperature above 18°C all year, but with 1 to 2 dry months. Both Project Area and Reference Region have the two climate types with predominance of the Am climate in the south of the areas and Af climate in the north of the areas. Source: Brazilian Institute for Geography and Statistics (IBGE, 2018) and Brazilian Environmental Agency (MMA, 2018).
Available at: <https://downloads.ibge.gov.br/downloads_geociencias.htm> and <http://mapas.mma.gov.br/i3geo/datadownload.htm>. Last visited on: 12-March-2018.

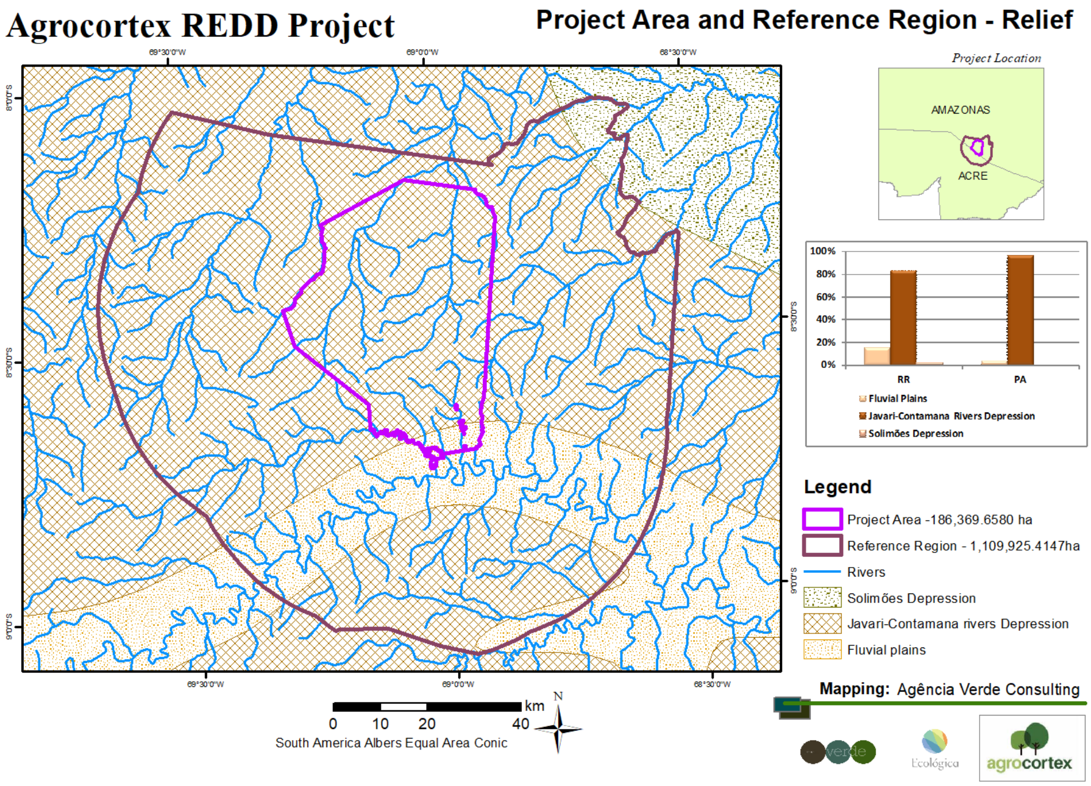


Figure 8. Relief types existing in the project region, showing similar relief conditions in the project region[27]

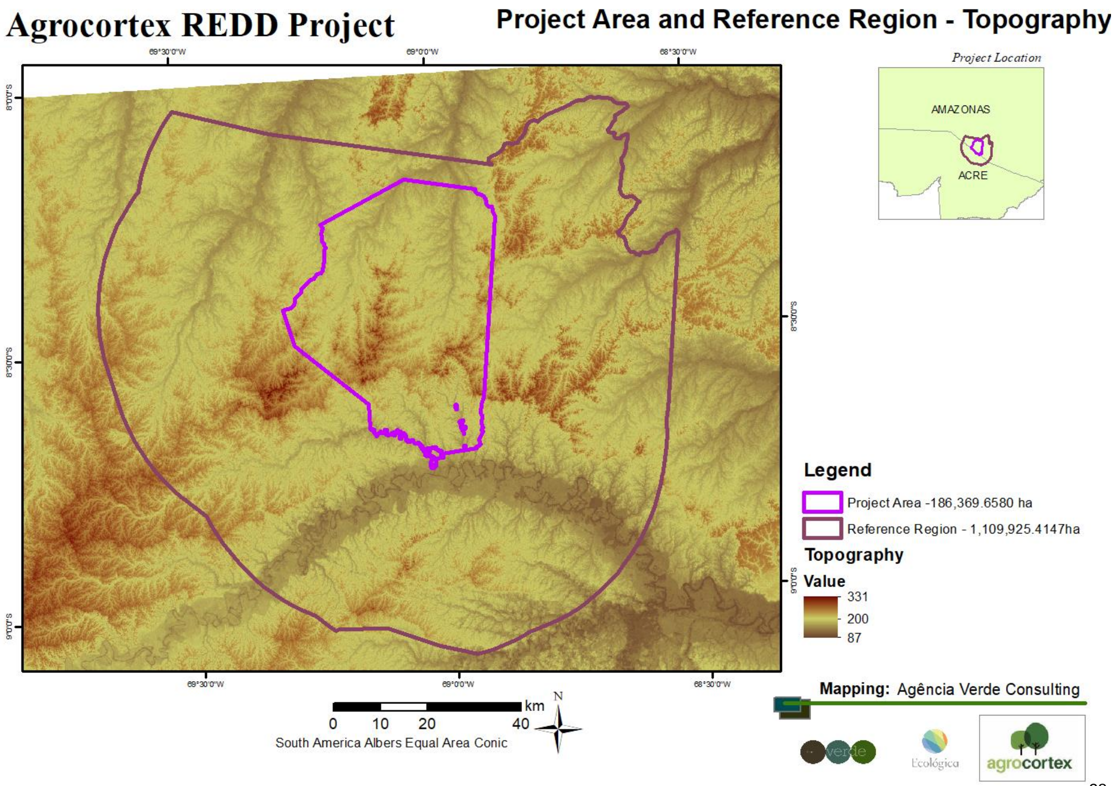


Figure 9. Elevation map of the project region, showing similar elevation conditions in the project region[28]

[27] The main relief type in the south of the region is the Fluvial Floodplain, due to the presence of the Purus River; and in the rest the Depression of the Javari-Contamana Rivers. In both Reference Region and Project Area, the predominance of relief is from the Javari-Contamana Rivers Depression, occurring in more than 80% of both areas. According to The Brazilian Institute for Geography and Statistics (IBGE, 2018) at: <https://downloads.ibge.gov.br/downloads_geociencias.htm>. Last visited on: 12-March-2018.

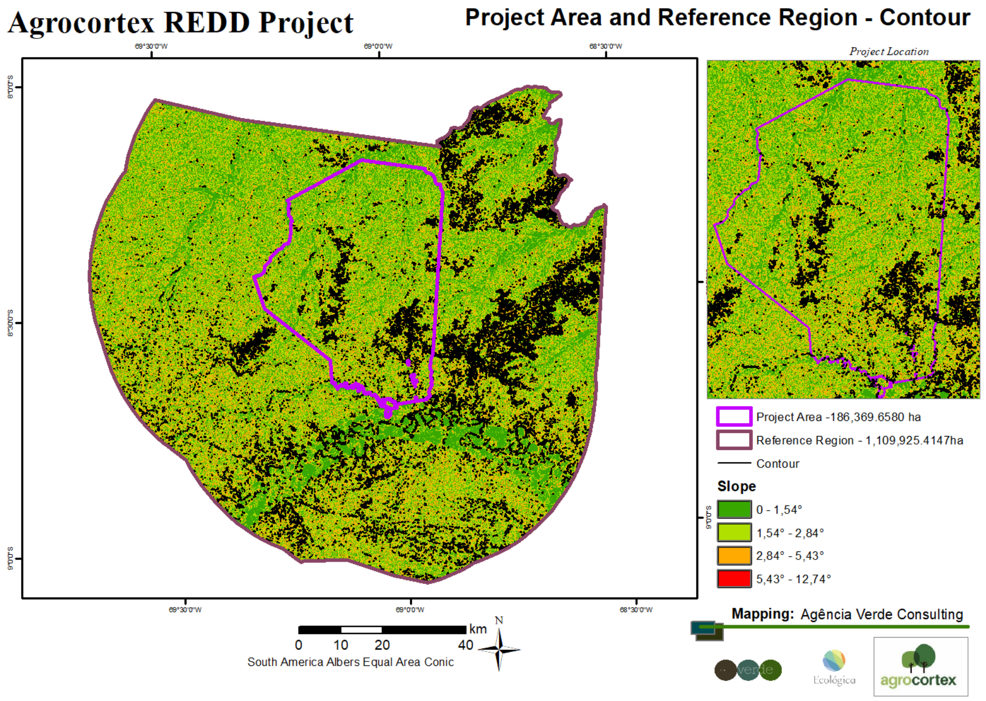


Figure 10. Slope map of the project region, showing similar slope classes in the project region[29]

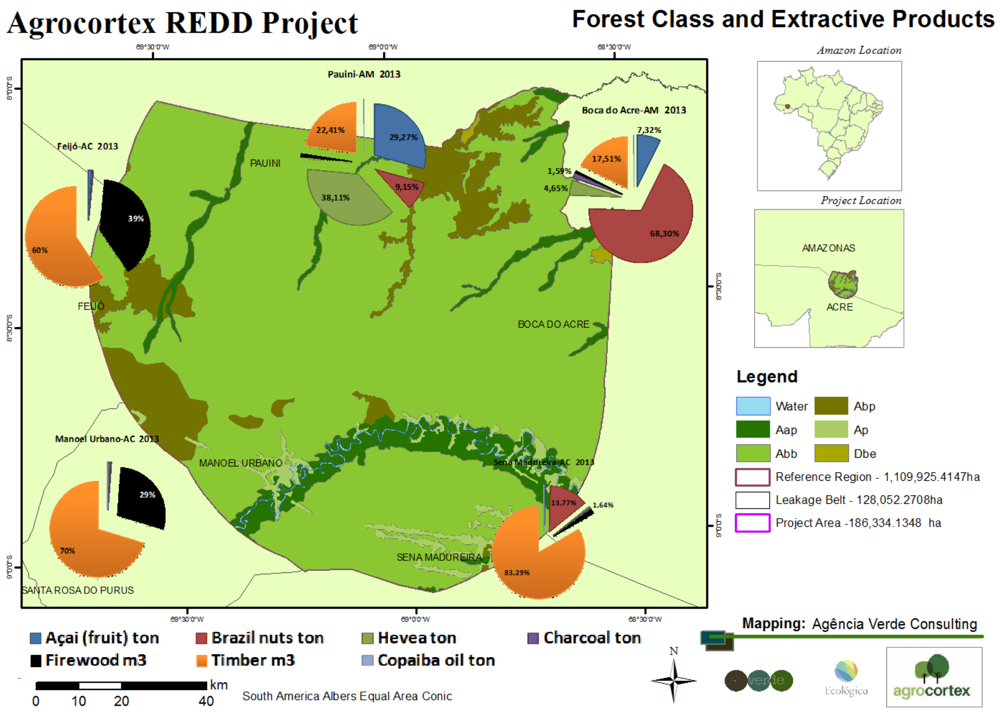


Figure 11. Forest classes existing in the project region and most common extractive products commercialized at each municipality surrounding the project area[30]

[28] Due to the presence of many rivers and more than 80% of the region is within the Javari-Contamana Rivers Depression, the region does not have very high elevation, maximum of 331 m of altitude and minimum of 87 m. The elevation range within the project area is between 100 m and 320 m and in the reference region between 87m and 331 m. Thus, 90% of the project area is within the elevation range of at least 90% of the rest of the reference region. According to Brazilian Agricultural Research Corporation (EMBRAPA, 2018) at: <https://www.cnpm.embrapa.br/projetos/relevobr/download/>. Last visited on: 12-March-2018.

[29] Due to the same conditions described above for topography, the average slope found within the project area is < 15%, maximum of 12.74%. The same slope class is found within the reference region. Thus, at least 90% of the project area is within ± 10% of the average slope of at least 90% of the reference region. According to Brazilian Institute for Geography and Statistics (IBGE, 2018) at: <https://downloads.ibge.gov.br/downloads_geociencias.htm>. Last visited on: 12-March-2018.

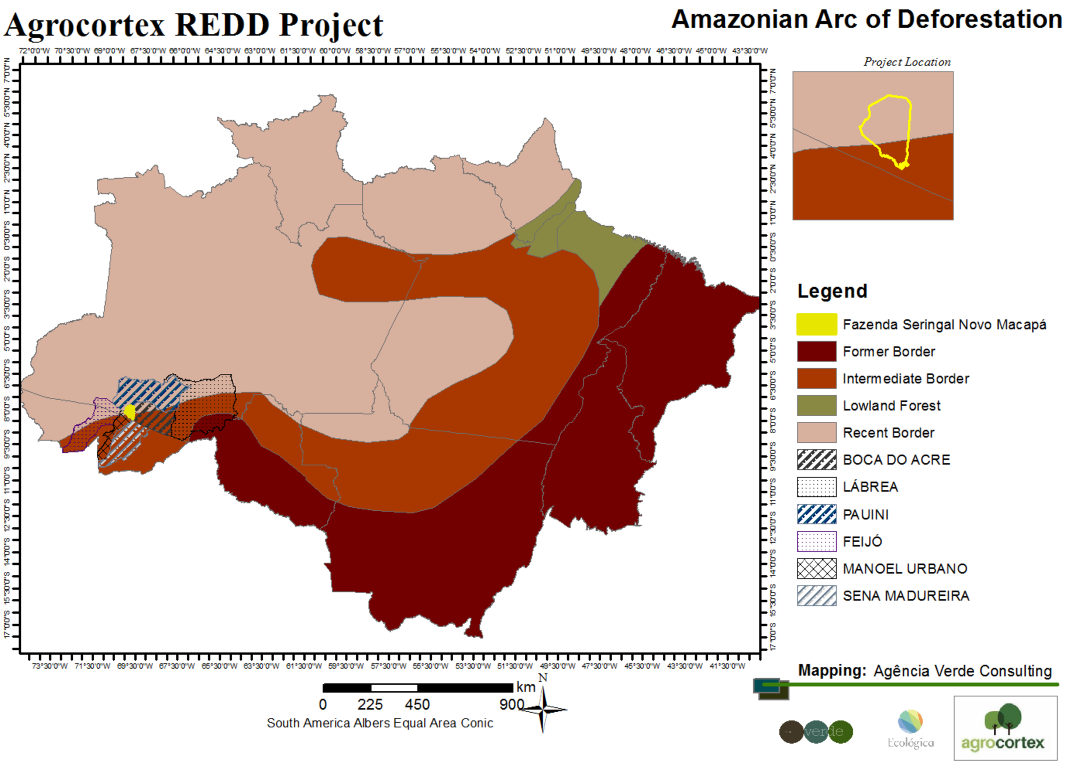


Figure 12. Amazonian Arc of Deforestation, showing that the project area is located within the recent and intermediate borders of the deforestation advancement in the region, including the same deforestation agent groups and economic growth tendency[31]

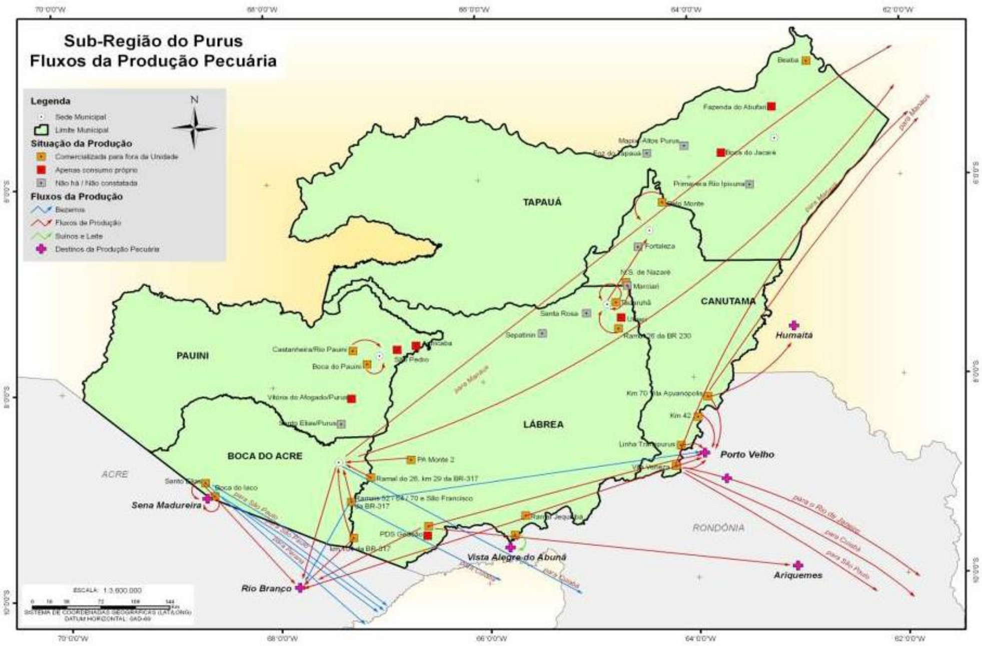


Figure 13. Catlle ranching production outflow routes within the project region, which is one of the main agent of deforestation expected to cause deforestation within the project area[32]

[30] Forest classes that exist in the Project Area are: Open tropical rainforests with bamboo (Abb), Open tropical rainforests with palm trees (Abp) and Open alluvial rainforest with palm trees (Aap). These same forest classes are also found in the Reference Region, wicth the excemption of Dense tropical rainforest (Dbe), which is found in less than 0.2% of the Reference Region. Thus, At least 90% of the project area has forest classes or vegetation types that exist in at least 90% of the rest of the reference region. According to Brazilian Institute for Geography and Statistics (IBGE, 2018) at: <https://downloads.ibge.gov.br/downloads_geociencias.htm>. Last visited on: 12-March-2018.

[31] Source: Brazilian Environmental Agency (MMA, 2018). Available at: <https://downloads.ibge.gov.br/downloads_geociencias.htm>. Last visited on: 12-March-2018.

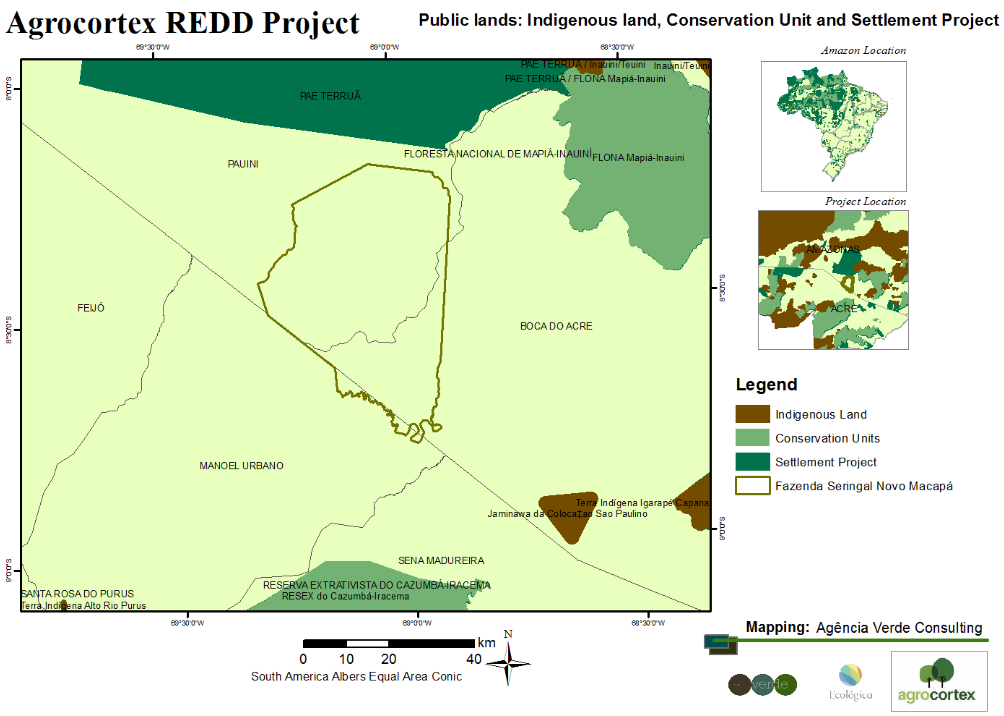


Figure 14. Public lands, such as Settlement Projects, Protected Areas and Indigenous Territories within the project region[33]

Using these criteria above, a refinement was made on the initial concentric buffer of 1,300,000 ha, which led to the Reference Region for this Project Activity.

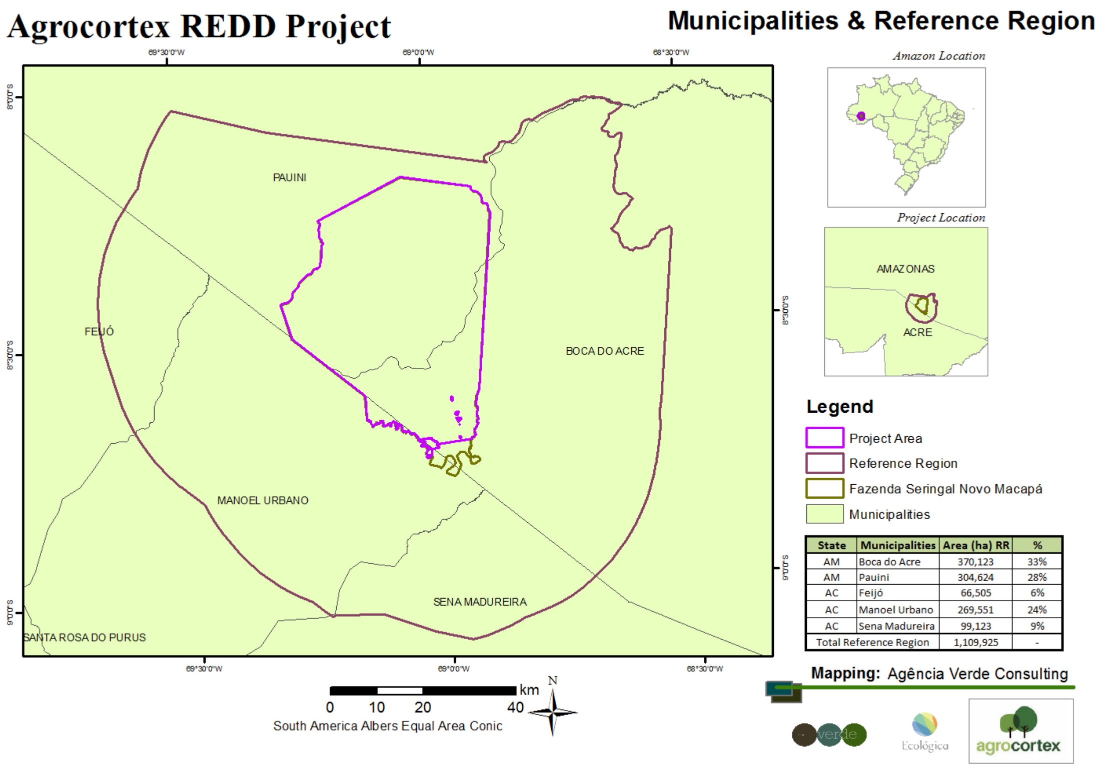


Figure 15. Reference region of Agrocortex REDD Project.

[32] Source: Zoneamento Ecológico-Econômico da Sub-Região do Purus. Volume I e Volume II, Governo do Estado do Amazonas, 2011.

[33] The project area is composed of 100% private land. Thus, the legal status of the land and the land tenure system found within the project area is also found in the reference region. Source: Brazilian Environmental Agency (MMA, 2018). Available at: <https://downloads.ibge.gov.br/downloads_geociencias.htm>. Last visited on: 12-March-2018.

The RR sums to 1,109,925.41 ha, i.e. 5.95 times the Project Area, and is distributed over 5 municipalities, although two of these are of low proportion, summing approximately to 15% of the total area (see Table 5 below).

Municipality	State	Hectares/ Municipality	% of total RR
Boca do Acre	Amazonas	370,049.13	33%
Pauini	Amazonas	304,674.53	28%
Manoel Urbano	Acre	269,600.88	24%
Sena Madureira	Acre	99,116.34	9%
Feijó	Acre	66,484.53	6%
TOTAL RR AREA	**-**	**1,109,925.41**	**100%**

Table 5. Reference Region areas and percentages per municipality

According to Table 5 above, although the reference region is distributed across 5 municipalities, three of them sum to 85% of the reference region: Pauini and Boca do Acre, both in the State of Amazonas, and Manoel Urbano, in the State of Acre.

Leakage Belt

In accordance with section 1.1.3 of the methodology, the Leakage Belt (LK) was defined by means of opportunity cost analysis. The latter is applicable when at least 80% of deforested area in the reference region during the historical reference period occurred where deforestation was profitable for at least one product.

The analysis performed on the land-use/land-cover changes during the historical reference period allowed determining that timber logging and cattle ranching are the main deforestation and degradation agents in the RR. Meanwhile, navigable rivers (especially the Purus River) and existing roads are the main drivers of deforestation.

The extraction of timber is most important in the State of Acre, while cattle ranching is more relevant in Amazonas, especially in the Municipality of Boca do Acre. The table below provides a summary of agents and drivers:

Land-use or activity	Role
Timber logging	Degradation agent
Cattle ranching	Deforestation agent
Rivers	Deforestation driver
Roads	Deforestation driver

Table 6. Summary of deforestation agents and drivers

Studies in the Amazon indicate 2/3 of deforestation activities occurred in a 50km range from paved roads[34] and that the maximum distance covered by communities living on the margin of rivers in the Amazon is equal to 5km, while the distance covered from previously deforested areas is equal to 17km[35].

[34] NEPSTAD, D.; CAPOBIANCO, J.P.; BARROS, A.C.; CARVALHO, G.; MOUTINHO, P.; LOPES, U.; LEFEBVRE, P. Avança Brasil: os custos ambientais para a Amazônia. Belém: Editora Alves, 24 p. 2000

[35] FONSECA, F. O. R. Simulação do desmatamento em Apuí-AM a partir de regras de uso do território. Universidade Federal Do Amazonas – UFAM, Manaus - AM, 2012.

The Leakage Belt was defined considering this information by means of a buffer analysis on each variable using ArcGIS software. This approach was chosen considering the opportunity cost analysis performed, indicating that timber logging and cattle ranching are, on a small scale, feasible activities on such regions.

The opportunity cost analysis was performed by Agência Verde (a service provider that was responsible for the following activities on the Project):

- Assessing the land-use and land-cover change during the historical reference period;
- Determining the agents and drivers of deforestation;
- Projecting the future deforestation;
- Defining the land-use and land-cover change component of the baseline.

Agência Verde has determined the opportunity cost for timber logging and cattle ranching based on data on the potential profitability associated to each activity. Profitability was determined using the Equation below:

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

Where:

PPxl	Potential profitability of product Px at location l
$/t S$x	Sale price per product
Pcxi	Average price for each Product on each strata
T Cv	Average transportation cost per tonne of product
TDv	Total transportation distance

Therefore, to determine the potential profitability, the above parameters were identified considering current conditions and potential markets for each activity and product. This assessment allowed concluding both activities are potentially profitable, especially to the south of the Project Area, near the Purus River and the main highway BR-364.

The combinations of the maps for each variable helped produce the following maps that led to the determination of the Leakage Belt.

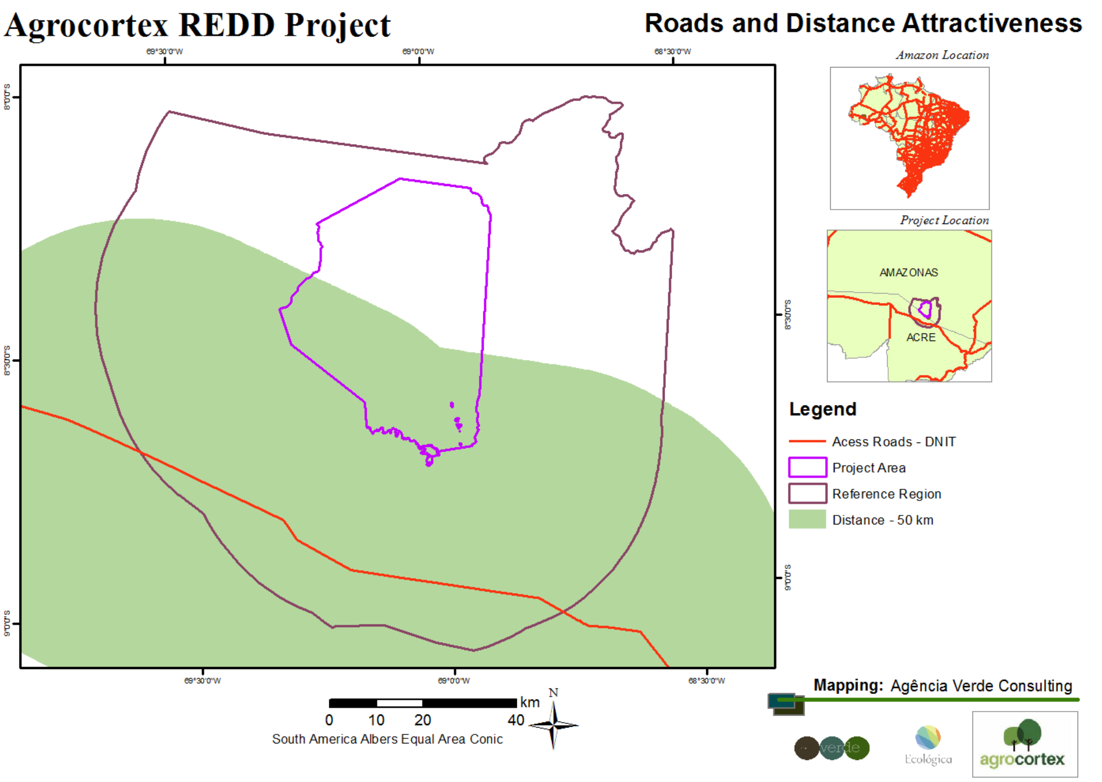


Figure 16. Attractiveness based on distance to existing roads

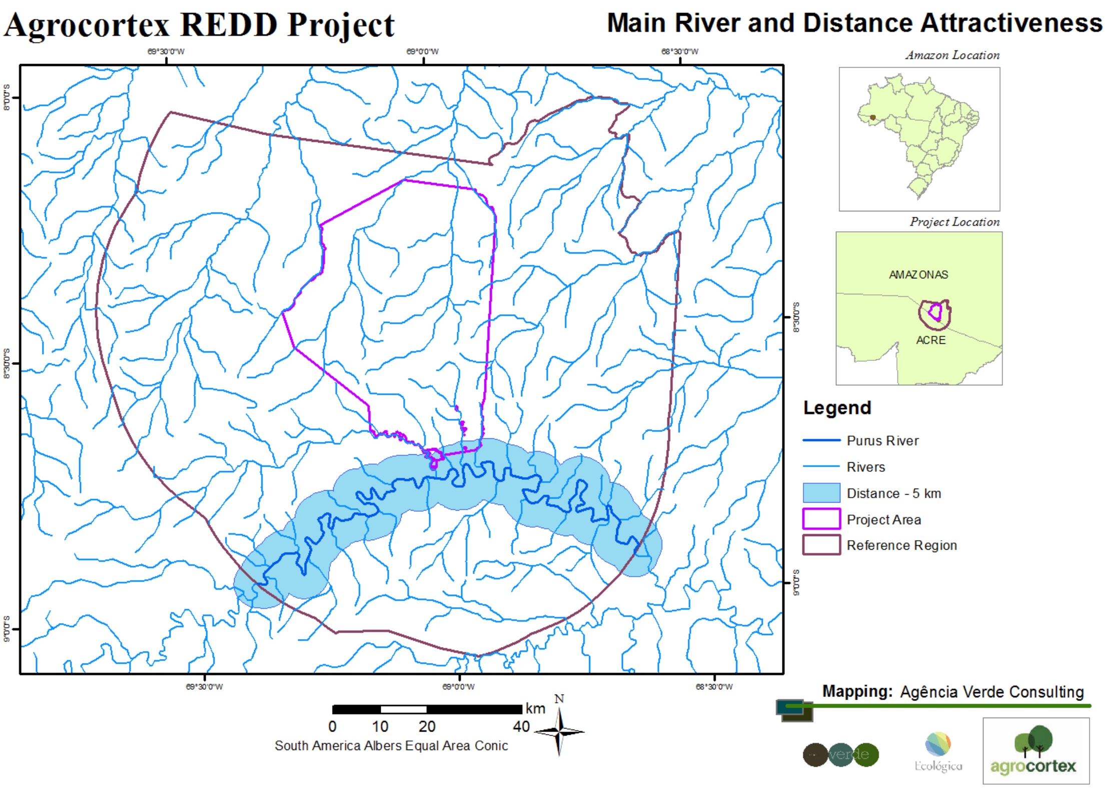


Figure 17. Attractiveness based on distance to main rivers.

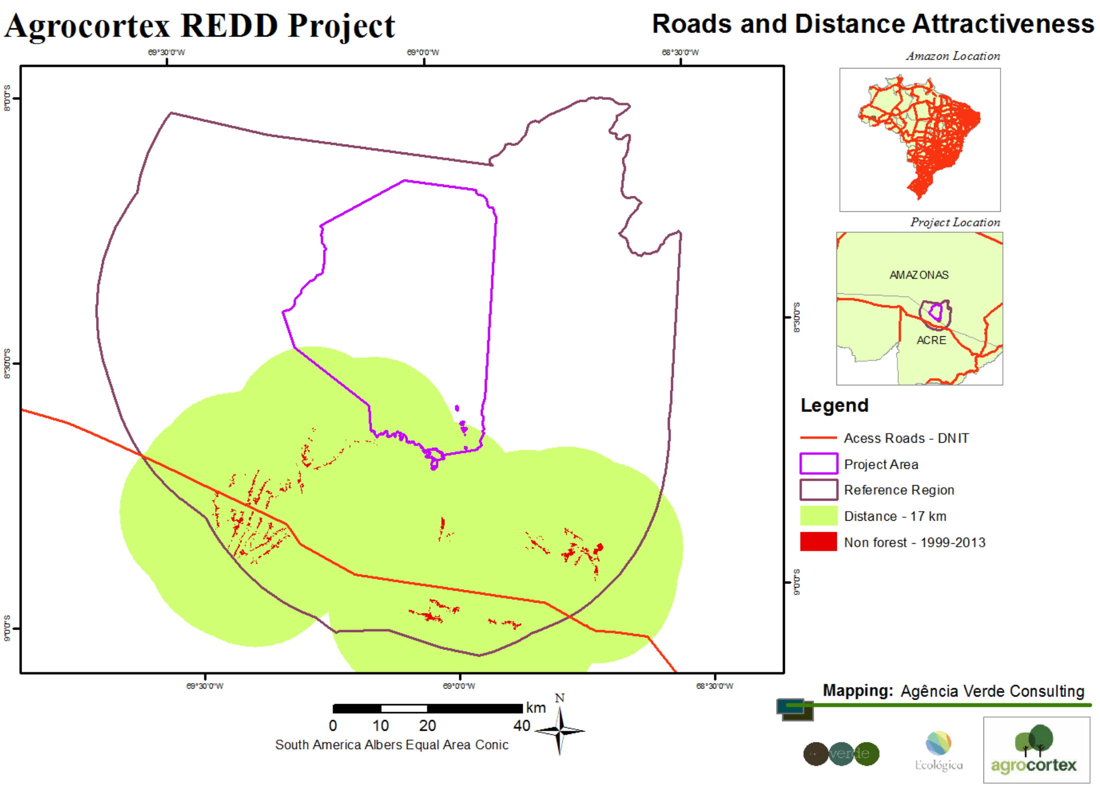


Figure 18. Attractiveness based on distance to roads and previously deforested areas.

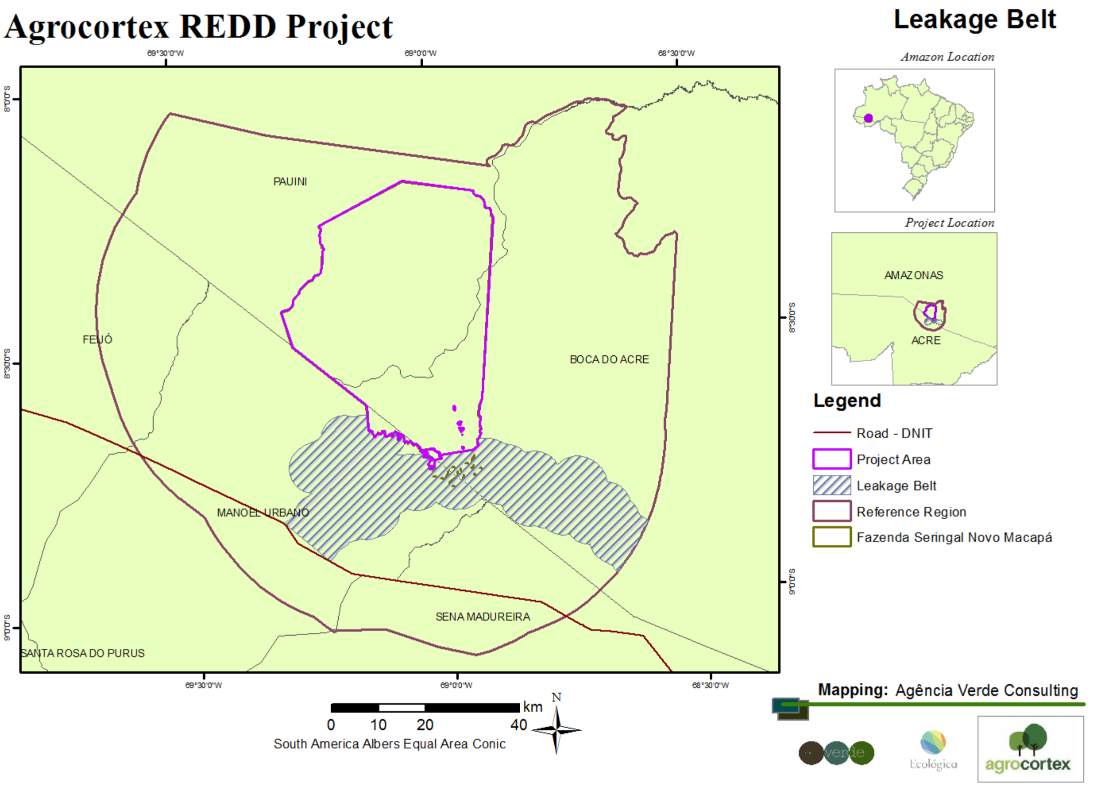


Figure 19. Leakage belt as defined by attractiveness from deforestation drivers.

Therefore, the Leakage Belt was defined as an area of 128,115.48 ha of land located to the South of the Project area, near the main deforestation drivers (roads and rivers).

Leakage Management Area

The Leakage Management Area (LMA) is designed to implement the activities which reduce the risk of leakage in the project scenario. These activities must include the agents of deforestation and involve seeking new sources of income which contribute to forest conservation. Leakage management could involve agricultural, agro-forestry, reforestation, education or other activities.

The present project intends to apply environmental education and capacity-building measures to all the communities located near the boundaries of the leakage belt and project area. Therefore, the leakage management area was designed to involve the communities located in the main access points to the project area.

The LMA is located within the area that will be transferred to the local community in the near future. There are nine communities located in the south of the project area. In total, an area of 3,690.22 ha will be transferred to the local community. The Leakage Management Area was defined as a portion of 631.60 hectares of non-forest land cover within this area.

The Figure 20 below shows the location of the Leakage Management Area.

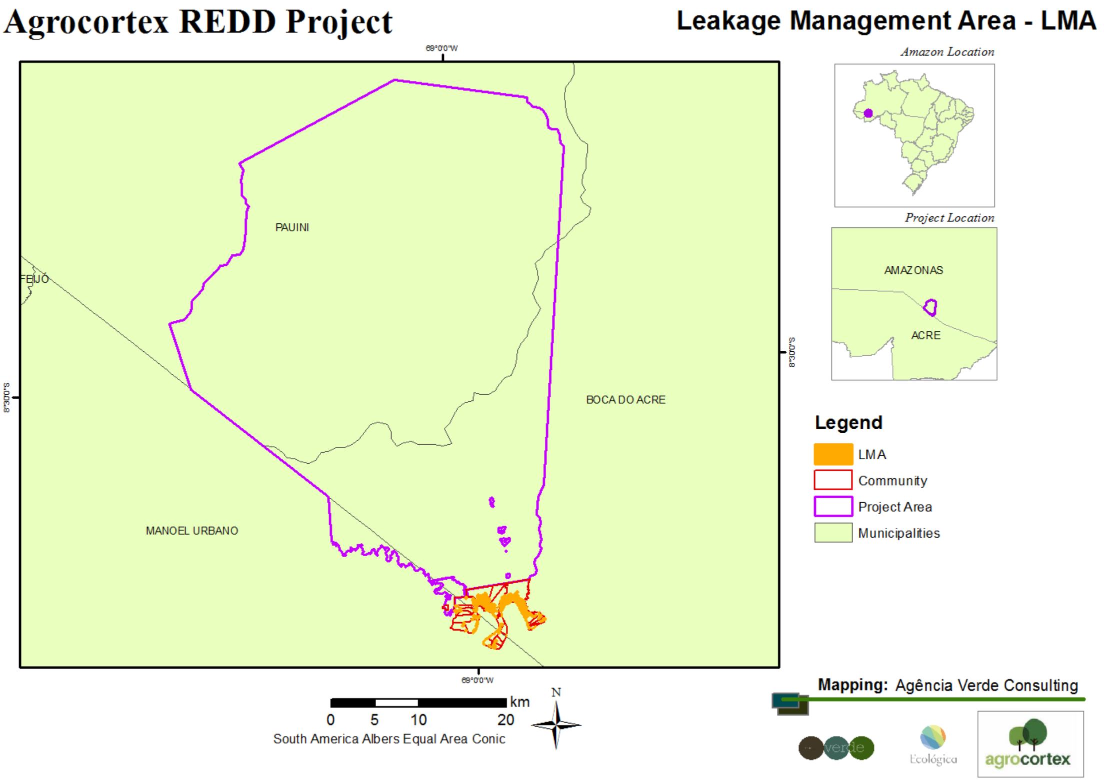


Figure 20. Leakage management area within the project's reference region

In addition, the implementation of social, environmental and economic activities for the local communities located within the LMA will be encouraged by the SOCIALCARBON Standard. The SOCIALCARBON indicators will evaluate if there are positive social impacts from the REDD Project within the LMA. Leakage risk will reduced by community activities, education and training, alternative income sources, among other aspects and these indicators will be monitored to demonstrate the project's contribution to sustainable development.

1.10 Conditions Prior to Project Initiation

The Agrocortex REDD Project makes an important contribution to the conservation of South-western 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 South-western 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

The project region is classified as Tropical rainforest climate type – Am category – according to the Köppen climate classification[36]. This means that it does not present a defined winter season, all months of the year have average temperatures > 18ºC, and the average annual rainfall is high. This category is also characterized by having a monsoon season associated with heavy rains during the summer.

The Am climate type is defined as follows:

1) The driest month have average rainfall <60mm;
2) The project area displays very little monthly and annual variation in temperature, ranging between 23°C and 25°C as a monthly average, the minimum temperature is always >18°C.

The project area is located in the South-western amazon region, where between April and July, polar cold fronts coming from the Andes Mountains can drop the temperature to 12°C with duration of three to eight days. However, the climate of the region is hot and humid, with annual average temperature around 24.5°C.

Rainfall in the project region varies between 1,750 and 2,250 mm per year, with two well defined seasons: rainy (November to May) and dry (June to October). The relative humidity in the region is high, usually above 80%[37].

[36] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928.
[37] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

Hydrography

The rivers flowing through the reference region are part of the Solimões River basin. The hydrological regime of the region is characterized by a flood period, which is related to the rainy season and another one of low water levels, corresponding to the dry season. Most of the rivers in the region are navigable only for about six months a year (rainy season), due to the lower water level during the dry season. The Figure below shows the hydrography in the project area and reference region.

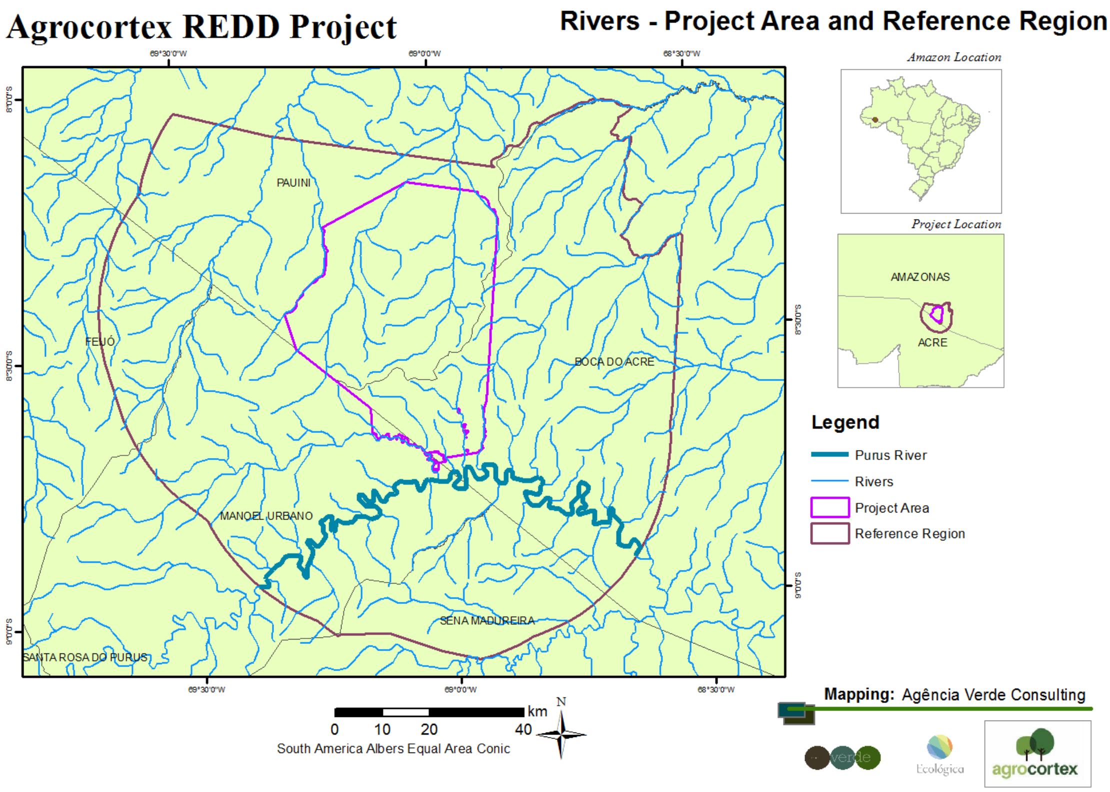


Figure 21. Hydrography in the project area and reference region

The project area is drained by four sub-basins: The Atucatiquini River, Igarapé Camurrão, Igarapé Casparão and Igarapé Macapá. All of them are contributors of the Purus River, which is one of the major tributaries of the Solimões River. Furthermore, the majority of rivers in the region are oriented in the south-north direction.

Many small and intermittent streams located within the project area dry completely during the dry season and are extremely muddy at the beginning of the rainy season, indicating the low soil permeability and the high erosion rate within the sub-basins area.

The project area's entire southern boundary is delimited by the Igarapé Macapá and by the Purus River. Part of the project area's western boundary is delimited by the Igarapé Casparão, while part of the eastern boundary is delimited by the Igarapé Bragança. The Atucatiquini River sub-basin flows through the entire western part of the project area, while the Igarapé Camurrão sub-basin crosses its middle and eastern limits, all of them oriented in the south-north direction.

Geology, Topography and Soils

According to the Sustainable Forest Management Plan[38], the project area belongs to the Solimões Formation Geological Domain, which is the main geological formation in the project area. The Floodplain Geological Domain is also present in some localities associated to large rivers within the project area.

The Solimões Formation consists of sandy and silty-clayey sediments. The Floodplain formation is present along rivers and is composed by alluvial sediments from sand, silt and clay. The geological domains present in the project area are shown in the Figure below.

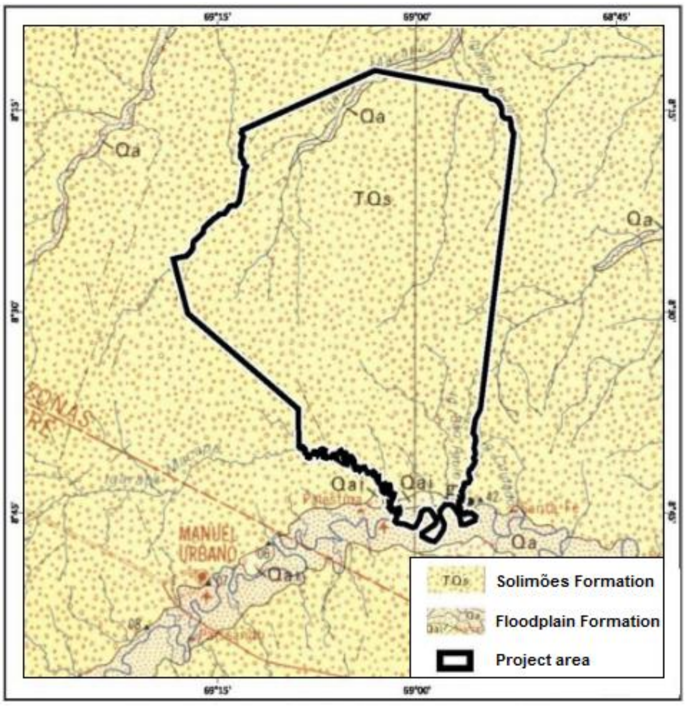


Figure 22. Geological Domains in the project area

The Solimões Formation is basically composed by two distinct morph structural units: The Western Amazon Lowered Plateau and the Acre River – Javari River Depression. The project area is located within the Acre River – Javari River Depression morph structural unit. The latter is an extensive lowered surface located between the Acre and Javari Rivers. The average altimetry is about 200m and the topography does not present large irregularities.

Generally, the aforementioned Depression comprises high activity clays, on which the predominant vegetation cover is the open forest with presence of bamboo, with some areas of dense forest. It is drained by large rivers within the Purus River watershed. Furthermore, this morph structural unit presents a vast area of fertile soils, classified as red-yellow podzolic and hydromorphic gley soils.

The red-yellow podzolic soil composes the largest part of the project area, forming a non-hydromorphic soil class and presenting a dark red colour. This soil type is derived from the weathering of basic rocks, rich in iron and magnesium oxides. In addition, its texture varies from clayey to very clayey, presenting a porous characteristic.

[38] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

The hydromorphic gley soil generally presents clay-silt texture and high fertility, usually sustaining a floodplain or alluvial forest.

The Floodplain Formation predominates in less than 5% of the total project area, concentrated in its southern portion. Most of the area within this geological formation lays over sedimentary substrate where part is periodically flooded during the rainy season, forming floodplain or alluvial forested lands.

There are two main geomorphologic structures within the project area, detailed in the Figure 23 below.

- Landscapes with different orders of elevation and deepening, generally separated by "V" plain valleys, composed of: Hills - slightly convex top relief, which covers nearly the entire project area; and Crest – continuous and pointed top relief, located in the central part of the project area.
- Plain areas resulting from fluvial accumulation and deposition, periodically or permanently flooded.

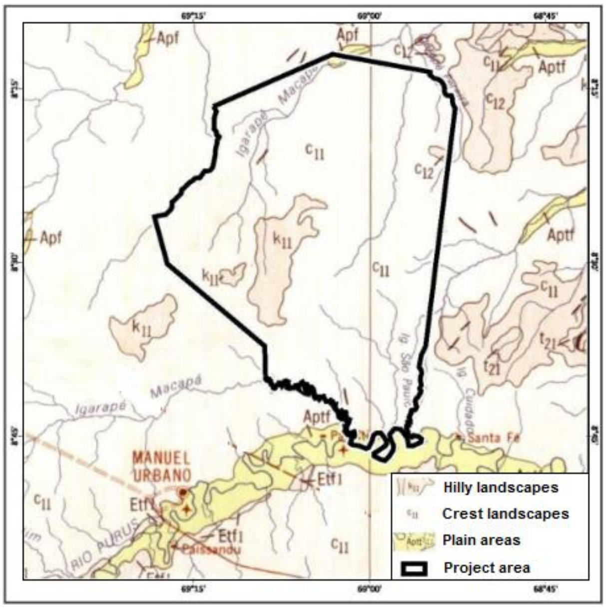


Figure 23. Geomorphology of the project area

The altitude variation in the reference region is relatively low. The higher parts of the project area do not exceed 320 m above sea level, with values between 100m and 319m, noting that the central and eastern portions of the project area present the highest values. The topography within the project area is detailed in the Figure below.

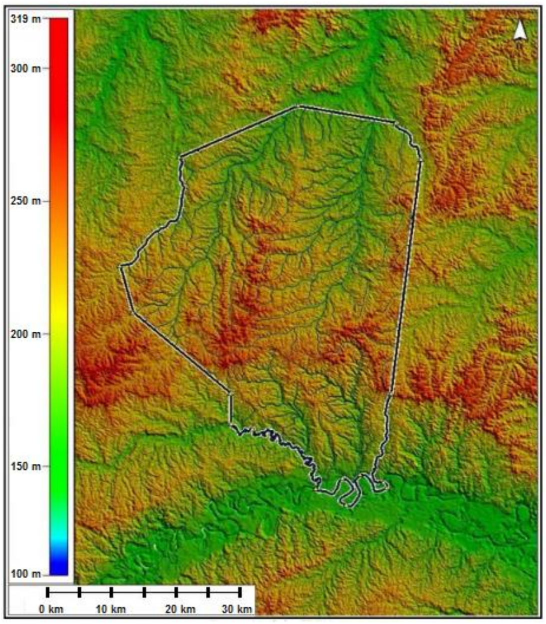
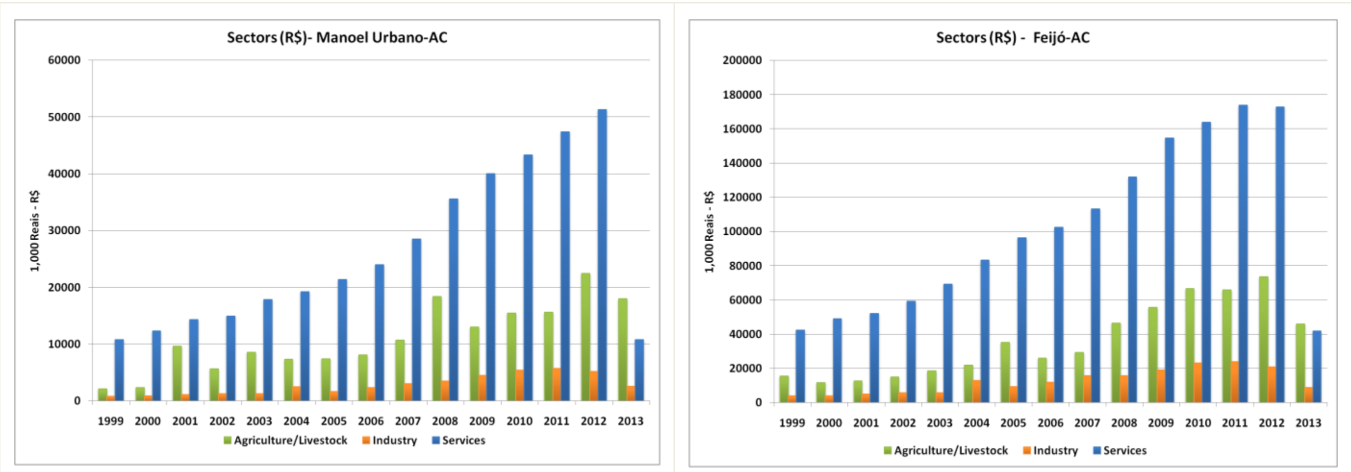


Figure 24. Topography within the project area

Socio-economic conditions

The following socioeconomic analysis considers the municipalities within the limits of the reference region: Boca do Acre and Pauini, both in the State of Amazonas, and Feijó, Manoel Urbano and Sena Madureira, in the State of Acre.

Analyzing the Gross Domestic Product (GDP) in these municipalities[39], it is verified that the highest proportion of the wealth produced comes from agriculture/livestock and services sectors. However, most services are generally provided and depending on the agricultural sector. Moreover, the low level of industrial activity in these municipalities is notable. Figure below shows the GDP by sector in the five municipalities of the reference region.



[39] The Brazilian Institute for Geography and Statistics (IBGE): Gross Domestic Product. Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/38/46996>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/38/46996>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/38/46996>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/38/46996>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/38/46996>. Last visited on: October 06th, 2017.

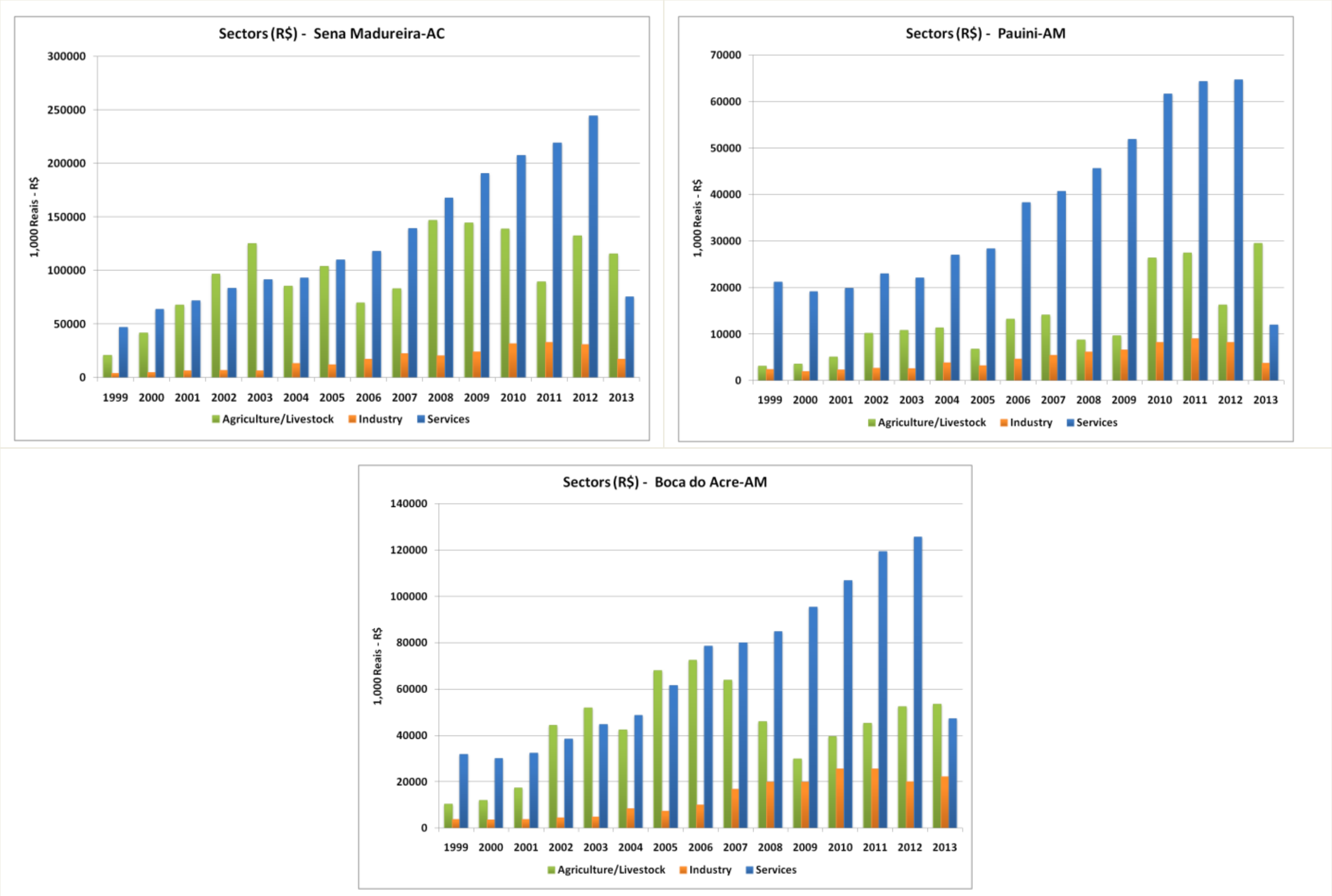


Figure 25. GDP by sector in the five municipalities of the reference region

GDP values from the agricultural/livestock sector in the five municipalities from the reference region are shown in the Figure below. In recent years, the GDP from agriculture/livestock sector in the municipalities of Sena Madureira and Boca do Acre were higher than in Feijó, Manoel Urbano and Pauini added together.

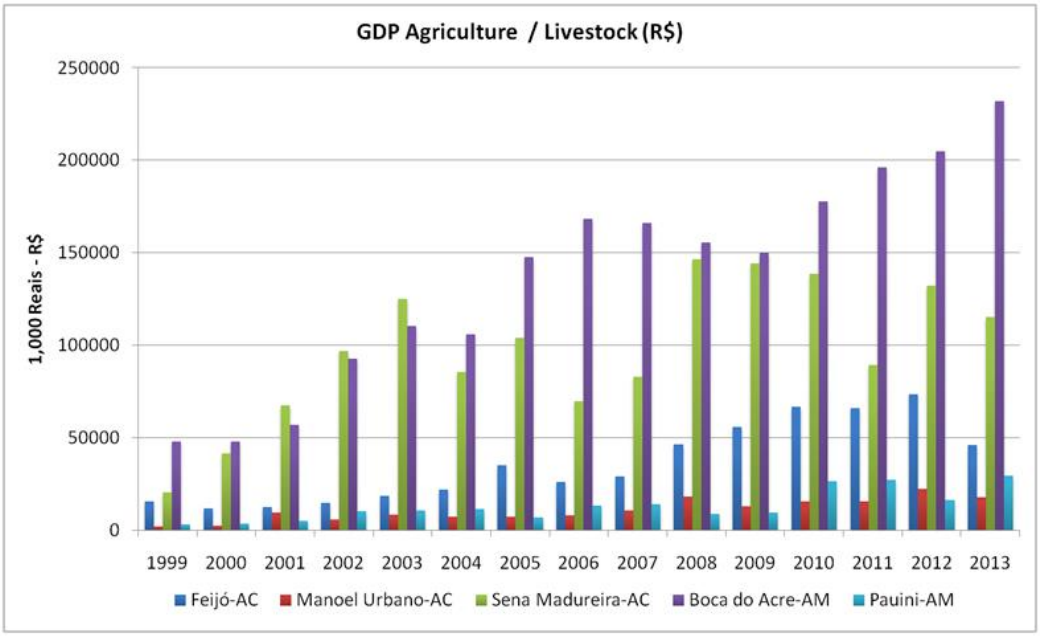


Figure 26. GDP values from the agricultural/livestock sector in the five municipalities from the reference region

In addition, analysis of Figure 27 below shows that the main land use in the five municipalities that compose the reference region is pastureland, according to the 2006 Agricultural Census [40]. Excluding forest areas, out of the total land use in the region (around 295,745 ha), almost 65% is pastureland (either planted, natural or degraded), which also shows that this is the main economic activity in the region.

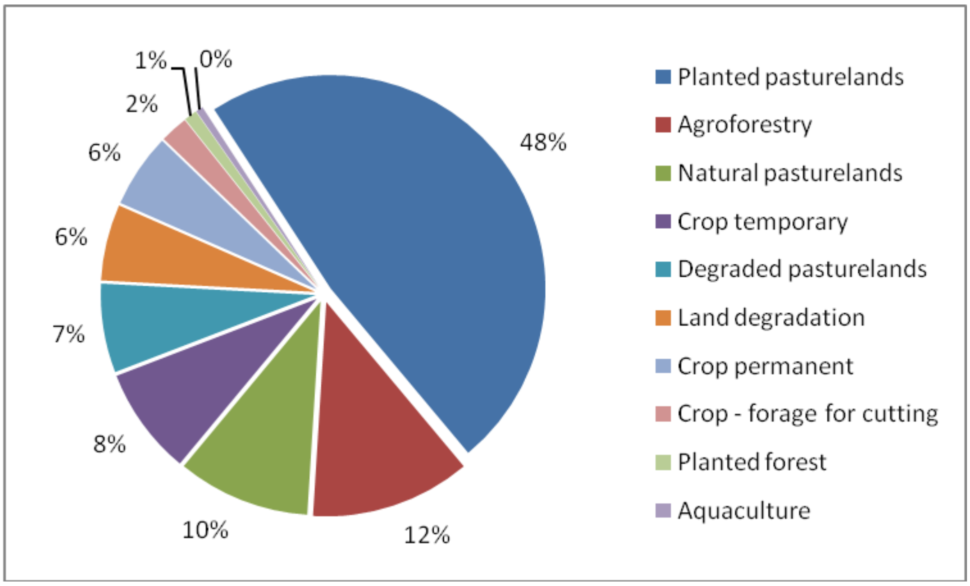


Figure 27. Agricultural census (land use) in the municipalities of the reference region

According to Pontes, Noronha and Pontes (2016)[41], the lack of economic alternatives has created the conditions for livestock farming to establish itself as the main economic activity causing deforestation in the Amazon, being primarily concentrated in the arc of deforestation, where road access has been established.

Traditional means of production such as extractivism and subsistence agriculture are combined with livestock farming and agriculture activities resulting in growth of the regional economy and population. This is putting pressure on land-use and creating land conflicts with indigenous and traditional communities[42].

The predominant animal types in the three main municipalities of the reference region in 2006 were cattle (76%), swine (11%), fowls (4%), and sheep (4%), composing around 95% of the total. The Figure 28 below shows the distribution of animal types within the reference region in 2006[43].

[40] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/24/27745>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/24/27745>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/24/27745>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/24/27745>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/24/27745>. Last visited on: October 06th, 2017.

[41] PONTES, Raimundo Vitor Ramos; NORONHA, Marconde Carvalho de; PONTES, Kelem Rodrigues de Melo. Desflorestamento no sul do Amazonas: embate entre o desenvolvimento econômico e a conservação ambiental. **Parcerias Estratégicas,** Brasília, v. 21, n. 42, p.61-88, jun. 2016.

[42] 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).

[43] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/24/27745>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/24/27745>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/24/27745>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/24/27745>;

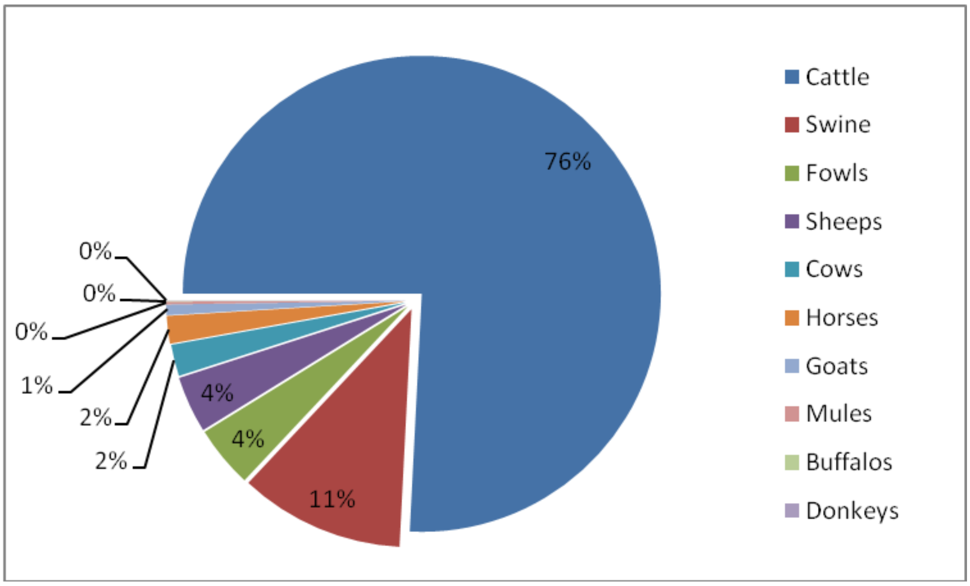


Figure 28. Animal types in the municipalities of the reference region in 2006

In 2006, there were around 295 thousand heads of cattle within the municipalities composing the reference region, occupying an area of around 200 thousand hectares of pasturelands. These figures show an average stocking rate of around 1.5 animal units/ha, which demonstrates the low efficiencies of the cattle industry in the region, mainly due to the low cost of the land.

Brazilian ranchers on average raise just over one head of cattle per hectare of land, but well managed pastures, with better grass production, can support three to five heads per hectare. Nevertheless, this situation is slowly improving; over the past decade, areas of pasture in the Amazon region have increased by 30% and the number of cattle has increased by 80%[44].

Forested areas in the Amazon Biome usually have a lower price per hectare than established pasturelands, corresponding to only 25% of the pastureland property value. This scenario promotes the purchase of forested lands, deforestation and further creation of new pasturelands. This is because the price of land is still fundamentally the result of the derived productive gains expected from agriculture/cattle ranching, taking into consideration that in deforested lands those uses can occur immediately and without costs of deforestation.

In the most extreme case, in the State of Acre, deforestation multiplies property values by more than 14 times, while in the State of Amazonas multiplies land value by nearly 10 times. Few investments have returns as high as this one[45].

Timber logging is also an important economic activity within the reference region. Usually, timber logging is the first driver of deforestation that reaches previously inaccessible forest lands, followed by land speculators or farmers in search of cheap land. It's a co-evolutionary process, that is, firstly the timber logging harvests all the species with commercial interest, then after clearing roads and settling in these areas, the deforestation continues in areas already explored and unexplored, and thus providing conditions for further expansion of

Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/24/27745>. Last visited on: October 06th, 2017.

[44] TOLLEFSON, Jeff. The Global Farm. **Nature**, Washington Dc., v. 466, n. 1, p.554-556, 20 jun. 2010.

[45] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. **Economia Verde: Desafios e Oportunidades,** Campinas, v. 8, p.143-155, jun. 2011. Available at: <http://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: April 16th, 2017.

logging and cattle ranching[46]. The illegal logging (without authorization or sustainable management) was reported by residents as a major environmental problem and cause of conflicts in the region[47]. Figure 29 below shows extractivism production values, in thousand Reais (1,000 R$) during the historical reference period for the municipalities composing the reference region[48].

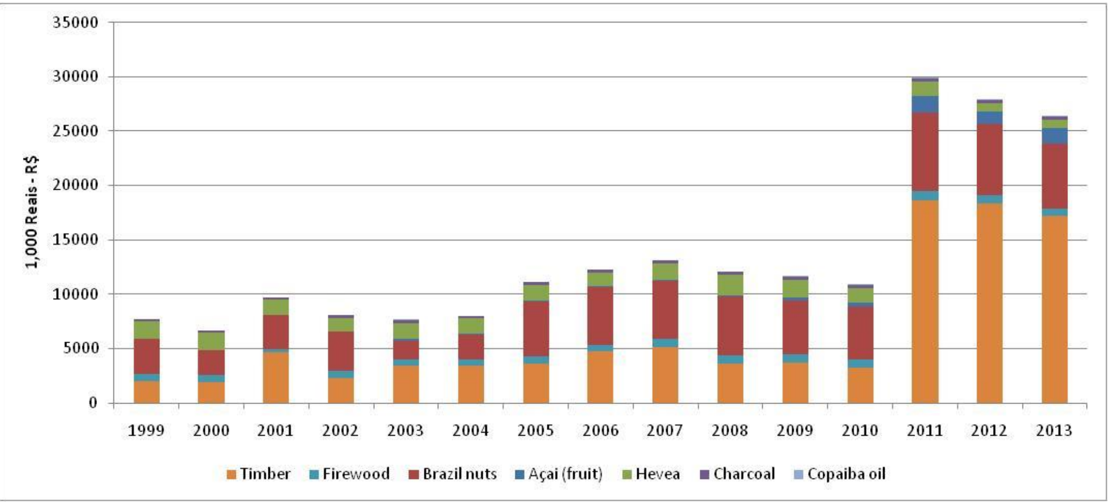


Figure 29. Extraction production values per product in the municipalities of the reference region during the 1999-2013 period

According to Figure above, it is important to note that Brazil nuts is also an important economic product within the reference region, representing around 33% of the total extraction production value in the five municipalities of the reference region. However, timber logging showed the highest production value within the reference region during the 1999-2013 period, representing around 47% of total extraction production values.

In addition, as can be seen in Figure 30 below, timber and firewood correspond to around 98% of the total quantity of extractive products (in tonnes) produced in the municipalities of the reference region in 2013.

[46] 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.

[47] 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).

[48] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/16/12705>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/16/12705>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/16/12705>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/16/12705>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/16/12705>. Last visited on: October 06th, 2017.

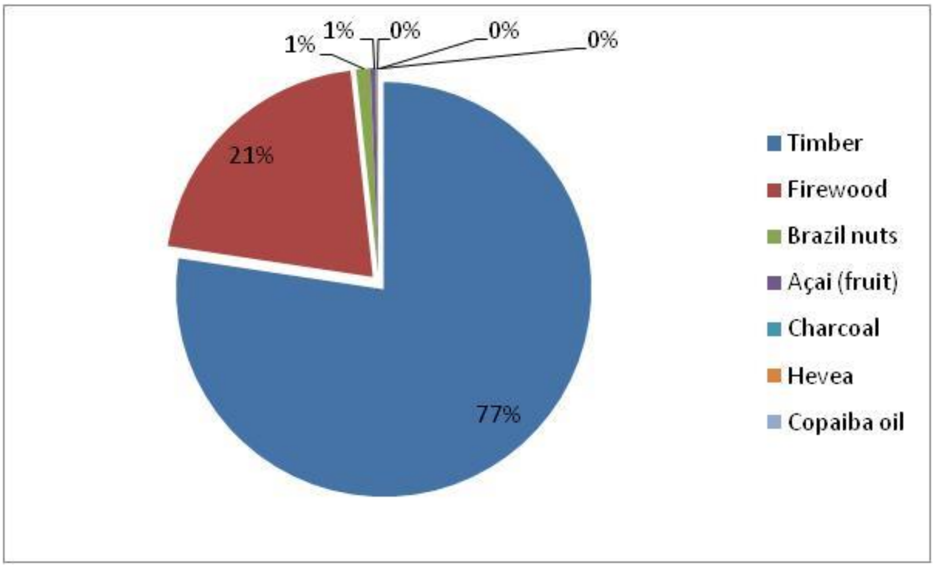


Figure 30. Proportion of extractive products produced in the municipalities of the reference region in 2013[49]

The majority of the agriculture and livestock production carried out in the reference region is transported along the BR-364 highway to Rio Branco, the capital Acre State. Some segments of the highway may be impassable during the rainy season between December and April, hindering and increasing the price of transport of people and merchandise[50].

The same highway also connects Rio Branco to Porto Velho, the capital of the State of Rondônia, as well as to other regions of the country, therefore having a better location in terms of commercial logistics. From Rio Branco it is possible to take the Trans-oceanic highway (BR-317), which is a transcontinental highway that connects Brazil to Peru and the port of San Juan de Marcona.

Figure 31 below shows the main highways for product offtake in the project region.

[49] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/16/12705>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/16/12705>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/16/12705>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/16/12705>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/16/12705>. Last visited on: October 06th, 2017.

[50] CARRERO, G.C. Dinâmica do Desmatamento e Consolidação de Propriedades Rurais na Fronteira de Expansão Agropecuária no Sudeste do Amazonas. Master thesis, Instituto Nacional de Pesquisas da Amazônia. 68p. 2009.

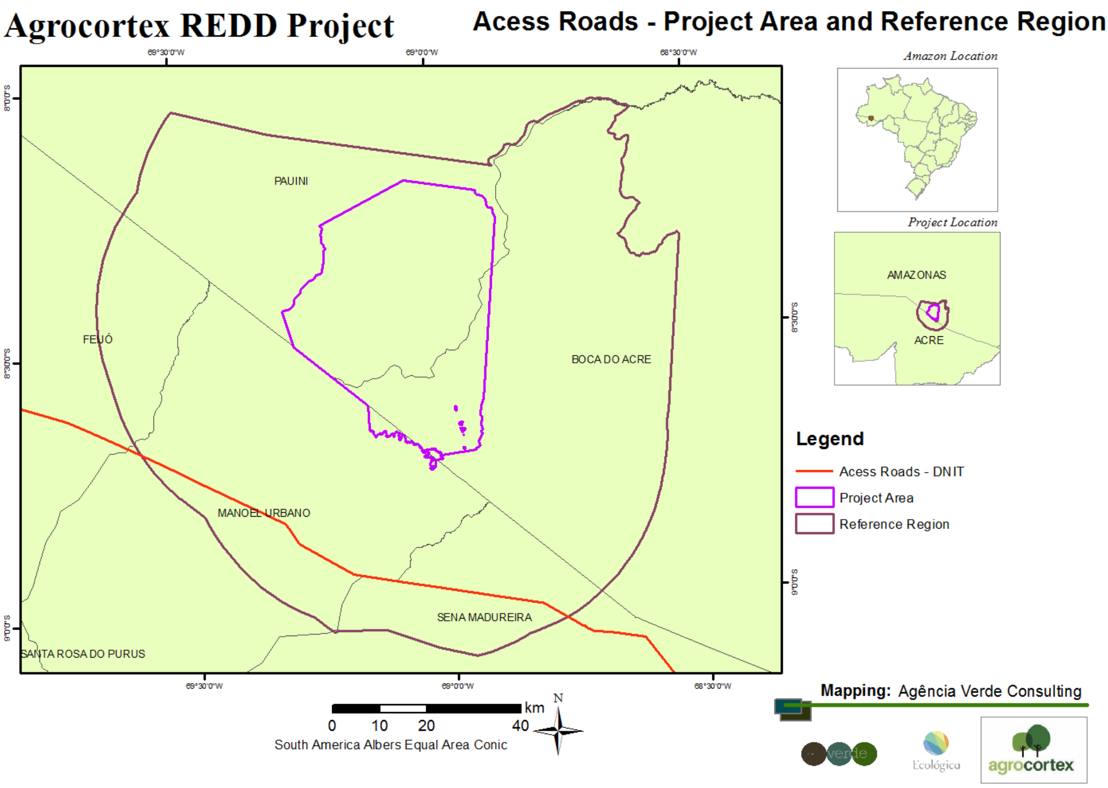


Figure 31. Main roads and highways within the reference region

Social conflict issues, primarily land conflict, are common in these regions because they lie at the frontiers with the arc of deforestation and contain a large quantity of unoccupied lands. The following activities are characteristic of the region: forced land settling by squatters or timber harvesters; illegal deforestation and mining present in many of Amazonia's watersheds[51].

Until the early 1960s, the region remained virtually wild and little known, but the construction of Brasília, inaugurated in 1960, and the opening of new roads such as the Belém-Brasilia highway (BR-060), eventually attracted migrants from other regions of Brazil.

More recently, State policies such as the National Integration Program (NIP, or *Programa de Integração Nacional*, PIN, in Portuguese), created in 1970 with the objective to to colonize the Amazon, led to the installation of new roads in the region, allowing the implementation of colonization programs as an incentive to immigration, primarily of population from the South and Southeast of the country, creating a great social diversity in the region. The aim was to populate the region with small and medium-sized farmers and diversify production, opening up new markets and also securing the Amazon territory. These communities, initially entirely rural, grew and expanded into urban centers, driven mainly by the creation of the Trans-Amazonian Highway (BR-230)[52].

The lack of alternatives in the frontier region has led many migrants to experiment with alternative income generation options. However, the lack of regulation regarding land-tenure issues has led to illegal activities, reducing any incentive for sustainable forest management.

[51] SECRETARIA DO ESTADO DO MEIO AMBIENTE E DESENVOLVIMENTO SUSTENTÁVEL (SDS). Unidades de Conservação do Estado do Amazonas. Manaus, 2007.
[52] 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).

This scenario continues to promote deforestation associated with livestock farming and land speculation in the project region, which concentrates one of the largest deforested areas in the southern Amazonas State. According to research carried out by IDESAM, the region has an urgent need to restructure land management governance at a local level, requiring investment in infrastructure, equipment and human resources to attend to the issues surrounding land-tenure[53].

The population in the five municipalities of the reference region increased around 42% during the 1991 – 2010 period, due to the aforementioned reasons above, reaching almost 130,000 people in 2010, as illustrated in Figure 32 below. Therefore, the population growth rate across the analyzed period was 2.2%/year[54]. Population increase also represents the human pressure for forest clearance in the region, demanding new lands for subsistence and income generation.

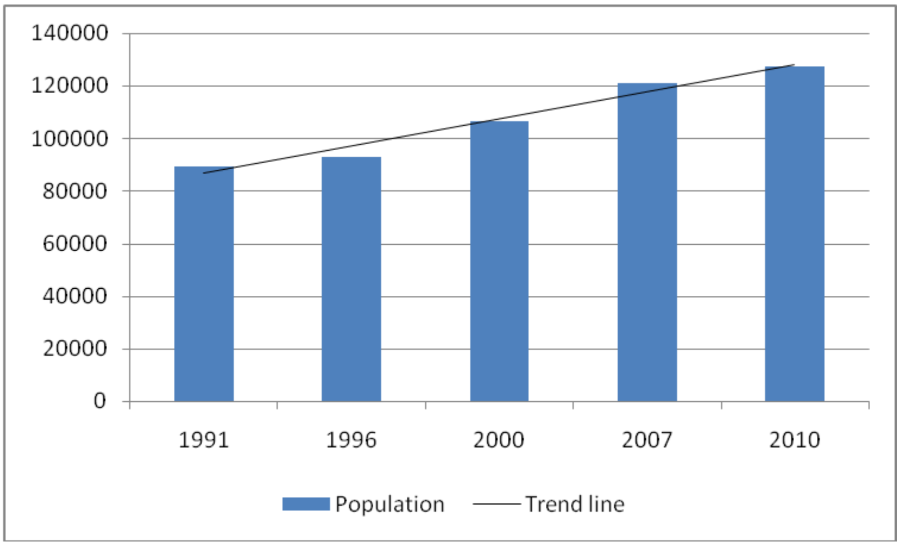


Figure 32. Population in the five municipalities of the reference region

The population within the reference region is mainly concentrated in towns and along the BR-364 Highway at the south of the project area. In general, all the municipalities within the reference region have a low population density, i.e., below 1.6 inhabitants/km² [55].

[53] 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).

[54] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at: Feijó: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120030&search=acre|feijo>; Manoel Urbano: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120034&search=acre|manoel-urbano>; Sena Madureira: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120050&search=acre|sena-madureira>; Boca do Acre: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=130070&search=amazonas|boca-do-acre>; Pauini: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=130350&search=amazonas|pauini>. Last visited on: October 06th, 2017.

[55] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at: Feijó: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120030&search=acre|feijo>; Manoel Urbano: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120034&search=acre|manoel-urbano>; Sena Madureira: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=120050&search=acre|sena-madureira>; Boca do Acre: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=130070&search=amazonas|boca-do-acre>; Pauini: <https://cidades.ibge.gov.br/painel/populacao.php?lang=&codmun=130350&search=amazonas|pauini>. Last visited on: October 06th, 2017.

According to a study carried out in 2010[56], the municipalities in the reference region were classified in the Medium (between 0.600 and 0.699), Low (0.500 and 0.599) and Very Low (0 and 0.499) Human Development Index (HDI) categories. Sena Madureira is in the medium category, with index of 0.603, Boca do Acre, Manoel Urbano and Feijó are in the low category, with indexes of 0.588, 0.551 and 0.539, respectively and Pauini has an index of 0.496, putting it in the Very Low Human Development class. These HDI are lower compared to the average for the State of Acre (0.663) and in the State of Amazonas (0.674).

According to Figure 33 below, the HDI scores showed significant growth over the years 1991 to 2010, reaching an average growth of 127% among the municipalities of the reference region. This indicates significant growth in the region, primarily associated with the Education indicator. However, of the municipalities studied Pauini has a very poor positioning, as it placed 5538th of 5565 Brazilian municipalities. Feijó placed 5332th, Manoel Urbano 5186th, Boca do Acre 4444th, and Sena Madureira 4081th [57].

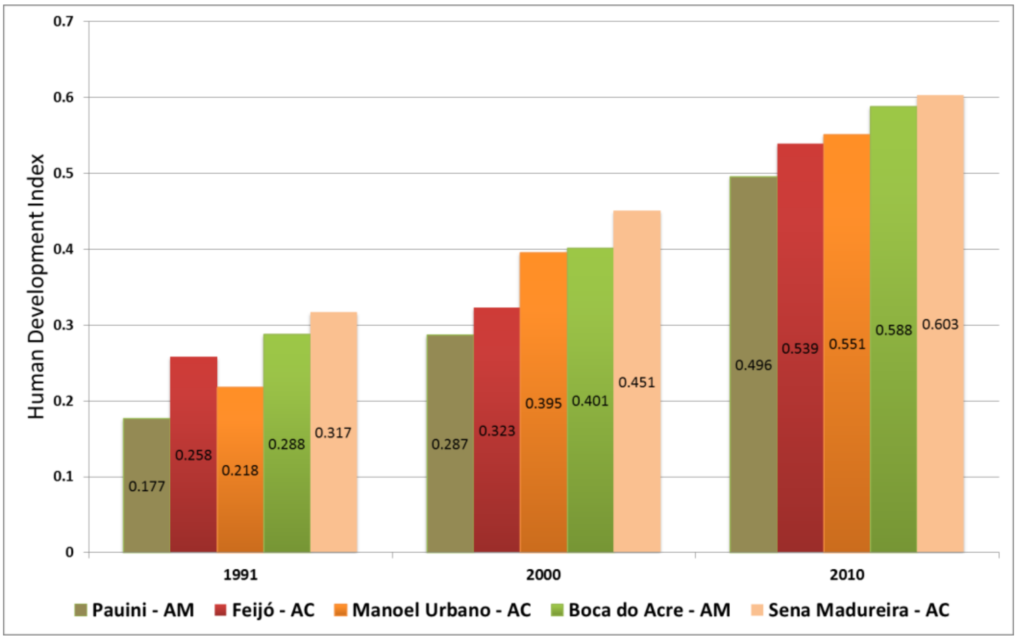


Figure 33. Human Development Index in the three main municipalities of the reference region

According to The National Historical and Artistic Heritage Institute (*Instituto Nacional do Patrimônio Histórico e Artístico* – Iphan), there is no presence of archaeological or historical sites within the project area[58]. The social survey conducted during the development of the SFMP did not find any area of historical and cultural importance by the communities in the region[59]. Furthermore, The National Indigenous Foundation (*Fundação Nacional do Índio* – FUNAI) certifies that there are no indigenous communities within the project area and surroundings[60].

[56] Atlas of Human Development in Brazil. Available at: <http://www.atlasbrasil.org.br/>. Last visit on: April 28th, 2017.
[57] Atlas of Human Development in Brazil. Available at: <http://www.atlasbrasil.org.br/>. Last visit on: April 28th, 2017.
[58] The National Historical and Artistic Heritage Institute (IPHAN). Consultation available at: <http://sicg.iphan.gov.br/sicg/pesquisarBem>. Last visited on: April 28th, 2017.
[59] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.
[60] The National Indigenous Foundation (FUNAI). Consultation available at: <http://www.funai.gov.br/index.php/2013-11-06-16-17-07>. Last visited on: April 28th, 2017.

The socio-economic climate described above is integrated into the Agrocortex REDD Project's goals, as the application of SOCIALCARBON® Standard combined with the FSC Certification aim to deliver appropriate, integrated and quantifiable ecological and socio-economic benefits to the population of the project region.

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 – which raises Brazil to the main nation among the 17 countries with the highest biodiversity levels globally, which contain over 70% of the planet's biodiversity[61].

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 of invertebrate species are known[62].

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[63]. 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[64].

In the regional context, the South-western region of Amazonia is within areas of high richness of birds, mammals and amphibian species, according to Figure 34 below. Although scientific research is scarce in the region, it is very likely that the existing biodiversity assessments underestimate the reality[65].

[61] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). The Brazilian Biodiversity. Available at: <http://www.mma.gov.br/biodiversidade/biodiversidade-brasileira>. Last visit on: April 20th, 2017.

[62] Information System about the Brazilian Biodiversity (SiBBr). Available at: <http://www.sibbr.gov.br/areas/?area=biodiversidade>. Last visit on: April 20th, 2017.

[63] Information System about the Brazilian Biodiversity (SiBBr). Available at: <http://www.sibbr.gov.br/areas/?area=biodiversidade>. Last visit on: April 20th, 2017.

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

[65] CASA DA FLORESTA. **Relatório do Monitoramento de Fauna em Áreas de Manejo Florestal Sustentável**, Agrocortex, Fazenda Seringal Novo Macapá, AC/AM, Piracicaba, 2016, 70 p..

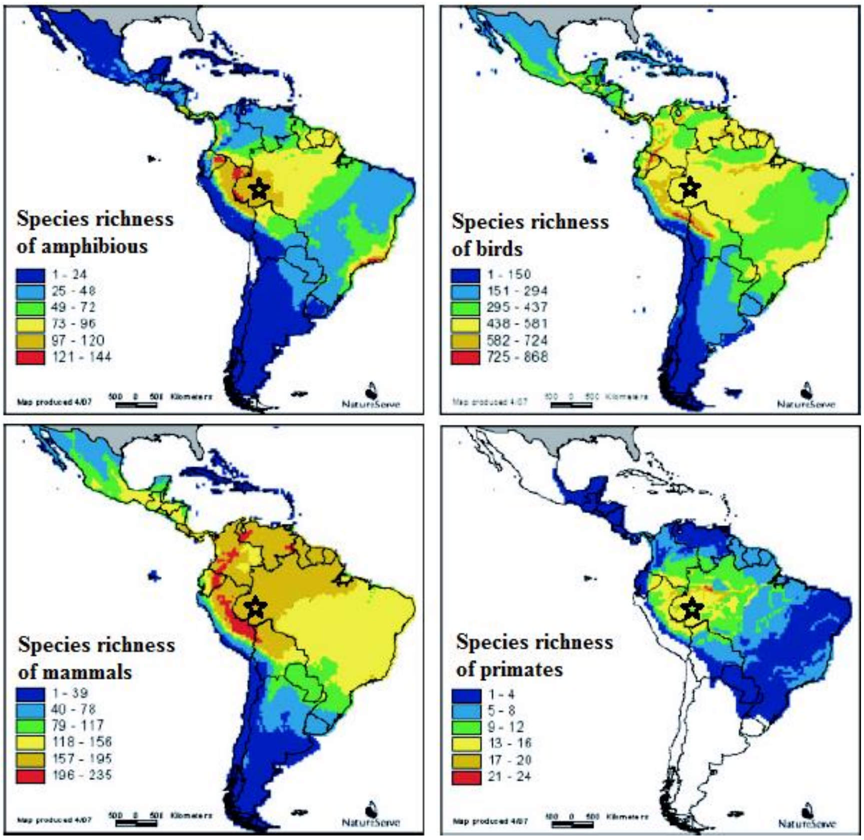


Figure 34. Species richness of amphibians, birds, mammals and primates in the project region

The South-western region of the Amazonis located in a well preserved region within the Legal Amazon, allowing species to move freely without much fragmentation, noting its high biological importance. However, this is also one of the least scientifically known regions of Brazil and therefore considered a priority area for wildlife inventories[66]. This is demonstrated by the fact that among the last 15 bird species described for the Brazilian Amazon, eight are within the project region.

This region is located within an important area for the worldwide conservation of birds. Birds are strictly associated to bamboos, which is the main vegetation type in the region associated to open tropical rainforests, making their distribution quite restricted. The region has one of the highest species richness of birds in the world.

The Project area presents a very rich biodiversity. Fauna surveys conducted on the Project area indicated the presence of 345 species of birds (which represents 18% of total species catalogued in Brazil), with the potential of reaching at least 467 bird species. Three of those species are vulnerable according to the International Union for Conservation of Nature – IUCN[67], the Ruddy Pigeon (*Patagioenas subvinacea)*, the Blue-headed Macaw (*Primolius couloni*) and the Channel-billed Toucan (*Ramphastos vitellinus culminatus*). Moreover, 27 species are endemic to the Southern Amazon region[68]. According to data available on the

[66] WWF (Brasil). **Mosaico da Amazônia Meridional:** Vencendo limites geográficos e integrando gestão. Brasília-DF: WWF, 2014. 136 p. Available at: <http://d3nehc6yl9qzo4.cloudfront.net/downloads/mam_livro_vencendo_limites_geograficos_final.pdf>. Last visit on: April 20th, 2017.

[67] IUCN 2016. The IUCN Red List of Threatened Species. Version 2016-3. Available at: <http://www.iucnredlist.org>. Last visit on: April, 20, 2017.

[68] CASA DA FLORESTA. **Relatório do Monitoramento de Fauna em Áreas de Manejo Florestal Sustentável**, Agrocortex, Fazenda Seringal Novo Macapá, AC/AM, Piracicaba, 2016, 70 p..

Global Forest Watch Interactive Map, the Project area lies inside birdlife endemic bird areas[69]. Some bird species present in the project area are detailed below.

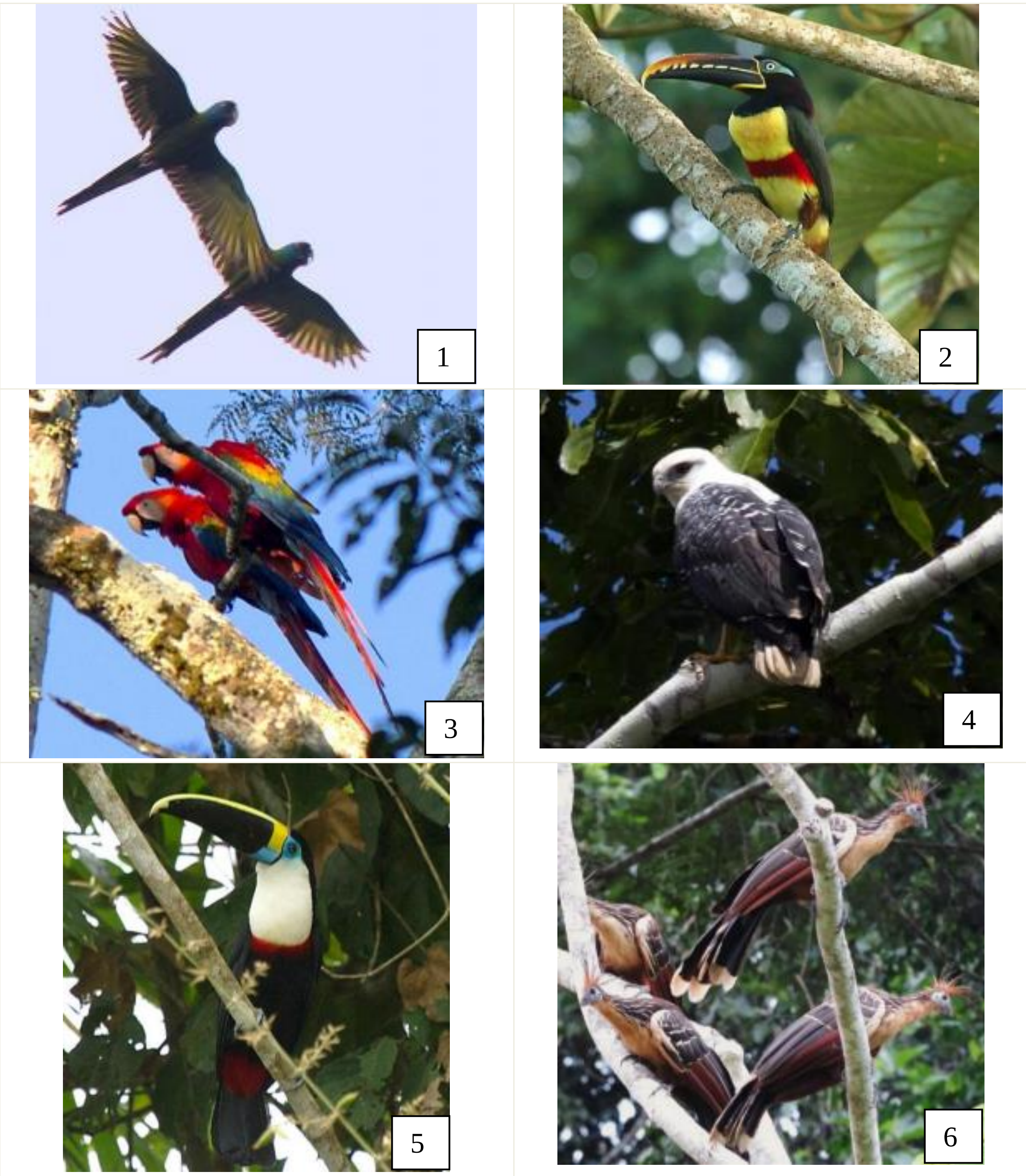


Figure 35. Examples of bird species found within the project area: 1. *Primolius couloni;* 2. *Pteroglossus castanotis;* 3. *Ara macao;* 4. *Pseudastur albicollis;* 5. *Ramphastos tucanus;* 6. *Opisthocomus hoazin*

Also, a total of 34 medium and large mammals were found in the project area, with the potential of reaching at least 44 mammal species according to richness estimates. From those species found in the area, 15 species are endemic from the region, and 8 are considered vulnerable or endangered according to IUCN or the Brazilian Government Ministry for the Environment [70]. The Pacarana (*Dinomys branickii*), the Goeldi's Monkey (*Callimico*

[69] The Global Forest Watch Interactive Map is available at: <http://www.globalforestwatch.org/map>. Please select the Birdlife endemic bird areas layers under the "conservation" category to view the areas covered.
[70] BRASIL, Ministério do Meio Ambiente. Lista Oficial das Espécies da Fauna Ameaçadas de Extinção. The full list is available at: <http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1&pagina=121&data=18/12/2014>. Last visited on April 20th, 2017.

goeldii), the Jaguar (*Panthera onca*), the Lowland Tapir (*Tapirus terrestris*), the Boto (*Inia geoffrensis*), the Margay (*Leopardus wiedii*), the Puma (*Puma concolor*) and the Jaguarundi (*Herpailurus yagouaroundi*) are among the vulnerable or endangered species that can be found on the Project area.

Thus, the present project contributes to the preservation of species that require large areas to move around freely and breed. Although scientific research is scarce in the region, it is very likely that the existing biodiversity assessments underestimate the reality[71].

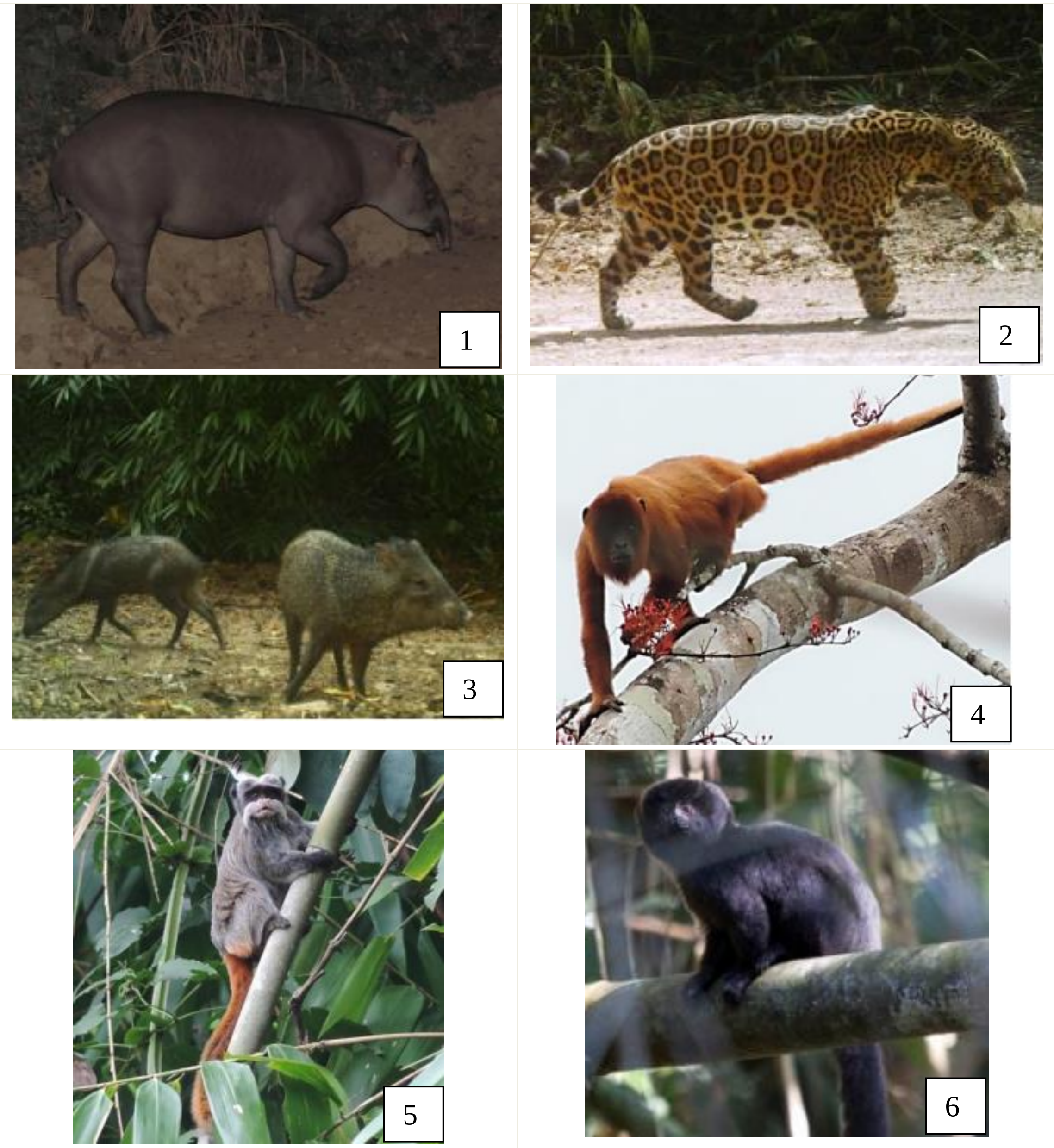


Figure 36. Examples of mammal species found within the project area: 1. *Tapirus terrestris;* 2. *Panthera onca*; 3. *Pecari tajacu*; 4. *Alouatta puruensis*; 5. *Saguinus imperator*; 6. *Callimico goeldii*

The Brazilian Government Ministry for the Environment included the Agrocortex REDD project region in its 2006 survey of Brazil's priority areas for conservation[72]. The project area is

[71] CASA DA FLORESTA. **Relatório do Monitoramento de Fauna em Áreas de Manejo Florestal Sustentável**, Agrocortex, Fazenda Seringal Novo Macapá, AC/AM, Piracicaba, 2016, 70 p..
[72] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). Brazilian priority areas for biodiversity conservation and sustainable use. Available at:

mostly classed within the category "very high", as detailed in Figure 37 below. This shows the significance of the present REDD project for conservation of Brazilian biodiversity. Thus, the conservation of this private land contributes to the Brazilian Government's conservation proposal.

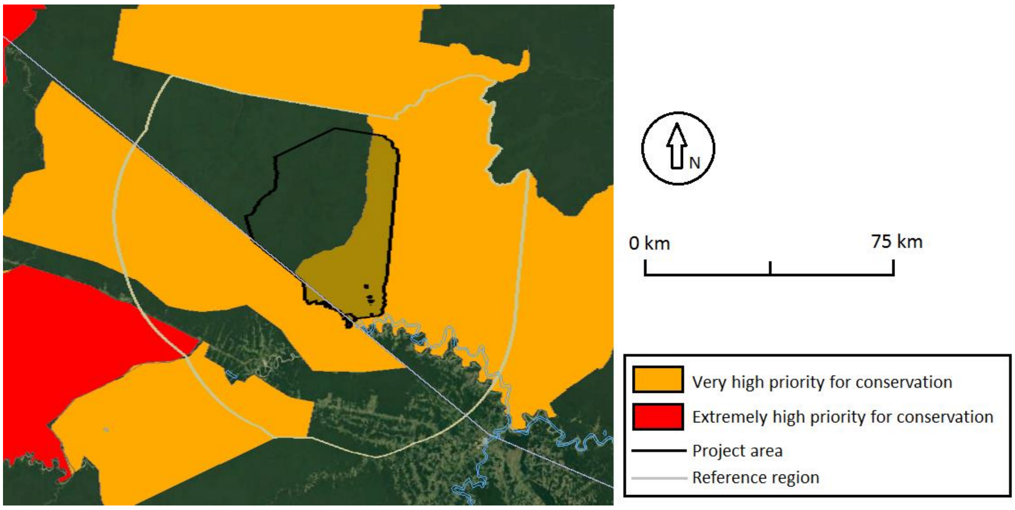


Figure 37. Brazil's priority areas for conservation and the Project Area

In terms of flora biodiversity, the vegetation within the project area itself was assessed by the Agrocortex Company in a forest inventory[73], consisting of linear samples of 10,000m^2, taken from Fazenda Seringal Novo Macapá property in the year 2000. These samples are grouped into 4 lines forming a cross around a central point, which received a reference number. A total of 144 crosses (i.e. 144 ha) were randomly distributed over the property, thus improving the efficiency of the sampling method. All trees with a Circumference at Breast Height (CBH) ≥ 30 cm were measured and identified. This inventory confirmed that three main vegetation types were present in the area: open tropical rainforest with bamboo, open tropical rainforest with palm trees, and open alluvial rainforest with palm trees.

A total of 158 different species from 47 families were found in this sample inventory within the project area. The tree species list from the forest inventory is provided in Table 7 below.

#	Common name	Scientific name	Family	Trees/ ha	Basal area (m²/ha)	Volume (m³/ha)
1	Marfim/azeitona	*Agonandra* sp.	OPILIACEAE	0.62	0.10	0.82
2	Coracao de nego	*Albizzia lebbeck*	LEGUMINOSAE MIMOSOIDEAE	0.02	0.01	0.06
3	Cerejeira	*Amburana acreana*	LEGUMINOSAE PAPILIONOIDEAE	1.15	0.21	1.52
4	Cajueiro	*Anacardium giganteum*	ANACARDIACEAE	0.03	0.00	0.01
5	Angico	*Anadenanthera* sp.	LEGUMINOSAE MIMOSOIDEAE	2.40	0.17	1.10
6	Angelim doce	*Andira* sp.	LEGUMINOSAE PAPILIONOIDEAE	0.24	0.05	0.43
7	Louro	*Aniba puchury-minor*	LAURACEAE	0.26	0.03	0.21
8	Pente de macaco	*Apeiba glabra*	TILIACEAE	0.25	0.03	0.17
9	Malva	*Apeiba* sp.	TILIACEAE	0.02	0.00	0.01
10	Garapeira	*Apuleia moralis*	LEGUMINOSAE CAESALPINIOIDEAE	0.27	0.15	1.15
11	Carapanauba	*Aspidosperma ablogum*	APOCYNACEAE	0.51	0.07	0.52
12	Canela de velho	*Aspidosperma discolor*	APOCYNACEAE	0.01	0.00	0.00
13	Peroba mico	*Aspidosperma macrocarpa*	APOCYNACEAE	0.05	0.01	0.10

<http://www.mma.gov.br/biodiversidade/biodiversidade-brasileira/áreas-prioritárias/item/489>. Last visit on: January 27th, 2015.

[73] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

#	Common name	Scientific name	Family	Trees/ ha	Basal area (m²/ha)	Volume (m³/ha)
14	Maracatiara	*Astronium lecointei*	ANACARDIACEAE	0.58	0.16	1.28
15	Pata de Vaca/mororo	*Bauhinia cf. macrostachya*	LEGUMINOSAE CAESALPINIOIDEAE	0.92	0.04	0.20
16	Castanheira do Brasil	*Bertholletia excelsa*	LECYTHIDACEAE	0.01	0.00	0.00
17	Urucum do mato	*Bixa arborea*	BIXACEAE	0.11	0.01	0.08
18	Sucupira	*Bowdichia* sp.	LEGUMINOSAE PAPILIONOIDEAE	0.13	0.03	0.27
19	Leiteiro	*Brosimum* sp.	MORACEAE	1.14	0.16	1.16
20	Amarelinho	*Buchenavia* sp.	COMBRETACEAE	0.40	0.04	0.33
21	Mirindiba	*Buchenavia* sp.	COMBRETACEAE	0.24	0.07	0.52
22	Muruci	*Byrsonima chrysophylla*	MALPHIGHIACEAE	0.01	0.00	0.00
23	Escorrega macaco	*Calycophyllum spruceanum*	RUBIACEAE	0.82	0.06	0.39
24	Jacareuba	*Calophyllum brasiliense*	CLUSIACEAE	0.01	0.00	0.01
25	Mulateiro	*Calycophyllum sprucanum*	RUBIACEAE	0.10	0.03	0.18
26	Andiroba	*Carapa guianensis* Aubl.	MELIACEAE	0.56	0.09	0.65
27	Jequitiba	*Cariniana estrellensis*	LECYTHIDACEAE	0.01	0.01	0.03
28	Piquia	*Caryocar vilosum*	CARYOCARACEAE	0.19	0.09	0.70
29	Caucho	*Castilloa ulei* Warburg	MORACEAE	0.72	0.22	1.58
30	Carijo	*Cayaponia espelina*	CUCURBITACEAE	0.01	0.00	0.00
31	Embauba	*Cecropia* spp.	CECROPIACEAE	1.04	0.05	0.29
32	Cedro rosa	*Cedrela odorata* L.	MELIACEAE	0.88	0.15	1.19
33	Cedro alagoano	*Cedrelinga cateneaformis*	LEGUMINOSAE MIMOSOIDEAE	0.01	0.01	0.04
34	Barriguda	*Ceiba erianthos*	BOMBACACEAE	0.09	0.05	0.32
35	Sumauma	*Ceiba pentandra*	BOMBACACEAE	2.63	0.78	6.18
36	Quariquara	*Cenostigma tocantinum*	LEGUMINOSAE CAESALPINIOIDEAE	0.01	0.00	0.00
37	Feijao cru	*Centrosema brasilianum*	LEGUMINOSAE PAPILIONOIDEAE	0.05	0.01	0.07
38	Paineira	*Chorisia pubiflora*	BOMBACACEAE	0.53	0.13	0.89
39	Oiticica	*Clarisia racemosa*	MORACEAE	0.45	0.10	0.73
40	Cauacu	*Coccoloba* sp.	POLYGONACEAE	0.56	0.04	0.24
41	Sobrasil	*Colubrina glandulosa*	RHAMANACEAE	0.26	0.03	0.17
42	Copaiba	*Copaifera* sp.	LEGUMINOSAE CAESALPINIOIDEAE	0.23	0.07	0.63
43	Freijo	*Cordia goeldiana* Huber	BORAGINACEAE	2.41	0.20	1.38
44	Mata fome	*Cordia sellowiana* Cham.	BORAGINACEAE	0.13	0.01	0.04
45	Ripeiro	*Corythophora alta* R. Knuth	LECYTHIDACEAE	0.08	0.01	0.06
46	Sorveira	*Couma guianensis* Aubl.	APOCYNACEAE	0.15	0.02	0.18
47	Sorva brava	*Couma* sp.	APOCYNACEAE	0.09	0.02	0.14
48	Tauari	*Couratari tenuicarpa*	LECYTHIDACEAE	0.39	0.12	1.09
49	Jurubeba	*Cyphomandra* sp.	SOLANACEAE	0.11	0.01	0.03
50	Tamarindo	*Dialium guianensis*	LEGUMINOSAE CAESALPINIOIDEAE	0.12	0.02	0.14
51	Cumarú	*Dipteryx odorata*	LEGUMINOSAE PAPILIONOIDEAE	0.93	0.28	2.31
52	Bacuri	*Ecclinusa guianensis* Eyma	SAPOTACEAE	0.14	0.01	0.04
53	Timburi	*Enterolobium contortisiliquum*	LEGUMINOSAE MIMOSOIDEAE	0.02	0.01	0.11
54	Orelha de macaco	*Enterolobium schomburgkii*	LEGUMINOSAE MIMOSOIDEAE	0.01	0.00	0.01
55	Espeteiro	*Eperua falcata* Aubl.	LEGUMINOSAE CAESALPINIOIDEAE	0.45	0.03	0.19
56	Cambara	*Erisma* sp.	VOCHYSIACEAE	0.01	0.00	0.02
57	Cambara rosa	*Erisma uncinatum* Warm.	VOCHYSIACEAE	0.08	0.01	0.03
58	Cedrilho/cedrinho	*Erisma uncinatum* Warm.	VOCHYSIACEAE	0.01	0.01	0.05
59	Matamata	*Eschweilera odorata*	LECYTHIDACEAE	0.94	0.26	2.07
60	Guaranta	*Esembeckia stipularis* Mart.	RUTACEAE	0.17	0.03	0.23
61	Figueira	*Ficus citrifolia*	MORACEAE	0.35	0.11	0.82
62	Gameleira	*Ficus maxima* Mill.	MORACEAE	0.04	0.01	0.12
63	Apui	*Ficus trigona* L.F.	MORACEAE	0.12	0.04	0.27
64	Pau d'alho	*Galesia garazema*	OLACACEAE	0.27	0.12	0.94
65	Genipapo	*Genipa americana* L.	RUBIACEAE	0.13	0.01	0.06
66	Farinha seca	*Gomphia castaneaefolia*	OCHNACE AE	0.01	0.00	0.02
67	Copiuva	*Goupia glaba* (Aubl.)	CELASTRACEAE	0.02	0.00	0.02
68	Cedro Marinheiro	*Guarea trichilioides* L.	MELIACEAE	0.28	0.04	0.24
69	Embira	*Guatteria amazonica*	ANNONACEAE	2.45	0.21	1.49
70	Laranjinha	*Guatteria citriodora* Ducke	ANNONACEAE	0.27	0.04	0.25
71	Candiuba/periquiteira	*Guazuma ulmifolia* Lam.	STERCULIACEAE	0.04	0.00	0.02

#	Common name	Scientific name	Family	Trees/ ha	Basal area (m²/ha)	Volume (m³/ha)
72	Angelca	*Guettarda argentea* Lam.	RUBIACEAE	0.47	0.03	0.19
73	Seringueira	*Hevea brasiliensis*	EUPHORBIACEAE	1.17	0.18	1.39
74	Assacú	*Hura crepitans L.*	EUPHORBIACEAE	0.99	0.49	3.98
75	Jatoba	*Hymenaea courbaryl* L.	LEGUMINOSAE CAESALPINIOIDEAE	0.32	0.12	1.09
76	Jutai	*Hymenaea* sp.	LEGUMINOSAE CAESALPINIOIDEAE	0.13	0.02	0.16
77	Inga	*Inga acreana* Harms	LEGUMINOSAE MIMOSOIDEAE	6.85	0.34	2.01
78	Ucuuba	*Iryanthera tricornis* Ducke	MYRISTICACEAE	1.66	0.19	1.41
79	Caroba	*Jacaranda copaia*	BIGNONIACEAE	0.12	0.02	0.16
80	Jaracatia	*Jaracatia spinosa*	CARICARACEAE	0.12	0.02	0.13
81	Urtigao	*Jatopha bahiana* Ule	EUPHORBIACEAE	0.26	0.01	0.03
82	Castanha de arara	*Joannesia heveoides* Ducke	EUPHORBIACEAE	0.06	0.02	0.12
83	Camaleao	*Laetia procera*	SALICACEAE	0.44	0.02	0.12
84	Apijo/Camaleao	*Laetia procera*	FLACOURTIACEAE	0.01	0.00	0.02
85	Cabelo de cotia	*Lafoensia* sp.	LYTHRACEAE	0.38	0.04	0.25
86	Niare/niarana	*Lecythis chartaceae* Berg.	LECYTHIDACEAE	0.13	0.03	0.25
87	Sapucaia	*Lecythis usitada*	LECYTHIDACEAE	0.01	0.00	0.01
88	Macucu	*Licania heteromorpha*	CHRYSOBALANACEAE	0.17	0.02	0.13
89	Milho torrado	*Licania kunthiana* Hook. f.	CHRYSOBALANACEAE	0.02	0.00	0.01
90	Caripe	*Licania quadrijuga* H.B.K	CHRYSOBALANACEAE	0.37	0.05	0.37
91	Oiti	*Licania tomentosa* (Benth) Fristch.	CHRYSOBALANACEAE	0.04	0.01	0.04
92	Mutamba	*Luehea* sp.	TILIACEAE	0.24	0.03	0.20
93	Cafezinho	*Lunania guianensis* Aubl.	FLACOURTIACEAE	1.31	0.08	0.52
94	Cumate	*Macairea viscosa* Ducke	MELASTOMATACEAE	0.03	0.00	0.02
95	Amoreira	*Maclura tinctoria* (L.)	MORACEAE	0.02	0.00	0.02
96	Mulungu	*Malouetia tamaquarina*	APOCYNACEAE	0.73	0.09	0.63
97	Massaranduba	*Manilkara huberi*	SAPOTACEAE	0.51	0.11	0.92
98	Paraju	*Manilkara* sp.	SAPOTACEAE	0.15	0.04	0.30
99	Ovo de codorna	*Manilkara zapota*	SAPOTACEAE	0.01	0.00	0.00
100	Itauba	*Mezilaurus itauba*	LAURACEAE	0.12	0.02	0.11
101	Pracuuba	*Mora paraensis* Ducke	LEGUMINOSAE CAESALPINIOIDEAE	0.01	0.00	0.00
102	Cabreuva	*Myroxylon balsamum*	LEGUMINOSAE PAPILIONOIDEAE	0.47	0.07	0.58
103	Aguano querozene	Not identified	NOT IDENTIFIED	0.34	0.08	0.58
104	Cacarecuia	Not identified	NOT IDENTIFIED	0.06	0.01	0.06
105	Casca de acai	Not identified	NOT IDENTIFIED	0.20	0.02	0.10
106	Fava jerem	Not identified	NOT IDENTIFIED	0.01	0.00	0.02
107	Favao	Not identified	NOT IDENTIFIED	0.01	0.00	0.00
108	Jaca brava	Not identified	NOT IDENTIFIED	0.02	0.00	0.02
109	Not identified	Not identified	NOT IDENTIFIED	2.00	0.28	1.98
110	Pau de nossa senhora	Not identified	NOT IDENTIFIED	0.01	0.00	0.00
111	Pimenta do reino	Not identified	NOT IDENTIFIED	0.01	0.00	0.00
112	Sino	Not identified	NOT IDENTIFIED	0.01	0.00	0.00
113	Tiago	Not identified	NOT IDENTIFIED	0.01	0.00	0.00
114	Joao mole	*Neea oppositifolia*	NYCTAGINACEAE	0.72	0.04	0.24
115	Loro pimenta	*Ocotea canaliculata*	LAURACEAE	0.01	0.00	0.01
116	Canela	*Ocotea* spp.	LAURACEAE	0.10	0.01	0.09
117	Sernambi de indio	*Ormosia flava* (Ducke) Rudd.	LEGUMINOSAE PAPILIONOIDEAE	0.02	0.00	0.01
118	Bandarra	Parkia paraensis Ducke	LEGUMINOSAE MIMOSOIDEAE	0.46	0.16	1.27
119	Pau-arara	*Parkia pendula* (Willd.) Benth. Ex. Walp.	LEGUMINOSAE MIMOSOIDEAE	0.15	0.05	0.36
120	Pama	*Perebea mollis* Standley	MORACEAE	3.81	0.35	2.32
121	Catuaba	*Phyllanthus nobilis*	LEGUMINOSAE PAPILIONOIDEAE	0.14	0.04	0.32
122	Piranheira	*Piranhea trifoliata* Baill.	EUPHORBIACEAE	0.01	0.01	0.05
123	Branquilho/cinzeiro	*Pithecelobium hassleri*	LEGUMINOSAE MIMOSOIDEAE	0.22	0.06	0.43
124	Bordao de velho	*Pithecelobium saman* var acutifolim Benth.	LEGUMINOSAE MIMOSOIDEAE	0.16	0.02	0.11
125	Macacauba	*Platymiscium* sp.	LEGUMINOSAE PAPILIONOIDEAE	0.11	0.01	0.08
126	Pintadinho	*Poeppigia procera*	LEGUMINOSAE CAESALPINIOIDEAE	0.25	0.02	0.11

#	Common name	Scientific name	Family	Trees/ ha	Basal area (m²/ha)	Volume (m³/ha)
127	Goiabao	*Pouteria pachycarpa*	SAPOTACEAE	0.13	0.01	0.02
128	Grao de galo	*Pouteria ramiflora*	SAPOTACEAE	0.01	0.00	0.01
129	Abiu	*Pouteria* sp.	SAPOTACEAE	1.03	0.18	1.35
130	Jara	*Pouteria* sp.	SAPOTACEAE	0.03	0.01	0.10
131	Amescla	*Protium heptaphuyllum*	BURSERACEAE	0.01	0.00	0.00
132	Breu	*Protium* sp.	BURSERACEAE	1.28	0.09	0.56
133	Ata	*Rollinia* sp.	ANNONACEAE	1.15	0.09	0.59
134	Sapota	*Salacia grandiflora*	CELASTRACEAE	0.90	0.11	0.77
135	Mandiocao/morototo	*Schefflera morototoni*	ARALIACEAE	0.68	0.08	0.57
136	Pinho Cuiabano	*Schizolobium amazonicum*	LEGUMINOSAE CAESALPINIOIDEAE	0.44	0.10	0.91
137	Cotia preta	*Scleronema* sp.	BOMBACACEAE	0.03	0.00	0.01
138	Caixeta	*Simarouba amara* Aubl.	SIMAROUBACEAE	0.08	0.02	0.16
139	Taperiba/cedro caja	*Spondias mombim lutea* L.	ANACARDIACEAE	0.02	0.01	0.06
140	Cajaseira	*Spondias* sp.	ANACARDIACEAE	0.92	0.20	1.50
141	Chicha	*Sterculia pilosa* Ducke	STERCULIACEAE	0.58	0.09	0.67
142	Gerimunzinho	*Swartzia ulei* Harms	LEGUMINOSAE PAPILIONOIDEAE	0.06	0.00	0.01
143	Mogno	*Swietenia macrophylla* King	MELIACEAE	0.08	0.05	0.45
144	Ipe roxo	*Tabebuia impetiginosa* (Marth) Standley	BIGNONIACEAE	0.03	0.01	0.07
145	Ipe	*Tabebuia serratifolia*	BIGNONIACEAE	0.89	0.15	1.34
146	Tachi	*Tachigali* sp.	LEGUMINOSAE CAESALPINIOIDEAE	0.97	0.09	0.63
147	Pitomba	*Talisia acutifolia* Radlk.	SAPINDACE AE	0.01	0.00	0.00
148	Cuiarana	*Terminalia amazonica*	CLUSIACEAE	0.01	0.00	0.02
149	Cacau	*Theobroma cacao*	STERCULIACEAE	0.06	0.00	0.02
150	Cupui	*Theobroma subincanum*	STERCULIACEAE	0.04	0.00	0.01
151	Angelim Amargoso	*Vatairea guianensis*	LEGUMINOSAE PAPILIONOIDEAE	0.10	0.02	0.15
152	Angelim Faveira	*Vatairea* sp.	LEGUMINOSAE PAPILIONOIDEAE	0.02	0.01	0.06
153	Virola	*Virola surinamensis*	MYRISTICACEAE	0.30	0.05	0.31
154	Lacre	*Vismia cayannensis*	GUTTIFERAE	0.05	0.00	0.01
155	Pindaiba	*Xilopia fruitescens* Aubl.	ANNONACEAE	0.09	0.01	0.06
156	Piaca/envira	*Xylopia* sp.	ANNONACEAE	0.61	0.03	0.19
157	Mamica de porca	*Zanthoxylum acreanum*	RUTACEAE	0.44	0.09	0.74
158	Espinheiro	*Zanthoxylum pterota*	RUTACEAE	1.69	0.13	0.78
TOTAL				**68.11**	**9.693**	**72.62**

Table 7. Tree species found within the project area[74]

The distribution of volume, basal area and number of trees per Diameter at Breast Height (DBH) class of all trees sampled in the forest inventory is detailed below. The local forest in the project region presents low values for the volume (72.62 m³/ha), basal area (9.69 m²/ha) and density (68.11 trees/ha) when compared to other Amazon rainforest types. This situation is explained by an extremely high abundance of bamboos in this area.

However, it is important to note that this sample forest inventory carried out in 2000 had the objective of analyzing the logging potential of the forest, not taking into account the total biomass volume. Thus, tree species with no logging potential as well as non-tree species, such as bamboos, palm trees and vines, were not inventoried.

[74] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

DBH class (cm)	Volume		Basal area		N° trees	
	m³/ha	%	m²/ha	%	N/ha	%
10 – 29.9	8.442	11.6	1.457	15.0	36.5	53.6
30 – 39.9	9.577	18.8	1.391	14.3	15.2	22.3
40 – 49.9	4.096	18.7	0.563	5.8	3.7	5.4
50 – 50.9	4.149	20.6	0.556	5.7	2.4	3.5
60 – 60.9	5.433	17.4	0.651	6.7	0.8	1.1
70 – 70.9	9.454	6.8	1.193	12.3	3.5	5.1
80 – 89.9	9.675	3.4	1.207	12.4	2.8	4.1
90 – 99.9	5.301	1.2	0.678	6.9	1.2	1.7
100 – 109.9	7.233	0.1	0.890	9.2	1.3	1.9
> 110	9.259	0.3	1.108	11.4	0.8	1.2
TOTAL	**72.62**	**100**	**9.69**	**100**	**68.11**	**100**

Table 8. Distribution of trees per DBH class

The number of trees per DBH class and volume per DBH class of sampled trees in the forest inventory are shown in Figures below.

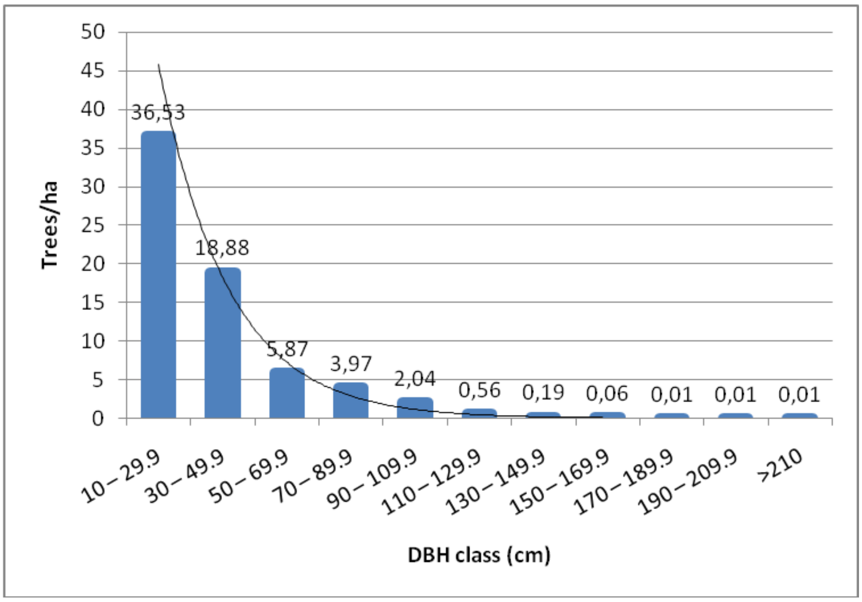


Figure 38. Distribution of the number of trees per DBH class, in trees/ha

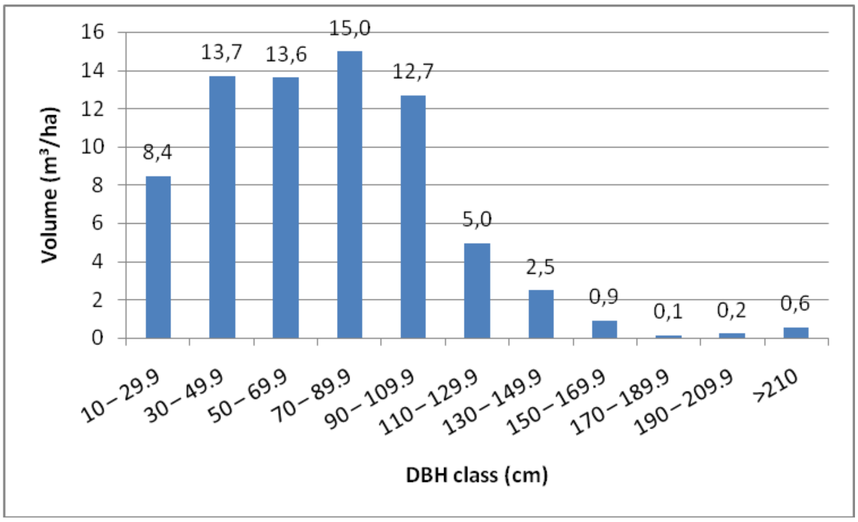


Figure 39. Distribution of the volume per DBH class, in m³/ha

Therefore, the south-western 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[75].

The Agrocortex REDD project therefore creates an important South-western Amazon biodiversity corridor in a threatened and still unknown region. Preserving such 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

The project area is covered by native Amazonian vegetation. The vegetation in the project area was mapped on the basis of CENSIPAM sources[76]. Three main vegetation types were found in the area, which were grouped according to the main category defined by The Brazilian Institute for Geography and Statistics (or *Instituto Brasileiro de Geografia e Estatística* – IBGE, in Portuguese) descriptions[77]: open tropical rainforest with bamboo, open tropical rainforest with palm trees, and open alluvial rainforest with palm trees.

A total of 14 different forest phytophysiognomies were identified in the reference region, while 3 types were found in the project area and 8 in the leakage belt. These forest phytophysiognomies were grouped in accordance to their presence in each site (RR, PA and LK), following a criterion of the predominant category of each phytophysiognomy. More details can be found in Appendix II.

According to forest class definitions established by IBGE in 1992, the main characteristics of the vegetation types existing within the project area are:

- Open tropical rainforests with bamboo: classified as the main vegetation cover type present in the project area, representing approximately 90% of the total. This forest type has more sparse crowns, allowing a greater incidence of light at ground level. The species *Guadua werberbaueri* is the most common bamboo species, reaching the forest canopy (20-35m high), and showing faster growth rate under favorable light conditions.

- Open tropical rainforests with palm trees: classified as the transition forest type between Amazon rainforest and extra-Amazon areas. They are found in climates with up to 60 days without precipitation per year. This forest type has a denser canopy cover with the presence of palm trees, and the bamboo disperses and integrates into the forest.

- Open alluvial rainforest with palm trees: classified as the most representative forest type of the floodable areas of the Amazon. They are open riparian ecosystems with the presence of palm trees associated with watersheds of white-water rivers (those with their sources in

[75] 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.

[76] Operations and Management Center of the Amazon Protection System. The CENSIPAM carried out updates of the IBGE Vegetation Base and the Radam Brazil Project to the Amazon biome, according to the current geoscientific concepts.

[77] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Manual Técnico da Vegetação Brasileira. Manuais Técnicos em Geociências n° 1, Rio de Janeiro, 1991.

mountainous regions) and with high erosion levels. They are lower and more open than *terra firme* forests.

The vegetation cover types within the project area, including the respective areas, are detailed in the Table 9 and Figure 40 below.

Vegetation type	Area (ha)	Percentage of the project area (%)
Open Tropical Rainforest with bamboo	172,554.03	92.6%
Open Tropical Rainforest with palm trees	9,531.80	5.2%
Open alluvial rainforest with palm trees	4,133.22	2.2%
TOTAL	**186,219.06**	**100%**

Table 9. Vegetation cover types within the project area

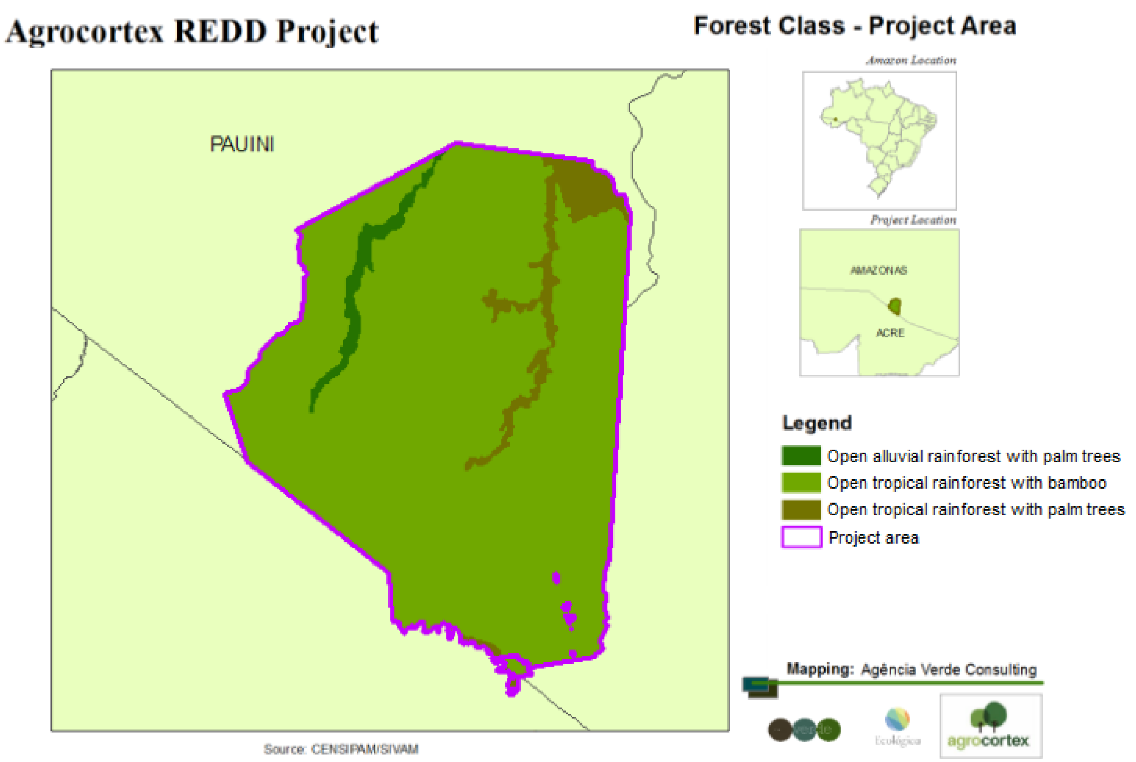


Figure 40. Vegetation cover types within the project area

Secondary vegetation associated with pasturelands in anthropic areas was also found within the Leakage Belt and Reference Region.

In addition, dense tropical rainforest was found in less than 0.2% of the Reference Region. This forest class occurs in areas with high temperature and high precipitation which is well distributed throughout the year. They are most common in low-fertility soils such as latosols and podsols.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

In the Amazon, regions known as the agricultural expansion frontier (usually located in remote areas where access is difficult and there is little action/control by government bodies), land occupation takes place in a disorderly manner and without regard for legislation[78].

The conditions of low governance, poorly defined land tenure and land occupation pressure through unofficial roads propagate an ideal scenario for the advancement of deforestation in Southern Amazonas State. This is a problem made possible by the local geo-political situation, which the municipalities do not have the capacity to deal with alone.

Deforestation in the Brazilian Amazon has been taking place at an average rate of 0.4% or 13,600 km^2 per year since 1996[79], showing a significant reduction from 2004 to 2012, but presenting a upwards trend from 2013 to 2016. Around 44% of the reduction observed has been attributed to negative trends in the livestock industry, 37% due to creation of new protected areas, and approximately 18% to causes potentially attributable to command and control campaigns by the federal government[80]. The deforested annual area in the 2010 to 2013 period reduced by 70% compared to the 1996 to 2005 period. However, data from recent years shows a new increase in deforestation and the need to improve efforts to preserve forest resources. Therefore, it is difficult to guarantee with certainty that deforestation is under control, mainly because it is ever more interlinked with commodities, mainly beef and soy, traded in global markets[81].

Command and control activities are more concentrated in the States of Pará, Mato Grosso and Rondônia, while in Southern Amazon they are rare. Given the advancement of the deforestation frontier associated with improvement of infrastructure, deforestation has tended to continue at the same pace, taking into account the dynamic of the agents involved as presented above and the great expanse of forested land still available[82].

However, despite the clear drop in deforestation in the Amazon between 2010 and 2012, data from PRODES shows deforestation observed in the biome increased for the following four years (2013 to 2016). Deforestation in 2016 has reached 7,989 km², which represents an increase of more than 35% compared to 2012 and the highest value since 2009. This fact demonstrates that deforestation in the Amazon biome is still not under control.

An excellent study by Antonio Nobre in 2014[83], which collected information from over 200 scientific studies and articles from the Amazon biome, reports that deforestation and degradation of the rainforest had reached 2,018,079 km², signifying that up to 47.34% of the entire forest had already undergone some kind of human impact. According to the report,

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[78] 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).
[79] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on April 06th, 2017.
[80] SOARES-FILHO, B. *et al*. **Role of Brazilian Amazon protected areas in climate change mitigation.** Nova York: Columbia University. 2010.
[81] NEPSTAD, Daniel C.; STICKLER, Claudia M.; ALMEIDA, Oriana T.. Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation. **Conservation Biology,** Belém, v. 20, n. 6, p.1595-1603, 30 mar. 2006.
[82] 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).
[83] NOBRE, Antonio Donato. **O Futuro Climático da Amazônia.** São José dos Campos: Articulación Regional Amazônica (ARA), 2014. 42 p.

deforestation may put at risk the forest's capacity to "export" moisture to other regions via the so-called "flying rivers" which regulate the climate, causing droughts and other negative effects. The Amazon rainforest survived over thousands of years of volcanic, meteoric, seismic, and glacial impacts, but in less than 50 years of human activity, it has been pushed to a significant level of threat.

Furthermore, the States of Acre and Amazonas, where the project area is located, have shown the highest deforestation rates from 2000 to 2016, according to PRODES[84]. The low presence of government in the region, combined with few awareness raising and anti-deforestation initiatives, will leave it poorly prepared to prevent deforestation in the coming years.

Therefore, as observed by Idesam (2011)[85], Carrero (2009)[86] and Nepstad *et al*. (2006)[87,88], these data confirm the acceleration of the deforestation dynamic in Acre and Southern Amazonas in relation to historical tendencies, indicating a frontier of agricultural expansion.

According to the Brazilian Forest Code (Law Nº 12.651, 25/05/2012[89]), all rural estates located in forest zones should have:

I - Permanent preservation area: protected areas covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, biodiversity, gene flow of plants and animals, protecting the soil and ensuring the well-being of human populations

II - Legal Reserve (LR): 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[90], eighty percent (80%) of a rural property should be preserved as LR.

However, there is a clear disregard for legal conservation requirements in the region. Much of the deforestation occurs on areas that should be preserved. In the State of Acre, 34% of deforestation occurs in areas registered on the Rural Environmental Registry (in Portuguese, *Cadastro Ambiental Rural* – CAR), a federal registry created to disclose information on preserved areas in rural properties[91].

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[84] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on April 06th, 2017.

[85] 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).

[86] CARRERO, G.C. Dinâmica do Desmatamento e Consolidação de Propriedades Rurais na Fronteira de Expansão Agropecuária no Sudeste do Amazonas. Master thesis, Instituto Nacional de Pesquisas da Amazônia. 68p. 2009.

[87] 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.

[88] Carrero, G. C., and P. M. Fearnside. Forest clearing dynamics and the expansion of landholdings in Apuí, a deforestation hotspot on Brazil's Transamazon Highway. **Ecology and Society** 16(2): 26. 2011

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

[90] 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.

[91] Information disclosed by Imazon (Instituto do Homem e Meio Ambiente da Amazônia), a non-profit research Institution whose mission is to promote sustainable development in the Amazon. Source:

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[92]. 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[93].

In spite of the legal provisions intended to preserve at least 80% of 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[94, 95].

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.

In this sense the preparation for REDD+ activities, programs and projects becomes 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 26th, 2015 ocurred the approval of the Federal Decree 8,576 / 2015, 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 +[96].

<http://www.ac24horas.com/2017/01/02/no-acre-34-das-derrubadas-ilegais-ocorreram-em-areas-registradas-no-car/>. Last visited on April 6th, 2017.

[92] FAO. **Global Forest Resource Assessment 2015**: Desk reference. Rome, 2015. 253 p.

[93] NOBRE, Antonio Donato. **O Futuro Climático da Amazônia.** São José dos Campos: Articulación Regional Amazônica (ARA), 2014. 42 p.

[94] 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.

[95] 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).

[96] The Decree is available in Portuguese at: <http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Decreto/D8576.htm> . Last visited on February 26th, 2018.

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, jurisdictionality and scope of the Decree 8,576 / 2015, it is understood that its application is merely administrative, that is, it merely organizes the functioning of the Federal Government about the REDD+ agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, does not establish duties or obligations to the society.

Thus, Article 6 of Decree 8,576 / 2015 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 Agrocortex project and such Decree.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

The project area is located within a private property named “Fazenda Seringal Novo Macapá”, which is located in the municipalities of Manoel Urbano, Pauini and Boca do Acre, in the States of Acre and Amazonas, South-western Amazon.

Agrocortex Madeiras do Acre Agroflorestal Ltda. (i.e., the project proponent) is the company responsible for operations in Brazil, being part of a Brazilian holding company named Agrocortex Florestas do Brasil S.A. The latter also holds Agrocortex Florestas Tropicais Ltda., which owns Batisflor Florestal Ltda., the landowner of Fazenda Seringal Novo Macapá. Figure 1 in Section 1.8 presents the organization chart of the company that owns the Project area.

1.12.2 Emissions Trading Programs and Other Binding Limits

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

A small part of the project area (±3%) is located within the State of Acre, where there is a proprietary and voluntary nested REDD+ program which is not validated by the VCS or other Carbon Standard[97].

However, it is important to note the difference between SISA-Carbon Program and the Acre's jurisdictional REDD+ program. The SISA-Carbon Program, established in Articles 22 and 23 of Law no. 2,308 / 2010, sets out only the objectives of this program, which is to promote the GHG emission reductions, according to the voluntary goal of the State of Acre. The SISA-Carbon Program described in articles 22 and 23 of Law no. 2,308 / 2010 does not provide any determination, rule, limitation or specification about the execution of REDD projects in the territory of the State of Acre, by private initiative or by the State of Acre itself.

Furthermore, articles 24 to 26 of Law no. 2,308 / 2010, mention that the State of Acre will define the commitment period, the limit of registrable units of carbon to be distributed to the special projects and the implementation of a registration system. However, such articles of law do not define or regulate the application of these themes. They only foresee the existence of such themes, without any regulation about them.

Thus, the articles of the Law on the SISA-Carbon Program were not regulated by the State of Acre in order to have a legal record on their accounting, registration of projects and distribution of emission reduction percentages. There is no regulation of articles 24, 25 and 26 of Law No. 2,308 / 2010, so that the applicability of these articles is not fully enforced. In other words, the SISA-Carbon Program has no legal applicability on these issues until they become fully regulated.

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

The normative instruction No. 1 of the Climate Change Institute (*Instituto de Mudanças Climáticas – IMC*, in Portuguese) only clarifies the procedure to be adopted for those who, voluntarily, want to be registered by the State of Acre as a special project. The normative instruction No. 1 of the IMC only tells which documents and information need to be submitted to the IMC to be able to register private REDD projects as special projects and defines the procedure for analyzing them for validation and certification by the IMC itself.

Regarding the Jurisdictional Program of the State of Acre, it is important to clarify that it is a mere administrative document of the State, it is not a document that has legal force. It is a document defining administrative guidelines of the Government of Acre about REDD+. Such a program does not impose, impede or create obligations for society. It is a public administration document that serves as a guide, which allows others to voluntarily join the Program if they so choose. Therefore, the adhesion of the private initiative to the Program is voluntary.

However, it is important to mention that the Acre REDD+ Jurisdictional Program, besides being a document without force of law, i.e., it is only a guideline document for the State's public administration, was not formally validated under the VCS, or any other standard of

[97] The ISA Carbon Program of Acre is the Jurisdictional REDD+ Program of the State of ACRE. More information on the ISA Carbon Program of Acre is available at: <https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000005599>. Last visited on April 12th, 2017.

REDD+ in Brazil or worldwide. This program only applies resources through performance in reducing GHG emissions from deforestation within the State.

Moreover, in the State of Acre there are already several private REDD projects validated and certified, including by the VCS, such as the projects[98]:

- The Envira Amazonia Project - A Tropical Forest Conservation Project in Acre (Project ID 1382)
- The Valparaiso Project (Project ID 1113)
- The Russas Project (Project ID 1112)
- The Purus Project (Project ID 963)

It is important to mention that Agrocortex sent a letter to the IMC of Acre in 2017, which previously informed the State about the execution of the present project, also mentioning that the project is available to cooperate with the SISA Carbon Program and its objectives, and, if the jurisdictional program is validated by the VCS, may, if it is possible and pertinent, adhere to it.

Thus, it is our understanding that there is no risk of double counting, since the Government of Acre does not have a jurisdictional program validated by a carbon market standard, it does not carry out market operations, either in a voluntary or regulated market.

Furthermore, the SISA-Carbon Program depends on regulations for legal applications on how to account for State GHG emission reductions and also about the participation of special projects in the distribution of the assets generated by private projects. It is important to emphasize that the adhesion to the jurisdictional program of the State of Acre is voluntary and when not carried out by the private projects, it should be considered by the State for the purposes of the environmental accounting of its system in order to avoid double counting[99].

1.12.3 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.

1.12.4 Participation under Other GHG Programs

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

[98] Information on these Projects are available at the VCS Project Database (http://www.vcsprojectdatabase.org) by searching the database using each Project name or ID number. Last visit on February 26th, 2018.
[99] According to ISA Carbon Program of Acre. Available at: <https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000005599>. The deduction of GHG emission reductions that were generated by private REDD projects within the State can be seen in Table 2 of (ACRE) Monitoring Report (01 Aug 2014-31 Jul 2015), available at: <https://mer.markit.com/br-reg/services/processDocument/downloadDocumentById/103000000078986>. Last visited on 12-March-2018.

1.12.5 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.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

This is not a grouped project.

Leakage Management

The leakage management plan and a map of the leakage management area are located in section 1.9 - Project Location, 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 Agrocortex REDD Project is to avoid the unplanned deforestation (AUD) of the 186,219.06 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 South-western 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 following objectives from the Brazilian Government related to the Sustainable Development Goals:

- Objective 12: Ensure sustainable production and consumption patterns.
- Objective 13: Take urgent action to combat climate change and its impacts.
- Objective 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.

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[100].

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

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

In addition, implementation of REDD and SOCIALCARBON mechanisms together with FSC-certified SFMP 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.

Further Information

Not applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

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: VCS Version 3, v3.3, published on 19-October-2016;
- CDM-approved and VCS-endorsed Tool for testing significance of GHG emissions in A/R CDM project activities, v01.

[100] Brazil's Nationally Determined Contribution towards achieving the objective of the United Nations Framework Convention On Climate Change can be accessed in full at: <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Brazil/1/BRAZIL%20iNDC%20english%20FINAL.pdf>. Last visited on April 10th, 2017.

2.2 Applicability of Methodology

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 planned deforestation under the VCS AFOLU Requirements v3.6. 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, there are plans for the expansion and/or retrofit of existing roads within the reference region, which will probably cause an increase in unplanned deforestation. Therefore the present criteria are fulfilled.
b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the methodology (table 1 and figure 2).	Within the categories of Table 1 and Figure 2 of the methodology, the present 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 agro-forestry systems meeting the definition of “forest”.	The REDD project area is 100% made up of Amazon tropical old growth rainforest, as described in section 1.10 of the present VCS PD. Moreover, as detailed in section 1.9 above, areas that were considered “non-forest” (i.e. non-forest vegetation, deforested areas, hydrography or rock formations) were excluded from area where the project is being developed, resulting in 186,219.06 ha, which was then defined as project area. 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 2004 – 10 years prior to project start date – all of which conformed to the FAO definition of forest[101]. This was ascertained using satellite

[101] According to the Brazilian Forestry Service, Brazil adopts the FAO forest definition. Available at: <http://www.florestal.gov.br/snif/recursos-florestais/index.php?option=com_k2&view=item&layout=item&catid=14&id=158>. Last visit on: February 04th, 2015.

	images, as described in section 1.10 of the present VCS PD.
e) The project area can include forested wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	As described in section 1.10 of the present VCS PD, around 2% of the project area is covered by floodplain forests (classified in this project as open alluvial rainforest with palm trees). However, no peat or peat swamp forests were found in the project area[102,103,104]. Therefore, none of the project area grows on peat, satisfying this applicability criterion.

2.3 Project Boundary

The project area is composed of one property (Portuguese: *Fazenda*) covered almost in its totality by native vegetation: Fazenda Seringal Novo Macapá, totaling 190,210 ha. The area contour coordinates are presented in the Appendix I of this VCS PD.

The leakage belt, as described on Section 1.9, was defined as as an area of 128,115.48 ha of land located to the South of the Project area, near the main deforestation drivers (roads and rivers).

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 10 below.

Name	Area (ha)
Project Area	186,219.06
Leakage Belt	128,115.48

Table 10. Project Area and Leakage Belt area

The applied Methodology considers the six carbon pools listed in Table 11 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.

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>. Last visit on: February 04th, 2015.

[102] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

[103] Brazilian Institute of Geography and Statistics (IBGE). Mapa de solos do Brasil. Available at: <ftp://geoftp.ibge.gov.br/informacoes_ambientais/pedologia/mapas/brasil/solos.pdf>. Last visit on: 08/08/2017.

[104] Brazilian Geological Service. Inventory and Mapping of the Conventional and Alternative Agrominerals Resources of the Brazilian Territory. Alternative inputs map for agriculture: rocks, minerals and peat. 2010. Available at: <http://www.cprm.gov.br/publique/media/rochagem_inv_cart.pdf>. Last visit on: February 04th, 2015.

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Carbon stock change in this pool is always significant
	Non-Tree: Included	Pool included in the forest class used in the baseline scenario (bamboo)
Below-ground	Included	Stock change in this pool is significant
Dead wood	Excluded	Excluded for simplification. This exclusion is conservative.
Harvested wood products	Included	Stock change in this pool is considered significant
Litter	Excluded	Not to be measured according to Agriculture, Forestry and Other Land Use (AFOLU) Requirements, v3.6.
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 Agriculture, Forestry and Other Land Use (AFOLU) Requirements, v3.6.

Table 11. Carbon pools included or excluded within the boundary of the proposed AUD project activity

Deforestation emissions were estimated for three forest strata, whose above- and belowground carbon pools were previously determined using literature and scientific articles.

Carbon stock of wood products is higher in the project case than in the baseline, that is, the conversion of forest into non-forest lands in the baseline scenario leads to a lower production of wood products when compared to the project scenario, where the forest is managed with the purpose of wood products production. As the change on the carbon stock from this pool is considered relevant, it was included in the Project boundary.

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 section 3.1, baseline emissions.

In addition, the Methodology considers the two sources of GHG emissions listed in Table 12 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. In addition, the map of the project boundaries including the locations of project area, reference region, leakage belt and leakage management area is shown at Figure 41 below.

Source		Gas	Included?	Justification/Explanation
Baseline scenario	Biomass burning	CO_2	Excluded	Excluded as recommended by the applied methodology. Counted as carbon stock change.
		CH_4	Excluded	Excluded as recommended by the applied methodology. This exclusion is conservative and does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the AUD project activity..
		N_2O	Excluded	Considered insignificant according to VCS Program Update of May 24th, 2010.
		Other	Excluded	No other GHG gases were considered in this project activity.

Source		Gas	Included?	Justification/Explanation
	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. In addition, It was assumed that planned harvest activities, such as sustainable logging for timber, produce less GHG emissions than baseline activities implemented prior and after deforestation on the deforested lands. Therefore considered insignificant.
		CH_4	Excluded	As above. No fire is predicted to occur in the project scenario resulting from REDD or sustainable forest management activities.
		N_2O	Excluded	Considered insignificant according to VCS Program Update of May 24th, 2010.
		Other	Excluded	No other GHG gases were considered in this project activity.
	Livestock emissions	CO_2	Excluded	Not a significant source
		CH_4	Excluded	No livestock agriculture increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		N_2O	Excluded	As above.
		Other	Excluded	No other GHG gases were considered in this project activity.

Table 12. Sources and GHG included or excluded within the boundary of the proposed AUD project activity

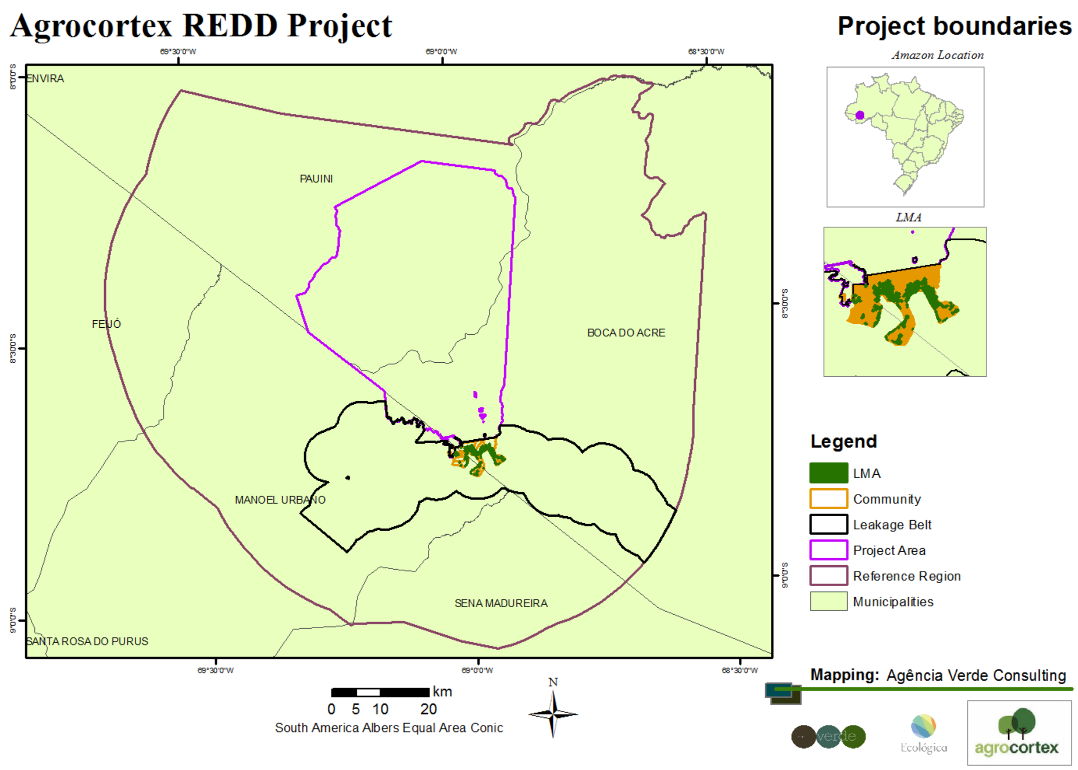

Figure 41. Agrocortex REDD project boundaries

2.4 Baseline Scenario

In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the reference region, project area and leakage belt, as described below. Therefore, the project falls into the AFOLU-REDD category, specifically: Avoided unplanned deforestation (AUD). The revenue from the present REDD project is essential to maintain this area as standing forest, as described under additionality (section 2.5), 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.

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

The classes of LU/LC were defined as "forest", "non-forest" and hydrography in accordance with the procedures described in section 1.10 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.

As described in section 1.10, stratification in the Project Area was carried out in the forest class, sub-dividing it into 3 types of forest with different carbon stocks; however, the "non-forest" category was not stratified and it has homogenous carbon stocks. Satellite images from 2013 were used to generate the land-use and land-cover map at project start date shown in Figure 42, which meets methodology requirements of being within 2 years ≤ of the project start date.

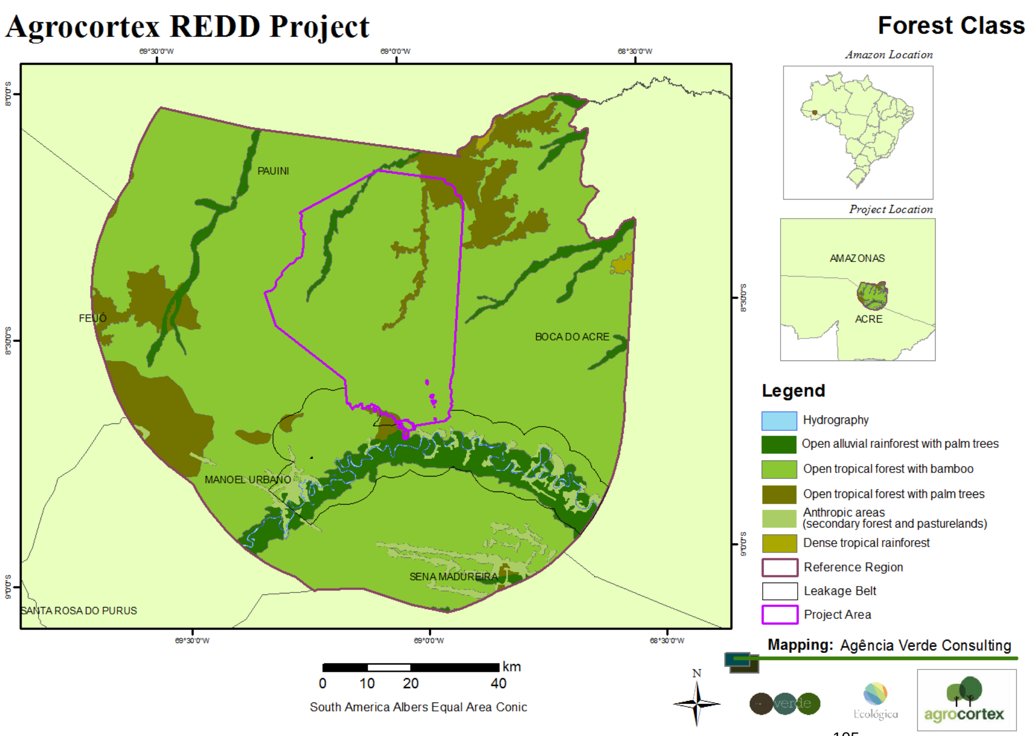

Figure 42. Land-Use and Land-Cover Map at project start date[105].

[105] Year 2013 meets methodology requirements: ≤ 2 years of project start date

The LU/LC classes present in the project area, reference region and leakage belt at the project start date are listed in Table 13 below, which specifies whether logging, fuel wood collection or charcoal production are occurring in the baseline case.

Class identifier[106]		Trend in carbon stock	Presence in[107]	Baseline activity[108]			Description (including criteria for unambiguous boundary definition)
ID_{cl}	Name			LG	FW	CP	
1	Open Tropical Rainforest with bamboo	decreasing	RR, PA, LK, LM	yes	no	no	According to official classification of the types of vegetation of Brazil (IBGE)[109]
2	Open Tropical Rainforest with palm trees	decreasing	RR, PA, LK	yes	no	no	According to official classification of the types of vegetation of Brazil (IBGE)
3	Open Alluvial Rainforest with palm trees	decreasing	RR, PA, LK, LM	yes	no	no	According to official classification of the types of vegetation of Brazil (IBGE)
4	Dense Tropical Rainforest	decreasing	RR	yes	no	no	According to official classification of the types of vegetation of Brazil (IBGE)
5	Secondary vegetation	decreasing	RR, LK, LM	no	no	no	Mosaic of vegetation that includes pasturelands and secondary vegetation
6	No forest	constant	RR, LK, LM	no	no	no	Mosaic of anthropic areas: pasturelands, annual and perennial crops, and roads according to the satellite image classification
7	Hydrography	constant	RR, PA, LK, LM	no	no	no	Presence of rivers and water bodies from satellite image classification and information from the National Water Agency[110]

Table 13. Identification and baseline activity of all LU/LC classes at project start date within the reference region, project area and leakage belt

[106] The methodology specifies: Each class shall have a unique identifier (IDcl). The notation I1, I2, etc. indicates “initial” (pre-deforestation) classes, which are all forest classes; and F1, F2 etc. to indicate final” (post-deforestation) classes.
[107] RR = Reference region, LK = Leakage belt, LM = Leakage management Areas, PA = Project area
[108] LG = Logging, FW = Fuel-wood collection; CP = Charcoal Production
[109] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Manual Técnico da Vegetação Brasileira. Manuais Técnicos em Geociências n° 1, Rio de Janeiro, 1991.
[110] National Water Agency (Agência Nacional de Águas, ANA). Available at: <http://www.ana.gov.br/>. Last visit on: March 30th, 2015.

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

The LU/LC-change categories that could occur within the project area and leakage belt during the project crediting period, in both the baseline and project case, are identified in the potential LU/LC-change matrix (Table 14) and the list of LU/LC-change categories during the project crediting period are shown in Table 15 below.

Table 14 shows 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 present within the PA and LK are shown in the LU/LC-change map (Figure 43). It is important to note that while the latter shows only deforestation from 1999 – 2013, Table 14 displays deforestation across the whole crediting period.

BASELINE SCENARIO

	Project Area	Initial LU/LC class			
	IDcl	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Non Forest
Final Class	Open Tropical Rainforest with bamboo	140,903.66	0.00	0.00	0.00
	Open Tropical Rainforest with palm trees	0.00	7,733.19	0.00	0.00
	Open Alluvial Rainforest with palm trees	0.00	0.00	4,085.67	0.00
	Non Forest	31,650.37	1,798.61	47.55	0.00

	Leakage Belt	Initial LU/LC class				
	IDcl	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation	Non Forest
Final Class	Open Tropical Rainforest with bamboo	10,837.70	0.00	0.00	0.00	0.00
	Open Tropical Rainforest with palm trees	0.00	0.00	0.00	0.00	0.00
	Open Alluvial Rainforest with palm trees	0.00	0.00	20,407.37	0.00	0.00
	Secondary vegetation	0.00	0.00	0.00	687.47	0.00
	Non Forest	46,963.25	2,493.58	16,635.90	4,324.76	22,851.65

PROJECT SCENARIO

	Project Area	Initial LU/LC class			
	IDcl	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Non Forest
Final Class	Open Tropical Rainforest with bamboo	169,290.23	0.00	0.00	0.00
	Open Tropical Rainforest with palm trees	0.00	9,347.46	0.00	0.00
	Open Alluvial Rainforest with palm trees	0.00	0.00	4,090.90	0.00
	Non Forest	3,263.81	184.34	42.32	0.00

	Leakage Belt	Initial LU/LC class				
	IDcl	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation	Non Forest
Final Class	Open Tropical Rainforest with bamboo	9,255.19	0.00	0.00	0.00	0.00
	Open Tropical Rainforest with palm trees	0.00	0.00	0.00	0.00	0.00
	Open Alluvial Rainforest with palm trees	0.00	0.00	20,405.00	0.00	0.00
	Secondary vegetation	0.00	0.00	0.00	687.47	0.00
	Non Forest	48,545.77	2,493.58	16,638.28	4,324.76	22,851.65

Table 14. Potential land-use and land-cover change matrix showing associated conversion levels in Project Area and Leakage Belt over the crediting period in both, the baseline and project scenarios

Table 15 below shows potential LU/LC-change categories that could occur within the project area and leakage belt during the project crediting period in both, the baseline and project case.

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	Open Tropical Rainforest with bamboo	decreasing	PA and LK	yes	no	no	Open Tropical Rainforest with bamboo	constant	PA and LK	yes	no	no
I1/F6	Open Tropical Rainforest with bamboo	decreasing	PA and LK	yes	no	no	Non Forest	constant	PA and LK	yes	no	no
I2/F2	Open Tropical Rainforest with palm trees	decreasing	PA and LK	yes	no	no	Open Tropical Rainforest with palm trees	constant	PA and LK	yes	no	no
I2/F6	Open Tropical Rainforest with palm trees	decreasing	PA and LK	yes	no	no	Non Forest	constant	PA and LK	yes	no	no
I3/F3	Open Alluvial Rainforest with palm trees	decreasing	PA and LK	no	no	no	Open Alluvial Rainforest with palm trees	constant	PA and LK	no	no	no
I3/F6	Open Alluvial Rainforest with palm trees	decreasing	PA and LK	no	no	no	Non Forest	constant	PA and LK	no	no	no
I4/F4	Dense Tropical Rainforest	decreasing	PA and LK	no	no	no	Dense Tropical Rainforest	constant	PA and LK	no	no	no
I4/F6	Dense Tropical Rainforest	decreasing	PA and LK	no	no	no	Non Forest	constant	PA and LK	no	no	no
I5/F5	Secondary vegetation	decreasing	PA and LK	no	no	no	Secondary vegetation	constant	PA and LK	no	no	no
I5/F6	Secondary vegetation	decreasing	PA and LK	no	no	no	Non Forest	constant	PA and LK	no	no	no
I6/F6	Non Forest	constant	LK	no	no	no	Non Forest	constant	LK	no	no	no

Table 15. List of LU/LC-change categories which could occur in project area and leakage belt during project crediting period

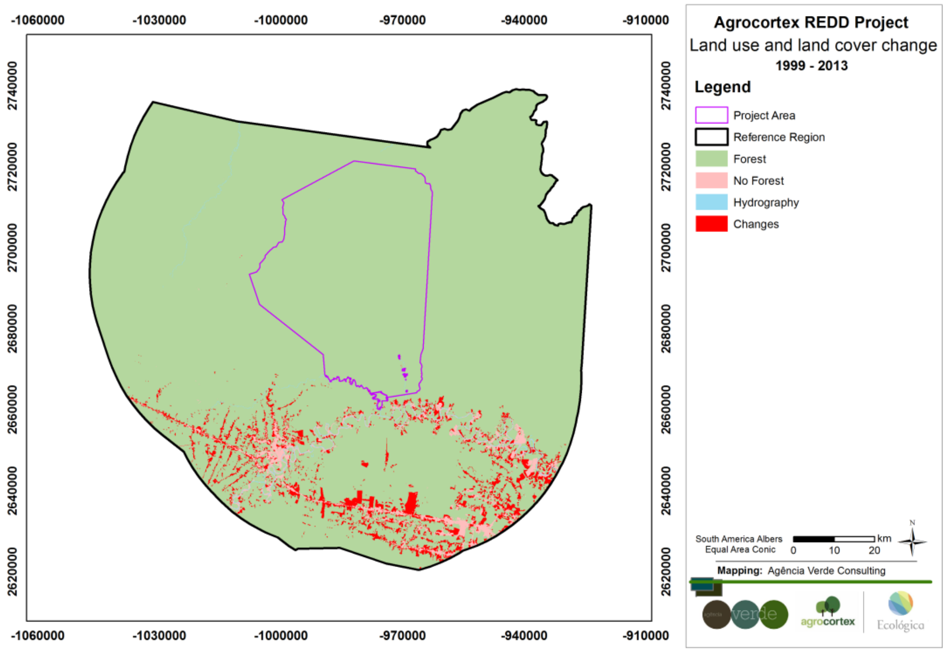

Figure 43. (1999-2013) LU/LC-change map period in the project area, leakage belt and Reference Region

Analysis of land-use and land-cover change

The classified images regarding the 1999-2013 period of the reference region by year follow below. These images were used to analyze the dynamics of deforestation during the historical reference period.

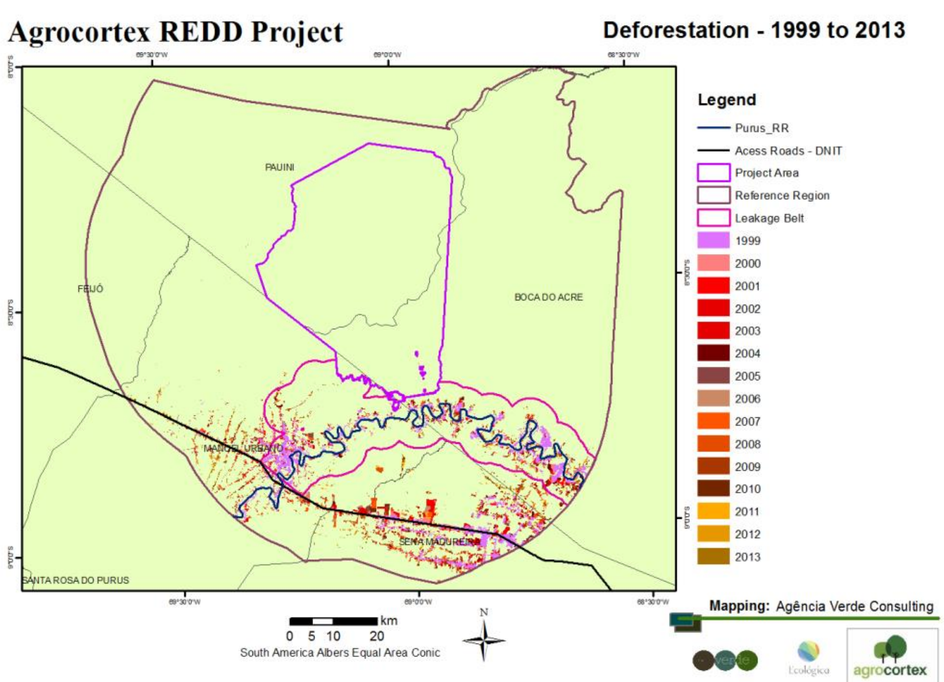

Figure 44. Map of the classification of the reference region by year across the historical reference period

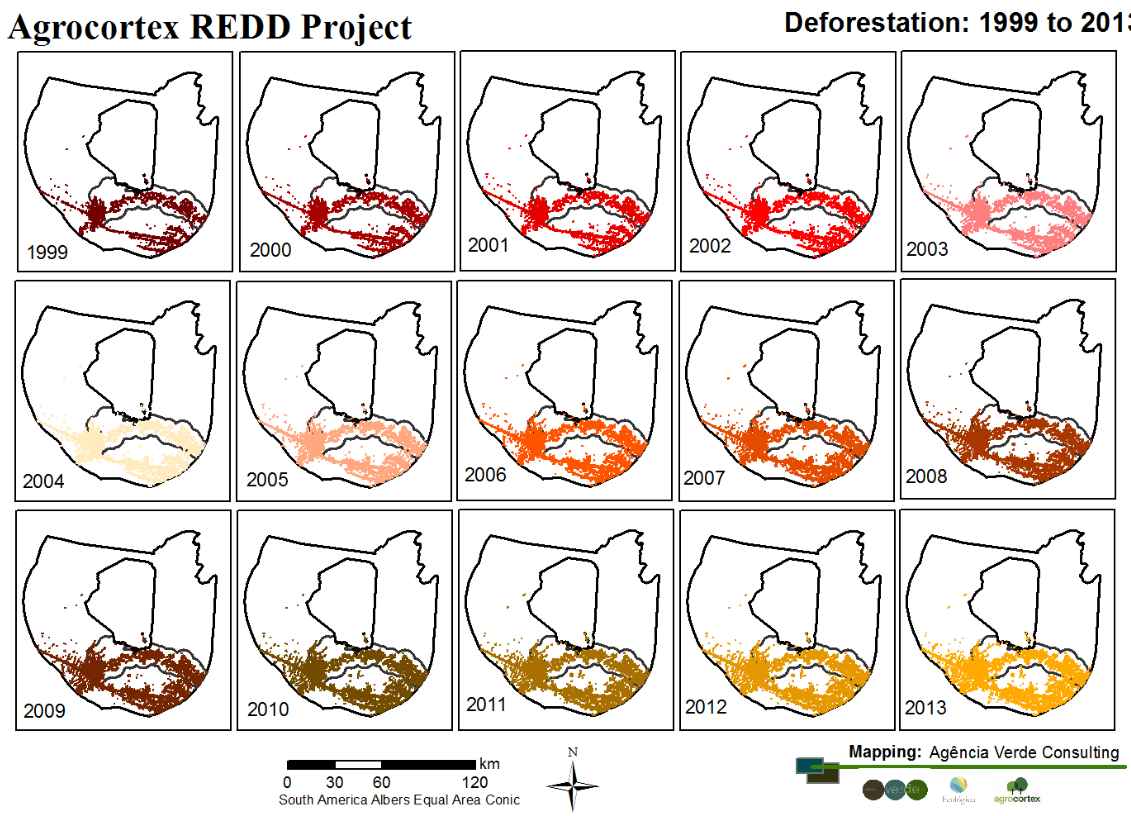

Figure 45. Deforestation within the reference region for each year of the historical reference period.

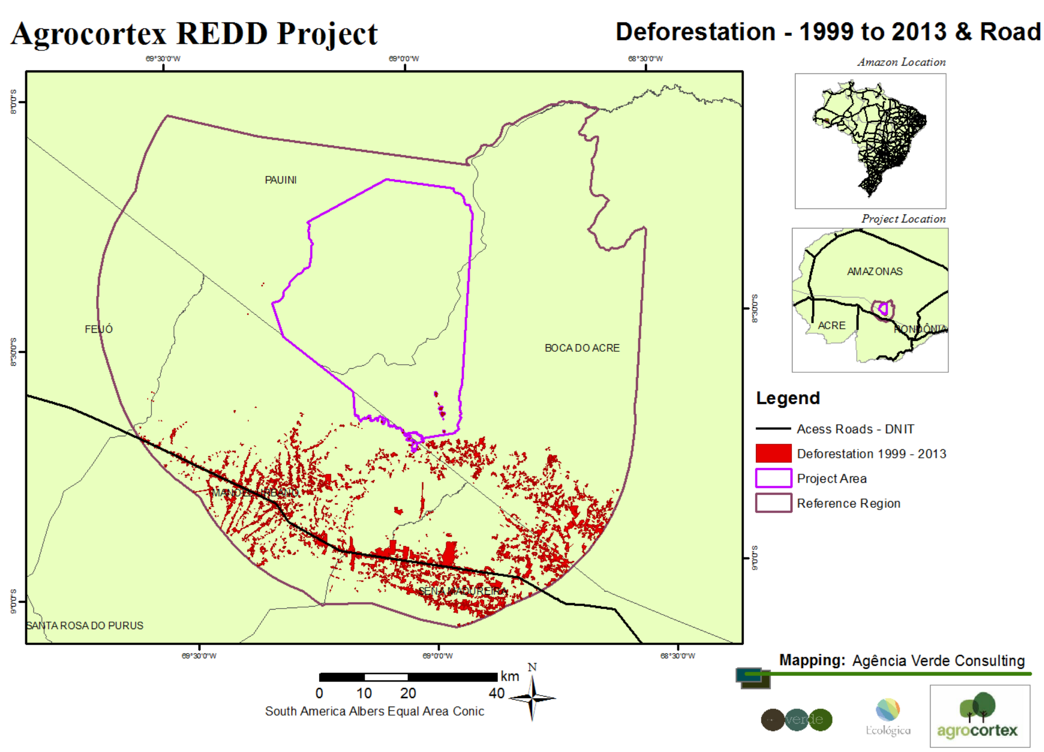

Figure 46. Accumulated deforestation within the reference region across the historical reference period

The deforestation activities caused the transformation from the initial land use/ land cover (LULC) class of tropical rainforest and its sub-types to the final class of non-forest. The annual deforestation values in the Reference Region during the historical reference period (1999-2013) can be seen in the Table 16 below.

In the reference region, from 1999 to 2013, the forested areas decreased by around 4%, which corresponds to an accumulated deforestation of 36,822.80 ha. The annual average deforestation rate during this period was of 0.25% (applying R: annual rate of change of forest cover[111]). 2007 was the year with the highest annual deforestation with almost 4 thousand hectares deforested area. However, as mentioned above, the construction of new roads and infrastructures in the region can be an important deforestation agent, as there is a direct relation between the deforestation and the creation of new paved or unpaved roads, mainly when within 100km[112].

Furthermore, around 63% of all non-forest areas within the reference region were deforested during the historical reference period (1999-2013), which shows the recent deforestation advancement in the region. During the same analyzed period, non-forest areas within the reference region almost triplicated from 1999 to 2013.

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palms	Dense Tropical Rainforest	Secondary vegetation	Total Forest area (ha)	No Forest area (ha)	Annual deforesta-tion (ha)	Cumulative deforesta-tion (ha)	R: annual rate of forest cover change
1999	877,630.36	104,812.73	81,429.79	2,762.62	17,330.76	1,083,966.26	21,647.93	0.00	0.00	-
2000	876,191.24	104,720.43	80,944.19	2,762.62	16,001.69	1,080,620.17	24,994.02	3,346.09	3,346.09	0.31%
2001	875,046.44	104,655.79	80,497.42	2,762.62	15,375.37	1,078,337.65	27,276.55	2,282.52	5,628.61	0.21%
2002	872,791.93	104,562.67	79,862.40	2,762.62	14,535.92	1,074,515.54	31,098.66	3,822.11	9,450.72	0.36%
2003	870,595.66	104,493.13	79,124.88	2,762.62	13,752.03	1,070,728.33	34,885.87	3,787.21	13,237.93	0.35%
2004	869,107.57	104,412.84	78,396.29	2,762.62	13,284.02	1,067,963.33	37,650.87	2,765.00	16,002.93	0.26%
2005	867,636.86	104,387.26	78,166.68	2,762.62	13,016.20	1,065,969.62	39,644.57	1,993.71	17,996.64	0.19%
2006	865,730.57	104,363.51	77,747.17	2,762.62	12,755.46	1,063,359.33	42,254.87	2,610.29	20,606.93	0.25%
2007	862,800.28	104,252.17	77,204.48	2,762.62	12,387.51	1,059,407.07	46,207.13	3,952.26	24,559.20	0.37%
2008	861,511.16	104,192.75	76,985.05	2,762.62	12,236.94	1,057,688.52	47,925.67	1,718.54	26,277.74	0.16%
2009	860,428.35	104,139.43	76,659.57	2,762.62	12,126.36	1,056,116.32	49,497.87	1,572.20	27,849.94	0.15%
2010	858,955.43	104,055.85	75,961.84	2,762.62	11,893.03	1,053,628.77	51,985.43	2,487.56	30,337.50	0.24%
2011	857,957.02	104,011.49	75,572.31	2,762.62	11,740.69	1,052,044.13	53,570.06	1,584.63	31,922.13	0.15%
2012	856,350.81	103,882.90	75,112.05	2,762.62	11,422.68	1,049,531.06	56,083.14	2,513.07	34,435.20	0.24%
2013	854,709.72	103,694.10	74,760.30	2,762.62	11,216.71	1,047,143.47	58,470.73	2,387.59	36,822.80	0.23%
Initial Forest area (year of 1999) (ha)									1,083,966.26	
Final Forest area (year of 2013) (ha)									1,047,143.47	
Total deforestation in the reference region (1999-2013 period) (ha)									36,822.80	
Average annual deforestation rate (1999-2013 period)									0.25%/year	

Table 16. Non-forest areas, annual deforestation, cumulative deforestation and R in all classes within the reference region during the 1999-2013 period

[111] Puyravaud, J.-P. (2003), “Standardizing the calculation of the annual rate of deforestation.” Forest Ecology and Management, 177: 593-596

[112] PFAFF, Alexander et al. Road investments, spatial spillovers, and deforestation in the Brazilian Amazon. **Journal of Regional Science.** Malden, USA, p. 109-123. 2007. Available at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9787.2007.00502.x/abstract>. Last visited on: January 15th, 2015.

As of 2000, there was marked deforestation in the project reference region, primarily in the years 2007, followed by 2002 and 2003, which had the highest deforestation rates, in accordance with Figure 47 below. Moreover, Figure 48 below shows the cumulative deforestation and non-forest progression (in hectares) within the reference region across the 1999-2013 period, also showing a clearly increasing trend throughout that period.

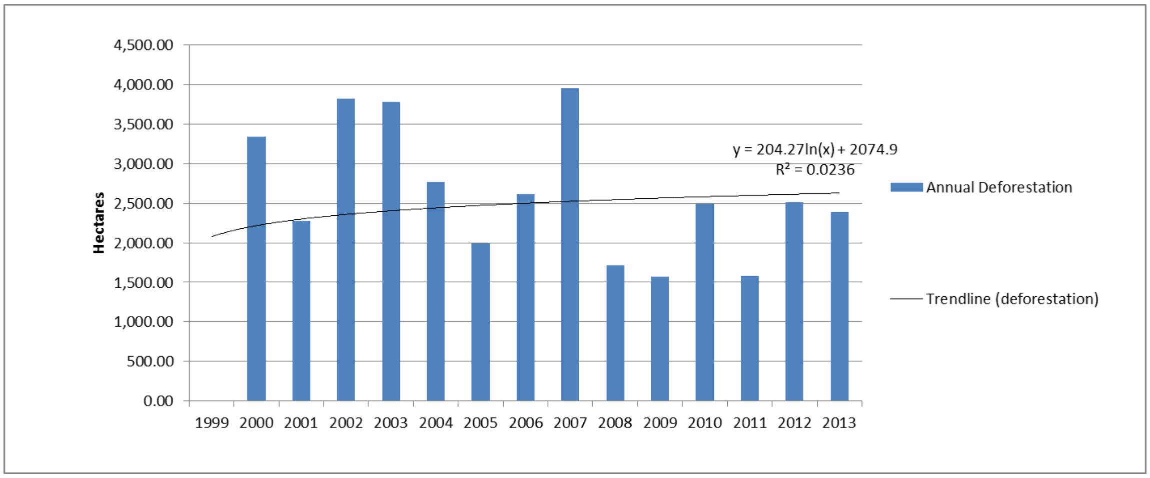

Figure 47. Annual deforestation in the reference region between 1999 and 2013, in hectares

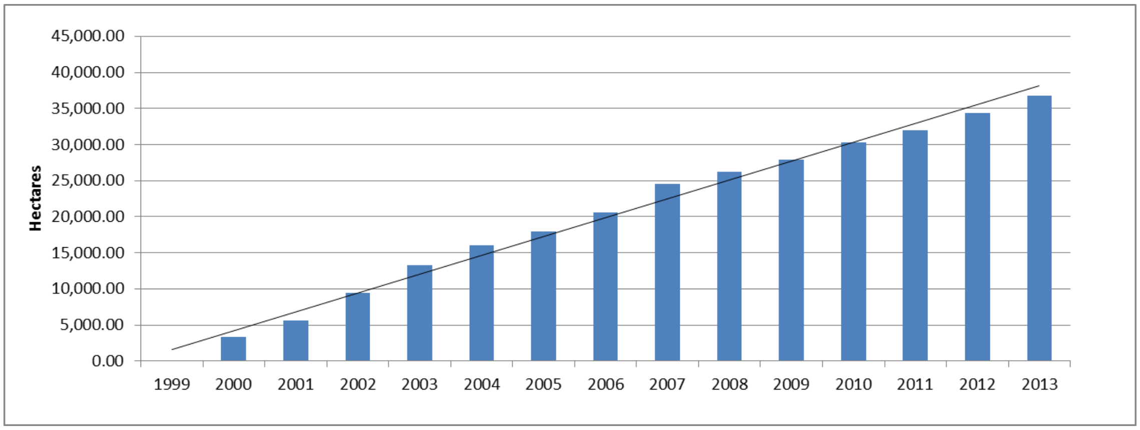

Figure 48. Evolution of the cumulative deforestation within the reference region during the 1999-2013 period

The annual baseline deforestation reveals there is no clear tendency for deforestation in the Reference Region, as verified in the chart above. Deforestation in the region increased and decreased throughout the historical series, without maintaining an annual pattern. This may be a consequence of the improvements to deforestation monitoring systems or a greater control of deforestation by the Government that developed policies to foster preservation and provide payment for environmental services that developed during this period.

It is possible to verify that in 2003/2004 and 2007/2008 the Reference Region had an increase on the area of non-forest, caused by clearance of areas near existing roads, accesses as well as around the Purus River. It is possible to justify why this occurred by assessing the socioeconomic conditions of the included municipalities during this period. An increase in agriculture GDP was observed in years following higher deforestation rates, which provides evidence to support the correlation between forest conversion and agriculture. The evolution on the agricultural GDP and the annual deforestation is provided on the Figure below. More detailed information on the GDP is available on Section 1.10.

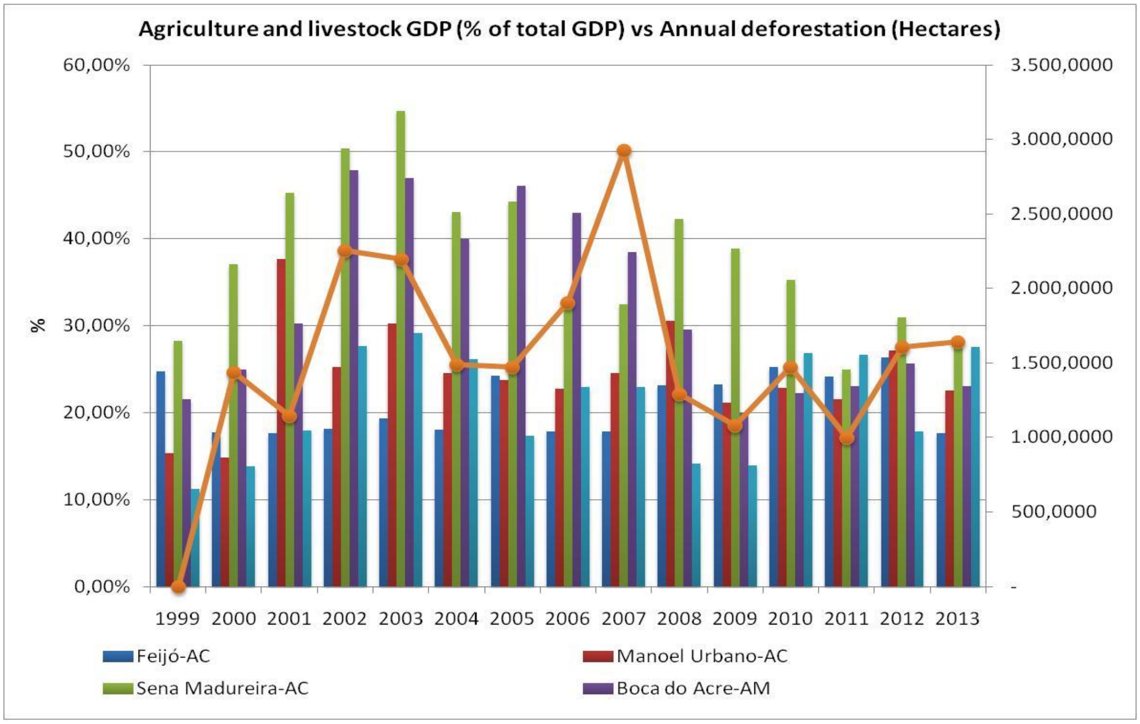

Figure 49. Agriculture and livestock GDP and annual deforestation on the municipalities of Reference Region

This data demonstrates an increase in the agriculture and livestock GDP is observed in years where deforestation is high or in subsequent years. This was the case for the Municipalities of Manoel Urbano and Boca do Acre between 2000 and 2003 and again in Boca do Acre between 2005 and 2007. A similar situation is found in the Municipality of Sena Madureira, where a high GDP was observed following the peak of deforestation in 2007.

In addition, during the historical period, areas classified as “non-forest” within the reference region are almost exclusively found in the southern portion of the latter, as can be seen on the land use/land cover change map for the period between 1999 and 2013 (Figure 43 above). Furthermore, it can be noted that deforestation was mainly carried out around existing roads and rivers, which stimulates the expansion of logging and pastureland creation to new areas. Deforestation was also more abundant around previously deforested areas. The creation of new access roads, added to the abundance of rivers in the region, increases anthropogenic pressure and consequently, the intensity of deforestation.

Meanwhile, little deforestation was observed during the analyzed period in the land where the project area is located. However, the increased deforestation pressure coming from the southern portion of the project area, combined with the expansion and/or retrofit of new infrastructure projects (roads) that will impact the area, will probably result in increased unplanned deforestation to the region. It is important to note that the project area contains only areas which were defined as “forest” in 2003 (more than 10 years prior to the project start date).

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Total forest area (ha)	Annual Deforesta-tion (ha)	Cumulative deforesta-tion (ha)	R: annual rate of forest cover change
1999	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2000	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2001	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2002	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2003	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2004	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2005	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2006	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2007	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2008	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2009	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2010	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2011	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2012	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
2013	172,554.03	9,531.80	4,133.22	186,219.06	0.00	0.00	0.00%
Initial Forest area (year of 1999) (ha)						186,219.06	
Final Forest area (year of 2013) (ha)						186,219.06	
Total deforestation in the reference region (1999-2013 period) (ha)						0.00	
Average annual deforestation rate (1999-2013 period)						0.00%/year	

Table 17. Annual deforestation, cumulative deforestation and R in all classes within the project area during the 1999-2013 period

The Leakage belt displayed higher deforestation levels than the reference region during the historical reference period. From 1999 to 2013, there was a forest cover decrease of around 10% within the leakage belt, at an average rate of 0.78%/year. The 2002-2004 period presented the highest annual deforestation rate, with around 1,200 ha per year (Table 18).

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation	Total Forest area (ha)	No Forest (ha)	Annual deforesta-tion (ha)	Cumulative deforesta-tion (ha)	R: annual rate of forest cover change
1999	61,300.50	2,694.49	42,722.60	7,368.65	114,086.24	11,115.44	0.00	0.00	-
2000	61,012.74	2,681.16	42,324.90	6,962.71	112,981.51	12,220.18	1,104.73	1,104.73	0.97%
2001	60,807.13	2,671.12	41,931.22	6,692.72	112,102.19	13,099.50	879.32	1,984.05	0.78%
2002	60,484.99	2,657.11	41,481.43	6,354.00	110,977.52	14,224.16	1,124.67	3,108.72	1.01%
2003	60,145.51	2,654.32	40,882.58	6,090.00	109,772.41	15,429.27	1,205.11	4,313.83	1.09%
2004	59,763.90	2,608.13	40,232.90	5,964.77	108,569.71	16,631.97	1,202.70	5,516.53	1.10%
2005	59,476.33	2,601.24	40,036.08	5,878.14	107,991.79	17,209.89	577.92	6,094.45	0.53%
2006	59,107.28	2,597.23	39,691.71	5,731.37	107,127.59	18,074.09	864.20	6,958.65	0.80%
2007	58,744.77	2,549.12	39,239.27	5,559.02	106,092.18	19,109.50	1,035.41	7,994.05	0.97%
2008	58,619.57	2,539.19	39,071.39	5,501.48	105,731.64	19,470.04	360.54	8,354.60	0.34%
2009	58,492.95	2,522.52	38,759.94	5,456.47	105,231.89	19,969.80	499.75	8,854.35	0.47%
2010	58,317.90	2,510.35	38,139.50	5,331.82	104,299.57	20,902.11	932.32	9,786.67	0.89%
2011	58,215.58	2,507.97	37,763.13	5,254.92	103,741.60	21,460.08	557.97	10,344.64	0.54%
2012	58,011.45	2,498.99	37,379.55	5,118.82	103,008.81	22,192.88	732.79	11,077.43	0.71%
2013	57,800.96	2,493.58	37,043.27	5,012.23	102,350.04	22,851.65	658.77	11,736.20	0.64%
Initial Forest area (year of 1999) (ha)								114,086.24	
Final Forest area (year of 2013) (ha)								102,350.04	
Total deforestation in the reference region (1999-2013 period) (ha)								11,736.20	
Average annual deforestation rate (1999-2013 period)								0.78%/year	

Table 18. Annual deforestation, cumulative deforestation and R in all classes within the leakage belt during the 1999-2013 period

According to Table 18 above, deforestation on the leakage belt summed up to 11,736.20 ha during the historical reference period. The analysis of the land use/land cover change map allows concluding that deforestation occurred mostly along the Purus River and close to Manoel Urbano municipality, in the southern border of the project area.

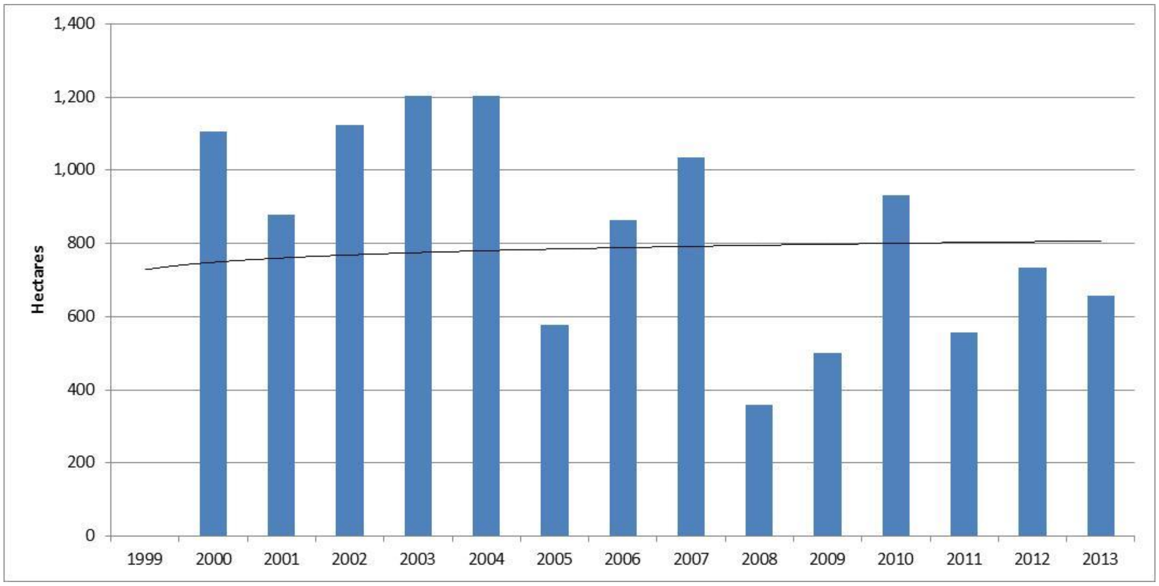

Figure 50. Annual deforestation in the leakage belt between 1999 and 2013, in hectares

All vegetation types present in the reference region underwent losses as deforestation rates went up, however the open tropical rainforest with bamboo class displayed the greatest number of deforested areas (Figure 51), reaching levels of 1,640 thousand hectares per year lost between 1999 and 2013. However, the secondary vegetation showed the highest deforestation rate during the analyzed period, around 3.6%/year, or almost 40% of its initial forested area in 1999.

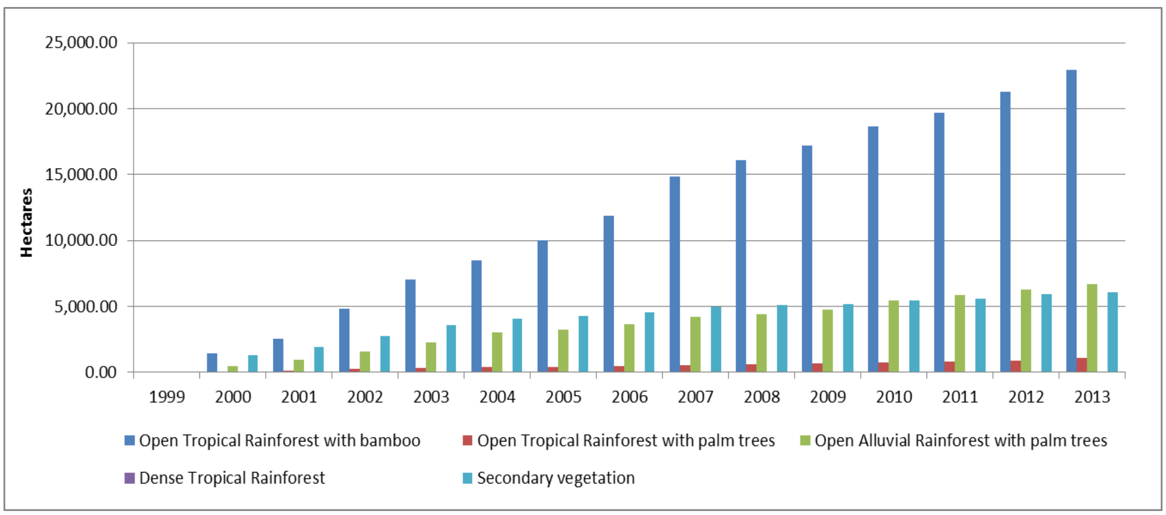

Figure 51. Evolution of the cumulative deforestation in each forest class within reference region during the 1999-2013 period

Analysis of agents, drivers and underlying causes of deforestation

As specified in the methodology, the analysis of deforestation agents is important for two reasons: i) estimating the quantity and location of future deforestation; and ii) Designing effective measures to address deforestation, including leakage prevention methods.

In recent years, the project region has been deforested for the expansion of agricultural and livestock activities, mainly due to the advancement of the arc of deforestation from the south of the Amazon biome. This pressure is expected to continue, given the globalization of markets in the Amazon region and international development policies planned for the region[113].

Furthermore, according to PRODES[114], the municipalities of Manoel Urbano, Pauini and Boca do Acre (which contain the project area in its entirety) were among the municipalities with the highest accumulated deforestation in the States of Acre and Amazonas up until 2014, a result of the disorganized occupation and the lack of economic alternatives for local communities and land owners.

The analysis performed on the historical land-use/land-cover changes during the historical reference period allowed conclusions to be drawn related to the correlation between deforestation and the main deforestation agents in the RR. Meanwhile, navigable rivers (especially the Purus River) and existing infrastructure (roads) are the main drivers of deforestation. Those deforestation agents are better described below.

Timber logging

As previously mentioned in section 1.10 (socio-economic conditions) above, timber logging (both legal and illegal) is an important economic activity within the reference region. Economic data sources between 2003 and 2013 [115] (see Figure 52 below), show that timber is the largest contributor to the value of annual production when compared to all extractivism products in the municipalities where the reference region is located.

[113] 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.
[114] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on 28-March-2017.
[115] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/16/12705>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/16/12705>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/16/12705>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/16/12705>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/16/12705>. Last visited on: October 06th, 2017.

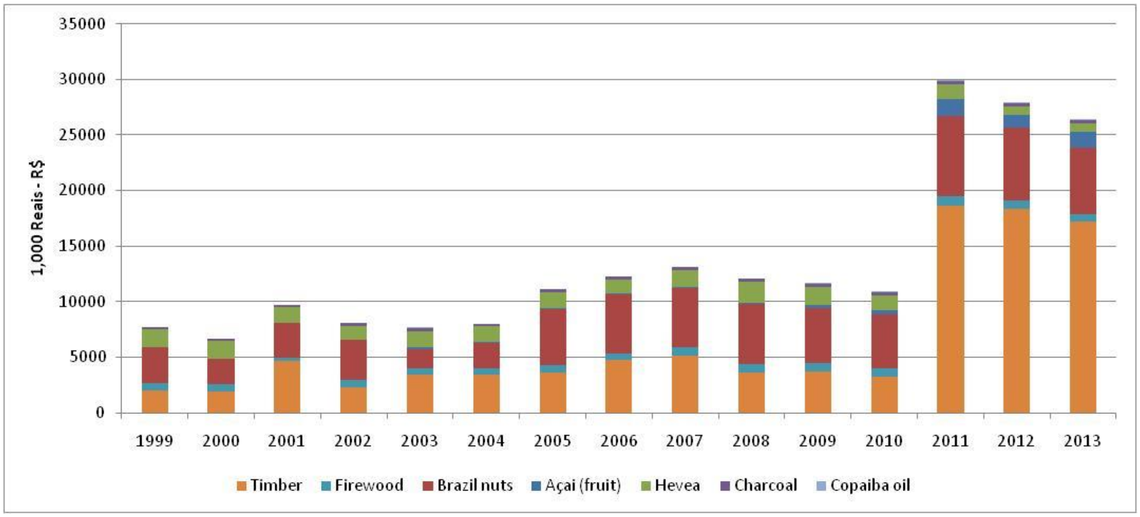

Figure 52. Extraction production values per product in the municipalities of the reference region during the 1999-2013 period

Historical data indicates timber logging has increase from 2010, as demonstrated on Figure 53, especially in the Municipalities of Feijó and Sena Madureira, both located in the State of Acre.

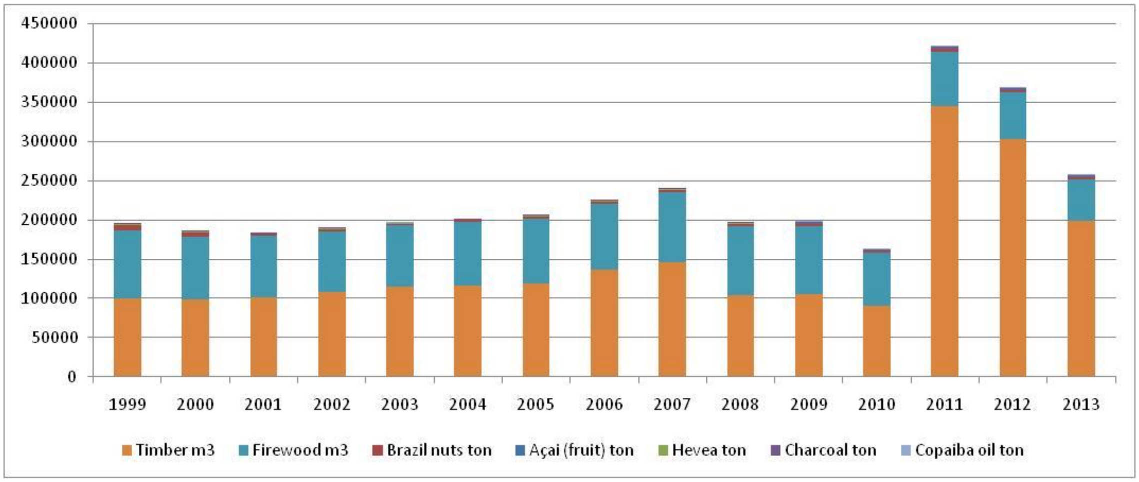

Figure 53. Quantity of timber and firewood produced from 1999 to 2013 within the municipalities of the Reference Region, in tonnes or m³

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

After harvesting the most valuable commercial species, the deforestation continues both in areas already explored and unexplored, and thus providing conditions for further expansion of logging and cattle ranching[116].

[116] 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.

Cattle ranching

As previously mentioned in section 1.10 (socio-economic conditions) above, almost 65% of the total land use within the main project area's municipalities is pastureland (either planted, natural or degraded), which demonstrates the importance of this economic activity in the region[117].

According to Piontekowski (2011)[118], the lack of planning for land occupation and economic and urban development in the Amazon region has created the conditions for livestock farming to establish itself as one of the main economic activities, resulting in the settlement of deforested areas in the region.

Low resource efficiency of the observed cattle ranching systems increases the necessity to convert forest area to pasture. The average stocking capacity in the region is roughly 1.5 animal units per hectare, which is low when compared to well managed pasturelands in other Brazilian regions. Cattle ranchers in the region are forced to convert forest to pastureland in search for healthy soils to support their heard, resulting in the continued expansion of the deforestation frontier.

According to Brandão (2013)[119], cattle farming in the Amazon is primarily due to low land prices combined with adequate rainfall levels. The study also shows that 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[120]. Thus land speculation and cattle farming contribute to the advancement of deforestation in more isolated regions.

Figure 54 below shows the increase of the cattle herd in the municipalities composing the reference region across the period 2007 - 2013[121]. It is possible to note that this number increased around 25% over this six years, which means almost 90 thousand heads more. The municipality responsible for the largest cattle herd is Sena Madureira (in the State of Acre), which is located in the south of the project area.

[117] The Brazilian Institute for Geography and Statistics (IBGE). Agricultural Census, 2006.
[118] PIONTEKOWSKI, v. *et al*. **O avanço do desflorestamento no município de Boca do Acre, Amazonas**: estudo de caso ao longo da BR-317. Rio Branco, AC: Universidade Federal do Acre – UFAC, 2011.
[119] BRANDÃO, Fernanda. **Tendências para o consumo de carne bovina no Brasil**. 2013. 102 f. Thesis (Doctor grade) - Curso de Agronegócio, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013.
[120] 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.
[121] The Brazilian Institute for Geography and Statistics (IBGE): Agricultural Census (2006). Available at:
Feijó: <https://cidades.ibge.gov.br/brasil/ac/feijo/pesquisa/18/16459>;
Manoel Urbano: <https://cidades.ibge.gov.br/brasil/ac/manoel-urbano/pesquisa/18/16459>;
Sena Madureira: <https://cidades.ibge.gov.br/brasil/ac/sena-madureira/pesquisa/18/16459>;
Boca do Acre: <https://cidades.ibge.gov.br/brasil/am/boca-do-acre/pesquisa/18/16459>;
Pauini: <https://cidades.ibge.gov.br/brasil/am/pauini/pesquisa/18/16459>. Last visited on: October 06th, 2017.

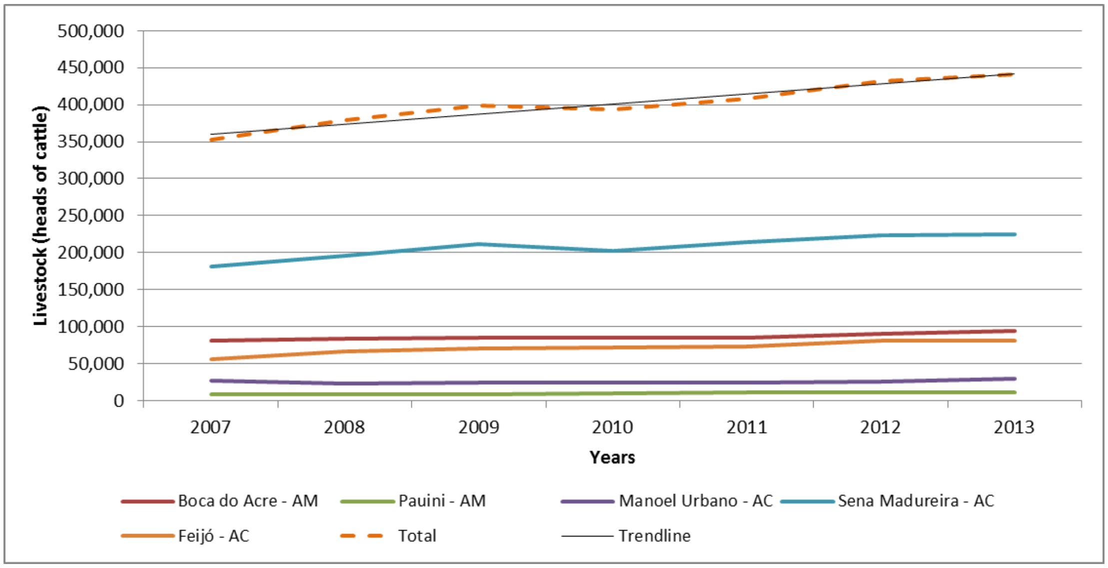

Figure 54. Annual livestock in the five municipalities of the reference region, in heads of cattle

Furthermore, according to the methodology, after analyzing the main deforestation agents acting within the Reference Region during the historical reference period, it is necessary to identify the main drivers affecting the amount of deforestation in the Reference Region, which are listed below:

1) Population growth

Population is a variable that significantly predict quantity of future deforestation. The local residents are expected to carry out unplanned deforestation, which involves economic activities. As described previously in section 1.10 (socio-economic conditions), the population in the five municipalities of the reference region increased around 38,000 people during the 1991 – 2010 period, which is equivalent to a 42% increase, which equates to an average rate of 2.2%/year[122]. Such increase also indicates the human pressure for clearance of forests in the region, demanding new lands for subsistence and income generation.

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

Although the population growth rate is expected to decrease in the future, the very high rate identified in the past years leading to the population increase is an important variable affecting the amount of deforestation in the reference region.

However, an important factor that will probably contribute to the decrease in deforestation in the reference region was the human development index (HDI) improvement. The analysis of the

[122] The Brazilian Institute for Geography and Statistics (IBGE).

average HDI in the municipalities covering the reference region shows a noteworthy increase of around 127% in the period 1991 – 2010, mainly in the education of the population[123]. This can be a factor that is contributing to the decrease in the population growth rate in the region.

2) Prices of timber logs and livestock per arroba

Prices of timber logs and arroba (livestock) have shown increase during the analyzed period. This was the main reason why the cattle herd increased around 25% during that period, reaching more than 440 thousand animals in the five main municipalities composing the reference region. In addition, during the same period, the timber logging also increased, reaching around 200 thousand m³/year, which represents a 100% increase. It is important to note that timber stands out as having the highest values among the total annual production in the analyzed municipalities, as previously described in Section 1.10[124].

In addition, according to Razera (2005)[125], 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. 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[126].

Furthermore, forested property values are almost 4 times cheaper than established pasturelands. Thus, this disparity promotes the purchase of new forested areas, deforestation and further creation of new pasturelands[127].

In addition, the main drivers affecting the location of deforestation in the reference region are:

1) Distance from deforested areas

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[128,129].

123 Atlas of Human Development in Brazil. Available at: <http://www.atlasbrasil.org.br/>. Last visit on: April 28th, 2017.
124 The Brazilian Institute for Geography and Statistics (IBGE).
125 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.
126 Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. **Conservation Biology** 19(3):680-688.
127 REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. **Economia Verde: Desafios e Oportunidades,** Campinas, v. 8, p.143-155, jun. 2011. Available at: <http://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: April 16th, 2017.
128 BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. **Biological Conservation**. Volume 141, Issue 7, July 2008, Pages 1745–1757

As described under the “projection of the location of future deforestation” section below, a regression was carried out between currently deforested areas and future deforestation, which yielded a significant result. This was used in the step projection of location of future deforestation, which carried out the projection used for calculation of GHG reductions. The probability of “non-forest” at time t+1 depends upon the arrangement of cells of “forest” and “non-forest” at time t. Thus the presence of “non-forest” is a driver variable predicting quantity and location of future deforestation.

2) Rivers

In the municipalities of the Reference Region that are located in the State of Amazonas, transportation is done mostly through navigable rivers. Currently, there are no roads connecting parts of these cities to other areas.

The Purus River is the main river used for the transportation of products and people, as it remains navigable during the dry season. An important harbor exists on the Purus River in the municipality of Boca do Acre and is an important asset for the logistics in the region.

3) Highways

As described on Section 1.10, extractivism and agriculture are important economic activities in the municipalities of the Reference Region. As these cities have small population, production is typically transported to larger markets (such as Rio Branco, the capital city of Acre). Due to the low infrastructure in the region, transportation is usually done by one main road. The main road connecting the region to Rio Branco and surrounding markets is BR-364, which is located to the south of the Project Area. This is the only road that crosses the State of Acre from East to West, and for that reason, it is important for the transportation of products and people.

The Federal Government is investing to improve infrastructure in the Reference Region, as part of the Growth Accelaration Program (in Portuguese, *Programa de Aceleração do Crescimento* – PAC). These investments include the expansion and/or retrofitting of sections of the BR-364 road in an area between Sena Madureira and Feijó. Such investments are being executed to reduce bottlenecks in local transportation and are expected to increase the flow of products and people.

This is expected to increase deforestation pressure in the Reference Region, as the production of timber (both legal and illegal) is an important economic activity. Therefore, the future deforestation dynamics are expected to be affected by the planned expansion and retrofitting of the BR-364. According to Government information, roadwork has already started as is planned to be completed by 2018[130].

[129] 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: February 12th, 2017.

[130] MINISTÉRIO DO PLANEJAMENTO. Information available at: http://www.pac.gov.br/infraestrutura-logistica/rodovias/ac. Last visit on April, 28, 2017.

4) Access roads

Access roads are means of transportation that influence the spatial distribution of land-uses. Access roads have an influence on fragmentation, population densities, agriculture and pastureland. The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation[131,132,133].

In addition, there are underlying causes that also promote deforestation in the region. Due to being located at the frontiers of the arc of deforestation and displaying a large amount of unoccupied lands, the reference region has a considerable social conflict issues, primarily land conflict. Land is occasionally illegally occupied by squatters and illegal loggers[134].

According to Razera (2005)[135], the absence of economic alternatives has created the conditions for livestock farming to establish itself as the primary land occupation activities in deforested areas in Amazonia, being primarily concentrated in the arc of deforestation, where preferably there are some means of access to the rest of the country.

The continued lack of resolution of land tenure issues contributes to reducing legal production options and continues to promote the expansion of deforestation associated with cattle farming and land speculation in southern Amazonas. According to studies conducted in the region by Idesam, there is a pressing need for restructuring at a local level, which is lacking investment in infrastructure, equipment, and human resources to attend to strong land-tenure demand. The low presence of Governance and lack of land-tenure documentation, with thousands of rural producers owning non-documented properties, promotes a scenario of forest destruction for exploration of natural resources and creation of pastureland, driving the tendency for the frontier to grow[136].

Thus, the main underlying causes of deforestation within the reference region are associated with land conflicts (tenure issues), and the lack of public policies promoting sustainable alternatives to combat deforestation and degradation activities.

The land-uses that stimulate deforestation within the project reference region have been the same ever since the era of expansion of the Brazilian national territory into the north of the country. The activities at that time included: clearing military era roads; infrastructure projects, such as Avança Brasil and the Program for Acceleration of Growth; and the belief that forests are

[131] HAWBAKER, T.J.; RADELOFF, V.C.; HAMMER, R.B.; CLAYTON, M.K. Road density and landscape pattern in relation to housing density, land ownership, land cover, and soils. Landscape Ecology, v.20, p.609-625, 2004.
[132] 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.
[133] 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.
[134] SECRETARIA DO ESTADO DO MEIO AMBIENTE E DESENVOLVIMENTO SUSTENTÁVEL (SDS). Unidades de Conservação do Estado do Amazonas. Manaus, 2007.
[135] 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.
[136] 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).

a non-productive domain and need to be replaced by productive areas, such as agriculture and livestock, especially in areas considered to hinder regional development or social and economic evolution. These State policies led to the clearing of new roads in the region, allowing the implementation of colonization programs as an incentive to immigration, primarily in the South and Southeast of the country, creating a great social diversity in the region.

The future trend of these underlying causes of deforestation will tend to remain as verified in the past years, as Brazilian government policies and recent changes in Brazilian environment laws still prioritize large agricultural and ranching companies[137]. This is a gap that needs to be addressed by projects seeking to develop alternative sources of income as well as ongoing training, being from private companies, NGOs, or donors.

Therefore, 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.

Most of the deforestation occurred in the Amazon region is related to the implementation of infrastructure projects, population increase and agricultural and cattle ranching activities, mainly in the region known as the "Brazilian arc of deforestation", where the present project is located. The historical deforestation that has been occurring over the past 15 years within the reference region has followed this same pattern.

Finally, global demand for agricultural commodities has increased the opportunity cost of conserving areas of standing forests in the Amazon biome. Specifically in the project's region, timber companies are considered the pioneers in colonizing previously inaccessible areas, entering via the means of illegal roads to harvest forests through selection of the most valuable commercial species. Afterwards, those degraded lands are occupied by property speculators and finally, cattle ranchers. Those two land-use changes (timber harvesting and cattle ranching) are the main deforestation agents in the region.

Considering that the population in the reference region is increasing at a high rate, and that new infrastructure projects are being developed, the pressure on the project areas' forests will likely increase.

[137] 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.

Description of baseline scenario adopted:

Based on the information gathered above and on the baseline analysis, it is possible to find conclusive evidence that the main land-uses between the years 1999 to 2013 that promoted or stimulated deforestation in the region, frequently followed this order of events:

- Highways, access roads, navigable rivers, and infrastructure projects reach remote forested areas;
- Illegal timber logging seeks the most valuable commercial species;
- Deforestation for livestock production.

The deforestation pattern explained by the relations 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. It is expected that agents and drivers of deforestation may increase as a result of a possible population growth in the reference region, which is also influenced by the prices of timber logs and livestock arroba, thus intensifying the demand to convert forested areas to productive areas in the region.

However, the annual deforestation analysis within the reference region during the historical reference period (1999 – 2013) reveals there is no clear tendency for deforestation in the region, which increased and decreased throughout the historical series without maintaining an annual pattern.

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 explained earlier in section 2.4, no clear trend in deforestation (decreasing, constant or increasing) during the historical reference period within the reference region is present. In addition, conclusive evidence from the analysis of the deforestation dynamic was found to suggest that this trend would continue in the future.

For this reason, approach c. Modelling, was adopted to create the baseline. With this approach, the rate of baseline deforestation will be estimated using a model that expresses deforestation as a function of driver variables, which is detailed below.

Projection of the quantity and location of future deforestation

The baseline simulation was constructed using GIS Idrisi Selva, specifically the sequence of functions: Markov chains; Calibration of the simulation model and Markov chains coupled with a cellular automaton algorithm (SCARASSATTI, 2007[138]; VALENTE & VETTORAZZI, 2008[139]; KAMUSOKO et al., 2009[140]) as depicted in the flowchart in Figure 56 below. According to Pereira (2011), this method provides consistent results when utilized to project the land use change[141].

Markov chains enabled the modelling of landscape dynamics based on a transition matrix[142]. This technique simulates the landscape state at time t+1 by using the landscape state at time t and taking account of two variables, which were generated year per year: a) transition probabilities and; b) the current distribution of land states in time t. The variable a) transition probabilities – represents the probability of each pixel of a specific class to whether change or not to other class in the period analyzed. The variable b) distribution of land states in time t – represents the landscape state in time t. The Markov chains are linked to these variables, according to the formula below:

$$\Pi t + 1 = P\eta \times \Pi t$$

Where,

$\Pi t + 1$ Landscape state at time *t+1;*

Πt Landscape state at time *t;*

$P\eta$ Transition probabilities expressing the probability of each pixel of a given class changing (or not) to another stipulated category.

In order to fix the problem of the presence of individual pixels in the landscape which did not fit with their surrounding pixels, the technique of cellular automatons was implemented[143], using the *ca_Markov* module of the IDRISI Selva software environment. The module employs the following rules governing transition of neighbouring cells:

[138] SCARASSATTI, D.F. **Modelagem Dinâmica na Projeção de Uso do Solo em função da Rede Viária de Transportes.** 119f. 2007. Dissertação (Mestrado em concentração de transportes) - Faculdade de Engenharia Civil e Arquitetura, Universidade Estadual de Campinas, Campinas. 2007.
[139] VALENTE, R.O.A.; VETTORAZZI, C.A. **Definition of priority areas for forest conservation through the ordered weighted averaging method**. *Forest Ecology and Management*, v.256, n.6, p.1408-1417, 2008.
[140] KAMUSOKO, C. *et al.*. **Rural sustainability under threat in Zimbabwe - Simulation of future land use/cover changes in the Bindura district based on the Markov-cellular automata model**. *Applied Geography*, v.29, p.435-447, 2009.
[141] PEREIRA, Gabriel Henrique de Almeida. **Simulação do Crescimento das Áreas Antropizadas utilizando Cadeia de Markov e Autômata Celular em Ambiente SIG**. Curitiba: Universidade Federal do Paraná, 2011. Available at: <http://www.egal2011.geo.una.ac.cr/index.php?option=com_remository&Itemid=180&func=fileinfo&id=129>.
[142] MOREIRA, D.A. (2007), "Pesquisa Operacional - Curso Introdutório." Thomson, 23x16x2, e.1, 356pp.
[143] VIDICA, P.M. (2007), "Novas abordagens na evolução de autômatos celulares aplicados ao escalonamento de tarefas em multiprocessadores." 236f: il. 2007. Dissertação (mestrado em Ciências da Computação) - Universidade Federal de Uberlândia.

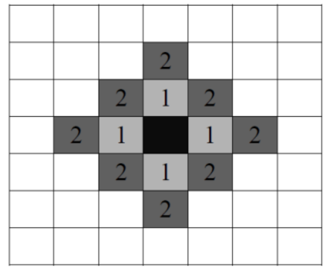

Figure 55. Von Neumann neighbourhood rules governing pixel transition

According to Figure 55 above, the state of pixels of at time t+1 is determined by the transition values – which are deterministic rules – corresponding to each pixel[144], i.e., knowing the state of the surrounding pixels, the future state of the analyzed pixel can be predicted.

The years 2012 and 2013 were chosen to be simulated in order to calibrate the modelling approach, based on the land-use maps from 1999-2005 and 2000-2006. The aim of the calibration is to find out the building error level of the simulation based on the parallel between the simulated map and the land-use map from the same year obtained via satellite images.

The Markov Module was applied with the entry data being the maps from 2005 and 2006 in *raster* format with a 30 x 30m pixel dimension, together with the Shuttle Radar Topography Mission (SRTM) digital elevation model of the area. The time interval between the two maps was of 7 years, and the interval to be simulated was defined as 7 years. The definition of the proportional error value was based on Pontius (2000)[145], who demonstrates that the majority of land-use maps display 85% mapping accuracy. The following were obtained as the outputs of this module:

- A transition probability matrix, which expressed the probability of each pixel of a given land-use category changing (or not) to another stipulated category;
- A matrix of transition areas that expressed total areas in pixels expected for a determined study period; and
- A group of images of conditional probabilities, in other words, images representing probabilities of each pixel of the study area becoming any of the respective categories in the future.

[144] WU, F.; WEBSTER, C.J. (2000), “Simulating artificial cities in a GIS environment: urban growth under alternative regulation regimes.” Int. j. Geographical Information Science, v.14, n.7, p.625-648.
[145] PONTIUS, R.G. Jr. **Quantification error versus location error in comparison of categorical maps**. *Photogramm Eng Remote Sensing* v.66, p.1011-1016, 2000.

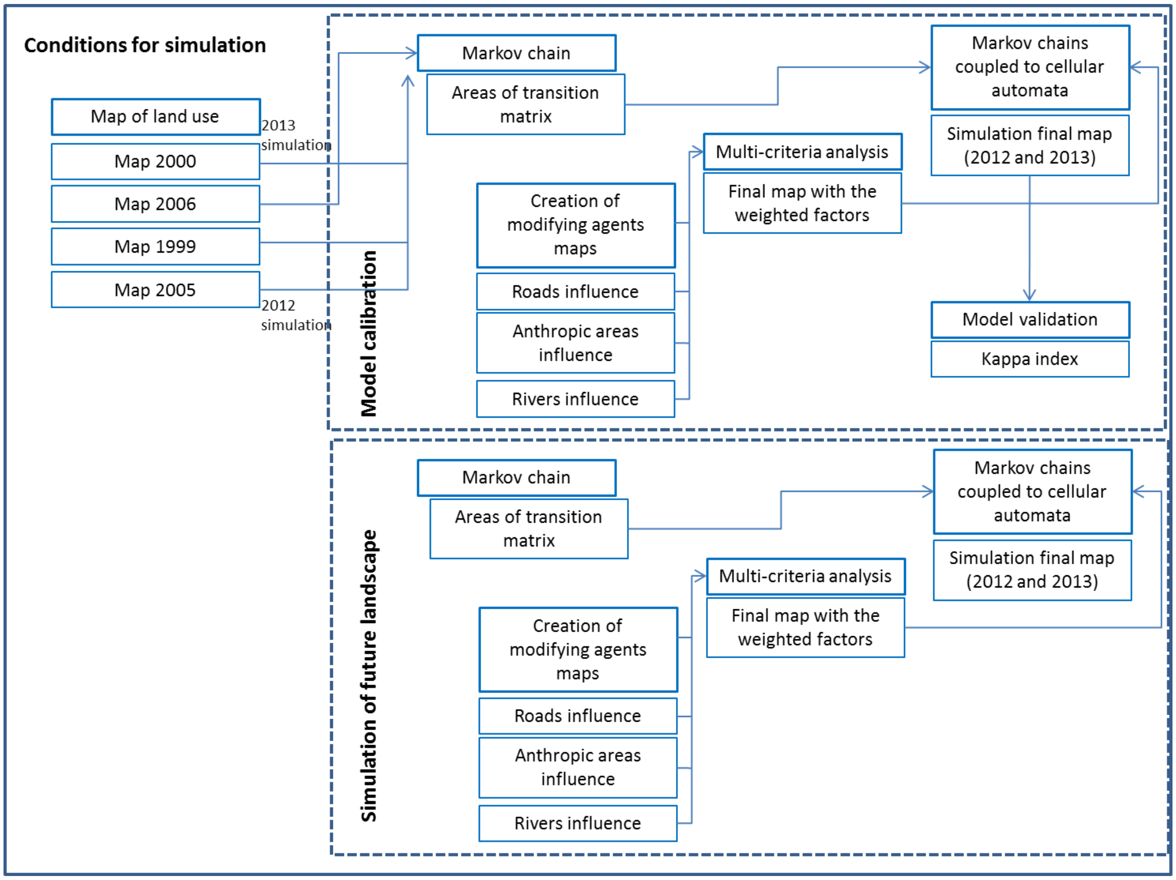

Figure 56. Flowchart depicting the activities carried out throughout the simulation of the baseline. Example for the years 2012 and 2013

The Land Change Modeler (LCM) was used for determining the location of future deforestation, an option of modeling land use and land cover available in the IDRISI Selva software. According to the applied methodology, the LCM is an appropriate model to analyze where future deforestation is most likely to happen in the baseline (deforestation risk).

The transition probability matrix was generated using the LCM software, using logistic regression to calculate the potential transition for all vegetation classes utilized in this project. This is an algorithm capable of estimating the environmental implications according to the chosen variable and its distance. Therefore, this algorithm determines the probability of a pixel from the forest class becoming non-forest within the reference region. The flowchart below illustrates the LCM modelling steps, showing how the risk map was generated.

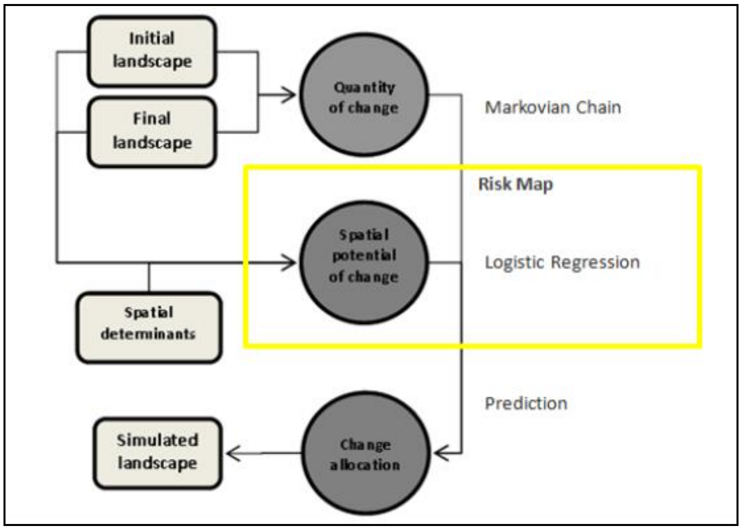

Figure 57. LCM modeling steps focusing on the creation of the deforestation risk map

The identification of the spatial variables who cause land use and land cover change is the initial condition for calibration of the model. In order to simulate the landscape, land use/ land cover (LU/LC) maps from the years 2000 to 2006 were used in the calibration phase. These maps were in the *tiff* format and contained the same two LU/LC classes: forest and non-forest. Only these two classes were included in the legend in order to improve the quality of the simulation resulting from the Markov model. However, following the creation of the simulated map, the latter was inserted into *ArcMap* and the classes of bodies of water and additional natural formations, as well as the forest class was inserted into the appropriate vegetation class.

Therefore, the spatial variables (or "predisposing factors") 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 in order to direct the landscape simulation.

The list of variables, maps and factor maps utilized to generate the transition probability maps are described in the table below.

Factor Map		Source	Variable represented		Meaning of the categories or pixel value		Other Maps and Variables used to create the Factor Map		Source	Algorithm or equation used	Comments
Id	File Name		Unit	Descrip-tion	Range	Meaning	Id	File Name			
1	1999_raster.rst	Satellite image - 1999 Landsat	Pixel	Classification: forest class	0-256	according to satellite image categories	5	hidrografia_total_distance_fz0_1500.rst	according to satellite image categories	LCM (Idrisi) – identifying drivers: Transition Potentials - distance+ fuzzy	Fuzzy: Sigmoidal Membership Function Type, Monotonically Decreasing Function shape with control point c: 0 and d: 1500

Factor Map		Source	Variable represented		Meaning of the categories or pixel value		Other Maps and Variables used to create the Factor Map		Source	Algorithm or equation used	Comments
Id	File Name		Unit	Descrip-tion	Range	Meaning	Id	File Name			
2	2013_raster.rst	Satellite image - 2013 Landsat	Pixel	Classification: forest class	0-256	according to satellite image categories	6	noForest1_dist_fz0_1000.rst	according to satellite image categories	LCM (Idrisi) – identifying drivers: Transition Potentials - distance+ fuzzy	Fuzzy: Sigmoidal Membership Function Type, Monotonically Decreasing Function shape with control point c: 0 and d: 1000
3	1999_NF.rst	Satellite image - 1999 Landsat	Pixel	Classification: non-forest	0-256	according to satellite image categories	7	vias_acesso_distance_fz0_1500.rst	according to satellite image categories	LCM (Idrisi) – identifying drivers: Transition Potentials - distance+ fuzzy	Fuzzy: Sigmoidal Membership Function Type, Monotonically Decreasing Function shape with control point c: 0 and d: 1500
4	2013_NF.rst	Satellite image - 2012 Landsat	Pixel	Classification: non-forest	0-256	according to satellite image categories					

Table 19. List of variables, maps and factor maps

The LCM software generated distance maps based on the deforestation likelihood, which was estimated through the percentage of pixels that were deforested during the historical reference period (based on the presence of forest and non-forest, agents, drivers and underlying causes of deforestation). Thus, the deforestation likelihood is the probability of a forest area becoming a non-forest area. Distance maps allow evaluating the probability of a particular pixel to belong to a certain category, which it is most likely due to its proximity to another pixel of the listed category.

The change agents (spatial variables) selected were: influence of access roads, influence of rivers, and influence of anthropic areas. According to the applied methodology, the heuristical approach was utilized to create a factor map for each change agent for the selected landscape, as described below. Value functions were defined representing the likelihood of deforestation based on the analyzed historical patterns, calculated as a function of distance from each identified change agent. Heuristical approach was used because the empirical approach did not produce accurate results when compared to the historical reference period.

Change agents	Justification
Influence of access roads	Access roads are corridors of interactions and connections, influencing the spatial distribution of land uses. Access roads influence forest fragmentation, density of habitations, agriculture and pasturelands.
Influence of anthropic areas	Humans are social beings. Therefore, when there is construction the probability of finding another next to it at a time (t + 1) is high.
Influence of rivers	The presence of navigable rivers can be considered a factor that influences deforestation due to the flow of products and other goods, mainly to areas without land access.

Table 20. Rationale used to select the modifying and restrictive agents of the present project

Furthermore, the decreasing sigmoidal function was decided to be the most appropriate. The values of the control points A) and B) were respectively (Figure 58 below):

- 500m and 3,000m for access roads;
- 0m and 15,000m for anthropic areas;
- 500m and 5,000m for hydrography.

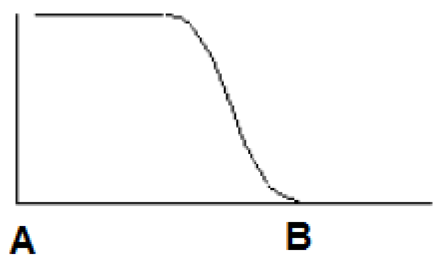

Figure 58. Representation of the sygmoidal function based on distance from points A) to B)

After the generation of distance (or factor) maps, the LCM identified land use and land cover transitions according to the deforestation drivers identified in the sections above. The “Distance” module was run with Boolean images. This module aims to calculate the distance between each polygon of the land-use under analysis. Based on the Distance module it was possible to establish the areas of high land-use concentration, as well as infer the influence of the latter on the project area.

Afterwards, Boolean maps of all change agents listed above were carried out. The spatial variables belonging to the project region were extracted and transformed from vectors into raster files using Idrisi software.

The resulting images from the Distance module were inputted into the fuzzy modules. A number of maps were created based on the fuzzy modules in order to ascertain the type of function and values of the control points.

Assigning weightings to change agents

The next step was to overlay the landscape change in order to obtain a map for each land-use. In order to do this, two questions were analyzed: a) Do agents display different levels of influence on the changes in land-use, expressed by different weightings?; b) Should the attributed weightings allow the closest possible simulation to the real scenario?

The SimWeight module (Similarity-Weighted Instance-based Machine Learning) was utilized, as it is strongly recommended by Idrisi Help System to simulate land uses transitions. This module automatically calculates weight for each map based on the spatial trend of change, and in this case, the map with the greatest weight given by the module was the non-forest class.

Using the Weight module, the weightings of the change agents were calculated, in which change factors were assigned the value 1 and the others uses assigned 0. The attributed weightings represent the importance of each change agent map in a given land-use, which are acceptable according to Saaty and Vargas (1991)[146] (Table 21 below). These were used in the multi-criteria evaluation (MCE), which aims to aggregate the three maps of the landscape change agents for each analyzed use, through multiplication of the maps by their weightings. Thus, each pixel of the final map represents the grade received, considering all chosen agents and the weightings attributed to them in the analysis below. The pixel's grade was presented at the side of each map using a 0 to 255 scale.

Change agent	Non-Forest
Map of access roads' influence	0.2583
Map of anthropic areas' influence	0.1047
Map of hydrography's influence	0.6370
Total	1

Table 21. Importance weighting matrix for the land-use change agents

Selection of most accurate deforestation risk map

In order to select the most accurate deforestation risk map, "calibration" of the output of the previous step was carried out (option A of the applied methodology). In order to do this, two LU/LC maps generated from satellite images should be used to simulate a "future map" corresponding to a scenario which is already known, in this way it is possible to calibrate the model for future simulations[147].

In order to calibrate the model, the simulated 2012 and 2013 scenarios were compared with the landscape mapped through satellite images from these same years, by means of applying the Kappa agreement index in Idrisi Selva software, as displayed in equation below.

[146] SAATY, T.L.; VARGAS, L.G. **Prediction, Projection, and Forecasting.** Boston: Kluwer Academic Publishers, 1991, 251p.
[147] KAMUSOKO, C. *et al.*(2009), "Rural sustainability under threat in Zimbabwe - Simulation of future land use/cover changes in the Bindura district based on the Markov-cellular automata model." *Applied Geography*, v.29, p.435-447.

$$ICK_{global} = \frac{N\sum_{i=1}^{c} x_{ii} - \sum_{i=1}^{c} x_{i+}x_{+i}}{N^2 - \sum_{i=1}^{r} x_{i+}x_{+i}}$$

Where:

K: Kappa agreement index;

N: Total number of observations (pixels – for example);

c: Number of classes evaluated (matrix c x c);

i: Row or column number (represents the class evaluated);

x_{ii} : Number of observations of the classes in the matrix's diagonal;

$x_{i+} = \sum_{j} x_{ij}$: Sum of the values in row i (totals row);

$x_{+i} = \sum_{j} x_{ji}$: Sum of the values in column i (totals column).

The process was repeated until a Kappa index higher than 0.95 between the simulated scenario and the real landscape was achieved (Figures 59 and 60 below). Therefore, the values presented previously for the importance weighting matrix and the fuzzy modules are the final numbers tested in the calibration process. After calibrating the model, the simulation of the landscape year by year up to 2044 was carried out.

Cross-tabulation Results

Using 2014_mapeado_overlay (columns) v.s. landcov_predict_2014_0120_overlay (rows)

(Created: 5/27/2017 7:03:12 AM)

Pixel Cross-tabulation

Category	1	2	Total
1	11630115	0	11630115
2	5070	697641	702711
Total	11635185	697641	12332826

Chi-square = 12238511.0000, df = 1, P-Level = 0.0000, Cramer's V = 0.9962

Proportional Cross-tabulation

Category	1	2	Total
1	0.9430	0.0000	0.9430
2	0.0004	0.0566	0.0570
Total	0.9434	0.0566	1.0000

Kappa Index of Agreement (KIA)

1) Using landcov_predict_2014_0120_overlay as the reference image

Category	KIA
1	1.0000
2	0.9924

2) Using 2014_mapeado_overlay as the reference image

Category	KIA
1	0.9924
2	1.0000

Overall Kappa: 0.9962

Figure 59. Value found by the Kappa index for the year 2014, comparing the simulated scenario (landcov_predict_2014_0120_overlay) and the real one (2014_mapeado_overlay), reaching an overall value of 0.9962

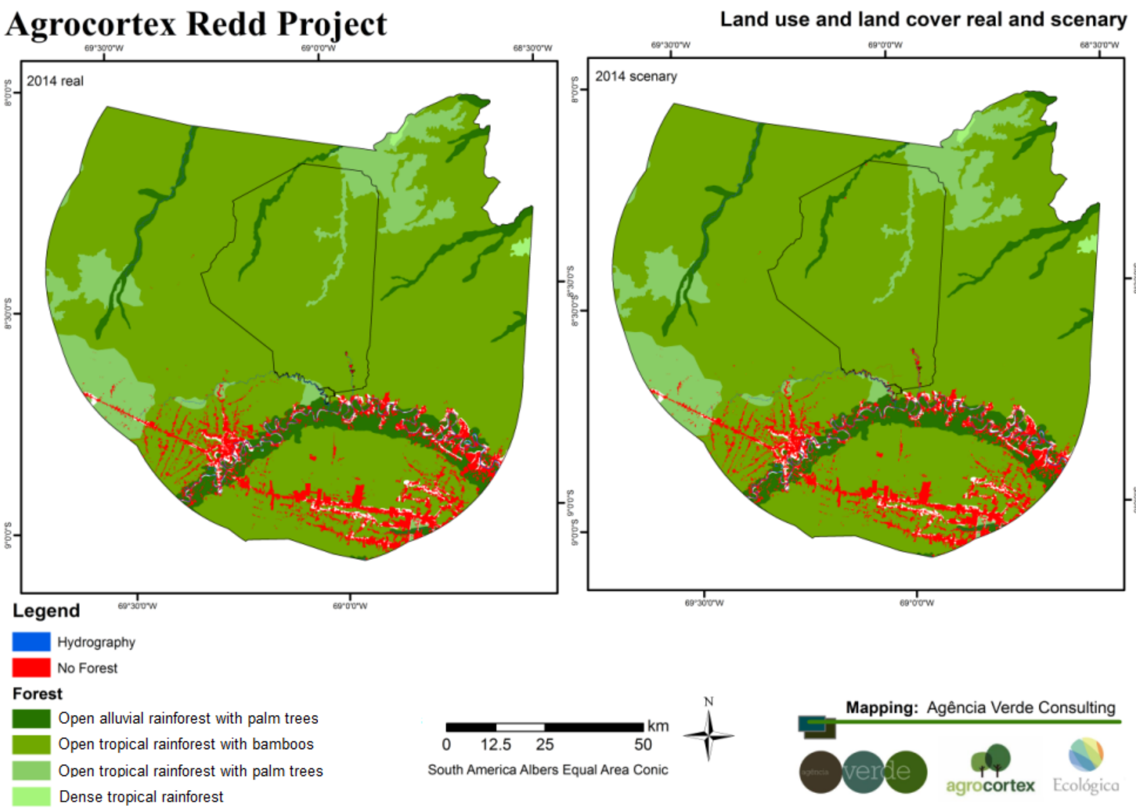

Figure 60. Comparison between the simulated and real scenarios of the year 2014.

To ensure that the cellular automata did not transform an area of non-forest into forest, every year was added to the forest area already existing in the preceding year. In other words, the deforestation was cumulative, where the year in t+1 contains exactly the same non-forest area as year t as well as the new area generated.

Therefore, distance maps and weighting of change agents enabled the creation of Risk Maps, which were then calibrated according to procedures above. These maps show at each pixel location the risk (or "probability") of deforestation in a numerical scale (e.g., 0 = minimum risk; 255 = maximum risk).

Two deforestation risk maps were generated through the LCM analysis, which are illustrated in Figure 61 below. They illustrate the probability of forest becoming non-forest within the reference region, i.e., the deforestation risk based on data described above. The map on the left represents the separation of the various inputted classes carried out by the software, in other words, the mask utilized to identify these spatial change factors. The map on the right is the result of its transition potential.

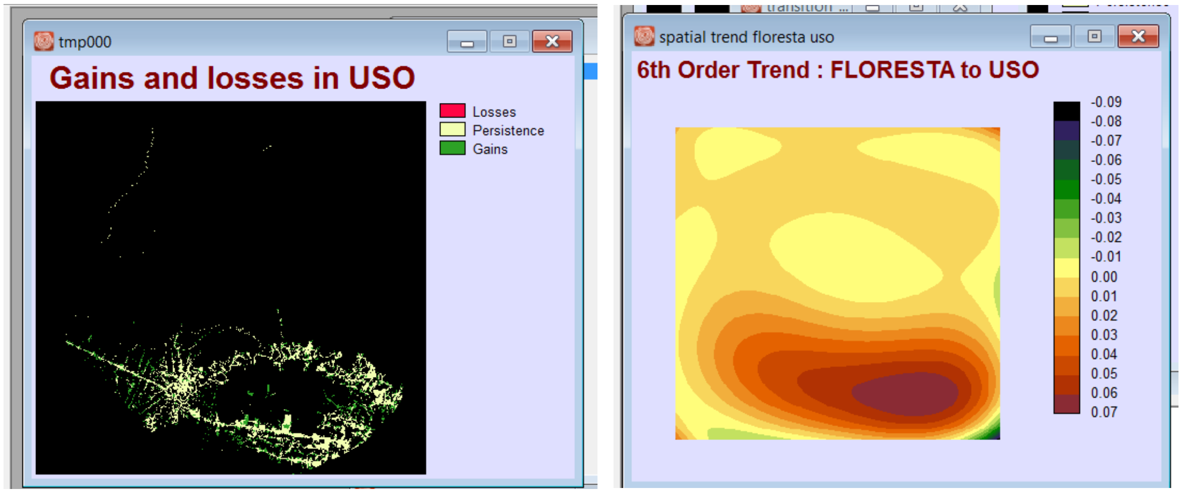

Figure 61. Deforestation risk maps within the reference region

The model found that the greatest LU/LC change risk was displayed in the Southern border of the project area, due to the proximity of agents to forest areas. In the northern part of the reference region, deforestation for any forest class is considered low due to the existence of remote forested areas and low presence of land use change agents.

Mapping of the locations of future deforestation

According to the applied methodology, future deforestation is assumed to happen first at locations with the highest deforestation risk value, as identified in sections above. The procedure for selecting pixels with the highest risk of deforestation was automatically performed by the IDRISI Selva LCM module.

The maps generated for multi-criteria analysis were inserted into the cellular automata module coupled with the Markov chains, in the same order as that in which the land-use categories were listed in the maps (forest and non-forest). Together with the latter, the transition area matrix file generated by the Markov module, and the maps generated by the weighing assign were also inserted.

The Markov transition matrix was fixed in order to obtain a similar rate change for each year, according to Table below. The probability of changing from Forest Class to a Non-Forest Class was 0.012.

<table>
<tr><th colspan="2" rowspan="2">Class name</th><th colspan="2">Final Class</th></tr>
<tr><th>Forest</th><th>Non-Forest</th></tr>
<tr><td rowspan="2">Initial Class</td><td>Forest</td><td>0.988</td><td>0.012</td></tr>
<tr><td>Non-Forest</td><td>0.000</td><td>1.000</td></tr>
</table>

Table 22. Transition matrix inserted in the Markov module

In the case of this study, the grid is in 2D and the cells are the pixels, as each pixel has a built-in classification of the specific land-use and land-cover. The cellular automata were applied using the *ca_Markov* module via Idrisi 17.0 Selva software. This applies a continuous filter based on the Von Newman rules of neighbourhood, as described above.

The rules determining the next state of a cell are deterministic, in other words if the state of neighbouring cells is known, the next state of a cell can be precisely determined. If a pixel is classified as deforested, the surrounding pixels may be deforested, and so on, repeatedly[148].

The inputting of annual data, beginning with the historical data classified to simulate the following year, did not allow future deforestation to be spatially projected. Non-forest areas did not disperse equally to both sides of a non-forest pixel due to the presence of large forested areas in the northern border of the Project Area. This is due to the fact that cellular automatons are used together with Markov chains to simulate future deforestation, which are dynamic and discrete systems formed by a regular *n-dimensional* grid of finite neighbouring cells, which influence the behavior of each analysed cell[149]. Therefore, another approach was used to adjust this method.

The selected method to be used together with Markov chains and Cellular automatons was the Hexagons Spatialization, which was created in ArcGis software to adequately spatialize the projected years according to the existence of the agents and vectors. The reasons for considering the spatialization with a hexagonal grid were based on the 4 points below:

- The hexagons reduce the sampling bias due to the shape of the grid edge, due to the low perimeter-area ratio of the hexagon shape. Hexagons are the closest polygons to a circle format[150];

- The circularity of a hexagonal grid allows representing curves because any point within a hexagon is closer to a circle format than a square format. Thus, the hexagons present better connectivity with other points and undergo less distortion for large areas, such as the reference region[151, 152];

- Thus, finding neighbours is more direct using a hexagonal grid, since the contact edge is the same on each side, i.e., the centroid of each neighbour is equidistant;

- Finally, since the distance between the centroids is the same in all six directions of the hexagons, using a distance range to find neighbours allows more neighbours to be included in the calculations for each class. Thus, it was possible to adequately spatialize classes in the reference region, project area and leakage belt.

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149 VIDICA, P.M. **Novas abordagens na evolução de autômatos celulares aplicados ao escalonamento de tarefas em multiprocessadores**. 236f: il. 2007. Masther thesis - Universidade Federal de Uberlândia. 2007.

150 BERTOLO, L.S.**Land use and land cover dinamycs in the hydrographic basin of Rio Machado. INPE, 2017.** Available at: <http://ainfo.cnptia.embrapa.br/digital/bitstream/item/162025/1/Bertolo-XVIIISBSR-2017.pdf>. Last visited on: August 18th, 2017.

151 BIRCH, COLIN P.D., OOM, SANDER P., AND BEECHAM, JONATHAN A. Rectangular and hexagonal grids used for observation, experiment, and simulation in ecology. **Ecological Modelling**, Vol. 206, No. 3–4. (August 2007), pp. 347–359.

152 MATEUCCI, S. D. y SILVA, M. **Selection of spatial configuration metrics for the regionalization of an anthropized territory**, GeoFocus : Revista Internacional de Ciencia y Tecnología de la Información Geográfica, ISSN 1578-5157, Nº. 5, , p. 180-202, 2005.

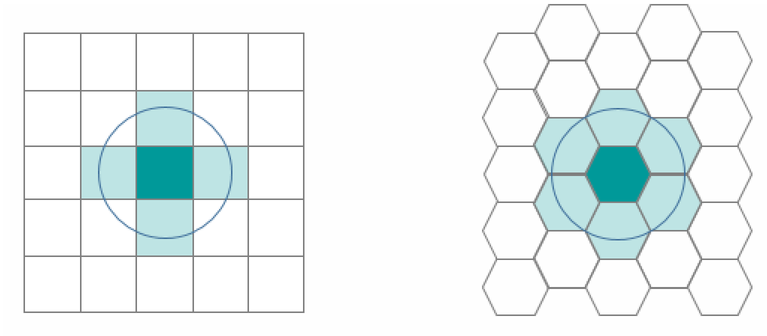

Figure 62. Neighbourhood difference for quadrangular and hexagonal grids

Thus, the location of future deforestation up to 2044 was projected for the entire reference region, generating maps showing the annually deforested areas across the whole baseline period. Afterwards, those maps were cropped with the limits of the project area and leakage belt to quantify the future baseline deforestation. The Table 23 below provides a brief summary of the stratification carried out in this analysis.

Stratum ID		Description
ID_i	Name	
1	Open Tropical Rainforest with bamboo	This forest type has more sparse crowns, allowing a greater incidence of light at ground level. High presence of bamboo. It is the main vegetation type present in the project area, representing approximately 90% of the total area.
2	Open Tropical Rainforest with palm trees	It is considered the transition forest type between Amazon rainforest and extra-Amazon areas. They are found in climates with up to 60 days without precipitation per year. Presence of palm trees, and the bamboo disperses and integrates into the forest.
3	Open alluvial rainforest with palm trees	Open riparian ecosystems with palm trees associated to floodable areas along Amazon rivers
4	Dense tropical rainforest	Occur in areas with high temperature and high precipitation.
5	Secondary vegetation	Mosaic of vegetation that includes pasturelands and secondary vegetation

Table 23. Stratification of the reference region

The projected annual deforestation values in the Reference Region, Project Area, and Leakage Belt during the crediting period (2014-2044) can be seen in the Tables below. In addition, maps representing the projection of future deforestation over the crediting period are illustrated in Figures 63 and 64.

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palms	Dense Tropical Rainforest	Secondary vegetation	Total Forest area (ha)	No Forest area (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R[153] (%/y)
2014	854,261.03	103,561.06	74,736.40	2,762.62	9,665.43	1,044,986.54	60,627.66	2,156.93	38,979.72	0.21%
2015	853,075.34	103,485.47	74,616.90	2,762.62	9,255.71	1,043,196.04	62,418.15	1,790.49	40,770.22	0.17%
2016	845,192.27	102,757.13	74,217.00	2,762.62	9,255.71	1,034,184.73	71,429.47	9,011.32	49,781.53	0.87%
2017	836,961.53	102,119.20	73,463.96	2,762.62	9,253.77	1,024,561.08	81,053.11	9,623.65	59,405.18	0.93%
2018	829,268.80	101,378.88	72,664.21	2,762.62	9,253.77	1,015,328.28	90,285.91	9,232.80	68,637.98	0.91%
2019	820,271.22	100,605.66	71,568.04	2,762.62	9,253.77	1,004,461.31	101,152.89	10,866.97	79,504.95	1.08%
2020	811,193.13	99,485.26	71,467.12	2,762.62	9,253.77	994,161.90	111,452.29	10,299.41	89,804.36	1.03%
2021	801,263.28	98,606.15	70,722.17	2,762.62	9,248.88	982,603.10	123,011.09	11,558.80	101,363.16	1.17%
2022	792,578.05	97,727.30	70,132.27	2,762.62	9,247.13	972,447.37	133,166.82	10,155.73	111,518.89	1.04%
2023	782,938.63	96,888.65	69,527.84	2,762.62	9,247.13	961,364.87	144,249.32	11,082.50	122,601.39	1.15%
2024	773,405.59	96,121.65	68,737.53	2,762.62	9,247.13	950,274.52	155,339.68	11,090.35	133,691.74	1.16%
2025	763,167.79	95,210.41	68,008.68	2,762.62	9,245.58	938,395.08	167,219.12	11,879.44	145,571.18	1.26%
2026	755,785.88	94,759.77	67,903.85	2,762.62	8,614.89	929,827.01	175,787.19	8,568.07	154,139.26	0.92%
2027	750,705.81	94,292.49	67,664.77	2,762.62	7,970.05	923,395.74	182,218.45	6,431.26	160,570.52	0.69%
2028	743,992.51	93,573.94	66,475.58	2,762.62	7,968.30	914,772.96	190,841.24	8,622.78	169,193.30	0.94%
2029	738,655.95	93,112.92	65,875.48	2,762.62	7,939.20	908,346.16	197,268.04	6,426.80	175,620.10	0.71%
2030	732,317.38	92,418.84	65,024.55	2,762.62	7,645.15	900,168.54	205,445.65	8,177.62	183,797.72	0.90%
2031	726,206.48	91,631.73	63,950.61	2,762.62	7,645.15	892,196.58	213,417.61	7,971.96	191,769.68	0.89%
2032	719,539.29	91,473.96	63,216.73	2,762.62	7,311.07	884,303.67	221,310.52	7,892.91	199,662.59	0.89%
2033	712,359.14	91,025.27	62,433.39	2,762.62	7,234.80	875,815.23	229,798.97	8,488.44	208,151.03	0.96%
2034	704,347.92	90,492.19	61,935.95	2,762.62	6,886.06	866,424.74	239,189.46	9,390.49	217,541.53	1.08%
2035	697,826.18	90,163.17	61,143.38	2,762.62	5,815.03	857,710.39	247,903.81	8,714.35	226,255.87	1.01%
2036	692,794.57	89,149.53	60,110.75	2,762.62	5,594.88	850,412.35	255,201.84	7,298.04	233,553.91	0.85%
2037	684,930.34	87,854.95	59,590.62	2,762.62	5,344.83	840,483.36	265,130.83	9,928.99	243,482.90	1.17%
2038	678,283.71	87,060.37	58,941.54	2,762.62	4,713.49	831,761.73	273,852.46	8,721.63	252,204.53	1.04%
2039	671,049.53	86,427.37	58,739.95	2,762.62	4,305.59	823,285.06	282,329.14	8,476.67	260,681.20	1.02%
2040	663,977.68	85,709.22	58,231.93	2,762.62	4,114.09	814,795.54	290,818.65	8,489.51	269,170.72	1.04%
2041	655,825.88	84,936.71	57,705.80	2,762.62	3,988.36	805,219.37	300,394.82	9,576.17	278,746.89	1.18%
2042	648,907.96	84,084.62	57,161.33	2,762.62	3,904.81	796,821.34	308,792.86	8,398.03	287,144.92	1.05%
2043	641,776.87	83,265.02	56,535.48	2,762.62	3,821.86	788,161.85	317,452.35	8,659.49	295,804.41	1.09%
2044	635,630.33	82,497.85	55,821.09	2,762.62	3,821.86	780,533.76	325,080.44	7,628.09	303,432.50	0.97%
Initial Forest area (year of 2014) (ha)									1,047,143.47	
Final Forest area (year of 2044) (ha)									780,533.76	
Total deforestation in the reference region (2014-2044 period) (ha)									266,609.71	
Average annual deforestation rate (2014-2044 period)									0.95%/year	

Table 24. Annual deforestation, cumulative deforestation and R in all classes within the reference region during the project crediting period

[153] R: annual rate of forest cover change. Calculated according to Puyravaud, J.-P. (2003), "Standardizing the calculation of the annual rate of deforestation." Forest Ecology and Management, 177: 593-596.

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Total forest area (ha)	Annual Deforesta-tion (ha)	Cumulative deforesta-tion (ha)	R[154] (%/year)
2014	172,125.37	9,398.76	4,109.32	185,633.45	585.60	585.60	0.31%
2015	171,100.53	9,343.01	4,109.32	184,552.86	1,080.60	1,666.20	0.58%
2016	170,094.20	9,273.67	4,109.32	183,477.19	1,075.67	2,741.87	0.58%
2017	169,096.13	9,217.19	4,109.32	182,422.64	1,054.55	3,796.42	0.58%
2018	167,892.88	9,123.17	4,109.32	181,125.37	1,297.27	5,093.68	0.71%
2019	166,830.22	9,050.57	4,109.32	179,990.11	1,135.26	6,228.94	0.63%
2020	165,881.30	9,003.58	4,109.32	178,994.20	995.91	7,224.85	0.55%
2021	164,755.90	8,931.10	4,109.32	177,796.32	1,197.88	8,422.73	0.67%
2022	163,725.27	8,905.85	4,109.32	176,740.44	1,055.88	9,478.61	0.60%
2023	162,592.91	8,899.95	4,109.32	175,602.18	1,138.26	10,616.87	0.65%
2024	161,834.03	8,899.95	4,109.32	174,843.29	758.89	11,375.76	0.43%
2025	160,798.08	8,899.95	4,109.32	173,807.35	1,035.95	12,411.71	0.59%
2026	159,758.85	8,899.95	4,109.32	172,768.12	1,039.23	13,450.94	0.60%
2027	158,712.24	8,890.19	4,108.23	171,710.65	1,057.46	14,508.40	0.61%
2028	157,598.58	8,890.19	4,108.23	170,597.00	1,113.66	15,622.06	0.65%
2029	156,522.44	8,890.19	4,108.23	169,520.85	1,076.14	16,698.20	0.63%
2030	155,435.56	8,890.19	4,108.23	168,433.98	1,086.87	17,785.08	0.64%
2031	154,396.33	8,890.19	4,108.23	167,394.75	1,039.23	18,824.31	0.62%
2032	153,357.10	8,890.19	4,108.23	166,355.52	1,039.23	19,863.54	0.62%
2033	152,401.01	8,890.19	4,108.23	165,399.43	956.09	20,819.63	0.58%
2034	151,278.64	8,890.19	4,085.67	164,254.50	1,144.93	21,964.56	0.69%
2035	150,159.45	8,890.19	4,085.67	163,135.31	1,119.19	23,083.75	0.68%
2036	149,203.36	8,890.19	4,085.67	162,179.22	956.09	24,039.84	0.59%
2037	148,041.44	8,751.44	4,085.67	160,878.55	1,300.66	25,340.50	0.81%
2038	146,949.09	8,621.08	4,085.67	159,655.84	1,222.71	26,563.22	0.76%
2039	145,860.47	8,537.62	4,085.67	158,483.76	1,172.08	27,735.30	0.74%
2040	144,846.73	8,412.12	4,085.67	157,344.52	1,139.24	28,874.53	0.72%
2041	143,942.14	8,275.96	4,085.67	156,303.76	1,040.76	29,915.29	0.66%
2042	143,036.40	8,115.59	4,085.67	155,237.66	1,066.11	30,981.40	0.68%
2043	141,748.67	7,990.42	4,085.67	153,824.76	1,412.89	32,394.29	0.91%
2044	140,903.66	7,733.19	4,085.67	152,722.52	1,102.24	33,496.53	0.72%
Initial Forest area (year of 2014) (ha)						186,219.06	
Final Forest area (year of 2044) (ha)						152,722.52	
Total deforestation in the reference region (2014-2044 period) (ha)						33,496.53	
Average annual deforestation rate (2014-2044 period)						0.64%/year	

Table 25. Annual deforestation, cumulative deforestation and R in all classes within the project area during the project crediting period

[154] R: annual rate of forest cover change. Calculated according to Puyravaud, J.-P. (2003), "Standardizing the calculation of the annual rate of deforestation." Forest Ecology and Management, 177: 593-596.

Year	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation	Total Forest area (ha)	No Forest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R[155] (%/y)
2014	57,750.46	2,475.35	36,081.34	4,740.03	101,047.19	24,154.49	1,302.84	13,039.05	1.28%
2015	57,680.95	2,470.91	35,994.25	4,517.36	100,663.47	24,538.21	383.72	13,422.77	0.38%
2016	57,352.56	2,469.36	35,564.85	4,517.36	99,904.13	25,297.55	759.34	14,182.11	0.76%
2017	56,578.08	2,112.58	34,813.47	4,515.42	98,019.55	27,182.13	1,884.58	16,066.69	1.90%
2018	53,567.33	1,801.79	34,014.41	4,515.42	93,898.96	31,302.72	4,120.59	20,187.28	4.29%
2019	46,940.56	1,314.67	32,996.10	4,515.42	85,766.75	39,434.94	8,132.22	28,319.49	9.06%
2020	42,241.37	1,314.67	32,816.63	4,515.42	80,888.09	44,313.59	4,878.65	33,198.14	5.86%
2021	41,101.55	1,313.87	32,071.68	4,515.42	79,002.52	46,199.16	1,885.57	35,083.72	2.36%
2022	39,960.02	1,311.06	31,481.79	4,515.42	77,268.29	47,933.39	1,734.23	36,817.95	2.22%
2023	38,476.11	1,309.97	30,877.54	4,515.42	75,179.04	50,022.65	2,089.25	38,907.20	2.74%
2024	35,505.51	1,308.58	30,087.92	4,515.42	71,417.43	53,784.25	3,761.61	42,668.81	5.13%
2025	34,111.60	1,278.10	29,430.08	4,514.35	69,334.13	55,867.55	2,083.29	44,752.10	2.96%
2026	31,806.46	1,278.10	29,332.09	3,903.22	66,319.87	58,881.82	3,014.27	47,766.37	4.44%
2027	29,823.24	823.66	29,001.20	3,258.38	62,906.48	62,295.20	3,413.38	51,179.76	5.28%
2028	29,682.55	393.95	27,904.51	3,257.13	61,238.14	63,963.54	1,668.34	52,848.10	2.69%
2029	29,682.55	3.83	27,586.68	3,257.13	60,530.19	64,671.50	707.95	53,556.05	1.16%
2030	28,839.74	3.83	26,735.76	3,250.04	58,829.36	66,372.32	1,700.82	55,256.87	2.85%
2031	26,061.97	3.83	26,304.17	3,250.04	55,620.01	69,581.67	3,209.35	58,466.23	5.61%
2032	25,289.23	0.00	25,570.30	3,011.63	53,871.16	71,330.53	1,748.85	60,215.08	3.19%
2033	23,576.01	0.00	24,786.96	2,965.18	51,328.15	73,873.53	2,543.01	62,758.09	4.84%
2034	21,127.29	0.00	24,448.21	2,789.56	48,365.05	76,836.63	2,963.10	65,721.19	5.95%
2035	20,575.90	0.00	23,655.64	1,791.35	46,022.88	79,178.80	2,342.17	68,063.36	4.96%
2036	19,483.25	0.00	23,487.70	1,791.35	44,762.30	80,439.38	1,260.58	69,323.94	2.78%
2037	19,483.25	0.00	23,165.39	1,791.35	44,439.99	80,761.70	322.31	69,646.25	0.72%
2038	18,159.45	0.00	22,516.32	1,160.54	41,836.31	83,365.37	2,603.68	72,249.93	6.04%
2039	15,201.21	0.00	22,468.11	1,058.10	38,727.41	86,474.27	3,108.90	75,358.83	7.72%
2040	14,301.03	0.00	21,960.09	866.60	37,127.72	88,073.96	1,599.69	76,958.52	4.22%
2041	14,002.23	0.00	21,433.96	740.87	36,177.06	89,024.63	950.66	77,909.18	2.59%
2042	13,742.49	0.00	21,394.64	740.87	35,878.00	89,323.69	299.06	78,208.24	0.83%
2043	13,135.96	0.00	21,121.76	687.47	34,945.19	90,256.49	932.81	79,141.05	2.63%
2044	10,837.70	0.00	20,407.37	687.47	31,932.55	93,269.14	3,012.64	82,153.69	9.02%
Initial Forest area (year of 2014) (ha)								102,350.04	
Final Forest area (year of 2044) (ha)								31,932.55	
Total deforestation in the reference region (2014-2044 period) (ha)								70,417.49	
Average annual deforestation rate (2014-2044 period)								3.76%/year	

Table 26. Annual deforestation, cumulative deforestation and R in all classes within the leakage belt during the project crediting period

155 R: annual rate of forest cover change. Calculated according to Puyravaud, J.-P. (2003), "Standardizing the calculation of the annual rate of deforestation." Forest Ecology and Management, 177: 593-596.

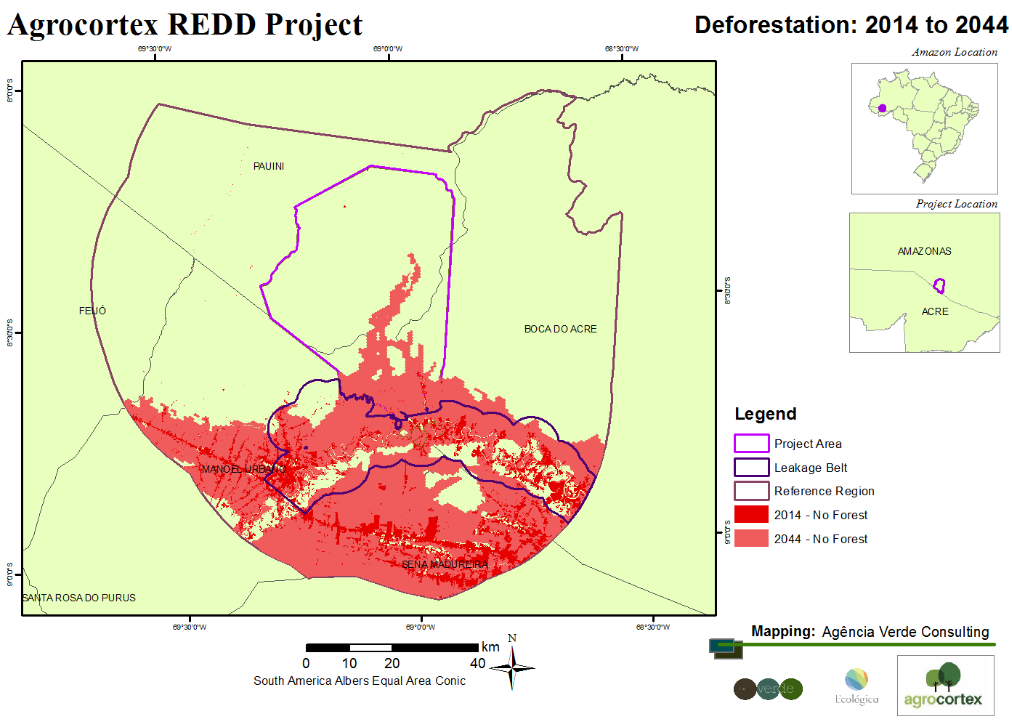

Figure 63. Map representing the projection of future deforestation over the entire crediting period, being 2014 to 2044, in the reference region

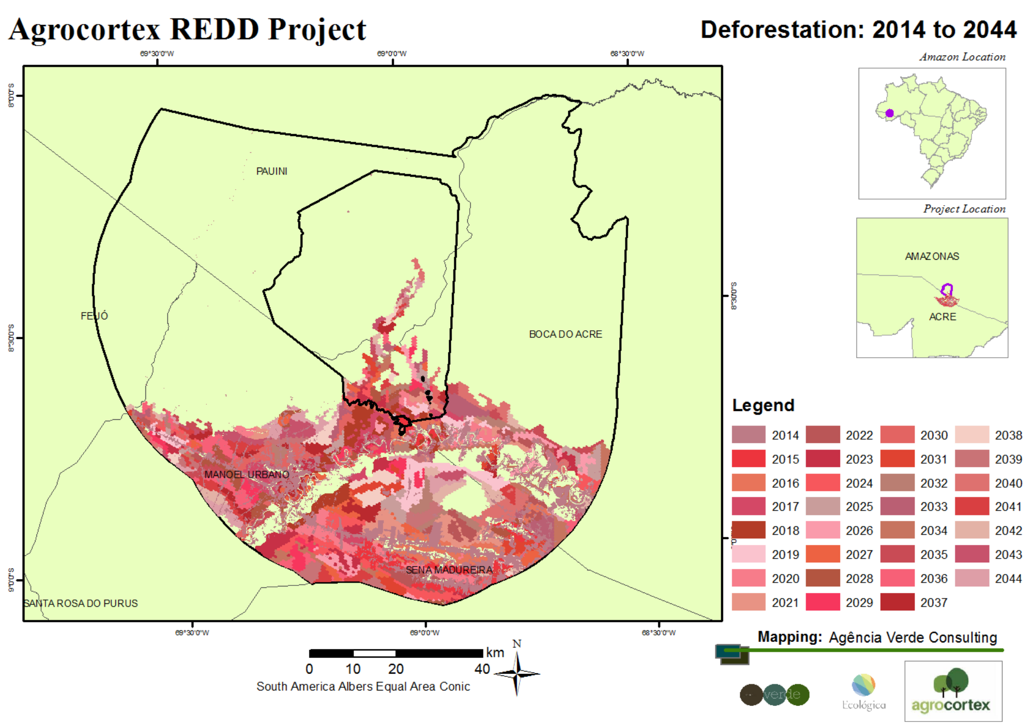

Figure 64. Map representing the projection of annual deforestation over the next 30 years, being 2014 to 2044, in the leakage belt.

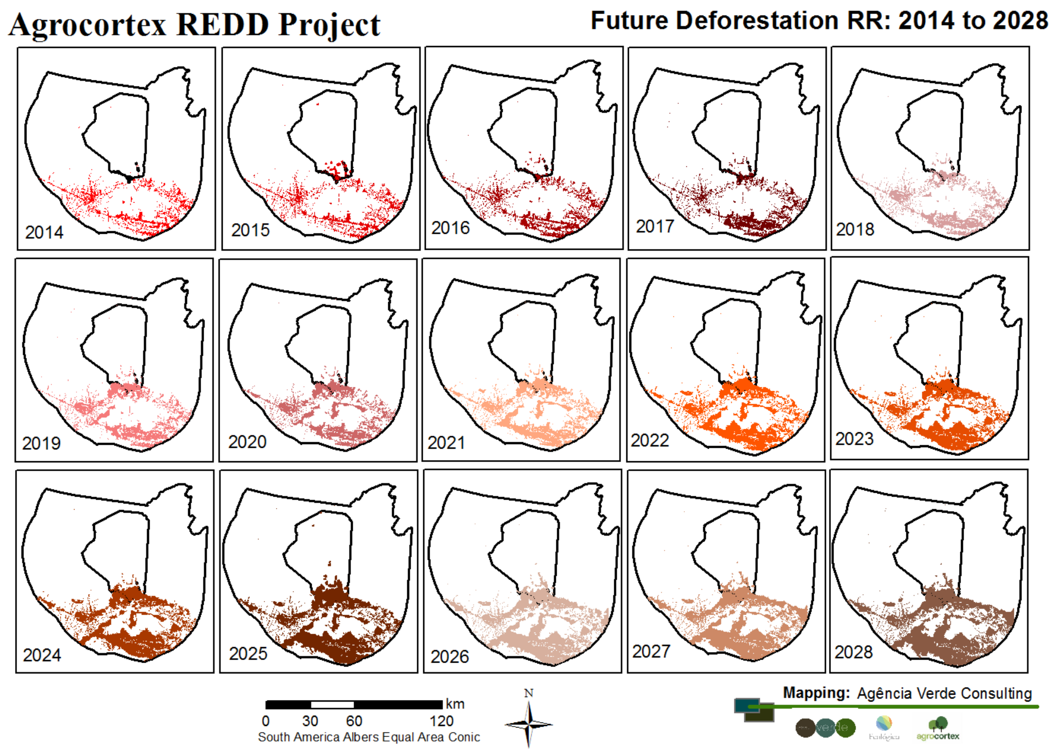

Figure 65. Maps representing the annual projection of deforestation in the reference region from 2014 to 2028.

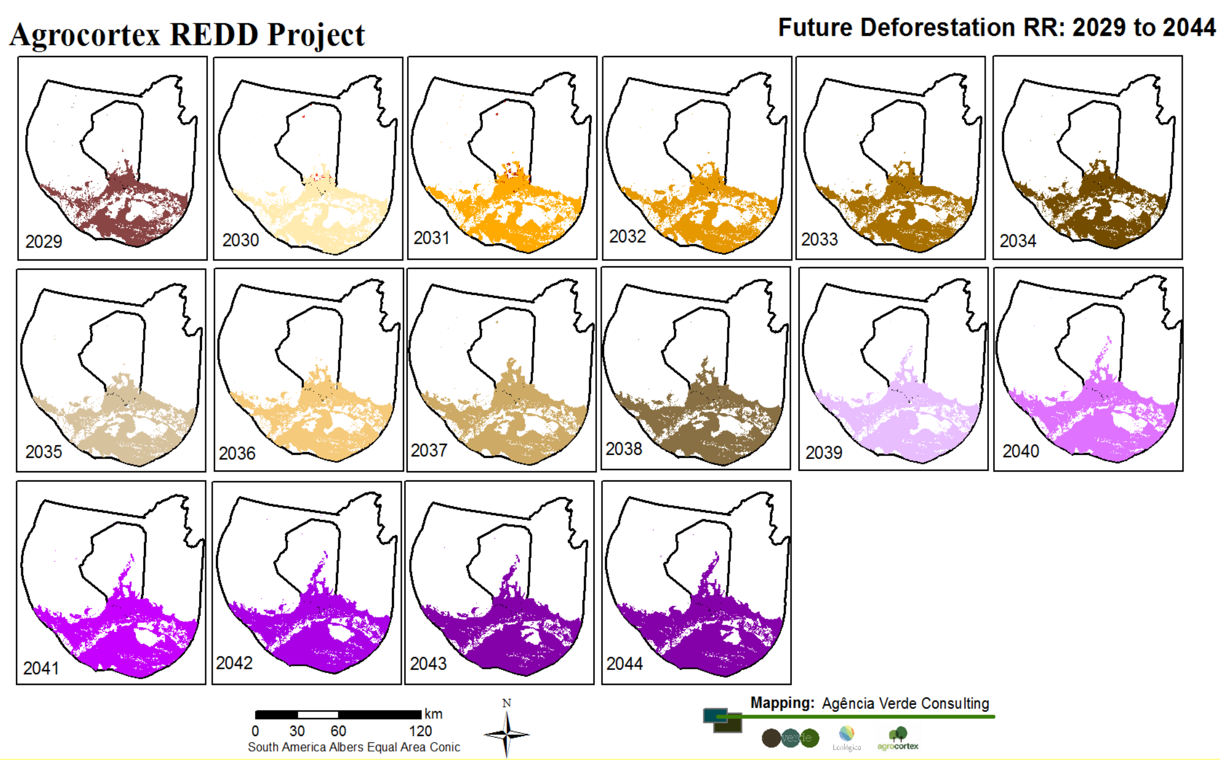

Figure 66. Maps representing the annual projection of deforestation in the reference region from 2029 to 2044.

Therefore, the projection of the annual areas of baseline deforestation of each stratum *i* within reference region, project area and leakage belt are provided in Tables 27-29 below. The “forest” strata used consisted of four forest classes, which are represented by statum *i*.

Project year t	Stratum i in the reference region (ha)					Total (ha)	
	$ABSLRR_1$ Open tropical rainforest with bamboo	$ABSLRR_2$ Open tropical rainforest with palm trees	$ABSLRR_3$ open alluvial rainforest with palm trees	$ABSLRR_4$ Dense tropical rainforest	$ABSLRR_5$ Secondary Vegetation	annual $ABSLRR_t$	cumulative ABSLRR
2014	448.70	133.04	23.91	0.00	1,551.28	2,156.93	2,156.93
2015	1,185.69	75.59	119.49	0.00	409.72	1,790.49	3,947.42
2016	7,883.07	728.34	399.91	0.00	0.00	9,011.32	12,958.74
2017	8,230.74	637.93	753.04	0.00	1.94	9,623.65	22,582.38
2018	7,692.74	740.32	799.75	0.00	0.00	9,232.80	31,815.18
2019	8,997.58	773.23	1,096.16	0.00	0.00	10,866.97	42,682.16
2020	9,078.08	1,120.40	100.93	0.00	0.00	10,299.41	52,981.56
2021	9,929.85	879.11	744.95	0.00	4.89	11,558.80	64,540.36
2022	8,685.24	878.85	589.90	0.00	1.75	10,155.73	74,696.09
2023	9,639.42	838.65	604.43	0.00	0.00	11,082.50	85,778.59
2024	9,533.04	767.00	790.31	0.00	0.00	11,090.35	96,868.95
2025	10,237.80	911.23	728.85	0.00	1.56	11,879.44	108,748.39
2026	7,381.91	450.64	104.83	0.00	630.69	8,568.07	117,316.46
2027	5,080.07	467.28	239.08	0.00	644.84	6,431.26	123,747.72
2028	6,713.29	718.55	1,189.19	0.00	1.75	8,622.78	132,370.51
2029	5,336.56	461.02	600.11	0.00	29.11	6,426.80	138,797.31
2030	6,338.57	694.08	850.92	0.00	294.05	8,177.62	146,974.92
2031	6,110.90	787.11	1,073.95	0.00	0.00	7,971.96	154,946.88
2032	6,667.18	157.78	733.88	0.00	334.08	7,892.91	162,839.79
2033	7,180.16	448.68	783.34	0.00	76.26	8,488.44	171,328.24
2034	8,011.22	533.09	497.44	0.00	348.74	9,390.49	180,718.73
2035	6,521.74	329.01	792.57	0.00	1,071.03	8,714.35	189,433.08
2036	5,031.61	1,013.65	1,032.63	0.00	220.15	7,298.04	196,731.11
2037	7,864.23	1,294.57	520.13	0.00	250.05	9,928.99	206,660.10
2038	6,646.63	794.58	649.07	0.00	631.34	8,721.63	215,381.73
2039	7,234.18	633.00	201.59	0.00	407.90	8,476.67	223,858.41
2040	7,071.85	718.15	508.02	0.00	191.50	8,489.51	232,347.92
2041	8,151.80	772.51	526.13	0.00	125.73	9,576.17	241,924.09
2042	6,917.92	852.09	544.47	0.00	83.55	8,398.03	250,322.13
2043	7,131.10	819.59	625.85	0.00	82.95	8,659.49	258,981.62
2044	6,146.53	767.17	714.39	0.00	0.00	7,628.09	266,609.71

Table 27. Annual areas of baseline deforestation in the reference region across the crediting period

Table below shows the projected annual deforestation in stratum *i* ("forest") within the project area across the project crediting period, represented by the variable *ABSLPA.*

Project year t	Stratum i in the project area (ha)			Total (ha)	
	$ABSLPA_1$ Open tropical rainforest with bamboo	$ABSLPA_2$ Open tropical rainforest with palm trees	$ABSLPA_3$ Open alluvial rainforest with palm trees	annual $ABSLPA_t$	cumulative ABSLPA
2014	428.66	133.04	23.90	585.60	585.60
2015	1,024.85	55.75	0.00	1,080.60	1,666.20
2016	1,006.33	69.34	0.00	1,075.67	2,741.87
2017	998.07	56.48	0.00	1,054.55	3,796.42
2018	1,203.24	94.02	0.00	1,297.27	5,093.68
2019	1,062.66	72.59	0.00	1,135.26	6,228.94
2020	948.92	47.00	0.00	995.91	7,224.85
2021	1,125.40	72.48	0.00	1,197.88	8,422.73
2022	1,030.64	25.25	0.00	1,055.88	9,478.61
2023	1,132.35	5.91	0.00	1,138.26	10,616.87
2024	758.89	0.00	0.00	758.89	11,375.76
2025	1,035.95	0.00	0.00	1,035.95	12,411.71
2026	1,039.23	0.00	0.00	1,039.23	13,450.94
2027	1,046.62	9.76	1.09	1,057.46	14,508.40
2028	1,113.66	0.00	0.00	1,113.66	15,622.06
2029	1,076.14	0.00	0.00	1,076.14	16,698.20
2030	1,086.87	0.00	0.00	1,086.87	17,785.08
2031	1,039.23	0.00	0.00	1,039.23	18,824.31
2032	1,039.23	0.00	0.00	1,039.23	19,863.54
2033	956.09	0.00	0.00	956.09	20,819.63
2034	1,122.37	0.00	22.56	1,144.93	21,964.56
2035	1,119.19	0.00	0.00	1,119.19	23,083.75
2036	956.09	0.00	0.00	956.09	24,039.84
2037	1,161.92	138.74	0.00	1,300.66	25,340.50
2038	1,092.35	130.37	0.00	1,222.71	26,563.22
2039	1,088.62	83.46	0.00	1,172.08	27,735.30
2040	1,013.74	125.50	0.00	1,139.24	28,874.53
2041	904.60	136.16	0.00	1,040.76	29,915.29
2042	905.74	160.37	0.00	1,066.11	30,981.40
2043	1,287.72	125.17	0.00	1,412.89	32,394.29
2044	845.01	257.23	0.00	1,102.24	33,496.53

Table 28. Annual areas of baseline deforestation in the project area across the crediting period

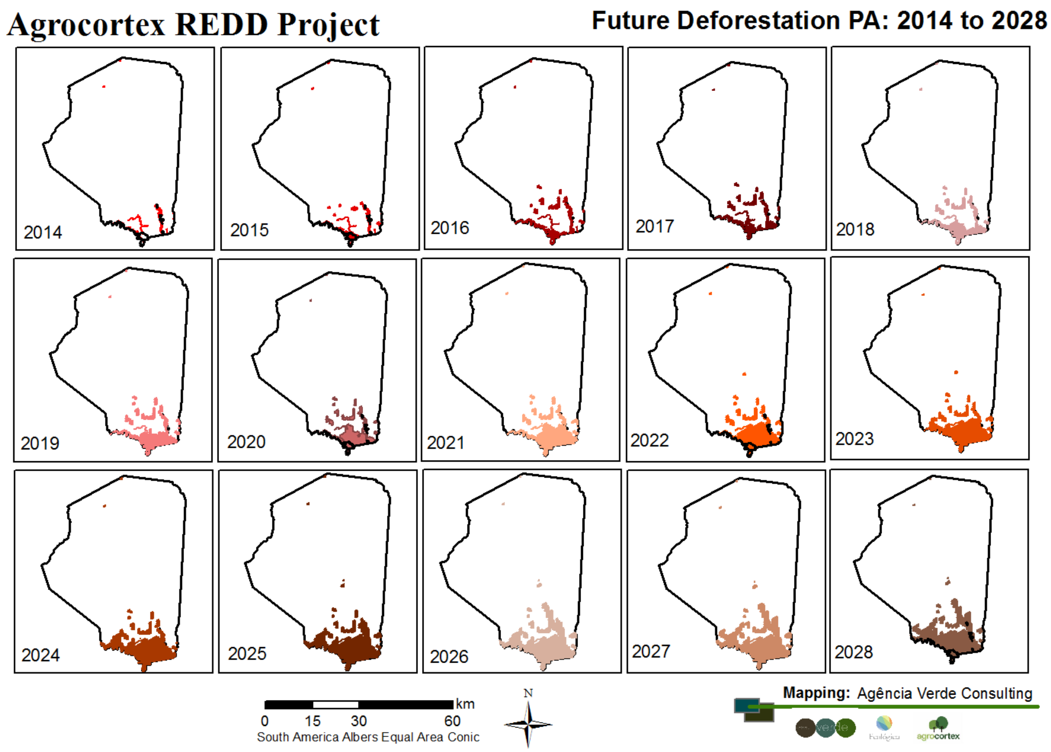

Figure 67. Maps representing the annual projection of deforestation in project area from 2014 to 2028.

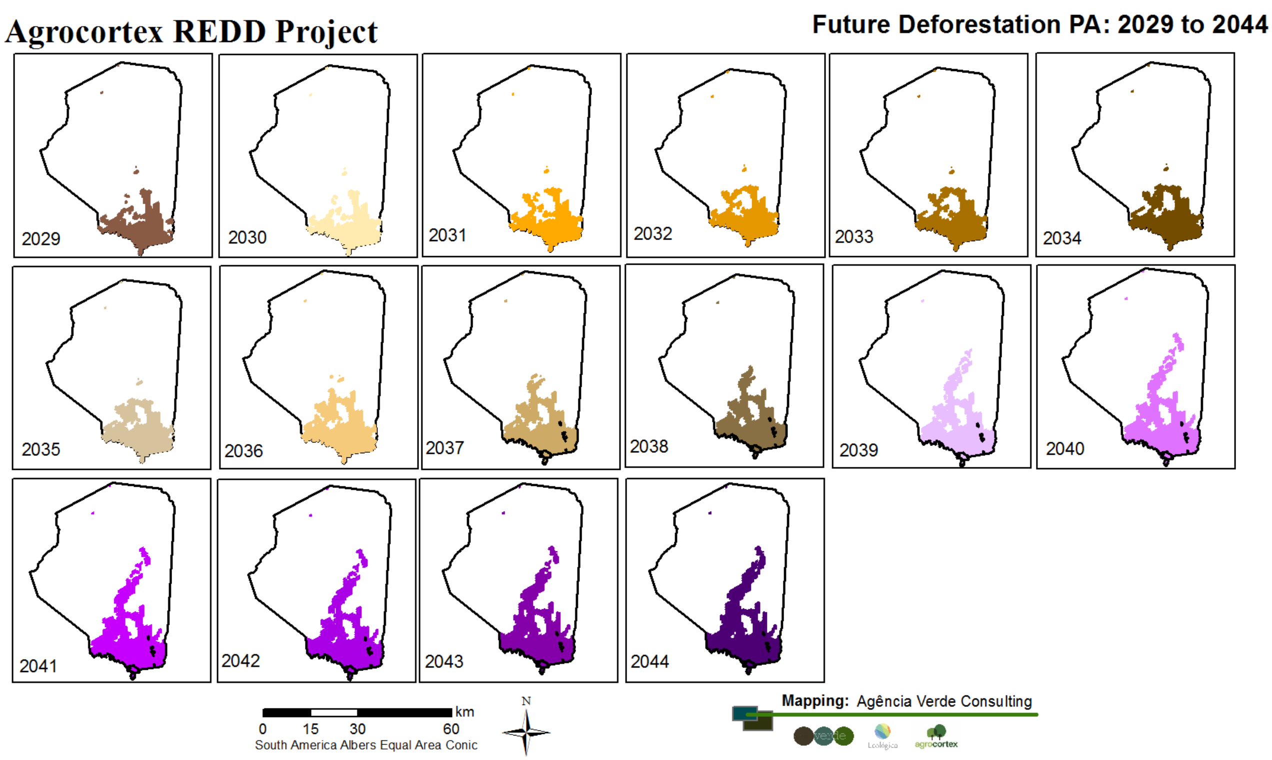

Figure 68. Maps representing the annual projection of deforestation in project area from 2029 to 2044.

Table below shows the projected annual deforestation in stratum *i* ("forest") within the leakage belt across the project crediting period, represented by the variable *ABSLLK.*

Project year t	Stratum i in the leakage belt (ha)				Total (ha)	
	$ABSLLK_1$ Open tropical rainforest with bamboo	$ABSLLK_2$ Open tropical rainforest with palm trees	$ABSLLK_3$ Open alluvial rainforest with palm trees	$ABSLLK_4$ Secondary Vegetation	annual $ABSLLK_t$	cumulative ABSLLK
2014	50.49	18.23	961.93	272.19	1,302.84	1,302.84
2015	69.51	4.44	87.09	222.68	383.72	1,686.56
2016	328.39	1.55	429.40	0.00	759.34	2,445.91
2017	774.49	356.78	751.38	1.94	1,884.58	4,330.49
2018	3,010.74	310.79	799.06	0.00	4,120.59	8,451.08
2019	6,626.78	487.12	1,018.32	0.00	8,132.22	16,583.29
2020	4,699.19	0.00	179.47	0.00	4,878.65	21,461.94
2021	1,139.82	0.80	744.95	0.00	1,885.57	23,347.52
2022	1,141.52	2.81	589.90	0.00	1,734.23	25,081.75
2023	1,483.91	1.09	604.25	0.00	2,089.25	27,171.00
2024	2,970.60	1.39	789.62	0.00	3,761.61	30,932.61
2025	1,393.91	30.48	657.84	1.07	2,083.29	33,015.90
2026	2,305.14	0.00	98.00	611.13	3,014.27	36,030.17
2027	1,983.22	454.44	330.88	644.84	3,413.38	39,443.55
2028	140.69	429.71	1,096.69	1.26	1,668.34	41,111.90
2029	0.00	390.13	317.83	0.00	707.95	41,819.85
2030	842.81	0.00	850.92	7.09	1,700.82	43,520.67
2031	2,777.77	0.00	431.59	0.00	3,209.35	46,730.03
2032	772.75	3.83	733.88	238.40	1,748.85	48,478.88
2033	1,713.22	0.00	783.34	46.45	2,543.01	51,021.89
2034	2,448.72	0.00	338.75	175.62	2,963.10	53,984.98
2035	551.39	0.00	792.57	998.21	2,342.17	56,327.15
2036	1,092.65	0.00	167.93	0.00	1,260.58	57,587.74
2037	0.00	0.00	322.31	0.00	322.31	57,910.05
2038	1,323.79	0.00	649.07	630.81	2,603.68	60,513.73
2039	2,958.25	0.00	48.21	102.44	3,108.90	63,622.63
2040	900.18	0.00	508.02	191.50	1,599.69	65,222.32
2041	298.80	0.00	526.13	125.73	950.66	66,172.98
2042	259.74	0.00	39.31	0.00	299.06	66,472.04
2043	606.53	0.00	272.88	53.40	932.81	67,404.85
2044	2,298.25	0.00	714.39	0.00	3,012.64	70,417.49

Table 29. Annual areas of baseline deforestation in the leakage belt across the crediting period

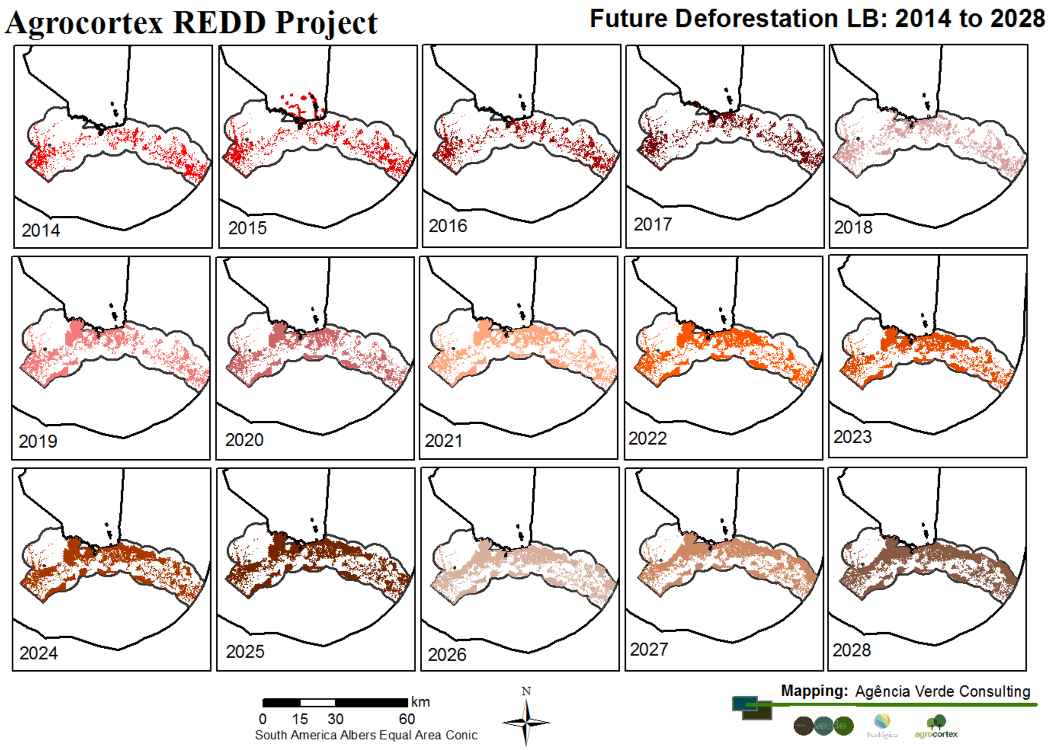

Figure 69. Maps representing the annual projection of deforestation in leakage belt from 2014 to 2028.

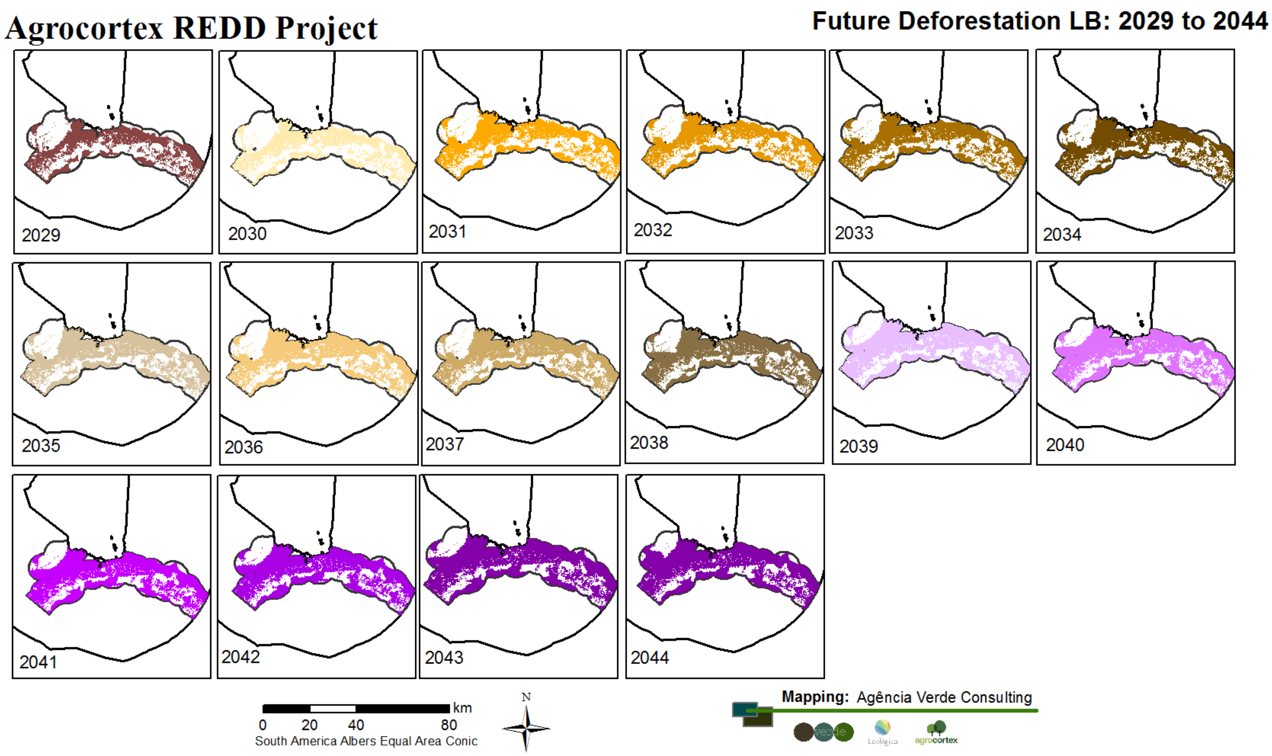

Figure 70. Maps representing the annual projection of deforestation in the leakage belt from 2029 to 2044.

Therefore, the average annual rate of deforestation predicted in the project area over the project crediting period (2014 – 2044) would be of 0.64%, resulting in the deforestation of a predicted 33,496.53 ha, equivalent to 18% of the Agrocortex REDD project area by the end of 2044. This value was lower than the one projected for the reference region due to the presence of large areas of preserved forest in the northern border of the project area.

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

In accordance with the location analysis, achieved through the procedures described above, the quantity of baseline LU/LC-change was projected throughout the entire baseline period for each stratum of the reference region, project area, and leakage belt. This is in accordance with step 5 of the Methodology - Definition of the Land-Use and Land-Cover Change Component of the Baseline.

The goal of this step is to calculate the area of the initial forest classes (*icl*) that will be deforested and the area of the post-deforestation classes (*fcl*) that will replace them in the baseline case. As calculated in the previous sections, the area and location of future deforestation are both known and 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 following is in accordance with step 5.1 of the Methodology: "Calculation of baseline activity data per forest class", in which it is stipulated that the previously-created maps of annual baseline deforestation and LU/LC map be combined, producing a map showing deforestation per class in the baseline case. The LU/LC-change within the project crediting period, caused by baseline deforestation, consisted of initial forest classes being converted to the final LU/LC class of "non-forest". The number of hectares deforested in each forest class, within the reference region, project area and leakage belt are found in Tables 30 – 32 below.

Area deforested per florest class *icl* within the reference region						Total baseline deforestation in the reference region	
IDicl	1	2	3	4	5	annual ABSLRRt (ha)	ABSLRR cumulative (ha)
Name	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Dense Tropical Rainforest	Secondary vegetation		
Project year *t*	ha	ha	ha	ha	ha		
2014	448.70	133.04	23.91	0.00	1,551.28	2,156.93	2,156.93
2015	1,185.69	75.59	119.49	0.00	409.72	1,790.49	3,947.42
2016	7,883.07	728.34	399.91	0.00	0.00	9,011.32	12,958.74
2017	8,230.74	637.93	753.04	0.00	1.94	9,623.65	22,582.38
2018	7,692.74	740.32	799.75	0.00	0.00	9,232.80	31,815.18
2019	8,997.58	773.23	1,096.16	0.00	0.00	10,866.97	42,682.16
2020	9,078.08	1,120.40	100.93	0.00	0.00	10,299.41	52,981.56
2021	9,929.85	879.11	744.95	0.00	4.89	11,558.80	64,540.36
2022	8,685.24	878.85	589.90	0.00	1.75	10,155.73	74,696.09
2023	9,639.42	838.65	604.43	0.00	0.00	11,082.50	85,778.59
2024	9,533.04	767.00	790.31	0.00	0.00	11,090.35	96,868.95
2025	10,237.80	911.23	728.85	0.00	1.56	11,879.44	108,748.39
2026	7,381.91	450.64	104.83	0.00	630.69	8,568.07	117,316.46
2027	5,080.07	467.28	239.08	0.00	644.84	6,431.26	123,747.72
2028	6,713.29	718.55	1,189.19	0.00	1.75	8,622.78	132,370.51
2029	5,336.56	461.02	600.11	0.00	29.11	6,426.80	138,797.31
2030	6,338.57	694.08	850.92	0.00	294.05	8,177.62	146,974.92
2031	6,110.90	787.11	1,073.95	0.00	0.00	7,971.96	154,946.88
2032	6,667.18	157.78	733.88	0.00	334.08	7,892.91	162,839.79
2033	7,180.16	448.68	783.34	0.00	76.26	8,488.44	171,328.24
2034	8,011.22	533.09	497.44	0.00	348.74	9,390.49	180,718.73
2035	6,521.74	329.01	792.57	0.00	1,071.03	8,714.35	189,433.08
2036	5,031.61	1,013.65	1,032.63	0.00	220.15	7,298.04	196,731.11
2037	7,864.23	1,294.57	520.13	0.00	250.05	9,928.99	206,660.10
2038	6,646.63	794.58	649.07	0.00	631.34	8,721.63	215,381.73
2039	7,234.18	633.00	201.59	0.00	407.90	8,476.67	223,858.41
2040	7,071.85	718.15	508.02	0.00	191.50	8,489.51	232,347.92
2041	8,151.80	772.51	526.13	0.00	125.73	9,576.17	241,924.09
2042	6,917.92	852.09	544.47	0.00	83.55	8,398.03	250,322.13
2043	7,131.10	819.59	625.85	0.00	82.95	8,659.49	258,981.62
2044	6,146.53	767.17	714.39	0.00	0.00	7,628.09	266,609.71

Table 30. 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 project area				Total baseline deforestation in the project area	
IDicl	1	2	3	annual ABSLPAt (ha)	ABSLPA cumulative (ha)
Name	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees		
Project year *t*	ha	ha	ha		
2014	428.66	133.04	23.90	585.60	585.60
2015	1,024.85	55.75	0.00	1,080.60	1,666.20
2016	1,006.33	69.34	0.00	1,075.67	2,741.87
2017	998.07	56.48	0.00	1,054.55	3,796.42
2018	1,203.24	94.02	0.00	1,297.27	5,093.68
2019	1,062.66	72.59	0.00	1,135.26	6,228.94
2020	948.92	47.00	0.00	995.91	7,224.85
2021	1,125.40	72.48	0.00	1,197.88	8,422.73
2022	1,030.64	25.25	0.00	1,055.88	9,478.61
2023	1,132.35	5.91	0.00	1,138.26	10,616.87
2024	758.89	0.00	0.00	758.89	11,375.76
2025	1,035.95	0.00	0.00	1,035.95	12,411.71
2026	1,039.23	0.00	0.00	1,039.23	13,450.94
2027	1,046.62	9.76	1.09	1,057.46	14,508.40
2028	1,113.66	0.00	0.00	1,113.66	15,622.06
2029	1,076.14	0.00	0.00	1,076.14	16,698.20
2030	1,086.87	0.00	0.00	1,086.87	17,785.08
2031	1,039.23	0.00	0.00	1,039.23	18,824.31
2032	1,039.23	0.00	0.00	1,039.23	19,863.54
2033	956.09	0.00	0.00	956.09	20,819.63
2034	1,122.37	0.00	22.56	1,144.93	21,964.56
2035	1,119.19	0.00	0.00	1,119.19	23,083.75
2036	956.09	0.00	0.00	956.09	24,039.84
2037	1,161.92	138.74	0.00	1,300.66	25,340.50
2038	1,092.35	130.37	0.00	1,222.71	26,563.22
2039	1,088.62	83.46	0.00	1,172.08	27,735.30
2040	1,013.74	125.50	0.00	1,139.24	28,874.53
2041	904.60	136.16	0.00	1,040.76	29,915.29
2042	905.74	160.37	0.00	1,066.11	30,981.40
2043	1,287.72	125.17	0.00	1,412.89	32,394.29
2044	845.01	257.23	0.00	1,102.24	33,496.53

Table 31. 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 leakage belt					Total baseline deforestation in the leakage belt	
IDicl	1	2	3	5	annual ABSLLKt (ha)	ABSLLK cumulative (ha)
Name	Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation		
Project year *t*	ha	ha	ha	ha		
2014	50.49	18.23	961.93	272.19	1,302.84	1,302.84
2015	69.51	4.44	87.09	222.68	383.72	1,686.56
2016	328.39	1.55	429.40	0.00	759.34	2,445.91
2017	774.49	356.78	751.38	1.94	1,884.58	4,330.49
2018	3,010.74	310.79	799.06	0.00	4,120.59	8,451.08
2019	6,626.78	487.12	1,018.32	0.00	8,132.22	16,583.29
2020	4,699.19	0.00	179.47	0.00	4,878.65	21,461.94
2021	1,139.82	0.80	744.95	0.00	1,885.57	23,347.52
2022	1,141.52	2.81	589.90	0.00	1,734.23	25,081.75
2023	1,483.91	1.09	604.25	0.00	2,089.25	27,171.00
2024	2,970.60	1.39	789.62	0.00	3,761.61	30,932.61
2025	1,393.91	30.48	657.84	1.07	2,083.29	33,015.90
2026	2,305.14	0.00	98.00	611.13	3,014.27	36,030.17
2027	1,983.22	454.44	330.88	644.84	3,413.38	39,443.55
2028	140.69	429.71	1,096.69	1.26	1,668.34	41,111.90
2029	0.00	390.13	317.83	0.00	707.95	41,819.85
2030	842.81	0.00	850.92	7.09	1,700.82	43,520.67
2031	2,777.77	0.00	431.59	0.00	3,209.35	46,730.03
2032	772.75	3.83	733.88	238.40	1,748.85	48,478.88
2033	1,713.22	0.00	783.34	46.45	2,543.01	51,021.89
2034	2,448.72	0.00	338.75	175.62	2,963.10	53,984.98
2035	551.39	0.00	792.57	998.21	2,342.17	56,327.15
2036	1,092.65	0.00	167.93	0.00	1,260.58	57,587.74
2037	0.00	0.00	322.31	0.00	322.31	57,910.05
2038	1,323.79	0.00	649.07	630.81	2,603.68	60,513.73
2039	2,958.25	0.00	48.21	102.44	3,108.90	63,622.63
2040	900.18	0.00	508.02	191.50	1,599.69	65,222.32
2041	298.80	0.00	526.13	125.73	950.66	66,172.98
2042	259.74	0.00	39.31	0.00	299.06	66,472.04
2043	606.53	0.00	272.88	53.40	932.81	67,404.85
2044	2,298.25	0.00	714.39	0.00	3,012.64	70,417.49

Table 32. Annual areas deforested per forest class *icl* within the leakage belt in the baseline case (baseline activity data per 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 VM0015, the historical LU/LC-change (Method 1) was used to calculate the LU/LC class that will replace the forest cover in the baseline scenario. Table 33 below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region. In addition, Tables 34-36 depict baseline activity data per post-deforestation forest class in the reference region, project area, and leakage belt, respectively.

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	266,609.71	24%	266,609.71	24%
Total area of each class *fcl*		266,609.71	24%	266,609.71	24%

Table 33. Zone of the reference region encompassing potential post-deforestation LU/LC class

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
2014	2,156.93	2,156.93	2,156.93
2015	1,790.49	1,790.49	3,947.42
2016	9,011.32	9,011.32	12,958.74
2017	9,623.65	9,623.65	22,582.38
2018	9,232.80	9,232.80	31,815.18
2019	10,866.97	10,866.97	42,682.16
2020	10,299.41	10,299.41	52,981.56
2021	11,558.80	11,558.80	64,540.36
2022	10,155.73	10,155.73	74,696.09
2023	11,082.50	11,082.50	85,778.59
2024	11,090.35	11,090.35	96,868.95
2025	11,879.44	11,879.44	108,748.39
2026	8,568.07	8,568.07	117,316.46
2027	6,431.26	6,431.26	123,747.72
2028	8,622.78	8,622.78	132,370.51
2029	6,426.80	6,426.80	138,797.31
2030	8,177.62	8,177.62	146,974.92
2031	7,971.96	7,971.96	154,946.88
2032	7,892.91	7,892.91	162,839.79
2033	8,488.44	8,488.44	171,328.24
2034	9,390.49	9,390.49	180,718.73
2035	8,714.35	8,714.35	189,433.08
2036	7,298.04	7,298.04	196,731.11
2037	9,928.99	9,928.99	206,660.10
2038	8,721.63	8,721.63	215,381.73
2039	8,476.67	8,476.67	223,858.41
2040	8,489.51	8,489.51	232,347.92
2041	9,576.17	9,576.17	241,924.09
2042	8,398.03	8,398.03	250,322.13
2043	8,659.49	8,659.49	258,981.62
2044	7,628.09	7,628.09	266,609.71

Table 34. Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data 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
2014	585.60	585.60	585.60
2015	1,080.60	1,080.60	1,666.20
2016	1,075.67	1,075.67	2,741.87
2017	1,054.55	1,054.55	3,796.42
2018	1,297.27	1,297.27	5,093.68
2019	1,135.26	1,135.26	6,228.94
2020	995.91	995.91	7,224.85
2021	1,197.88	1,197.88	8,422.73
2022	1,055.88	1,055.88	9,478.61
2023	1,138.26	1,138.26	10,616.87
2024	758.89	758.89	11,375.76
2025	1,035.95	1,035.95	12,411.71
2026	1,039.23	1,039.23	13,450.94
2027	1,057.46	1,057.46	14,508.40
2028	1,113.66	1,113.66	15,622.06
2029	1,076.14	1,076.14	16,698.20
2030	1,086.87	1,086.87	17,785.08
2031	1,039.23	1,039.23	18,824.31
2032	1,039.23	1,039.23	19,863.54
2033	956.09	956.09	20,819.63
2034	1,144.93	1,144.93	21,964.56
2035	1,119.19	1,119.19	23,083.75
2036	956.09	956.09	24,039.84
2037	1,300.66	1,300.66	25,340.50
2038	1,222.71	1,222.71	26,563.22
2039	1,172.08	1,172.08	27,735.30
2040	1,139.24	1,139.24	28,874.53
2041	1,040.76	1,040.76	29,915.29
2042	1,066.11	1,066.11	30,981.40
2043	1,412.89	1,412.89	32,394.29
2044	1,102.24	1,102.24	33,496.53

Table 35. Annual areas deforested in each zone within the project area in the baseline case (baseline activity data zone)

Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	*$ABSLLK_t$*	*ABSLLK*
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2014	1,302.84	1,302.84	1,302.84
2015	383.72	383.72	1,686.56
2016	759.34	759.34	2,445.91
2017	1,884.58	1,884.58	4,330.49
2018	4,120.59	4,120.59	8,451.08
2019	8,132.22	8,132.22	16,583.29
2020	4,878.65	4,878.65	21,461.94
2021	1,885.57	1,885.57	23,347.52
2022	1,734.23	1,734.23	25,081.75
2023	2,089.25	2,089.25	27,171.00
2024	3,761.61	3,761.61	30,932.61
2025	2,083.29	2,083.29	33,015.90
2026	3,014.27	3,014.27	36,030.17
2027	3,413.38	3,413.38	39,443.55
2028	1,668.34	1,668.34	41,111.90
2029	707.95	707.95	41,819.85
2030	1,700.82	1,700.82	43,520.67
2031	3,209.35	3,209.35	46,730.03
2032	1,748.85	1,748.85	48,478.88
2033	2,543.01	2,543.01	51,021.89
2034	2,963.10	2,963.10	53,984.98
2035	2,342.17	2,342.17	56,327.15
2036	1,260.58	1,260.58	57,587.74
2037	322.31	322.31	57,910.05
2038	2,603.68	2,603.68	60,513.73
2039	3,108.90	3,108.90	63,622.63
2040	1,599.69	1,599.69	65,222.32
2041	950.66	950.66	66,172.98
2042	299.06	299.06	66,472.04
2043	932.81	932.81	67,404.85
2044	3,012.64	3,012.64	70,417.49

Table 36. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data zone)

2.5 Additionality

For the purpose of the present analysis, the VCS Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities (VT0001) v3.0 was applied (hereafter, "the additionality tool").

This tool is applicable to this project activity because the following conditions have been met:

a) AFOLU activities equal or similar to the activities proposed by Agrocortex REDD Project, within the project boundary, whether registered or not as a VCS AFOLU Project, do not violate any applicable law, even if the law is not enforced; and

b) the applied baseline methodology (VM0015, v1.1) provides a stepwise approach to justify the determination of the most plausible baseline scenario, in accordance to VCS AFOLU Requirements, v3.5.

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

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

Credible alternatives 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 2.4 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.

II. **Implementation of a sustainable forest management plan, combined with the implementation of additional activities to reduce the deforestation pressures**: 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, probably certified by FSC.

    Additionally, complementary activities to improve the monitoring of deforestation caused by the agents (identified in section 2.4 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. **Implementation of a sustainable forest management plan, however without the implementation of additional activities to reduce deforestation pressures:** this scenario involves the Implementation of 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.

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[156,157,158,159,160].

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. Besides that, local population is motivated to perform this unplanned activity, followed by 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. Half of the conservation areas located in the Amazon does not have an approved management plan, and a large amount does not have a management

[156] BRASIL. Ministério do Meio Ambiente (MMA). Plano de ação para prevenção e controle do desmatamento na Amazônia. Brasília, 2012.

[157] 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

[158] 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 .

[159] 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.

[160] VERWEIJ, P. *et al*. Keeping the Amazon Forests standing: a matter of values. Zeist: WWF, 2009. 72p.

team. Furthermore, the number of Government agents assigned to these areas is greatly lacking and insufficient to carry out effective surveillance (an average of 1 person per 1,871.7 km²). The result is intense deforestation and pressure on protected areas in the legal Amazon, primarily because of wood harvesting activities, agriculture, road construction and mining[161,162].

In addition, recent budget cuts from the Federal Government to the Brazilian Government Ministry for the Environment will likely reduce the Government capacity to prevent deforestation, leading to environmental impacts and increased GHG emissions from land use change in the Amazon region[163].

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

Some activities carried out under scenario I. above are illegal or of uncertain legal status, not being enforced namely due to the lack of control[164] and government capacity. 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.

The States of Acre and Amazonas, where the Project area is located, have showed a significant increase in deforestation rates in 2016, when compared to 2015. Deforestation on both states also demonstrates an increasing trend since 2013[165]. The analysis of deforestation dynamics indicated that the critical areas are located primarily at the borders of highways in municipalities in the south of the State of Amazonas, where 75% of Amazonas State's total deforestation occurred. In the State of Acre, deforestation is concentrated in the South East of the State. This pattern of deforestation is rooted in the expansion of the Brazilian arc of deforestation: the advancement of livestock farming and predatory wood harvesting, coming from neighbouring States; from the establishment of settlement areas as well as the potential for construction of new infrastructure in the region (primarily highways), which resulted in an increase in land-use pressure in its area of influence..

Between 2008 and 2009, the municipality of Boca do Acre, where the project area is partly located, was among the top ten municipalities in the State of Amazonas in terms of

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

[162] 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.

[163] OECO.ORG.BR Corte prejudicará fiscalização, diz Sirkis. 2017. Available at: <http://www.oeco.org.br/reportagens/corte-prejudicara-fiscalizacao-diz-sirkis/>. Last visit on April 26th, 2017.

[164] 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.

[165] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on 28-March-2017.

deforestation[166]. The expansion of roads followed by the conversion of land for cattle ranching were the main drivers of deforestation.

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 exploration of wood (degradation) has occurred in many of them.

One way to avoid increased accessibility and illegal exploration of protected areas would be to increase the effectiveness of sanctions in cases of environmental malpractice. Up to 2008, IBAMA registered approximately 1,200 crimes in protected areas in the Amazon (it should be noted that the real number of crimes is much larger, but due to the shortage of Government agents and their limited capacity to monitor deforestation, many crimes go unaccounted for). However, most environmental malpractice goes unsanctioned: under 5% of reviewed cases were concluded. Moreover, deforestation began to increase again following the approval of the new Forest Code (Law 12.651/2012), which fostered a general feeling of impunity in the region, as well as providing amnesty for deforestation, which occurred prior to July/ 2008[167].

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.

On the other hand, scenarios II. and III. presented above are in compliance with all applicable legal and regulatory requirements. Therefore, there are no restrictions for SFMP within the areas where the Agrocortex REDD project's properties are located.

Sub-step 1c. Selection of the baseline scenario

The most plausible baseline scenario was identified in section 2.4 above according to procedures provided on the applied methodology (VM0015, v1.1). The main land-uses that promoted or stimulated deforestation within the reference region during the historical reference period were:

- Agricultural and livestock production;
- Timber harvesting;
- Roads, highways, access roads and other infrastructure projects.

[166] PIONTEKOWSKI, v. *et al*. O avanço do desflorestamento no município de Boca do Acre, Amazonas: estudo de caso ao longo da BR-317. Rio Branco, AC: 1Universidade Federal do Acre – UFAC, 2011.
[167] INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Apuí é o segundo município mais desmatado na Amazônia Legal em Agosto de 2012. 2012. Available at: <http://www.idesam.org.br/apui-e-o-segundo-municipio-mais-desmatado-na-amazonia-legal-em-agosto-de-2012/#.VQChxMt0wdU>. Last visit on: March 10th, 2015.

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

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

The Agrocortex REDD Project generates financial benefits other than the revenue from the sale of VCUs, primarily from the commercialization of timber, as a result of the sustainable forest management plan. Thus, an 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

The Internal Rate of Return was considered the most suitable financial indicators to carry out the investment comparison analysis of alternative land use scenarios. The IRR of all scenarios will be analyzed. 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)[168], Barreto *et al.* (1998)[169], Schneider (2000)[170], Razera (2005)[171], Arima, Barreto and Brito (2005)[172], Young et al. (2007)[173], IDESAM (2011)[174], and IDESAM (2014)[175]. However, Project Proponents consider choosing the IRR is also consistent, given the IRR and the NPV are related, as the IRR is the discount rate that brings the NPV to zero on a discounted cash flow analysis, such as the one performed as part of this investment analysis.

[168] AMARAL, P. *et al*. **Floresta para Sempre**: um Manual para Produção de Madeira na Amazônia. Belém: Imazon, 1998. p. 130
[169] BARRETO, P. *et al*. Custos e Benefícios do Manejo Florestal para Produção de Madeira na Amazônia Oriental. **Série Amazônia** N°10 - Belém: Imazon, 1998.
[170] 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.
[171] 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.
[172] 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.
[174] 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).
[175] 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.

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

An investment analysis will be carried out comparing scenarios II and III described above, because they are the most likely activities to be carried out by the project proponent in a legal manner. In addition, it would be possible to implement cattle ranching on the proportion of the lands which lie outside protected areas, according to Brazilian Law. However, Agrocortex Madeiras do Acre Agroflorestal Ltda. would not undertake such activities as cattle ranching are not their area of specialization. In addition, a study from IDESAM demonstrates small scale cattle ranching is likely to present lower returns on investment than the project activity[176].

On such study, IDESAM has analyzed the expected return on investment for cattle ranching under different scenarios. Results from this study indicate the expected NPV and IRR is lower than the project expected NPV and IRR if taken in consideration that Agrocortex would only be allowed to convert 20% of its land area to pastureland, as defined by current Brazilian regulations. The study also indicates expected NPV and IRR from cattle ranching increase considerably for larger scale operations.

Given the above, the following scenarios were compared:

#	Scenario	Expenses	Revenues
II	Implementation of a sustainable forest management plan, combined with the implementation of additional activities to reduce the deforestation pressures	Sustainable forest management and REDD activities	Timber production
III	Implementation of a sustainable forest management plan, without the implementation of additional activities to reduce the deforestation pressures	Sustainable forest management	Timber production

Table 37. Comparison analysis between the selected land use scenarios

The main assumptions considered for the development of the investment comparison analysis will be presented below and on a separate spreadsheet, allowing for the direct comparison of total costs, total revenues and the expected figures for the chosen financial indicators.

This analysis will consider only the forest operations performed by Agrocortex and not their industrial operations. Agrocortex industrial operations are composed of 10 sawmills and 20 kilns, which process timber into raw lumber, that are exported air dried or kiln dried.

This means the investment comparison analysis will not take into consideration Agrocortex actual costs and revenues to produce and export raw lumber. Instead, the analysis will consider a scenario where Agrocortex would sell unprocessed timber to third parties[177]. This approach was chosen considering timber processing lies outside the VCS REDD Project boundaries.

[176]IDESAM (INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS). Viabilidade econômicada pecuária semi-intensivano sul do Amazonas. Document available at: <http://www.idesam.org.br/publicacao/relatorio-viabilidade-pecuaria.pdf >. Lastvisiton 12-June-2017.

[177] A price of R$ 250,00/m³ of unprocessed timber will be used to determine expected revenues. This was an estimate provided by Agrocortex management team. According to last available data from Imazon regarding timber prices at Rio Branco (dated July, 2010), the average price for unprocessed timber was around R$ 220,00/m³. Hence,

Such analysis is described in the Table 38 below .

Parameter	Scenario	
	Scenario II (in US$)	Scenario III (in US$)
Implementation costs - Purchase of land (partial payment during the period analyzed)	-43,847,147	-48,957,892
Yearly project maintenance costs	-155,740,100	-155,740,100
Forest conservation and social environmental activities	-15,825,773	0
Other expenses	-6,631,679	-6,631,679
Revenues from the sale of unprocessed timber	169,205,691	169,205,691
Other revenues (bamboo)	59,000,000	59,000,000

Table 38. Main assumptions and results of the investment comparison analysis.

It is important to note that all assumptions and input data used in the present investment analysis did not differ across the land use scenarios. Implementation costs present different values for each scenario due to the commercial conditions defined on the contractual agreement for the purchase of land (such conditions were made available to the Validation and Verification Body during the roject validation).

This condition is considered conservative, as it reduces the difference on the IRR of each scenario. However, it is important to note the total cost for the purchase of land is expected to be the same for both scenarios, but Agrocortex would require a longer period to pay for the land under Scenario II.

Investment Analysis Comparison - 30 years project lifetime (US$)		
Land use scenarios / Variables	***II - SFMP + VCS AFOLU project without the financial benefits from the VCS***	***III - Sustainable Forest Management Plan (SFMP)***
Total costs	-222,044,700	-211,329,671
Total Revenues	228,205,691	228,205,691
Accumulated cashflow	6,160,992	16,876,020
IRR	1.13%	2.79%

Table 39. Results from the investment analysis comparison between project activity (REDD) and land use scenario (SFMP)

Through this analysis, it can be concluded that scenario III would have a higher IRR indicator than those 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 IRR that would be generated by the sustainable forest management activity alone.

this estimate is considered conservative. Imazon data available at: <http://imazon.org.br/PDFimazon/Portugues/precos%20da%20madeira/Precos_10.pdf>.

This represents a significant barrier for adopting additional deforestation reduction practices. Scenario III, where no REDD activities are undertaken together with the SFMP, is therefore a more economically attractive scenario than the measures proposed by the project activity.

Therefore, all the additional costs to monitor and reduce deforestation would not be needed if the REDD project did not occur, thus making the proposed VCS AFOLU project without the financial benefits from 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:

- Price of unprocessed timber (US$/m³);
- Average timber production (m³/year).
- Cost for forest conservation measures and social and environmental activities required by the REDD Project (US$/year);

Project maintenance costs will not be subjected to variations in this analysis because they would not change according to different land use scenarios. This means that both the scenarios being compared would be equally impacted by changes in project maintenance costs. The chart below provides a summary of the findings of the sensitivity analysis:

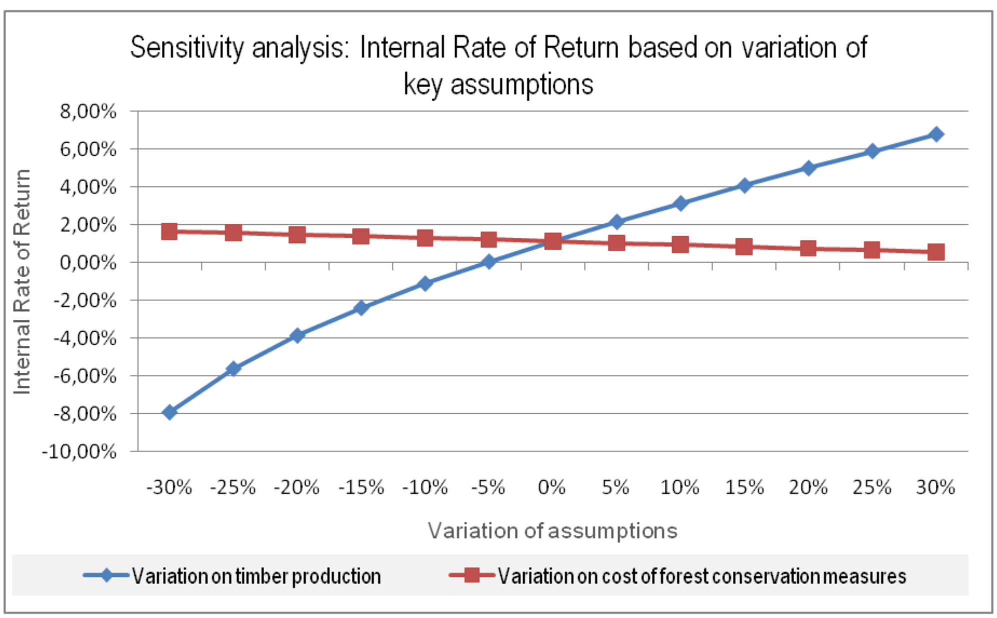

Figure 71. Results of the sensitivity analysis

The sensitivity analysis on the parameters affecting the generation of revenues (price of unprocessed timber and the average timber production) demonstrates Scenario II would be more profitable than Scenario III in case either of these parameters would suffer a variation of +8%.

However, it is not expected that the price of a cubic meter of unprocessed timber under a sustainable forest management plan would change in the “with-REDD” scenario (Scenario II). Such a price increase has not been observed in other SFMP+REDDS projects, as it is usually a reflection of market demand, which prefers already established forestry certifications, such as FSC. Since Agrocortex has already applied the FSC certification to the project area, the price of timber is not expected to be affected by the development and successful execution of a REDD project.

In addition, competition from illegal timber usually decreases the market price for timber, and extra costs, such as those required to develop a REDD project, may cause sustainable forest management plans to enter into financial shutdown, as explained in the section below – Common Practice Analysis.

The variable average timber production would make the REDD project more financially attractive if the project resulted in an increase in timber production as a result of increased surveillance and other measures to reduce illegal logging by third parties. The sensitivity analysis demonstrates an increase of 8% on timber sold would make Scenario II more attractive than Scenario III. Such an increase is not expected to occur in a scale to affect the project additionality.

It is important to note that an increase in timber production would only result in increased revenues with an equal increase in wood harvest and commercialization. It is more likely that market demand and the costs involved to harvest the additional timber resulting from the REDD Project would limit additional revenues. This means potential revenues from additional timber would most likely not compensate for the costs involved in preventing deforestation and forest degradation.

Finally, the variation on costs for forest conservation measures was performed to assess if a decrease in such costs would impact the project additionality. The sensitivity analysis demonstrates this parameter has a low effect on the resulting IRR. Even in a scenario where such costs would suffer a reduction of 50% compared to current assumptions, the IRR of Scenario II would not be as high as Scenario III.

Project proponents consider this parameter will not affect additionality, as project costs are not expected to reduce drastically. Project costs are composed of costs of services provided by third party consultants, Validation and Verification Bodies and the payment of fees, among others.

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.

Scenario III would only be more attractive if there was a reduction of 40% on the costs of forest conservation measures combined with a 5% increase on revenues from the sale of timber. This scenario is considered unlikely by the Project Proponents. Hence, the project owner would hardly invest in activities to prevent deforestation beyond what is required by the forest management plan and by the FSC requirements in the absence of the REDD project.

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 Agrocortex REDD project activity.

Similar activities to the proposed REDD project, i.e., that are of similar scale, take place in a comparable environment, inter alia, with respect to the regulatory framework and are undertaken in the relevant geographical area, shall be analyzed. Other registered VCS AFOLU Project activities shall not be included in this analysis.

The practice of conservation of privately-owned forest areas located in the project region is extremely rare. The conservation of native forest is far from being the most attractive economic scenario[178].

The barriers to preserve forests can be easily explained just by comparing the price of land in the region: forested property values are almost 4 times cheaper than established pasturelands. This fact alone promotes the purchase of new forested areas, deforestation and further creation of new pasturelands[179]. In addition to that, as mentioned above in Section 2.4, there are several other drivers and underlying causes of deforestation in the region, such as population growth, increase of prices of timber logs and beef, lack of resolution of land tenure, absence of economic alternatives, and low presence of Governance. Additionally, the implementation of new infrastructure projects attracts more people to live in a region with a widespread culture of deforestation. Therefore, forest conservation is not the common practice.

Moreover, sustainable forest management plans are currently undergoing a crisis in Brazil. There are sustainable forest management areas close to the project area, however the majority of companies who exploit Amazon rainforest in a legal and sustainable fashion – following the rules designated by environmental organs or more demanding social and environmental precepts such as the FSC – are entering into financial shutdown. The illegal timber, known as “counterfeit legal” is directly competing with sustainable timber operations. Roughly 66% of all timber logs harvested from the Amazon in 2009 are alleged to have been sourced from Ibama-authorized or by State Environment Secretary offices. In other words, what seems to be legal wood is actually sourced from illegal operations, and sawmills that do not abide by the governments laws and control systems.

[178] MINISTÉRIO DO MEIO AMBIENTE (MMA). Unidades De Conservação Federais, RPPNs, Centros Especializados e Coordenações Regionais. Map available at: http://www.icmbio.gov.br/portal/images/stories/servicos/geoprocessamento/DCOL/Mapa_UC_fed_fev_2015.pdf. Last visited on April 12th, 2017.

[179] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. **Economia Verde: Desafios e Oportunidades,** Campinas, v. 8, p.143-155, jun. 2011. Available at: <http://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: April 16th, 2017.

Due to weak monitoring, the flaws in the relevant information systems and the shortage of intelligence professionals to analyze the data collected by them, there are many ways to outsmart the supervision and avoid adoption of good forestry practices. As a result, illegal timber is sold on today's market at a price roughly 40% inferior to that of legally harvested wood. Comparing to FSC-certified wood, the difference may reach up to 50%[180].

These risks can be considered barriers to the continuation of the forest management project, and resources from the sales of carbon credits would be a very important component of the sustainable forest management operation.

Activities that are similar to those proposed by the Agrocortex REDD Project were only identified among those involved in REDD schemes or programs for the payment for ecosystem services, such as VCS REDD Projects and initiatives under the System of Incentives for Environmental Services (In Portuguese, *Sistema de Incentivos aos Serviços Ambientais* – SISA) run the by Government of Acre[181]. These initiatives cannot be considered *business as usual* and, therefore, should not be considered for the analysis of common practice.

Sustainable forest management in the project region has gained relevance in recent years. However, forest management does not involve additional measures to prevent deforestation and forest degradation as those developed by Agrocortex. Also, the certification of sustainable forest management practices according to good practice standards (such as the FSC) is still not common in the region. Hence, even private areas under sustainable forest management (as defined solely by legal requirements) cannot be considered a similar activity to the Agrocortex REDD Project. Table below provides information on existing FSC certified sustainable forest management plans in the State of Acre[182].

[180] REVISTA EXAME. **A exploração legal da floresta amazônica agoniza**. February 25th, 2013. Available at: <http://exame.abril.com.br/revista-exame/edicoes/1035/noticias/quando-a-lei-e-para-poucos>. Last visit on: April 10th, 2015.

[181] The ISA Carbon Program of Acre is the Jurisdictional REDD+ Program of the State of ACRE and is being developed as one component of the SISA. More information on the ISA Carbon Program of Acre is available at: <https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000005599>. Last visited on April, 12, 2017.

[182] Data sourced from: http://info.fsc.org/certificate.php. Last visited on April, 12, 2017.

Name	*FSC Certificate Code*	*FSC License code*	*Forest area*	*Type of Sustainable Forest Management*
Agrocortex Madeiras do Acre Agroflorestal Ltda.	*RA-FM/COC-007255*	*FSC-C121950*	*190,210*	*Business*
Associação de Moradores e Produtores da Reserva Extrativista Chico	*RA-FM/COC-007365*	*FSC-C111334*	*21,778*	*Community*
Assoc. Morad. e Produt. do Projeto Agroestrativista Chico Mendes - AMPPAECM	*RA-FM/COC-000181*	*FSC-C01125*	*12,187*	*Community*

Table 40. Valid FSC certified sustainable forest management in the State of Acre

As the table above demonstrates, Agrocortex has the only “business” sustainable forest management that is FSC certified. Other than Agrocortex, only community forest management exists in Acre. Business and community forest management are of a very different nature, as community forest management is usually performed by community associations that manage and harvest public forests and have access to incentives that are not available to commercial operations such as the one developed by Agrocortex.

Also, no FSC certified sustainable forest management areas are found in the Southwestern region of the State of Amazonas. Sustainable forest management areas certified according to other relevant certification standards (such as the CERFLOR, the Brazilian Program for Forest Certification) were not found in the project region[183].

Given the crucial differences between the Agrocortex REDD Project and similar projects in the area, , as described above, Project Proponents consider **the proposed VCS AFOLU project activity is not the baseline scenario, and hence it is additional.**

2.6 Methodology Deviations

Not applicable. The project does not have any methodology deviations.

[183] Information on CERFLOR certified areas is available at: < http://www.inmetro.gov.br/qualidade/pdf/empresas-cerflor.pdf>. Last visited on April, 12, 2017.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

The total average biomass stock per hectare (Mg ha^{-1}) was converted to tCO_2e using the following equations:

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

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

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

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:

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

Where,

$\Delta CBSLPAt$	Total baseline carbon stock changes in the project area at year *t*; tCO_2e
$\Delta CabBSLPA_{icl,\mathrm{t}}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e
$\Delta CbbBSLPA_{icl,\mathrm{t}}$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year *t*; tCO_2e

$$\Delta \boldsymbol{CabBSLPA}_{\boldsymbol{icl},\boldsymbol{t}} = \boldsymbol{ABSLPA}_{\boldsymbol{icl},\boldsymbol{t}} \times \Delta \boldsymbol{Cab}_{\boldsymbol{icl}}$$

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*; $tCO_2e\ ha^{-1}$

$$\Delta \boldsymbol{CbbBSLPA}_{\boldsymbol{icl},\boldsymbol{t}} = \boldsymbol{ABSLPA}_{\boldsymbol{icl},\boldsymbol{t}} \times \Delta \boldsymbol{Cbb}_{\boldsymbol{icl}}$$

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*; $tCO_2e\ ha^{-1}$

Carbon stocks

Project carbon stocks were calculated on the basis of biomass values from the study presented in Tables 41-43 below. An average of biomass values (above ground) from Salimon *et al.* (2011)[184] was utilized, which was a study conducted in the State of Acre that covered all the forest types in the State. The results from this study were also compared with Nogueira *et al.* (2008)[185] and Saatchi *et al.* (2007)[186], presenting very similar conclusions. The cited studies obtained these values via inventoried remote sensing, wood volumes and alometric equations, using data from Amazonian regions.

This data were chosen after a literature search revealed that those studies had the most accurate biomass values for the vegetation-cover of the Project's reference region. In addition, Salimon *et al.* (2011)'s estimates of the above-ground biomass within the Brazilian State of Acre were mainly based on a remote sensing methodology carried out by Saatchi *et al.* (2007) and Nogueira *et al.* (2008), through the utilization of sophisticated methods to estimate biomass through remote

[184] SALIMON,C.I; PUTZ, F.E.; MENEZES-FILHO, L.; ANDERSON,A.; SILVEIRA, M.; FOSTER BROWN, I.; OLIVEIRA, L.C. Estimating state-wide biomass carbon stocks for a REDD plan in Acre, Brazil. 2011, **Forest Ecology and Management**, 262, p. 555–560, 2011.

[185] 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. 2008. 151 f. Doctor Thesis - Curso de Ciências de Florestas Tropicais, INPA, Manaus, 2008.

[186] SAATCHI, S.S.; HOUGHTON, R.A., ALVALÁ, R.C.S.; SOARES J.V.; YU, Y. Distribution of aboveground live biomass in the amazon basin. **Global Change Biology**, v.13, p. 816-837, 2007

sensing. Those three literature estimates of the above-ground biomass presented very similar results for the State of Acre.

The average biomass stock per hectare was calculated for each project boundary (reference region, project area and leakage belt) and for each vegetation group using weighted average. More details can be found in Appendix II.

Below ground biomass values were estimated to be 24% of the above ground biomass, according to the applied methodology VM0015 v1.1 (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).

REFERENCE REGION			
Vegetation	Above-ground Biomass (Mg/ha)	Below-ground Biomass (Mg/ha)	Total biomass (Mg/ha)
Open tropical rainforest with bamboo	257.82	61.88	319.70
Open tropical rainforest with palm trees	245.98	59.04	305.01
Open alluvial rainforest with palm trees	218.50	52.44	270.94
Dense tropical rainforest	323.88	77.73	401.61
Secondary vegetation	37.00	7.40	44.40

Table 41. Biomass values used for the "forest" classes within the reference region

PROJECT AREA			
Vegetation	Above-ground Biomass (Mg/ha)	Below-ground Biomass (Mg/ha)	Total biomass (Mg/ha)
Open tropical rainforest with bamboo	274.20	65.81	340.01
Open tropical rainforest with palm trees	234.30	56.23	290.53
Open alluvial rainforest with palm trees	218.50	52.44	270.94

Table 42. Biomass values used for the "forest" classes within the project area

LEAKAGE BELT			
Vegetation	Above-ground Biomass (Mg/ha)	Below-ground Biomass (Mg/ha)	Total biomass (Mg/ha)
Open tropical rainforest with bamboo	256.59	61.58	318.17
Open tropical rainforest with palm trees	234.30	56.23	290.53
Open alluvial rainforest with palm trees	218.50	52.44	270.94
Secondary vegetation	37.00	7.40	44.40

Table 43. Biomass values used for the "forest" classes within the leakage belt

In order to convert biomass into carbon, and carbon into carbon-dioxide (see Tables 45-47), the conversion factors defined in Table 44 were used.

Conversion Factors	
Biomass to Carbon	0.5
C to CO_2	44/12

Table 44. Biomass to CO_2 conversion factors[187]

REFERENCE REGION			
Vegetation	Aboveground biomass Cab_{icl} (tCO_2e/ha)	Belowground biomass Cbb_{icl} (tCO_2e/ha)	Total $Ctot_{icl}$ (tCO_2e/ha)
Open tropical rainforest with bamboo	472.67	113.44	586.12
Open tropical rainforest with palm trees	450.96	108.23	559.19
Open alluvial rainforest with palm trees	400.58	80.12	480.70
Dense tropical rainforest	593.79	142.51	736.29
Secondary vegetation	67.83	13.57	81.40

Table 45. Average CO_2 per hectare of initial forest classes *icl* existing in the reference region

PROJECT AREA			
Vegetation	Aboveground biomass Cab_{icl} (tCO_2e/ha)	Belowground biomass Cbb_{icl} (tCO_2e/ha)	Total $Ctot_{icl}$ (tCO_2e/ha)
Open tropical rainforest with bamboo	502.70	120.65	623.35
Open tropical rainforest with palm trees	429.55	103.09	532.64
Open alluvial rainforest with palm trees	400.58	80.12	480.70

Table 46. Average CO_2 per hectare of initial forest classes *icl* existing in the project area

LEAKAGE BELT			
Vegetation	Aboveground biomass Cab_{icl} (tCO_2e/ha)	Belowground biomass Cbb_{icl} (tCO_2e/ha)	Total $Ctot_{icl}$ (tCO_2e/ha)
Open tropical rainforest with bamboo	470.41	112.90	583.31
Open tropical rainforest with palm trees	429.55	103.09	532.64
Open alluvial rainforest with palm trees	400.58	80.12	480.70
Secondary vegetation	67.83	13.57	81.40

Table 47. Average CO_2 per hectare of initial forest classes *icl* existing in the leakage belt

[187] 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

Average carbon stocks of post-deforestation classes

Fearnside (1996)[188] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post-deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO_2e/ha. It is important to note that no sampling was applied to calculate this data.

Post deforestation class *fcl*	
Name	Non forest
ID_{fcl}	1
$Ctot_{fcl}$	
tCO_2e/ha	
46.93	

Table 48. Long-term (20-years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

The use of this value for non-forest vegetation carbon stocks in equilibrium is conservative because Fearnside (1996) considered that around 45% of deforested areas would be secondary forest from pasture, which has a biomass stock of around 50.5 tons/ha. Actually, secondary forests are accounted for over one-third of the total deforested area in the Legal Amazon by 2008. However, the intensive land use system established in the project region, where deforestation rates were above the average found in the whole Amazon biome in the last decade, results in a high decrease of secondary forests[189].

Uncertainty assessment

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

Salimon *et al.* (2011) present uncertainties as one standard deviation of the mean. Thus, confidence interval of this method was around 68.27%. This was converted to a confidence interval of 90% by multiplying the standard deviation by the value of 1.64[190].

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

[188] FEARNSIDE, Philip M.. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996. Available at: <http://www1.uwindsor.ca/ees/system/files/Reference 4 - Amazonian deforestation and global warming- carbon stocks in.pdf>. Last visit on: April 13th. 2015.

[189] MASSOCA, P. E. S. et al. Dinâmica espaço-temporal da vegetação secundária no município de Apuí (AM). In: XVI SIMPÓSIO BRASILEIRO DE SENSORIAMENTO REMOTO - SBSR, 1., 2013, Foz do Iguaçu. **Anais...** . Manaus: Instituto Nacional de Pesquisas da Amazônia - Inpa, 2013. p. 7639 - 7646.

[190] SOUZA, A. M. Intervalos de Confiança. Departamento de Estatística - PPGEMQ / PPGEP – UFSM. 2008. Available at: <http://w3.ufsm.br/adriano/aulas/ic/tintconf.pdf>. Last visited on: 12-March-2018.

Initial forest class *icl*																								
Boundaries	Average carbon stock 90% CI																							
	Name	Open tropical rainforest with bamboo					Name	Open tropical rainforest with palm trees					Name	Open alluvial rainforest with palm trees					Name	Secondary vegetation				
	ID_{icl}	1					ID_{icl}	2					ID_{icl}	3					ID_{icl}	5				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI
	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e/ ha	tCO2e /ha	tCO2e /ha	tCO2e /ha
Project Area	502.70	45.23	120.65	10.85	623.35	56.08	429.55	211.09	103.09	50.66	532.64	261.75	400.58	45.23	80.12	10.85	480.70	56.08	-	-	-	-	-	-
Leakage Belt	470.41	64.42	112.90	15.46	583.31	79.87	429.55	211.09	103.09	50.66	532.64	261.75	400.58	45.23	80.12	10.85	480.70	56.08	67.83	30.16	13.57	6.03	81.40	36.19

Table 49. 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	Open alluvial rainforest with bamboo					Name	Open tropical rainforest with palm trees					Name	Open alluvial rainforest with palm trees					Name	Secondary vegetation				
	ID_{icl}	1					ID_{icl}	2					ID_{icl}	3					ID_{icl}	5				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock chang	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock chang
	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e/h a	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2 e/ha	tCO2 e/ha	tCO2e/ ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2e /ha	tCO2 e/ha	tCO2 e/ha
Project Area	502.70	502.70	120.65	120.65	623.35	623.35	429.55	218.46	103.09	52.43	532.6	270.89	400.58	355.36	80.12	69.26	480.70	424.62	-	-	-	-	-	-
Leakage Belt	470.41	534.83	112.90	128.36	583.31	663.19	429.55	640.64	103.09	153.75	532.6	794.39	400.58	445.81	80.12	90.97	480.70	536.78	67.83	97.99	13.57	19.60	81.40	117.59

Table 50. Carbon stocks per hectare of initial forest classes *icl* existing in the project area and leakage belt after discounts for uncertainties

Carbon stock change factors

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

a) Above-ground biomass:

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

b) Below-ground biomass:

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

As such, Tables 51 – 57 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 in various classes and pools.

Year after deforestation		$\Delta Cab_{icl,t}$ (tCO_2e/ha)				
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees	Dense tropical rainforest	Secondary vegetation
1	t*	-472.67	-450.96	-400.58	-593.79	-67.83
2	t*+1	0	0	0	0	0
3	t*+2	0	0	0	0	0
4	t*+3	0	0	0	0	0
5	t*+4	0	0	0	0	0
6	t*+5	0	0	0	0	0
7	t*+6	0	0	0	0	0
8	t*+7	0	0	0	0	0
9	t*+8	0	0	0	0	0
10	t*+9	0	0	0	0	0
11	t*+10	0	0	0	0	0
12	t*+11	0	0	0	0	0
13	t*+12	0	0	0	0	0
14	t*+13	0	0	0	0	0
15	t*+14	0	0	0	0	0

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

Table 51. Carbon stock change factors for initial forest classes (*icl*) in the reference region, above-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cbb_{icl,t}$ (tCO_2e/ha)				
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees	Dense tropical rainforest	Secondary vegetation
1	t*	-11.34	-10.82	-8.01	-14.25	-1.36
2	t*+1	-11.34	-10.82	-8.01	-14.25	-1.36
3	t*+2	-11.34	-10.82	-8.01	-14.25	-1.36
4	t*+3	-11.34	-10.82	-8.01	-14.25	-1.36
5	t*+4	-11.34	-10.82	-8.01	-14.25	-1.36
6	t*+5	-11.34	-10.82	-8.01	-14.25	-1.36
7	t*+6	-11.34	-10.82	-8.01	-14.25	-1.36
8	t*+7	-11.34	-10.82	-8.01	-14.25	-1.36
9	t*+8	-11.34	-10.82	-8.01	-14.25	-1.36
10	t*+9	-11.34	-10.82	-8.01	-14.25	-1.36
11	t*+10	0	0	0	0	0
12	t*+11	0	0	0	0	0
13	t*+12	0	0	0	0	0
14	t*+13	0	0	0	0	0
15	t*+14	0	0	0	0	0
16	t*+15	0	0	0	0	0
17	t*+16	0	0	0	0	0
18	t*+17	0	0	0	0	0
19	t*+18	0	0	0	0	0
20	t*+19	0	0	0	0	0
21-T	t*+20...	0	0	0	0	0

Table 52. Carbon stock change factors for initial forest classes (*icl*) in the reference region, below-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cab_{icl,t}$ (tCO_2e/ha)		
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees
1	t*	-502.70	-218.46	-355.36
2	t*+1	0	0	0
3	t*+2	0	0	0
4	t*+3	0	0	0
5	t*+4	0	0	0
6	t*+5	0	0	0
7	t*+6	0	0	0
8	t*+7	0	0	0
9	t*+8	0	0	0
10	t*+9	0	0	0
11	t*+10	0	0	0
12	t*+11	0	0	0
13	t*+12	0	0	0
14	t*+13	0	0	0
15	t*+14	0	0	0
16	t*+15	0	0	0
17	t*+16	0	0	0
18	t*+17	0	0	0
19	t*+18	0	0	0
20	t*+19	0	0	0
21-T	t*+20...	0	0	0

Table 53. Carbon stock change factors for initial forest classes (*icl*) in the project area, above-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cbb_{icl,t}$ (tCO_2e/ha)		
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees
1	t*	-12.06	-5.24	-6.93
2	t*+1	-12.06	-5.24	-6.93
3	t*+2	-12.06	-5.24	-6.93
4	t*+3	-12.06	-5.24	-6.93
5	t*+4	-12.06	-5.24	-6.93
6	t*+5	-12.06	-5.24	-6.93
7	t*+6	-12.06	-5.24	-6.93
8	t*+7	-12.06	-5.24	-6.93
9	t*+8	-12.06	-5.24	-6.93

Year after deforestation		$\Delta Cbb_{icl,t}$ (tCO_2e/ha)		
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees
10	t*+9	-12.06	-5.24	-6.93
11	t*+10	0	0	0
12	t*+11	0	0	0
13	t*+12	0	0	0
14	t*+13	0	0	0
15	t*+14	0	0	0
16	t*+15	0	0	0
17	t*+16	0	0	0
18	t*+17	0	0	0
19	t*+18	0	0	0
20	t*+19	0	0	0
21-T	t*+20...	0	0	0

Table 54. Carbon stock change factors for initial forest classes (*icl*) in the project area, below-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cab_{icl,t}$ (tCO_2e/ha)			
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees	Secondary vegetation
1	t*	-534.83	-640.64	-445.81	-97.99
2	t*+1	0	0	0	0
3	t*+2	0	0	0	0
4	t*+3	0	0	0	0
5	t*+4	0	0	0	0
6	t*+5	0	0	0	0
7	t*+6	0	0	0	0
8	t*+7	0	0	0	0
9	t*+8	0	0	0	0
10	t*+9	0	0	0	0
11	t*+10	0	0	0	0
12	t*+11	0	0	0	0
13	t*+12	0	0	0	0
14	t*+13	0	0	0	0
15	t*+14	0	0	0	0
16	t*+15	0	0	0	0
17	t*+16	0	0	0	0
18	t*+17	0	0	0	0

19	t*+18	0	0	0	0
20	t*+19	0	0	0	0
21-T	t*+20...	0	0	0	0

Table 55. Carbon stock change factors for initial forest classes (*icl*) in the leakage belt, above-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cbb_{icl,t}$ (tCO_2e/ha)			
		Open tropical rainforest with bamboo	Open tropical rainforest with palm trees	Open alluvial rainforest with palm trees	Secondary vegetation
1	t*	-12.84	-15.38	-9.10	-1.96
2	t*+1	-12.84	-15.38	-9.10	-1.96
3	t*+2	-12.84	-15.38	-9.10	-1.96
4	t*+3	-12.84	-15.38	-9.10	-1.96
5	t*+4	-12.84	-15.38	-9.10	-1.96
6	t*+5	-12.84	-15.38	-9.10	-1.96
7	t*+6	-12.84	-15.38	-9.10	-1.96
8	t*+7	-12.84	-15.38	-9.10	-1.96
9	t*+8	-12.84	-15.38	-9.10	-1.96
10	t*+9	-12.84	-15.38	-9.10	-1.96
11	t*+10	0	0	0	0
12	t*+11	0	0	0	0
13	t*+12	0	0	0	0
14	t*+13	0	0	0	0
15	t*+14	0	0	0	0
16	t*+15	0	0	0	0
17	t*+16	0	0	0	0
18	t*+17	0	0	0	0
19	t*+18	0	0	0	0
20	t*+19	0	0	0	0
21-T	t*+20...	0	0	0	0

Table 56. Carbon stock change factors for initial forest classes (*icl*) in the leakage belt, below-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/ha)
1	t*	0
2	t*+1	+4.69
3	t*+2	+4.69
4	t*+3	+4.69
5	t*+4	+4.69
6	t*+5	+4.69
7	t*+6	+4.69
8	t*+7	+4.69
9	t*+8	+4.69
10	t*+9	+4.69
11	t*+10	+4.69

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/ha)
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

Table 57. Carbon stock change factors for final classes (*fcl*) (Method 1)

Illegal logging activities are present in the baseline scenario, thus the significance of this activity shall be estimated and, if deemed significant, it must be accounted. In the baseline scenario, it is considered that wood products would result from the logging of trees species with high commercial value, as most of remaining trees would be burned for the conversion of forest into pasture land.

According to the forest inventory carried out during the elaboration of the Agrocortex's Sustainable Forest Management Plan, there is an average of 13.35 m³/ha of trees with commercial value in the Project Area[191]. Considering illegal loggers would not preserve remaining trees as required by the minimum limit of preservation of 10-20% (depending on tree species), the average logging rate for illegal logging would be equal to 16 m³/ha. Converting this value to GHG emissions, the average reduction in carbon stocks due to illegal logging would be of 17.12 tCO2e/ha.

The significance of this activity was calculated by comparing the illegal logging rate with the average carbon stock of forests within the project area. The considered forest type in this analysis was the Open tropical rainforest with bamboo, which is present in more than 93% of the project area[192]. This comparison allowed Project Proponents to conclude that only 2.7% of carbon stocks in the Project Area would result in long term wood products[193], which is below the significance level established by the Methodology VM0015 v1.1 (defined as 5%).

Therefore, harvested wood product carbon pool in the baseline scenario is not significant. According to the applied methodology, this parameter does not need to be accounted for, and *ex post* monitoring will not be required.

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 58 – 60 below.

[191] The Forest inventory indicates the existence of 64,946m³ of trees with high commercial value in an area of 4,863.8 ha.
[192] The open tropical rainforest with bamboo forest class is the most common forest class (93%) among all forest types within the project area.
[193] Only 17.12 tCO2e/ha of a total of 623.35 tCO2e/ha (or 2.7%) would produce long term would products.

Carbon stock change in the above-ground biomass per initial forest class *icl*						Total carbon stock change in the above-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	Dense Tropical forest	Second veget	annual	cumulat.
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	212,086	59,997	9,577	0	105,229	386,889	386,889
2015	560,443	34,088	47,867	0	27,793	670,192	1,057,081
2016	3,726,117	328,456	160,196	0	0	4,214,768	5,271,848
2017	3,890,453	287,681	301,656	0	131	4,479,922	9,751,770
2018	3,636,153	333,855	320,365	0	0	4,290,373	14,042,143
2019	4,252,919	348,696	439,105	0	0	5,040,720	19,082,863
2020	4,290,970	505,257	40,429	0	0	4,836,656	23,919,520
2021	4,693,579	396,445	298,414	0	332	5,388,769	29,308,289
2022	4,105,281	396,328	236,304	0	119	4,738,032	34,046,321
2023	4,556,297	378,200	242,125	0	0	5,176,623	39,222,944
2024	4,506,017	345,889	316,584	0	0	5,168,490	44,391,434
2025	4,839,137	410,931	291,966	0	106	5,542,140	49,933,574
2026	3,489,234	203,224	41,993	0	42,782	3,777,232	53,710,806
2027	2,401,216	210,724	95,771	0	43,741	2,751,452	56,462,258
2028	3,173,197	324,040	476,369	0	119	3,973,725	60,435,983
2029	2,522,452	207,903	240,393	0	1,974	2,972,722	63,408,705
2030	2,996,075	313,002	340,865	0	19,946	3,669,888	67,078,593
2031	2,888,461	354,957	430,206	0	0	3,673,624	70,752,217
2032	3,151,400	71,151	293,979	0	22,662	3,539,192	74,291,409
2033	3,393,870	202,338	313,793	0	5,173	3,915,174	78,206,584
2034	3,786,692	240,402	199,267	0	23,656	4,250,018	82,456,602
2035	3,082,652	148,373	317,490	0	72,651	3,621,167	86,077,768
2036	2,378,308	457,117	413,653	0	14,934	3,264,012	89,341,780
2037	3,717,213	583,804	208,356	0	16,962	4,526,335	93,868,116
2038	3,141,687	358,327	260,009	0	42,826	3,802,849	97,670,964
2039	3,419,407	285,458	80,755	0	27,669	3,813,289	101,484,254
2040	3,342,675	323,859	203,503	0	12,990	3,883,028	105,367,281
2041	3,853,139	348,372	210,761	0	8,529	4,420,801	109,788,082
2042	3,269,919	384,262	218,105	0	5,667	3,877,954	113,666,036
2043	3,370,681	369,606	250,704	0	5,627	3,996,617	117,662,653
2044	2,905,304	345,964	286,173	0	0	3,537,441	121,200,094

Carbon stock change in the below-ground biomass per initial forest class *icl*						Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	Dense Tropical forest	Second veget	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	5,090	1,440	192	0	2,105	8,826	8,826
2015	18,541	2,258	1,149	0	2,660	24,608	33,434
2016	107,968	10,141	4,353	0	2,660	125,122	158,556
2017	201,338	17,045	10,386	0	2,663	231,433	389,989
2018	288,606	25,058	16,793	0	2,663	333,120	723,109
2019	390,676	33,427	25,575	0	2,663	452,341	1,175,450
2020	493,659	45,553	26,384	0	2,663	568,259	1,743,709
2021	606,305	55,067	32,352	0	2,670	696,395	2,440,103
2022	704,832	64,579	37,078	0	2,672	809,162	3,249,265
2023	814,183	73,656	41,921	0	2,672	932,432	4,181,697
2024	917,238	80,517	48,061	0	567	1,046,383	5,228,081
2025	1,019,926	89,562	52,943	0	14	1,162,445	6,390,525
2026	1,014,241	86,556	50,579	0	869	1,152,245	7,542,770
2027	978,499	84,709	46,461	0	1,742	1,111,411	8,654,182
2028	967,388	84,474	49,581	0	1,744	1,103,187	9,757,369
2029	925,857	81,095	45,607	0	1,783	1,054,342	10,811,711
2030	894,780	76,480	51,616	0	2,182	1,025,058	11,836,769
2031	851,457	75,485	54,252	0	2,176	983,369	12,820,138
2032	828,564	67,681	55,405	0	2,627	954,276	13,774,414
2033	800,665	63,460	56,838	0	2,730	923,694	14,698,107
2034	783,402	60,928	54,492	0	3,203	902,025	15,600,132
2035	741,246	54,627	55,003	0	4,654	855,529	16,455,662
2036	714,584	60,720	62,436	0	4,097	841,837	17,297,498
2037	746,168	69,674	64,687	0	3,562	884,091	18,181,589
2038	745,411	70,497	60,360	0	4,416	880,684	19,062,274
2039	766,938	72,358	57,167	0	4,930	901,394	19,963,667
2040	775,257	72,619	54,420	0	4,790	907,086	20,870,754
2041	798,409	72,461	50,031	0	4,961	925,862	21,796,616
2042	801,254	79,975	48,514	0	4,621	934,364	22,730,980
2043	800,697	83,990	47,252	0	4,630	936,569	23,667,549
2044	779,544	86,523	48,990	0	4,157	919,214	24,586,764

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	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e
2014	0	0	0
2015	10,123	10,123	10,123
2016	18,527	18,527	28,650
2017	60,820	60,820	89,469
2018	105,987	105,987	195,456
2019	149,319	149,319	344,775
2020	200,322	200,322	545,097
2021	248,660	248,660	793,757
2022	302,909	302,909	1,096,666
2023	350,574	350,574	1,447,240
2024	402,588	402,588	1,849,828
2025	444,515	444,515	2,294,343
2026	491,866	491,866	2,786,209
2027	489,786	489,786	3,275,994
2028	474,803	474,803	3,750,797
2029	471,940	471,940	4,222,737
2030	451,100	451,100	4,673,837
2031	441,142	441,142	5,114,979
2032	424,308	424,308	5,539,287
2033	413,688	413,688	5,952,975
2034	401,513	401,513	6,354,488
2035	393,535	393,535	6,748,023
2036	378,680	378,680	7,126,703
2037	372,719	372,719	7,499,422
2038	389,135	389,135	7,888,558
2039	389,599	389,599	8,278,157
2040	399,220	399,220	8,677,377
2041	400,684	400,684	9,078,061
2042	408,213	408,213	9,486,274
2043	410,584	410,584	9,896,858
2044	411,387	411,387	10,308,245

Total net carbon stock change in the reference region	
$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
annual	cumulat
tCO_2e	tCO_2e
395,715	395,715
684,677	1,080,392
4,321,363	5,401,755
4,650,535	10,052,289
4,517,507	14,569,796
5,343,742	19,913,538
5,204,594	25,118,132
5,836,504	30,954,636
5,244,284	36,198,920
5,758,481	41,957,401
5,812,286	47,769,687
6,260,069	54,029,756
4,437,612	58,467,368
3,373,078	61,840,446
4,602,109	66,442,555
3,555,125	69,997,679
4,243,846	74,241,525
4,215,851	78,457,376
4,069,160	82,526,536
4,425,180	86,951,716
4,750,530	91,702,246
4,083,161	95,785,407
3,727,169	99,512,576
5,037,707	104,550,282
4,294,398	108,844,680
4,325,084	113,169,764
4,390,894	117,560,658
4,945,979	122,506,637
4,404,105	126,910,742
4,522,603	131,433,344
4,045,269	135,478,613

Table 58. 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 project area	
ID_{cl}	1	2	3	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	215,486	29,065	8,493	253,044	253,044
2015	515,190	12,179	0	527,369	780,413
2016	505,881	15,148	0	521,029	1,301,442
2017	501,731	12,338	0	514,069	1,815,512
2018	604,871	20,540	0	625,411	2,440,923
2019	534,201	15,859	0	550,060	2,990,983
2020	477,020	10,267	0	487,287	3,478,270
2021	565,738	15,834	0	581,572	4,059,842
2022	518,100	5,515	0	523,616	4,583,457
2023	569,234	1,290	0	570,524	5,153,982
2024	381,493	0	0	381,493	5,535,474
2025	520,770	0	0	520,770	6,056,244
2026	522,421	0	0	522,421	6,578,665
2027	526,133	2,132	387	528,652	7,107,318
2028	559,835	0	0	559,835	7,667,153
2029	540,977	0	0	540,977	8,208,130
2030	546,372	0	0	546,372	8,754,502
2031	522,421	0	0	522,421	9,276,923
2032	522,421	0	0	522,421	9,799,344
2033	480,627	0	0	480,627	10,279,972
2034	564,215	0	8,017	572,232	10,852,203
2035	562,617	0	0	562,617	11,414,820
2036	480,627	0	0	480,627	11,895,447
2037	584,098	30,310	0	614,408	12,509,855
2038	549,124	28,480	0	577,603	13,087,458
2039	547,250	18,233	0	565,483	13,652,941
2040	509,605	27,417	0	537,022	14,189,963
2041	454,740	29,746	0	484,486	14,674,449
2042	455,315	35,034	0	490,349	15,164,798
2043	647,338	27,344	0	674,683	15,839,481
2044	424,788	56,194	0	480,982	16,320,463

Carbon stock change in the below-ground biomass per initial forest class *icl*				Total carbon stock change in the below-ground biomass of initial forest class in the project area	
ID_{cl}	1	2	3	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	5,172	698	166	6,035	6,035
2015	17,536	990	166	18,692	24,726
2016	29,677	1,353	166	31,196	55,923
2017	41,719	1,650	166	43,534	99,457
2018	56,236	2,142	166	58,544	158,001
2019	69,057	2,523	166	71,745	229,746
2020	80,505	2,770	166	83,440	313,186
2021	94,083	3,150	166	97,398	410,584
2022	106,517	3,282	166	109,965	520,549
2023	120,179	3,313	166	123,657	644,206
2024	124,163	2,615	0	126,778	770,984
2025	124,297	2,323	0	126,620	897,604
2026	124,694	1,959	0	126,653	1,024,257
2027	125,280	1,715	8	127,002	1,151,259
2028	124,199	1,222	8	125,428	1,276,687
2029	124,361	841	8	125,210	1,401,897
2030	126,026	595	8	126,628	1,528,524
2031	124,986	215	8	125,208	1,653,733
2032	125,090	82	8	125,180	1,778,912
2033	122,963	51	8	123,022	1,901,934
2034	127,349	51	164	127,564	2,029,498
2035	128,353	51	164	128,568	2,158,066
2036	127,350	51	164	127,565	2,285,631
2037	128,741	727	156	129,625	2,415,255
2038	128,484	1,411	156	130,051	2,545,307
2039	128,635	1,849	156	130,639	2,675,946
2040	127,752	2,507	156	130,415	2,806,361
2041	126,128	3,220	156	129,504	2,935,865
2042	124,517	4,061	156	128,735	3,064,600
2043	128,518	4,718	156	133,392	3,197,992
2044	125,172	6,066	0	131,238	3,329,230

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	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e
2014	0	0	0
2015	2,748	2,748	2,748
2016	7,820	7,820	10,568
2017	12,868	12,868	23,437
2018	17,818	17,818	41,255
2019	23,906	23,906	65,161
2020	29,235	29,235	94,396
2021	33,909	33,909	128,304
2022	39,531	39,531	167,835
2023	44,486	44,486	212,321
2024	49,829	49,829	262,150
2025	50,642	50,642	312,792
2026	50,432	50,432	363,224
2027	50,261	50,261	413,485
2028	50,275	50,275	463,760
2029	49,413	49,413	513,173
2030	49,136	49,136	562,309
2031	49,563	49,563	611,872
2032	48,818	48,818	660,690
2033	48,740	48,740	709,430
2034	47,885	47,885	757,314
2035	49,697	49,697	807,011
2036	50,087	50,087	857,099
2037	49,697	49,697	906,796
2038	50,839	50,839	957,635
2039	51,351	51,351	1,008,985
2040	51,801	51,801	1,060,786
2041	52,047	52,047	1,112,832
2042	52,054	52,054	1,164,886
2043	52,180	52,180	1,217,066
2044	54,324	54,324	1,271,390

Total net carbon stock change in the project area	
$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
annual	cumulat
tCO_2e	tCO_2e
259,079	259,079
543,312	802,391
544,405	1,346,796
544,735	1,891,531
666,137	2,557,668
597,899	3,155,568
541,493	3,697,060
645,061	4,342,121
594,050	4,936,171
649,695	5,585,866
458,442	6,044,309
596,748	6,641,057
598,642	7,239,699
605,393	7,845,092
634,988	8,480,080
616,774	9,096,853
623,864	9,720,717
598,067	10,318,784
598,783	10,917,567
554,910	11,472,476
651,910	12,124,387
641,488	12,765,874
558,105	13,323,979
694,335	14,018,314
656,816	14,675,130
644,772	15,319,902
615,636	15,935,538
561,944	16,497,482
567,030	17,064,512
755,895	17,820,407
557,896	18,378,303

Table 59. 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 leakage belt	
ID_{cl}	1	2	3	5	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	Second veget	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	27,005	11,676	428,840	26,673	494,194	494,194
2015	37,176	2,843	38,828	21,821	100,667	594,861
2016	175,633	995	191,431	0	368,060	962,921
2017	414,219	228,564	334,974	190	977,948	1,940,868
2018	1,610,234	199,105	356,228	0	2,165,568	4,106,436
2019	3,544,200	312,070	453,977	0	4,310,246	8,416,682
2020	2,513,266	0	80,008	0	2,593,274	11,009,956
2021	609,612	513	332,107	0	942,231	11,952,187
2022	610,522	1,799	262,984	0	875,305	12,827,492
2023	793,639	701	269,382	0	1,063,721	13,891,213
2024	1,588,767	890	352,021	0	1,941,678	15,832,891
2025	745,506	19,527	293,271	104	1,058,408	16,891,299
2026	1,232,858	0	43,688	59,886	1,336,432	18,227,731
2027	1,060,685	291,134	147,512	63,189	1,562,520	19,790,251
2028	75,244	275,288	488,918	123	839,573	20,629,824
2029	0	249,930	141,691	0	391,622	21,021,445
2030	450,760	0	379,351	695	830,805	21,852,251
2031	1,485,633	0	192,406	0	1,678,039	23,530,290
2032	413,289	2,451	327,171	23,362	766,272	24,296,562
2033	916,279	0	349,222	4,552	1,270,053	25,566,615
2034	1,309,649	0	151,020	17,210	1,477,878	27,044,493
2035	294,901	0	353,337	97,816	746,054	27,790,547
2036	584,383	0	74,866	0	659,249	28,449,796
2037	0	0	143,690	0	143,690	28,593,486
2038	708,004	0	289,365	61,814	1,059,183	29,652,669
2039	1,582,160	0	21,493	10,038	1,613,691	31,266,360
2040	481,441	0	226,480	18,765	726,687	31,993,047
2041	159,806	0	234,557	12,321	406,684	32,399,731
2042	138,919	0	17,527	0	156,446	32,556,176
2043	324,391	0	121,652	5,233	451,275	33,007,452
2044	1,229,175	0	318,483	0	1,547,658	34,555,110

Carbon stock change in the below-ground biomass per initial forest class *icl*					Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	2	3	5	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Open Tropical forest with bamboo	Open Tropical forest with palm trees	Open Alluvial forest with palm trees	Secon veget	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	648	280	8,751	533	10,213	10,213
2015	1,540	348	9,543	970	12,402	22,614
2016	5,756	372	13,449	970	20,547	43,162
2017	15,697	5,858	20,285	974	42,813	85,975
2018	54,342	10,636	27,554	974	93,506	179,481
2019	139,403	18,126	36,818	974	195,321	374,802
2020	199,722	18,126	38,450	974	257,272	632,074
2021	214,352	18,138	45,227	974	278,692	910,765
2022	229,005	18,182	50,594	974	298,754	1,209,519
2023	248,052	18,198	56,091	974	323,315	1,532,834
2024	285,534	17,939	54,523	440	358,437	1,891,271
2025	302,534	18,340	59,715	6	380,595	2,271,866
2026	327,908	18,316	56,700	1,204	404,128	2,675,994
2027	343,423	19,818	52,875	2,464	418,579	3,094,574
2028	306,583	21,646	55,583	2,466	386,278	3,480,852
2029	221,522	20,155	49,210	2,466	293,353	3,774,205
2030	172,022	20,155	55,319	2,480	249,975	4,024,180
2031	193,047	20,142	52,468	2,480	268,137	4,292,317
2032	188,313	20,158	53,778	2,947	265,196	4,557,514
2033	191,257	20,141	55,407	3,038	269,843	4,827,356
2034	184,558	20,120	51,305	3,382	259,365	5,086,722
2035	173,743	19,651	52,531	5,337	251,262	5,337,984
2036	158,180	19,651	53,167	4,139	235,137	5,573,121
2037	132,723	12,664	53,089	2,875	201,352	5,774,473
2038	147,910	6,057	49,017	4,109	207,093	5,981,565
2039	185,881	59	46,564	4,310	236,814	6,218,380
2040	186,618	59	43,445	4,671	234,793	6,453,172
2041	154,798	59	44,305	4,918	204,079	6,657,252
2042	148,213	0	37,987	4,450	190,650	6,847,902
2043	134,008	0	33,343	4,464	171,814	7,019,716
2044	132,076	0	36,760	4,120	172,956	7,192,672

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_{lz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulat
Project year	tCO_2e	tCO_2e	tCO_2e
2014	0	0	0
2015	6,115	6,115	6,115
2016	7,916	7,916	14,030
2017	11,479	11,479	25,510
2018	20,324	20,324	45,834
2019	39,664	39,664	85,498
2020	77,831	77,831	163,329
2021	100,728	100,728	264,057
2022	109,578	109,578	373,635
2023	117,717	117,717	491,352
2024	127,523	127,523	618,874
2025	139,062	139,062	757,936
2026	147,039	147,039	904,975
2027	157,622	157,622	1,062,598
2028	164,797	164,797	1,227,395
2029	153,288	153,288	1,380,683
2030	118,444	118,444	1,499,127
2031	103,529	103,529	1,602,656
2032	109,742	109,742	1,712,398
2033	109,811	109,811	1,822,208
2034	111,940	111,940	1,934,148
2035	108,192	108,192	2,042,341
2036	109,407	109,407	2,151,748
2037	101,177	101,177	2,252,925
2038	86,669	86,669	2,339,594
2039	91,059	91,059	2,430,654
2040	102,328	102,328	2,532,981
2041	101,853	101,853	2,634,834
2042	91,252	91,252	2,726,087
2043	84,448	84,448	2,810,535
2044	76,891	76,891	2,887,425

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulat
tCO_2e	tCO_2e
504,406	504,406
106,954	611,361
380,691	992,052
1,009,281	2,001,334
2,238,750	4,240,083
4,465,903	8,705,986
2,772,715	11,478,701
1,120,195	12,598,896
1,064,481	13,663,377
1,269,319	14,932,695
2,172,592	17,105,288
1,299,941	18,405,229
1,593,521	19,998,750
1,823,477	21,822,227
1,061,054	22,883,281
531,687	23,414,967
962,337	24,377,304
1,842,647	26,219,952
921,726	27,141,678
1,430,085	28,571,763
1,625,303	30,197,066
889,124	31,086,190
784,979	31,871,169
243,865	32,115,034
1,179,606	33,294,640
1,759,446	35,054,086
859,152	35,913,238
508,910	36,422,148
255,843	36,677,991
538,642	37,216,633
1,643,724	38,860,357

Table 60. Baseline carbon stock change in the leakage belt

Baseline non-CO_2 emissions from forest fires

Non-CO_2 emissions from fires used to clear forests in the baseline scenario were omitted in this project. Therefore, $EBBBSLPA_t$ equals to zero.

3.2 Project Emissions

***Ex ante* estimation of actual carbon stock changes due to planned activities**

The FSC-certified sustainable forest management plan implemented by Agrocortex in 2014 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[194], and timber yards in each annual production unit – APU (*Unidade de Produção Anual*, in portuguese) within the project area, estimated to be around 1% of each APU. According to the sustainable forest management plan[195], 175,707.55 ha (92.4% of total property area) are subject to SFMP. The adopted rotation cycle is 30 years, thus each annual productive unit (APU) has around 5,856.9 hectares.

The location of areas to be protected and the allocation of infrastructures within each APU are planned based on an aerial survey, such as the Light Detection and Ranging (LIDAR) tool, which has a high-resolution of 1.5m. These data allow generating the Digital Terrain Model and the Digital Drainage Model. From these models, it is possible to generate level curves and to identify PPAs according to legislation. With the aforementioned models and the spatial distribution of the selected trees for cutting, Agrocortex plans the infrastructure construction in each APU within the project area, such as opening of main and secondary roads, skidding trails, and timber yards.

The construction of the infrastructure is carried out in accordance with techniques provided by the Tropical Forest Institute (*Instituto Floresta Tropical* - IFT), an NGO that promotes the adoption of

[194] According to the SFMP implemented by Agrocortex, 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 FSC-certified SFMP implemented by Agrocortex 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.
[195] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

good practices sustainable in forest management plans, contributing to the conservation of natural resources and improving the life quality of the population[196].

The location of each APU and protection areas within the Agrocortex property area, which will be subject to planned deforestation and planned logging activities during the project crediting period, is detailed in the Figure 72 below.

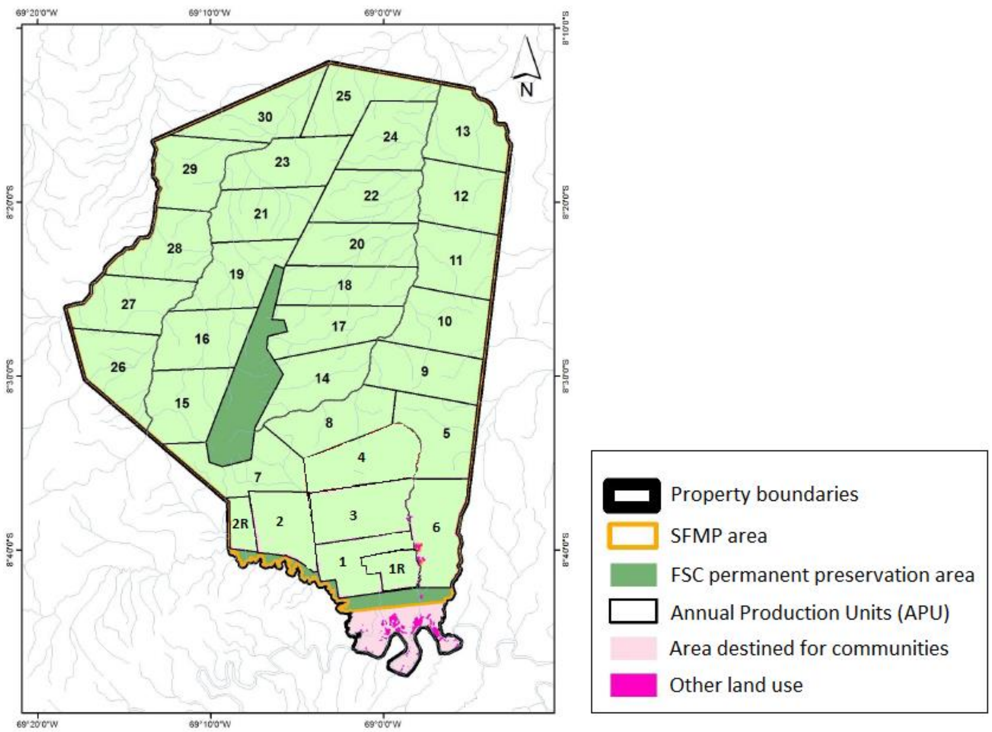

Figure 72. Location of each APU within the Sustainable Forest Management Plan area

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

[196] Available at: <http://ift.org.br/>. Last visited on: April 26th, 2017

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 Open tropical rainforest with bamboo		ID_{cl} = 2 Open tropical rainforest with palm trees		ID_{cl} = 3 Open alluvial rainforest with palm trees		annual	cumulative
	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$
	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e
2014	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	35,179.47
2015	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	70,358.94
2016	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	105,538.41
2017	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	140,717.88
2018	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	175,897.35
2019	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	211,076.82
2020	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	246,256.29
2021	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	281,435.76
2022	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	316,615.23
2023	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	351,794.70
2024	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	386,974.17
2025	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	422,153.64
2026	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	457,333.11
2027	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	492,512.58
2028	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	527,692.05
2029	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	562,871.52
2030	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	598,050.99
2031	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	633,230.46
2032	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	668,409.93
2033	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	703,589.40
2034	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	738,768.87
2035	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	773,948.34
2036	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	809,127.81
2037	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	844,307.28
2038	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	879,486.75
2039	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	914,666.22
2040	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	949,845.69
2041	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	985,025.16
2042	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	1,020,204.63
2043	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	1,055,384.10
2044	54.24	623.35	3.05	270.89	1.29	424.62	35,179.47	1,090,563.57

Table 61. *Ex ante* estimated actual carbon stock decrease due to planned deforestation in the project area

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.

The maximum cutting level adopted by Agrocortex is 25.8 m^3/ha, which is 14% lower than the legal harvesting volume allowed by Law. However, due to conservation measures, the actual logging intensity carried out by Agrocortex is around 9 m^3/ha. Furthermore, trees shall have minimum diameter of 50cm for felling, and 60cm for Mahogany.

At least 10% of the remaining trees per species in the effective exploration area are guaranteed, respecting the minimum limit of preservation of at least 3 trees per species per 100 ha, in each subdivision of the plot. For vulnerable species, those figures are stricter: 15% of the remaining trees per species in the effective exploration area shall be guaranteed, and at least 4 trees per species per 100 ha shall be preserved. Moreover, at least 20% of the remaining Mahogany trees in the effective exploration area shall be preserved, respecting the minimum limit of preservation of at least 5 trees per 100 ha, in each subdivision of the plot. Furthermore, according to the Brazilian Forest Code, trees located within permanent preservation areas (PPA), i.e. at the borders of waterways or springs, shall be comprehensively preserved.

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 the Sustainable Forest Management Plan, it is estimated that 1m^3 of forest residues is generated for each m^3 of log harvested through sustainable forest management. Thus, GHG emissions from logging activities include the volume of harvested timber plus the logging damage factor, as follows.

$$\Delta \mathrm{CLd}_{icl} = (\mathrm{HI}_{\boldsymbol{icl,t}} + \mathrm{LDF}) \times \mathrm{D_m} \times \mathrm{CF} \text{ x } 44 \;/\; 12$$

Where,

$\Delta \mathrm{CLd}_{icl,\mathrm{t}}$	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

In addition, Agrocortex core activity is the sustainable forest management plan, therefore harvested wood products are a significant carbon pool under the project scenario. Carbon stocks in wood products are those stocks that become wood products pool at the time of deforestation. They are divided in three fractions, as follows:

- Short-term wood products: wood products and waste that would decay within 3 years; all carbon shall be assumed to be lost immediately;

- Medium-term wood products: wood products that are retired between 3 and 100 years; for this group of wood products, a 20-year linear decay function shall be applied;

- Long-term wood products: wood products that are considered permanent (i.e. carbon is stored for 100 years or more); it may be assumed that no carbon is released.

Agrocortex divides timber production in four commercial groups. These groups were classified in two larger groups, based on their properties and characteristics, as described on Table 62 below. According to the SFMP, 50% of the Commercial Group 2 category are destined for the production of durable wood products such as decks, tables, doors, etc. (which have potential to become long-lived wood products), and 50% for construction, which are short-lived wood products.

Commercial Groups				
Group	Characteristics	Lifetime category	% of total harvested and commercialized wood	Average wood density (g/cm³)
Group 1, 50% of Group 2, Group 4	High density woods and Mahogany	Medium-term and Long-term	59%	0.76
50% of Group 2, Group 3	White wood (low density wood)	Short-term	41%	0.57

Table 62. Commercial timber groups produced by Agrocortex

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

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

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

Where,

$CXB_{w,icl,t}$	Mean carbon stock per hectare of extracted biomass carbon by class of wood product *w* from forest class *icl* at time *t*; tCO_2e/ha
icl	1, 2, 3, …*icl* initial pre-deforestation forest classes; dimensionless
w	1, 2, 3 … *w* wood product class (sawn-wood, wood-based panels, other industrial roundwood, paper and paper board, and other); dimensionless
t	1, 2, 3… *t* years, a year of the project crediting period; dimensionless

t*	the year at which the area $ABSLPA_{icl,t}$ is deforested in the baseline case; dimensionless
j	1, 2, 3 … *j* tree species; dimensionless
$ABSLPA_{icl,t}$	Area of forest class *icl* deforested at year *t**; ha
$VEX_{,w,j,fcl,t}$	Volume of timber for product class *w*, of species *j*, extracted from within forest class *fcl* at time *t*; m^3
D_j	Mean wood density of species *j*; t d.m.m-3
CF_j	Carbon fraction of biomass for tree species *j*; tC t-1 d.m.
44/12	Ratio of molecular weight of CO_2 to carbon; dimensionless

A volumetric efficiency coefficient of 35%[197] was utilized to calculate the parameter $VEX_{,w,j,fcl,t}$, in order to convert the volume of timber harvested into volume of final wood products.

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

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

Where,

$Cwp_{icl,t}$	Carbon stock in the wood products carbon pool in initial forest class *icl* at time *t*; tCO_2e/ha
STF_w	Fraction of wood products and waste that will be emitted to the atmosphere within 3 years; all carbon shall be assumed to be lost immediately; dimensionless

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

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

Where,

$Cwp_{mt,icl,t}$	Carbon stock in the medium-term wood products carbon pool at the time of deforestation *t* of the initial forest class *icl*; tCO_2e/ha
LTF_w	Fraction of wood products that are considered permanent (i.e. carbon is stored for 100 years or more); it may be assumed no carbon is released

[197] CONSELHO NACIONAL DO MEIO AMBIENTE (CONAMA). Resolução nº 474, de 6 de abril de 2016. **Altera a resolução no 411, de 6 de maio de 2009, que dispõe sobre procedimentos para inspeção de indústrias consumidoras ou transformadoras de produtos e subprodutos florestais madeireiros de origem nativa, bem como os respectivos padrões de nomenclatura e coeficientes de rendimento volumétricos, inclusive carvão vegetal e resíduos de serraria, e dá outras providências.**. Brasília, DF, 2016.

Step 4: Calculate the biomass carbon extracted at time *t* that becomes the long-term wood products at the time of harvesting.

$$Cwp_{lt,icl,t} = Cwp_{icl,t} - (Cwp_{icl,t} * (1 - STF_w) * (1 - MTF_w))$$

Where,

$Cwp_{lt,icl,t}$ Carbon stock in the long-term wood products carbon pool at the time of deforestation *t* of the initial forest class *icl*; tCO_2e/ha

MTF_w Fraction of wood products that are retired between 3 and 100 years; for this group of wood products, a 20-year linear decay function shall be applied

Based on calculations above, the average carbon stock factor for harvested wood products carbon pool in the initial forest class icl applicable at time *t* is reported in Table 63 below.

Year after timber harvest		$\Delta Cwp_{st,icl,t}$ (tCO_2e/ha)	$\Delta Cwp_{mt,icl,t}$ (tCO_2e/ha)	$\Delta Cwp_{lt,icl,t}$ (tCO_2e/ha)
		Short-lived	Medium-lived	Long-lived
1	t*	0	0.05	1.87
2	t*+1	0	0.05	0
3	t*+2	0	0.05	0
4	t*+3	0	0.05	0
5	t*+4	0	0.05	0
6	t*+5	0	0.05	0
7	t*+6	0	0.05	0
8	t*+7	0	0.05	0
9	t*+8	0	0.05	0
10	t*+9	0	0.05	0
11	t*+10	0	0.05	0
12	t*+11	0	0.05	0
13	t*+12	0	0.05	0
14	t*+13	0	0.05	0
15	t*+14	0	0.05	0
16	t*+15	0	0.05	0
17	t*+16	0	0.05	0
18	t*+17	0	0.05	0
19	t*+18	0	0.05	0
20	t*+19	0	0.05	0
21-T	t*+20...	0	0	0

Table 63. Carbon stock factors for initial forest classes (*icl*) for harvested wood products carbon pool (Method 1)

The average carbon stock per hectare in the harvested wood products carbon pool of initial forest class *icl* at time *t* (ΔCwp_t) is calculated as follows:

$$\Delta Cwp_t = \sum_{icl=1}^{icl} (Cwp_{mt,icl,t} + Cwp_{lt,icl,t})$$

Therefore, the *ex ante* estimated carbon stock decrease due to planned logging activities in the project area was calculated using the following equation:

$$\Delta CPLdPA_{t} = \sum_{icl=1}^{icl} (APLPA_{icl,t} \times \Delta CLd_{icl,t}) - (\sum_{icl=1}^{icl} APLPA_{icl,t}) \times \Delta Cwp_{t}$$

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 64 below presents an *ex ante* estimated 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						Wood products		Total carbon stock decrease due to planned logging activities	
	ID_{cl} = 1 Open tropical rainforest with bamboo		ID_{cl} = 2 Open tropical rainforest with palm trees		ID_{cl} = 3 Open alluvial rainforest with palm trees		annual	cumulative	annual	cumulative
	$APLPA_{icl,t}$	$\Delta CLd_{icl,t}$	$APLPA_{icl,t}$	$\Delta CLd_{icl,t}$	$APLPA_{icl,t}$	$\Delta CLd_{icl,t}$	ΔCwp_t	ΔCwp	$\Delta CPLdPA_t$	$\Delta CPLdPA$
	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	5,423.51	18.25	304.56	18.25	128.85	18.25	11,257.51	11,257.51	95,625.83	95,625.83
2015	5,423.51	18.25	304.56	18.25	128.85	18.25	11,550.09	22,807.60	95,333.24	190,959.07
2016	5,423.51	18.25	304.56	18.25	128.85	18.25	11,842.68	34,650.28	95,040.65	285,999.72
2017	5,423.51	18.25	304.56	18.25	128.85	18.25	12,135.27	46,785.55	94,748.07	380,747.78
2018	5,423.51	18.25	304.56	18.25	128.85	18.25	12,427.85	59,213.40	94,455.48	475,203.26
2019	5,423.51	18.25	304.56	18.25	128.85	18.25	12,720.44	71,933.84	94,162.89	569,366.16
2020	5,423.51	18.25	304.56	18.25	128.85	18.25	13,013.03	84,946.87	93,870.31	663,236.46
2021	5,423.51	18.25	304.56	18.25	128.85	18.25	13,305.61	98,252.49	93,577.72	756,814.18
2022	5,423.51	18.25	304.56	18.25	128.85	18.25	13,598.20	111,850.69	93,285.13	850,099.31
2023	5,423.51	18.25	304.56	18.25	128.85	18.25	13,890.79	125,741.48	92,992.55	943,091.86
2024	5,423.51	18.25	304.56	18.25	128.85	18.25	14,183.37	139,924.85	92,699.96	1,035,791.82
2025	5,423.51	18.25	304.56	18.25	128.85	18.25	14,475.96	154,400.81	92,407.37	1,128,199.19
2026	5,423.51	18.25	304.56	18.25	128.85	18.25	14,768.55	169,169.36	92,114.79	1,220,313.97
2027	5,423.51	18.25	304.56	18.25	128.85	18.25	15,061.13	184,230.49	91,822.20	1,312,136.17
2028	5,423.51	18.25	304.56	18.25	128.85	18.25	15,353.72	199,584.21	91,529.61	1,403,665.79
2029	5,423.51	18.25	304.56	18.25	128.85	18.25	15,646.31	215,230.52	91,237.03	1,494,902.81
2030	5,423.51	18.25	304.56	18.25	128.85	18.25	15,938.89	231,169.42	90,944.44	1,585,847.25
2031	5,423.51	18.25	304.56	18.25	128.85	18.25	16,231.48	247,400.90	90,651.85	1,676,499.10
2032	5,423.51	18.25	304.56	18.25	128.85	18.25	16,524.07	263,924.97	90,359.27	1,766,858.37
2033	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	280,741.62	90,066.68	1,856,925.04
2034	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	297,558.28	90,066.68	1,946,991.72
2035	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	314,374.93	90,066.68	2,037,058.40
2036	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	331,191.59	90,066.68	2,127,125.08
2037	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	348,008.24	90,066.68	2,217,191.76
2038	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	364,824.90	90,066.68	2,307,258.44
2039	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	381,641.55	90,066.68	2,397,325.11
2040	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	398,458.21	90,066.68	2,487,391.79
2041	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	415,274.86	90,066.68	2,577,458.47
2042	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	432,091.52	90,066.68	2,667,525.15
2043	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	448,908.17	90,066.68	2,757,591.83
2044	5,423.51	18.25	304.56	18.25	128.85	18.25	16,816.65	465,724.83	90,066.68	2,847,658.51

Table 64. *Ex ante* estimated actual carbon stock decrease due to planned logging activities in the project area

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 65 below presents an *ex ante* estimated 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
2014	35,179.47	35,179.47	95,625.83	95,625.83	0.00	0.00	130,805.30	130,805.30
2015	35,179.47	70,358.94	95,333.24	190,959.07	0.00	0.00	130,512.71	261,318.01
2016	35,179.47	105,538.41	95,040.65	285,999.72	0.00	0.00	130,220.12	391,538.13
2017	35,179.47	140,717.88	94,748.07	380,747.78	0.00	0.00	129,927.54	521,465.66
2018	35,179.47	175,897.35	94,455.48	475,203.26	0.00	0.00	129,634.95	651,100.61
2019	35,179.47	211,076.82	94,162.89	569,366.16	0.00	0.00	129,342.36	780,442.97
2020	35,179.47	246,256.29	93,870.31	663,236.46	0.00	0.00	129,049.78	909,492.75
2021	35,179.47	281,435.76	93,577.72	756,814.18	0.00	0.00	128,757.19	1,038,249.94
2022	35,179.47	316,615.23	93,285.13	850,099.31	0.00	0.00	128,464.60	1,166,714.54
2023	35,179.47	351,794.70	92,992.55	943,091.86	0.00	0.00	128,172.02	1,294,886.56
2024	35,179.47	386,974.17	92,699.96	1,035,791.82	0.00	0.00	127,879.43	1,422,765.99
2025	35,179.47	422,153.64	92,407.37	1,128,199.19	0.00	0.00	127,586.84	1,550,352.83
2026	35,179.47	457,333.11	92,114.79	1,220,313.97	0.00	0.00	127,294.26	1,677,647.08
2027	35,179.47	492,512.58	91,822.20	1,312,136.17	0.00	0.00	127,001.67	1,804,648.75
2028	35,179.47	527,692.05	91,529.61	1,403,665.79	0.00	0.00	126,709.08	1,931,357.83
2029	35,179.47	562,871.52	91,237.03	1,494,902.81	0.00	0.00	126,416.50	2,057,774.33
2030	35,179.47	598,050.99	90,944.44	1,585,847.25	0.00	0.00	126,123.91	2,183,898.24
2031	35,179.47	633,230.46	90,651.85	1,676,499.10	0.00	0.00	125,831.32	2,309,729.56
2032	35,179.47	668,409.93	90,359.27	1,766,858.37	0.00	0.00	125,538.73	2,435,268.29
2033	35,179.47	703,589.40	90,066.68	1,856,925.04	0.00	0.00	125,246.15	2,560,514.44
2034	35,179.47	738,768.87	90,066.68	1,946,991.72	0.00	0.00	125,246.15	2,685,760.59
2035	35,179.47	773,948.34	90,066.68	2,037,058.40	0.00	0.00	125,246.15	2,811,006.74
2036	35,179.47	809,127.81	90,066.68	2,127,125.08	0.00	0.00	125,246.15	2,936,252.89
2037	35,179.47	844,307.28	90,066.68	2,217,191.76	0.00	0.00	125,246.15	3,061,499.03
2038	35,179.47	879,486.75	90,066.68	2,307,258.44	0.00	0.00	125,246.15	3,186,745.18
2039	35,179.47	914,666.22	90,066.68	2,397,325.11	0.00	0.00	125,246.15	3,311,991.33
2040	35,179.47	949,845.69	90,066.68	2,487,391.79	0.00	0.00	125,246.15	3,437,237.48
2041	35,179.47	985,025.16	90,066.68	2,577,458.47	0.00	0.00	125,246.15	3,562,483.63
2042	35,179.47	1,020,204.63	90,066.68	2,667,525.15	0.00	0.00	125,246.15	3,687,729.78
2043	35,179.47	1,055,384.10	90,066.68	2,757,591.83	0.00	0.00	125,246.15	3,812,975.92
2044	35,179.47	1,090,563.57	90,066.68	2,847,658.51	0.00	0.00	125,246.15	3,938,222.07

Table 65. Total *ex ante* carbon stock decrease due to planned activities in the project area

Forests that will be subject to planned logging activities under the project scenario have the potential to grow and accumulate significant carbon stocks after the periodical harvest cycle due to natural regeneration. The mean annual increment of managed forests in Brazil is estimated to be 0.86 m³/ha/year[198].

[198] BRASIL. Conselho Nacional do Meio Ambiente (CONAMA). Estabelece parâmetros técnicos a serem adotados na elaboração, apresentação, avaliação técnica e execução de Plano de Manejo Florestal Sustentável - PMFS com

Due to the periodical harvesting, the projected increase in carbon stocks of each forest class in the project case is estimated by assuming that the maximum carbon stock is the long term average carbon stock (the average of a production cycle). Therefore, once a class reaches this level of carbon stock, no more carbon stock increase can be attributed to it.

Table 66 below provides an *ex ante* estimate of carbon stock increase following planned logging activities in the project area, which is calculated as follows:

$$\Delta \mathrm{CPLiPA}_{t} = \sum_{icl=1}^{icl} (\mathrm{APLPA}_{icl,t} \times \Delta \mathrm{CLi}_{icl,t})$$

Where,

$\Delta \mathrm{CPLi}PA_{\mathrm{t}}$	Total increase in carbon stock due to planned logging activities at year *t* in the project area; tCO_2e
$\mathrm{APLPA}_{icl,\mathrm{t}}$	Areas of planned logging activities in forest class *icl* at year *t* in the project area; ha
$\Delta \mathrm{CLi}_{icl,\mathrm{t}}$	Average carbon stock increase due to sustainable logging activities in forest class *icl* at time *t*; tCO_2e/ha

fins madeireiros, para florestas nativas e suas formas de sucessão no bioma Amazônia. Resolução nº. 406, de 02 de fevereiro de 2009. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 06 feb. 2009.

Project year t	Areas of planned logging activities x Carbon stock change (increase up to maximum long-term average)						Total carbon stock increase due to planned logging activities	
	ID_{cl} = 1 Open tropical rainforest with bamboo		ID_{cl} = 2 Open tropical rainforest with palm trees		ID_{cl} = 3 Open alluvial rainforest with palm trees		annual	cumulative
	$APLPA_{icl,t}$	$\Delta CLi_{icl,t}$	$APLPA_{icl,t}$	$\Delta CLi_{icl,t}$	$APLPA_{icl,t}$	$\Delta CLi_{icl,t}$	$\Delta CPLiPA_t$	$\Delta CPLiPA$
	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e
2014	5,423.51	0.00	304.56	0.00	128.85	0.00	0.00	0.00
2015	5,423.51	0.92	304.56	0.92	128.85	0.92	5,383.66	5,383.66
2016	5,423.51	0.92	304.56	0.92	128.85	0.92	10,767.32	16,150.98
2017	5,423.51	0.92	304.56	0.92	128.85	0.92	16,150.98	32,301.96
2018	5,423.51	0.92	304.56	0.92	128.85	0.92	21,534.64	53,836.60
2019	5,423.51	0.92	304.56	0.92	128.85	0.92	26,918.30	80,754.90
2020	5,423.51	0.92	304.56	0.92	128.85	0.92	32,301.96	113,056.86
2021	5,423.51	0.92	304.56	0.92	128.85	0.92	37,685.62	150,742.47
2022	5,423.51	0.92	304.56	0.92	128.85	0.92	43,069.28	193,811.75
2023	5,423.51	0.92	304.56	0.92	128.85	0.92	48,452.94	242,264.69
2024	5,423.51	0.92	304.56	0.92	128.85	0.92	53,836.60	296,101.29
2025	5,423.51	0.92	304.56	0.92	128.85	0.92	59,220.26	355,321.55
2026	5,423.51	0.92	304.56	0.92	128.85	0.92	64,603.92	419,925.47
2027	5,423.51	0.92	304.56	0.92	128.85	0.92	69,987.58	489,913.04
2028	5,423.51	0.92	304.56	0.92	128.85	0.92	75,371.24	565,284.28
2029	5,423.51	0.92	304.56	0.92	128.85	0.92	80,754.90	646,039.18
2030	5,423.51	0.92	304.56	0.92	128.85	0.92	86,138.56	732,177.73
2031	5,423.51	0.92	304.56	0.92	128.85	0.92	91,522.22	823,699.95
2032	5,423.51	0.92	304.56	0.92	128.85	0.92	96,905.88	920,605.83
2033	5,423.51	0.92	304.56	0.92	128.85	0.92	102,289.54	1,022,895.36
2034	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,129,778.70
2035	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,236,662.03
2036	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,343,545.36
2037	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,450,428.70
2038	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,557,312.03
2039	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,664,195.36
2040	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,771,078.70
2041	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,877,962.03
2042	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	1,984,845.36
2043	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	2,091,728.70
2044	5,423.51	0.92	304.56	0.92	128.85	0.92	106,883.33	2,198,612.03

Table 66. *Ex ante* estimated carbon stock increase following planned logging activities in the project area

Neither planned protection of secondary/degraded forests without harvest nor production of fuel-wood and charcoal are expected to occur within the project area under the project scenario. Thus, carbon stock increase due to growth without harvest or due to planned fuel-wood and charcoal activities will not be monitored. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out. According to the applied methodology, if the project activity generates a significant change in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

Therefore, the total *ex ante* estimated carbon stock increase due to planned activities in the project area is detailed in Table 67 below.

Project year *t*	Total carbon stock increase due to growth without harvest		Total carbon stock increase due to planned logging activities		Total carbon stock increase due to planned fuel-wood and charcoal activities		Total carbon stock increase due to planned activities	
	annual	cumulat	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPNiPA_t$	$\Delta CPNiPA$	$\Delta CPLiPA_t$	$\Delta CPLiPA$	$\Delta CPFiPA_t$	$\Delta CPFiPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0.00	5,383.66	5,383.66	0.00	0.00	5,383.66	5,383.66
2016	0.00	0.00	10,767.32	16,150.98	0.00	0.00	10,767.32	16,150.98
2017	0.00	0.00	16,150.98	32,301.96	0.00	0.00	16,150.98	32,301.96
2018	0.00	0.00	21,534.64	53,836.60	0.00	0.00	21,534.64	53,836.60
2019	0.00	0.00	26,918.30	80,754.90	0.00	0.00	26,918.30	80,754.90
2020	0.00	0.00	32,301.96	113,056.86	0.00	0.00	32,301.96	113,056.86
2021	0.00	0.00	37,685.62	150,742.47	0.00	0.00	37,685.62	150,742.47
2022	0.00	0.00	43,069.28	193,811.75	0.00	0.00	43,069.28	193,811.75
2023	0.00	0.00	48,452.94	242,264.69	0.00	0.00	48,452.94	242,264.69
2024	0.00	0.00	53,836.60	296,101.29	0.00	0.00	53,836.60	296,101.29
2025	0.00	0.00	59,220.26	355,321.55	0.00	0.00	59,220.26	355,321.55
2026	0.00	0.00	64,603.92	419,925.47	0.00	0.00	64,603.92	419,925.47
2027	0.00	0.00	69,987.58	489,913.04	0.00	0.00	69,987.58	489,913.04
2028	0.00	0.00	75,371.24	565,284.28	0.00	0.00	75,371.24	565,284.28
2029	0.00	0.00	80,754.90	646,039.18	0.00	0.00	80,754.90	646,039.18
2030	0.00	0.00	86,138.56	732,177.73	0.00	0.00	86,138.56	732,177.73
2031	0.00	0.00	91,522.22	823,699.95	0.00	0.00	91,522.22	823,699.95
2032	0.00	0.00	96,905.88	920,605.83	0.00	0.00	96,905.88	920,605.83
2033	0.00	0.00	102,289.54	1,022,895.36	0.00	0.00	102,289.54	1,022,895.36
2034	0.00	0.00	106,883.33	1,129,778.70	0.00	0.00	106,883.33	1,129,778.70
2035	0.00	0.00	106,883.33	1,236,662.03	0.00	0.00	106,883.33	1,236,662.03
2036	0.00	0.00	106,883.33	1,343,545.36	0.00	0.00	106,883.33	1,343,545.36
2037	0.00	0.00	106,883.33	1,450,428.70	0.00	0.00	106,883.33	1,450,428.70
2038	0.00	0.00	106,883.33	1,557,312.03	0.00	0.00	106,883.33	1,557,312.03
2039	0.00	0.00	106,883.33	1,664,195.36	0.00	0.00	106,883.33	1,664,195.36
2040	0.00	0.00	106,883.33	1,771,078.70	0.00	0.00	106,883.33	1,771,078.70
2041	0.00	0.00	106,883.33	1,877,962.03	0.00	0.00	106,883.33	1,877,962.03
2042	0.00	0.00	106,883.33	1,984,845.36	0.00	0.00	106,883.33	1,984,845.36
2043	0.00	0.00	106,883.33	2,091,728.70	0.00	0.00	106,883.33	2,091,728.70
2044	0.00	0.00	106,883.33	2,198,612.03	0.00	0.00	106,883.33	2,198,612.03

Table 67. Total *ex ante* estimated carbon stock increase due to planned activities in the project area

<u>*Ex ante* estimation of carbon stock changes due to unavoidable unplanned deforestation within the project area</u>

No significant unavoidable unplanned deforestation is expected in the project scenario, due to the present conservation measures and sustainable forest management practices adopted by Agrocortex. As mentioned above in Section 1.8, more than 8% of the population of Manoel Urbano is employed by Agrocortex, generating a great positive impact on the local economy.

However, 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:

$$\Delta \boldsymbol{CUDdPA_t} = \Delta \boldsymbol{CBSLPA_t} \text{ x } (\boldsymbol{1-EI})$$

Where:

$\Delta CUDdPA_t$	Total *ex ante* actual carbon stock change due to unavoidable 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

Due to the importance of Agrocortex activities in the local economy and employment generation, the Effectiveness Index (*EI*) was conservatively assumed as 95%.

This value represents the efficiency of Agrocortex activities in reducing deforestation within the project area due to the combination of FSC-SFMP in addition to the proposed REDD+SOCIALCARBON activities. It was then applied to calculate the *ex ante* estimate of net carbon stock change in the project area under the project scenario ($\Delta CPSPA_t$), 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 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 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 ante estimated net carbon stock change in the project area under the project scenario is showed in Table 68 below.

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	cumulat	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAi\ PA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	130,805.30	130,805.30	0.00	0.00	12,953.94	12,953.94	143,759.23	143,759.23
2015	130,512.71	261,318.01	5,383.66	5,383.66	27,165.62	40,119.56	152,294.67	296,053.90
2016	130,220.12	391,538.13	10,767.32	16,150.98	27,220.26	67,339.82	146,673.07	442,726.97
2017	129,927.54	521,465.66	16,150.98	32,301.96	27,236.75	94,576.57	141,013.30	583,740.27
2018	129,634.95	651,100.61	21,534.64	53,836.60	33,306.85	127,883.42	141,407.16	725,147.43
2019	129,342.36	780,442.97	26,918.30	80,754.90	29,894.97	157,778.39	132,319.03	857,466.47
2020	129,049.78	909,492.75	32,301.96	113,056.86	27,074.63	184,853.02	123,822.45	981,288.91
2021	128,757.19	1,038,249.94	37,685.62	150,742.47	32,253.05	217,106.07	123,324.62	1,104,613.54
2022	128,464.60	1,166,714.54	43,069.28	193,811.75	29,702.48	246,808.55	115,097.80	1,219,711.34
2023	128,172.02	1,294,886.56	48,452.94	242,264.69	32,484.77	279,293.32	112,203.85	1,331,915.19
2024	127,879.43	1,422,765.99	53,836.60	296,101.29	22,922.12	302,215.44	96,964.95	1,428,880.13
2025	127,586.84	1,550,352.83	59,220.26	355,321.55	29,837.40	332,052.83	98,203.98	1,527,084.11
2026	127,294.26	1,677,647.08	64,603.92	419,925.47	29,932.11	361,984.95	92,622.45	1,619,706.57
2027	127,001.67	1,804,648.75	69,987.58	489,913.04	30,269.64	392,254.59	87,283.73	1,706,990.30
2028	126,709.08	1,931,357.83	75,371.24	565,284.28	31,749.39	424,003.98	83,087.23	1,790,077.53
2029	126,416.50	2,057,774.33	80,754.90	646,039.18	30,838.69	454,842.67	76,500.29	1,866,577.82
2030	126,123.91	2,183,898.24	86,138.56	732,177.73	31,193.20	486,035.87	71,178.55	1,937,756.37
2031	125,831.32	2,309,729.56	91,522.22	823,699.95	29,903.34	515,939.20	64,212.44	2,001,968.81
2032	125,538.73	2,435,268.29	96,905.88	920,605.83	29,939.13	545,878.33	58,571.99	2,060,540.80
2033	125,246.15	2,560,514.44	102,289.54	1,022,895.36	27,745.48	573,623.81	50,702.09	2,111,242.89
2034	125,246.15	2,685,760.59	106,883.33	1,129,778.70	32,595.52	606,219.33	50,958.33	2,162,201.22
2035	125,246.15	2,811,006.74	106,883.33	1,236,662.03	32,074.39	638,293.72	50,437.20	2,212,638.43
2036	125,246.15	2,936,252.89	106,883.33	1,343,545.36	27,905.24	666,198.96	46,268.06	2,258,906.49
2037	125,246.15	3,061,499.03	106,883.33	1,450,428.70	34,716.75	700,915.72	53,079.57	2,311,986.06
2038	125,246.15	3,186,745.18	106,883.33	1,557,312.03	32,840.79	733,756.50	51,203.60	2,363,189.66
2039	125,246.15	3,311,991.33	106,883.33	1,664,195.36	32,238.59	765,995.10	50,601.41	2,413,791.06
2040	125,246.15	3,437,237.48	106,883.33	1,771,078.70	30,781.79	796,776.88	49,144.60	2,462,935.66
2041	125,246.15	3,562,483.63	106,883.33	1,877,962.03	28,097.20	824,874.08	46,460.02	2,509,395.68

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	cumulat	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAi\ PA_t$	ΔCPAiPA	$\Delta CUDdPA_t$	ΔCUDdPA	$\Delta CPSPA_t$	ΔCPSPA
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2042	125,246.15	3,687,729.78	106,883.33	1,984,845.36	28,351.52	853,225.60	46,714.34	2,556,110.02
2043	125,246.15	3,812,975.92	106,883.33	2,091,728.70	37,794.75	891,020.36	56,157.57	2,612,267.58
2044	125,246.15	3,938,222.07	106,883.33	2,198,612.03	27,894.80	918,915.16	46,257.62	2,658,525.20

Table 68. Ex ante estimated net carbon stock change in the project area under the project scenario

Ex ante estimation of actual non-CO_2 emissions from forest fires

Forest fires have not been included in the baseline scenario, thus non-CO_2 emissions from biomass burning shall not be included in the project scenario. Therefore, $EBBPSPA_t$ equals to zero.

Total _ex ante_ estimations for the project area

The expected *ex ante* net carbon stock changes and non-CO_2 emissions in the Project area under the project scenario is summarized in Table 69 below.

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	cumulat.	annual	cumulat	annual	cumulative	annual	cumulat.
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	130,805	130,805	0	0	12,954	12,954	143,759	143,759	0	0
2015	130,513	261,318	5,384	5,384	27,166	40,120	152,295	296,054	0	0
2016	130,220	391,538	10,767	16,151	27,220	67,340	146,673	442,727	0	0
2017	129,928	521,466	16,151	32,302	27,237	94,577	141,013	583,740	0	0
2018	129,635	651,101	21,535	53,837	33,307	127,883	141,407	725,147	0	0
2019	129,342	780,443	26,918	80,755	29,895	157,778	132,319	857,466	0	0
2020	129,050	909,493	32,302	113,057	27,075	184,853	123,822	981,289	0	0
2021	128,757	1,038,250	37,686	150,742	32,253	217,106	123,325	1,104,614	0	0
2022	128,465	1,166,715	43,069	193,812	29,702	246,809	115,098	1,219,711	0	0
2023	128,172	1,294,887	48,453	242,265	32,485	279,293	112,204	1,331,915	0	0
2024	127,879	1,422,766	53,837	296,101	22,922	302,215	96,965	1,428,880	0	0
2025	127,587	1,550,353	59,220	355,322	29,837	332,053	98,204	1,527,084	0	0
2026	127,294	1,677,647	64,604	419,925	29,932	361,985	92,622	1,619,707	0	0
2027	127,002	1,804,649	69,988	489,913	30,270	392,255	87,284	1,706,990	0	0
2028	126,709	1,931,358	75,371	565,284	31,749	424,004	83,087	1,790,078	0	0
2029	126,416	2,057,774	80,755	646,039	30,839	454,843	76,500	1,866,578	0	0
2030	126,124	2,183,898	86,139	732,178	31,193	486,036	71,179	1,937,756	0	0
2031	125,831	2,309,730	91,522	823,700	29,903	515,939	64,212	2,001,969	0	0
2032	125,539	2,435,268	96,906	920,606	29,939	545,878	58,572	2,060,541	0	0
2033	125,246	2,560,514	102,290	1,022,895	27,745	573,624	50,702	2,111,243	0	0
2034	125,246	2,685,761	106,883	1,129,779	32,596	606,219	50,958	2,162,201	0	0
2035	125,246	2,811,007	106,883	1,236,662	32,074	638,294	50,437	2,212,638	0	0
2036	125,246	2,936,253	106,883	1,343,545	27,905	666,199	46,268	2,258,906	0	0
2037	125,246	3,061,499	106,883	1,450,429	34,717	700,916	53,080	2,311,986	0	0
2038	125,246	3,186,745	106,883	1,557,312	32,841	733,757	51,204	2,363,190	0	0
2039	125,246	3,311,991	106,883	1,664,195	32,239	765,995	50,601	2,413,791	0	0
2040	125,246	3,437,237	106,883	1,771,079	30,782	796,777	49,145	2,462,936	0	0
2041	125,246	3,562,484	106,883	1,877,962	28,097	824,874	46,460	2,509,396	0	0
2042	125,246	3,687,730	106,883	1,984,845	28,352	853,226	46,714	2,556,110	0	0
2043	125,246	3,812,976	106,883	2,091,729	37,795	891,020	56,158	2,612,268	0	0
2044	125,246	3,938,222	106,883	2,198,612	27,895	918,915	46,258	2,658,525	0	0

Table 69. Total ex ante estimated actual net carbon stock changes and emissions of non-CO_2 gasses in the project area

3.3 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.

$$\Delta \boldsymbol{CLPMLK_t} = \Delta \boldsymbol{CPSLK_t} - \Delta \boldsymbol{CBSLLK_t}$$

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.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_20man_t$$

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 Agrocortex 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 Table 70 below.

Project year *t*	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total *ex ante* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	0	0	0
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0
2021	0	0	0	0	0	0

2022	0	0	0	0	0	0
2023	0	0	0	0	0	0
2024	0	0	0	0	0	0
2025	0	0	0	0	0	0
2026	0	0	0	0	0	0
2027	0	0	0	0	0	0
2028	0	0	0	0	0	0
2029	0	0	0	0	0	0
2030	0	0	0	0	0	0
2031	0	0	0	0	0	0
2032	0	0	0	0	0	0
2033	0	0	0	0	0	0
2034	0	0	0	0	0	0
2035	0	0	0	0	0	0
2036	0	0	0	0	0	0
2037	0	0	0	0	0	0
2038	0	0	0	0	0	0
2039	0	0	0	0	0	0
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0
2044	0	0	0	0	0	0

Table 70. *Ex ante* estimated total emissions above the baseline from leakage prevention activities

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.

***Ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage**

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted *ex ante* would indicate displacement of deforestation activities due to the project. The *ex ante* activity displacement leakage was calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This was 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:

$$\Delta \boldsymbol{CADLK_t} = \Delta \boldsymbol{CBSLPA_t} \times \boldsymbol{DLF}$$

Where,

$\Delta CADLK_t$ Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e

$\Delta CBSLPA_t$ Total baseline carbon stock change in the project area at year t; tCO_2e

DLF Displacement leakage factor; %

The present project activity intends to apply environmental education and capacity-building measures aiming to attain all the communities located near the boundaries of the leakage belt and project area. Thus a conservative *DLF* value was calculated according to the method below.

As mentioned above in Section 1.8, more than 8% of the population of Manoel Urbano is employed by Agrocortex, generating a great positive impact on the local economy, benefiting lots of families. In addition, Agrocortex SFMP+FSC+REDD+SOCIALCARBON project activities are estimated to benefit a large part of the population in the region. The SOCIALCARBON project will monitor and encourage Agrocortex's contribution to several indicators aimed to the community livin within the leakage management area, such as: expansion of community activities, conflict management, community education and training, public health, alternative income sources, socio-environmental investments, non-timber forest products and stakeholders consultation. Even so, the percent of deforestation with potential to leak outside the project boundaries was conservatively assumed to be 5%. Therefore, the displacement leakage factor (DLF) was conservatively assumed as 5%.

Furthermore, forest fires have not been included in the baseline scenario, thus *ex ante* estimated increase in GHG emissions due to displaced forest fires ($EADLK_t$) shall not be included in the activity displacement leakage analysis.

The actual calculated values for $\Delta CADLK_t$, annually and cumulatively, across the project crediting period are shown in Table 71 below.

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 $\Delta CADLK_t$ tCO_2e	cumulative $\Delta CADLK$ tCO_2e	annual $EADLK_t$ tCO_2e	cumulative $EADLK$ tCO_2e
2014	12,953.94	12,953.94	0	0
2015	27,165.62	40,119.56	0	0
2016	27,220.26	67,339.82	0	0
2017	27,236.75	94,576.57	0	0
2018	33,306.85	127,883.42	0	0
2019	29,894.97	157,778.39	0	0
2020	27,074.63	184,853.02	0	0
2021	32,253.05	217,106.07	0	0
2022	29,702.48	246,808.55	0	0
2023	32,484.77	279,293.32	0	0
2024	22,922.12	302,215.44	0	0
2025	29,837.40	332,052.83	0	0
2026	29,932.11	361,984.95	0	0
2027	30,269.64	392,254.59	0	0
2028	31,749.39	424,003.98	0	0
2029	30,838.69	454,842.67	0	0

2030	31,193.20	486,035.87	0	0
2031	29,903.34	515,939.20	0	0
2032	29,939.13	545,878.33	0	0
2033	27,745.48	573,623.81	0	0
2034	32,595.52	606,219.33	0	0
2035	32,074.39	638,293.72	0	0
2036	27,905.24	666,198.96	0	0
2037	34,716.75	700,915.72	0	0
2038	32,840.79	733,756.50	0	0
2039	32,238.59	765,995.10	0	0
2040	30,781.79	796,776.88	0	0
2041	28,097.20	824,874.08	0	0
2042	28,351.52	853,225.60	0	0
2043	37,794.75	891,020.36	0	0
2044	27,894.80	918,915.16	0	0

Table 71. *Ex ante* estimated leakage due to activity displacement

***Ex ante* estimation of total leakage**

The result of all sources of leakage is calculated as follows:

$$\Delta \boldsymbol{CLK_t} = \Delta \boldsymbol{CLPMLK_t} + \Delta \boldsymbol{CADLK_t}$$

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

$$\boldsymbol{ELK_t} = \boldsymbol{EgLK_t} + \boldsymbol{EADLK_t}$$

Where:

ELK_t Sum of *ex ante* estimated 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 ante* increase in GHG emissions due to displaced forest fires at year *t*; tCO_2e

The calculated values of ΔCLK_t and ELK_t in the present project are shown in Table 72 below.

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 $EgLK_t$ tCO_2e	cumulative EgLK tCO_2e	annual $EADLK_t$ tCO_2e	cumulative EADLK tCO_2e	annual $\Delta CADLK_t$ tCO_2e	cumulative $\Delta CADLK$ tCO_2e	annual $\Delta CLPMLK_t$ tCO_2e	cumulative $\Delta CLPMLK$ tCO_2e	annual ΔCLK_t tCO_2e	cumulative ΔCLK tCO_2e	annual ELK_t tCO_2e	cumulative ELK tCO_2e
2014	0.00	0.00	0.00	0.00	12,953.94	12,953.94	0.00	0.00	12,953.94	12,953.94	0.00	0.00
2015	0.00	0.00	0.00	0.00	27,165.62	40,119.56	0.00	0.00	27,165.62	40,119.56	0.00	0.00
2016	0.00	0.00	0.00	0.00	27,220.26	67,339.82	0.00	0.00	27,220.26	67,339.82	0.00	0.00
2017	0.00	0.00	0.00	0.00	27,236.75	94,576.57	0.00	0.00	27,236.75	94,576.57	0.00	0.00
2018	0.00	0.00	0.00	0.00	33,306.85	127,883.42	0.00	0.00	33,306.85	127,883.42	0.00	0.00
2019	0.00	0.00	0.00	0.00	29,894.97	157,778.39	0.00	0.00	29,894.97	157,778.39	0.00	0.00
2020	0.00	0.00	0.00	0.00	27,074.63	184,853.02	0.00	0.00	27,074.63	184,853.02	0.00	0.00
2021	0.00	0.00	0.00	0.00	32,253.05	217,106.07	0.00	0.00	32,253.05	217,106.07	0.00	0.00
2022	0.00	0.00	0.00	0.00	29,702.48	246,808.55	0.00	0.00	29,702.48	246,808.55	0.00	0.00
2023	0.00	0.00	0.00	0.00	32,484.77	279,293.32	0.00	0.00	32,484.77	279,293.32	0.00	0.00
2024	0.00	0.00	0.00	0.00	22,922.12	302,215.44	0.00	0.00	22,922.12	302,215.44	0.00	0.00
2025	0.00	0.00	0.00	0.00	29,837.40	332,052.83	0.00	0.00	29,837.40	332,052.83	0.00	0.00
2026	0.00	0.00	0.00	0.00	29,932.11	361,984.95	0.00	0.00	29,932.11	361,984.95	0.00	0.00
2027	0.00	0.00	0.00	0.00	30,269.64	392,254.59	0.00	0.00	30,269.64	392,254.59	0.00	0.00
2028	0.00	0.00	0.00	0.00	31,749.39	424,003.98	0.00	0.00	31,749.39	424,003.98	0.00	0.00
2029	0.00	0.00	0.00	0.00	30,838.69	454,842.67	0.00	0.00	30,838.69	454,842.67	0.00	0.00
2030	0.00	0.00	0.00	0.00	31,193.20	486,035.87	0.00	0.00	31,193.20	486,035.87	0.00	0.00
2031	0.00	0.00	0.00	0.00	29,903.34	515,939.20	0.00	0.00	29,903.34	515,939.20	0.00	0.00
2032	0.00	0.00	0.00	0.00	29,939.13	545,878.33	0.00	0.00	29,939.13	545,878.33	0.00	0.00
2033	0.00	0.00	0.00	0.00	27,745.48	573,623.81	0.00	0.00	27,745.48	573,623.81	0.00	0.00
2034	0.00	0.00	0.00	0.00	32,595.52	606,219.33	0.00	0.00	32,595.52	606,219.33	0.00	0.00
2035	0.00	0.00	0.00	0.00	32,074.39	638,293.72	0.00	0.00	32,074.39	638,293.72	0.00	0.00
2036	0.00	0.00	0.00	0.00	27,905.24	666,198.96	0.00	0.00	27,905.24	666,198.96	0.00	0.00
2037	0.00	0.00	0.00	0.00	34,716.75	700,915.72	0.00	0.00	34,716.75	700,915.72	0.00	0.00
2038	0.00	0.00	0.00	0.00	32,840.79	733,756.50	0.00	0.00	32,840.79	733,756.50	0.00	0.00
2039	0.00	0.00	0.00	0.00	32,238.59	765,995.10	0.00	0.00	32,238.59	765,995.10	0.00	0.00
2040	0.00	0.00	0.00	0.00	30,781.79	796,776.88	0.00	0.00	30,781.79	796,776.88	0.00	0.00
2041	0.00	0.00	0.00	0.00	28,097.20	824,874.08	0.00	0.00	28,097.20	824,874.08	0.00	0.00
2042	0.00	0.00	0.00	0.00	28,351.52	853,225.60	0.00	0.00	28,351.52	853,225.60	0.00	0.00
2043	0.00	0.00	0.00	0.00	37,794.75	891,020.36	0.00	0.00	37,794.75	891,020.36	0.00	0.00
2044	0.00	0.00	0.00	0.00	27,894.80	918,915.16	0.00	0.00	27,894.80	918,915.16	0.00	0.00

Table 72. *Ex ante* estimated total leakage

3.4 Net GHG Emission Reductions and Removals

The net anthropogenic GHG emission reduction of the proposed AUD project activity is calculated as follows:

$$\Delta \boldsymbol{REDD_t} = (\Delta \boldsymbol{CBSLPA_t} + \boldsymbol{EBBBSLPA_t}) - (\Delta \boldsymbol{CPSPA_t} + \boldsymbol{EBBPSPA_t}) - (\Delta \boldsymbol{CLK_t} + \boldsymbol{ELK_t})$$

Where:

$\Delta REDD_t$	*Ex ante* estimated 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 ante* estimated actual carbon stock changes in the project area at year *t*; tCO_2e **Note:** If $\Delta CPSPA_t$ represents a net increase in carbon stocks, a negative sign before the absolute value of $\Delta CPSPA_t$ shall be used. If $\Delta CPSPA_t$ represents a net decrease, the positive sign shall be used.
$EBBPSPA_t$	Sum of (*ex ante* estimated) actual emissions from biomass burning in the project area at year *t*; tCO_2e
ΔCLK_t	Sum of *ex ante* 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 ante* estimated leakage emissions at year *t*; tCO_2e
t	1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

The number of Verified Carbon Units (VCUs) to be generated through the proposed AUD project activity at year *t* is calculated as follows:

$$\boldsymbol{VCU_t} = \Delta \boldsymbol{REDD_t} - \boldsymbol{VBC_t}$$

$$\boldsymbol{VBC_t} = (\Delta \boldsymbol{CBSLPA_t} - \Delta \boldsymbol{CPSPA_t}) \times \boldsymbol{RF_t}$$

Where:

VCU_t	Number of Verified Carbon Units that can be traded at time *t*; tCO_2e

	Note: If VCU_t < 0 no credits (VCUs) will be awarded to the proponents of the AUD project activity.
$\Delta REDD_t$	*Ex ante* 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 ante* estimated actual 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 was 15%.

The specific summary of GHG reductions and removals in the Agrocortex REDD project is included in Table 73 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).

In addition, the net GHG emission reductions and removals in the Agrocortex REDD Project are summarized in the Table 74, which follows.

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	cumulat	annual	cumulative	annual	cumulat	annual	cumulat.	annual	cumul.	annual	cumulat.	annual	cumulat.	annual	cumulat.
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	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
2014 (01/07/2014 to 31/12/2014)	129,539	129,539	0	0	71,880	71,880	0	0	6,477	6,477	0	0	51,183	51,183	42,533	42,533	8,649	8,649
2015	543,312	672,852	0	0	152,295	224,174	0	0	27,166	33,643	0	0	363,852	415,035	305,199	347,732	58,653	67,302
2016	544,405	1,217,257	0	0	146,673	370,847	0	0	27,220	60,863	0	0	370,512	785,547	310,852	658,584	59,660	126,961
2017	544,735	1,761,992	0	0	141,013	511,861	0	0	27,237	88,100	0	0	376,485	1,162,032	315,926	974,510	60,558	187,520
2018	666,137	2,428,129	0	0	141,407	653,268	0	0	33,307	121,406	0	0	491,423	1,653,455	412,713	1,387,223	78,709	266,229
2019	597,899	3,026,028	0	0	132,319	785,587	0	0	29,895	151,301	0	0	435,685	2,089,140	365,848	1,753,071	69,837	336,066
2020	541,493	3,567,521	0	0	123,822	909,409	0	0	27,075	178,376	0	0	390,596	2,479,736	327,945	2,081,016	62,651	398,717
2021	645,061	4,212,582	0	0	123,325	1,032,734	0	0	32,253	210,629	0	0	489,483	2,969,219	411,222	2,492,238	78,260	476,977
2022	594,050	4,806,632	0	0	115,098	1,147,832	0	0	29,702	240,332	0	0	449,249	3,418,468	377,406	2,869,644	71,843	548,820
2023	649,695	5,456,327	0	0	112,204	1,260,036	0	0	32,485	272,816	0	0	505,007	3,923,475	424,383	3,294,027	80,624	629,444
2024	458,442	5,914,769	0	0	96,965	1,357,001	0	0	22,922	295,738	0	0	338,555	4,262,030	284,333	3,578,360	54,222	683,665
2025	596,748	6,511,517	0	0	98,204	1,455,204	0	0	29,837	325,576	0	0	468,707	4,730,737	393,924	3,972,284	74,782	758,447
2026	598,642	7,110,160	0	0	92,622	1,547,827	0	0	29,932	355,508	0	0	476,088	5,206,825	400,184	4,372,468	75,903	834,350
2027	605,393	7,715,552	0	0	87,284	1,635,111	0	0	30,270	385,778	0	0	487,839	5,694,664	410,123	4,782,591	77,716	912,066
2028	634,988	8,350,540	0	0	83,087	1,718,198	0	0	31,749	417,527	0	0	520,151	6,214,815	437,366	5,219,957	82,785	994,851
2029	616,774	8,967,314	0	0	76,500	1,794,698	0	0	30,839	448,366	0	0	509,435	6,724,250	428,393	5,648,350	81,041	1,075,892
2030	623,864	9,591,178	0	0	71,179	1,865,877	0	0	31,193	479,559	0	0	521,492	7,245,742	438,589	6,086,939	82,903	1,158,795
2031	598,067	10,189,245	0	0	64,212	1,930,089	0	0	29,903	509,462	0	0	503,951	7,749,693	423,872	6,510,811	80,078	1,238,873
2032	598,783	10,788,027	0	0	58,572	1,988,661	0	0	29,939	539,401	0	0	510,272	8,259,965	429,239	6,940,050	81,032	1,319,905
2033	554,910	11,342,937	0	0	50,702	2,039,363	0	0	27,745	567,147	0	0	476,462	8,736,427	400,830	7,340,880	75,631	1,395,536
2034	651,910	11,994,847	0	0	50,958	2,090,322	0	0	32,596	599,742	0	0	568,356	9,304,783	478,213	7,819,093	90,143	1,485,679
2035	641,488	12,636,335	0	0	50,437	2,140,759	0	0	32,074	631,817	0	0	558,976	9,863,759	470,318	8,289,411	88,658	1,574,336
2036	558,105	13,194,440	0	0	46,268	2,187,027	0	0	27,905	659,722	0	0	483,932	10,347,691	407,156	8,696,567	76,776	1,651,112
2037	694,335	13,888,775	0	0	53,080	2,240,106	0	0	34,717	694,439	0	0	606,539	10,954,230	510,350	9,206,917	96,188	1,747,300
2038	656,816	14,545,591	0	0	51,204	2,291,310	0	0	32,841	727,280	0	0	572,771	11,527,001	481,929	9,688,846	90,842	1,838,142
2039	644,772	15,190,363	0	0	50,601	2,341,911	0	0	32,239	759,518	0	0	561,932	12,088,933	472,806	10,161,652	89,126	1,927,268
2040	615,636	15,805,998	0	0	49,145	2,391,056	0	0	30,782	790,300	0	0	535,709	12,624,642	450,735	10,612,387	84,974	2,012,241
2041	561,944	16,367,942	0	0	46,460	2,437,516	0	0	28,097	818,397	0	0	487,387	13,112,029	410,064	11,022,451	77,323	2,089,564
2042	567,030	16,934,973	0	0	46,714	2,484,230	0	0	28,352	846,749	0	0	491,965	13,603,994	413,917	11,436,368	78,047	2,167,611
2043	755,895	17,690,868	0	0	56,158	2,540,388	0	0	37,795	884,543	0	0	661,943	14,265,936	556,982	11,993,350	104,961	2,272,572
2044 (01/01/2044 to 30/06/2044)	278,948	17,969,816	0	0	23,129	2,563,517	0	0	13,947	898,491	0	0	241,872	14,507,808	203,498	12,196,848	38,373	2,310,945

Table 73. *Ex ante* estimated net anthropogenic GHG emission reductions ($\Delta REDD_t$) and Verified Carbon Units (VCU_t)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2014 (01-Jul to 31-Dec)	129,539	71,880	6,477	51,183
2015	543,312	152,295	27,166	363,852
2016	544,405	146,673	27,220	370,512
2017	544,735	141,013	27,237	376,485
2018	666,137	141,407	33,307	491,423
2019	597,899	132,319	29,895	435,685
2020	541,493	123,822	27,075	390,596
2021	645,061	123,325	32,253	489,483
2022	594,050	115,098	29,702	449,249
2023	649,695	112,204	32,485	505,007
2024	458,442	96,965	22,922	338,555
2025	596,748	98,204	29,837	468,707
2026	598,642	92,622	29,932	476,088
2027	605,393	87,284	30,270	487,839
2028	634,988	83,087	31,749	520,151
2029	616,774	76,500	30,839	509,435
2030	623,864	71,179	31,193	521,492
2031	598,067	64,212	29,903	503,951
2032	598,783	58,572	29,939	510,272
2033	554,910	50,702	27,745	476,462
2034	651,910	50,958	32,596	568,356
2035	641,488	50,437	32,074	558,976
2036	558,105	46,268	27,905	483,932
2037	694,335	53,080	34,717	606,539
2038	656,816	51,204	32,841	572,771
2039	644,772	50,601	32,239	561,932
2040	615,636	49,145	30,782	535,709
2041	561,944	46,460	28,097	487,387
2042	567,030	46,714	28,352	491,965
2043	755,895	56,158	37,795	661,943
2044 (01-Jan to 30-Jun)	278,948	23,129	13,947	241,872
TOTAL	**17,969,816**	**2,563,517**	**898,491**	**14,507,808**
Average/year	**598,994**	**85,451**	**29,950**	**483,594**

Table 74. Net GHG emission reductions and removals in the Agrocortex REDD Project

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	***CF***
Data unit	tC/tdm
Description	Default value of carbon fraction in biomass
Source of data	Values from the literature (e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>).
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default value was used.
Purpose of data	This parameter was 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	ab_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest classes *icl* in Mg/ha
Source of data	Average values for the above-ground biomass were taken from the following study: SALIMON,C.I; PUTZ, F.E.; MENEZES-FILHO, L.; ANDERSON,A.; SILVEIRA, M.; FOSTER BROWN, I.; OLIVEIRA, L.C. Estimating state-wide biomass carbon stocks for a REDD plan in Acre, Brazil. 2011, **Forest Ecology and Management**, 262, p. 555–560, 2011.
Value applied	(see table below)

Above-ground biomass ab_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Open tropical rainforest with bamboo	257.82	274.20	291.73
Open tropical rainforest with	245.98	119.16	349.44

	<table><tr><td>palm trees</td><td></td><td></td><td></td></tr><tr><td>Open alluvial rainforest with palm trees</td><td>218.50</td><td>193.83</td><td>243.17</td></tr><tr><td>Dense tropical rainforest</td><td>323.88</td><td>-</td><td>-</td></tr><tr><td>Secondary vegetation</td><td>37.00</td><td>-</td><td>53.45</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	Following a literature search, the above-ground biomass values of this study was used as they were determined to accurately represent the values of the vegetation within the project reference region. In addition, the results from this study were also compared with Nogueira *et al.* (2008)[199] and Saatchi *et al.* (2007)[200], presenting very similar conclusions. The average biomass stock per hectare was calculated for each project boundary (reference region, project area and leakage belt) and for each vegetation group using weighted average, considering discounts for uncertainties.
Purpose of data	This parameter was used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an average of the biomass stock per hectare in the above-ground biomass within the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	bb_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest classes *icl* in Mg/ha
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Value applied	<table><tr><td colspan="4">Below-ground biomass bb_{icl} (Mg/ha)</td></tr><tr><td>Vegetation</td><td>Reference Region</td><td>Project Area</td><td>Leakage Belt</td></tr><tr><td>Open tropical rainforest with</td><td>61.88</td><td>65.81</td><td>70.01</td></tr></table>

[199] 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. 2008. 151 f. Doctor Thesis - Curso de Ciências de Florestas Tropicais, INPA, Manaus, 2008.
[200] SAATCHI, S.S.; HOUGHTON, R.A., ALVALÁ, R.C.S.; SOARES J.V.; YU, Y. Distribution of aboveground live biomass in the amazon basin. **Global Change Biology**, v.13, p. 816-837, 2007

	<table><tr><td>bamboo</td><td></td><td></td><td></td></tr><tr><td>Open tropical rainforest with palm trees</td><td>59.04</td><td>28.60</td><td>83.87</td></tr><tr><td>Open alluvial rainforest with palm trees</td><td>52.44</td><td>37.78</td><td>49.62</td></tr><tr><td>Dense tropical rainforest</td><td>77.73</td><td>-</td><td>-</td></tr><tr><td>Secondary vegetation</td><td>7.40</td><td>-</td><td>10.69</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	Following a literature search, the below-ground biomass values of the applied methodology were used as they were determined to accurately represent the values of the vegetation within the project reference region. The average biomass stock per hectare was calculated for each project boundary (reference region, project area and leakage belt) and for each vegetation group using weighted average, considering discounts for uncertainties.
Purpose of data	This parameter was used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an average of the biomass stock per hectare in the below-ground biomass within the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	$\boldsymbol{Ctot_{fcl}}$
Data unit	tCO_2e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class *fcl* in tCO_2e/ha
Source of data	Long-term average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region were taken from the following study: FEARNSIDE, Philip M. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996.
Value applied	46.93
Justification of choice of data or description of measurement methods and procedures applied	Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas.
Purpose of data	This parameter was used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within

	the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	D_m
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. 2008. 151 f. Doctor Thesis - Curso de Ciências de Florestas Tropicais, INPA, Manaus, 2008.
Value applied	0.583
Justification of choice of data or description of measurement methods and procedures applied	The mean wood density presented in Nogueira (2008) was obtained from southern and southwestern portions of the Brazilian Amazon, where the project region is located.
Purpose of data	This parameter will be 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 can be 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.
Comments	Nogueira (2008) defined wood density as "specific gravity" or "basic specific gravity '. This is the ratio between the dry mass and the volume of green wood. If new and more accurate wood density data become available, these can be used to estimate project emissions of the subsequent fixed baseline period.

Data / Parameter	D_j
Data unit	g/cm³
Description	Mean wood density of species *j*
Source of data	SERVIÇO FLORESTAL BRASILEIRO. **Fichas Tecnológicas das Madeiras da FLONA Jamari**. Available at: <http://www.florestal.gov.br/documentos/concessoes-florestais/concessoes-florestais-florestas-sob-concessao/flona-do-jamari/edital/192-fichas-tecnologicas/file>. Last visit on: July 14th, 2017. OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:**

<table>
<tr><td></td><td>Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th colspan="3">Commercial Groups</th></tr>
<tr><th>Timber commercial Group</th><th>Characteristics</th><th>Average wood density (g/cm³)</th></tr>
<tr><td>High density woods and Mahogany</td><td>High density woods, with the potential to become long-lived wood products</td><td>0.76</td></tr>
<tr><td>White woods</td><td>Low density woods, mainly destined for construction (short-lived wood products)</td><td>0.57</td></tr>
</table>
</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>Agrocortex divides timber production in commercial groups, which have different rates of commercialization and wood densities. These groups were classified in two larger groups, based on their properties and characteristics.
The wood density presented by the cited study was obtained by the Brazilian Forest Service Forest Products Laboratory, which analyzed wood properties from different Brazilian Amazon species, where the project region is located.</td></tr>
<tr><td>Purpose of data</td><td>This parameter will be used to calculate project emissions due to harvested wood products carbon pool in the project scenario. Carbon stock per hectare of extracted biomass by class of wood product can be calculated through multiplying the timber volume per product class by the wood density of species belonging to a specific class of wood products.</td></tr>
<tr><td>Comments</td><td>If new and more accurate wood density data become available, these can be used to estimate project emissions of the subsequent fixed baseline period.</td></tr>
</table>

Data / Parameter	***EI***
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p. Forest Stewardship Council (FSC) Certification for Forest Management (FSC-C121950) and Chain of Custody (FSC-C127203) for Agrocortex SFMP activities.
Value applied	95
Justification of choice of data or description of measurement methods and procedures applied	The calculation of the effectiveness index was estimated on the efficiency in reducing deforestation within the project area due to Agrocortex REDD Project activities.

Purpose of data	This parameter was 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 shall be done to determine deforestation rate and the project emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	***DLF***
Data unit	%
Description	Displacement Leakage Factor
Source of data	OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p. Forest Stewardship Council (FSC) Certification for Forest Management (FSC-C121950) and Chain of Custody (FSC-C127203) for Agrocortex SFMP activities. SOCIALCARBON Indicators for REDD+SFMP Projects
Value applied	5
Justification of choice of data or description of measurement methods and procedures applied	The *DLF* was estimated as 5%, which is considered as a conservative estimate based on the referenced literature and taking into account the project situation, where Agrocortex SFMP+FSC+REDD+SOCIALCARBON project activities are estimated to benefit a large part of the population in the region.
Purpose of data	This parameter was used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an ex ante estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	Ex post monitoring of the leakage belt shall be done to determine deforestation rate outside the project area and consequently, the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$\boldsymbol{EBBBSLPA_t}$
Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO_2 emissions from forest fire at year t in the project area

Source of data	- Remote sensing data and GIS; - Supervisor information.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.
Purpose of data	This parameter was 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	Non-CO_2 emissions from fires used to clear forests in the baseline scenario were omitted in this project. Therefore, $EBBBSLPA_t$ equals to zero. *Ex post* monitoring of forest fires and *non-CO_2 emissions* shall be done to determine GHG emissions within the project area (when the forest fire is significant). This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	Δ***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 Agrocortex REDD Project; - 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. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented in the leakage management area.
Comments	Ex post monitoring of the leakage management area shall be done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.

4.2 Data and Parameters Monitored

Data / Parameter	***ACPA**$_{icl,t}$*
Data unit	Hectare
Description	Annual area of initial forest classes *icl* within the Project Area affected by catastrophic events at year *t*
Source of data	- Remote sensing data and GIS, - Agrocortex management team and other field data.
Description of measurement methods and procedures to be applied	In addition to remote sensing data and GIS, which can identify the area affected by catastrophic events, the measurement of this parameter will also be based in national database at each monitoring period: - INMET[201] - INPE[202] Moreover, periodic reports from local Agrocortex management team, could also confirm the data obtained from remote sensing and GIS measurement.
Frequency of monitoring/recording	At each time a significant catastrophic event occurs
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Periodic reports from Agrocortex management team
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides an *ex post* estimation of initial forest classes (*icl*) areas 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

[201] INMET. National Meteorology Institute. Automatic Station – Graphics. Available at: <http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_auto_graf>. Last visit on: May 29th, 2017.

[202] INPE. Brazilian National Space Research Institute catalogue. Available at: < http://www.inpe.br/queimadas/risco-de-fogo-meteorologia >. Last visit on: May 29th, 2017.

	(such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$AUFPA_{icl,t}$
Data unit	Hectare
Description	Annual area of initial forest classes *icl* within the Project Area affected by forest fires at year *t*
Source of data	- Remote sensing data and GIS, - Supervisor information and other field data.
Description of measurement methods and procedures to be applied	In addition to remote sensing data and GIS, which can identify the area affected by forest fires, the measurement of this parameter will also be based in national database at each monitoring period: - INMET[203] - INPE[204] Moreover, periodic reports from local Agrocortex management team could also confirm the data obtained from remote sensing and GIS measurement.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Periodic reports from Agrocortex management team
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides an *ex post* estimation of initial forest classes (*icl*) areas affected by forest fires 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

[203] INMET. National Meteorology Institute. Automatic Station – Graphics. Available at: <http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_auto_graf>. Last visit on: May 29th, 2017.

[204] INPE. Brazilian National Space Research Institute catalogue. Available at: < http://www.inpe.br/queimadas/risco-de-fogo-meteorologia >. Last visit on: May, 29, 2017.

	must be accounted under the project scenario, when significant.

Data / Parameter	***ABSLLK$_{icl,t}$***
Data unit	Hectare
Description	Annual area of deforestation of initial forest classes *icl* 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 can 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	Annual average deforestation in the leakage belt during the crediting period per forest class: Open Tropical Rainforest with bamboo: 1,565.44 Open Tropical Rainforest with palm trees: 83.12 Open Alluvial Rainforest with palm trees: 554.53 Secondary vegetation: 144.16
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 deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
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.

Open Tropical Rainforest with bamboo	Open Tropical Rainforest with palm trees	Open Alluvial Rainforest with palm trees	Secondary vegetation
1,565.44	83.12	554.53	144.16

Data / Parameter	***ABSLPA$_{icl,t}$***
Data unit	Hectare
Description	Annual area of deforestation of initial forest classes *icl* in the project area at year *t*
Source of data	- Field reports; - Annual post-harvesting report; - Remote sensing and GIS.

Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	Annual average deforestation in the project area during the crediting period per forest class: <table><tr><th>Open Tropical Rainforest with bamboo</th><th>Open Tropical Rainforest with palm trees</th><th>Open Alluvial Rainforest with palm trees</th></tr><tr><td>1,055.01</td><td>59.95</td><td>1.58</td></tr></table>
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 the project scenario. Provides the *ex post* value of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$ABSLRR_{icl,t}$
Data unit	Hectare
Description	Annual area of deforestation of initial forest classes *icl* 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 assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	Annual average deforestation in the reference region during the crediting period per forest class: <table><tr><th>Open Tropical Rainforest with bamboo</th><th>Open Tropical Rainforest with palm trees</th><th>Open Alluvial Rainforest with palm trees</th><th>Dense Tropical Rainforest</th><th>Secondary Vegetation</th></tr><tr><td>7,302.65</td><td>706.54</td><td>631.31</td><td>0.00</td><td>246.49</td></tr></table>
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 in the project scenario. Provides the *ex post* value of the deforested area per forest class within the reference region.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$APDPA_{icl,t}$
Data unit	Hectare
Description	Areas of planned deforestation in forest class *icl* at year *t* in the project area
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned deforestation activities in the project area that resulted in carbon stock decrease shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	Open Tropical Rainforest with bamboo: 54.24 Open Tropical Rainforest with palm trees: 3.05 Open Alluvial Rainforest with palm trees: 1.29
Monitoring equipment	- Remote sensing and GIS - Agrocortex Management team, based on the Sustainable Forest Management Plan for Fazenda Seringal Novo Macapá
QA/QC procedures to be applied	Best practices in remote sensing. Internal audit of the SFMP.
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 estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Values above represent the annual average planned deforestation per forest class during the 2014-2044 period. 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 (*Unidade de Produção Anual* - UPA, in portuguese) within the project area. Such infrastructure is estimated to cause the deforestation of around 1% of each UPA.

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
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.
Description of measurement methods and procedures to be 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	<table><tr><th>Open Tropical Rainforest with bamboo</th><th>Open Tropical Rainforest with palm trees</th><th>Open Alluvial Rainforest with palm trees</th></tr><tr><td>5,423.51</td><td>304.56</td><td>128.85</td></tr></table>
Monitoring equipment	- Remote sensing and GIS - Agrocortex Management team, based on the Sustainable Forest Management Plan for Fazenda Seringal Novo Macapá
QA/QC procedures to be applied	Best practices in remote sensing. Internal audit of the SFMP.
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 estimated 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 estimated 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[205], 175,707.55 ha are subject to sustainable forest management plan (SFMP). The adopted rotation cycle is 30 years, thus each annual productive unit (APU) has around 5,856.9 hectares. The SFMP provides guidance to Agrocortex management team in order to harvest forest products/by-products in a manner consistent with the conservation of the local ecosystem.

Data / Parameter	$\boldsymbol{APFPA_{icl,t}}$
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
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS; - Other SFMP documents.
Description of measurement methods and procedures to be applied	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, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	- Remote sensing and GIS - Planned interventions proposed by Agrocortex REDD Project
QA/QC procedures to be applied	Best practices in remote sensing. Internal audit of the SFMP.
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 fuel-wood collection and charcoal production activities in the project area.
Calculation method	Emissions at each forest class are estimated 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

[205] OLIVEIRA, Luiz Rogério. **Plano de Manejo Florestal Sustentado:** Fazenda Seringal Novo Macapá. Rio Branco: GerFlor Gerenciamento Florestal, 2010. 286 p.

Data / Parameter	$\Delta CPAdPA_t$
Data unit	tCO_2e
Description	Total decrease in carbon stock due to all planned activities at year *t* in the project area
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS; - Other SFMP documents.
Description of measurement methods and procedures to be applied	The planned activities in the project area that resulted in carbon stock decrease shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	127,039
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing. Internal audit of the SFMP.
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 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	No production of fuel wood or charcoal is expected to occur within the project area under the project scenario. Value above represents the annual decrease in carbon stocks due to all planned activities within the project area.

Data / Parameter	$\Delta CPAiPA_t$
Data unit	tCO_2e
Description	Total increase in carbon stock due to all planned activities at year *t* in the project area
Source of data	- Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS; - Permanent plots monitoring reports; - Other SFMP related documents.

Description of measurement methods and procedures to be applied	The planned activities in the project area that resulted in carbon stock increase shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	70,923
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing. Internal audit of the SFMP.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the increase in carbon stocks due to planned activities in the project area, which could reduce the decrease in carbon stocks in the project area.
Calculation method	Carbon stock increase from planned logging activities at each forest class are estimated 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. Due to the periodical harvesting, the projected increase in carbon stocks of each forest class in the project scenario is estimated by assuming that the maximum carbon stock is the long term average carbon stock (the average of a production cycle). Therefore, once a class reaches this level of carbon stock, no more carbon stock increase can be attributed to it.
Comments	No production of fuel wood or charcoal is expected to occur within the project area under the project scenario. In addition, there are no secondary forests or degraded forests within the project area that have the potential to grow and accumulate significant carbon stocks. A sustainable forest management plan (SFMP) was developed for the Project Area, which has been carried out by Agrocortex management team since 2014. Forests that will be subject to planned logging activities under the project scenario have the potential to grow and accumulate significant carbon stocks after the periodical harvest cycle due to natural regeneration. Value above represents the annual increase in carbon stocks due to all planned activities within the project area.

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 can 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	29,642 (*ex ante* annual average 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	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	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 proposed by Agrocortex REDD Project; - SOCIALCARBON Reports; - Field assessment; - Remote sensing and GIS
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that resulted in carbon stock decrease shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually

Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing. FSC annual reports.
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 - Supervisor reports.
Description of measurement methods and procedures to be applied	Forest cover change due to unplanned deforestation will be monitored through assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	29,642 (*ex ante* annual average total decrease in carbon stocks due to unavoided unplanned deforestation 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	***$EBBPSPA_t$***
Data unit	tCO_2e
Description	Sum of (or total) actual non-CO_2 emissions from forest fire at year *t* in the project area
Source of data	- Remote sensing data and GIS - Supervisor reports.
Description of measurement methods and procedures to be applied	If forest fires occur, these non-CO_2 emissions are subjected to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, periodic reports from area supervisors, who live inside the project area, could also confirm the data obtained.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate *non-CO_2* emissions due to forest fires within the project area in the project scenario, providing an *ex post* project emissions value.
Calculation method	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.
Comments	N/A

Data / Parameter	***$EgLK_t$***
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year *t*.
Source of data	- Activities report related to leakage prevention measures proposed by Agrocortex REDD Project; - SOCIALCARBON Reports; - Field assessment; - Remote sensing data and GIS.
Description of measurement methods and procedures to be	GHG emissions from grazing animals in leakage management areas (i.e. enteric fermentation or manure management) were subjected to monitoring, when significant.

applied	
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. FSC annual reports.
Purpose of data	This parameter will be used to calculate GHG leakage emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology (VM0015, v1.1), section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	There are no predicted activities in the leakage management area that will result in GHG emissions during the crediting period.

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex 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 can be considered activity displacement leakage. GHG emissions due displaced forest fires shall be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the increase in GHG emissions due to displaced forest fires 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	$HI_{icl,t}$
Data unit	m³/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 Agrocortex employees. Agrocortex controls all the harvested timber from the forest management area through a software named *Inforest*. Harvesting intensity shall follow procedures described in the Sustainable Forest Management Plan for Fazenda Seringal Novo Macapá.
Frequency of monitoring/recording	Annually
Value applied	9
Monitoring equipment	The same equipment applied in the forest inventory. Each harvested timber log is measured by Agrocortex employees and stored in a collector, which is linked to the *Inforest* software.
QA/QC procedures to be applied	Control procedures applied to forest inventory. FSC Certification. SFMP internal audit. Logging authorization from the Brazilian Environmental Agency[206].
Purpose of data	This parameter will be 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 will be calculated through the annual timber inventory, which is carried out before harvesting and contains the timber volume from each APU. After harvesting operations, each harvested timber log is measured (diameter and height) by Agrocortex employees and stored in a collector, which automatically calculate the timber volume through the following equation: lnV= -9,41417 + 0,97524 x ln (D² x H) Where, D = Diameter H = Height

[206] The responsible environmental agency in this case is the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* - IBAMA.

	Carbon stock decrease from planned logging activities at each forest class are estimated 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	A sustainable forest management plan (SFMP) was developed and has been executed by Agrocortex management team since 2014. Value above is only an *ex ante* estimate based on an annual harvest of 50,000 m³ in each APU, which has an average area of 5,857 ha. This value will be calculated *ex post*, following the operation of the SFMP. If new and more accurate harvest intensity data become available, these can be used to estimate project emissions.

Data / Parameter	***Logging damage factor (LDF)***
Data unit	m³/m³ 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 (m³). 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.
Description of measurement methods and procedures to be applied	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. According to the Sustainable Forest Management Plan, it is estimated that 1m³ of forest residues is generated for each m³ of log harvested through sustainable forest management.
Frequency of monitoring/recording	Annually
Value applied	1
Monitoring equipment	The same equipment applied in the forest inventory.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP internal audit. FSC Reports.
Purpose of data	This parameter will be 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.
Calculation method	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.
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

Data / Parameter	LTF_w
Data unit	%
Description	Fraction of wood products that are considered permanent (i.e. carbon is stored for 100 years or more).
Source of data	Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report. Financial reports may also be utilized to calculate this parameter.
Description of measurement methods and procedures to be applied	Forest inventory and measurements of harvested wood logs by Agrocortex employees. Agrocortex controls all the harvested timber from the forest management area through the *Inforest* software. Agrocortex divides timber production in commercial groups, which have different rates of commercialization. Each group has a specific durability and lifetime, which mainly depends on the quality and density of the wood.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	The same equipment applied in the forest inventory.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP internal audit. FSC Reports.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario, specifically for calculations of harvested wood products carbon pool.
Calculation method	This parameter will be calculated through the percentage of final wood products that are considered permanent (long lifetime).
Comments	Value above is only an *ex ante* estimate. This value will be calculated *ex post*, following the operation of the SFMP.

Data / Parameter	MAI_{icl}
Data unit	m³/ha/year
Description	Mean annual increment at each forest class due to natural regeneration of managed forests following planned sustainable

	logging activities
Source of data	- Field measurements in sample plots; - BRASIL. Conselho Nacional do Meio Ambiente (CONAMA). Resolution 406, dated 02/02/2009. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 06 fev. 2009. This Resolution establishes technical parameters to be adopted in the preparation, presentation, technical evaluation and execution of a Sustainable Forest Management Plan - SFMP for logging purposes, for native forests and their succession forms in the Amazon biome.
Description of measurement methods and procedures to be applied	Forests that will be subject to planned logging activities under the project scenario have the potential to grow and accumulate significant carbon stocks after the periodical harvest cycle due to natural regeneration. This parameter will be calculated through the annual monitoring of permanent plots following planned sustainable logging activities. However, if no onitoring data is available, literature data shall be used. Brazilian official data estimates that the annual productivity of managed forests is 0.86 m^3/ha/year, such that at the end of 30 timber that was previously extracted, with a maximum harvesting intensity of 25 m^3/ha will be recovered. This means the management practices will ensure timber (and carbon) stocks are fully recovered by the end of 30 years period.
Frequency of monitoring/recording	Annually
Value applied	0.86
Monitoring equipment	The same equipment applied in the forest inventory.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP internal audit. FSC Reports.
Purpose of data	This parameter will be 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 increase due to natural regeneration of managed forests after planned sustainable logging activities.
Calculation method	This parameter will be calculated through the annual measurement of the diameter of all remaining trees located within permanent plots following planned sustainable logging activities. The diameter is a good parameter to estimate the mean annual increment due to natural regeneration. Carbon stock increase from previously planned logging areas within each forest class is estimated via the increase in DBH

	assessed in measured trees within permanent plots. If no monitoring data is available, Brazilian official data shall be used.
Comments	A SFMP was developed and is executed by Agrocortex management team since 2014. Value above is only an *ex ante* estimate and is in line with definitions of the SFMP. This value will be calculated *ex post*, after the operation of the SFMP. Nevertheless, if no monitoring data is available, Brazilian official data shall be used. If new and more accurate harvest intensity data become available, these can be used to estimate project emissions

Data / Parameter	***MTF_w***
Data unit	%
Description	Fraction of wood products that are retired between 3 and 100 years.
Source of data	Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report. Financial reports may also be utilized to calculate this parameter.
Description of measurement methods and procedures to be applied	Forest inventory and measurements of harvested wood logs by Agrocortex employees. Agrocortex controls all the harvested timber from the forest management area through the *Inforest* software. Agrocortex divides timber production in commercial groups, which have different rates of commercialization. Each group has a specific durability and lifetime, which mainly depends on the quality and density of the wood.
Frequency of monitoring/recording	Annually
Value applied	59
Monitoring equipment	The same equipment applied in the forest inventory.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP internal audit. FSC Reports.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario, specifically for calculations of harvested wood products carbon pool.
Calculation method	This parameter will be calculated through the percentage of final wood products that have an expected lifetime between 3 to 100 years.
Comments	Value above is only an *ex ante* estimate. This value will be

	calculated *ex post*, following the operation of the SFMP.

Data / Parameter	***RF_t***
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report_Agrocortex REDD Project, - Remote sensing data and GIS, - Supervisor informationLiterature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report were used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	15
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
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 AFOLU Non-Permanence Risk Tool. All the risk factors described in the VCS Non-Permanence Risk Report were assessed.
Comments	N/A

Data / Parameter	***STF_w***
Data unit	%
Description	Fraction of wood products and waste that will be emitted to the atmosphere within 3 years.
Source of data	Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report. Financial reports may also be utilized to calculate this parameter.
Description of measurement methods and procedures to be applied	Forest inventory and measurements of harvested wood logs by Agrocortex employees. Agrocortex controls all the harvested timber from the forest management area through the *Inforest* software. Agrocortex divides timber production in commercial groups, which have different rates of commercialization. Each group has a specific durability and lifetime, which mainly depends on the

	quality and density of the wood.
Frequency of monitoring/recording	Annually
Value applied	41
Monitoring equipment	The same equipment applied in the forest inventory.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP internal audit. FSC Reports.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario, specifically for calculations of harvested wood products carbon pool.
Calculation method	This parameter will be calculated through the percentage of final wood products that have an expected lifetime below 3 years.
Comments	Value above is only an *ex ante* estimate. This value will be calculated *ex post*, following the operation of the SFMP.

<table>
<tr><td>Data / Parameter</td><td>VEX_{w,j,icl,t}</td></tr>
<tr><td>Data unit</td><td>m³</td></tr>
<tr><td>Description</td><td>Volume of timber for product class w, of species j, extracted from within forest class fcl at time t</td></tr>
<tr><td>Source of data</td><td>Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report. Financial reports may also be utilized to calculate this parameter.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Forest inventory and measurements of wood logs by Agrocortex employees. Agrocortex controls all the harvested timber from the forest management area through a software named Inforest.
Agrocortex divides timber production in commercial groups, which have different rates of commercialization.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Annually</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><td colspan="3">Commercial Groups</td></tr>
<tr><td>Timber commercial Group</td><td>Characteristics</td><td>$VEX_{w,j,icl,t}$ (m³)</td></tr>
<tr><td>High density woods and Mahogany</td><td>High density woods, with the potential to become long-lived wood products</td><td>10,411</td></tr>
<tr><td>White woods</td><td>Low density woods, mainly destined for construction (short-lived wood products)</td><td>7,089</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>The same equipment applied in the forest inventory. Each harvested</td></tr>
</table>

	timber log is measured by Agrocortex employees and stored in a collector, which is linked to the *Inforest* software.
QA/QC procedures to be applied	Control procedures applied to forest inventory. FSC Certification. SFMP internal audit. Logging authorization from the Brazilian Environmental Agency[207].
Purpose of data	This parameter will be used to calculate project emissions in the project scenario, specifically for calculations of harvested wood products carbon pool. Provides the *ex post* value of the final wood products volume per product class due to planned logging activities in the project area.
Calculation method	This parameter is calculated based on the production of timber per commercial group. A volumetric efficiency coefficient of 35%[208] was utilized to calculate the parameter $VEX_{,w,j,fcl,t}$, in order to convert the volume of timber harvested into volume of final wood products.
Comments	Value above is only an *ex ante* estimate. This value will be calculated *ex post*, following the operation of the SFMP.

4.3 Monitoring Plan

This monitoring plan has been developed according to the VCS Methodology VM0015, version 1.1.

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.

Revision of the baseline

The current baseline is valid for 10 years, i.e. through 30/June/2024. The baseline will be reassessed every 10 years, and it will be validated at the same time as the subsequent verification. If an applicable sub-national or national jurisdictional baseline becomes available, the baseline will be reassessed earlier and it will be used for the subsequent period.

[207] The responsible environmental agency in this case is the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* - IBAMA.
[208] CONSELHO NACIONAL DO MEIO AMBIENTE (CONAMA). Resolução nº 474, de 6 de abril de 2016. **Altera a resolução no 411, de 6 de maio de 2009, que dispõe sobre procedimentos para inspeção de indústrias consumidoras ou transformadoras de produtos e subprodutos florestais madeireiros de origem nativa, bem como os respectivos padrões de nomenclatura e coeficientes de rendimento volumétricos, inclusive carvão vegetal e resíduos de serraria, e dá outras providências.**. Brasília, DF, 2016.

Information on agents, drivers and underlying causes of deforestation in the reference region will be collected at the end of each fixed baseline period, as these are essential for improving future deforestation projections and the design of the project activity. In addition, in the same frequency, the projected annual areas of baseline deforestation for the reference region will be revisited and eventually adjusted for the subsequent fixed baseline period.

Furthermore, the location of the projected baseline deforestation will be reassessed using the adjusted projections for annual areas of baseline deforestation and spatial data. All areas credited for avoided deforestation in past fixed baseline periods will be excluded from the revisited baseline projections as these areas cannot be credited again.

Monitoring Deforestation and Project Emissions

Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

The project boundary, as set out in the PD, will serve as the initial “forest cover benchmark map” against which changes in forest cover will be assessed over the interval of the monitoring period.

The entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event.

A SFMP was developed and is executed by Agrocortex management team since 2014, in order to harvest forest products/by-products in a manner consistent with the conservation of the local ecosystem. The increase or decrease in carbon stocks due to planned activities in the project area will also be monitored through SFMP 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. Furthermore, in case of logging or fuelwood collection, emissions are estimated by multiplying the detected area subject to logging by the harvested timber volume intensity, and then by the mean wood density in order to convert this value to tonnes of carbon.

Forests that will be subject to planned logging activities under the project scenario have the potential to grow and accumulate significant carbon stocks after the periodical harvest cycle due to natural regeneration. Carbon stock increase from planned logging activities at each forest class are estimated 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. In addition, the mean annual increment at each forest class due to natural regeneration of managed forests following planned sustainable logging activities will be calculated through the annual measurement of the diameter of all remaining trees located within permanent plots following planned sustainable logging activities. The diameter, is a good parameter to estimate the mean annual increment due to natural regeneration.

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.

Monitoring of non-CO_2 emissions from forest fires

If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.

Monitoring Leakage

The most recent VCS guidelines on this subject matter shall be applied. Furthermore, as the leakage belt was determined using Option 1 (Opportunity cost analysis), the boundary of the leakage belt will have to be reassessed at the end of each fixed baseline period using the same methodological approaches used in the first period.

The calculation procedure for estimating leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

- Carbon stock changes and GHG emissions associated with leakage prevention activities.

The carbon stock decrease 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 may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Monitoring of Natural Disturbance and catastrophic events

The carbon stock losses within the project area will be estimated as soon as possible after the natural event, e.g. uncontrolled forest fires and other catastrophic events.

Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, flooding, drought, fires or storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring, when significant. If the area (or a sub-set of it) affected by natural disturbances or man-made events generated VCUs in past verifications, the total net change in carbon stocks and GHG emissions in the area(s) that generated VCUs will be estimated, and an equivalent amount of VCUs will be cancelled from the VCS buffer. No VCUs can be issued for the project until all carbon stock losses and increases in GHG emissions have been offset.

Updating Forest Carbon Stock Estimates

Forest inventories are annually conducted in accordance with the forest management plan, and this information may be used in updating forest carbon stock estimates. If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period. For the current fixed baseline period, new data on carbon stocks will only be used if they are validated by an accredited VCS verifier. If new data are used in the current fixed baseline period, the baseline will be recalculated using the new data.

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 Agrocortex, located in São Paulo, Brazil. 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 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 parameters related to sustainable forest management activities are generated, recorded, aggregated and collated using the *Inforest* software. To ensure quality assurance and quality control, Agrocortex has implemented this controlling system where the complete forestry census is inserted into the system, which monitors every single tree within each APU. Furthermore, this software is in accordance with the federal and local legislation.

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 *Ms. Ana Beatriz Melo*, who is a Forest Engineer and is part of the Agrocortex management team. Monitored parameters are described in Section 4.2 and will be monitored with the frequency described in Table 75.

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 plans of the PD.

The implementation of the project activity will be monitored by continuous monitoring activities using remote sensing techniques. Additionally, field studies will also be used. The land-use monitoring will be carried out with remote sensing methods, using images generated by INPE (PRODES)[209], Landsat, ResourceSat, or other, 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 local staff from Agrocortex management team. These members of the team are physically present in the Project Area during most of harvesting season and live in nearby cities. They are able to provide periodic reports to the project proponent, who is responsible for managing the monitoring, quality control and quality assessment procedures. All the monitored parameters will be checked with the frequency detailed in the Table 75, as requested in the VCS Methodology VM0015, version 1.1.

Agrocortex will also implement the sustainability report following the SOCIALCARBON methodology, which was developed by *Instituto Ecológica* and focuses on implementing environmental and social activities within the Project Area and Leakage Management Area. This methodology follows the SOCIALCARBON Guidelines available at: http://www.socialcarbon.org/documents/.

In addition, the SOCIALCARBON Reports will be available on Public Registry /SOCIALCARBON Registry once the project is registered.

[209] Available at: <http://www.obt.inpe.br/prodes/index.php>.

Procedures for handling internal auditing and non-conformities

Internal auditing and non-conformities will be managed according to Agrocortex internal procedures. Agrocortex manages forest resources according to a Sustainable Forest Management Plan developed by third party experts and performed by its management team with significant experience in forest management. Such plan has procedures to identify and assess non-conformities and risks. The plan also establishes procedures for the regular training of Agrocortex staff.

Forest management is also certified according to FSC requirements on a regular basis. Ecológica Assessoria will also support Agrocortex on the management of this VCS REDD Project. Ecológica Assessoria will also be responsible for performing quality control and quality assurance for the data involved on the Project monitoring that is not control by Agrocortex management team. In case of erroneous measurements, Ecológica Assessoria will investigate the causes of consequences of each event to identify root causes and prevent similar problems in the future. Ecológica Assessoria will also determine how to measure and report data affected by erroneous measurement in a conservative manner. All these facts ensure solid procedures are in place to handle non-conformities.

Organizational structure, responsibilities and competencies

Monitoring will be done by the project proponent and/or 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 Table 75.

For all aspects of project monitoring, Agrocortex 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 *Mr. Marcos Preto*.

Variables to be monitored	Responsible	Frequency
Revision of the baseline	Ecológica Assessoria and Agência Verde or another external institutions qualified for the monitoring	Every 10 years
Monitoring Deforestation and Project Emissions	Agrocortex together with Ecológica Assessoria and Agência Verde or another external institutions qualified for the monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Agrocortex together with Ecológica Assessoria and Agência Verde or another external institutions qualified for the monitoring	Prior to each verification
Monitoring Leakage	Agrocortex together with Ecológica Assessoria and Agência Verde or another external institutions qualified for the monitoring	Prior to each verification

Monitoring of Natural Disturbance and catastrophic events	Agrocortex	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Agrocortex	At least, every 10 years, only if necessary.
Quality Assurance and Quality control	Agrocortex management team will perform QA/QC procedures for its operations. Ecológica Assessoria or another external institutions qualified for the monitoring will perform QA/QC procedures for other parameters of the project monitoring plan	Prior to each verification.

Table 75. Type of Monitoring and Party Responsible for Monitoring.

5 SAFEGUARDS

5.1 No Net Harm

Agrocortex has conducted a social and environmental impact assessment of the sustainable forest management carried out within the Project Area in May, 2015[210]. This assessment was performed by Agrocortex management team with support from an experienced consultant. The assessment included consultations with local stakeholders, who were asked about their impressions on the expected impacts related to Agrocortex activities.

According to this assessment, there were 120 families living around the Project Area at the time of the study. As part of the surveys conducted, all 120 families have been consulted on potential social and environmental impacts resulting from the forest management implemented by Agrocortex. In addition, local presentations and meeting were performed for one of the communities where 10 families lived at the time of the survey.

A new assessment of potential environmental and socio-economic risks of the Project was conducted in April 2017 as part of the design of the SOCIALCARBON Indicators for REDD+SFMP Projects, which were developed by Ecológica Assessoria for their application to the Agrocortex REDD Project[211]. This assessment took into consideration the findings of the assessment achieved by Agrocortex in 2015 and identified the main risks that should be evaluated as part of SOCIALCARBON certification. Table below provides details on the identified potential risks:

[210] AGROCORTEX, **Identificação dos Impactos do Manejo Florestal Fazenda Seringal Novo Macapá à População do Entorno**. May, 2015.

[211] Indicators available at: <http://www.socialcarbon.org/wp-content/uploads/2012/11/Template_Submission_of_new_indicators_REDD+SFMP_v1.2_EN1.pdf>. Last access on 10/07/2017. These indicators were approved by the Ecológica Institue and can now be applied for similar REDD projects.

Activity	Aspect	Impact	Effect		SOCIALCARBON Indicators that will monitor the identified potential risks
			Beneficial	Adverse	
Sustainable forest management	Frighten animals	Hunting shortage		X	- Biodiversity resource: Biodiversity monitoring; Impact on remaining flora
Sustainable forest management	Vehicle transport	Air Pollution, Noise and soil erosion		X	- Human resource: Conflict management
Sustainable forest management	Land demarcation processes	Land tenure	X		- Natural resource: Land tenure
Sustainable forest management	Presence of company/workers on local communities	Conflicts between company/workers and local communities		X	- Human resource: Conflict management; Public health - Carbon resource: Stakeholder consultation
REDD carbon project	Conservation of Amazon Rainforest	Avoided deforestation	X		- Carbon resource: Project performance; Buffer reduction
REDD carbon project	Empowerment	Increase independence of communities in the project area.	X		- Social resource: Associations and cooperatives; Women inclusion - Human resource: Community education and training - Financial resource: Alternative income sources Biodiversity resource: Non timber forest products (NTFPs)
REDD carbon project	Application of the Social Carbon methodology	Encouragement, monitoring and investment on social, economic and environmental aspects in the project region.	X		- Social resource: Women inclusion; Expansion of community activities - Financial resource: Secure funds; Carbon credit Investments - Natural resource: Social and Environmental Investments; Control and Quality monitoring

Table 76. Potential environmental and socio-economic risks

As available on the table above, three negative impacts were considered for the SOCIALCARBON certification and shall be monitored as part of the indicators created.

The impact of hunting shortage will be monitored through the indicators described on the last column of the above table: biodiversity monitoring and impact on remaining flora. The following measures were planned by Agrocortex to mitigate this risk:

- Restrict the circulation of personnel and equipment on the Project Area to avoid frightening or modifying the behaviour of animals;
- Regular meetings with communities living within the leakage management area explaining about the difference between the customary and the predatory hunting and fishing[212];
- Timber harvesting should be performed on annual plots and not at several locations simultaneously;
- Establish procedures to monitor fauna on traditional hunting spots inside each APU.

Air pollution, noise and soil erosion will be monitored through the conflict management indicator. The following measures were planned by Agrocortex to mitigate this risk:

- Monitor vehicles for their compliance on driving speed;
- Establish speed bumps and spray roads with water near populated areas
- Establish and monitor time limits for harvest transportation to avoid disturbing locals during rest periods.

Finally, the impact related to conflicts between company/workers and local communities will be monitored through the indicators of conflict management, public health and stakeholder consultation. The following measures were planned by Agrocortex to mitigate this risk:

- Establish and monitor a Code of Conduct for employees, including information related to issues such as drugs and alcohol, prostitution, the use of firearms, amongst others.
- Promote lectures and educational campaigns on respecting local culture;
- Establish procedures to ensure employee's health is assessed on a regular basis to prevent the spread of infectious diseases;
- Create a permanent communication channel with local stakeholders and address all inputs, suggestions and outcomes from local consultations.

[212] It is constantly clarified that the customary activity that communities practice may continue as it has always been; however, the predatory activity is prohibited because it can bring harmful results for the biodiversity and for the community itself, since it may lead to a decrease of animals supply. It is important to note that Agrocortex offers all meals for all employees, thus there is no need of fishing/hunting within the project area.

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

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

Table 77. Significant risks to the Project

These risks will be monitored as part of the monitoring report described on Section 4 of this VCS PD and also as part of the monitoring of the non-permanence risk, which shall be evaluated at each verification event. Nevertheless, these risks will also be assessed by the SOCIALCARBON Indicators described on the last column of the Table above.

5.2 Environmental Impact

Agrocortex 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:

Impacts to the soil: to prevent impacts to the soil, which could result from the use of heavy machinery to harvest timber, the following measures are taken:

- Adequate machinery is always used to prevent soil compaction;
- Vines are removed one year before trees are harvested, to reduce the impacts of harvesting to surrounding vegetation and soil;
- Harvesting and transportation of timber is not performed during the rainy season to avoid soil erosion and compaction;
- Permanent Protection Areas and areas with slopes are not harvested;
- Access roads are planned with geoprocessing data to prevent damage to the soil and to the forest drainage system.

Impacts to water resources: to prevent impacts to water resources, the following measures are taken:

- All rivers, streams, springs and slopes are identified and preserved according to Brazilian legislation;
- The disposal of toxic material on water springs and streams/rivers is prohibited;
- Main roads are constructed with drainage systems to promote an adequate flow of rain water and to prevent erosion.

Impacts to air quality: to prevent impacts on air quality, the following measures are taken:

- Periodic checks are performed on machinery and vehicles to prevent pollution;
- Burning of vegetation is prohibited;
- Revegetation of cleared areas with native species is performed to support carbon fixation and recompose the forest capacity to improve air quality.

Impacts to biodiversity: the following measures are taken by Agrocortex to reduce impacts to biodiversity:

- Reduced impact logging techniques are applied, which reduce harvest impacts;
- Careful planning for forest operation and infrastructure reduce the need to clear other areas;
- Revegetation and the management of remaining trees and seedlings is performed to cleared areas and on the borders of roads and storage yards;
- Rare and endemic tree species are not harvested, as well as dead trees that serve as refugee for animals;
- Forest residues are used to reduce forest harvesting;
- The complete chain of custody management system ensures the origin of all forest products;
- Biodiversity corridors are maintained and connect Permanent Protection Areas and areas that will not be subject to harvesting;
- Agrocortex promotes scientific research in partnership with academic and research organizations. The management of fauna and flora follows scientific and technical criteria;
- Agrocortex promotes environmental education to employees and local communities.

In addition, Agrocortex utilizes the concepts of High Conservation Values (HCV) to manage the Project Area. According to the HCV Resource Network, HCVs are biological, ecological, social or cultural values which are considered outstandingly significant or critically important, at the national, regional or global level[213].

Agrocortex has established criteria to define HCV and the corresponding areas of significant value or extreme importance at regional or global levels. Definitions on such areas were taken

[213] More information on the HCV resource network is available at: < https://www.hcvnetwork.org/about-hcvf>.

considering 2012 guidelines from the HCV Resource Network, documents from other institutions, internal data and information from the consultation of local communities.

Such definitions allowed Agrocortex to map the locations and boundaries of areas of significant value. On such areas, specific monitoring and maintenance measures are taken to prevent environmental impacts and to ensure their environmental and socioeconomic values are preserved. Measures include applying reduced impact harvesting, supervising worker's operations around these areas, incidents record, and report on the status of HCV areas by the end of each harvest season.

5.3 Local Stakeholder Consultation

The purpose of the local stakeholder consultation was:

2) Ensure that all stakeholders are aware and informed about the REDD project and its objectives;

3) Assist the project proponent/developer in identifying potential topics for local communities;

4) Provide different opportunities to stakeholders for discussion and participation in the validation process.

The main stakeholders considered in this project are:

- The local community surrounding the project area;
- Local community associations and labour unions;
- Agrocortex employees;
- Agrocortex shareholders;
- The Brazilian Environmental Agency (IBAMA);
- The State Environmental Agency of Acre (SEMA-AC);
- The State Environmental Agency of Amazonas (SEMA-AM);
- The Climate Change Institute of Acre (IMC);
- The State System of Incentives for Environmental Services of Acre (SISA);
- The Environmental Institute of Acre (IMAC);
- The Institute of Lands of the State of Acre (ITERACRE);
- The Educational Agency of Manoel Urbano Municipality;
- The Health Agency of Manoel Urbano Municipality;
- The Department of Forest Development, Commerce, Industry and Sustainable Services of Acre (SEDENS);
- The State Department of Agroforestry Extension and Family Production of Acre;
- The State Technology Foundation of Acre (FUNTAC);

- The Chico Mendes Institute for Biodiversity Conservation (ICMBio);
- The Institute of National Historical and Artistic Heritage (IPHAN);
- The Tropical Forest Institute;
- The Forest Stewardship Council (FSC);
- The National Indigenous Foundation (FUNAI);
- Certification bodies;
- Banks;
- The Brazilian Biodiversity Fund (FUNBIO);
- The Brazilian Department of Biodiversity and Forest (SBF);
- Sustainable forest management companies;
- Non-Governmental Organizations (NGOs);
- Universities and Institutes.

Table 78 below shows the number of people/organizations informed about the project, organized by type.

Stakeholder classification	Number of People/ Organizations informed about the Agrocortex REDD Project
Governmental entities	28
Local communities	6
Local community associations and labour unions	3
Agrocortex employees	30
Agrocortex shareholders	4
Certification bodies	5
Banks	2
Sustainable forest management companies	5
NGOs	10
Universities	5
TOTAL	**98**

Table 78. Stakeholders informed about the Agrocortex REDD Project, organized by type

An explanatory letter was sent to all stakeholders asking their opinion about the project. Moreover, they were also invited to attend a local stakeholders' consultation in Manoel Urbano Municipality. The local community was personally invited by one of the project forest engineers who visited them by boat. The invitation letter (shown in Figure 73 below) was sent 30 days before the consultation meeting.

CONVITE ÀS PARTES INTERESSADAS

São Paulo, 20 de maio de 2017.

Assunto: Apresentação da Agrocortex Madeiras do Acre Agroflorestal Ltda. - Projeto Agrocortex REDD

Prezado Senhor(a).

Vimos por meio desta informar a V.Sa. que estamos desenvolvendo um projeto de mitigação dos impactos relacionados aos Gases de Efeito Estufa (GEE) produzidos pelo desmatamento não planejado. Este projeto tem como objetivo final a Redução das Emissões por Desmatamento e Degradação (REDD) evitando o desmatamento não planejado. O projeto está em consonância com as diretrizes e critérios de desenvolvimento sustentável do Brasil.

Com esta iniciativa, a Agrocortex visa mitigar, de forma voluntária, os impactos ambientais provocados pelos gases liberados através do desmatamento da Floresta Amazônica.

O projeto encontra-se na fase de validação, para posteriormente ser apresentado ao VCS (*Verified Carbon Standard*), atendendo aos procedimentos estabelecidos para a geração de créditos de carbono através da redução de emissões voluntárias de GEE.

Assim, como parte do processo de certificação, a Agrocortex está entrando em contato com as partes interessadas para divulgação do projeto. Para isso, no dia 20/06/2016, às 8 horas, faremos uma apresentação sobre o projeto. A apresentação será realizada no complexo industrial da Agrocortex, sediado na cidade de Manoel Urbano/AC.

A partir desta data, a Agrocortex está aberta a solicitações de informações e comentários. Informações e documentos técnicos do projeto estão disponíveis na seguinte página da internet:

http://www.vcsprojectdatabase.org/#/pipeline_details/PL1686

Solicitações de informações e comentários podem ser enviados através desta página da internet até o dia 11/06/2017. Ainda, solicitações podem ser encaminhadas diretamente para a Agrocortex no prazo de 30 dias a partir da data deste documento. Por favor, entre em contato com a Agrocortex caso deseje receber cópias eletrônicas do relatório técnico. As informações para contato estão disponíveis ao final deste documento.

INFORMAÇÕES DO PROJETO

Nome do projeto:
Agrocortex REDD Project
(Projeto Agrocortex REDD)

Tipo de projeto:
Redução das Emissões por Desmatamento e Degradação (REDD)

Proponentes:
Agrocortex Madeiras do Acre Agroflorestal Ltda.

Localização:
Fazenda Seringal Novo Macapá, localizada nos municípios de Manoel Urbano (AC), Boca do Acre (AM) e Pauini (AM).

Padrões de certificação:
Verified Carbon Standard (VCS) e SOCIALCARBON

Etapa de desenvolvimento:
Em validação

Órgão de validação:
RINA Services S.p.A

Período creditício:
Julho/2014 a Junho/2044

Agrocortex Madeiras do Acre Agroflorestal Ltda.

SEDE CORPORATIVA | São Paulo/SP

Rua Dr. Rafael de Barros, 210 - 8º andar, Paraíso
CEP: 04003-041
São Paulo – SP, Brasil
Telefone: (11) 3254-4777

COMPLEXO INDUSTRIAL | Manoel Urbano/AC

Rodovia BR 364, s/nº, Sitio Katiani, Zona Rural
Manuel Urbano - AC, Brasil
CEP 69950-000

Para solicitar informações ou enviar comentários, entre em contato com:

Ana Beatriz Melo
Técnica de certificação florestal
ana.beatriz@agrocortex.com.br
Telefone: (11) 99441-4761

Figure 73. Explanatory letter about the Project and invitation for the Local Stakeholders Consultation

The local stakeholders' consultation was held on 20/06/2017 in the Agrocortex industrial complex located in Manoel Urbano, State of Acre. This presentation detailed a summary of the proposed activities of the REDD project implementation and monitoring, including FSC-certified sustainable forest management operations and potential socioenvironmental activities related to the SOCIALCARBON Methodology and Leakage Management Area involving the local community. An auditor from RINA Services S.p.A. (RINA), who is conducting the validation of this project, was also present at this meeting. Pictures of the local stakeholder consultation are available below.

The presentation raised several questions from the participants, which were promptly answered, resulting in great interest in understanding the challenges and benefits of this project. No negative input or comment was received. The stakeholder consultation attendance list is available at Figure 74 below.

Furthermore, all stakeholders were informed that the period for requesting information and comments about the Agrocortex REDD Project was open. The deadline for comments was 30 days from the presentation date, and it could be done by phone or e-mail, both of which were provided in the presentation and explanatory letters. No answer was obtained during the 30 days comment period, thus it was assumed that stakeholders have no objections to the project activity.

However, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. Furthermore, local communities surrounding the project area will be regularly visited as part of the FSC certification, which requires a social analysis and assessment about the impacts of the SFMP in the local communities. 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. The project proponent intends to conduct a stakeholder consultation at each monitoring period.

Figure 74. Local stakeholders consultation held in Agrocortex industrial complex, 20-June-2017

MADEIRAS DO ACRE

LISTA DE PRESENÇA
AGROCORTEX MADEIRAS DO ACRE AGROFLORESTAL LTDA
CNPJ: 19.848.073/0001-66

MADEIRAS DO ACRE

DATA: 20/06/2017	**HORÁRIO:** 8:40 – 9:30	**TOTAL DE PARTICIPANTES:** 23
DURAÇÃO: 50 min.	**LOCAL:** Refeitório Industria	

ASSUNTO:

Apresentação do Projeto de REDD Agrocortex (Primeira apresentação)

	NOME	ASSINATURA
1	Ana Beatriz Melo – Agrocortex	Ana Melo
2	Lays Gollovitz Miranda – Agrocortex	Lays Gollovitz Miranda
3	Talita C. Beck – RINA	[illegible]
4	Ítalo Augusto C. Lima – Bco. Amazônia	[illegible]
5	Aldenor Oliveira de Araújo	Coopin[illegible]
6	Edson Amaral – ICMBio	[illegible]
7	Avila B Almeida Dantas – Agrocortex	Avila Dantas
8	Jean Carlos Alves Meneses Agrocortex	Jean Carlos
9	Elza Rodrigues dos Santos – Agrocortex	Elza Rodrigues
10	Rafaele Dantas Cardoso – Agrocortex	Rafaele Dantas
11	Vaniusa Araujo da Cruz – Agrocortex	Vaniusa Araujo
12	João Pinto Aquino Dias	João Pinto Aquino Dias
13	[illegible]	[illegible]
14	Agnaldo Jesus Galvão de Lima.	[illegible]
15	Antonio [illegible] da Silva de Souza – Agrocortex	Antonio [illegible]
16	Edenaldo Gomes dos Santos Agrocortex	Edenaldo Gomes
17	Tardenson de Oliveira Barros Agrocortex	Tardenson Barros
18	Arizão Gonçalves [illegible] Agrocortex	[illegible]
19	[illegible] Araújo Vasconcelos	Agrocortex [illegible]
20	Jéssica Bispo do Carmo	JBCarmo
21	Adelvides de Fátima G Oliveira	[illegible] (Filoc)
22	Armando Luiz Piroski	[illegible] (Vago[illegible])
23	Ricardo Cesar Sitta	Ricardo Cesar Sitta
24		
25		

Observações:

Ana Melo
AGROCORTEX MADEIRAS DO ACRE AGROFLORESTAL LTDA
CNPJ: 19.848.073/0001-66

INSTRUTOR

Figure 75. Attendance list – Local Stakeholders Consultation

5.4 Public Comments

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

APPENDIX

APPENDIX I: PROJECT AREA CONTOUR COORDINATES

Project Area Contour Coordinates											
UTM 19L, Datum WGS84											
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1	497572.79	9036841.97	268	503153.60	9042237.99	535	488400.14	9040803.03	802	503153.14	9042178.05
2	497707.38	9036830.75	269	503153.14	9042229.16	536	488397.91	9040799.64	803	503185.37	9042151.20
3	497813.94	9036836.36	270	503153.14	9042237.99	537	488248.61	9040572.71	804	503237.68	9042107.60
4	497948.53	9036645.68	271	503153.60	9042237.99	538	488232.53	9040548.26	805	503281.24	9042073.72
5	498043.87	9036583.99	272	511826.19	9087206.05	539	488216.26	9040519.49	806	503292.53	9042070.49
6	498116.78	9036612.03	273	512159.68	9086960.66	540	488145.37	9040394.06	807	503292.69	9042065.72
7	498245.76	9036527.91	274	512807.77	9086954.37	541	488108.72	9040407.63	808	503296.70	9042065.72
8	498357.93	9036365.28	275	513018.56	9086293.69	542	487964.34	9040461.10	809	503296.70	9042046.88
9	498543.00	9036365.28	276	512980.81	9086016.83	543	487817.37	9040400.44	810	503288.90	9042037.66
10	498711.24	9036314.80	277	513023.76	9085804.44	544	487610.43	9040315.04	811	503261.88	9042030.16
11	498795.36	9036269.94	278	513094.07	9085456.82	545	487541.96	9040286.78	812	503189.28	9041996.28
12	498851.44	9036090.48	279	513395.36	9084919.63	546	487516.06	9040295.73	813	503165.08	9041947.88
13	498918.74	9036051.22	280	513358.46	9084617.94	547	487173.21	9040414.17	814	503213.48	9041899.48
14	498918.74	9035978.31	281	513240.19	9083651.31	548	487209.75	9040464.41	815	503261.88	9041889.80
15	498789.75	9035759.60	282	508748.87	9047024.50	549	487226.85	9040487.92	816	503309.39	9041896.13
16	498733.67	9035681.08	283	508087.89	9045661.42	550	487297.04	9040537.47	817	503369.01	9041881.46
17	498784.15	9035596.96	284	507759.13	9043731.58	551	487454.80	9040648.83	818	503417.23	9041869.60
18	498868.27	9035501.62	285	508062.27	9043261.92	552	487354.23	9040782.92	819	503417.81	9041869.45
19	498812.19	9035355.81	286	508147.66	9042732.50	553	487246.96	9040776.21	820	503419.69	9041868.88
20	498789.75	9035243.65	287	507964.07	9042083.52	554	487300.60	9040970.65	821	503421.52	9041868.19
21	498896.31	9035120.27	288	507946.99	9041613.87	555	487073.28	9041242.89	822	503423.31	9041867.38
22	499002.86	9035052.97	289	508016.04	9041233.08	556	487244.19	9041402.12	823	503425.04	9041866.46
23	499120.25	9034950.90	290	508005.41	9041233.08	557	487091.36	9041470.89	824	503426.71	9041865.42
24	499121.01	9034940.24	291	508005.41	9041261.79	558	487028.27	9041448.18	825	503428.31	9041864.28
25	497637.57	9034940.24	292	507976.70	9041261.79	559	487007.86	9041457.66	826	503429.82	9041863.04
26	497637.57	9034198.52	293	507976.70	9041204.37	560	486928.19	9041382.12	827	503431.26	9041861.69
27	497504.44	9033589.93	294	508005.41	9041204.37	561	486847.19	9041482.12	828	503432.60	9041860.26
28	497528.53	9033509.65	295	508005.41	9041175.66	562	486744.20	9041452.12	829	503433.85	9041858.75
29	497531.20	9033500.74	296	508026.45	9041175.66	563	486735.16	9041424.21	830	503434.99	9041857.15
30	497524.71	9033499.06	297	508087.89	9040836.81	564	486731.51	9041382.84	831	503436.03	9041855.49
31	497440.18	9033455.29	298	507861.60	9040341.54	565	486742.40	9041301.17	832	503436.95	9041853.76
32	497468.23	9033422.55	299	507895.76	9040145.14	566	486707.01	9041203.16	833	503437.76	9041851.97
33	497468.23	9033394.80	300	508066.54	9039931.66	567	486705.37	9041197.75	834	503438.46	9041850.13
34	497476.80	9033394.80	301	507972.61	9039590.09	568	486709.60	9041175.66	835	503439.03	9041848.26
35	497324.67	9033320.42	302	507712.17	9039239.99	569	486712.20	9041162.12	836	503439.47	9041846.35
36	497300.62	9033308.66	303	507549.92	9038906.96	570	486689.53	9041145.71	837	503439.80	9041844.41
37	497295.96	9033306.39	304	507268.13	9038667.87	571	486687.95	9041140.54	838	503439.99	9041842.46
38	497256.82	9033287.25	305	507144.31	9038240.91	572	486685.23	9041105.15	839	503440.05	9041840.50
39	497247.10	9033285.56	306	507246.78	9037788.34	573	486615.22	9041066.52	840	503440.00	9041838.64
40	497076.97	9033255.97	307	507383.41	9037378.46	574	486606.28	9041061.58	841	503439.33	9041827.72
41	497105.54	9033290.89	308	507122.97	9036934.42	575	486609.53	9041075.08	842	503558.71	9041840.92
42	497020.05	9033294.61	309	506542.31	9036823.41	576	486613.23	9041090.47	843	503615.91	9041819.47
43	496982.87	9033287.17	310	506478.26	9036533.08	577	486577.98	9041064.95	844	503657.31	9041836.03
44	496934.55	9033261.15	311	506485.92	9036467.95	578	486491.20	9041002.12	845	503669.95	9041836.03
45	496880.12	9033267.20	312	506488.74	9036468.23	579	486471.67	9040973.64	846	503669.95	9041841.08
46	496878.36	9033295.29	313	506481.15	9036461.72	580	486395.20	9040862.12	847	503710.94	9041857.48
47	496804.85	9033287.12	314	503843.01	9036204.45	581	486373.68	9040915.92	848	503711.88	9041857.86
48	496810.30	9033205.45	315	503728.38	9036193.28	582	486331.20	9041022.12	849	503716.13	9041858.33
49	496838.86	9033206.51	316	499063.95	9035739.02	583	486174.20	9041062.12	850	503716.40	9041859.34
50	496842.84	9033193.46	317	499116.28	9035006.43	584	486020.20	9041202.12	851	503809.32	9041845.37
51	496792.36	9033158.19	318	499081.38	9035052.97	585	485884.20	9041202.12	852	503823.87	9041988.72
52	496808.93	9033120.76	319	498929.96	9035165.13	586	485883.20	9041052.12	853	503831.02	9042008.77
53	496862.39	9033069.04	320	498851.44	9035260.47	587	486013.20	9040862.12	854	503838.36	9042096.76
54	496905.74	9033118.44	321	498840.23	9035350.20	588	485907.42	9040815.32	855	503841.73	9042137.18
55	496975.44	9033075.30	322	498913.13	9035473.58	589	485900.20	9040812.12	856	503842.20	9042142.93
56	496990.13	9033078.97	323	498890.70	9035529.66	590	485687.00	9040875.76	857	503860.49	9042229.57
57	497034.91	9033090.17	324	498800.97	9035664.26	591	485632.20	9040892.12	858	503892.31	9042266.70
58	497005.18	9033138.49	325	498823.40	9035720.34	592	485417.20	9040782.12	859	503899.64	9042266.70
59	496980.53	9033181.63	326	498918.74	9035866.15	593	485227.20	9040532.12	860	503899.64	9042275.25
60	497061.67	9033050.26	327	498986.04	9036073.65	594	485233.70	9040428.22	861	503899.86	9042275.51

61	497089.21	9033005.66	328	498868.27	9036281.15	595	485237.20	9040372.12	862	503908.71	9042295.41
62	497008.85	9032888.21	329	498772.93	9036398.92	596	485089.41	9040335.41	863	503928.35	9042295.41
63	497002.05	9032878.28	330	498514.95	9036410.14	597	485076.20	9040332.12	864	503928.35	9042324.12
64	496983.51	9032906.70	331	498408.40	9036443.79	598	484944.20	9040402.12	865	503957.07	9042324.12
65	496980.13	9032911.88	332	498301.85	9036578.39	599	484944.20	9040582.12	866	503957.07	9042378.01
66	496927.34	9032992.84	333	498167.25	9036673.72	600	484875.20	9040792.12	867	503960.28	9042381.55
67	496922.71	9032999.93	334	498077.52	9036701.76	601	484802.20	9040842.12	868	503985.78	9042381.55
68	496908.61	9033021.55	335	497982.18	9036690.55	602	484757.21	9040962.12	869	503985.78	9042409.60
69	496901.48	9033032.48	336	497847.59	9036881.23	603	484605.21	9040992.12	870	503986.38	9042410.26
70	496526.03	9032998.96	337	497673.73	9036881.23	604	484607.21	9041182.12	871	504014.49	9042410.26
71	496298.08	9033334.18	338	497572.79	9036926.09	605	484585.21	9041282.12	872	504014.49	9042441.18
72	496319.77	9033341.41	339	497539.14	9036999.00	606	484512.21	9041342.12	873	504020.32	9042447.60
73	496463.32	9033389.27	340	497662.52	9037122.38	607	484540.21	9041582.12	874	504035.06	9042444.32
74	496479.10	9033394.53	341	497701.77	9037189.67	608	484459.21	9041682.12	875	504035.06	9042491.33
75	496463.32	9033633.40	342	497623.26	9037228.93	609	484248.21	9041512.12	876	504010.28	9042511.15
76	496458.22	9033710.63	343	497421.37	9037268.19	610	484179.21	9041562.12	877	503985.78	9042525.15
77	496455.63	9033749.87	344	497247.51	9037200.89	611	484228.21	9041652.12	878	503985.78	9042553.82
78	496418.92	9033764.08	345	497040.01	9037178.46	612	484213.21	9041852.12	879	503870.93	9042553.82
79	496387.58	9033770.39	346	496372.64	9037116.77	613	484020.21	9041862.12	880	503153.14	9042291.63
80	496279.90	9033770.39	347	496076.49	9037080.25	614	483975.21	9041652.12	881	503166.00	9042324.12
81	496274.21	9033854.10	348	495553.85	9037015.82	615	483864.21	9041672.12	882	503153.14	9042324.12
82	496301.03	9034024.36	349	494864.05	9036948.52	616	483815.21	9041802.12	883	503153.14	9042291.63
83	496423.75	9034060.53	350	494757.75	9036920.18	617	483979.21	9041942.12	884	503181.85	9042364.20
84	496430.01	9034069.30	351	494732.57	9036934.52	618	483734.26	9042082.82	885	503200.07	9042410.26
85	496402.00	9034098.50	352	494713.98	9037016.70	619	483637.73	9047072.46	886	503181.85	9042410.26
86	496421.09	9034144.32	353	494814.69	9037112.61	620	468415.62	9060128.09	887	503181.85	9042364.20
87	496536.09	9034420.32	354	494873.27	9037238.13	621	466380.02	9067629.65	888	503223.66	9042465.48
88	496602.44	9034571.98	355	494806.32	9037338.54	622	467456.21	9067898.34	889	503274.62	9042525.11
89	496606.88	9034582.13	356	494698.64	9037414.55	623	468197.88	9068030.90	890	503210.56	9042525.11
90	496615.00	9034600.69	357	494711.54	9037500.57	624	468841.28	9068751.99	891	503210.56	9042436.78
91	496635.59	9034647.76	358	494711.91	9037503.02	625	469115.83	9069165.80	892	503218.57	9042457.03
92	496652.68	9034686.82	359	494720.16	9037557.99	626	469148.93	9070000.39	893	503218.75	9042457.45
93	496664.31	9034713.39	360	494724.46	9037586.70	627	469715.39	9070494.82	894	503219.55	9042459.24
94	496677.81	9034744.25	361	494725.61	9037594.35	628	470523.35	9071341.49	895	503220.48	9042460.97
95	496693.02	9034779.01	362	494735.62	9037661.04	629	470602.70	9071904.52	896	503221.51	9042462.64
96	496735.74	9034876.67	363	494749.33	9037752.47	630	471886.22	9073110.27	897	503222.66	9042464.24
97	496736.81	9034876.88	364	494707.30	9037741.58	631	472442.82	9073441.79	898	503223.66	9042465.48
98	496755.91	9034811.41	365	494568.31	9037705.54	632	472706.88	9073796.40	899	507783.82	9041099.17
99	496841.13	9034794.37	366	494414.10	9037490.99	633	473467.02	9073887.44	900	507740.08	9041035.20
100	496932.03	9034794.37	367	494413.59	9037492.11	634	474211.26	9074911.96	901	507755.34	9040988.85
101	497068.39	9034794.37	368	494373.88	9037578.15	635	475066.51	9074991.57	902	507809.45	9040985.75
102	497125.20	9034868.22	369	494381.62	9037640.07	636	475481.78	9075561.29	903	507868.05	9041055.87
103	497102.48	9035004.58	370	494392.89	9037730.26	637	475737.04	9076637.61	904	507858.41	9041126.01
104	497119.56	9035049.60	371	494400.69	9037792.70	638	475894.76	9077591.94	905	507817.57	9041118.23
105	497164.97	9035169.34	372	494125.81	9037886.56	639	475928.67	9078437.75	906	507783.82	9041099.17
106	497079.75	9035180.70	373	494157.81	9037927.71	640	476158.88	9079438.57	907	504436.79	9041109.91
107	497045.74	9035175.60	374	494172.74	9037946.90	641	476147.02	9079782.60	908	504428.52	9041209.15
108	496966.12	9035163.66	375	494281.24	9037986.88	642	476469.25	9080341.93	909	504337.55	9041200.88
109	496880.90	9035072.76	376	494300.13	9037993.83	643	476108.25	9080741.93	910	504300.58	9041144.00
110	496843.56	9035074.25	377	494276.26	9038091.94	644	476102.86	9081116.85	911	504246.09	9041141.41
111	496768.08	9035083.85	378	494274.77	9038098.06	645	475674.25	9081651.93	912	504153.17	9041152.56
112	496767.67	9035077.29	379	494239.79	9038241.90	646	475773.21	9082842.14	913	504091.32	9041149.47
113	496738.86	9035078.44	380	494194.04	9038257.97	647	475692.62	9083266.28	914	504064.08	9041161.16
114	496716.14	9034947.76	381	494058.98	9038305.43	648	476055.25	9084431.91	915	504058.78	9041074.82
115	496719.40	9034936.58	382	493991.72	9038329.06	649	475644.71	9085235.60	916	504030.50	9040970.42
116	496705.25	9034929.66	383	493917.97	9038436.33	650	491931.83	9092531.60	917	503933.86	9040862.63
117	496546.14	9035030.43	384	493879.27	9038418.39	651	494213.96	9093555.16	918	503926.03	9040848.54
118	496841.14	9035399.18	385	493649.58	9038311.86	652	494251.44	9093548.23	919	503842.86	9040812.90
119	496750.44	9035444.53	386	493633.69	9038304.49	653	494437.34	9093513.84	920	503818.84	9040810.26
120	496658.00	9035490.75	387	493620.87	9038298.55	654	494816.29	9093443.76	921	503762.19	9040907.39
121	496549.46	9035545.02	388	493455.36	9038221.79	655	504521.78	9091650.73	922	503822.42	9040950.41
122	496543.16	9035548.17	389	493234.11	9038228.49	656	509484.11	9090735.41	923	503839.63	9041062.27
123	496492.04	9035573.73	390	493200.94	9038291.75	657	509496.02	9090384.01	924	503813.82	9041242.96
124	496485.73	9035576.88	391	493104.06	9038476.49	658	509460.56	9090271.46	925	503812.16	9041244.02
125	496463.32	9035588.09	392	493089.96	9038503.38	659	509626.35	9090106.16	926	503813.73	9041253.66
126	496438.87	9035600.32	393	493019.89	9038618.78	660	509838.14	9089969.11	927	503801.70	9041250.67
127	496348.48	9035531.74	394	492984.09	9038677.74	661	510021.90	9089744.86	928	503719.17	9041303.20
128	496332.29	9035519.46	395	492903.08	9038811.18	662	510246.16	9089654.53	929	503584.16	9041196.61
129	496319.77	9035509.96	396	492879.50	9038850.01	663	510786.55	9089523.72	930	503511.63	9041178.59
130	496256.59	9035462.04	397	492874.37	9038858.47	664	511247.51	9089202.91	931	503509.99	9041201.63
131	496244.44	9035452.82	398	492862.00	9038878.83	665	511638.40	9088586.21	932	503489.67	9041226.47

132	496061.36	9035448.75	399	492827.59	9038964.86	666	511755.20	9088090.99	933	503457.45	9041202.31
133	495975.23	9035446.83	400	492794.96	9039046.45	667	511712.93	9087558.42	934	503448.82	9041195.83
134	495942.74	9035446.11	401	492473.14	9039033.04	668	511826.19	9087206.05	935	503424.56	9041204.39
135	495922.03	9035462.04	402	492479.45	9039022.28	669	502519.23	9045829.83	936	503448.31	9041166.39
136	495768.42	9035580.20	403	492496.28	9038993.57	670	502498.13	9045783.42	937	503451.39	9041162.54
137	495573.26	9035485.77	404	492501.11	9038985.32	671	502434.99	9045787.05	938	503402.42	9041157.10
138	495560.58	9035479.63	405	492513.11	9038964.86	672	502431.31	9045636.40	939	503323.36	9041148.32
139	495548.04	9035490.75	406	492529.94	9038936.15	673	502427.53	9045628.10	940	503309.68	9041118.23
140	495314.86	9035697.43	407	492587.12	9038838.61	674	502430.19	9045590.88	941	503300.16	9041097.27
141	495288.90	9035720.44	408	492558.54	9038832.59	675	502427.84	9045494.65	942	503280.33	9041053.67
142	495265.58	9035741.11	409	492501.11	9038820.50	676	502439.21	9045494.00	943	503324.52	9041047.35
143	495286.15	9035761.68	410	492357.56	9038790.28	677	502439.44	9045493.98	944	503340.57	9041045.06
144	495312.51	9035788.04	411	492332.35	9038784.97	678	502441.39	9045493.79	945	503374.98	9040993.43
145	495440.29	9035749.15	412	492321.86	9038774.48	679	502443.33	9045493.47	946	503452.43	9040993.43
146	495466.71	9035741.11	413	492164.73	9038617.36	680	502445.24	9045493.03	947	503473.53	9040993.43
147	495500.24	9035848.38	414	492150.33	9038649.03	681	502447.12	9045492.46	948	503490.10	9040980.49
148	495429.70	9035930.67	415	492131.21	9038691.11	682	502447.30	9045492.40	949	503542.01	9040960.39
149	495419.78	9035942.25	416	492151.32	9038818.49	683	502555.91	9045417.20	950	503542.64	9040960.14
150	495429.70	9035946.31	417	491896.55	9039033.04	684	502536.40	9045395.52	951	503544.43	9040959.33
151	495439.07	9035950.14	418	491798.25	9039000.27	685	502431.30	9045434.38	952	503546.16	9040958.41
152	495458.42	9035958.05	419	491695.42	9038965.99	686	502426.37	9045434.66	953	503547.83	9040957.37
153	495567.28	9036002.59	420	491635.08	9038758.15	687	502426.08	9045422.86	954	503549.42	9040956.23
154	495601.97	9035936.10	421	491621.29	9038764.28	688	502441.76	9045239.61	955	503550.94	9040954.99
155	495624.61	9035892.71	422	491582.34	9038781.59	689	502470.87	9045055.59	956	503552.38	9040953.65
156	495630.69	9035881.07	423	491574.73	9038784.97	690	502545.05	9044947.13	957	503553.72	9040952.22
157	495639.59	9035864.00	424	491576.46	9038821.30	691	502660.14	9044821.80	958	503554.96	9040950.70
158	495647.74	9035848.38	425	491577.83	9038850.01	692	502636.76	9044823.15	959	503555.68	9040949.70
159	495676.13	9035864.00	426	491580.57	9038907.44	693	502566.13	9044862.51	960	503555.68	9040912.83
160	495716.82	9035886.38	427	491581.44	9038925.76	694	502451.75	9044784.34	961	503546.49	9040889.59
161	495728.33	9035892.71	428	491553.63	9038931.85	695	502518.49	9044681.65	962	503495.45	9040838.55
162	495745.53	9035902.17	429	491533.97	9038936.15	696	502529.23	9044737.52	963	503495.45	9040778.32
163	495781.83	9035922.13	430	491521.93	9038938.78	697	502597.33	9044775.98	964	503572.89	9040700.88
164	495775.49	9036036.27	431	491383.10	9038969.15	698	502670.99	9044785.87	965	503607.31	9040649.25
165	495775.12	9036042.82	432	491366.89	9038972.70	699	502729.23	9044782.53	966	503608.62	9040646.62
166	495835.46	9036042.82	433	491269.68	9039348.15	700	502730.02	9044795.46	967	503641.72	9040580.42
167	495860.38	9036016.43	434	491383.46	9039575.71	701	502784.81	9044782.23	968	503658.93	9040494.37
168	495868.76	9036007.56	435	491383.66	9039576.10	702	502802.59	9044893.79	969	503712.52	9040429.30
169	495889.09	9035986.03	436	491323.31	9039723.60	703	502802.92	9045035.94	970	503706.53	9040400.10
170	495895.88	9035978.85	437	491323.31	9039891.22	704	502730.13	9045078.48	971	503714.95	9040336.97
171	495899.86	9035974.63	438	491189.22	9039985.08	705	502728.62	9045079.43	972	503756.02	9040341.86
172	495881.92	9035975.91	439	491193.95	9040055.90	706	502727.02	9045080.57	973	503778.54	9040344.54
173	495831.67	9035978.42	440	491201.60	9040170.75	707	502725.50	9045081.81	974	503791.77	9040362.18
174	495831.67	9035978.85	441	491202.63	9040186.22	708	502724.07	9045083.15	975	503788.70	9040371.41
175	495830.93	9035978.85	442	490947.86	9040534.85	709	502722.73	9045084.59	976	503894.98	9040393.70
176	495830.80	9035978.47	443	490760.13	9040528.15	710	502721.48	9045086.10	977	503931.44	9040446.63
177	495827.47	9035978.63	444	490750.30	9040515.29	711	502720.34	9045087.70	978	503951.49	9040451.35
178	495825.35	9035961.72	445	490694.70	9040442.58	712	502719.30	9045089.36	979	503953.29	9040478.34
179	495814.59	9035928.66	446	490676.55	9040418.84	713	502718.75	9045090.36	980	503978.96	9040515.60
180	495820.54	9035923.25	447	490672.97	9040414.17	714	502675.92	9045171.39	981	503959.17	9040566.57
181	495819.30	9035913.29	448	490681.76	9040395.35	715	502675.55	9045172.12	982	503960.06	9040579.96
182	495843.80	9035880.62	449	490706.18	9040343.02	716	502674.73	9045173.91	983	503960.09	9040580.42
183	495900.97	9035872.45	450	490751.34	9040246.25	717	502674.04	9045175.74	984	504080.56	9040666.46
184	495904.53	9035874.75	451	490766.84	9040213.03	718	502673.47	9045177.62	985	504185.95	9040734.22
185	495960.20	9035866.12	452	490741.73	9040203.24	719	502673.32	9045178.26	986	504306.31	9040697.70
186	495978.82	9035865.04	453	490520.01	9040116.71	720	502758.93	9045237.53	987	504353.86	9040824.28
187	495983.16	9035892.71	454	490491.95	9040105.76	721	502766.81	9045242.98	988	504361.32	9040825.46
188	495975.23	9035892.71	455	490490.04	9040055.90	722	502764.88	9045250.68	989	504361.32	9040844.14
189	495975.23	9035918.70	456	490485.33	9039933.55	723	502751.85	9045302.82	990	504363.28	9040849.36
190	495975.54	9035918.88	457	490485.25	9039931.44	724	502746.36	9045324.76	991	504428.52	9040878.35
191	496004.43	9035943.24	458	490585.82	9039777.24	725	503013.62	9045337.01	992	504436.79	9041109.91
192	496056.16	9035956.85	459	490564.62	9039748.98	726	502995.55	9045481.32	993	503893.65	9039811.07
193	496009.04	9035962.51	460	490557.94	9039740.08	727	502809.29	9045512.23	994	503907.54	9039699.96
194	496061.36	9035997.95	461	490525.48	9039696.79	728	502748.47	9045701.46	995	504011.70	9039727.73
195	496157.28	9036062.93	462	490433.88	9039691.96	729	502684.28	9045884.85	996	503990.87	9039852.74
196	496061.36	9036124.71	463	490398.09	9039690.08	730	502519.23	9045829.83	997	503893.65	9039811.07
197	495975.78	9036179.83	464	490397.49	9039682.65	731	502952.16	9043156.76	998	494629.66	9037938.39
198	495959.50	9036190.32	465	490384.68	9039522.47	732	502952.16	9043128.05	999	494636.16	9037736.03
199	496033.25	9036237.25	466	490368.46	9039457.57	733	502980.87	9043128.05	1000	494672.17	9037750.91
200	496207.56	9036277.47	467	490357.86	9039415.19	734	502980.87	9043099.34	1001	494673.96	9037751.58
201	496321.54	9036438.38	468	490334.09	9039421.53	735	503067.00	9043099.34	1002	494675.84	9037752.15
202	496261.20	9036599.29	469	490146.76	9039471.49	736	503067.00	9043128.05	1003	494677.75	9037752.60

203	496147.50	9036593.96	470	490108.58	9039481.67	737	503095.72	9043128.05	1004	494679.69	9037752.92
204	496090.07	9036591.27	471	490056.16	9039495.65	738	503095.72	9043099.34	1005	494681.64	9037753.11
205	495887.89	9036581.79	472	490020.64	9039537.43	739	503124.43	9043099.34	1006	494683.60	9037753.18
206	495832.11	9036579.18	473	489942.18	9039629.74	740	503124.43	9043070.63	1007	494685.56	9037753.12
207	495829.28	9036581.79	474	490062.86	9039897.92	741	503153.14	9043070.63	1008	494687.51	9037752.92
208	495774.24	9036632.59	475	490062.86	9040033.34	742	503153.14	9043128.05	1009	494689.45	9037752.61
209	495767.07	9036639.22	476	490062.86	9040132.58	743	503124.43	9043128.05	1010	494691.36	9037752.16
210	495657.79	9036740.09	477	489955.59	9040213.03	744	503124.43	9043214.19	1011	494693.24	9037751.59
211	495483.48	9036559.06	478	489885.19	9040461.10	745	503101.47	9043214.19	1012	494695.08	9037750.90
212	495322.57	9036612.70	479	489916.55	9040486.58	746	503089.79	9043307.37	1013	494696.86	9037750.09
213	495255.30	9036581.79	480	489917.07	9040487.00	747	502975.40	9043325.48	1014	494698.60	9037749.17
214	495200.01	9036556.39	481	489931.79	9040498.97	748	502934.07	9043300.91	1015	494700.26	9037748.14
215	495192.81	9036553.08	482	489992.47	9040548.26	749	502913.71	9043228.93	1016	494701.86	9037746.99
216	495142.59	9036530.01	483	490000.98	9040551.83	750	502967.39	9043195.05	1017	494703.38	9037745.75
217	495130.32	9036524.37	484	490200.31	9040635.42	751	502980.87	9043173.87	1018	494704.06	9037745.11
218	495085.16	9036503.62	485	490280.76	9040776.21	752	502980.87	9043156.76	1019	494730.10	9037795.33
219	495074.50	9036498.72	486	490220.42	9040963.94	753	502952.16	9043156.76	1020	494707.19	9037955.04
220	495034.27	9036565.77	487	490118.05	9040957.34	754	503187.19	9042962.64	1021	494629.66	9037938.39
221	495065.17	9036581.79	488	490031.91	9040951.78	755	503213.28	9042911.72	1022	495544.55	9037758.97
222	495113.88	9036607.04	489	490012.58	9040950.53	756	503268.76	9042908.53	1023	495544.55	9037701.55
223	495120.55	9036610.50	490	490009.53	9040945.96	757	503271.95	9042915.41	1024	495601.97	9037701.55
224	495171.30	9036636.82	491	490003.20	9040936.46	758	503260.85	9042972.53	1025	495601.97	9037672.84
225	495215.29	9036659.63	492	489990.39	9040917.25	759	503203.91	9042996.99	1026	495659.40	9037672.84
226	495113.88	9036717.38	493	489974.49	9040893.40	760	503187.19	9042962.64	1027	495659.40	9037787.68
227	495099.88	9036725.35	494	489971.25	9040888.54	761	503088.83	9042902.31	1028	495573.26	9037787.68
228	495056.45	9036750.08	495	489917.07	9040807.26	762	503096.30	9042791.33	1029	495573.26	9037758.97
229	495049.46	9036754.06	496	489894.69	9040773.69	763	503163.98	9042822.75	1030	495544.55	9037758.97
230	494970.32	9036799.13	497	489888.35	9040764.19	764	503168.74	9042900.15	1031	504000.16	9037205.83
231	494948.62	9036811.49	498	489876.68	9040746.69	765	503110.93	9042910.53	1032	503833.07	9037169.71
232	494811.10	9036889.80	499	489865.08	9040729.28	766	503088.83	9042902.31	1033	503833.07	9037156.03
233	495217.37	9036914.87	500	489847.97	9040752.09	767	503870.93	9042553.82	1034	503833.07	9037107.19
234	496101.28	9037016.47	501	489824.85	9040782.92	768	503870.93	9042496.39	1035	503832.06	9037098.60
235	496193.18	9037027.04	502	489854.91	9040879.11	769	503899.64	9042496.39	1036	503812.22	9037098.60
236	497124.13	9037127.98	503	489871.23	9040931.34	770	503899.64	9042488.67	1037	503812.36	9037098.01
237	497398.93	9037178.46	504	489891.90	9040997.46	771	503861.60	9042496.28	1038	503812.68	9037096.07
238	497511.10	9037189.67	505	489824.38	9041004.00	772	503813.51	9042498.96	1039	503812.86	9037094.28
239	497628.87	9037150.42	506	489772.33	9041009.04	773	503813.51	9042525.11	1040	503819.93	9036995.48
240	497499.88	9037071.90	507	489684.06	9041017.58	774	503698.66	9042525.11	1041	503818.44	9036982.81
241	497483.06	9036970.96	508	489543.26	9041325.99	775	503698.66	9042553.82	1042	503821.97	9036966.91
242	497572.79	9036841.97	509	489502.57	9041305.64	776	503612.53	9042553.82	1043	503823.15	9036950.46
243	496121.38	9035905.97	510	489391.25	9041249.98	777	503612.53	9042525.11	1044	503823.16	9036950.30
244	496150.40	9035852.22	511	489382.35	9041245.53	778	503583.81	9042525.11	1045	503823.18	9036950.01
245	496301.47	9035853.93	512	489371.54	9041119.43	779	503583.81	9042467.68	1046	503823.94	9036936.56
246	496266.93	9035954.30	513	489362.24	9041010.87	780	503526.39	9042467.68	1047	503828.49	9036937.59
247	496121.38	9035905.97	514	489125.44	9040917.25	781	503497.68	9042467.68	1048	503832.37	9036920.11
248	495692.73	9035774.43	515	489103.17	9040908.45	782	503354.12	9042467.68	1049	503828.96	9036890.49
249	495726.73	9035626.64	516	489073.94	9040896.90	783	503354.12	9042525.11	1050	503826.53	9036890.63
250	495803.23	9035643.07	517	489062.68	9040866.07	784	503353.51	9042525.11	1051	503827.33	9036876.44
251	495855.67	9035619.21	518	489058.87	9040855.65	785	503272.50	9042430.31	1052	503823.55	9036843.67
252	495887.20	9035688.80	519	488983.10	9040648.27	786	503268.40	9042419.94	1053	503829.58	9036836.68
253	495748.38	9035802.47	520	488946.56	9040548.26	787	503242.98	9042415.70	1054	503832.34	9036787.78
254	495692.73	9035774.43	521	488940.59	9040493.69	788	503220.10	9042301.32	1055	503832.38	9036786.90
255	496441.58	9033759.51	522	488923.09	9040333.72	789	503220.96	9042300.03	1056	503832.50	9036782.28
256	496478.15	9033746.16	523	488986.90	9040200.78	790	503218.91	9042294.84	1057	504049.78	9036760.63
257	496478.02	9033752.18	524	489003.55	9040166.10	791	503176.59	9042279.73	1058	504051.71	9036791.92
258	496441.58	9033759.51	525	488894.38	9040212.89	792	503155.40	9042272.16	1059	504147.34	9036842.55
259	497120.17	9033430.83	526	488878.85	9040219.54	793	503154.04	9042246.27	1060	504166.42	9037014.30
260	497147.89	9033427.63	527	488862.75	9040226.44	794	503149.50	9042266.70	1061	504170.94	9037015.33
261	497172.39	9033446.69	528	488862.12	9040227.39	795	503124.43	9042266.70	1062	504169.39	9037041.08
262	497186.01	9033498.41	529	488842.46	9040256.88	796	503124.43	9042237.99	1063	504172.15	9037065.84
263	497158.82	9033533.97	530	488826.02	9040281.54	797	503095.72	9042237.99	1064	504180.42	9037189.89
264	497150.61	9033544.70	531	488823.32	9040285.60	798	503095.72	9042180.57	1065	504089.15	9037195.60
265	497066.21	9033482.08	532	488768.60	9040367.67	799	503124.43	9042180.57	1066	504086.39	9037208.61
266	497077.11	9033435.80	533	488742.07	9040407.47	800	503124.43	9042151.85	1067	504000.16	9037205.83
267	497120.17	9033430.83	534	488668.32	9040843.26	801	503153.14	9042151.85			

APPENDIX II: DEFINITION OF BIOMASS STOCKS

A total of 14 different forest phytophysiognomies were identified in the reference region, while 3 of them are present in the project area and 8 in the leakage belt.

These forest phytophysiognomies were grouped in accordance to their presence in each project spatial boundary (reference region, project area and leakage belt), according to the predominant category of each phytophysiognomy, following instructions from the Brazilian Institute for Geography and Statistics - IBGE.

Afterwards, biomass stocks were calculated through the weighted average between above ground biomass values for each phytophysiognomy, which were obtained from Salimon *et al.* (2011)[214], and the presence of each phytophysiognomy within each project boundary.

Table 79 below details the presence of each phytophysiognomy within each project spatial boundary and the grouping method adopted according to the predominant forest class. These data were used to calculate the weighted average of biomass stocks in each grouped forest class.

[214] SALIMON,C.I; PUTZ, F.E.; MENEZES-FILHO, L.; ANDERSON,A.; SILVEIRA, M.; FOSTER BROWN, I.; OLIVEIRA, L.C. Estimating state-wide biomass carbon stocks for a REDD plan in Acre, Brazil. 2011, **Forest Ecology and Management**, 262, p. 555–560, 2011.

				REFERENCE REGION			PROJECT AREA			LEAKAGE BELT		
Acronym	Vegetation classes (IBGE)	Grouped classes	Average above ground biomass (Mg ha^{-1})	Area of the vegetation class in the RR (ha)	% of the class in the grouped vegetation type	% of the class in the RR	Area of the vegetation class in the PA (ha)	% of the class in the grouped vegetation type	% of the vegetation class in the PA	Area of the vegetation class in the LK (ha)	% of the class in the grouped vegetation type	% of the vegetation class in the Leakage Belt
Abb	Floresta Ombrófila Aberta Terras Baixas com Bambu	Abb	192.80	362.16	0.04%	0.03%						
Abb+Abp	Floresta Ombrófila Aberta Terras Baixas com Bambu + Palmeiras		186.50	163,377.76	18.55%	14.72%				11,537.28	19%	9%
Abb+Abp+ Dbe	Floresta Ombrófila Aberta Terras Baixas com Bambu + Palmeiras + Floresta Ombrófila Densa de terras Baixas com Dossel Emergente		274.90	41,426.30	4.70%	3.73%						
Abb+Dbe	Floresta Ombrófila Aberta Terras Baixas com Bambu + Floresta Ombrófila Densa de terras Baixas com Dossel Emergente		274.20	675,167.73	76.64%	60.83%	172,554.03	100%	93%	50,159.25	81%	39%
Abb+Vs	Floresta Ombrófila Aberta Terras Baixas com Bambu + Vegetação Secundária		114.90	625.84	0.07%	0.06%				526.94	1%	
Dbe	Floresta Ombrófila Densa de Terras Baixas com Dossel Emergente	Dbe	328.80	1,709.61	61.88%	0.15%						
Dbe+Abp	Floresta Ombrófila Densa de Terras Baixas com Dossel Emergente + Floresta Ombrófila Aberta Terras Baixas com Palmeiras		315.90	1,053.01	38.12%	0.09%						

Aap+Aab+ Dau	Floresta Ombrófila Aberta Aluvial com Palmeiras + Bambu + Floresta Ombrófila Densa Aluvial com Dossel Uniforme		218.50	2,589.03	3.03%	0.23%							
Aap+Dae	Floresta Ombrófila Aberta Aluvial com Palmeiras + Floresta Ombrófila Densa Aluvial com Dossel Emergente	Aap	218.50	27,683.70	32.36%	2.49%	4,133.22	100%	2%	18,796.21	41%	15%
Aap+Dau	Floresta Ombrófila Aberta Aluvial com Palmeiras + Floresta Ombrófila Densa Aluvial com Dossel Uniforme		218.50	55,264.26	64.61%	4.98%				27,023.56	59%	21%
Abp+Abb	Floresta Ombrófila Aberta Terras Baixas com Palmeiras + Bambu		234.30	74,968.58	71.23%	6.75%	9,531.80	100%	5%	2,694.49	100%	2%
Abp+Dbe+ Abb	Floresta Ombrófila Aberta Terras Baixas com Palmeiras + Floresta Ombrófila Densa de terras Baixas com Dossel Emergente + Bambu	Abp	274.90	30,275.41	28.77%	2.73%						
Ap+Vs.A	Pecuária + Vegetação Secundária		37.00	27,709.95	91.78%	2.50%				12,645.19	87%	10%
Ap+Vs+ Aap	Pecuária + Vegetação Secundária + Floresta Ombrófila Aberta Aluvial com Palmeiras	Ap	37.00	2,481.65	8.22%	0.22%				1,818.77	13%	1%

Table 79. Presence of each phytophysiognomy within each project boundary and the grouping method adopted according to the predominant forest class