ECOMAPUÁ AMAZON REDD PROJECT

Document Prepared by Sustainable Carbon – Projetos Ambientais Ltda.

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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Project

Brazil has more than 470 million hectares of forest, covering 60.14% of its entire territory (FAO – FRA, 2010[1]), putting it in second place for nations with most forest area worldwide. Brazil has at times also been the country with the highest levels of forest loss in the world, for example 3,090,000ha was deforested from 2000 to 2005 (FAO – FRA, 2010). The expansion of the agriculture frontier due to cattle ranching, timber collection, and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The Ecomapuá Amazon REDD Project is located on Marajó Island, Pará State, in the Eastern Amazon region of Brazil. The island lies at the mouth of the Amazon River, which has been called the rainforest's "super highway", being the principal means of transportation as well as a strong driver of deforestation. Marajó is Brazil's richest region in terms of waterways[2], and it has a long history of colonization especially by small-scale subsistence farmers, beginning early in the history of Amazon exploration during the rubber-tapping era. The Marajó várzea is a critically valuable ecosystem for many species, but especially noted for its avifauna[3], adding to the importance of the present project.

The primary objective of the Ecomapuá Amazon REDD Project is to avoid the unplanned deforestation (AUD) of a subsection of the 97,007.22 ha project area, which is within a private property on Marajó Island, owned by Ecomapuá Conservação Ltda. (hereafter, Ecomapuá Ltda. or "the company"). The company is a private Brazilian sustainable development firm engaged in renewable energy and carbon finance projects, with the mission of conserving the environment and improving living standards of isolated communities on the island. Ecomapuá Ltda. was created on 19-July-2001, with the following goal described in their Social Contract[4]: "development of sustainable development projects, clean development mechanisms, carbon sequestration". The diagnostic study of the project area, published on 01-September-2002, was

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[1] Global Forest Resource Assessment: Main Report, available at: <http://www.fao.org/docrep/013/i1757e/i1757e.pdf>; and Country Report for Brazil, available at: <http://www.fao.org/forestry/20288-0f6ee8584eea8bff0d20ad5cebcb071cf.pdf>.

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

[3] Antonio A. F. Rodrigues, (June 2007) "Priority Areas for Conservation of Migratory and Resident Waterbirds on the Coast of Brazilian Amazonia". *Revista Brasileira de Ornitologia 15 (2) 209-218*.

[4] São Paulo, 19.07.01 - "Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.".

the first action of the company in terms of initiating the present REDD project, and is thus the designated project start date.

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

According to VCS requirements, the baseline must be reassessed every 10 years because projections for deforestation are difficult to predict over the long term. This updated version of the VCS PD covers the second baseline period of the Ecomapuá Amazon REDD Project, from 01-January-2013 to 31-December-2022.

This REDD project is expected to avoid a predicted 1,157 ha of deforestation, equating to around 942,324 tCO_2e in emissions reductions across the second and third baseline periods (01-January-2013 to 31-December-2032).

During the first baseline period, the dynamic of deforestation within the project's reference region involved overlapping agents, which cannot be separated in terms of deforestation location. Specifically, the agents were: timber harvesters, acting both legally and illegally; subsistence farming relying on slash and burn practices for cultivation[5]; and extraction of palm heart, which supplements the income and subsistence from latter activity. Regarding the revision of the second baseline period (2013 to 2022), which is revised in this updated version of the VCS PD, the projection required the PA-159 road to be also taken into account. This road will link Breves to Anajás and will be an important driver of deforestation during the second baseline period because, while it failed to open by the scheduled date of 2008/2009, work on it will resume in 2014.

Revenue from the sale of VCUs is essential for this conservation project activity to compete with other profitable alternative land-use scenarios.

1.2 Sectoral Scope and Project Type

14. Agriculture, Forestry, Land Use

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

This is not a grouped project.

[5] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

1.3 Project Eligibility

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

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

1.4 Project Design

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

Eligibility Criteria

Not applicable. This is not a grouped project.

1.5 Project Proponent

Organization name	Ecomapuá Conservação Ltda.
Contact person	Lap Tak Chan
Title	Managing Partner
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Organization name	Sustainable Carbon – Projetos Ambientais Ltda.: Project developer, Project participant and Project conceiver. As the authorized project contact, Sustainable Carbon was given the responsibility of developing the present Project Document.
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1.6 Other Entities Involved in the Project

Organization name	Uezu Planejamento Ambiental S/S LTDA
Role in the project	Coordinator
Contact person	Alexandre Uezu
Title	CEO
Address	Rod. D. Pedro I KM 47, SN, Nazaré Paulista – SP
Telephone	-
Email	-

1.7 Ownership

The five properties making up the Ecomapuá Amazon REDD Project are owned by the company Ecomapuá Conservação Ltda. The legal documents proving the land title and ownership of each property will be made available to the auditors during the validation process, specifically in Appendix II.

1.8 Project Start Date

The project start date is 01-September-2002 because an initial diagnostic study of the area, commissioned by Ecomapuá Ltda., was published on this date, analysing the risk of deforestation over the next 30 years[6]. The deforestation rate identified in the aforementioned study was 0.685% per year – an estimated baseline which justified the probable viability of a future REDD project. To clarify, this deforestation rate is not the one utilized in the present REDD project, merely a preliminary estimate.

Ecomapuá Ltda. was created on 19-July-2001, with the following goal described in their Social Contract[7]: “development of sustainable development projects, clean development mechanisms, carbon sequestration”. Therefore, the diagnostic study mentioned above was the first action of the company in terms of initiating the present REDD project, and is thus the designated project start date.

1.9 Project Crediting Period

The project has a crediting period of 30 years, from 01-January-2003 until 31-December-2032.

This document covers the second baseline period of this project activity, from 01-Janaury-2013 to 31-December-2022.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2013	65,678
2014	59,690
2015	62,718
2016	54,077
2017	54,093
2018	68,231
2019	55,731
2020	44,097

[6] P. G. Martorano (September 2002), “Caracterização da vegetação e uso do solo das terras pertencentes à empresa Ecomapuá Conservação Ltda No Município de Breves, Pará”.

[7] São Paulo, 19.07.01 - “Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.”.

2021	41,196
2022	53,074
2023	38,402
2024	41,373
2025	45,772
2026	39,193
2027	40,781
2028	31,621
2029	37,816
2030	33,974
2031	38,686
2032	36,121
Total estimated ERs	**942,324**
Total number of crediting years	**20**
Average annual ERs	**47,116**

1.11 Description of the Project Activity

The principal objective of the present REDD project is the conservation of 97,007.22 ha of forest area within the five Ecomapuá properties. This will be achieved through avoidance of unplanned deforestation. It is important to note that this project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

As required by the VCS, the baseline must be reassessed every 10 years because projections for deforestation are difficult to predict over the long term. This updated version of the VCS PD covers the second baseline period of the Ecomapuá Amazon REDD Project, from 01-January-2013 to 31-December-2022. Additionally to the baseline reassessment, some corrections were made during the first baseline period, which affected the *ex-ante* estimates.

The *ex-ante* updated estimate for the predicted avoided deforestation within the project area over the 30 year project lifetime would be 1,157 ha. The avoided emissions due to the Ecomapuá Amazon REDD AUD Project are expected to be 851,933 tCO_2e across the project crediting period (01-January-2003 to 31-December-2032), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

The Ecomapuá Amazon REDD project committed to conservation of its properties as of 2002, despite a consistently negative financial balance. For this reason, and because of competition pressures described in the Additionality section, the revenue from the present REDD project is essential to the continued conservation of this native rainforest area. Conservation activities involve the banning of logging in the project area as of the project start date, which invoked a strong reaction from the community upon its implementation[8]. The supervision of logging is carried out by three supervisors from within the project area communities, who deliver periodic reports to the project owner.

To consolidate this commitment to conservation, Ecomapuá Ltda. will invest in environmental education that will benefit families living within the Ecomapuá properties, with plans to expand this program to more families. This activity forms part of the IAS/UFRA Fome Zero project[9], which ceased to function after 2006 and will be able to resume thanks to carbon credits from the present REDD project. The main social activities developed by Ecomapuá within the project area during the 2003-2012 period (1st baseline period) are listed below. More detailed information can be found in the respective SOCIALCARBON Report – Point Zero.

- Community capacity building about family agricultural production, developed in partnership with the Federal Rural University of Amazônia (UFRA), Petrobrás Company, and the Support Foundation of Research, Extension and Education in Agricultural Sciences (FUNPEA). This project lasted from 2005 to 2007;
- Community capacity building about family agricultural production, developed in partnership with the Federal Rural University of Amazônia, and Petrobras Company. This project lasted from 2005 to 2007, and was called Petrobrás Fome Zero;
- Construction of a support home and refurbishment of the local school, both located within the leakage management area;
- Construction of an aviculture structure, vegetable gardens, fish tanks and apiaries;
- Building of a forestry nursery in the leakage management area;
- Donation of a motor boat to the community transportation.

These social activities involving the local community contributed to environmental education, reforestation and alternative livelihood projects encompassing generation of income and production of food. Combined with Government's actions, these social activities developed by Ecomapuá may have contributed in part to reduce the deforestation rate within the project area, when comparing to the 90s' rate.

[8] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002".

[9] Universidade Federal Rural da Amazônia (UFRA), Instituto Amazônia Sustentável (IAS), Petrobrás (2007), "Projeto piloto de geração de renda e alimento através de produção agrícola familiar e manejo florestal sustentável em comunidades ribeirinhas carentes no rio Mapuá – Relatório Final".

FSC-certified, low-impact logging is being considered by the management of Ecomapuá Conservação as a future income source, however this activity would be strictly on the condition of FSC certification being obtained. In this case, wood harvesting activities will be included in the monitoring period concerned.

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

Corrections relating to the previously validated VCS PD

During the reassessment of the second baseline period, land-use change analyses were made through MapBiomas images, which is a new platform that produces maps through a pixel-by-pixel classification from Landsat satellites images. The entire process is done with extensive machine learning algorithms through the Google Earth Engine system that offers more detailed, precise and available information. The use of MapBiomas as image reference was made because the region has a high cloud cover throughout the whole year, and thus, the official data from Prodes were highly impacted by this condition.

However, changing the land use data during the second baseline reassessment resulted in different polygons of forest/non-forest areas within the project area at the project start date, showing either deforested areas inside the project area and forested areas outside the project area. According to the applied VM0015 methodology, the project area shall include only forest land at the project start date. Thus, a comparison between 1992 and 2002 has been conducted to include only land qualifying as “forest” for a minimum of 10 years prior to the project start date, in accordance to the methodology.

Therefore, the project area was corrected and has in fact an area of 97,007.22 ha instead of 86,269.84 ha, which was defined in the previous VCS PD corresponding to the first baseline period. The old classification method utilized in the previous VCS PD was conservative because a smaller project area resulted in a lower GHG emission reductions generation during the first baseline period.

In addition, the correction of the boundaries of forested and non-forested lands within Ecomapuá properties at the project start date also resulted in the rectification of the leakage management area. According to the applied methodology, the leakage management area shall be located outside the project area and contain only non-forested lands. Thus, a new delineation of the leakage management area had to be carried out. The previous one was located in Fazenda Bom Jesus and presented an area of 817.17 ha. The corrected leakage management area has 12.74 ha and is now split into two properties: Fazenda Bom Jesus and Fazenda Lago do Jacaré. This way, leakage management areas are now more distributed along the project area and more accessible to communities, as most of them live within Fazenda Lago do Jacaré.

Furthermore, this subsection also includes the corrections carried out in the previous VCS PD regarding the first baseline period, which were included as project description deviations in the verified Monitoring Report regarding the first monitoring period (2003-2012 period).

While comparing the classification and projections in the VCS PD for the 1st baseline period, a discrepancy was noted between the areas represented in the tables in the VCS PD and those found in the final shapefiles of the baseline referring to the Project Area, used for comparison purposes during the monitoring phase.

Following exhaustive checking of all the files used to generate data used in the VCS PD, it was realized that the shapefile from which the projected areas were derived did not exclude areas considered to be “non-forest” in 2001, but only those from 1993, having a different frontier from the final file. In this way, the numerical data presented in the tables in the VCS PD differed from the official spatial file, and the VCS PD made an error in projecting a lower figure than it should have for future deforestation.

The source of the discrepancy having been identified, it was necessary to correct the tables in the VCS PD, updating the values for “forest” and “non-forest” for each simulated year, in accordance with the perimeters of the official shapefile.

In order to correct the previously validated VCS PD and to carry out the revision of the 2nd baseline period, it was deemed necessary to revise the process regarding the year 2002. As there were no good-quality images for the year 2002, the classification was not possible to be made. After a great many analyses, the conclusion was reached that the most conservative and realistic way to project the deforestation in the 1st baseline period would be to exactly replicate the map from 2001 in order to represent 2002, in other words, the deforestation from 2001 to 2002 was considered to be 0 (zero). Thus, the starting year of the projection was altered in the process, starting from the year of 2003 instead of 2002. This decision was judged to be more conservative than projecting the year 2002, because it decreased the deforestation rate during the historical reference period, which was then utilized to project the deforestation in the 2003 – 2012 period (1st baseline period).

Given this, it was felt necessary to repeat the entire simulation process referring to the VCS PD, from which the maps were simulated based on Markov chains coupled with cellular automata, and in which the input maps were 1993 and 2002, thus forming a nine-year interval between them. As of the year 2011, the input maps were 2002 to 2011, thus generating the scenarios up to 2020. For the 2021 scenario the input maps were 2011 to 2020 resulting in the maps up to 2029. For the final three years simulated, the input maps were 2020 and 2029. After the entire historical series was re-generated, the Kappa index was applied, from which the effective similarity value was found, with a high similarity index between the simulated and mapped results. These are values which, according to the literature, represent the reality of the landscape.

However, in order to be conservative, a correction factor was applied to the new simulated deforestation values obtained for the 2003 – 2012 period.

The accuracy assessment was carried out using Kappa statistics, through comparison of the real map from 2001 with the projection of the same year. As mentioned above, there were no good-quality images for the year 2002, thus the year 2001 was considered as the final year of this analysis. The Kappa index achieved between these two figures was of 0.7105. Therefore, the correction factor was calculated by considering the 28.95% error resulted from the Kappa index analysis (100%-71.05%), which was applied to the simulated deforestation values obtained for the 2003 – 2012 period, resulting in a total predicted deforestation of 4,929.03 ha. These updated values were used to calculate the cumulative areas for carbon credit generation in the first baseline period.

1.12 Project Location

The Ecomapuá Amazon REDD Project (hereafter "the project" or "the present project") is situated on Marajó Island (Ilha de Marajó) in Pará state in the far north-east of Brazil, which is the lower Amazon Basin. The island forms the mouth of the Amazon River, the Amazon and Tocantins rivers being the west and the eastern boundaries of Marajó Island, respectively. Marajó is considered the largest river/sea island in the world, being almost the size of Switzerland and spanning 48,000 km^2 [10].

There are 16 municipalities in the Marajó archipelago, divided into three micro-regions: Portel, Furos de Breves and Ararí. The areas belonging to Ecomapuá Ltda. are located in the Furos de Breves micro-region, in the western part of Marajó Island, and fall into three municipalities: Breves, Curralinho and São Sebastião da Boa Vista. In terms of transport, the project is only reachable by a 12-hour boat journey or a 45-minute flight from the city of Belem.

The project area comprehensively belongs to Ecomapuá Ltda., and is split into five properties (Portuguese: Fazendas): Bom Jesus, Brasileiro, Lago do Jacaré, São Domingos and Vila Amélia (Figure below). In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, they are areas which 'include only "forest"[11] for a minimum of ten years prior to the project start date'. As shown in Figure below, the size of the areas that were considered as "non-forest" within the project area was 1,414.25ha. This was excluded from the initial area of 98,421.47ha, resulting in 97,007.22ha, which was then defined as project area. As detailed in the section 1.11 above, this area was updated from the previous VCS PD corresponding to the first baseline period. The use of a more precise land use/land use change data, which was available at the second baseline reassessment, resulted in different quantities

[10] WWF (2008), "The Encyclopedia of Earth": <https://editors.eol.org/eoearth/wiki/Maraj%C3%B3_varzea>

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

of forest/non-forest lands within the project area at the project start date and thus, a correction was necessary in order to be in accordance with the applied methodology.

The Ecomapuá properties are located on either side of the Mapuá River, and span three municipalities: the four smaller properties are located in Breves municipality, while the largest property, “Lago do Jacaré”, extends into the municipalities of Curralinho and São Sebastião da Boa Vista. The full contour coordinates of the project area are found in Appendix I. The northern boundary of the property is constituted by the delta of the Aramã and Mapuá rivers, and to the east by the municipality of São Sebastião da Boa Vista, to the west by the delta of the Mapua-Mirim and Furo dos Macacos, and to the South by the municipality of Curralinho.

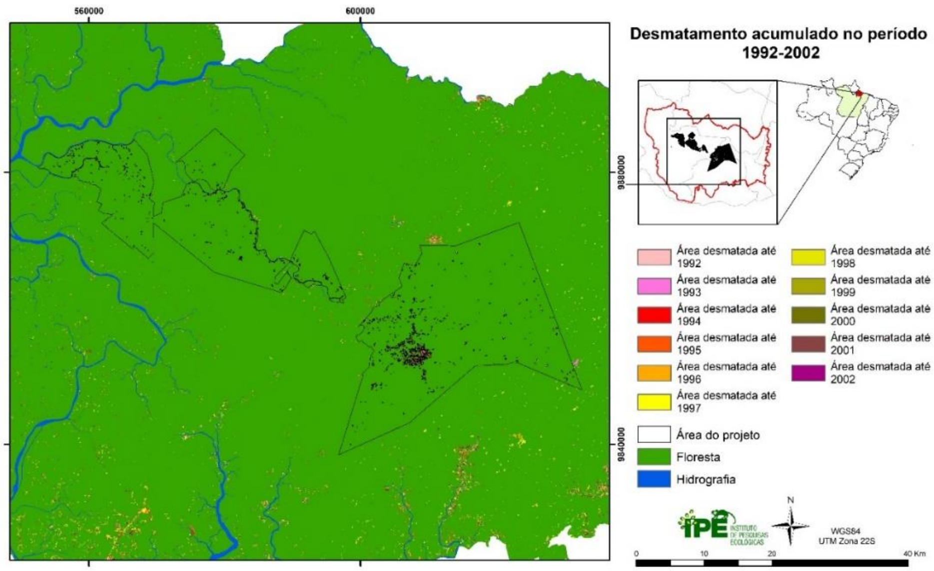

Figure 1. REDD area, showing the areas to be excluded, not being defined as forest 10 years prior to the project start date

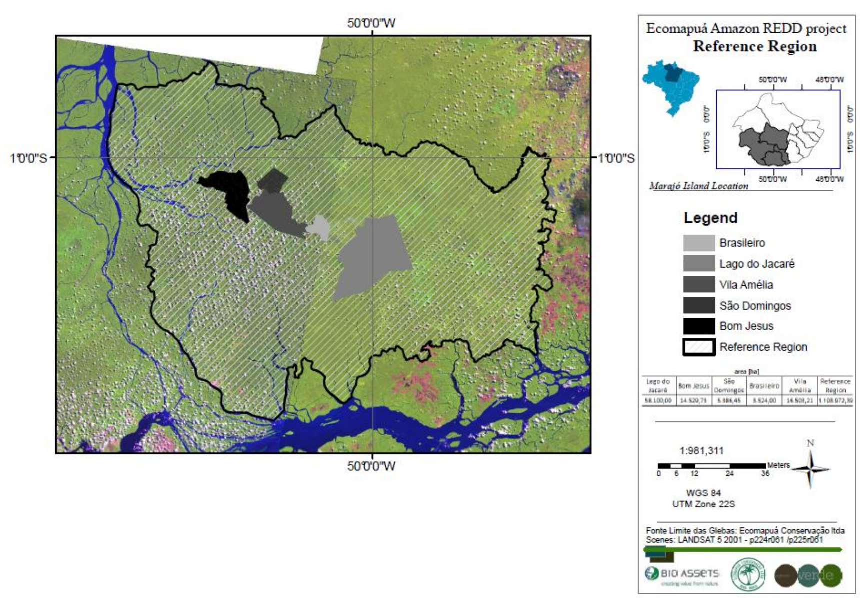

Figure 2. Ecomapuá REDD project’s five properties and reference region

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

The project area borders used in the Ecomapuá Amazon REDD Project were extracted from technical appraisals (Portuguese: laudos) registered at an official notary and at INCRA[12]. 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[13].

Reference Region

The reference region (RR) (see Figure below) 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 sums to 1,108,972.39 ha and is distributed among 7 municipalities, although two of these are insignificant, summing to 0.004% of the total area (see table below)

The RR was defined in accordance with two criteria:

- The methodology recommendation that projects over 100,000ha in size should have RRs 5 – 7 times bigger than the project area. The Ecomapuá REDD project is somewhat below the latter figure. For this reason, an approximate factor of ten was decided upon to calculate the RR. This was appropriate as the key region of western Ilha de Marajó is in the right size range for the resulting RR size: 1,108,972.39 ha.
- Adjustment criteria were applied to the RR in order for it to more accurately represent the land-use dynamics. Specifically, this was based on the waterways, which are the principal means of human transportation in the region[14,15]. As such, from the areas surrounding the project area, the RR was expanded to meet the nearest main waterways.

Municipality	Hectares/ Municipality	% RR / TOTAL RR
Afuá	27.30	0.002%
Anajás	216,265.55	19.50%
Breves	523,254.01	47.18%
Curralinho	214,611.87	19.35%
Muanã	33,562.87	3.03%
Ponta de Pedras	12.67	0.001%
São Sebastião da Boa Vista	121,238.13	10.93%
TOTAL RR AREA	**1,108,972.39**	**100.00%**

Table 1. Reference Region areas and percentages

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

[13] Full process described Appendix III

[14] Amaral, D.D., Vieira, I.C.G., Salomão, R.P., Almeida, S.S., Silva, J.B.F., Costa Neto, S.V., Santos, J.U.M., Carreira, L.M.M. & Bastos, M.N.C. (2007), 'Campos e Florestas das bacias dos rios Atuá e Anajás. Ilha do Marajó, Pará. Museu Emílio Goeldi. Coleção Adolpho Ducke. Belém'.

[15] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

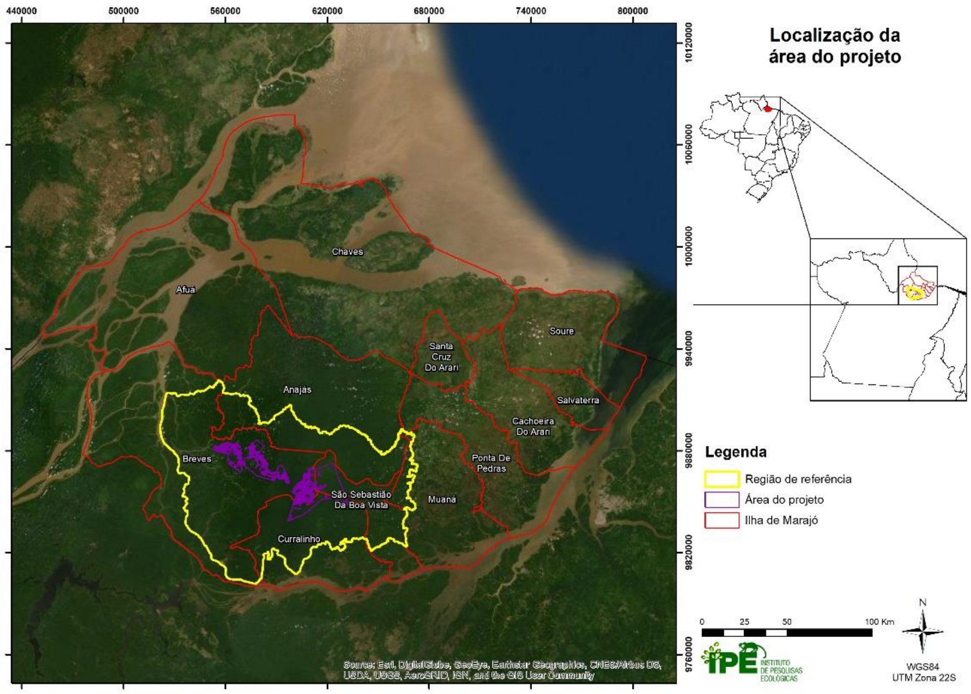

Figure 3. Ecomapuá REDD project's five properties and reference region

Leakage Belt

During the revision of the second baseline period, the classification identified deforestation with linear patterns indicating possible road creation, which will be better described in the Baseline Scenario section. 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. Meanwhile, it is observed that this pressure comes from the South of the Reference Area and appears to originate from outside the latter, not influencing the dynamics of land-use change in the Leakage Belt.

During the first baseline period (2003-2012), the deforestation pattern within the leakage belt showed a greater intensity in its western portion, nearer to the main watercourses. This observation does not represent a substantial alteration in the leakage belt defined during the first baseline assessment, and reinforces the importance of rivers in impacting land-use changes. Therefore, during this second baseline reassessment, the GIS analysis led to the conclusion that the increase in deforestation in the south-southwest of the Reference Region is not associated with the initiation of the project; and that there were no significant changes in the predicted patterns of deforestation in the Leakage Belt.

Furthermore, according to IBGE[16], despite the fact that logged timber decreased during the first baseline period, production (m^3) and value of production (R$) of timber presented a similar

[16] Brazilian Institute of Geography and Statistics (IBGE). Available at: <https://cidades.ibge.gov.br/brasil/pa/breves/pesquisa/16/12705?tipo=grafico&indicador=12804>.

evolution over the first baseline period, which shows that costs and revenues for timber harvesting in the region maintained the same proportion. Thus, the leakage belt limits defined in the first baseline period were maintained for this second baseline.

Therefore, the definition of the leakage belt was based on the three spatially overlapping activities that cause deforestation in the project region (as defined in the first baseline period): firstly, extraction of commercially valuable tree species by resident families for sale to timber companies. This is accompanied by palm-heart extraction, which is both for commercial ends and for consumption or trade in kind by the harvesters themselves. The final step is the slash-and-burn deforestation of the area above for subsistence agriculture.

The implementation of the present project in 2002 led to the banning of timber harvesting in the areas belonging to Ecomapuá Ltda and, since then, there have been many initiatives to promote sustainable forest management in the project areas. However, according to several studies[17,18,19], subsistence agriculture activities continue to be practiced by the Mapuá River communities, as they were before the initiation of the project, being that they were not regulated by the project proponent.

Given that subsistence agriculture was not prohibited by the project proponent, deforestation caused by this agent outside the project area is not attributable to project leakage. Thus, it is inferred that timber harvesting is the most probable activity to have leaked outside the project area, due to its prohibition within the latter since the project start date. This inference is reinforced by FADESP (2002), who collected interviews in which residents stated that they could no longer harvest timber within the project area, and also from the protests and complaints observed in certain communities due to the prohibition, which had been their primary source of income. This being the case, the leakage belt corresponds to the area most likely to be used for timber extraction after its prohibition within the project area.

In accordance with section 1.1.3 of the methodology, the leakage belt 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. Given that the principal causes of deforestation in the reference region generally overlap, due to the land-use dynamic, it was concluded that deforestation was lucrative for at least one product, namely timber.

[17] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002."

[18] Instituto Florestal Tropical (IFT) (2012), "Visita técnica de prospecção para avaliação do potencial do manejo florestal na Reserva Extrativista Mapuá, Breves, Pará. Relatório Final."

[19] Herrera, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA. Dissertação de mestrado. Universidade Federal do Pará."

The vast majority of the timber extracted in the Mapuá River region, in particular after the closing of Santana Madeireira in 2001, the biggest timber company in the region, is processed in small sawmills. As described in the FADESP[20] and IFT [21]reports, and the Masters' Degree Thesis by Herrera[22], along the banks of the Mapuá River there are numerous sawmills, the majority of which are of small size. There are two possibilities for the economic dynamic of the timber harvesting: either the sawmills have their own team, who conduct the harvesting; or the sawmill buys the timber harvested by the river-dwellers and splits the profits with them. The latter option is the most common in the Mapuá River region, according to interview conducted with an employee of the ICMBio[23] – the government organ for biodiversity conservation, active in the region. These sawmills generally operate for 6 months of the year, during the flooding season, when transport is facilitated by the swollen rivers.

As specified by the methodology, the analysis of the products' profitability was conducted according to the following formula:

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

Where,

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

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

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

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

TDv: Transport distance on land, river or road of type v; km v 1, 2, 3 ...V, type of surface to on which transport occurs; dimensionless

The formula above is used to calculate the potential profitability of a given product in a given location and the borders of the leakage belt correspond to the area where the profitability of at least one product is equal or above 1. The leakage belt is here established on the basis of

20 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

21 Instituto Florestal Tropical (IFT) (2012), "Visita técnica de prospecção para avaliação do potencial do manejo florestal na Reserva Extrativista Mapuá, Breves, Pará. Relatório Final".

22 Herrera, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA." Dissertação de mestrado. Universidade Federal do Pará.

23 Interview: D. Meneses (23.11.12).

analyses and calculations from a study conducted within the reference region[24] on the costs and profits from harvesting and processing of timber. This study was chosen because it provides complete and thorough field information.

The table below shows the average costs of production and income from small sawmills in the Amazon estuary and lower Amazon River area over the period of a year:

Cost of production (US$)	
Depreciation	118
Maintenance	787
Fuel	1.13
Labour	5.05
Purchase of logs	5.88
Transport of logs	1.72
Cost of capital	89
Total cost of production	14,795
Value of production	17,550
Liquid income	2,755
Profit margin	17%

Table 2. Annual average costs of production and income from small sawmills in the project reference area

The two common scenarios of production in the reference region of the project are:

1) The sawmills can purchase timber from the individuals carrying out the harvesting;

2) The sawmills split the profits with the harvesters instead of paying them directly for the services.

On the basis of the aforementioned study of the Amazon estuary, the following observations and calculations were made, described below, treating each scenario in turn. Concerning scenario 1), the calculations are as follows:

	Item	Variables	Calculation
a)	Total annual transport costs	1,721	
b)	Total annual fuel costs	89	
c)	Fuel cost per liter (US$/l)	0.23	
d)	Total annual fuel expenditure boat transport (l/h)	3.4	
e)	Average boat transport journey time (h)	2.75 h	11 km / 4 km.h

[24] BARROS, A. C.; UHL, C. (1997), "Padrões, problemas e potencial da extração madeireira ao Longo do Rio Amazonas e do seu Estuário". In BARROS, A. C.; VERÍSSIMO, A. (Eds) A expansão Madeireira na Amazônia: impactos e perspectivas para o desenvolvimento sustentável do Pará. Belém: Imazon.

f)	Annual Quantity of fuel used (l)	386.96	US$ 89 / 0.23 US$.l^{-1}
g)	Annual time taken (h)	113.81	386.96 l / 3.4 l.h^{-1}
h)	Annual journeys undertaken	41.38	113.81 h / 2.75 h
i)	Annual distance travelled (km)	455.24	41.38 journeys x 11 km

Table 3. Annual average values per sawmill concerning scenario 1

The calculation of distance within which profitability≥1 was conducted on the basis of liquid income of the small sawmills. As defined by VCS methodology VM0015, the calculation was made as follows:

Liquid income (US$2,755) – Costs of transport (US$2,754) = 1

Kilometres travelled = Cost of transport where profitability≥1: (US$2,754) x 455.24km average distance/ 1,721US$ average transport costs = 728.5km.

Scenario 1) Annual average values per sawmill

	Item	Variables	Calculation
j)	Distance travelled where profitability ≥ 1	728.5 km	Cost of transport where profitability ≥1 (US$ 2,754) x average distance (455.24 km) / average transport costs (US$1,721)
k)	Difference between distance travelled where profitability ≥1 and distance travelled when transport costs are industry average US$ 1,721 (km)	273.26 km	728.5 km - 455.24km
l)	Equivalent of calculation b) above in terms of journeys	24.84	
m)	Extra distance per journey required to attain profitability ≥1 (km)	6.60	273.26 km / 41.38 journeys
n)	Total distance required to attain profitability ≥1 (km)	17.60	Average journey time (11 km) + calculation m).

Table 4. Calculations for distance corresponding to profitability ≥ 1 in leakage scenario 1)

In scenario 1, 17.60km, is the calculated maximum distance that timber collectors would travel to collect wood and remain profitable.

Secondly, scenario 2: the sawmills split the profits with the harvesters instead of paying them directly for the services; the calculations are as follows:

Scenario 2) Annual average values per sawmill

	Item	Costs/ Variables	Calculation
o)	Costs for raw material (US$)	8,912	Total cost of production (US$ 14,795) - cost of timber (US$ 5,883). No cost of timber because instead of

			payment, profits are divided with harvester.
p)	Liquid income (US$)	8,638	Value of production (US$ 17,550) - calculation o)
q)	Profit for sawmill/ harvester (US$)	4,319	Item p)/ 2
r)	Total cost (US$)	13,231	Total cost = item o) + item q)
s)	Liquid profit (US$)	4,319	Total value of production (US$ 17,550) - item r)
t)	Cost of transport where profitability ≥1 (US$)	4,318	item s) - t) = 1
u)	Distance travelled given cost in item t)	1,142.20	item t) x item i) / item a)
v)	Difference between item u) and average distance travelled (km)	686.96	item u) - item i)
w)	Number of journeys extra journeys required corresponding to item t)	62.45	Item v) / average boat journey (11 km)
x)	Number of km / journey necessary to achieve extra distance (item v)	16.60	Item v) / average distance (11 km)
y)	Average total distance from sawmills per journey (km)	27.60	item x) + average distance (11 km)

Table 5. Calculations for distance corresponding to profitability ≥1 in leakage scenario 2)

In scenario 2, 27.60km is the calculated maximum distance that timber collectors would travel to collect wood and remain profitable. The two distances calculated in item n) and item y) therefore correspond to the maximum distance from sawmills that harvesters would travel to collect primary materials.

In accordance with various sources[25,26,27], both the sawmills, in their vast majority, and the communities in the project reference areas are located on the banks of rivers. The aforementioned IFT (2012) source notes there are at least 17 sawmills along the Mapuá River, which is also the river which passes all the communities of the present project. It was therefore determined that the leakage belt of the present project will follow the rivers. As to the radius of the reference area, it was determined that 27.60km (item y) should be used, as use of the larger of the two calculations (items n) and y)) is both conservative and it corresponds to the more common of the land use dynamics, scenario 2, above.

The leakage belt of the Ecomapuá Amazon REDD Project (Figure below) was defined by quantitative parameters of feasible distance in terms of: (1) a sawmill could have access to

[25] SOUZA ,A.L. *et al.* (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002".

[26] HERRERA, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA. Dissertação de mestrado. Universidade Federal do Pará".

[27] INSTITUTO FLORESTAL TROPICAL (IFT) (2012), "Visita técnica de prospecção para avaliação do potencial do manejo florestal na Reserva Extrativista Mapuá, Breves, Pará. Relatório Final".

timber harvested by local populations and; (2) the maximum distance travelled by the population to extract timber was realistic taking into account the project area.

Parameter	Distance	Criteria
1	27km	A 27km radius was considered starting from the Mapuá around the entire project area. This was because it was assumed that a consequence of the Project's existence was displacement of activity, utilizing the rivers for transportation, accessible within 27km of the mouth of the Mapuá river.
2	2km	A buffer of 2km was created, surrounding the boundaries of all the rivers affected by parameter 1, which was an arbitrary value defined by analysis of satellite imagery as being the average non-forest area surround rivers.

Table 6. Adjustment criteria used in defining the leakage belt

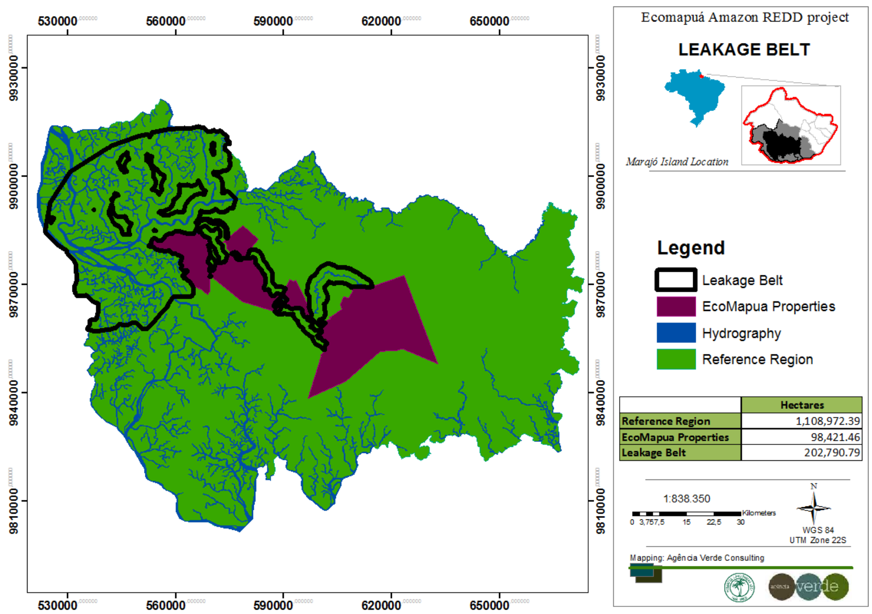

Figure 4. Leakage belt of the Ecomapuá Amazon REDD project

<u>Leakage Management Area</u>

The leakage management area 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.

As previously mentioned in the section 1.11 above, during the reassessment of the second baseline period, the location of the leakage management area had to be modified due to the update of land use data and consequent changes in the forested/non-forested lands at the project start date. Using this new and more precise data, most of the previous leakage management area was covered with forest at the project start date and thus, not in accordance with methodology requirements.

The updated Ecomapuá Amazon REDD Project's leakage management areas are now located within *Fazenda Bom Jesus* and *Fazenda Lago do Jacaré*, specifically the areas distributed along the two properties where most of communities live and that usually concentrates events and meetings. Furthermore, the leakage management area also includes the Rural Family House (CFR), which Ecomapuá supports. The CFR is an educational institution created to seek a personalized education and an integral formation of rural people.

Therefore, these areas were chosen due to the presence of activities including: environmental education, reforestation and alternative livelihood projects involving generation of income, electricity and production of food. These activities mainly involve the residents of both the Bom Jesus, Vila Amélia and Lago do Jacaré properties, being around 89% of the population in the project area[28].

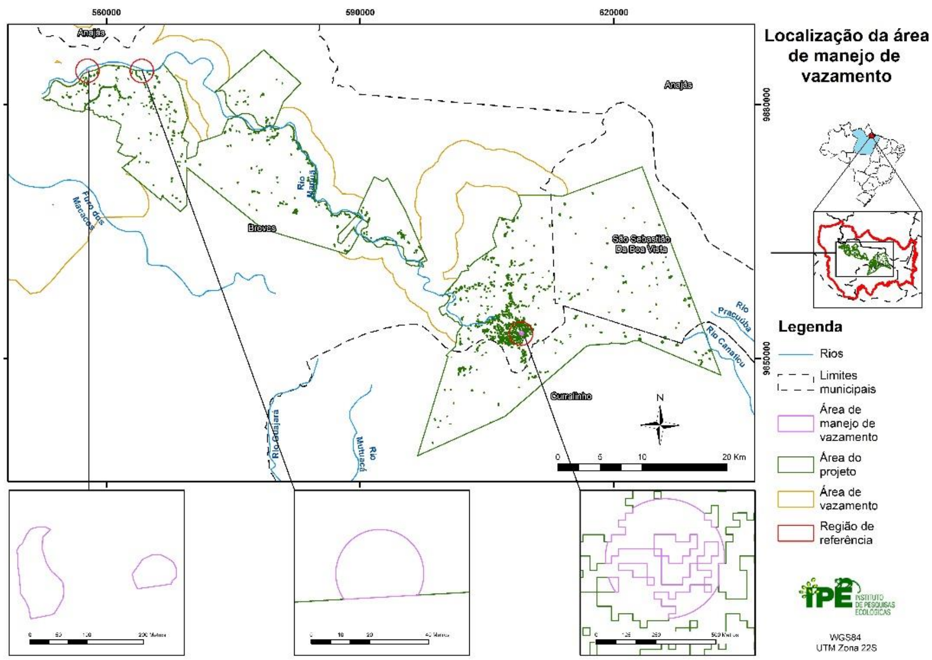

Figure 5. The Project's leakage management area and the project area

The following activities take place in the leakage management area:

- A technical school and tree nursery, currently and continuously active in the leakage management area[29];
- Capacitation courses and alternative income generation opportunities;
- Stakeholders consultations;
- The *Fome Zero* project by UFRA University in conjunction with IAS, the NGO active in the project area, which aims to create a viable and replicable capacity-building model for family agriculture

[28] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

[29] Interview with project supervisor, Mr Aloísio (09.01.13)

in the communities[30]. This aim will be achieved through improvement of capacity and techniques in sustainable forest use, in order to create permanent and temporary jobs for the local community. This project last ran in 2006 and will be able to resume activities thanks to income from sales of carbon credits from the present project.

1.13 Conditions Prior to Project Initiation

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

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

Climate

The Furos de Breves region is classified as Tropical rainforest climate type – category Af – in the Köppen climate classification[31]. This means that it has no dry season, and the average annual rainfall is high, averaging 2.200mm $year^{-1}$, due to the convergence of trade winds and sea-breezes[32]. The relative humidity in the region is always above 80%[33].

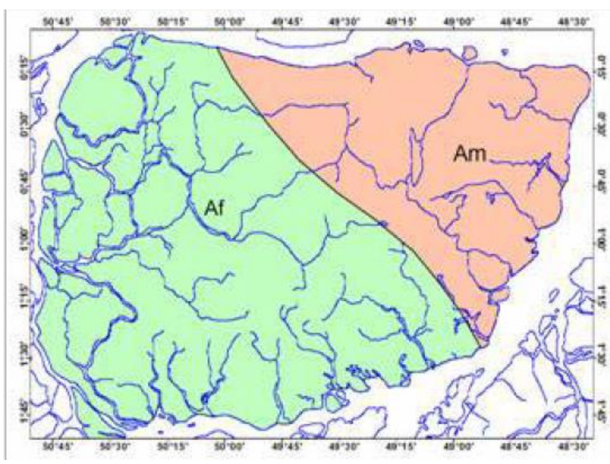

Figure 6. Marajó Island divided into climate type[34]

[30] Universidade Federal Rural da Amazônia (UFRA), Instituto Amazônia Sustentável (IAS), Petrobrás (2007), "Projeto piloto de geração de renda e alimento através de produção agrícola familiar e manejo florestal sustentável em comunidades ribeirinhas carentes no rio Mapuá – Relatório Final".

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

[32] Municipal Statistics Report, developed by the Executive Secretary of Planning, Budget, and Finance (SEPOF) (Pará, 2006), based on data from IBGE (2004).

[33] Municipal Statistics Report, developed by the Executive Secretary of Planning, Budget, and Finance (SEPOF) (Pará, 2006), based on data from IBGE (2004).

[34] Lima, A.M.; Oliveira, L.L.; Fontinhas, R.L.; Lima R.J.S. (SECTAM/NHM) (2004),"The Marajó Island: Historical Revision, Hydroclimatology. Hydrographical Basins and Management Proposals."

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

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

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

This classification is in accordance with the findings of a 2004 study by the Brazilian Executive Secretary of Science, Technology and the Environment[35], which classified the western half of the island as Tropical rainforest climate, and the eastern half as Tropical monsoon climate.

Geology, Topography and Soils

Relief and topography within the project area is flat to mildly hilly, with rock formations from either the Holocene or Pleistocene, rocks and stones largely absent, and poor drainage[36]. This fits with the topography of the vast majority of Marajó, which is below < 25–30m a.s.l. In the western half of the island, where the project is located, the geological basis is of pre-Cambrian rocks of the Guiana Shield in the higher land to the to the northwest; and Cretaceous rocks of the Alter do Chão Formation to the west and southwest[37].

The general vegetation pattern on Marajó island described in the literature is that dense tropical rainforest (Portuguese: floresta ombrófila densa) is associated with older sediments found in the Western portion[38], clearly shown in Figure below. The aforementioned authors describe this pattern as follows: “an open vegetation pattern dominates in areas with Holocene sedimentation, while ombrophyla forests are widespread on older deposits”. In-line with this expectation pattern, the project area is covered with riparian dense tropical rainforest.

[35] Lima, A.M.; Oliveira, L.L.; Fontinhas, R.L.; Lima R.J.S (SECTAM/NHM) (2004),“The Marajó Island: Historical Revision, Hydroclimatology. Hydrographical Basins and Management Proposals.”

[36] A. Ribeiro de Barros (2001), “Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará”.

[37] Source: INPE/ PRODES municipal deforestation data, Breves municipality: <http://www.dpi.inpe.br/prodesdigital/prodesmunicipal.php>.

[38] França, C.F., Pimentel, M.A., & Prost, M.T.R.C. (2010), “Geomorfologia e Paisagem: Contribuições à classificação de unidades da paisagem na região oriental da Ilha do Marajó, Norte do Brasil.” VI Seminário Latino Americano de Geografia Física. II Seminário Ibero Americano de Geografia Física. Universidade de Coimbra.

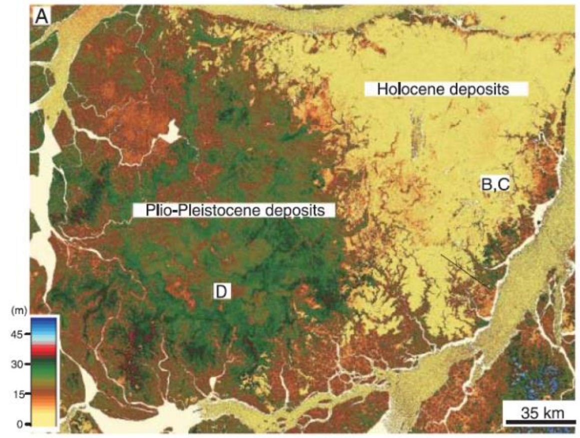

Figure 7. The contrast in geology between west and eastern sides of Marajó island[39]

Soil types across the project area were characterised by influence of water, in a pilot forest inventory[40] of the project area: the majority of soil types in every Ecomapuá property were of hydromorphic gley type, the majority being humic gley or low-humic gley, with occasional strips of yellow latosol.

Regarding soil content, the soils are described as being of gley type, therefore distinct from peat[41], therefore meeting applicability conditions of the methodology. For example, in the Fazenda Bom Jesus by Morris et al. [42]: "all of the soil profiles observed were characterized by fine-textured silty clay, silty clay loam and silty loams throughout the soil profile. In a few instances, coarser textured surfaces with sand percentages greater than 30% occurred over the finer texture subsoil."

<u>Socio-economic conditions</u>

Industrial activity in the Furos de Breves micro-region is concentrated in timber production, palm heart and açaí berries. During the 2004-2012 period, in the three municipalities in which the project is located, almost 52% of the total value of production from these three products was represented by açaí berries, while around 43% was represented by logged timber and 5% by palm heart[43] (Table below). These figures changed considerably comparing to the first baseline period, when from 1992 to 2002, almost 83% of the total value of production was represented by logged timber, and less than 1% by açaí berries.

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[39] D. F. Rossetti and P. M. De Toledo (2006), "Biodiversity from a historical geology perspective: a case study from Marajó Island, lower Amazon." *Geobiology, vol. 4.*

[40] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'.

[41] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'

[42] Morris et al., 'Land Use and Soil Change on Fazenda Bom Jesus, Ilha Marajó , Pará, Brazil'.

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

	Açaí berries	Palm heart	Timber Logs	TOTAL
Breves	R$ 1,367,222.22	R$ 644,222.22	R$ 5,545,555.56	R$ 7,557,000.00
Curralinho	R$ 1,473,333.33	R$ 79,000.00	R$ 2,260,000.00	R$ 3,812,333.33
São Sebastião da Boa Vista	R$ 7,174,111.11	R$ 244,000.00	R$ 453,222.22	R$ 7,871,333.33
Total production (R$)	R$ 10,014,666.67	R$ 967,222.22	R$ 8,258,777.78	R$ 19,240,666.67
Percentage total value of production	52.05%	5.03%	42.92%	100%

Table 7. Annual average values of production in municipalities of project area (2004 - 2012) (R$)[44]

Regarding the commerce of timber in the local market, a considerable proportion of the timber production in Brazil is illegal, 36% according to the SFB[45], making the true value of timber in the market considerably higher than these official figures. Therefore, despite a general decline in timber production since the mid-1990s in Furos de Breves, corresponding to a general reduction in timber production in the Brazilian legal Amazon[46], the product remains the one of the most important commercial product in the micro-region.

However, although the deforestation rate in the State of Pará has shown a constant decrease over the 2003-2012 period, the last year of this period showed an increase trend in the deforestation. This was overwhelmingly concentrated in illegal deforestation activities, increasing by 151% between 2010 and 2012, which is the deforestation type most likely to affect the present project[47].

While palm heart is a commercial product, açaí is produced mainly for subsistence, being an integral and traditional part of the daily diet[48]. Açaí is not considered a significant element of the deforestation dynamic as it does not require deforestation for its production[49]. In fact, açaí

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

[45] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras"

[46] SFB & IMAZON (2010), "A atividade madeireira na Amazônia brasileira: produção, receita e mercados".

[47] Instituto do Homem e Meio Ambiente da Amazônia (Imazon): <http://envolverde.com.br/noticias/imazon-desmatamento-ilegal-cresce-151/>. Last visited on 09/01/2014.

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

[49] Interview: D. Meneses 23.11.12.

production has been positively correlated with forest conservation in a study of Pará state municipalities[50].

Aspects of Furos de Breves' demography are presented in the Table below. The region had 204,114 inhabitants in 2010, with a density of 7.9 inhabitants per km^2, a majority (58%) of the population being concentrated in rural areas. This indicates an economy strongly tied to natural resources. The main forms of subsistence of this rural population are extraction of non-timber forest products (NTFPs) and small-scale farming[51]. The main NTFPs extracted from the forest are açaí berries and palm-heart, while crops planted include manioc, corn, and banana[52].

According to the social study of the project area and surroundings, 99 families in the project area, and an estimated 187 families in the reference region are known to rely on family agriculture and extractivism for subsistence[53,54], confirming the predominance of this mode of life. The following table below shows the number of families located in the project areas in 2002, and numbers interviewed.

Property name	Number of families	Number of families interviewed
Fazenda Brasileiro	04	04
Comunidade Bom Jesus	17	14
São Domingos	07	0
Fazenda Lago do Jacaré	50	0
Comunidade Vila Amélia	21	20

Table 8. Families located in project areas and numbers interviewed[55]

Moreover, according to the aforementioned social study, the residents' agricultural activities rely on slash-and-burn practices to clear land for plantation; as such subsistence agriculture is an important component of the dynamic of deforestation in the project area and reference region.

[50] Almeida et al. (2010), "Potencial para conservação do açaí: uma análise da produção de açaí e desmatamento no estado do Pará." In: 62 Reunião Anual da SBPC, 2010, Natal. Ciência do Mar: herança para o futuro. Natal: SBPC.

[51] Herrera, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA." Dissertação de mestrado. Universidade Federal do Pará.

[52] Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano de desenvolvimento territorial sustentável do arquipélago do Marajó".

[53] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

[54] Amaral, D.D., Vieira, I.C.G., Salomão, R.P., Almeida, S.S., Silva, J.B.F., Costa Neto, S.V., Santos, J.U.M., Carreira, L.M.M. & Bastos, M.N.C. (2007), 'Campos e Florestas das bacias dos rios Atuá e Anajás. Ilha do Marajó, Pará. Museu Emílio Goeldi. Coleção Adolpho Ducke. Belém'.

[55] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

Municipalities: Furos de Breves Micro-region	Area (Km²)	Urban population	Rural population	Total population	Population growth rate (2000-2010)	Population density (inhabitants/ km²)
Anajás	6,922	9,494	15,265	24,759	3.06%	3.58
Breves	9,551	46,560	46,300	92,860	1.48%	9.72
Curralinho	3,617	10,930	17,619	28,549	3.61%	7.89
São Sebastião da Boa Vista	1,632	9,902	13,002	22,904	2.63%	14.03
Afuá	8,372	9,478	25,564	35,042	1.73%	4.19
Furos de Breves micro-region	30,095	86,364	117,750	204,114	2.50%	7.88

Table 9. Demographic statistics on the Furos de Breves micro-region – Year 2010[56]

Figure 8 below illustrates the far lower cattle and buffalo production of Furos de Breves compared to the other micro-regions of Marajó Island. It is shown that cattle farming, being dependent on pastureland, is not a factor in the project area and reference region, being prevalent only on the eastern side of the island, as is further explained in terms of vegetation and geology.

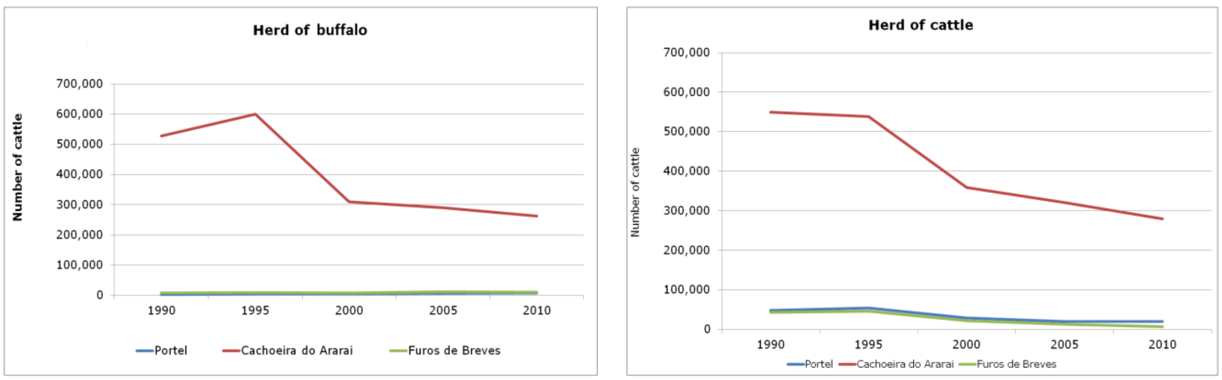

Figure 8. Distribution of buffalo and cattle herds across the micro-regions of Marajó Island[57]

The economic context of the Project is therefore one of poverty, characterized by inequality, and low social indicators. The average time spent in school in 2000 still did not exceed 4 years, and illiteracy is widespread. Furthermore, many rural communities in Breves do not have access to basic services and facilities such as sanitation, education, healthcare and electricity.

Municipalities	Proportion of population below poverty line (%)	Rate of completion of high school in the youth from 15 to 17 years (%)	Infant mortality (%)
Afuá	65.4	17.4	19.5
Anajás	62.2	15.9	26.1
Breves	56.5	17.8	31.6

[56] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE), 2010; PODM, 2010.

[57] Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

Curralinho	60.4	12.7	25.4
São Sebastião da Boa Vista	56.6	32.5	32.5
State of Pará	34.2	33.1	21.5

Table 10. Social indicators in the municipalities of the reference region - 2010[58]

The socio-economic climate described is integrated into the Ecomapuá Amazon REDD Project's goals, as the application of SOCIALCARBON® Standard, and the planned collaboration with a government environmental body[59], aims to deliver appropriate, integrated and quantifiable ecological and socio-economic benefits to the population of the project area.

<u>Biodiversity</u>

The Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included Marajó Island in its 2003 survey of Brazil's 900 priority areas for conservation[60]. The entire island is classed within the ministry's highest priority category: "extremely high".

The combination of various forest types, fields, and areas under marine influence makes Marajó Island's vegetation unique in the Amazon biome. However, the great biodiversity which this environment harbours is little known[61]. The island stands out as particularly important in relation to birdlife[62]: Alfred Russel Wallace's pioneering study (1835) and a more recent compilation by Henriques and Oren (1997) put the island's avifauna at some 361 species. Moreover, two expeditions in 2007 and 2008 coordinated by Petrobras/CENPES, added a further 11 species to this list, illustrating the richness, the conservation value, and the insufficiency of study in this area.

Bird species of note include a broad range of aquatic birds, such as herons (*Egretta* sp.) and egrets (*Ardea* sp.), ducks *Dendrocygna* spp., ibis *Cercibis* spp., *Theristicus* spp., and rosette spoonbills *Ajaia ajaia*. Birds found here and in only few other places include white-bellied seedeaters *Sporophila leucoptera*, grassland yellow-finches *Sicalis luteola*, chalk-browed mockingbirds *Mimus saturninus*, tropical peewees *Contopus cinereus*, rufous-throated antbirds *Gymnopithys rufigula*, black-breasted puffbirds *Notharchus pectoralis*, and plain-bellied emeralds *Amazilia leucogaster*[63].

Concerning mammalian life, scientists have reported 99 species in the ecoregion which comprises the western half of Marajó Island, known as the *várzea*. Species which are endemic

58 Sources: PODM (2010) and Datasus (2010).

59 Currently under negotiation

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

61 Congresso Brasileiro de Ornitologia 29 Jun – 04 Julho 2008. 'A Ornitologia no Cerrado e Ecótonos do Brasil'.

62 Antonio A. F. Rodrigues, 'Priority Areas for Conservation of Migratory and Resident Waterbirds on the Coast of Brazilian Amazonia'. *Revista Brasileira de Ornitologia 15 (2) 209-218,* June 2007.

63 WWF (2008), "The Encyclopedia of Earth": http://www.eoearth.org/article/Maraj%C3%B3_varzea

here include the armadillo *Dasypus septemcinctus*, bats (*Platyrrhinus recifinus*, *Natalus stramineus*, and *Molossops greenhalli*), primates such as marmosets (*Callithrix argentatado*), tamarins (*Saguinus midas*), night monkeys (*Aotus infulatus*), and savanna foxes (*Cerdocyon thous*). Cats include jaguars (*Panthera onca*), which is near threatened[64], and pumas (*Puma concolor*)[65].

Notable marine life includes mammals, such as the American manatee (*Trichechus manatus*), which is classed as Vulnerable[66], the Amazonian manatee (*Trichechus inunguis*), the Costelo sea dolphin (*Sotalia guianensis),* Tucuxi dolphin (*Sotalia fluviatilis*), and Boto Amazon River Dolphin (*Inia geoffrensis*)[67].

The characteristically large river fish include various freshwater stingrays (*Plesiotrygon, Paratrygon*, and *Potamotrygon spp*.)[68], Pacus (*Metynnis* and *Mylossoma spp*.), Tambaqui (*Colossoma macropomum*), Arapaima (*Arapaima gigas*), and Sardines (*Triportheus angulatus*).

<u>Vegetation Cover</u>

The vegetation in the present project was mapped on the basis of SIVAM Amazônia information sources[69]. Two vegetation types were found to be present on the island: riparian (Portuguese: aluvial) dense tropical rainforest and lowland tropical rainforest.

Given that the morpho-structural features of the Ecomapuá Project's reference area match IBGE descriptions[70] of riparian dense tropical forest, and that all vegetation cover types identified by the Museu Emílio Goeldi study[71] fall within the class of riparian forests, it was determined that one single class of forest exists within the project area and reference region: riparian dense tropical rainforest (Figure below).

[64] Source: http://www.iucnredlist.org

[65]Source, WWF: http://www.worldwildlife.org/science/wildfinder/profiles/nt0138.html

[66] Source: http://www.iucnredlist.org

[67] Arquivos do Museu Nacional, Rio de Janeiro, v.66. n.2, (Jun 2008), 'Revisão do Conhecimento sobre os Mamíferos Aquáticos da Costa Norte do Brasil'.

[68] 'Factors affecting the distribution and abundance of freshwater stingrays (Chondrichthyes: Potamotrygonidae) at Marajó Island, mouth of the Amazon River'. *Pan-American Journal of Aquatic Sciences* (2009) 4 (1): 1-95

[69]Sistema de vigilância da Amazônia: SIVAM

[70] IBGE (1992), "Manual Técnico Da Vegetação Brasileira"

[71] Amaral, D.D., Vieira, I.C.G., Salomão, R.P., Almeida, S.S., Silva, J.B.F., Costa Neto, S.V., Santos, J.U.M., Carreira, L.M.M. & Bastos, M.N.C. (2007), 'Campos e Florestas das bacias dos rios Atuá e Anajás. Ilha do Marajó, Pará. Museu Emílio Goeldi. Coleção Adolpho Ducke. Belém'.

Marajó Island's vegetation is characterised by the seasonal flooding and sedimentary deposits of the island[72]. As indicated in the previous sections of geology and climate, rainforest is principally located in the western portion of Marajó island[73], while grasslands predominate in the east. The vegetation in Marajó's Western portion, while all within the riparian dense tropical rainforest class, is sub-divided into the following categories, broadly distinguished by the extent to which they are flooded:

- Lowland terra firme forest, with little flooding influence, this is the dominant type of forest in the Amazon rainforest, and was identified as dominating in the area of Marajó island studied by Amaral et al. (2007);
- The periodically flooded várzea forest is characteristic of the Marajó ecosystem, and is the most common forest type in floodable areas throughout the Amazon;
- The permanently flooded igapó forest type is identified in the project area by the pilot forest inventory described below[74];
- Secondary forest establishes itself after human deforestation activity, and is often associated, in terra firme and agricultural regions, with planting of manioc, banana, corn and, in floodable regions, the açaí palm.

The vegetation within the project area itself was assessed in a 2001 pilot forest inventory[75], consisting of 13 samples of 2,500m^2, taken from four of the six properties that compose the project area. The 2001 inventory confirmed that the general class is riparian dense tropical rainforest, identifying the three sub-classes previously mentioned: *várzea*, *igapó*; and bands of *terra firme* tropical wet forest.

Species of commercial interest are predominantly found in areas of *terra firme* forest with occasional small watercourses, such as: *C. odorata*, *V. maxima*, *G. glabra*, *V. americana*, and *O. glomerata*, among others. Further trees of notable commercial value present in the project area, which are of special conservation interest[76], include: *V. surinamensis*, and *C. pentandra*, as well as the Buriti palm, *M. flexuosa,* which is commonly replaced with commercially valuable Açaí palm, *E. oleracea*, by the island's farmers.

[72] Amaral, D.D., Vieira, I.C.G., Salomão, R.P., Almeida, S.S., Silva, J.B.F., Costa Neto, S.V., Santos, J.U.M., Carreira, L.M.M. & Bastos, M.N.C. (2007), 'Campos e Florestas das bacias dos rios Atuá e Anajás. Ilha do Marajó, Pará. Museu Emílio Goeldi. Coleção Adolpho Ducke. Belém'.

[73] Eliana da C. Segundo (2009) 'Estudo de Energia Eólica Para a Ilha de Marajó - PA'. *INPE*.

[74] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'.

[75] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'.

[76] WWF (2008), "The Encyclopedia of Earth": https://editors.eol.org/eoearth/wiki/Maraj%C3%B3_varzea

The species list from the pilot forest inventory is provided in Table below.

N°	Common Name	Scientific Name	Family	N° of Trees	% n° of Trees
1	Abiu	*Pouteria krukovii*	SAPOTACEAE	5	0.3%
2	Abiu casca grossa	*Planchonella pachycarpa*	SAPOTACEAE	12	0.8%
3	Abiu cutiti	*Pouteria macrophylla*	SAPOTACEAE	2	0.1%
4	Abiurana	*Pouteria macrophylla*	SAPOTACEAE	6	0.4%
5	Acapu	*Vouacapoua americana*	CAESALPINIACEAE	26	1.7%
6	Acariquara	*Minquartia guianensis*	OLACACEAE	10	0.6%
7	Amapá	*Parahancornia amapa*	APOCYNACEAE	18	1.2%
8	Anani	*Symphonia globulifera*	CLUSIACEAE	67	4.4%
9	Angelim fava	*Hymenolobium flavum*	FABACEAE	1	0.1%
10	Angico	*Anadenanthera peregrine*	MIMOSACEAE	74	4.8%
11	Anoera	*Licania macrophylla*	CHRYSOBALANACEAE	41	2.7%
12	Axixá	*Sterculia speciosa*	STERCULIACEAE	3	0.2%
13	Barrote	*Tetragastris panamensis*	BURSERACEAE	48	3.1%
14	Breu branco	*Tratinnickia burseraefolia*	BURSERACEAE	36	2.3%
15	Caju	*Anacardium giganteum*	ANACARDIACEAE	12	0.8%
16	Carapanã	*Aspidosperma laxiflorum*	APOCYNACEAE	3	0.2%
17	Caripé	*Licania heteromorpha*	CHRYSOBALANACEAE	4	0.3%
18	Cariperana	*Licania micrantha*	ROSACEAE	2	0.1%
19	Casca seca	*Ouratea castaneaefolia*	OCHNACEAE	58	3.8%
20	Cedro	*Cedrela odorata*	MELIACEAE	10	0.6%
21	Cedrorana	*Cedrelinga catenaeformis*	MIMOSACEAE	23	1.5%
22	Copaiba	*Copaifera reticulata*	CAESALPINIACEAE	2	0.1%
23	Cumaru	*Dipteryx odorata*	FABACEAE	19	1.2%
24	Cupiúba	*Goupia glabra*	CELASTRACEAE	36	2.3%
25	Cupuí	*Theobroma subincanum*	STERCULIACEAE	22	1.4%
26	Envira preta	*Guatteria procera*	ANNONACEAE	18	1.2%
27	Esponjeiro	*Parkia oppositifolia*	MIMOSACEAE	19	1.2%
28	Farinha seca	*Lindackeria paraensis*	LEGUMINOSAE	7	0.5%
29	Fava	*Panopsis sessilifolia*	PROTEACEAE	25	1.6%
30	Fava bolota	*Parkia pendula*	MIMOSACEAE	4	0.3%

31	Fava orelha de macaco	*Enterlobium maximum*	MIMOSACEAE	2	0.1%
32	Faveira	*Parkia nitida*	MIMOSACEAE	2	0.1%
33	Goiabinha	*Myrciaria floribunda*	MYRTACEAE	8	0.5%
34	Guajará	*Neoxythece robusta*	SAPOTACEAE	43	2.8%
35	Ingá vermelha	*Inga heterophylla*	MIMOSACEAE	88	5.7%
36	Jatobá	*Hymenaea courabril*	CAESALPINIACEAE	11	0.7%
37	Jutaí	*Hymenaea parvifolia*	LEGUMINOSAE	1	0.1%
38	Louro	*Ocotea glomerata*	LAURACEAE	25	1.6%
39	Louro amarelo	*Licania rigida*	LAURACEAE	4	0.3%
40	Louro cheiroso	*Aniba paraense*	LAURACEAE	12	0.8%
41	Louro pimenta	*Licania armeniaca*	LAURACEAE	9	0.6%
42	Louro piriquito	*Ocotea guianensis*	LAURACEAE	19	1.2%
43	Louro preto	*Ocotea caudate*	LAURACEAE	13	0.8%
44	Louro vermelho	*Ocotea rubra*	LAURACEAE	11	0.7%
45	Maçaranduba	*Manilkara huberi*	SAPOTACEAE	1	0.1%
46	Macucu	*Aldina heterophylla*	LEGUMINOSAE CAESALPINOIDEAE	102	6.6%
47	Mari	*Cassia leiandra*	LEGUMINSOAE CAESALPINOIDEAE	5	0.3%
48	Marupá	*Simaruba amara*	SIMARUBACEAE	10	0.6%
49	Matá matá	*Eschweilera odorata*	LECHYTHIDACEAE	269	17.5%
50	Morototó	*Didymopanax morototoni*	ARALIACEAE	11	0.7%
51	Murta	*Myreia falax*	MYRTACEAE	5	0.3%
52	Mururé	*Brosimum obovata*	MORACEAE	1	0.1%
53	Pará pará	*Jacaranda copaia*	BIGNONIACEAE	16	1.0%
54	Pau de remo	*Rauwolfia pentaphylla*	LEGUMINOSAE	18	1.2%
55	Pente de macaco	*Apeiba echinata*	TILIACEAE	9	0.6%
56	Piquiá	*Caryocar villosum*	CARYOCARACEAE	5	0.3%
57	Piquiarana	*Caryocar glabrum*	CARYOCARACEAE	5	0.3%
58	Pracuuba	*Mora paraensis*	CAESALPINIACEAE	1	0.1%
59	Quaruba	*Vochysia maxima*	VOCHYSIACEAE	3	0.2%
60	Quaruba cedro	*Vochysia inundata*	VOCHYSIACEAE	21	1.4%
61	Ripeiro	*Guatteria calophylla*	ANNONACEAE	32	2.1%
62	Seringueira	*Hevea brasiliensis*	EUPHORBIACEAE	5	0.3%
63	Sorva	*Couma guianensis*	APOCYNACEAE	17	1.1%
64	Sucupira	*Diplotropis martiusii*	FABACEAE	2	0.1%
65	Tachi	*Sclerolobium chrysophyllum*	CAESALPINIACEAE	22	1.4%
66	Tamanqueira	*Zanthoxylum regneliana*	RUTACEAE	2	0.1%
67	Tanimbuca	*Buchevania capitata*	COMBRETACEAE	3	0.2%

68	Tatapiririca	*Tapirira guianensis*	ANACARDIACEAE	18	1.2%
69	Tento	*Ormosia paraensis*	FABACEAE	5	0.3%
70	Ucuuba	*Virola Surinamensis*	MYRISTICACEAE	12	0.8%
71	Ucuubarana	*Lryanthera grandis*	MYRISTICACEAE	73	4.7%
72	Urucarana	*Sloanea grandiflora*	TILIACEAE	6	0.4%
Total				**1,540**	**100%**

Table 11. Species found within the project area[77]

The Figure below shows that all vegetation cover types within the project area and reference region fall within the class of riparian dense tropical rainforest.

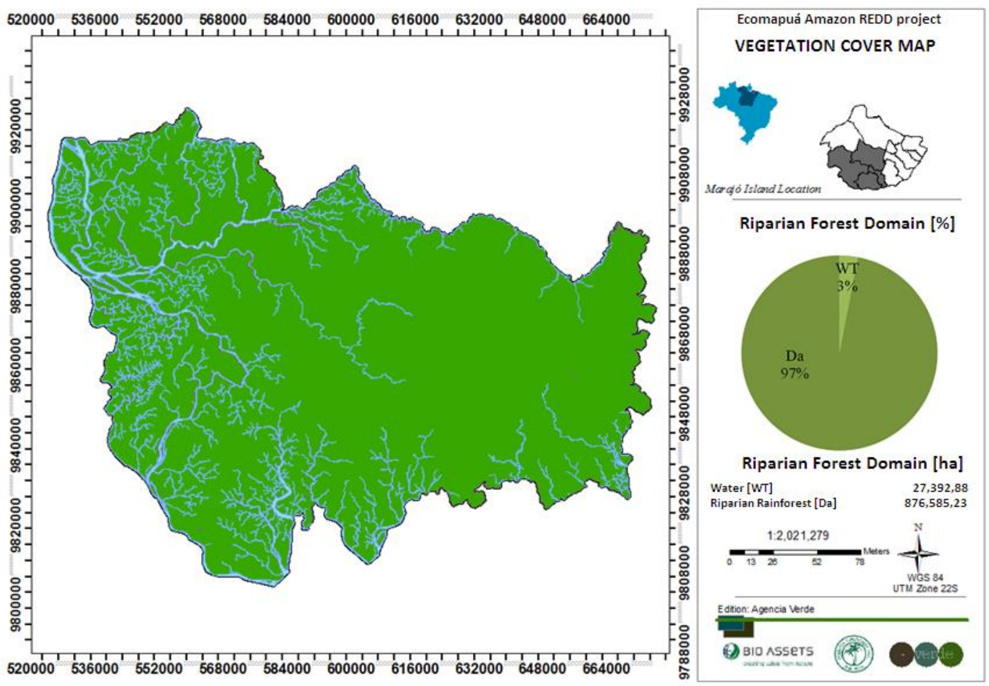

Figure 9. Vegetation cover of the reference region and project area

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law Nº 12.651, 25/05/2012[78]), all rural estates located in forest zones should have:

[77] A. Ribeiro de Barros (2001), "Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará".

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

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

II - Legal Reserve (LR): an area located within a rural property or possession, except for the permanent preservation, necessary for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[79], eighty percent (80%) of a rural property should be preserved as LR.

In the Reference Region, although 80% of native vegetation in land properties should be preserved as LR, there is a general non-compliance with the Brazilian Forest Code, as around 23.4% of native vegetation has already been suppressed in 2001 (i.e. there was a deficit of 3.4% of native forest areas that should not have been suppressed in the Reference Region before the crediting period start date).

One of the main ways to combat deforestation in Brazil are the command and control mechanisms, such as effective monitoring, requiring compliance with environmental legislation along with a greater state presence. However, this does not seem effected in most regions of the country, because the weakness of the government to fulfil these responsibilities in comparison with other social goals and economic interests has put Brazil among the world's largest deforesters[80].

In spite of the legal provisions intended to preserve at least 80% of the Amazon Forest coverage, lack of law enforcement by local authorities along with public policies seeking to increase commodities production and encourage land use for agricultural, bio energy and cattle breeding purposes created a scenario of complete disregard of the mandatory provisions of the Forest Code. In addition to that, to cover vast distances of areas with low demographic density makes tracking of illegal activities and land surveillance very difficult for the authorities[81].

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.

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

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

[81] MOUTINHO, P. et al. REDD no Brasil: um enfoque amazônico: fundamentos, critérios e estruturas institucionais para um regime nacional de Redução de Emissões por Desmatamento e Degradação Florestal – REDD. Brasília, DF: Instituto de Pesquisa Ambiental da Amazônia, 2011.

1.15 Participation under Other GHG Programs

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

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

1.15.2 Projects Rejected by Other GHG Programs

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

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

1.16.2 Other Forms of Environmental Credit

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

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

1.17 Additional Information Relevant to the Project

Leakage Management

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

Commercially Sensitive Information

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

Sustainable Development

The primary objective of the Ecomapuá Amazon REDD Project is to avoid the unplanned deforestation (AUD) of the 97,007.22 ha project area, consisting of 100% Amazon rainforest at the project start date.

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

- SDG 1: No poverty.
- SDG 4: Quality education.
- SDG 8: Decent work and economic growing.
- SDG 12: Ensure sustainable production and consumption patterns.
- SDG 13: Take urgent action to combat climate change and its impacts.
- SDG 15: To protect, restore and promote the sustainable use of terrestrial ecosystems, to manage forests sustainably, to combat desertification, to halt and reverse land degradation, and to halt the loss of biodiversity.

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[82].

The following components of the Brazilian commitments under the Convention are reinforced by the development of the Ecomapuá Amazon 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, beyond the project's ecological and carbon benefits, the implementation of REDD and SOCIALCARBON mechanisms promotes benefit sharing: a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project

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

region, specifically contributing to improving deforestation control, and developing environmental education and other social activities.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

Ecomapuá has conducted a social and environmental impact assessment within the Project Area in 2002[83]. According to this assessment, there were 99 families in the project area, and an estimated 187 families in the reference region at the time of the study. In addition, local presentations and meeting were performed for some communities.

This assessment identified the main potential environmental and socio-economic risks that should be evaluated as part of SOCIALCARBON certification. Table below provides details on the identified potential risks:

Activity	Aspect	Impact	Effect		Comments/ Observation
			Beneficial	Adverse	
REDD: Carbon credit project	Conservation of Amazon Rainforest	Greenhouse Gas Emissions Reductions	X		Monitored by the Carbon resource: • Project performance Monitored by the Natural resource: • Efficiency of project in countering agents of deforestation/ degradation
REDD: Carbon credit project	Conservation of Amazon Rainforest	Monitoring and supervision to avoid deforestation of forest within the project area.	X		Monitored by the Biodiversity resource: • Biodiversity conservation Monitored by the Natural resource: • Monitoring Methods

[83] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

REDD: Carbon credit project	Conservation of Amazon Rainforest	Conflict management with communities in the project area, due to banning of timber product extraction.		X	Monitored by the Carbon resource: • Stakeholder consultation and support for the project
REDD: Carbon credit project	Empowerment	Increased independence of the communities in the project area.	X		Monitored by the Social resource: • Associations and cooperatives • Alternative income sources • Extent of alternative income generation sources and further programs Monitored by the Human resource: • Community education and training Monitored by the Financial resource: • Employment opportunities Monitored by the Natural resource: • Tree nursery and maintenance of planted trees. Monitored by the Biodiversity resource: • Non timber forest products (NTFPs)
REDD: Carbon credit project	Application of the Social Carbon methodology	Encourageme nt and investment in research on social,	X		Monitored by the Social resource: • Social research Monitored by the Human resource:

		economic and environmental aspects in the project region.			• Health • Leisure, culture and sport • Equipment and infrastructure Monitored by the Financial resource: • Securing of funds • Carbon credit Investments Monitored by the Biodiversity resource: • Biodiversity research

Table 12. Main social, economic and environmental impacts of the Ecomapuá Amazon REDD Project

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

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

Activity	Aspect	Risk	SOCIALCARBON Indicators that will monitor the identified potential risks
REDD carbon project	Uncertainties relating to standing forest in the future.	Non permanence of carbon: Time which carbon will remain stocked in live biomass, without being emitted into the atmosphere. Due to the uncertainties related to what will happen to the forest in future, there is a risk of non-permanence of forest carbon.	Monitored by the Carbon resource: • Buffer reduction

Table 13. Significant risks to the Project

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

2.2 Local Stakeholder Consultation

The main stakeholders considered in this project are:

- The local community living inside the project area;
- The local community surrounding the project area;
- The Municipalities of Breves, Curralinho and São Sebastião da Boa Vista;
- The Environmental Agencies of Breves and São Sebastião da Boa Vista Municipalities;
- The Agriculture Agency of Breves Municipality;
- The Educational Agency of Breves Municipality;
- The Chico Mendes Institute for Biodiversity Conservation (ICMBio);
- Amazon Oil (chemical-oil industry that operates in the area of extraction of Amazon oilseeds);

An explanatory letter was sent to the stakeholders asking their opinion about the project. Moreover, they were also invited to attend a local stakeholders' consultation in Breves Municipality. The local community was invited by one of the project supervisors who lives in the Bom Jesus community of the project area. This invitation letter is shown below.

The local stakeholders' consultation was held on 07-February-2013 in the Environmental Agency of Breves Municipality (SEMMA). This presentation detailed a summary of the proposed activities of the project implementation and monitoring, including potential activities related to production of Amazon seed oils involving the local community. The auditor from TÜV Rheinland, who conducted the validation of this project, was also present at this meeting.

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. In addition, the following materials were distributed: Sustainable Carbon Folder and the Project Idea Note (PIN), both in Portuguese. Furthermore, a preliminary version of the VCS PD was available for local consultation.

Furthermore, the participants were informed that the period for requesting information and comments about the Ecomapuá Amazon 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. As no answer was obtained within 30 days, it was assumed that stakeholders have no objections to the project activity.

A minute of this meeting was made and registered at the SEMMA office. A copy of this document is also shown below.

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

Furthermore, the project intends to carry out an average of at least one local stakeholders consultation per year. This consultation will also communicate:

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

BIO ASSETS

Breves, 8 de Fevereiro, 2013.

ATA DE REUNIÃO

Assunto: APRESENTAÇÃO da EcoMapuá Conservação Ltda. – **Projeto EcoMapuá Amazon REDD**

Aos 7 dias do mês de Fevereiro de 2013, às 14 horas, foi realizado na Secretaria Municipal do Meio Ambiente de Breves (SEMMA), localizada na Av. Presidente Getúlio Vargas, S/N, Breves, Pará, a apresentação do projeto de redução de gases de efeito estufa produzidos pelo desmatamento não planejado: Projeto EcoMapuá Amazon REDD. Este projeto tem como escopo final a Redução Das Emissões por Desmatamento e Degradação (REDD) evitando desmatamento não planejado.

A apresentação iniciou-se pontualmente e estavam presentes representantes das seguintes entidades (conforme lista de presença em anexo):

Presidente da Assossiação Amorama (Rio Mapuá)
Conselheira da Associação Amorama (Rio Mapuá)
Vereador do Municipio de Breves
Representante da Fazenda Bom Jesus (Rio Mapuá)
Representante da Fazenda Santo Amaro (Rio Parauaú)
Representante da Secretaria de Agricultura (SEMAGRI)
Representante da Secretaria do Meio Ambiente Estado do Pará (SEMA)
Secretário Municipal do Meio Ambiente de Breves (SEMMA)
Representante da Secretaria Municipal do Meio Ambiente de Breves (SEMMA)
Representante da Nativa Florestal
Representante da Empresa EcoMapuá
Representante da Empresa Sustainable Carbon
Consultor da Validadora TUV Rheinland

O projeto foi apresentado pelo representante da Empresa Sustainable Carbon, que elaborou o DCP (Documento de Concepção do Projeto), e o representante da Empresa EcoMapuá Conservação Ltda. (proprietária das áreas onde será realizado o projeto). A apresentação detalhou de forma resumida as atividades propostas de implantação e monitoramento do projeto, inclusive o pontencial da implantação de atividades ligadas a produção de óleos de sementes da amazônia com empresas já estabelecidas no processamento e comercialização destes. Foi informado que o projeto encontra-se na fase de validação, seguindo as regras do VCS (Verified Carbon Standard), atendendo aos procedimentos estabelecidos para a geração de créditos de carbono por meio da redução de emissões voluntárias.

Durante a apresentação houveram várias perguntas dos participantes, que prontamente foram respondidas, resultando em grande interesse dos presentes no entendimento dos desafios e benefícios deste projeto, inclusive para as áreas no entorno (incluindo a RESEX Mapuá e RESEX Pracuúba), o Município de Breves como um todo e as comunidades locais. Foram distribuídos os seguintes materiais: Apresentação da Sustainable Carbon e Folheto descritivo da Idéia do Projeto (PIN), além de estar disponível para consulta local o DCP.

Após 2 horas de apresentação, a Sustainable Carbon e EcoMapuá agradeceram a presença de todos e informaram aos presentes que estaria aberto o período para solicitação de informações e comentários sobre o relatório técnico do Projeto EcoMapuá Amazon REDD. O prazo para comentários é de 30 dias, a partir da data da apresentação, podendo ser realizado por telefone ou e-mail informados na apresentação.

Breves, 8 de fevereiro de 2013.

Marcelo Haddad
Sustainable Carbon – Projetos Ambientais Ltda.

Lap Chan
EcoMapuá Conservação Ltda.

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Figure 10. Local stakeholders consultation minute registered at SEMMA office

BIO ASSETS

Breves, 25 de Janeiro, 2013.

CONVITE ÀS PARTES INTERESSADAS

Assunto: APRESENTAÇÃO da EcoMapuá Conservação Ltda. – **Projeto EcoMapuá Amazon REDD**

Prezado Senhor/a,

Vimos, por meio desta, informar V.Sa. que estamos desenvolvendo um projeto de mitigação dos impactos relacionados aos gases de efeito estufa produzidos pelo desmatamento não planejado. Este projeto tem como escopo final a Redução Das Emissões por Desmatamento e Degradação (REDD) evitando desmatamento não planejado. O projeto está em consonância com as diretrizes e critérios de desenvolvimento sustentável do país.

Com esta iniicativa, a EcoMapuá Conservação Ltda. visa a 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.

Assim, para o cumprimento de uma das diretrizes, a EcoMapuá está entrando em contato com as partes interessadas para divulgação do projeto no dia **7 de Fevereiro, 2013, na Fazenda Santo Amaro, localizado de frente a cidade de Breves às 14:00 horas.** Providenciaremos transporte do trapiche municipal. Caso haja alteração do local, será informado através de um cartaz postado no trapiche municipal ou informado por nova comunicação.

A partir desta data, está aberta a solicitações de informações e comentários sobre o relatório técnico do Projeto EcoMapuá Amazon REDD. O prazo para comentários é de 30 dias, a partir da presente data. Favor entrar em contato para o envio da cópia por meio eletrônico ou em papel.

Atenciosamente,

Chan Lap Tak
EcoMapuá Conservação Ltda.

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Figure 11. Explanatory letter sent to the stakeholders

2.3 Environmental Impact

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

The Amazon Biome, the location of a hugely diverse fauna and flora, spreads over almost 50% of the Brazilian territory[84]. However, the uncontrolled deforestation is breaking up the forest in this habitat and, without necessary care, entire regions with local fauna and ancient habitats of unique species are at risk of complete destruction[85]. To quantify further, this biome holds the biggest variety of species in the world, and deforestation and degradation of tropical forests are the main causes of global biodiversity loss[86].

The Second Brazilian Inventory of Anthropogenic Greenhouse Gas Emissions[87] indicates that in 2005, the major source of GHG emissions in Brazil was deforestation (more than 75% of the total emissions in the country), which mainly takes place in the Amazon (51.5% of the total emissions in the country) and *Cerrado* biomes (16.8%).

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

Environmental Factor	Environmental Impact	Classification
Soil	Improvement of soil conditions and minimization of soil loss. Preservation of the nutrient cycles (e.g., phosphorous and nitrogen)	Positive
Air	Improvement of local air by filtering pollutants	Positive
Climate	GHG emission reduction	Positive

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

85 Margulis S. Causas do Desmatamento da Amazônia Brasileira. BANCO MUNDIAL. Brasil. July, 2003. Available at: <http://siteresources.worldbank.org/BRAZILINPOREXTN/Resources/3817166-1185895645304/4044168-1185895685298/010CausasDesmatamentoAmazoniaBrasileira.pdf>.

86 BRASIL. Ministério do Meio Ambiente (MMA). Inter-relações entre biodiversidade e mudanças climáticas: Recomendações para a integração das considerações sobre biodiversidade na implementação da Convenção-Quadro das Nações-Unidas sobre Mudança do Clima e seu Protocolo de Kyoto. Brasília, 2007. 220 p. (Biodiversidade, v.28). Available at: <http://www.mma.gov.br/estruturas/chm/_arquivos/prefacio2_bio_28.pdf>.

87 BRASIL. Ministério da Ciência, Tecnologia e Inovação (MCTI). Inventário Brasileiro de Emissões Antrópicas por Fontes e Remoções por Sumidouros de Gases de Efeito Estufa não Controlados pelo Protocolo de Montreal - Parte II da Segunda Comunicação Nacional do Brasil. Brasília, 2010. Available at: <https://sirene.mctic.gov.br/portal/opencms/publicacao/index.html>.

Water/ hydric resources	Preservation of ground water quality	Positive
Water/ hydric resources	Water cycle renewal	Positive
Fauna	Biodiversity preservation	Positive
Flora	Biodiversity preservation	Positive

Table 14. Main environmental impacts generated by Ecomapuá Amazon REDD Project Activity

Therefore, the Ecomapuá Amazon REDD Project will bring a net positive environmental impact, also benefiting the local communities. Furthermore, the Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included the Marajó Island in its 2003 survey of Brazil's 900 priority areas for conservation[88]. The entire island is classed within the ministry's highest priority category: "extremely high". Thus, the conservation of this private land located inside the Marajó Island is in accordance with the Brazilian Government proposal for conservation, helping to reach this goal, and encouraging the creation of new conservation projects and areas.

2.4 Public Comments

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

2.5 AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

Stakeholders were identified through researches and previous social activities developed by Ecomapuá in the project area. The main stakeholders included representants from communities living within and outside the project area, Governmental agents, Environmental and Agricultural Agencies, and private sector. The list is available at section Local Stakeholders Consultation above.

Communities have customary tenure/access rights to territories and resources. Therefore, since the beginning of Ecomapuá's activities within the project area, the company's main intention was to carry out environmental activities that brings possibilities of generation of alternative income sources to local communities, without affecting in anyway the ownership of the land or right to use natural resources by local communities. However, it should also be noted that Ecomapuá has never supported illegal logging activities, which is not a legal practice. This inference is reinforced by report conducted by FADESP (2002)[89], who collected interviews in which residents stated that

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

[89] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

they could no longer harvest timber within the project area, and also from the protests and complaints observed in certain communities due to the prohibition.

According to the aforementioned social study, the residents' agricultural activities rely on slash-and-burn practices to clear land for plantation; as such subsistence agriculture is an important component of the dynamic of deforestation in the project area and reference region. The communities have a lower HDI than the average for the region (0.473), and the main production activity is the extraction of wood, palm heart and manioc flour for own consumption. Therefore, Ecomapuá's main activities are to provide alternative income sources to communities, potentially the açaí.

The main impacted communities by the project are located along the Mapuá River, i.e., within the five properties composing the project area, as well as in areas in the border of the project area. It is important to note that environmental and social activities carried out by the project will try to benefit all communities. This will be measured by SOCIALCARBON indicators at each verification event, which will analyse the extent of alternative income generation sources and further programs and alternative income sources, besides the applied methods for local stakeholders consultation.

<u>Risks to Local Stakeholders</u>

The main potential environmental and socio-economic risks for stakeholders will be evaluated as part of SOCIALCARBON certification at each verification event. The identified risks were described at Section 2.1 above (No Net Harm).

As described above, Ecomapuá management team has expertise and prior experience in implementing projects with community engagement within the project region, such as the Fome Zero Project (2005 / 2006), which made it possible to identify the main difficulties of the communities and future projects to be developed in the region.

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

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

After the acquisition of the properties where the project area is located, in 2001, Ecomapuá's main intention was to carry out environmental and social activities that brings possibilities of generation of alternative income sources to local communities, as detailed in the company's Social Contract objectives. The company has never questioned the community or raised any concerns about land tenure and natural resources access issues.

No community member has been removed from their land, on the contrary, communities have been supported through programs and incentives the project proponent has instigated. Several social and environmental projects have been developed within the project area since the beginning of activities in 2001, however all these activities did not affect in anyway the ownership of the land or right to use natural resources by local communities. Ecomapuá always tried to reach the maximum communities as possible in the region, which were directly involved in these project activities.

Any conflict management will be monitored by SOCIALCARBON indicators, specifically Stakeholder consultation and support for the project.

In addition, the project will not introduce any invasive species or allow an invasive species to thrive through project implementation. If the project implements any reforestation project with non-native species over native species, the possible risks and adverse effects of exotic species will be justified and explained to communities.

Communication and Consultation

The project will take all appropriate measures to communicate and consult with local stakeholders in an ongoing process for the life of the project. As described above, the project intends to carry out an average of one or two local stakeholders consultations per year, which will be monitored by SOCIALCARBON certification. This consultation will communicate:

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

Grievance redress and conflict management procedures, as well as benefit sharing mechanisms, will be discussed with communities through stakeholders consultations. Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All comments received will be responded, and grievances will be resolved in a suitable timeframe whenever possible, taking into account culturally-appropriate conflict resolution methods.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

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

Furthermore, the following tools were used:

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

3.2 Applicability of Methodology

Applicability Conditions	Justification of Applicability
a) Baseline activities may include planned or unplanned logging for timber, fuel-wood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.	None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4.0. The primary land uses in the baseline scenario consists of three overlapping activities: clearing for timber collection, extraction of palm-heart and clearing of plantation land, 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 A, "Avoided Deforestation without Logging". The reason is that the project area contains only riparian dense tropical rainforest, and degradation is not included in either the baseline or project scenario.
c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agro-forestry systems meeting the definition of "forest".	The REDD project area is 100% made up of riparian dense tropical rainforest, as described in the section Conditions Prior to Project Initiation of the present VCS PD.

	No deforested, degraded or areas otherwise modified by humans were included in the project area at Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The project area consisted of 100% tropical rainforest in 1992 – 10 years prior to project start date – all of which conformed to the FAO definition of forest [90]. This was ascertained using satellite images, as described in the section Project Location of the present VCS PD.
e) The project area can include forested wetlands (such as bottomland forests, flood plain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes a forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	As described in the section Conditions Prior to Project Initiation of the present VCS PD, all soil types are mineral, as they are in the entirety of Marajó Island [91,92,93]. Therefore, none of the project area grows on peat, satisfying this applicability criterion.

3.3 Project Boundary

The project area is composed of five properties as described in the section Project Location. Given that the coordinates represented by these properties are extensive, the area contour coordinates of the properties composing the Ecomapuá Amazon REDD Project are presented in Appendix I.

The leakage belt is formed of an area primarily to the north-west of the project, and also adjoining the Fazenda Lago do Jacaré to the other properties, as shown in the section Project Location, these do not form part of the REDD project.

[90] 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>.

[91] Morris et al., 'Land Use and Soil Change on Fazenda Bom Jesus, Ilha Marajó , Pará, Brazil'

[92] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves –Pará'

[93] D. F. Rossetti and P. M. De Toledo (2006), "Biodiversity from a historical geology perspective: a case study from Marajó Island, lower Amazon." *Geobiology, vol. 4.*

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

Name	Net Forest Area (ha)
Project Area	97,007.22
Leakage Belt	119,037.32

Table 15. Forested areas within the Project Area and Leakage Belt

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

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	included	Carbon stock change in this pool is always significant
	Non-Tree: Excluded	No existence of perennial crops as final class
Below-ground	Included	Stock change in this pool is significant
Dead wood	Exluded	Excluded for simplification. This exclusion is conservative.
Harvested wood products	Excluded	Not significant
Litter	Excluded	Not to be measured according to VCS Methodology Requirements, 4.0.
Soil organic carbon	Excluded	Recommended when forests are converted to cropland. Not to be measured in conversions to pasture grasses and perennial crop according to VCS Methodology Requirements, 4.0.

Table 16. Carbon pools included or excluded within the boundary of the proposed AUD project activity

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

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

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

Table 17. Sources and GHG included or excluded within the boundary of the proposed AUD project activity

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

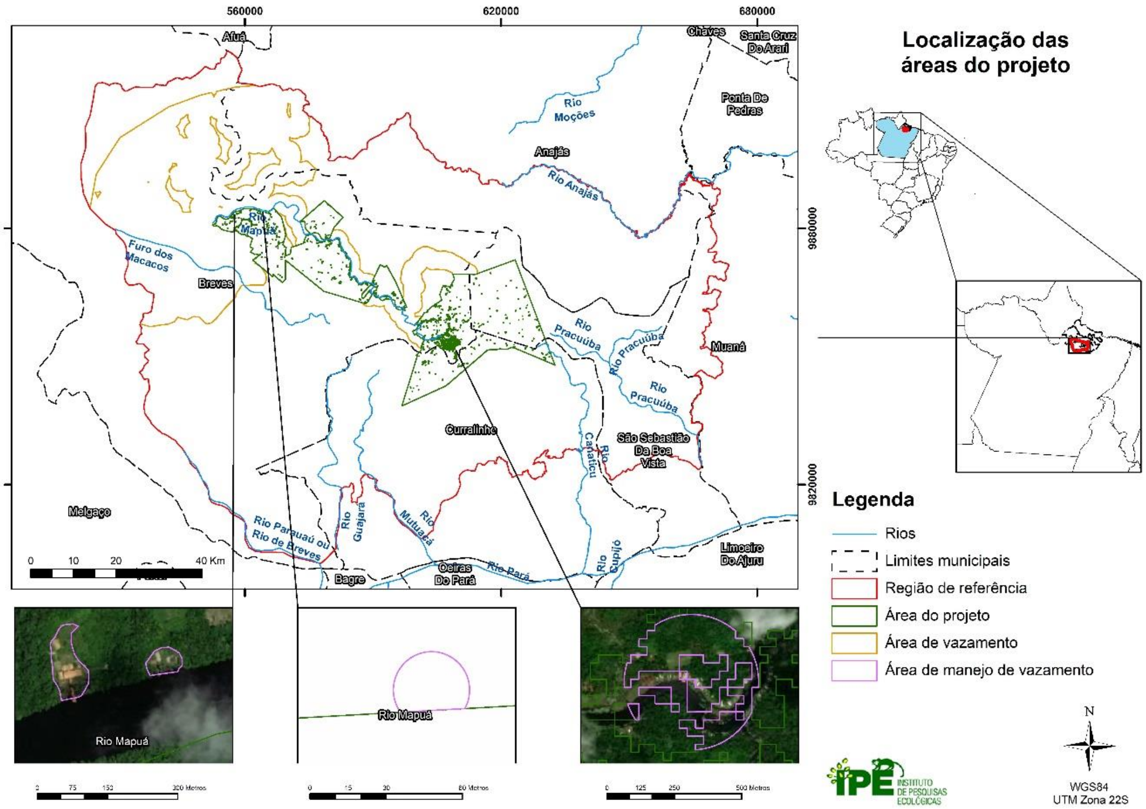

Figure 12. Project boundaries

3.4 Baseline Scenario

According to VCS requirements, the baseline must be reassessed every 10 years because projections for deforestation are difficult to predict over the long term. This section presents the updated baseline scenario for the second baseline period of the Ecomapuá Amazon REDD Project.

In the baseline scenario, forest land is expected to be converted to non-forest land by the agents of deforestation acting in the reference region, project area and leakage belt, as described below. Therefore, 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 the additionality section, as well as to carry out the environmental education and plantation activities involved in the implementation and leakage management of the present project.

Degradation was not considered in the present REDD project, which is in accordance with methodology requirement, which define “forest” and “non-forest” as the minimum land-use and land-cover classes. The principal reasons for discounting degradation were:

- Impossibility of detection of degradation with the resolution of satellite images described under “image classification”;

- Non-availability of widely accepted methods for quantifying and monitoring with confidence[94] of the expected type of degradation, which is local fuelwood collection[95,96], via remote sensing, being the method used in the present project;
- Excluding degradation from this project activity is conservative, as according to IBGE data detailed in section Baseline Scenario below, timber harvesting has been decreasing within the reference region over the last analyzed period (2003 – 2012), so it is expected that project emissions due to illegal harvesting be lower than baseline emissions (if they had been considered).

GIS MAPPING, REMOTE SENSING TECHNIQUES

In order to analyze land use and land cover (LU/LC) for the baseline reassessment, remote sensing satellite analysis was carried out, which is described below.

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. The historical reference period for the present project during the reassessment of second baseline period comprised analysis of images from 2003 - 2012. In accordance with the methodology, the analysis shall be made using the data obtained from monitoring LU/LC changes in the reference region during the past fixed baseline period.

Image sources used in the revision of the second baseline period

To carry out the reassessment of the second baseline period (2013-2022 period), the analyses of land-use change referring to the past fixed baseline period (2003-2012) were made utilizing images found in MapBiomas. All MapBiomas annual coverage and land use maps are produced from the pixel-by-pixel classification of images from Landsat satellites. The entire process is done with extensive machine learning algorithms through the Google Earth Engine platform that offers immense processing capacity in the cloud. To facilitate the parameterization of the algorithms and the organization of all processing steps, the 556 maps from IBGE with 1 x 1.5º (lat / long) are used.[97].

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[94] COP 17 (2011), "GOFC – GOLD Sourcebook COP17, Version 1" (p.2 – 110, p.1 – 5)

[95] Amaral, D.D., Vieira, I.C.G., Salomão, R.P., Almeida, S.S., Silva, J.B.F., Costa Neto, S.V., Santos, J.U.M., Carreira, L.M.M. & Bastos, M.N.C. (2007), 'Campos e Florestas das bacias dos rios Atuá e Anajás. Ilha do Marajó, Pará. Museu Emílio Goeldi. Coleção Adolpho Ducke. Belém'

[96] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002."

[97] Available at: <http://mapbiomas.org/atbd>.

The use of MapBiomas as image reference was made because the region has a high cloud cover over the year, and thus, Prodes data are highly impacted by this condition. As the Prodes methodology uses only the month of August as base for the satellite image generation, the time window for the mapping is reduced, and the chances to find an image with low cloud density is very small. This creates a limitation since many areas of deforestation are omitted from those years when the amount of cloud was very high, underestimating this conversion of land use.

On the other hand, MapBiomas searches a larger number of images within each year, since it is not restricted to a specific month. Although this generates a smaller time precision, the deforested area within each year is much more representative of the region's reality. The figure below.

Therefore, the dynamic of land use in the reference region was conducted from maps produced by MapBiomas, available in raster format at the program's website (http://mapbiomas.org/). At least two Landsat scenes per year were necessary to compose the entire reference region (orbit/point: 224/61 and 225/61). The final mapping resolution was of 30m.

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (μm)	(Km²)	DD/MM/YY	Path	Row
Satellite	Landsat TM	30	0.45 – 2.35	34,225	2003 - 2012	224	61
Satellite	Landsat TM	30	0.45 – 2.35	34,225	2003 - 2012	225	61

Table 18. Data used for historical reference period

Image classification

The historic deforestation of the reference region was analyzed through maps from MapBiomas (version 4.0), during the period of 2003 to 2012, downloaded from the http://mapbiomas.org/ website. MapBiomas is a multi-institutional initiative of the Greenhouse Gas Emissions Estimation System (SEEG - http://seeg.eco.br/en/) promoted by the Climate Observatory. Map Biomas co-creation involves NGO's, universities and technology companies.

The image classification methodology used, for each year, involved all Lansat images available for each period (Landsat 5 [L5] and Landsat 7 [L7]) with a cloud cover less than or equal to 50%. Thus, a representative mosaic of each year was generated, selecting cloud free pixels from the available images. Metrics are extracted for each pixel that describes its behavior during the year and can contain up to 105 layers of information. The mapping is made with an artificial intelligence classifier, the Randon Forest. The Landsite images acquisition is made through Google Earth Engine, with data from NASA and USGS (U.S. Geological Survey).

The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomas series, and direct collection by visual interpretation of Landsat images in order to classify a single map per class. This classification then goes through the stages of the spatial filter, applying neighborhood rules and temporal filters to reduce spatial and temporal inconsistencies.

The MapBiomas results go through an accuracy evaluation, which remains in 95% for the entire Amazon Biome. However, to meet the particularities of the project's region, an independent evaluation was carried out for the reference region for the years 2003-2012.

Thus, in order to assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated calculating the percentages of user and producer correctness, omission errors and commission. 210 random points were drawn on the reference region (70 points for each land use class – Forest, Non-Forest and Hydrography) and the degree of correctness of the classification was verified. High resolution images from Google Earth and Landsat images were used as reference, in which land use was visually possible at the drawn points. Omission and commission errors averaged 89%. The table below shows the accuracy analysis carried out for each year and each land use class.

	Producer accuracy			User accuracy		
Year	Forest	Hydrography	Deforestation	Forest	Hydrography	Deforestation
2003	85.90%	98.55%	95.24%	95.71%	97.14%	85.71%
2004	79.22%	98.46%	85.29%	87.14%	91.43%	82.86%
2005	78.21%	100.00%	81.82%	87.14%	94.29%	77.14%
2006	74.70%	98.55%	84.48%	88.57%	97.14%	70.00%
2007	85.14%	100.00%	88.41%	90.00%	95.71%	87.14%
2008	80.77%	95.71%	91.94%	90.00%	95.71%	81.43%
2009	83.78%	98.57%	89.39%	88.57%	98.57%	84.29%
2010	83.33%	100.00%	85.29%	85.71%	100.00%	82.86%
2011	78.48%	100.00%	87.50%	88.57%	95.71%	80.00%
2012	86.57%	95.71%	86.30%	82.86%	95.71%	90.00%

Table 19. Summary of confusion matrices from the evaluation of MapBiomas from 2003 to 2012

It is important to note that the project area contains only areas which were defined as "forest" 10 (±2) years prior to the project start date, as depicted in the forest cover benchmark map in the Figure below.

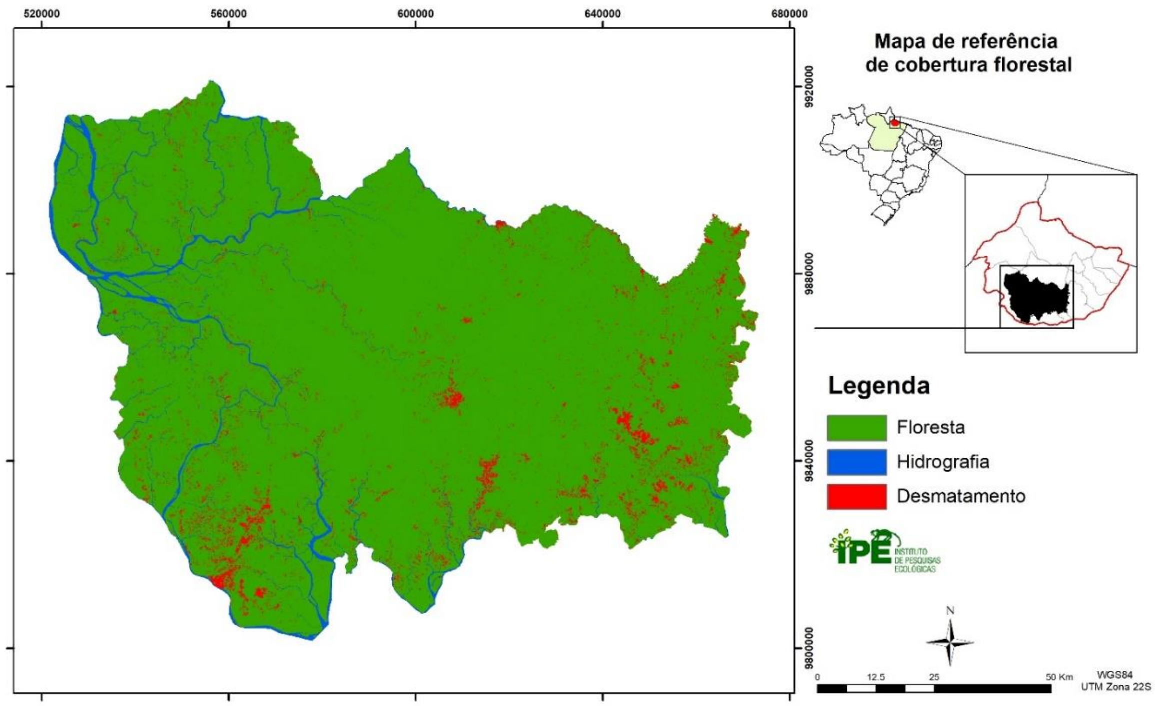

Figure 13. Forest cover benchmark map from 2012

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 v 1.1.

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

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

Stratification was not carried out in either class, and therefore the categories "forest" and "non-forest" have homogenous carbon stocks. Satellite images were used to generate the land-use and land-cover map at 2012 shown in the Figure below.

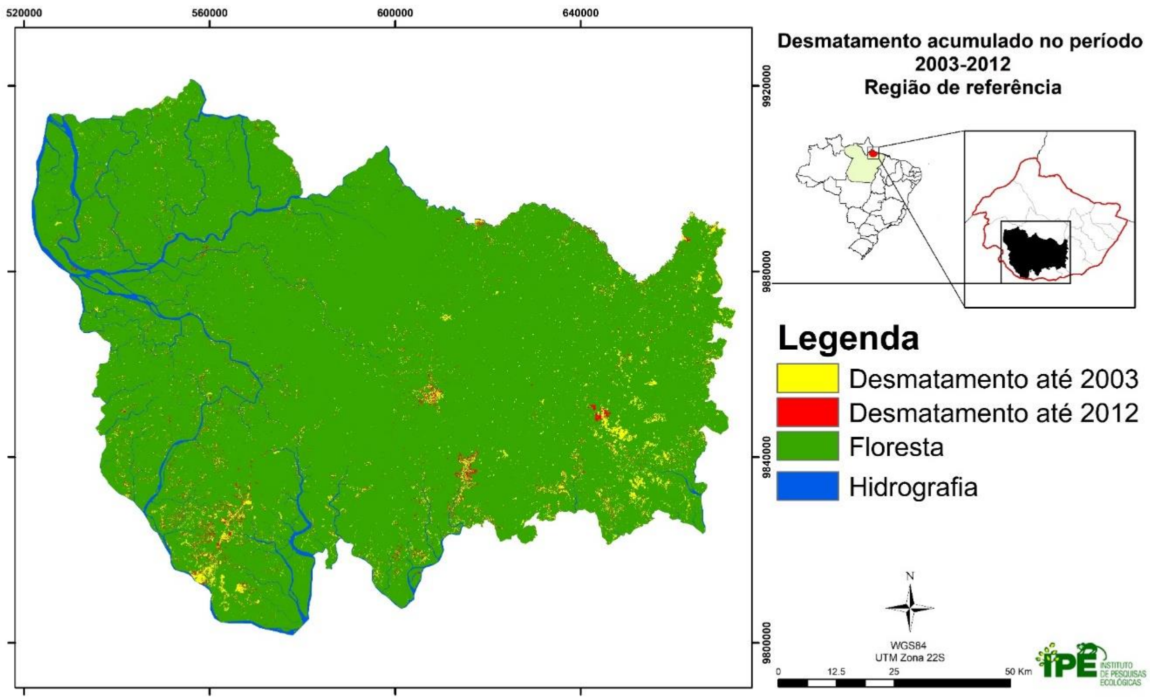

Figure 14. Land-Use and Land-Cover Map comparing 2003 and 2012

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

Class identifier		Trend in carbon stock[98]	Presence in	Baseline activity[99]			Description (including criteria for unambiguous boundary definition)
IDcl	Name			LG	FW	CP	
1	Riparian (Aluvial) Dense Tropical Rainforest	Decreasing	RR, PA, LK[100]	no	no	no	The categories were defined through: Analysis of the histogram of bands used, identifying its peaks and using them as a reference for grouping the most common values, associating them with the most common LU/LC types, followed by refinement through visual interpretation of the results.

98 The methodology specifies: Note if "decreasing", "constant", or "increasing".

99 LG = Logging, FW = Fuel-wood collection; CP = Charcoal Production (yes/no).

100 RR = Reference region, LK = Leakage belt, LM = Leakage management Areas, PA = Project area.

2	Non forest	Increasing	RR, PA, LK	no	no	no	Same as above.
3	Hydrography	Constant	RR, PA, LK	no	no	no	Same as above.

Table 20. Identification and baseline activity of all LU/LC classes at project start date within the reference region, project area and leakage belt

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

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

Table 21 below shows that deforestation could occur in the baseline and project scenarios within both the PA and LK areas and shows the quantities of deforestation observed within the historical reference period associated with each identifier. The deforestation present within the PA and LK are shown in the LU/LC-change map. This Table displays deforestation across the whole reference period (taking into account the revision of the 2^{nd} baseline period).

BASELINE SCENARIO

	Project Area	Initial LU/LC class	
	IDcl	Riparian (Aluvial) Dense Tropical Rainforest	Non Forest in the PA
Final Class	Riparian (Aluvial) Dense Tropical Rainforest	94,366.44	0.00
	Non Forest in the PA	1,702.71	938.07

	Leakage Belt	Initial LU/LC class	
	IDcl	Riparian (Aluvial) Dense Tropical Rainforest	Non Forest in the LK
Final Class	Riparian (Aluvial) Dense Tropical Rainforest	181,893.33	0.00
	Non Forest in the LK	4,157.37	4,013.01

PROJECT SCENARIO

	Project Area	Initial LU/LC class	
	IDcl	Riparian (Aluvial) Dense Tropical Rainforest	Non Forest in the PA
Final Class	Riparian (Aluvial) Dense Tropical Rainforest	95,523.43	0.00
	Non Forest in the PA	545.72	938.07

	Leakage Belt	Initial LU/LC class	
	IDcl	Riparian (Aluvial) Dense Tropical Rainforest	Non Forest in the LK
Final Class	Riparian (Aluvial) Dense Tropical Rainforest	181,893.33	0.00
	Non Forest in the LK	4,157.37	4,013.01

Table 21. Potential land-use and land-cover change matrix showing associated conversion levels over the remaining crediting period (2013 – 2032) in the baseline and project scenarios

As shown in the Table below, degradation was not considered in any of the LU/LC classes, for reasons described at the beginning of the present section. This table also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

IDct	Name - Initial	Trend in carbon stock	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	Riparian (Aluvial) Dense Tropical Rainforest	decreasing	PA and LK	no	no	no	Riparian (Aluvial) Dense Tropical Rainforest	constant	PA and LK	no	no	no
I1/F2	Riparian (Aluvial) Dense Tropical Rainforest	decreasing	PA and LK	no	no	no	Non Forest	constant	PA and LK	no	no	no
I2/F2	Non Forest	constant	LK	no	no	no	Non Forest	constant	LK	no	no	no

Table 22. List of LU/LC-change categories which could occur in PA and LK during the crediting period

The Land-Use and Land-Cover Change Map for the most recent period analyzed depicting the LU/LC-change categories defined is presented below.

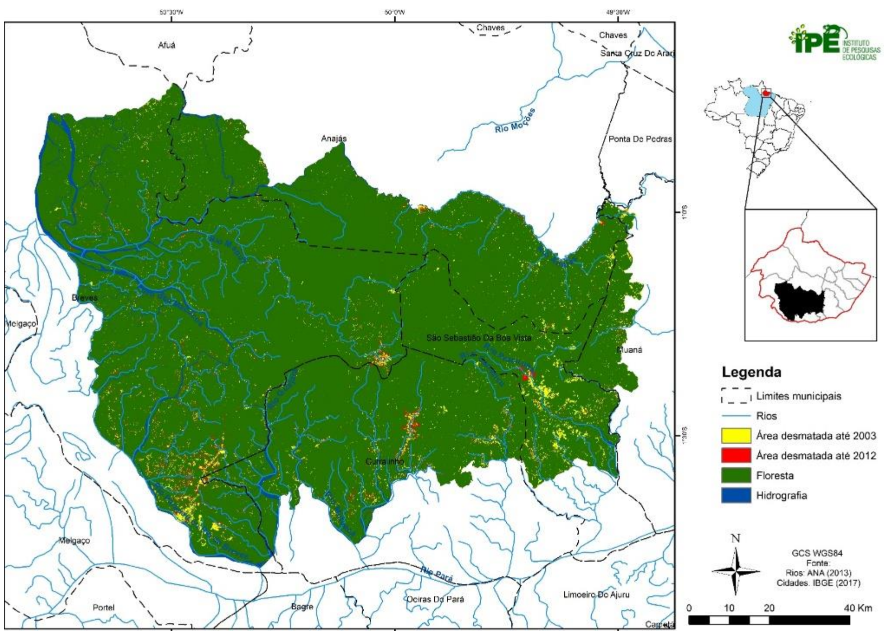

Figure 15. LU/LC-change map period in the reference region

<u>Analysis of land-use and land-cover change in revision of second baseline period</u>

The classified images regarding the 2003-2012 period of the reference region, project area and leakage belt by year follow below. These images were used to analyse the dynamics of deforestation in order to carry out the revision of the second baseline period.

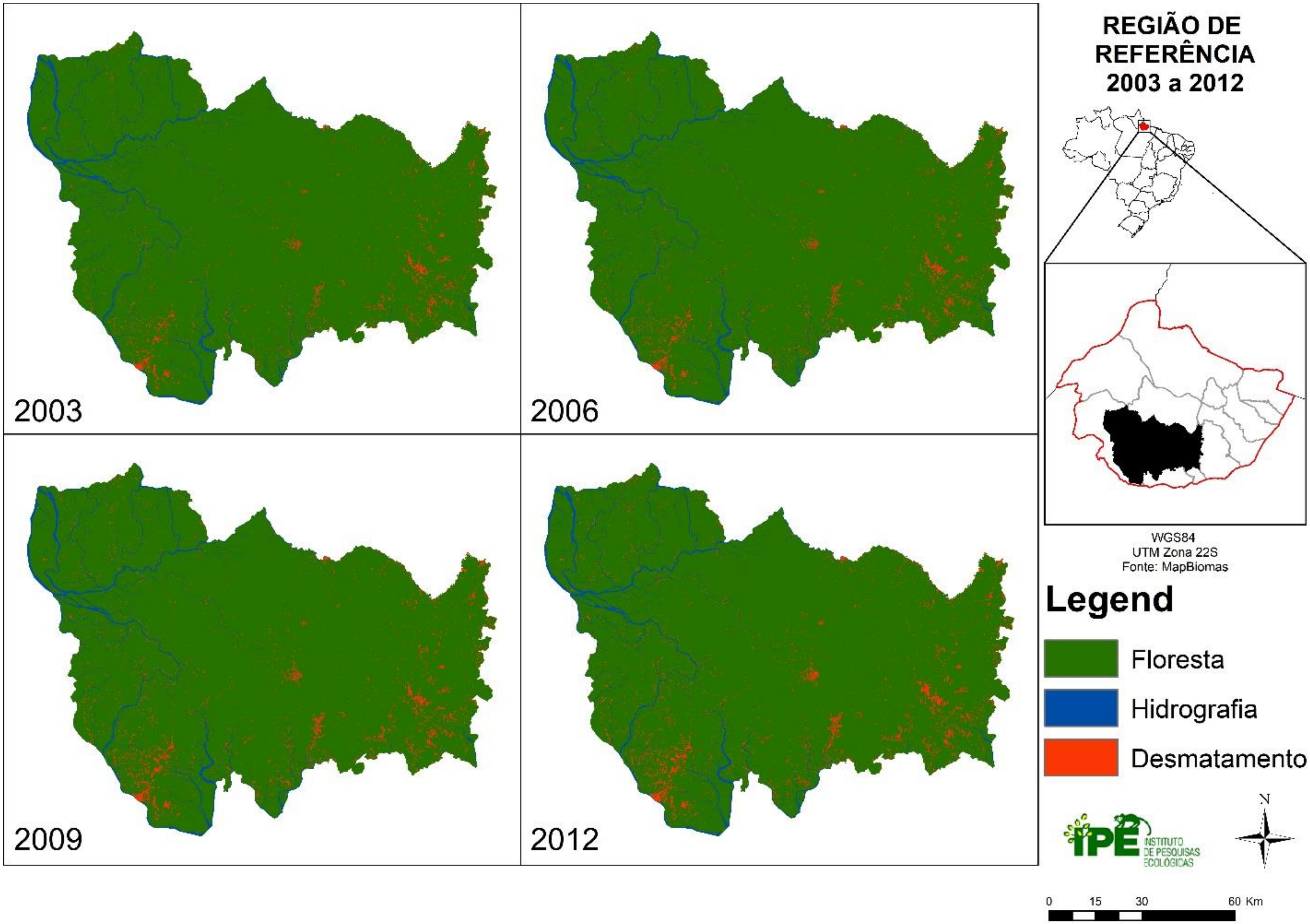

Figure 16. Maps of the classification of the reference region for the years 2003-2012

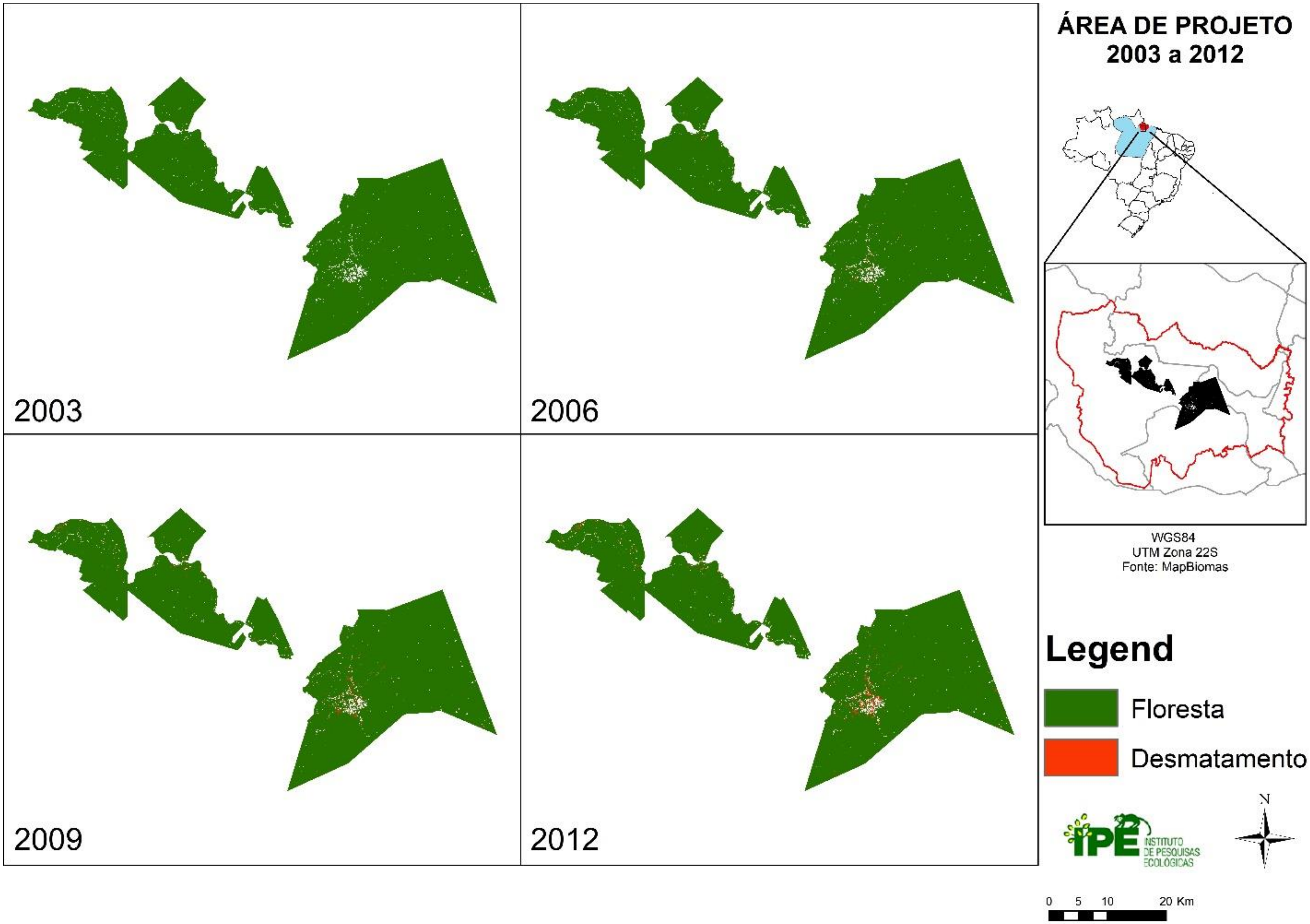

Figure 17. Maps of the classification of the Project Area for years 2003-2012

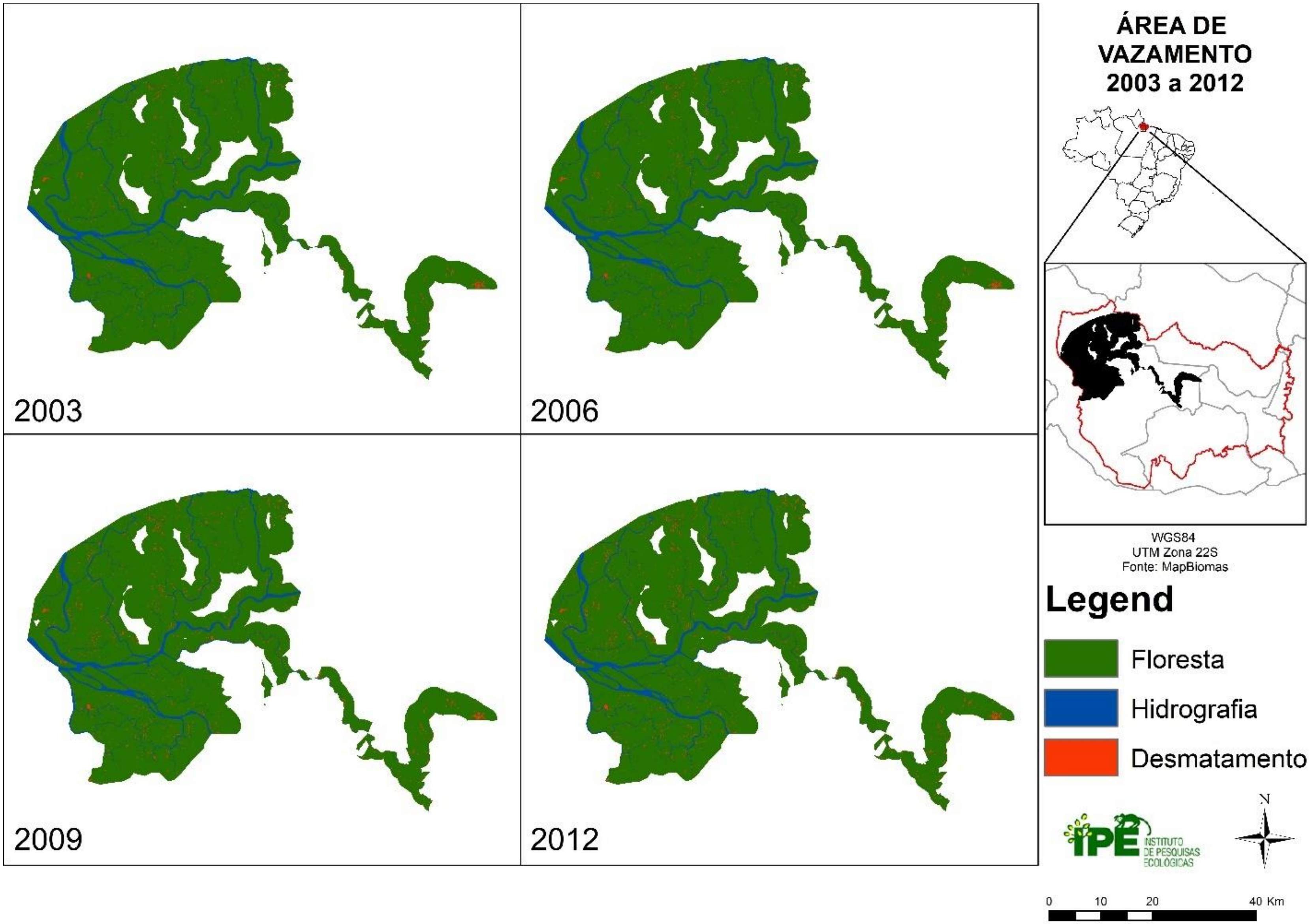

Figure 18. Maps of the classification of the Leakage Belt for years 2003-2012

In the Reference Region, during the last historical reference period, areas classified as "non-forest" are of greater concentration and larger in the south and south-western portion of the latter, as shown in the cumulative deforestation map below.

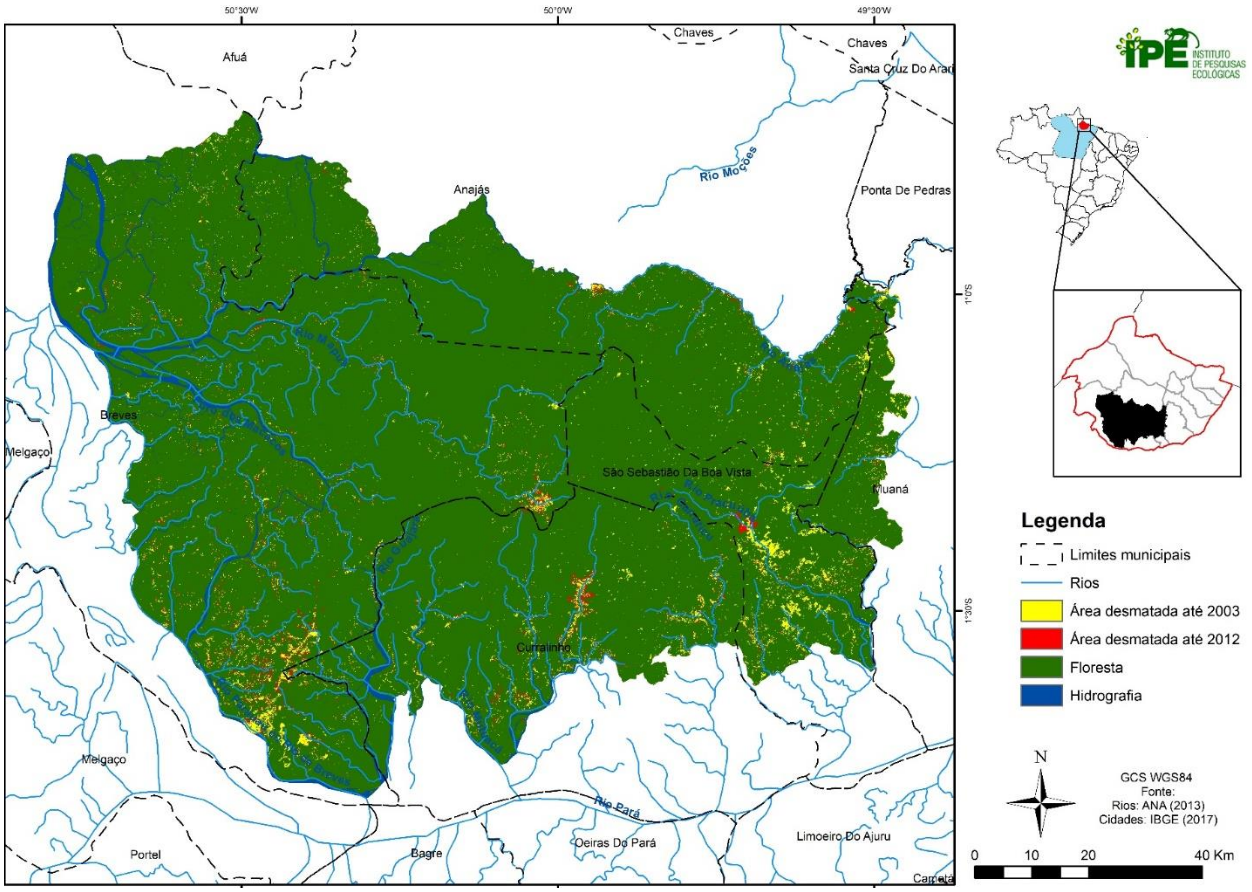

Figure 19. Deforestation pressure in the Reference Region over the 2003 – 2012 period

Furthermore, it can be noted that the classification identified deforestation with linear patterns indicating possible road creation (Figure below). The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation. Meanwhile, it is observed that this pressure comes from the South of the Reference Area and appears to originate from outside the latter, not influencing the dynamics of land-use change either in the Leakage Belt or in the Project Area.

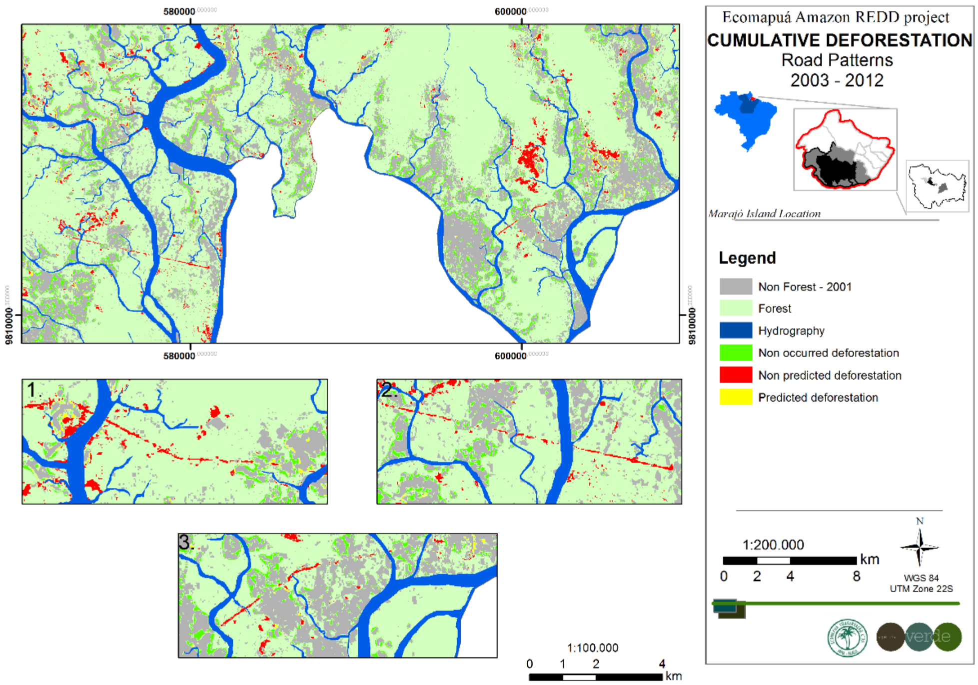

Figure 20. Deforestation in linear patterns indicating possible presence of roads

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

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2002	1,059,948.90		26,009.91	
2003	1,058,773.95	1,174.95	27,184.86	0.11%
2004	1,057,622.31	1,151.64	28,336.50	0.11%
2005	1,056,814.11	808.20	29,144.70	0.08%
2006	1,055,831.58	982.53	30,127.23	0.09%
2007	1,052,874.90	2,956.68	33,083.91	0.28%
2008	1,052,099.91	774.99	33,858.90	0.07%
2009	1,050,047.28	2,052.63	35,911.53	0.20%
2010	1,047,755.16	2,292.12	38,203.65	0.22%
2011	1,047,232.71	522.45	38,726.10	0.05%
2012	1,046,578.41	654.30	39,380.40	0.06%

Table 23. Annual deforestation in the reference region during historical reference period

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2002	97,007.22		0.00	
2003	96,968.88	38.34	38.34	0.04%
2004	96,911.01	57.87	96.21	0.06%
2005	96,876.90	34.11	130.32	0.04%
2006	96,821.37	55.53	185.85	0.06%
2007	96,586.11	235.26	421.11	0.24%
2008	96,520.14	65.97	487.08	0.07%
2009	96,401.88	118.26	605.34	0.12%
2010	96,108.93	292.95	898.29	0.30%
2011	96,098.49	10.44	908.73	0.01%
2012	96,069.15	29.34	938.07	0.03%

Table 24. Annual deforestation in the project area during the historical reference period

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2002	187,656.75		2,406.96	
2003	187,485.84	170.91	2,577.87	0.09%
2004	187,354.44	131.40	2,709.27	0.07%
2005	187,286.94	67.50	2,776.77	0.04%
2006	187,255.53	31.41	2,808.18	0.02%
2007	186,849.54	405.99	3,214.17	0.22%
2008	186,755.94	93.60	3,307.77	0.05%
2009	186,448.95	306.99	3,614.76	0.16%
2010	186,242.58	206.37	3,821.13	0.11%
2011	186,135.84	106.74	3,927.87	0.06%
2012	186,050.70	85.14	4,013.01	0.05%

Table 25. Annual deforestation in the leakage belt during the historical reference period

In the reference region, from 2003 to 2012, the forested areas decreased by around 1.26%, which corresponds to an accumulated deforestation of 13,370.49 ha. However, as mentioned above, high population growth rate and the construction of new roads in the region can be important deforestation agents, as there is a direct relation between the deforestation and the creation of new paved or unpaved roads, mainly when within 100km, which is the project area case[101]. The annual deforestation in the reference region during the analysed period is depicted in the figure below.

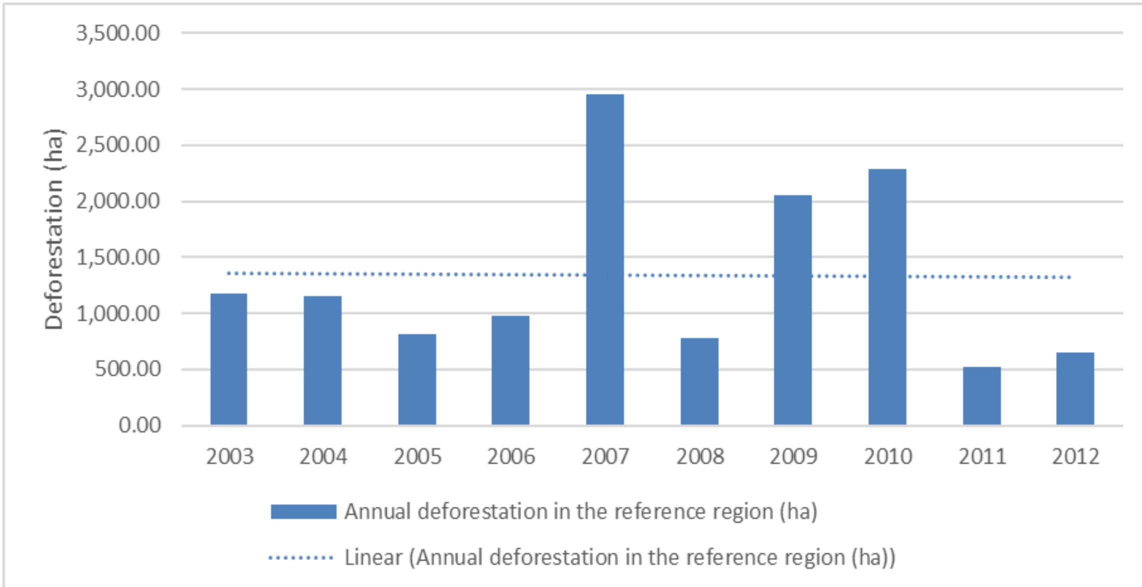

Figure 21. Annual deforestation in the reference region during the 2003 – 2012 period

It is possible to note a large oscillation of the annual deforestation during the reference period, and this pattern of deforestation also occurred in the project area and leakage belt. Furthermore, an average constant deforestation rate over the analysed years could be observed in the reference region. The average annual deforestation within the reference region during the analysed period was around 1,337.05 ha per year.

Meanwhile, the project area displayed an annual average deforestation rate of 0.10% per year during the 2003 – 2012 period (applying R: annual rate of change of forest cover[102]), which corresponds to an accumulated deforestation of 938.07 ha. The forested areas within the project area decreased by around 0.97% over the first baseline period, i.e., a deforestation rate 25% lower than the reference region. However, it is possible to note that deforestation rate has been increasing over the analysed years, although it has reduced to the lowest levels at the end of the first baseline period.

[101] 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: <https://www.researchgate.net/publication/4914862_Road_Investments_Spatial_Spillovers_and_Deforestation_in_the_Brazilian_Amazon>.

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

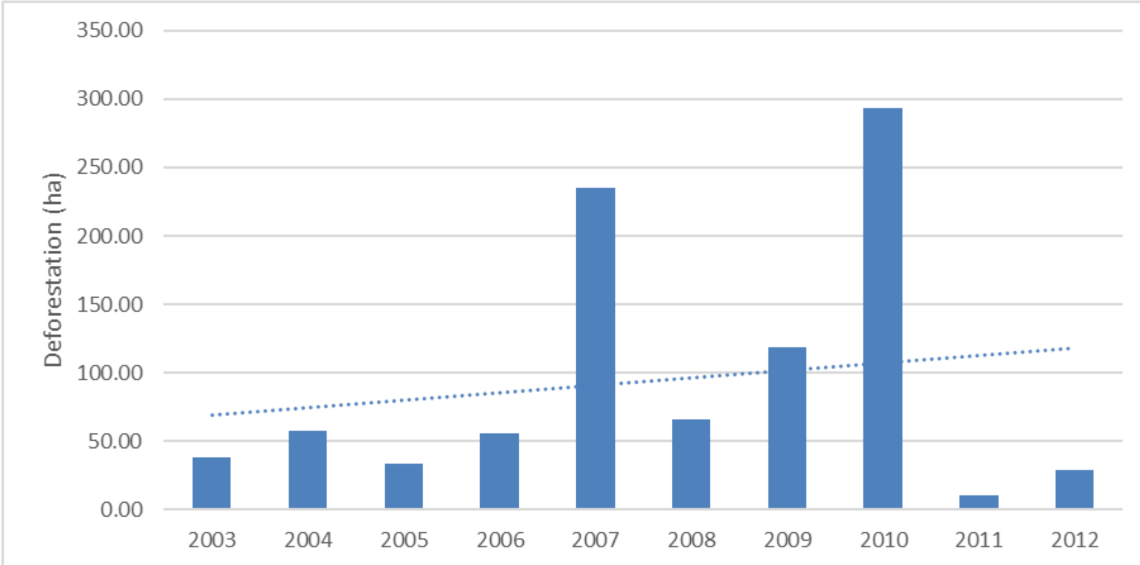

Figure 22. Annual deforestation in the project area during the 2003 – 2012 period

The leakage belt presented a forest cover decrease of around 1% during the 2003 – 2012 period, which corresponds to an accumulated deforestation of 1,606.05 ha during this period. The annual deforestation can be seen in the Figure below.

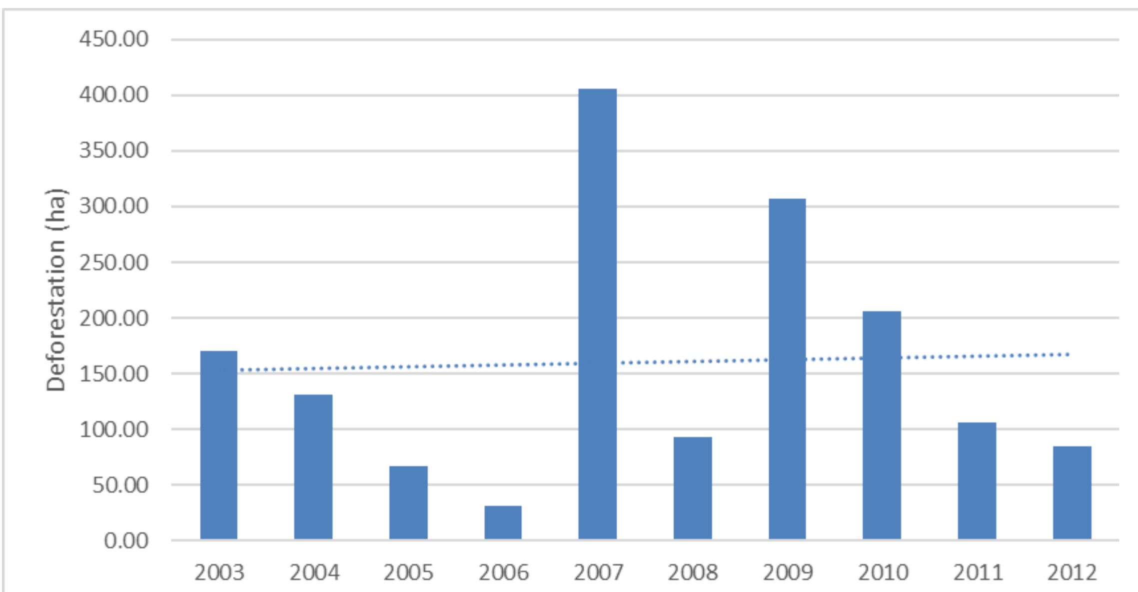

Figure 23. Annual deforestation in the leakage belt during the 2003 – 2012 period

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

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.

Identification of agents of deforestation

The main agent of deforestation within the reference region during the analysed period continued to be the local community. Importantly, in terms of analysing deforestation patterns, the components below are not considered separately, but as being spatially overlapping and forming a single deforestation dynamic. Thus, their activity is indistinguishable in reality and in terms of GIS analysis. While resident families feed the supply chain for all the products concerned[103], the historical pattern of colonization in the area and available field studies show that agricultural activities are mainly responsible for deforestation in the area [104,105,106], meaning that subsistence agriculture is the primary element of the composite deforestation agent.

The primary element the dynamic of deforestation, therefore, is deforestation for subsistence agriculture land; but the following other elements are secondary contributing factors: timber harvesting, both legal and illegal; and extraction of palm-heart.

In accordance with the analysis in the validated VCS PD, the reassessment of the second baseline period revealed that the principal products harvested and extracted in the project area continue to be:

- Açaí berries;
- Palm-heart;
- Wood.

However, compared to the initial assessment of the first baseline period, lower values for timber extraction are encountered for the second baseline period, probably due to the activities implemented in the project area since the project's initiation, which reduced deforestation. Palm-heart, being an illegal activity as well, similarly decreased.

Meanwhile the values for açaí collection are increasing, given that this is a legal activity which is encouraged in the project area. It is important to note that açaí-related activities are not a deforestation agent as they do not cause trees to be cut down. On the other hand, açaí production has been positively correlated with forest conservation in a study of Pará state[107].

103 Herrera, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA." Dissertação de mestrado. Universidade Federal do Pará.

104 Interview: D. Meneses 23.11.12.

105 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002."

106 P. G. Martorano (September 2002) "Caracterização da vegetação e uso do solo das terras pertencentes à empresa Ecomapuá Conservação Ltda No Município de Breves, Pará"

107 Almeida et al. (2010), "Potencial para conservação do açaí: uma análise da produção de açaí e desmatamento no estado do Pará." In: 62 Reunião Anual da SBPC, 2010, Natal. Ciência do Mar: herança para o futuro. Natal: SBPC.

The patterns of harvesting of the respective products are depicted in the Figures below.

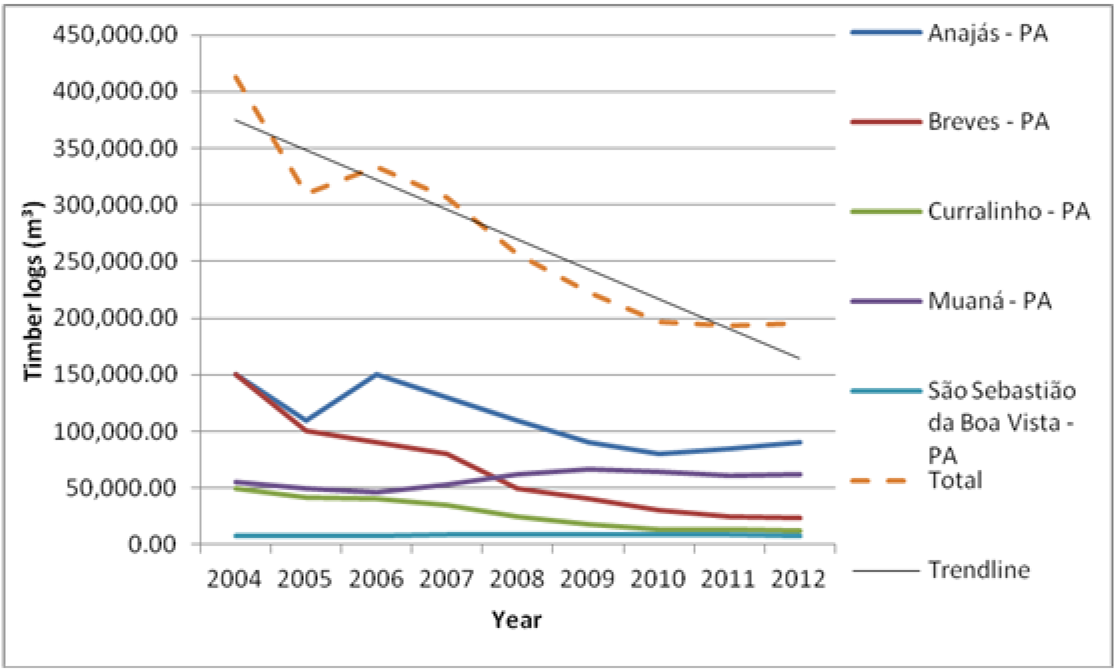

Figure 24. Log production in the municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

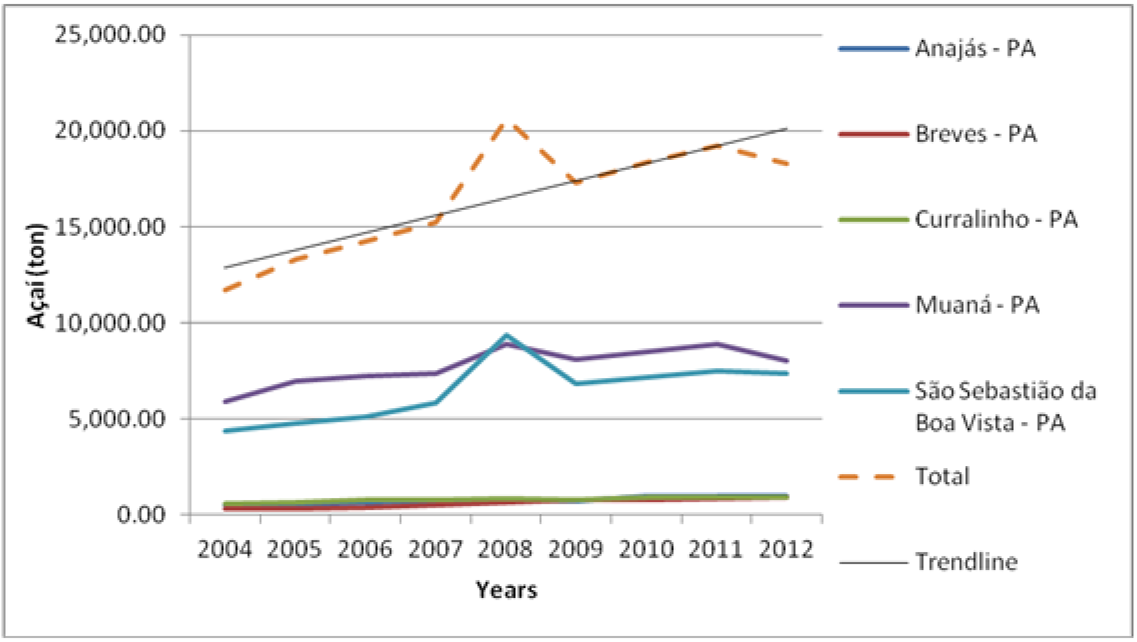

Figure 25. Açaí berry production in the municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

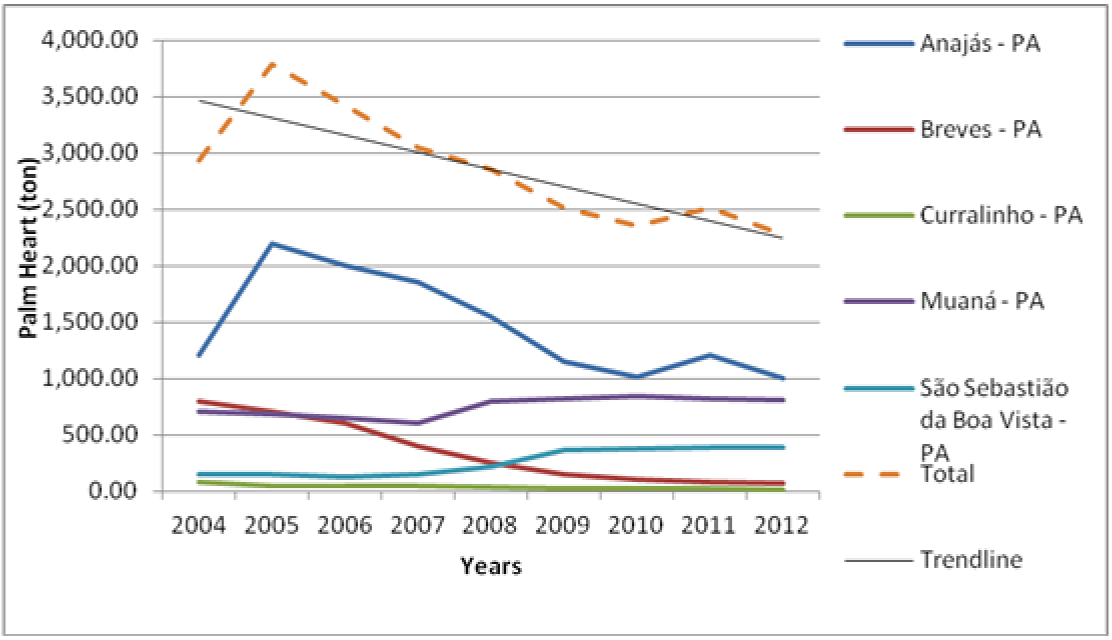

Figure 26. Palm heart production in municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

The agents composing the dynamic of deforestation are discussed below.

<u>Timber harvesting</u>

Although Figure 24 above shows a reduction in wood production in the project reference region during 2004-2012 period, economic data[108] sources between 1994 and 2010 (see Figures below), show that timber stands out as having one of the highest values of annual production in the project area municipalities of Breves and Curralinho[109] where 75% of the project area is located. However, this does not mean it is the primary deforestation agent, as explained below.

The large-scale commercial logging for timber which occurs on Marajó Island is sold on local, national and international markets[110]. The economic demand for timber peaked in Breves municipality in the 1970 and 1980 decades, and has declined since 2000 due to environmentalist pressure[111]. However, beyond the high production level shown in official data, the production of timber continues to be conducted illegally: studies, estimate that 36% of Brazil's

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

[109] Source: IBGE Cidades: https://cidades.ibge.gov.br/

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

[111] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002),, "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA: Diagnóstico Socio-Econômico."

timber production is legal[112]. Illegal wood harvesting is known to take place within the reference region and project area[113], being transported to the sawmills by riverboat .

Sawmills located on the riverbanks are the first destination for timber before it is taken to markets, the main market being located in the city of Breves.

Timber production was the pre-project activity, being that Santana Madeiras Ltda. timber company exploited the area before its acquisition by Ecomapuá Conservação Ltda., the project proponent of the present project[114]. This increased the facility and incentive for residents of the project area to carry out deforestation and sale of timber in the baseline case.

However, while timber has a strong representation in the municipal statistics, subsistence agriculture is considered to be the primary element and driving force of deforestation in the project area. Subsistence agriculture is thus the key alternative land use to the project, which would have predominated in the baseline, as discussed further below.

Palm heart extraction

Large areas of land in the Furos de Breves micro-region have been devastated by non-sustainable extractivism practices. Palm-heart comes from the açaí palm (*Euterpe oleracea*), which is naturally abundant in the Marajó ecosystem, however palm heart extraction is a destructive agent of deforestation because it is highly space-intensive - it is estimated that 24,000ha would be necessary to maintain the production of 100 tons of palm heart per month - and demand for the product has been growing since at least the 1990s[115]. The natural occurrence of the species is supplemented by plantation or enrichment in order to meet this high demand[116]. Similarly to timber harvesting, palm-heart production reduced over the 2004-2012 period within the reference region, as can be seen in the Figure 26 above.

Family/ subsistence agriculture

Subsistence agriculture is the foundation of the livelihood of project area and reference region residents[117,118] and is designated as the primary element of the composite deforestation agent.

112 Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), “Florestas Nativas de Produção Brasileiras”.

113 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), ‘Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico’.

114 São Paulo, 19.07.01 - “Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.”.

115 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), “Comunidades Agroextrativistas do Rio Mapuá – Breves/PA: Diagnóstico Socio-Econômico.”

116 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), ‘Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico’.

117 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), ‘Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico’.

118 Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará.

Studies of the project area and surroundings[119,120] show that subsistence agriculture is an important component of the deforestation dynamic, although it does not appear in the economic figures as the products – being primarily manioc and corn – are practically exclusively for subsistence purposes, with little potential for insertion into the market, because of low productivity and lack of access to credit, as well as an absence of political support[121].

Degraded and deforested areas within the project have been linked primarily to subsistence farming, specifically planting of manioc[122]. Key aspects of the land use cycle are as follows: approximately 4 hectares are required per family over three years[123,124]. Thus, the agricultural cycle involves the clearing of an approximately 4 hectare plot of land per family to be used for around 2.5 years, followed by a fallow period, and subsequent re-use of the same area. The total length of the production/fallow cycle is 10 years[125,126].

In more detail, first commercially-valuable products, timber, açaí and palm-heart, are extracted, then the land is cleared using slash and burn techniques, with the ashes serving as fertilizer[127]. The main crops planted are manioc and corn.

These farmers have traditionally lived in a condition of dependence upon land owners, with practically no rights and carrying out activities of illegal or uncertain legal status[128].

Thus although subsistence farming is not present in the economic figures due to not participating in the market economy, its predominance as the mode of production in the project area[129] make it the key component of the deforestation dynamic. The annual values of production of

[119] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'.

[120] Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará

[121] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'.

[122] Instituto Amazônia Sustentável, (2005), "Submission of proposal to Nike Mata no Peito Program." São Paulo. 32 p

[123] P. G. Martorano (September 2002) "Caracterização da vegetação e uso do solo das terras pertencentes à empresa Ecomapuá Conservação Ltda No Município de Breves, Pará"

[124] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'

[125] CASARIM, F. et al. (WINROCK International) (2010), "Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil".

[126] P. G. Martorano (September 2002) "Caracterização da vegetação e uso do solo das terras pertencentes à empresa Ecomapuá Conservação Ltda No Município de Breves, Pará"

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

[128] Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará.

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

agricultural and forest products in the four main municipalities of the reference region are depicted in the Figures below[130].

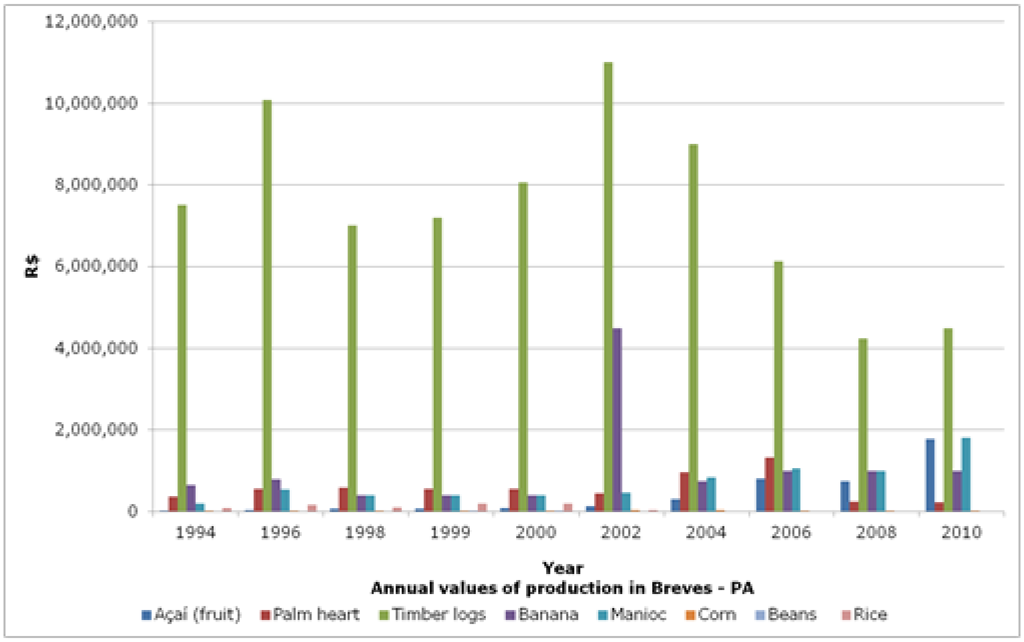

Figure 27. Annual values of total production in the municipality of Breves (State of Pará)

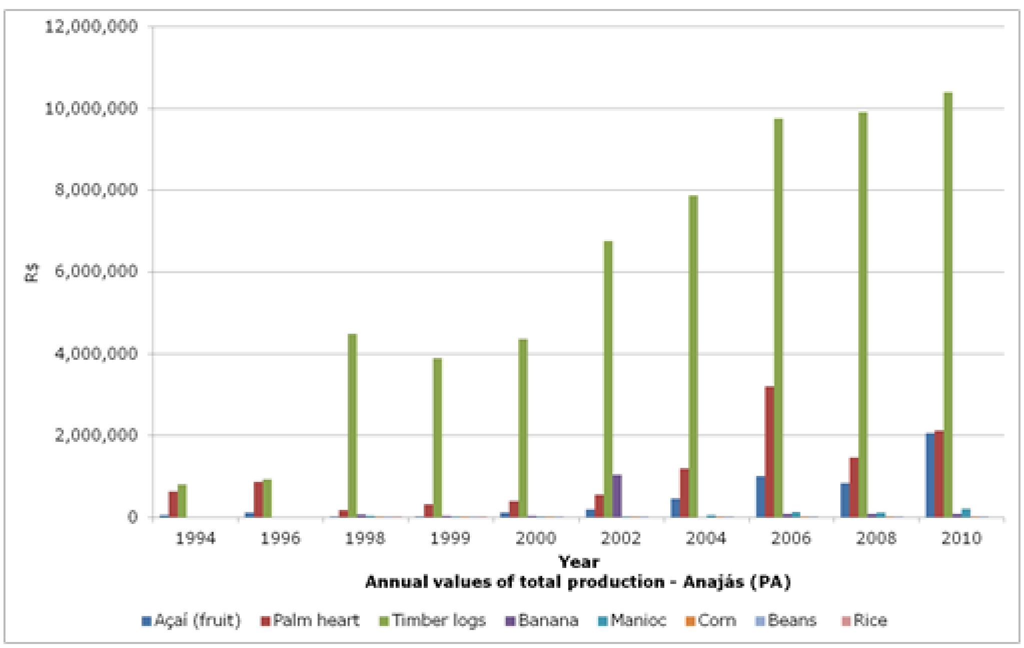

Figure 28. Annual values of total production in the municipality of Anajás (State of Pará)

130 Source: Instituto Brasileiro de Geografia e Estatística (IBGE).

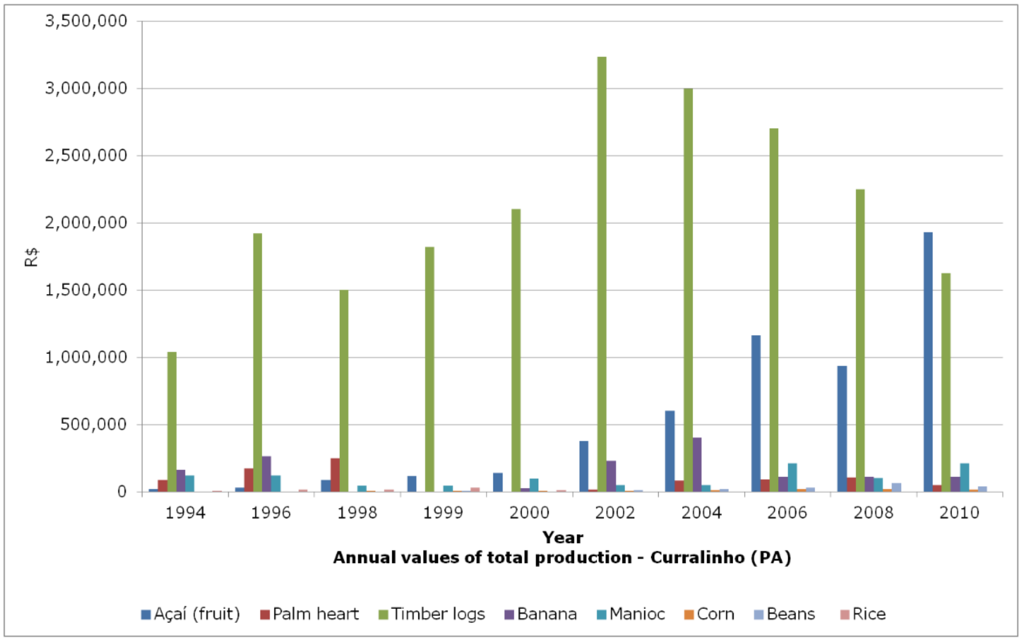

Figure 29. Annual values of total production in the municipality of Curralinho (State of Pará)

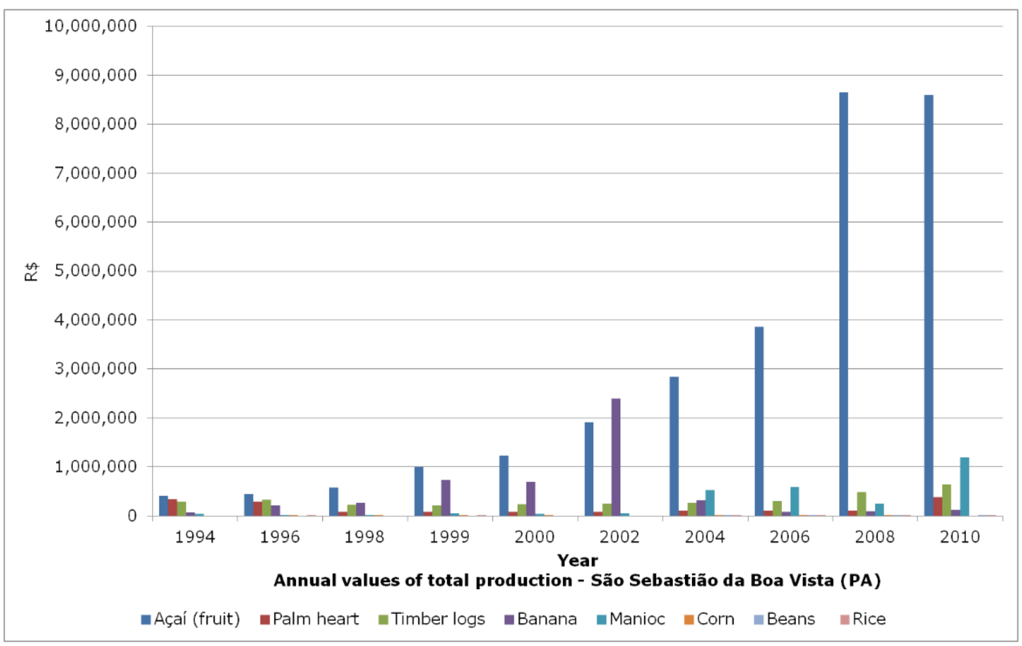

Figure 30. Annual values of total production in the municipality of São Sebastião da Boa Vista (State of Pará)

Identification of Deforestation Drivers

<u>Driver variables explaining the quantity of deforestation</u>

Several studies for the Amazon biome[131, 132, 133] mention that deforestation rates may increase because the population growth and the need for more land for food, fuelwood, timber, or other forest products. The number of people and their socio-economic conditions both have a significant impact on deforestation. As agriculturally based population density increases in and near forested areas, the strongest relationship between population growth and deforestation occurs, as local people and young migrant families arrive at the forest frontier and clear land to provide more area for subsistence farming. Therefore, besides addressing the population numbers, policies that impact the socio-economic conditions of the people are needed if deforestation is to be delayed or forests are to be sustained.

Less et al. (2018)[134] found a strong positive correlation between the population growth and deforestation (r = 0.95), proving that this is the main factor that had a direct influence on deforestation in the state of Amapá, which is very close to the project area. The strong relationship found in the study is due to the increased domestic demand for food and forest products to meet the needs of the population growth, which is similar to what is found in the reference region.

The annual averages of the population growth rate from the municipalities comprising significant proportions (>99%) of the reference region were gathered. In the current revision of the 2nd baseline period, the period analysed begins in 2000 and ends in the year of 2010, because the last two population census were conducted in those years by Brazilian Institute of Geography and Statistics[135].

The population in these municipalities grew 16% between 1991-2000, and 26% between 2000 and 2010. Therefore, there was an increase of 57.6% in the population growth rate between these decades. The Figure below shows the average population in the main municipalities composing the reference region between 1991 and 2010. It is possible to note a clear increase trend during the analyzed period, which will probably continue over the next years.

131 ANGELSEN; KAIMOWITZ. Rethinking the Causes of Deforestation: Lessons from Economic Models. The World Bank Research Observer, vol. 14, no. 1 (February 1999), pp. 73–98.

132 ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997.

133 MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003

134 LESS, F. R.; LESS, D. F. S.; SZLAFSZTEIN, C. F. Análise da relação entre o crescimento populacional e o desmatamento no estado do Amapá, Brasil. Revista Ibero Americana de Ciências Ambientais, v.9, n.6, p.344-356, 2018. Available at: http://doi.org/10.6008/CBPC2179-6858.2018.006.0032

135 Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

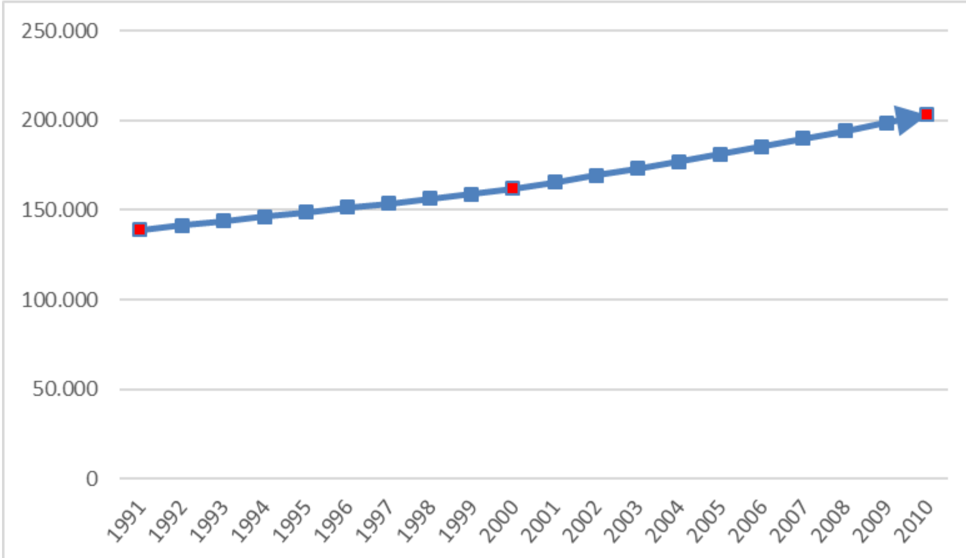

Figure 31. Reference period trends in population growth

Comparing the population growth rate, an average value of 1.70%/year was verified during the 1991-2000 period, which increased to 2.32%/year in the next decade from 2000-2010.

The number of families living within the project area itself was estimated at 99 in 2002, with some 188 families known to be in the project's region (6 people per family)[136]. In 2012, the number of families grew to around 340 (5 people per family), an average increase of 4.2% per year, which is almost the double than verified in the municipalities within the reference region[137]. Moreover, most of these families (47%) live in the Lago do Jacaré property, where it was observed the largest concentration of deforestation in the project area during the analyzed period.

According to the aforementioned studies, population is a variable which significantly predict quantity of future deforestation. As described in the adopted baseline, the local residents are expected to carry out unplanned deforestation, which involves spatially overlapping activities. Therefore, as the population growth rate is expected to increase, this variable was used in the baseline approach, described below.

Driver variables explaining the location of deforestation

The presence of "non-forest" is a driver variable predicting quantity and location of future deforestation.

[136] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002."

[137] INSTITUTO FLORESTA TROPICAL. Visita técnica de prospecção para avaliação do potencial do manejo florestal na Reserva Extrativista Mapuá, Breves, Pará. Belém, 2012.

The reference region is located in one of Brazil's richest areas in terms of waterways, which historically determined the locations of settlements in relation to extraction of non-timber forest products (NTFPs) and timber. Waterways remain the overwhelmingly predominant means of transport and access to forest products. Furthermore, the small sawmills to which timber is taken for processing are located on riverbanks. For these reasons, the great majority of the regional population is located in small settlements on the banks of the rivers[138]. This data from literature, and the projection of the location of future deforestation described below, suggest that proximity to rivers is correlated to the location of deforestation.

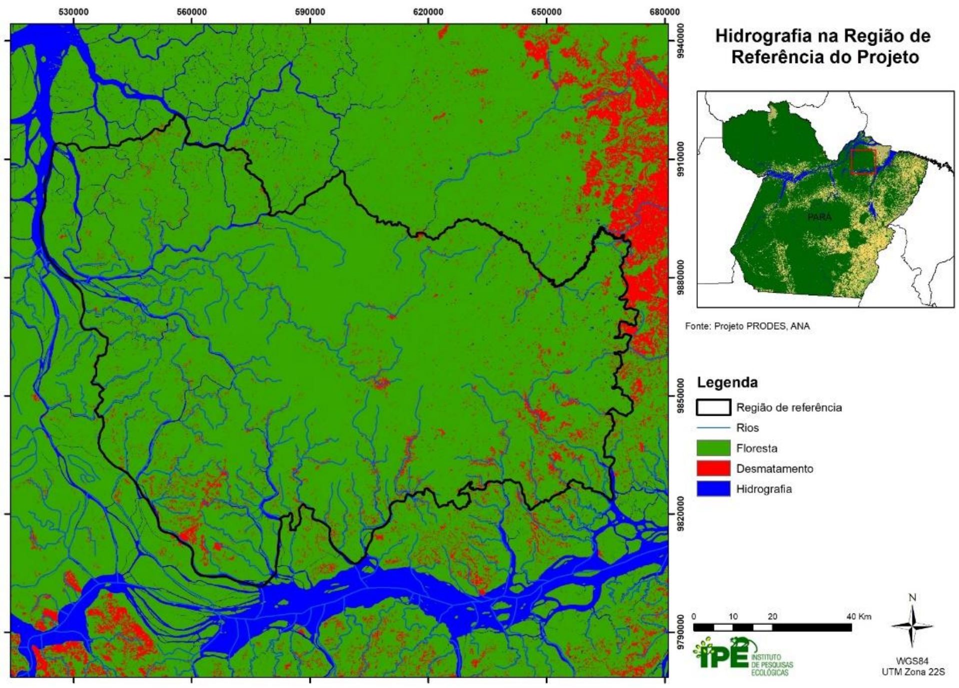

Figure 32. Hydrography and main rivers of the reference region that give access to the project area

Another important driver explaining the location and quantity of deforestation is slope. The GIS analysis concluded that deforestation patterns are more concentrated in flat areas, avoiding high slope areas. The figures below show the topology and slope of the reference region, indicating the areas with high slope.

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

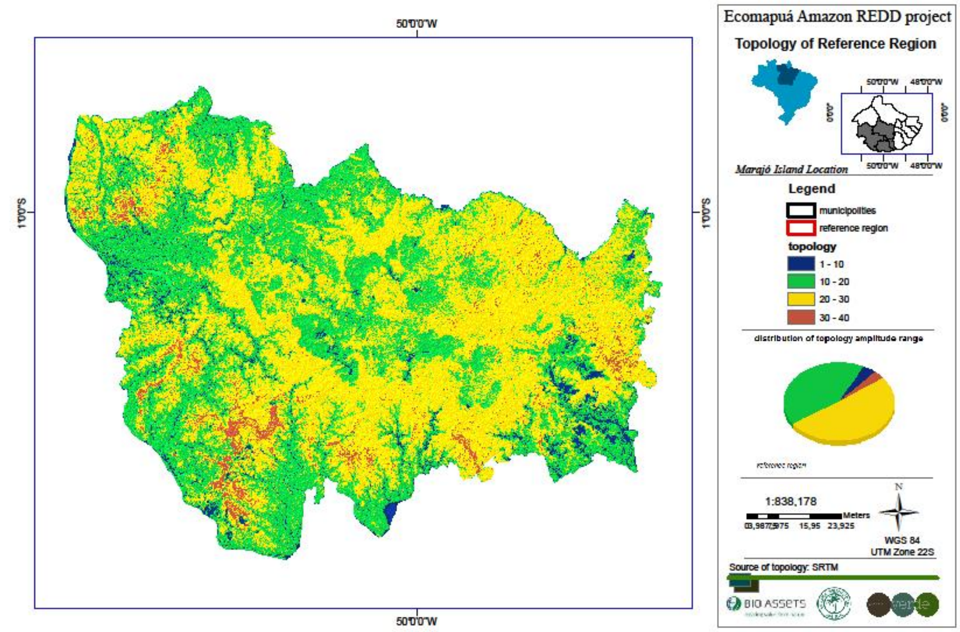

Figure 33. Topology of the reference region

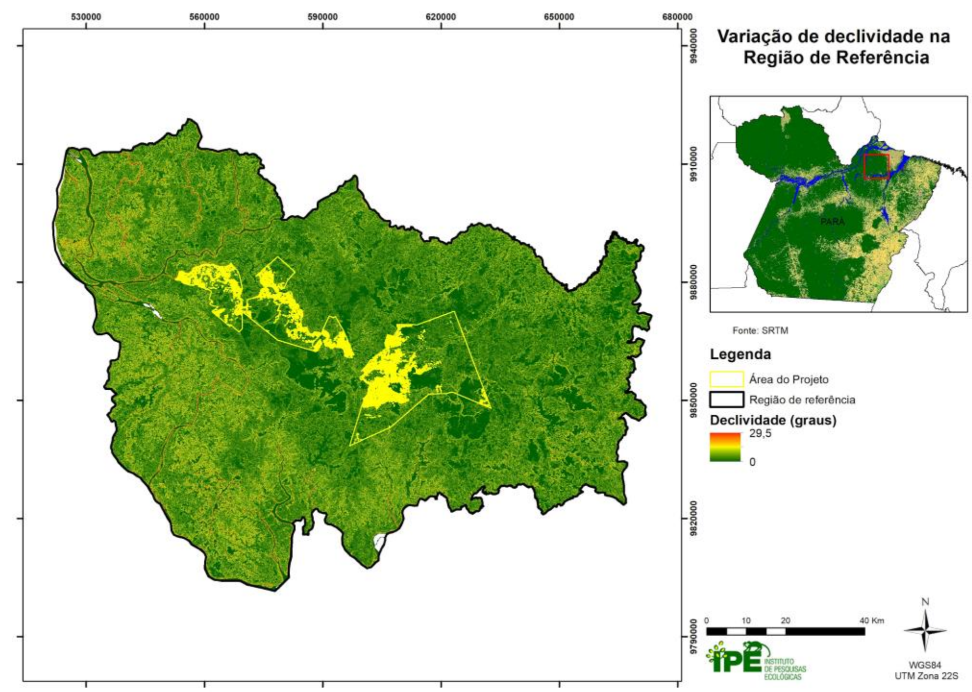

Figure 34. Slope classes of the reference region

Moreover, the identified deforestation with linear patterns within the reference region during the last analysed period indicates road creation. 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.

The future deforestation dynamic is expected to be affected by the planned construction of the PA-159 Pará State road, which is predicted to cut through the Lago do Jacaré property, however it has not yet been carried out. It is important to note that the increase in economic development that comes with the construction of roads, for example in terms of power lines and increased access, will result in higher population pressure and deforestation rates in the project area[139]. The figure below shows the PA-159 road connecting the municipalities of Breves and Anajás[140]. This map is from official sources in 2013, displaying the PA-159 road's status as "planned" (Portuguese: *planejado*).

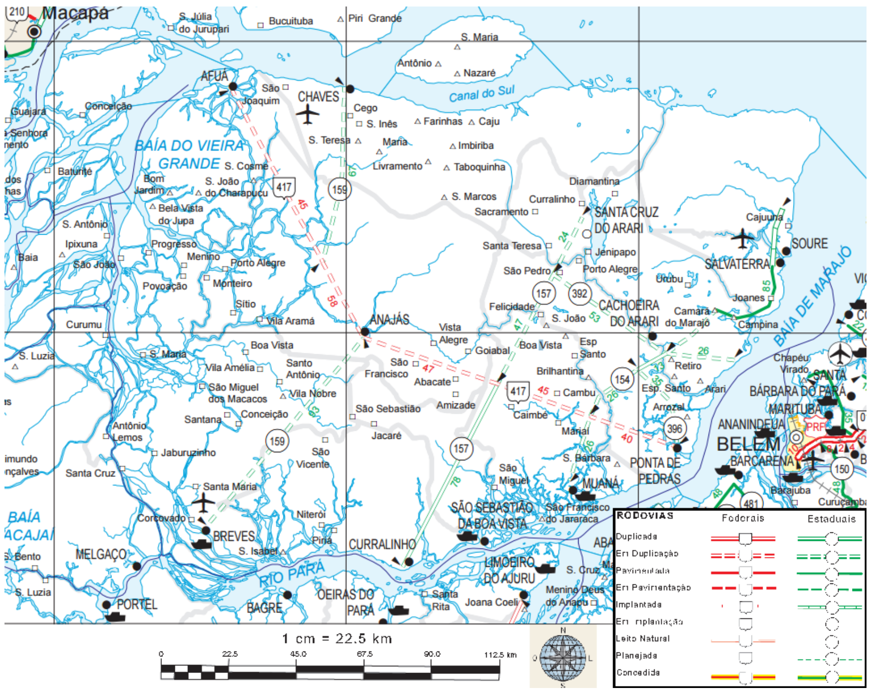

Figure 35. Roads conditions in the Marajó island, year 2013

139 CASARIM, F. et al. (WINROCK International) (2010), "Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil".

140 National Department of Infrastructure and Transportation (DNIT). Available at: <http://www.dnit.gov.br/download/mapas-multimodais/mapas-multimodais/pa.pdf>. Last visited on: 08/02/2018.

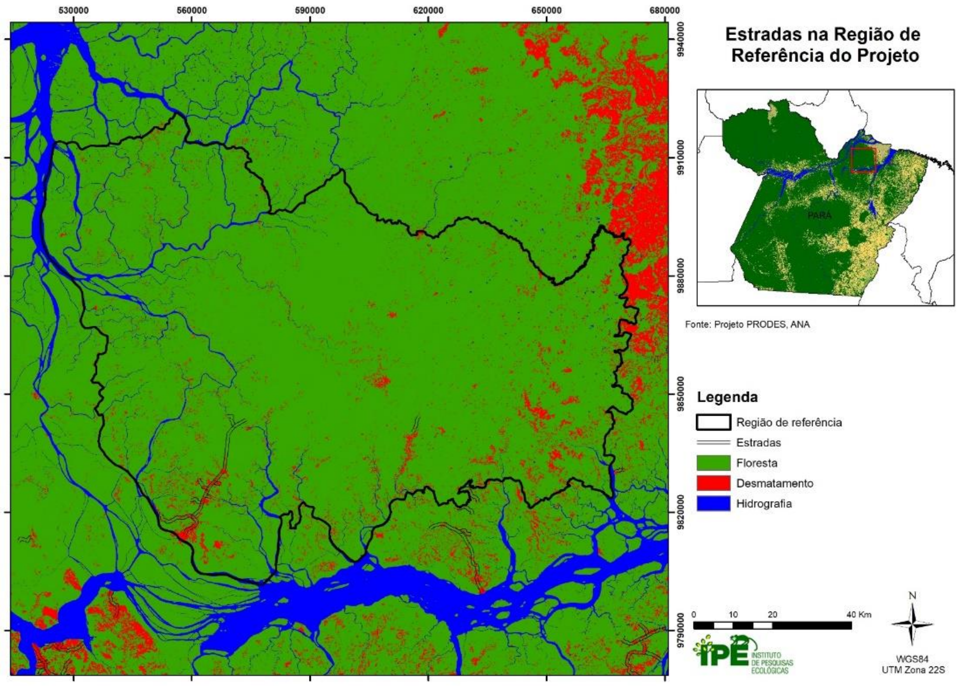

Figure 36. Roads within the reference region

Underlying causes of deforestation

Underlying causes of deforestation include the political scenario related to environment in 2011 and 2012, the last years of the first baseline period. This political instability would probably reflect in the increase of deforestation.

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

In 2012, several NGOs subscribed to a document[141], alerting public opinion to the fact that Brazil was experiencing an unprecedented setback in the socio-environmental area, which would make it impossible for the country to continue the advancement towards sustainable development.

The year of 2012 was marked by the greatest setback in the socio-environmental agenda since the end of the military dictatorship, reversing a trend towards improving the sustainable development agenda that had been implemented throughout all governments since 1988.

[141] WWF. Financiamento Público em Meio Ambiente: Um Balanço da Década e Perspectivas.2018. Available at: <https://d3nehc6yl9qzo4.cloudfront.net/downloads/financiamentomma_final2_web.pdf>

Some facts that occurred in 2011 / 2012 were the flexibilization of the forest code legislation and amnesty to deforesters; the interruption of the creation of protected areas, even reaching the unprecedented reduction of several of these protected areas in the Amazon; the interruption of the processes of recognition of indigenous lands; the cessation of the climate change agenda in 2011.

Other important fact was the reduction of the Ibama's control and power, which is the Governmental body responsible for deforestation control in Brazil. In 2012, the federal government, with the largest rural group in the country's history, removed powers from federal agencies, such as Ibama and Conama, weakening those bodies that were of fundamental importance in reducing deforestation in the Amazon and in building environmental policy over the last years.

In addition, between 2012 and 2013, the approved budget for the Ministry of the Environment and its bodies, such as Ibama, ICMBio, the National Water Agency (ANA) and the Brazilian Forest Service (SFB), had the largest decrease ever noticed, of around -27%. According to Castelo et al. (2018)[142], the drop in resources destined to environmental programs may have influenced the reduction of protected forest areas because with less investments, less resources will be generated and the capacity for monitoring, inspection and management becomes limited. Furthermore, according to this same scientific article, deforestation control programs carried out in the state of Pará were the most significant parameter to explain the evolution of deforestation. The policy was the factor that obtained the greatest sensitivity in relation to deforestation, reaching a correlation of 68%, more than cattle ranching and agriculture. This positive correlation is also evidenced by other scientific studies[143].

The resources of the Action Plan for Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) decreased from around R$ 2.5 billion in 2008 to around R$ 250 million in 2012, a 90% reduction in the period. Those several setbacks in the Brazilian environmental agenda contributed to the increase of deforestation after 2012, as verified by Prodes in the Brazilian Amazon[144].

Analysis of chain events leading to deforestation

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

142 Castelo, 2018. Governos e mudanças nas políticas de combate ao desmatamento na Amazônia. Revista Iberoamericana de Economía Ecológica Vol. 28, No. 1: 111-134. Available at: <https://redibec.org/ojs>.

143 ARIMA; BARRETO; ARAÚJO; SOARES-FILHO. Public policies can reduce tropical deforestation: Lessons and challenges from Brazil. Land Use Policy, vol. 41, pages 465–473. November, 2014. Available at: <https://doi.org/10.1016/j.landusepol.2014.06.026>

144 According to PRODES: <http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates>.

A growing population of local residents are expected to carry out unplanned deforestation, converting forest into non-forest. The scenario involves three spatially overlapping activities: firstly, extraction of commercially valuable tree species by resident families, frequently beyond levels permitted by Brazilian law[145], for sale to timber companies. This is accompanied by palm-heart extraction, which is both for commercial ends and for consumption or trade in kind by the harvesters themselves[146]. The former two activities may not result in conversion of forest to non-forest, however they are integral parts of the deforestation process. Finally, slash-and-burn deforestation of the area above for subsistence agriculture, and the planting of crops[147,148,149].

Furthermore, location of deforestation usually occurs nearby already deforested areas, along rivers, and in low sloped areas.

In addition, another important deforestation diver analysed in the revision of the baseline period was the PA-159 road, which had to be taken into account. This road will link Breves to Anajás and will be an important agent of deforestation during the 2nd baseline period because, while it failed to open by the scheduled date of 2008/2009, work on it will resume in the next years.

Deforestation will probably increase due to setbacks in environmental legislation and deforestation control occurred in 2011 and 2012, namely reduction in control programs to reduce deforestation in the Amazon, reduction of protected areas and the amnesty to deforesters. Therefore, according to Castelo at al. (2018)[150], deforestation might rise as from 2012 due to the reformulation of environmental legislation, in addition to other retrograde measures for the environment.

Conclusion of the analysis of agents, drivers and underlying causes of deforestation and their likely future development

Conclusive evidence from this analysis of agents, drivers, and underlying causes has been found that, although deforestation rates in the reference region presented a great oscillation and did

[145] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), “Florestas Nativas de Produção Brasileiras”.

[146] FADESP (2002), “Comunidades Agroextrativistas do Rio Mapuá – Breves/PA: Diagnóstico Socio-Econômico.”

[147] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), “Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico”.

[148] CASARIM, F. et al. (WINROCK International) (2010), “Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil”.

[149] Martorano, P.G. (2002), “Caracterização da vegetação e uso do solo das terras pertencentes à empresa Ecompauá conservação LTDA no município de Breves, PA.” Convênio Nº 518 Nova Amafruta/ FADESP / Empresa Ecomapuá Conservação Ltda.

[150] Castelo, 2018. Governos e mudanças nas políticas de combate ao desmatamento na Amazônia. Revista Iberoamericana de Economía Ecológica Vol. 28, No. 1: 111-134. Available at: <https://redibec.org/ojs>.

not reveal any trend during the revised historical reference period, the future trend in deforestation in the region will most likely be increasing due to the population growth and the underlying causes that will probably promote deforestation, which are the parameters that have the highest correlation to deforestation in the region according to literature.

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 described above, no trend in deforestation during the historical reference period within the reference region was present. Conclusive evidence from the analysis of the deforestation dynamic was found to suggest that deforestation trend would increase in the future.

For this reason, approach a. Historical average approach, was adopted to create the baseline.

This historical average is the most suitable approach to be used for future projections, given that, due to the large oscillation in deforestation patterns in the reference period, it is difficult to obtain variables with high covariance to predict changes in deforestation rates.

Projection of the quantity and location of future deforestation

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

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

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

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

(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2003 to 2012) through the Business-as-Usual scenario.

Definition of the model assumptions

As previously described, there was a large variation in the rate of deforestation between 2003 and 2012, with no increase or decrease tendency over time (R^2 = 0.0007 and p = 0.98). This pattern makes the historical average more suitable to be used for future projections due to this great oscillation in deforestation rates.

According to Dinamica EGO calculation of the average rate of deforestation within the reference region between 2003 and 2012, based on the total area of the reference region (including forest and non-forest areas), the average value was of 0.13%/year, however, due to external issues that will influence the rate of deforestation after 2012, described in the subsection chain events leading to deforestation, this value was modified to 0.2%/year, i.e., an increase of 61.2%.

This value was obtained utilizing the two variables that most influence deforestation rates in the region: population growth rate and decrease in Government deforestation control programs. According to a scientific study conducted by Castelo et al. (2018)[151], the most significant parameter to explain the evolution of deforestation in the state of Pará was the implementation of deforestation control programs, with a positive correlation of 68%. However, at the end of the first baseline period, Governmental resources applied in PPCDAm decreased 90% between 2008 and 2012. Based on the correlation calculated by Castelo et al. (2018), this 90% reduction would result in a deforestation increase of 61.2% after 2012. Other chain events would contribute even more to this increase in levels of deforestation, such as the setbacks established by the new Forest Code in 2012, and the high population growth rate in the region, which increased between the decades of 2010 and 2000.

Database organization and pre-processing

The forest dynamics data, the deforestation vectors and other base data from the studied region, which were used for the project's baseline construction, were organized in a spatialized database, in the File Geodatabase format from ArcGIS 10.6. The data comes from different sources and different cartographic scales. The files are stored in vector and matrix format (raster). In order to standardize spatial references, all data has been redesigned for the UTM and Datum WGS84, Zone 22S projection.

It was necessary to first identify the most important agents responsible for LU/LC change in the study region, in order to direct the landscape simulation. In this first moment several layers were pre-selected, which may be related to the greater chance of deforestation in the reference region and in the project area. For example, rivers and roads usually are deforestation vectors because they are access ways to forest areas, in which people may occupy, harvest wood and clear the area for production.

The most important predictor variables that influence the risk of deforestation in the region are the proximity to non-forest areas, the proximity to roads, the type of soil, slope, the presence of settlement, proximity to rivers and the underlying causes of deforestation. Other potential risk factors were also considered, such as proximity to cities and the IBGE population census, categorized and grouped by population density.

[151] Castelo, 2018. Governos e mudanças nas políticas de combate ao desmatamento na Amazônia. Revista Iberoamericana de Economía Ecológica Vol. 28, No. 1: 111-134. Available at: <https://redibec.org/ojs>.

Preparation of deforestation risk maps

Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created considering the variables presented above using Dinamica EGO Software, which modeling techniques are used for calibrating, running and validating space-time models[152].

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

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

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

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

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

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

[152] Dinamica Ego Software. Available at: <https://csr.ufmg.br/dinamica/>.

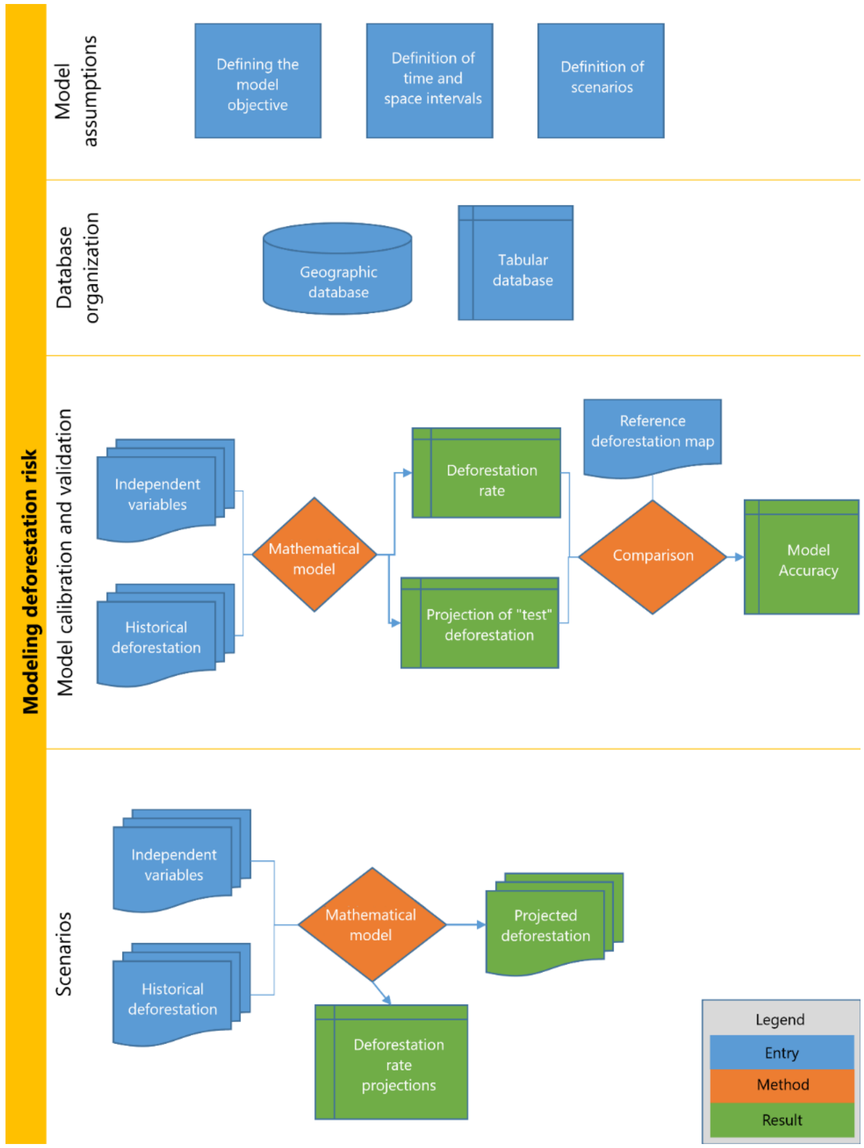

Figure 37. Modeling steps focusing on the creation of the deforestation risk map and the projection of future deforestation

The spatial variables that most likely represent the patterns of baseline deforestation in the reference region were identified, and the digital maps representing the spatial features of each variable were created. The list of variables, maps and factor maps are presented below.

Factor Map		Source	Variable represented		Meaning of categories or pixel value		Other maps or variables used to create the Factor Map		Algorithm or equation used	Comments
ID	File Name		Unit	Description	Range	Meaning	ID	File Name		
1	assent.tif	INCRA		Rural settlement	1 - 2	Areas covered by settlement				
2	d_cidade.tif	IBGE	meter	Euclidean Distance from cities	0 - 53172.5	Areas closer to cities are more prone to forest deforestation				
3	d_estrad.tif	Imazon	meter	Euclidean Distance from roads	0 - 82018.4	Areas closer to roads are more prone to forest deforestation				
4	d_rios.tif	ANA	meter	Euclidean Distance from rivers	0 - 11299.5	Areas closer to rivers are more prone to forest deforestation				
5	d_rios_g.tif	ANA	meter	Euclidean Distance from large rivers	0 - 32871.1	Areas closer to large rivers are more prone to forest deforestation				
6	declividade.tif	SRTM	degrees	Slope	0 - 42.77	Areas with higher slope are more prone to forest deforestation				
7	dem.tif	SRTM	meter	Altitude	0 - 51	Areas with higher altitudes are more prone to forest deforestation				
8	setores_censi.tif	IBGE		Census sectors	1 - 4	Sectors with higher population densities are more prone to forest deforestation				
9	solo.tif	IBGE		Soil type	1 - 5	Soil type may influence on human occupations				

Table 26. List of variables, maps and factor maps

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

Distance from deforested areas (m)	Weights of evidence
0-100	1.931
100-200	0.726
200-300	0.072
300-400	-0.506
400-500	-0.973
500-600	-1.319
600-700	-1.526
700-800	-1.638
800-900	-1.975
900-1000	-2.227
1000-1200	-2.267
1200-1500	-2.559
1500-2000	-2.627
2000-4100	-4.036
4100-6500	0.000

Table 27. Variation of the weights of evidence according to deforestation distance ranges

Slope (degrees)	Weights of evidence
0-2	-0.567
2-3	-0.320
3-4	0.039
4-5	0.429
5-6	0.767
6-7	1.070
7-10	1.403
10-43	1.603

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

Distance from cities and inhabitants' nuclei (m)	Weights of evidence
0-100	3.688
100-2800	2.141
2800-2900	0.998
2900-3100	1.219
3100-3600	0.865

Distance from cities and inhabitants' nuclei (m)	Weights of evidence
27100-28500	-0.564
28500-28600	-0.294
28600-28800	-0.055
28800-30500	0.062
30500-31300	-0.115

Distance from cities and inhabitants' nuclei (m)	Weights of evidence
43900-44000	-0.682
44000-44100	-0.118
44100-45800	0.122
45800-45900	1.02
45900-46100	0.725

3600-3700	0.403	31300-31400	-0.428	46100-46700	0.447
3700-3800	0.556	31400-31600	-0.234	46700-46800	-0.529
3800-7100	0.378	31600-31700	0.138	46800-46900	-0.204
7100-7200	-0.17	31700-31800	-0.064	46900-47100	-0.49
7200-7300	0.072	31800-32200	0.123	47100-47200	-1.538
7300-7700	0.255	32200-33400	-0.059	47200-47300	-2.43
7700-9800	0.245	33400-33500	-0.411	47300-47400	-0.796
9800-11600	0.064	33500-33600	-1.018	47400-47600	-0.452
11600-11700	-0.124	33600-33700	-0.671	47600-47700	-0.867
11700-11900	0.171	33700-38600	-0.488	47700-47800	-0.581
11900-12000	-0.059	38600-38700	-0.041	47800-48100	-0.03
12000-12600	0.133	38700-39500	-0.23	48100-48200	-0.728
12600-14100	0.197	39500-39600	-0.647	48200-48300	-3.27
14100-15400	0.189	39600-40200	-0.398	48300-48400	-1.105
15400-16600	0.176	40200-41800	-0.601	48400-48500	-0.109
16600-16900	-0.005	41800-41900	0.024	48500-48600	0.608
16900-17600	-0.204	41900-42000	-0.307	48600-48900	0.319
17600-17700	-0.028	42000-42100	0.503	48900-49000	-0.511
17700-18700	0.088	42100-42200	0.119	49000-49200	-0.2
18700-19700	0.026	42200-42400	0.447	49200-49400	-0.48
19700-20500	-0.148	42400-42600	-0.029	49400-49600	-0.762
20500-21500	-0.024	42600-42700	-0.651	49600-49700	0.002
21500-22600	-0.151	42700-42900	-0.393	49700-49800	0.413
22600-23300	-0.333	42900-43000	-0.782	49800-49900	0.73
23300-24000	-0.541	43000-43100	-0.55	49900-50500	1.058
24000-24100	-0.796	43100-43200	-0.863	50500-51600	0.798
24100-24400	-0.558	43200-43400	-0.391	51600-51700	-0.174
24400-24800	-0.359	43400-43500	0.51	51700-51800	0.102
24800-24900	-0.576	43500-43600	0.758	51800-51900	1.068
24900-26100	-0.446	43600-43700	0.029	51900-52000	1.44
26100-27100	-0.649	43700-43900	-0.432	52000-53200	1.329

Table 29. Variation of the weights of evidence according to the distance from cities and inhabitants' nuclei

Settlements	Weights of evidence
1	0.176
2	-0.198

Table 30. Variation of the weights of evidence according to the presence of settlements

Distance from roads (m)	Weights of evidence
0-100	2.108
100-400	1.539
400-1100	1.177
1100-2400	0.899
2400-2500	0.657
2500-2700	0.444
2700-4600	0.453
4600-5600	0.256
5600-5700	-0.054
5700-5800	0.249
5800-7900	0.287
7900-9100	0.104
9100-11200	0.229
11200-13500	0.4
13500-13800	0.19
13800-13900	0.427
13900-16400	0.338
16400-16500	0.056
16500-18100	-0.124
18100-18200	-0.624
18200-18300	-0.877
18300-18400	-0.513
18400-18600	-0.721
18600-21200	-0.72
21200-21300	-0.517
21300-22200	-0.738
22200-24900	-0.586
24900-25000	-1.311
25000-25400	-0.873
25400-25500	-0.052
25500-25600	0.15
25600-25700	0.372
25700-28500	0.237
28500-28600	-0.041
28600-28800	-0.24
28800-29000	-0.594
29000-29100	-0.845
29100-30700	-1.11
30700-30800	-1.848

Distance from roads (m)	Weights of evidence
31800-31900	-0.76
31900-32000	-0.476
32000-32200	-0.751
32200-32300	-1.127
32300-32800	-0.864
32800-32900	-0.637
32900-35900	-0.725
35900-36100	-1.07
36100-39200	-1.054
39200-40100	-0.803
40100-40200	-0.475
40200-40300	-0.286
40300-43400	-0.477
43400-43500	-0.922
43500-43600	-0.667
43600-45900	-0.457
45900-46000	-0.014
46000-49000	-0.195
49000-49300	-0.384
49300-49500	-0.068
49500-49600	0.368
49600-49900	0.058
49900-54900	-0.115
54900-55000	-1.402
55000-55100	-0.551
55100-55200	-0.82
55200-55400	-0.289
55400-55500	0.234
55500-55800	0.035
55800-55900	-0.44
55900-56000	-0.166
56000-56600	-0.346
56600-56800	-0.624
56800-56900	-1.658
56900-57000	-1.061
57000-57100	-0.633
57100-57900	-0.412
57900-58000	-0.033
58000-58100	-0.49

Distance from roads (m)	Weights of evidence
60000-67800	-0.616
67800-68100	-0.991
68100-68200	-4.128
68200-68400	-1.598
68400-68700	-2.257
68700-69000	-1.639
69000-72300	-1.23
72300-72400	-0.564
72400-72500	-1.278
72500-72600	-2.469
72600-72800	-0.425
72800-72900	-0.844
72900-73000	-0.496
73000-73800	-0.7
73800-74000	-0.403
74000-74100	-0.121
74100-74200	-0.469
74200-74300	-0.886
74300-74400	-1.525
74400-74500	-0.022
74500-74600	-0.833
74600-74900	-1.317
74900-75100	-0.236
75100-75400	-0.58
75400-75500	-1.622
75500-75600	-3.169
75600-75900	-1.69
75900-76000	0
76000-77100	-2.427
77100-77200	0
77200-78100	-2.215
78100-78300	-0.927
78300-78400	-2.006
78400-78500	-0.393
78500-78600	0.647
78600-78800	-0.087
78800-78900	0
78900-79000	-0.092
79000-79100	-0.629

30800-30900	-0.91	58100-58200	-0.199	79100-79200	0
30900-31000	-0.61	58200-58900	-0.416	79200-79700	-2.139
31000-31200	-0.846	58900-59500	-0.172	79700-79800	0.305
31200-31300	-1.155	59500-59600	-0.44	79800-80000	-0.184
31300-31600	-0.848	59600-59700	-0.695	80000-80100	0
31600-31700	-0.53	59700-59900	-0.27	80100-82000	0
31700-31800	-1.005	59900-60000	-0.769		

Table 31. Variation of the weights of evidence according to the distance from roads

Distance from rivers (m)	Weights of evidence
0-100	0.58
100-300	0.574
300-500	0.556
500-700	0.44
700-900	0.322
900-1100	0.21
1100-1300	-0.007
1300-1500	-0.06
1500-1700	-0.14
1700-1800	-0.328
1800-2000	-0.335
2000-2300	-0.262
2300-2600	-0.436
2600-3000	-0.483
3000-3100	-0.86
3100-3700	-1.034
3700-4100	-1.385
4100-4200	-1.833
4200-5300	-1.431
5300-7300	-1.639
7300-7900	-2.265
7900-8200	-4.198
8200-11300	-3.936

Table 32. Variation of the weights of evidence according to the distance from rivers

Distance from large rivers (m)	Weights of evidence	Distance from large rivers (m)	Weights of evidence
0-100	0.274	17200-17300	0.556
100-600	0.258	17300-18600	0.34

600-1100	0.192	18600-21200	0.21
1100-1600	0.055	21200-21300	-0.305
1600-2200	-0.017	21300-21600	-0.534
2200-2800	-0.071	21600-21700	-0.339
2800-3500	0.036	21700-21800	-0.665
3500-4200	0.019	21800-24500	-0.567
4200-4900	0.096	24500-27700	-0.511
4900-5700	0.145	27700-27800	0.014
5700-6500	0.198	27800-27900	-0.545
6500-7400	0.229	27900-28000	-0.325
7400-8400	0.294	28000-28100	-0.534
8400-9500	0.192	28100-28300	-0.797
9500-10800	0.033	28300-28400	-1.099
10800-10900	-0.314	28400-28700	-1.457
10900-11400	-0.135	28700-28800	-2.153
11400-13100	-0.328	28800-28900	-1.587
13100-14700	-0.523	28900-29000	-2.509
14700-14800	-0.902	29000-29200	-1.732
14800-17200	-0.622	29200-32900	-1.806

Table 33. Variation of the weights of evidence according to the distance from large rivers

Topography (m)	Weights of evidence
0-2	1.201
41365	1.522
41365	1.475
13-14	0.866
14-16	0.511
16-17	0.206
17-18	0.035
18-19	-0.064
19-20	-0.146
20-21	-0.243
21-22	-0.33
22-23	-0.429
23-24	-0.514
24-25	-0.587
25-26	-0.653
26-27	-0.685
27-28	-0.695
28-30	-0.716

30-33	-0.531
33-34	-0.283
34-35	0.041
35-39	0.225
39-40	0.876
40-41	0.552
41-42	1.175
42-43	0.391
43-44	0
44-46	0

Table 34. Variation of the weights of evidence according to topography ranges

Soil types	Weights of evidence
1	-0.075
2	1.404
3	-0.049
4	0.378
5	0

Table 35. Variation of the weights of evidence according to soil types

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

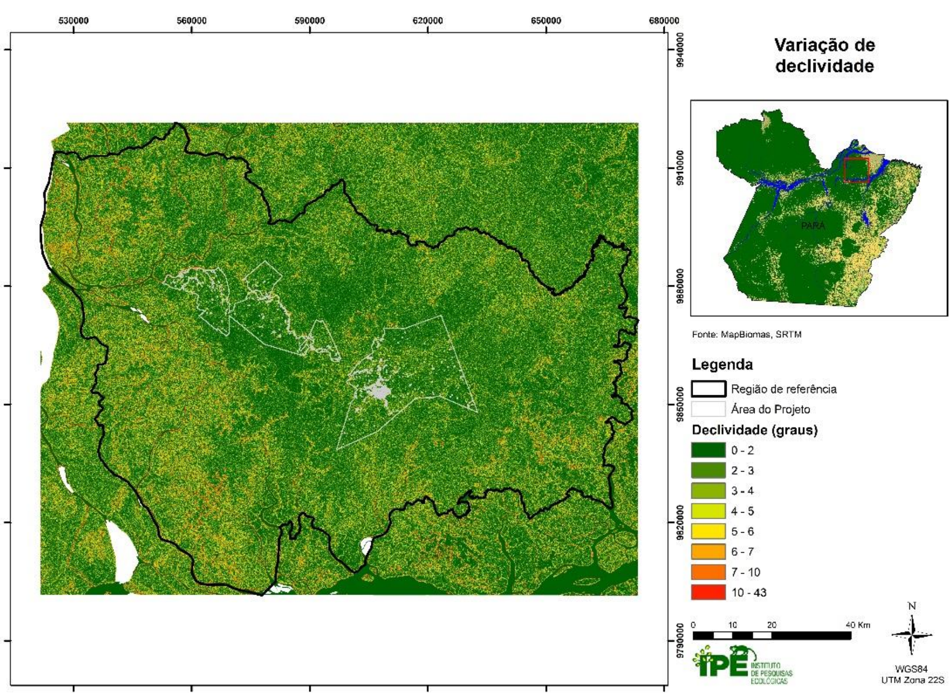

Figure 38. Slope factor map

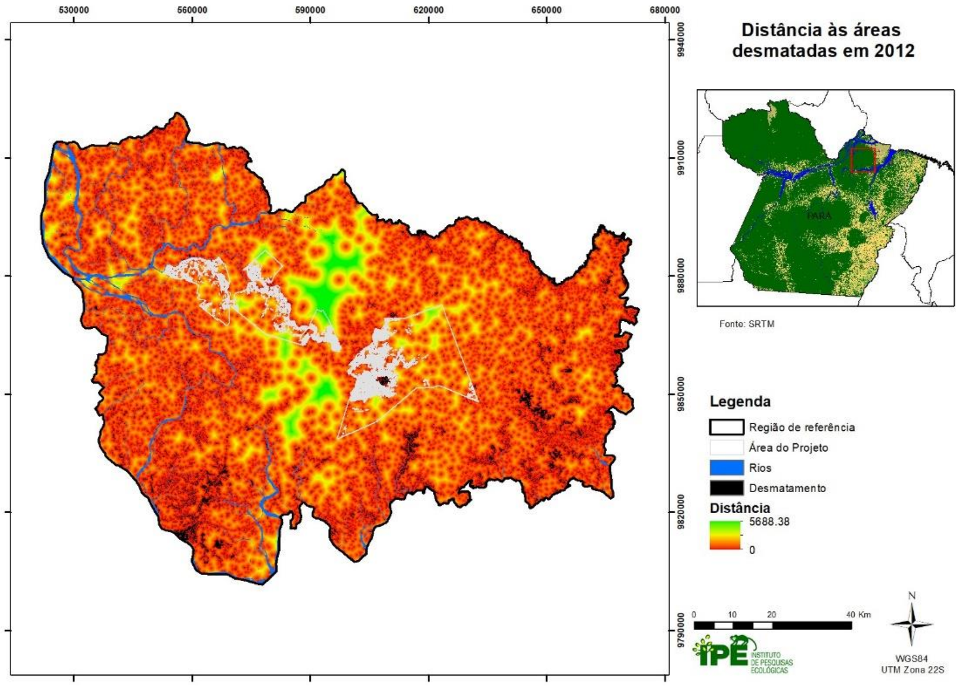

Figure 39. Factor map representing the distance from deforested areas

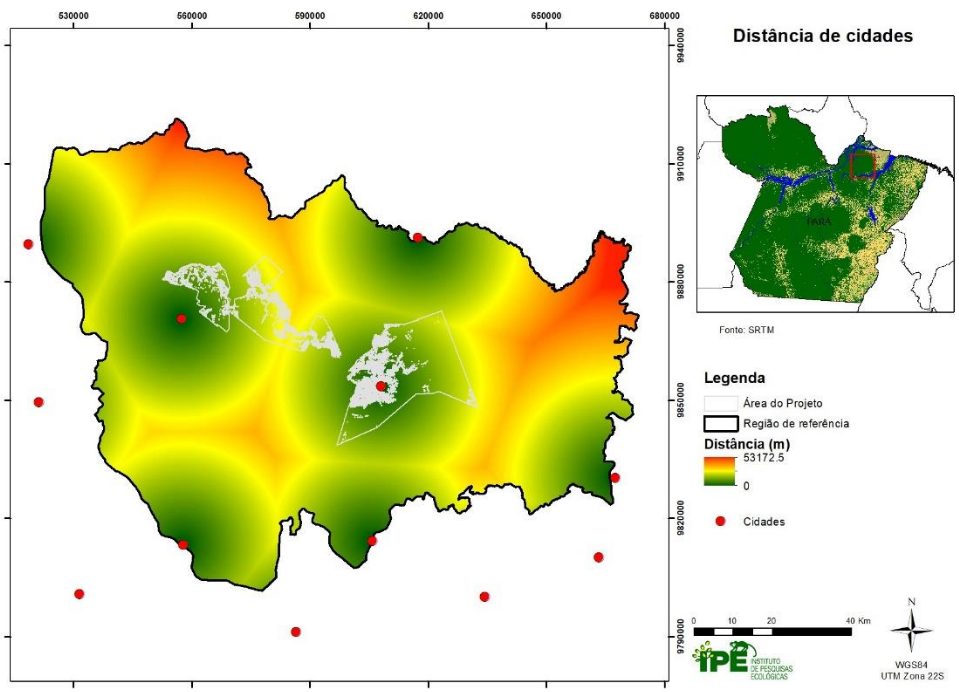

Figure 40. Factor map representing the distance from cities and main inhabitants' nuclei

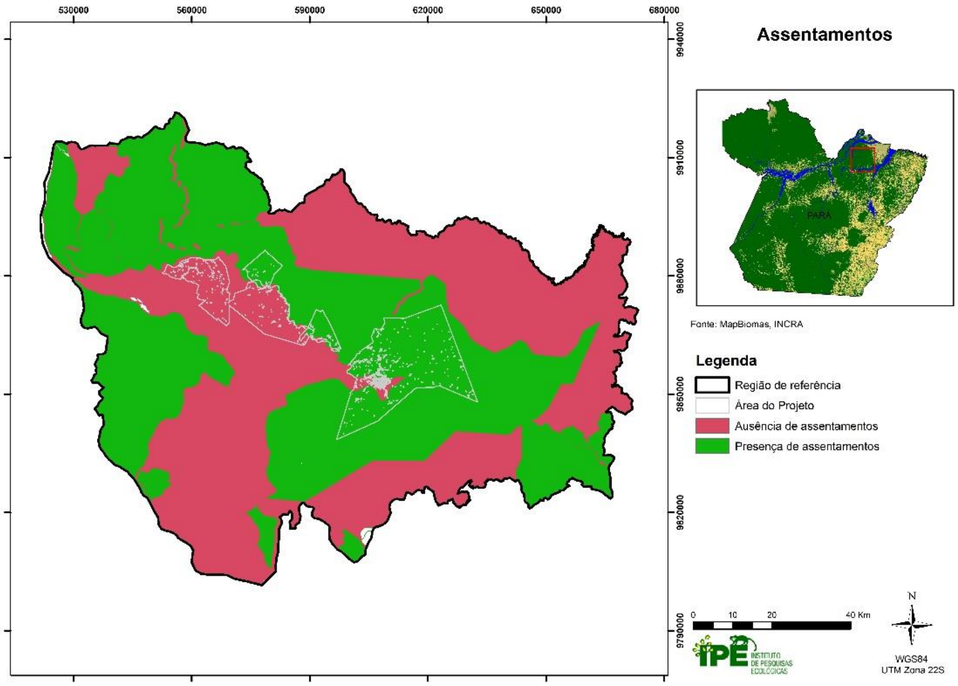

Figure 41. Factor map representing the distance from settlements

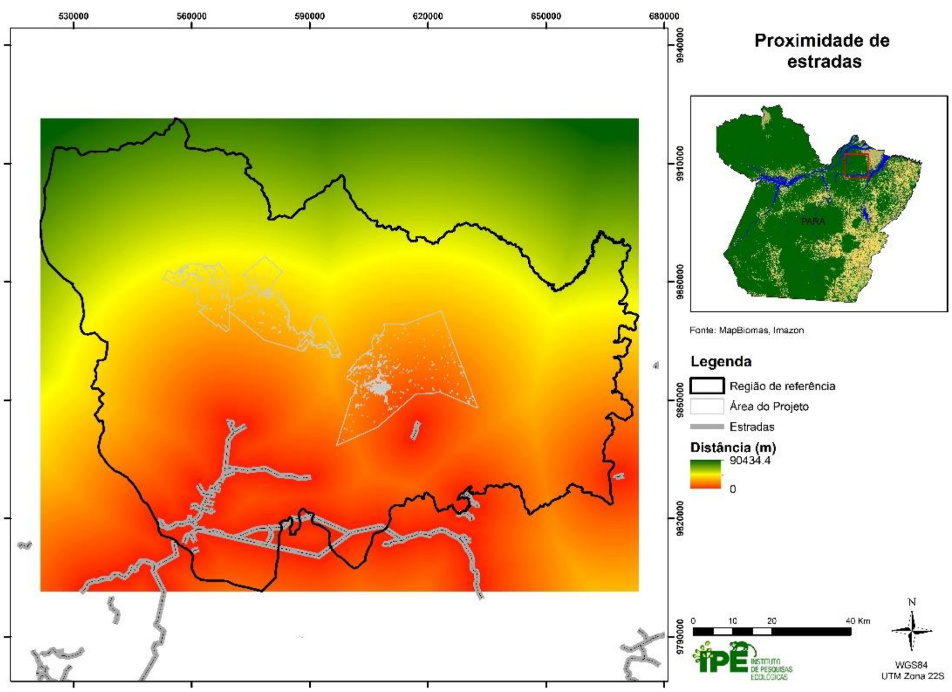

Figure 42. Factor map representing the distance from roads

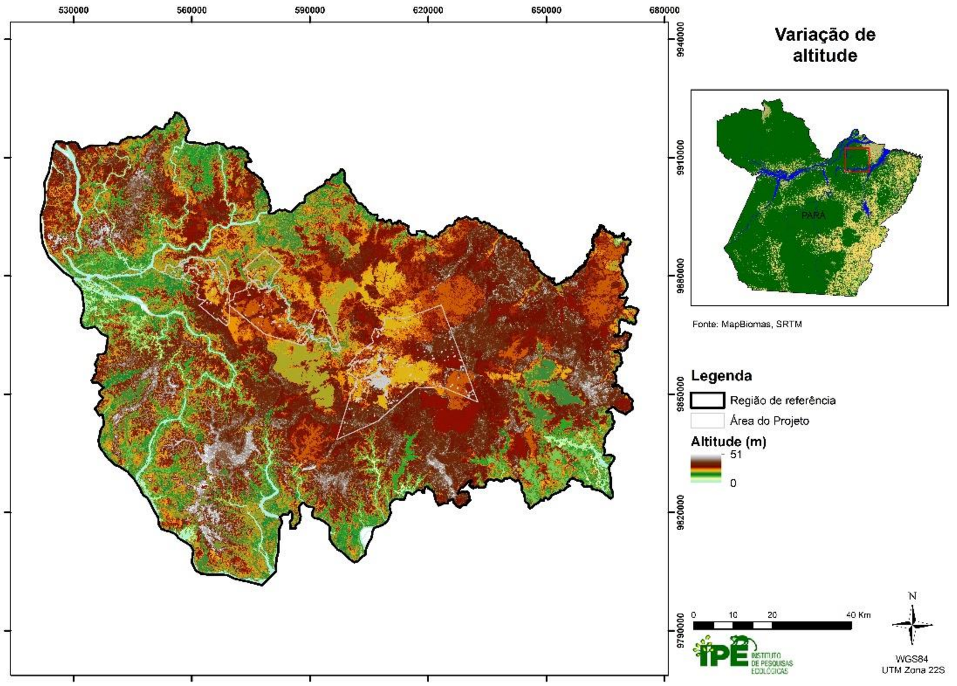

Figure 43. Factor map representing the topography degree

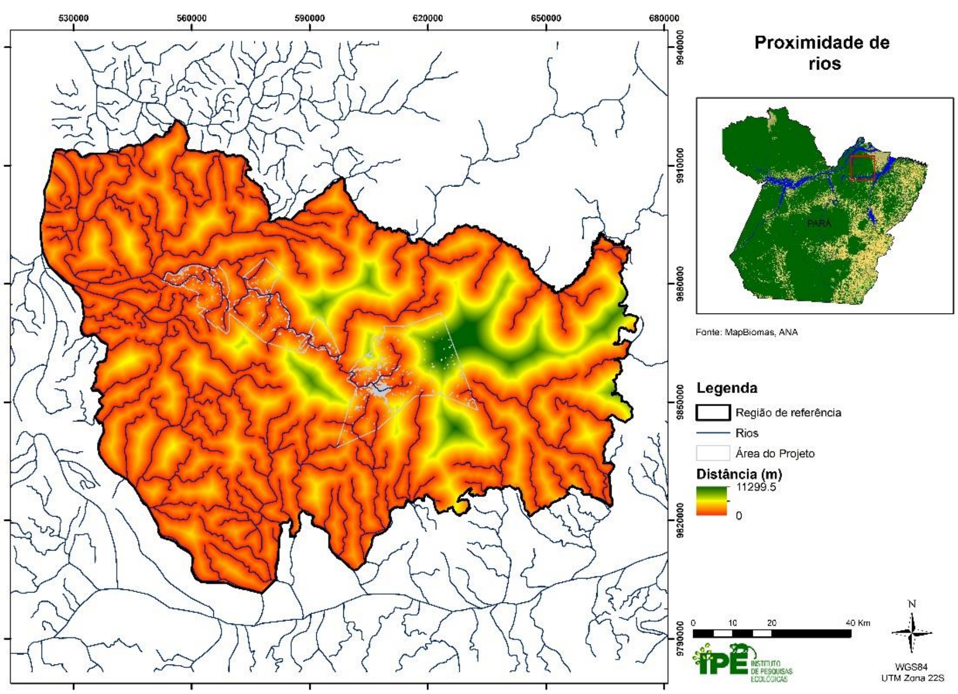

Figure 44. Factor map representing the distance from rivers

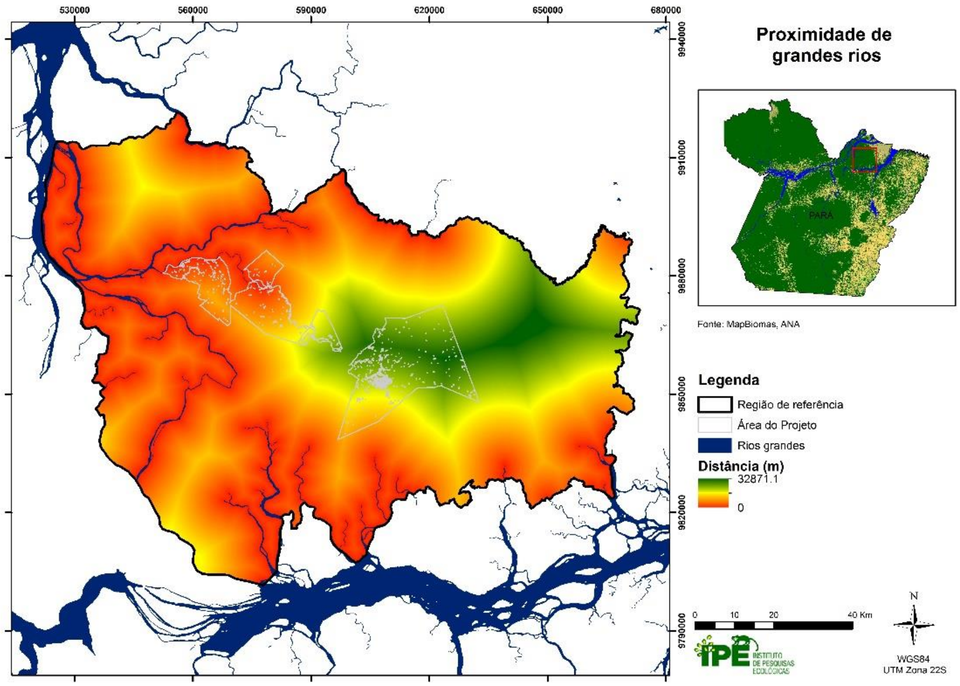

Figure 45. Factor map representing the distance from large rivers

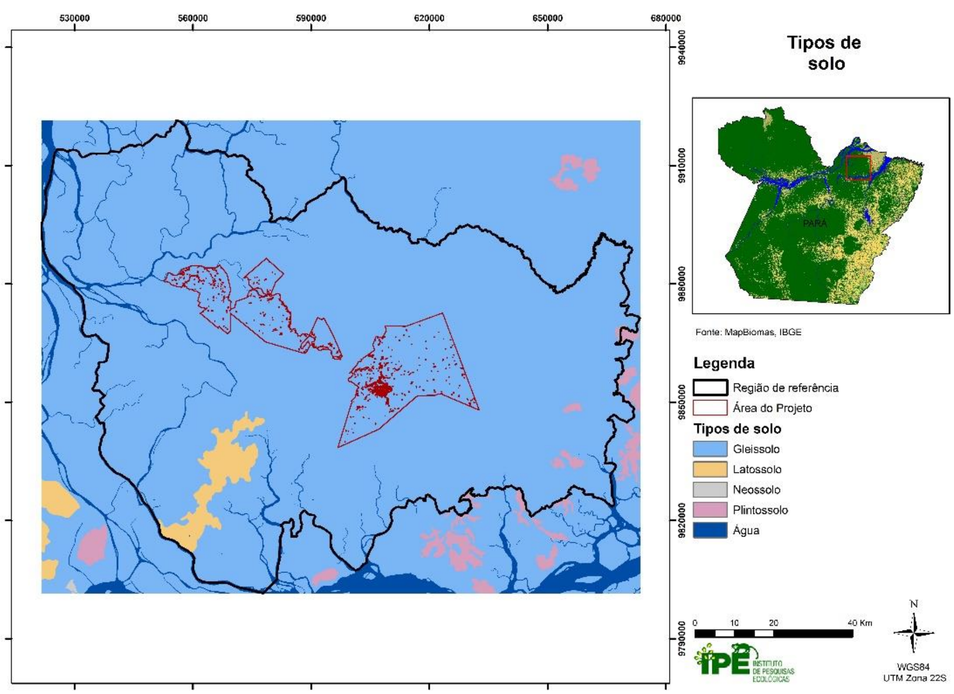

Figure 46. Factor map representing the soil types

Selection of the most accurate deforestation risk map

It is important to note that the deforestation risk map illustrates the probability of a forest area becoming a non-forest area. This map was generated through the analysis of all the variables and deforestation patterns measured over the years during the second baseline period, which were obtained through the satellite image classification.

In order to select the most accurate deforestation risk map, "calibration" of the output of the previous step was carried out. 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[153].

In order to conduct the calibration and validation of the most accurate deforestation risk map, the methods of similarity degree with exponential decay due to distance were utilized.

For both methods, simulations of deforestation projection were made taking as a reference three dates: 2003, 2008 and 2012. The period from 2003 to 2008 was used to generate the existing correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the models. Then a projection was made from 2008 to 2012, generating a scenario of the reference region for that date. Therefore, deforestation risk maps for the 2008-2012 period were generated, together with two scenarios for 2012: the real one and the projected one. These scenarios were compared in terms of similarity degree considering the exponential decay. The greater the similarity, better the model prediction, however as the analyzed region is large and deforestation pattern is very diffuse, it is not likely that a high similarity index would be achieved. The average similarity values of the models varied between 0.112 and 0.203.

Several models were created, which are detailed in the Table below. The first model tested was the one that had all the variables predicting deforestation (m00), then models were tested by removing each factor separately and measuring the degree of correctness of the model. I.e., the most important variables were those in which their absence caused a greater drop in the degree of similarity between the actual and projected deforestation maps. A total of 24 models were created, and the only variable utilized in all of them was the distance from deforested areas due to the importance of this variable to predict deforestation.

The best model was the m08, which had an average similarity value of 0.203. This model included almost all considered variables, only the census sectors was not incorporated. Thus, this model was selected to project the future deforestation in the project's reference region.

[153] 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.

Modelos	Similaridade 1	Similaridade 2	Similaridade média	Assentamentos	Proximidade de cidades	Proximidade de estradas	Proximidade de rios	Proximidade de rios grandes	Declividade	Elevação	Setores censitários	Tipo de solo	Proximidades a desmatamentos
m08	0.174	0.232	0.203	1	1	1	1	1	1	1		1	1
m22	0.171	0.230	0.201	1		1			1	1		1	1
m04	0.163	0.230	0.196	1	1	1		1	1	1	1	1	1
m07	0.156	0.235	0.196	1	1	1	1	1	1		1	1	1
m19	0.170	0.221	0.195			1			1				1
m21	0.167	0.222	0.195			1			1	1		1	1
m00	0.163	0.226	0.194	1	1	1	1	1	1	1	1	1	1
m24	0.156	0.220	0.188	1	1	1			1	1	1	1	1
m05	0.158	0.217	0.188	1	1	1	1		1	1	1	1	1
m02	0.154	0.218	0.186	1		1	1	1	1	1	1	1	1
m20	0.164	0.206	0.185			1			1	1			1
m01	0.156	0.214	0.185		1	1	1	1	1	1	1	1	1
m09	0.158	0.211	0.184	1	1	1	1	1	1	1	1		1
m23	0.147	0.212	0.179	1		1			1	1	1	1	1
m06	0.142	0.217	0.179	1	1	1	1	1		1	1	1	1
m12	0.128	0.218	0.173			1							1
m03	0.147	0.197	0.172	1	1		1	1	1	1	1	1	1
m15	0.151	0.181	0.166						1				1
m16	0.137	0.181	0.159							1			1
m18	0.108	0.172	0.140									1	1
m10	0.120	0.148	0.134	1									1
m17	0.108	0.158	0.133								1		1
m11	0.091	0.155	0.123		1								1
m13	0.095	0.148	0.122				1						1
m14	0.087	0.137	0.112					1					1

Table 36. Deforestation projection models from 2008 to 2012. Each line corresponds to a model and was evaluated by the Similarity degree.

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

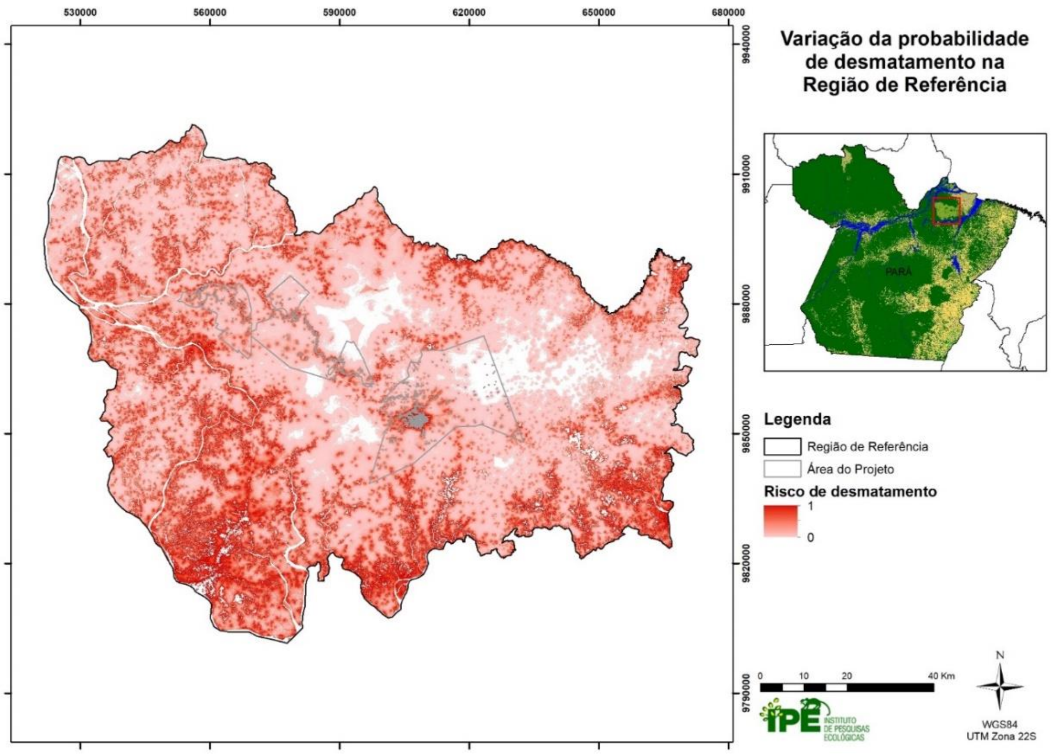

Figure 47. Potential risk map for the occurrence of deforestation in the reference region, using Dinamica Ego Software

The Tables below show the projected annual deforestation values for the reference region, project area and leakage belt within the 2013-2022 period.

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha) RR	Cumulative deforestation (ha)
Second baseline period	2013	1,044,712.35	1,866.06	41,246.46
	2014	1,042,562.97	2,149.38	43,395.84
	2015	1,040,418.09	2,144.88	45,540.72
	2016	1,038,277.62	2,140.47	47,681.19
	2017	1,036,141.65	2,135.97	49,817.16
	2018	1,034,010.00	2,131.65	51,948.81
	2019	1,031,882.85	2,127.15	54,075.96
	2020	1,029,760.11	2,122.74	56,198.70
	2021	1,027,641.78	2,118.33	58,317.03
	2022	1,025,527.86	2,113.92	60,430.95

Third baseline period	2023	1,023,418.26	2,109.60	62,540.55
	2024	1,021,313.07	2,105.19	64,645.74
	2025	1,019,212.29	2,100.78	66,746.52
	2026	1,017,115.74	2,096.55	68,843.07
	2027	1,015,023.60	2,092.14	70,935.21
	2028	1,012,935.78	2,087.82	73,023.03
	2029	1,010,852.28	2,083.50	75,106.53
	2030	1,008,773.19	2,079.09	77,185.62
	2031	1,006,698.24	2,074.95	79,260.57
	2032	1,004,627.70	2,070.54	81,331.11

Table 37. Values obtained for land use and land cover from 2013 to 2032 in the reference region

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha) PA	Cumulative deforestation (ha)
Second baseline period	2013	95,946.66	122.49	1,060.56
	2014	95,837.49	109.17	1,169.73
	2015	95,723.37	114.12	1,283.85
	2016	95,627.97	95.40	1,379.25
	2017	95,529.15	98.82	1,478.07
	2018	95,402.61	126.54	1,604.61
	2019	95,301.81	100.80	1,705.41
	2020	95,220.99	80.82	1,786.23
	2021	95,149.17	71.82	1,858.05
	2022	95,053.23	95.94	1,953.99
Third baseline period	2023	94,986.72	66.51	2,020.50
	2024	94,913.46	73.26	2,093.76
	2025	94,830.39	83.07	2,176.83
	2026	94,760.91	69.48	2,246.31
	2027	94,687.65	73.26	2,319.57
	2028	94,632.39	55.26	2,374.83
	2029	94,563.72	68.67	2,443.50
	2030	94,502.97	60.75	2,504.25
	2031	94,432.32	70.65	2,574.90
	2032	94,366.44	65.88	2,640.78

Table 38. Values obtained for land use and land cover from 2013 to 2032 in the project area

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha) LK	Annual deforestation (ha) LK	Cumulative deforestation (ha)
Second baseline period	2013	185,867.19	183.51	4,196.52
	2014	185,686.20	180.99	4,377.51
	2015	185,500.71	185.49	4,563.00
	2016	185,315.04	185.67	4,748.67
	2017	185,116.50	198.54	4,947.21
	2018	184,948.65	167.85	5,115.06
	2019	184,751.28	197.37	5,312.43
	2020	184,590.54	160.74	5,473.17
	2021	184,383.72	206.82	5,679.99
	2022	184,177.80	205.92	5,885.91
Third baseline period	2023	183,949.74	228.06	6,113.97
	2024	183,743.64	206.10	6,320.07
	2025	183,517.38	226.26	6,546.33
	2026	183,287.52	229.86	6,776.19
	2027	183,057.57	229.95	7,006.14
	2028	182,844.90	212.67	7,218.81
	2029	182,621.88	223.02	7,441.83
	2030	182,394.54	227.34	7,669.17
	2031	182,153.43	241.11	7,910.28
	2032	181,893.33	260.10	8,170.38

Table 39. Values obtained for land use and land cover from 2013 to 2032 in the leakage belt

The maps showing the annually deforested areas within the reference region, project area and leakage belt across the 2nd baseline period are illustrated in Figures below. Furthermore, it is important to note that these maps were generated excluding areas that have already generated credits, according to the requirements of the applied methodology.

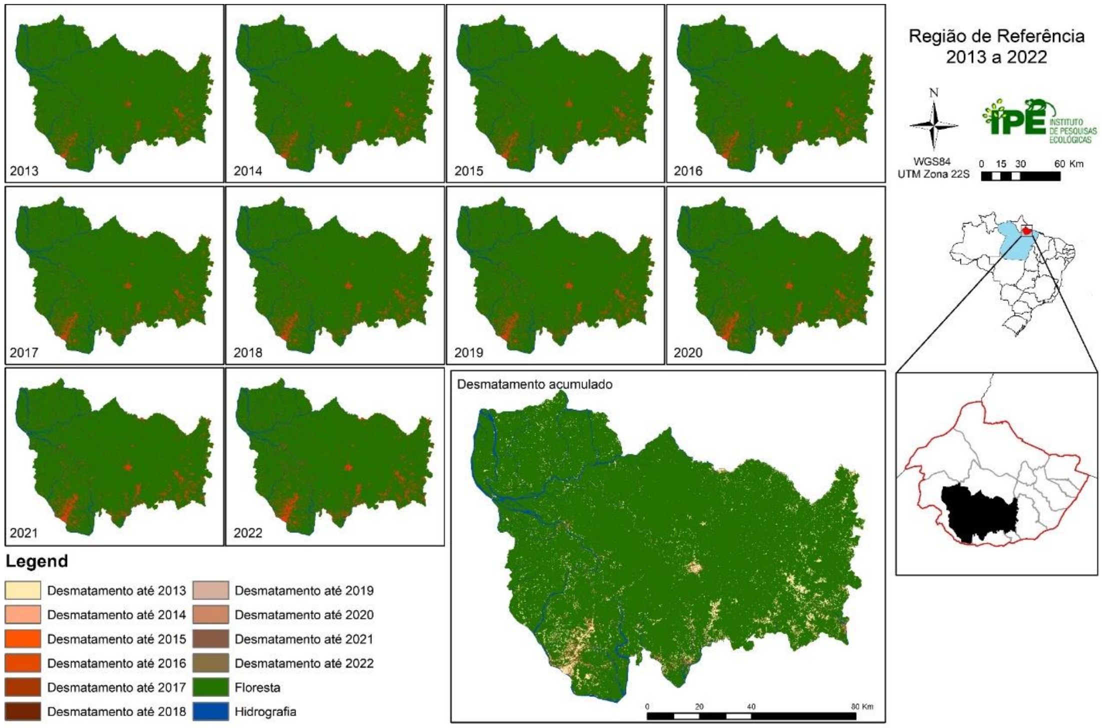

Figure 48. Map representing the projection of future deforestation over the next 10 years, being 2013 to 2022, in the reference region

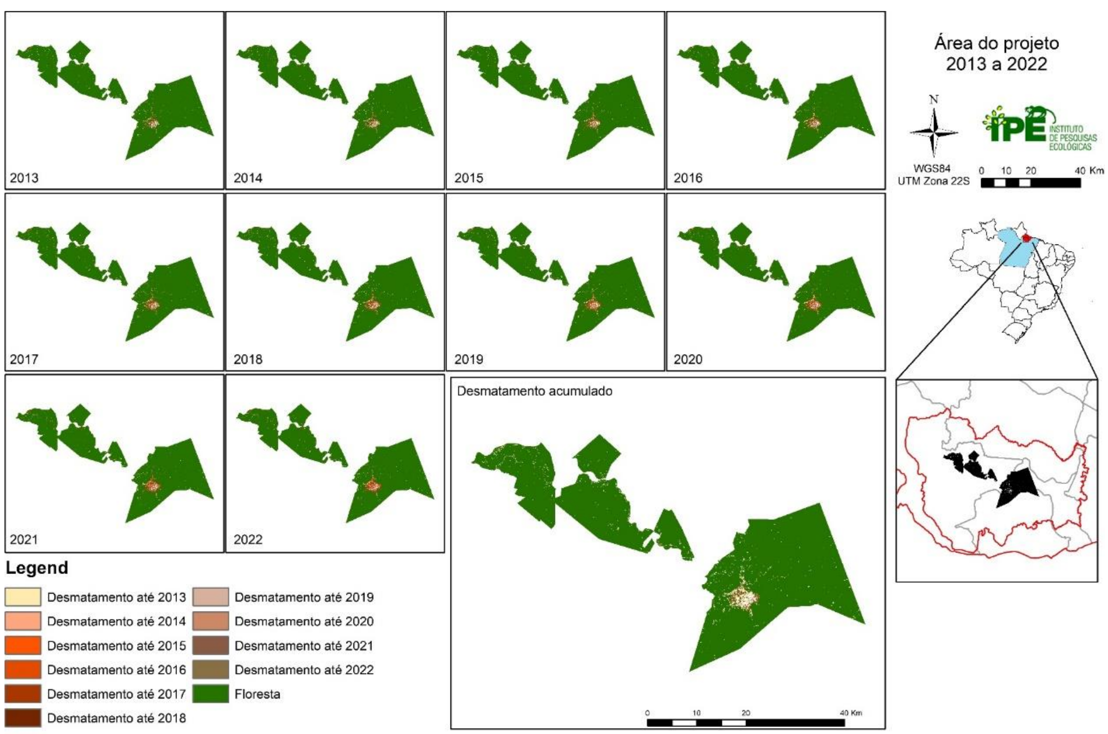

Figure 49. Map representing the projection of future deforestation over the next 10 years, being 2013 to 2022, in the project area

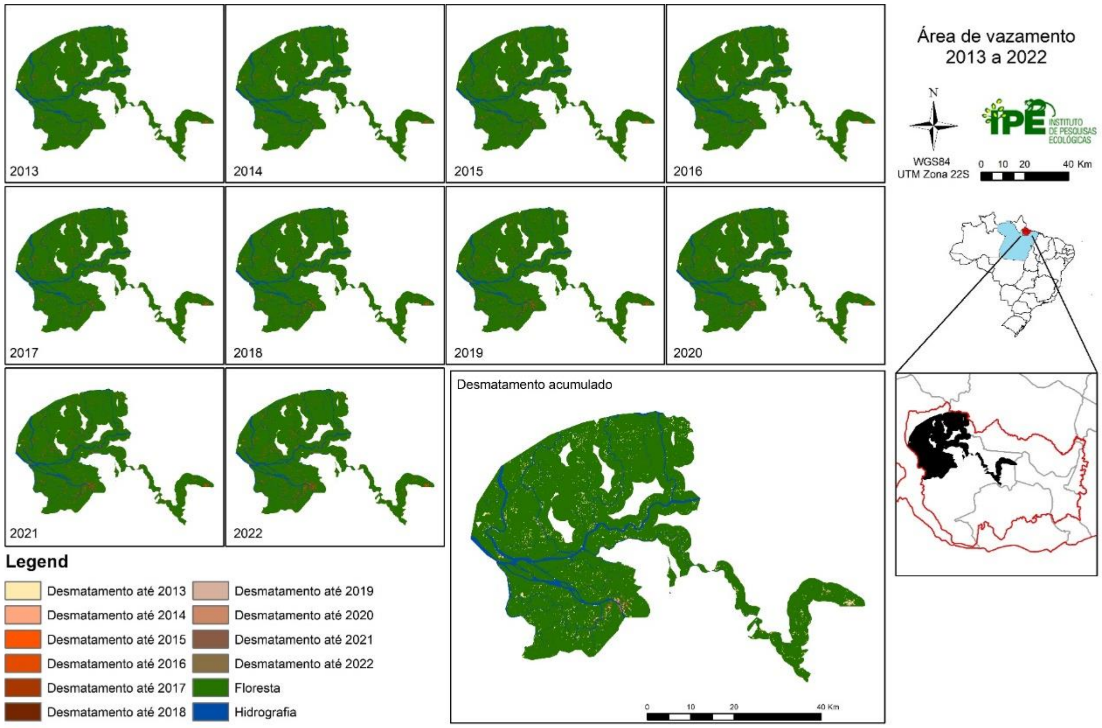

Figure 50. Map representing the projection of future deforestation over the next 10 years, being 2013 to 2022, in the leakage belt

After the revision of the 2nd baseline period, the average annual rate of deforestation predicted in the project area over the second and third baseline periods (2013 – 2032) would be of 0.09%/year, resulting in the deforestation of a predicted 1.8% of the Ecomapuá Amazon REDD project area by the end of 2032.

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

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

In accordance with the location analysis, achieved through the procedure described above, the quantity of baseline LU/LC-change was projected throughout the 2nd baseline period, in the reference region, project area, and leakage belt in each stratum. This is in accordance with step 5 of the Methodology - Definition of the Land-Use and Land-Cover Change Component of the Baseline. Table below show the baseline deforestation within the reference region, project area and leakage belt per stratum. The only "forest" stratum used consisted of riparian dense tropical rainforest, which is represented by statum i.

	Project year t	Stratum i in the reference region (ha)	Total (ha)	
		ABSLRR i,t	annual ABSLRRt	cumulative ABSLRR
Second baseline period	2013	1,866.06	1,866.06	1,866.06
	2014	2,149.38	2,149.38	4,015.44
	2015	2,144.88	2,144.88	6,160.32
	2016	2,140.47	2,140.47	8,300.79
	2017	2,135.97	2,135.97	10,436.76
	2018	2,131.65	2,131.65	12,568.41
	2019	2,127.15	2,127.15	14,695.56
	2020	2,122.74	2,122.74	16,818.30
	2021	2,118.33	2,118.33	18,936.63
	2022	2,113.92	2,113.92	21,050.55
Third baseline period	2023	2,109.60	2,109.60	23,160.15
	2024	2,105.19	2,105.19	25,265.34
	2025	2,100.78	2,100.78	27,366.12
	2026	2,096.55	2,096.55	29,462.67
	2027	2,092.14	2,092.14	31,554.81
	2028	2,087.82	2,087.82	33,642.63
	2029	2,083.50	2,083.50	35,726.13
	2030	2,079.09	2,079.09	37,805.22
	2031	2,074.95	2,074.95	39,880.17
	2032	2,070.54	2,070.54	41,950.71

Table 40. Annual areas of baseline deforestation in the reference region across the 2nd and 3rd baseline periods

	Project year t	Stratum i in project area (ha)	Total (ha)	
		$ABSLPA_{i,t}$	annual $ABSLPA_t$	cumulative ABSLPA
Second baseline period	2013	122.49	122.49	122.49
	2014	109.17	109.17	231.66
	2015	114.12	114.12	345.78
	2016	95.40	95.40	441.18
	2017	98.82	98.82	540.00
	2018	126.54	126.54	666.54
	2019	100.80	100.80	767.34
	2020	80.82	80.82	848.16
	2021	71.82	71.82	919.98
	2022	95.94	95.94	1,015.92

Third baseline period	2023	66.51	66.51	1,082.43
	2024	73.26	73.26	1,155.69
	2025	83.07	83.07	1,238.76
	2026	69.48	69.48	1,308.24
	2027	73.26	73.26	1,381.50
	2028	55.26	55.26	1,436.76
	2029	68.67	68.67	1,505.43
	2030	60.75	60.75	1,566.18
	2031	70.65	70.65	1,636.83
	2032	65.88	65.88	1,702.71

Table 41. Annual areas of baseline deforestation in the project area across the 2nd and 3rd baseline periods

	Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
		$ABSLLK_{i,t}$	annual $ABSLLK_t$	cumulative ABSLLK
Second baseline period	2013	183.51	183.51	183.51
	2014	180.99	180.99	364.50
	2015	185.49	185.49	549.99
	2016	185.67	185.67	735.66
	2017	198.54	198.54	934.20
	2018	167.85	167.85	1,102.05
	2019	197.37	197.37	1,299.42
	2020	160.74	160.74	1,460.16
	2021	206.82	206.82	1,666.98
	2022	205.92	205.92	1,872.90
Third baseline period	2023	228.06	228.06	2,100.96
	2024	206.10	206.10	2,307.06
	2025	226.26	226.26	2,533.32
	2026	229.86	229.86	2,763.18
	2027	229.95	229.95	2,993.13
	2028	212.67	212.67	3,205.80
	2029	223.02	223.02	3,428.82
	2030	227.34	227.34	3,656.16
	2031	241.11	241.11	3,897.27
	2032	260.10	260.10	4,157.37

Table 42. Annual areas of baseline deforestation in the leakage belt across the 2nd and 3rd baseline period

Calculation of baseline activity data per forest class

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 the initial class of riparian dense tropical rainforest being converted to the final LU/LC class of "non-forest". The number of hectares deforested in each forest class, within the reference region, project area and leakage belt are found in Tables below.

	Area deforested per forest class icl within the reference region		Total baseline deforestation in the reference region	
	ID_{icl}	1	Annual ABSLRRt (ha)	ABSLRR cumulative (ha)
	Name	Riparian (Aluvial) Dense Tropical Rainforest		
	Project year *t*	ha		
Second baseline period	2013	1,866.06	1,866.06	1,866.06
	2014	2,149.38	2,149.38	4,015.44
	2015	2,144.88	2,144.88	6,160.32
	2016	2,140.47	2,140.47	8,300.79
	2017	2,135.97	2,135.97	10,436.76
	2018	2,131.65	2,131.65	12,568.41
	2019	2,127.15	2,127.15	14,695.56
	2020	2,122.74	2,122.74	16,818.30
	2021	2,118.33	2,118.33	18,936.63
	2022	2,113.92	2,113.92	21,050.55
Third baseline period	2023	2,109.60	2,109.60	23,160.15
	2024	2,105.19	2,105.19	25,265.34
	2025	2,100.78	2,100.78	27,366.12
	2026	2,096.55	2,096.55	29,462.67
	2027	2,092.14	2,092.14	31,554.81
	2028	2,087.82	2,087.82	33,642.63
	2029	2,083.50	2,083.50	35,726.13
	2030	2,079.09	2,079.09	37,805.22
	2031	2,074.95	2,074.95	39,880.17
	2032	2,070.54	2,070.54	41,950.71

Table 43. Annual areas deforested per forest class icl within the reference region in the baseline case (baseline activity data per forest class)

	Area deforested per forest class *icl* within the project area		Total baseline deforestation in the project area	
	ID_{icl}	1	Annual $ABSLPA_t$ (ha)	ABSLPA cumulative (ha)
	Name	Riparian (Aluvial) Dense Tropical Rainforest		
	Project year *t*	(ha)		
Second baseline period	2013	122.49	122.49	122.49
	2014	109.17	109.17	231.66
	2015	114.12	114.12	345.78
	2016	95.40	95.40	441.18
	2017	98.82	98.82	540.00
	2018	126.54	126.54	666.54
	2019	100.80	100.80	767.34
	2020	80.82	80.82	848.16
	2021	71.82	71.82	919.98
	2022	95.94	95.94	1,015.92
Third baseline period	2023	66.51	66.51	1,082.43
	2024	73.26	73.26	1,155.69
	2025	83.07	83.07	1,238.76
	2026	69.48	69.48	1,308.24
	2027	73.26	73.26	1,381.50
	2028	55.26	55.26	1,436.76
	2029	68.67	68.67	1,505.43
	2030	60.75	60.75	1,566.18
	2031	70.65	70.65	1,636.83
	2032	65.88	65.88	1,702.71

Table 44. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)

	Area deforested per forest class *icl* within the leakage belt		Total baseline deforestation in the leakage belt	
	ID_{icl}	1	Annual $ABSLLK_t$ (ha)	ABSLLK cumulative (ha)
	Name	Riparian (Aluvial) Dense Tropical Rainforest		
	Project year *t*	ha		
Second baseline period	2013	183.51	183.51	183.51
	2014	180.99	180.99	364.50
	2015	185.49	185.49	549.99
	2016	185.67	185.67	735.66
	2017	198.54	198.54	934.20
	2018	167.85	167.85	1,102.05

	2019	197.37	197.37	1,299.42
	2020	160.74	160.74	1,460.16
	2021	206.82	206.82	1,666.98
	2022	205.92	205.92	1,872.90
Third baseline period	2023	228.06	228.06	2,100.96
	2024	206.10	206.10	2,307.06
	2025	226.26	226.26	2,533.32
	2026	229.86	229.86	2,763.18
	2027	229.95	229.95	2,993.13
	2028	212.67	212.67	3,205.80
	2029	223.02	223.02	3,428.82
	2030	227.34	227.34	3,656.16
	2031	241.11	241.11	3,897.27
	2032	260.10	260.10	4,157.37

Table 45. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

Calculation of baseline activity data per post-deforestation forest class

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

According to the Methodology 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. The table below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region during the second and third baseline periods (2013 – 2032).

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	41,950.71	4%	41,950.71	4%
Total area of each class *fcl*		41,950.71	4%	41,950.71	4%

Table 46. Zone of the reference region encompassing potential post-deforestation LU/LC class during the 2013-2032 period

Tables below depict the annual areas deforested in each zone in the baseline case within the reference region, project area and leakage belt, respectively.

	Area established after deforestation per zone within the reference region		Total baseline deforestation in the reference region	
	IDct Name	2 Non forest	$ABSLRR_t$ annual	ABSLRR cumulative
	Project year	ha	ha	ha
Second baseline period	2013	1,866.06	1,866.06	1,866.06
	2014	2,149.38	2,149.38	4,015.44
	2015	2,144.88	2,144.88	6,160.32
	2016	2,140.47	2,140.47	8,300.79
	2017	2,135.97	2,135.97	10,436.76
	2018	2,131.65	2,131.65	12,568.41
	2019	2,127.15	2,127.15	14,695.56
	2020	2,122.74	2,122.74	16,818.30
	2021	2,118.33	2,118.33	18,936.63
	2022	2,113.92	2,113.92	21,050.55
Third baseline period	2023	2,109.60	2,109.60	23,160.15
	2024	2,105.19	2,105.19	25,265.34
	2025	2,100.78	2,100.78	27,366.12
	2026	2,096.55	2,096.55	29,462.67
	2027	2,092.14	2,092.14	31,554.81
	2028	2,087.82	2,087.82	33,642.63
	2029	2,083.50	2,083.50	35,726.13
	2030	2,079.09	2,079.09	37,805.22
	2031	2,074.95	2,074.95	39,880.17
	2032	2,070.54	2,070.54	41,950.71

Table 47. Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data per zone)

	Area established after deforestation per zone within the project area		Total baseline deforestation in the project area	
	IDct Name	2 Non forest	$ABSLPA_t$ annual	ABSLPA cumulative
	Project year	ha	ha	ha
Second baseline period	2013	122.49	122.49	122.49
	2014	109.17	109.17	231.66
	2015	114.12	114.12	345.78
	2016	95.40	95.40	441.18
	2017	98.82	98.82	540.00
	2018	126.54	126.54	666.54
	2019	100.80	100.80	767.34
	2020	80.82	80.82	848.16
	2021	71.82	71.82	919.98
	2022	95.94	95.94	1,015.92
Third baseline period	2023	66.51	66.51	1,082.43
	2024	73.26	73.26	1,155.69
	2025	83.07	83.07	1,238.76
	2026	69.48	69.48	1,308.24
	2027	73.26	73.26	1,381.50
	2028	55.26	55.26	1,436.76
	2029	68.67	68.67	1,505.43
	2030	60.75	60.75	1,566.18
	2031	70.65	70.65	1,636.83
	2032	65.88	65.88	1,702.71

Table 48. 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**	
	IDct **Name**	2 Non forest	**$ABSLLK_t$** **annual**	**ABSLLK** **cumulative**
	Project year	**ha**	**ha**	**ha**
Second baseline period	2013	183.51	183.51	183.51
	2014	180.99	180.99	364.50
	2015	185.49	185.49	549.99
	2016	185.67	185.67	735.66
	2017	198.54	198.54	934.20
	2018	167.85	167.85	1,102.05
	2019	197.37	197.37	1,299.42

	2020	160.74	160.74	1,460.16
	2021	206.82	206.82	1,666.98
	2022	205.92	205.92	1,872.90
Third baseline period	2023	228.06	228.06	2,100.96
	2024	206.10	206.10	2,307.06
	2025	226.26	226.26	2,533.32
	2026	229.86	229.86	2,763.18
	2027	229.95	229.95	2,993.13
	2028	212.67	212.67	3,205.80
	2029	223.02	223.02	3,428.82
	2030	227.34	227.34	3,656.16
	2031	241.11	241.11	3,897.27
	2032	260.10	260.10	4,157.37

Table 49. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

3.5 Additionality

According to VCS Standard v4.0 requirements, a full reassessment of additionality is not required during the reassessment of baseline.

According to regulatory surplus analysis, this REDD project activity does not lead to the violation of any applicable law. Moreover, it is not mandated by any law, statute or other regulatory framework, i.e., this is a voluntary conservation project.

The additionality analysis below was carried out during the development of the VCS PD for the first baseline period and took into consideration the VCS Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities (VT0001) Version 3.0.

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

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

As described in the description of baseline scenario, the alternatives to the project activity considered are:

- Palm-heart extraction;
- Timber production;
- Small-scale subsistence agriculture;

These activities are shown to be credible alternatives by official data[154], timber and palm-heart being the products with the highest average production values in the four municipalities of the project area. Furthermore, these products are cited as the principal products in studies analysing the economy of the project area specifically[155].

Timber production was also the pre-project activity, being that Santana Madeiras Ltda. timber company exploited the area before its acquisition by Ecomapuá Conservação Ltda., the project proponent of the Ecomapuá Amazon REDD project[156].

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

Subsistence agriculture:

Given that the Ecomapuá lands are private property, subsistence agriculture and the accompanying slash-and-burn practices, along with planting of corn and manioc, which occur within the project area, are illegal or of uncertain legal status[157]. The historical social dynamics in the region involve extractivist peoples settling unofficially and working, with practically no rights, for property owners, extracting products from the forest, which has been the established pattern for decades[158].

The presence of the estimated 99 families living in the project area is not prohibited by Ecomapuá Ltda., 90% of the families within the project area having been there for over ten years, on the contrary, one of the goals of the present REDD project is to contribute to a solution to this social problem, through collaboration with a government environmental body. In this sense, laws against subsistence agriculture are systematically not enforced in the entirety of the project area, and the practice is widespread.

Palm heart extraction and timber production:

The extraction of palm heart and wood were prohibited in the project area at the time when Ecomapuá acquired the project area in 2001[159].

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154 Source: IBGE Cidades: https://cidades.ibge.gov.br/

155 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.

156 São Paulo, 19.07.01 - "Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.".

157 Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará.

158 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.

159 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.

Studies argue that a large proportion of timber activity in Brazil is illegal, for instance SFB argued 36% in 2011[160]. This dynamic generally continues unchecked with, for example, Pará being estimated to be the state most at risk of deforestation in the Amazon in 2011[161]. The illegal exploration of timber and palm heart by residents in the project area was severe enough to cause Ecomapuá Ltda. to report these activities to IBAMA, the Brazilian environmental authority[162]. This report did not result in any follow-up punitive action from any party.

For these reasons it is concluded that the laws relating to palm heart exploration and timber production are systematically not enforced and illegal activities are widespread in the project area.

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

Outcome of sub-step 1b:

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

- Palm-heart extraction;
- Timber production;
- Small-scale subsistence agriculture.

Sub-step 1c. Selection of the baseline scenario:

The most plausible baseline scenario, as suggested by sub-step 1b, is commercial logging beyond the limits of Brazilian law, followed by slash-and-burn subsistence agriculture, planting manioc and corn. This dynamic, well-known in the project region, is confirmed by studies[163, 164].

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160 Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras

161 IMAZON (2011), "Sistema prevê desmate na Amazônia": http://www.imazon.org.br/imprensa/imazon-na-midia/sistema-preve-desmate-na-amazonia

162 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.

163 Herrera (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará".

164 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

Sub-step 2b. Simple Cost Analysis

The simple cost analysis was determined as the appropriate analysis method, for the following reason: it was determined that the Ecomapuá Amazon REDD project does not generate any financial or economic benefits other than VCS related income. There is no for-profit sale of NTFPs, timber or any other product involved in the project activity, and the sum of Ecomapuá Ltda. annual financial balance, since the company's founding in 2001 until 2011, was minus R$ 298,222. Some of the costs involved in preservation of the area, without considering the costs of the present carbon project, are listed in the table below.

	Estimated Annual Costs of Conservation (R$)
Monitoring: Satellite Images	R$ 27,734.56
Minimum salary for 3 area supervisors	R$ 24,408.00
TOTAL	**R$ 52,142.56**

Table 50. Ecomapuá Ltda. estimated annual costs of conservation

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

STEP 4. Common Practice Analysis:

Given that no financial benefits were found in the results of the simple cost analysis, the following step according to the V-C-S Addtionality Tool v3.0 is common practice analysis.

The practice of conservation of privately-owned forest areas on Marajó Island, as well as Pará state as a whole, is extremely rare. As such, no areas which are not REDD+ projects were found. The dominant practices in the area that compose the deforestation dynamics include timber harvesting, extraction of palm heart, and subsistence agriculture.

The Brazilian Ministry of the Environment (MMA) provides a list of all the mapped REDD+ projects in Brazil up to 2012 under the following web link: http://www.mma.gov.br/redd/

All of the projects located in the State of Pará in the above list can be considered similar activities to the present REDD project, however they all have the essential distinction that none are located within privately-owned areas. For example, the following two projects in Pará state, which are located in Indigenous Reserves: the "Fundo Kayapó de Conservação em Terras Indígenas", and the Pilot REDD project in São Félix do Xingu municipality. The fact of being located within a government conservation area makes these projects essentially different to the Ecomapuá REDD project.

Other projects in the above list pursue fundamentally different routes to conservation in conjunction with government organs, such as the SEMA Pará project, implemented by the Pará state environmental organ, which aims to strengthen and improve the rural registration system (CAR) in order to reduce deforestation.

The exception to this is the RainTrust REDD+ project, which is a privately-owned forest conservation area, however it cannot be considered in the present common practice analysis because it is a registered V-C-S AFOLU project, which is to be excluded in accordance with the V-C-S Additionality Tool.

For the aforementioned reasons of the essential difference between the Ecomapuá Amazon REDD Project and similar projects in the area, **the proposed project VCS AFOLU activity is not the baseline scenario, and hence it is additional.**

3.6 Methodology Deviations

This project activity does not apply any methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

$$Cab_{icl} = bb \times CF \times 44$$

Where,

Cab_{icl}	Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class icl; tCO_2e ha^{-1}
ab	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl; Mg ha^{-1}
CF	Default value of carbon fraction in biomass
44/12	Ratio converting C to CO_2e

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

Where,

Cbb_{icl}	Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class icl; $tCO_2e\ ha^{-1}$
bb	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl; $Mg\ ha^{-1}$
CF	Default value of carbon fraction in biomass
44/12	Ratio converting C to CO_2e

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

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

Where,

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

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

Where,

$\Delta CabBSLPA_{icl,t}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO_2e
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCab_{icl}	Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class icl; $tCO_2e\ ha^{-1}$

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

Where,

$\Delta CbbBSLPA_{icl,t}$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO_2e
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha

ΔCbb_{icl}	Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category icl; $tCO_2e\ ha^{-1}$

Estimation of the average carbon stocks

The utilized carbon stocks in the Project were calculated on the basis of above ground biomass values from the study presented in Cunha (2018)[165] for riparian dense tropical rainforest.

This study analyzed the patterns of productivity and dynamics of igapó (black-water) forest in the National Forest of Caxiuanã, Eastern Amazonia, which is located close to the south-western portion of Marajó Island (where the reference region is located) and contains the same forest type of the project area (riparian dense tropical rainforest).

Forest inventory was conducted on a six-year follow-up basis between 2012 and 2017. Results were analyzed in terms of growth, mortality and recruitment of tree species with Diameter at Breast Height (DBH) ≥ 10 cm. Two long-term plots of 1 ha each were installed, which were subdivided into five plots of 20 x 100 m each. In each plot, all trees, lianas and palm trees with a DBH ≥ 10 cm were identified and analyzed in terms of above ground biomass.

The above-ground biomass estimates per plot were obtained from the sum of the individuals biomass using the allometric equation developed by Chambers et al. (2001) and modified by Baker et al. (2004) for above-ground biomass estimation in flooded forests:

$Biomass = \Sigma n\ DEN / 0.67 * \exp(0.33 (\ln(DAP)) + 0.933 (\ln(DAP^2)) - 0.122 (\ln(DAP^3)) - 0.37)$[166]

The igapó forests analyzed presented biomass equivalent to 359.8 ± 10.8 $Mg\ ha^{-1}$ and a mean increase of 6.3 ± 3.7 $Mg\ ha^{-1}\ y^{-1}$ indicating that these forests during the analyzed period acted as a carbon sink.

This value was chosen after a literature search revealed that this study had the most accurate biomass values for the vegetation-cover of the Project's reference region.

In addition, average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha.

Vegetation	Aboveground Biomass ($Mg\ ha^{-1}$)	Belowground Biomass ($Mg\ ha^{-1}$)	Total biomass ($Mg\ ha^{-1}$)
Riparian Dense Tropical Rainforest	359.80	86.35	446.15

Table 51. Biomass values used for the class "forest"

[165] CUNHA, Denise de Andrade. **Dinâmica e produtividade em florestas de igapó e várzea na Amazônia Oriental.** 2018. 144 f. Tese (Doutorado) - Curso de Doutorado do Programa de Pós-graduação em Biodiversidade e Biotecnologia, Rede Bionorte, Museu Paraense EmÍlio Goeldi, Belém, 2018.

[166] Where 'n' the number of trees per plot and 'DEN' the specific density of wood for each species.

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

In order to convert biomass into carbon, and carbon into carbon-dioxide, the conversion factors[167] defined in table below were used.

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

Table 52. Biomass to CO_2 conversion factors

Therefore, the table below depicts the average above and below ground CO_2 stock values for riparian dense tropical rainforest present in the project region.

Vegetation	Aboveground CO_2 - Cabicl (tCO_2 ha^{-1})	Belowground CO_2 - Cbbicl (tCO_2 ha^{-1})	Total CO_2 - Ctoticlt (tCO_2 ha^{-1})
Riparian Dense Tropical Rainforest	659.63	158.31	817.95

Table 53. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt

<u>Average carbon stocks of post-deforestation classes</u>

Fearnside (1996)[168] 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.

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

Table 54. 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.

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[167] 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>.

[168] FEARNSIDE, Philip M.. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996. Available at: <https://www.sciencedirect.com/science/article/abs/pii/0378112795036474>.

Calculation of 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 (fcl). In addition, the methodology stipulates that various change factors must be applied to the baseline case initial and post-deforestation classes in above-ground and below ground biomass:

a) Above-ground biomass:

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

b) Below-ground biomass:

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

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

Year after deforestation		ΔCab*icl,t*
		tCO_2e/ha
1	t*	-659.63
2	t*+1	0
2	t*+2	0
4	t*+3	0
5	t*+4	0
6	t*+5	0
7	t*+6	0
8	t*+7	0
9	t*+8	0
10	t*+9	0
11	t*+10	0
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0

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

Table 55. Carbon stock change factors for initial forest classes icl, above-ground carbon stocks

Year after deforestation		$\Delta Cbb_{icl,t}$ tCO₂e/ha
1	t*	-15.83
2	t*+1	-15.83
2	t*+2	-15.83
4	t*+3	-15.83
5	t*+4	-15.83
6	t*+5	-15.83
7	t*+6	-15.83
8	t*+7	-15.83
9	t*+8	-15.83
10	t*+9	-15.83
11	t*+10	0
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0
16	t*+15	0
17	t*+16	0
18	t*+17	0
19	t*+18	0
20	t*+19	0
21-T	t*+20…	0

Table 56. Carbon stock change factors for initial forest classes icl, below-ground carbon stocks

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
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)

Calculation of baseline carbon stock changes

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

	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		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		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region		Total net carbon stock change in the reference region	
	ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$	ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$	ID_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$	$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Second baseline period	2013	1,230,915	1,230,915	1,230,915	2013	222,612	222,612	222,612	2013	62,752	62,752	62,752	1,390,775	1,390,775
	2014	1,417,803	1,417,803	2,648,718	2014	238,407	238,407	461,019	2014	65,996	65,996	128,748	1,590,214	2,980,990
	2015	1,414,834	1,414,834	4,063,552	2015	259,569	259,569	720,588	2015	70,679	70,679	199,426	1,603,725	4,584,714
	2016	1,411,925	1,411,925	5,475,478	2016	277,900	277,900	998,488	2016	76,952	76,952	276,378	1,612,874	6,197,588
	2017	1,408,957	1,408,957	6,884,435	2017	264,907	264,907	1,263,396	2017	82,387	82,387	358,765	1,591,478	7,789,066
	2018	1,406,107	1,406,107	8,290,542	2018	286,385	286,385	1,549,781	2018	78,535	78,535	437,300	1,613,958	9,403,023
	2019	1,403,139	1,403,139	9,693,681	2019	287,565	287,565	1,837,345	2019	84,902	84,902	522,202	1,605,802	11,008,825
	2020	1,400,230	1,400,230	11,093,911	2020	284,883	284,883	2,122,229	2020	85,252	85,252	607,453	1,599,862	12,608,687
	2021	1,397,321	1,397,321	12,491,232	2021	310,148	310,148	2,432,377	2021	84,457	84,457	691,910	1,623,012	14,231,699
	2022	1,394,412	1,394,412	13,885,644	2022	333,255	333,255	2,765,632	2022	91,947	91,947	783,857	1,635,721	15,867,420
Third baseline period	2023	1,391,562	1,391,562	15,277,207	2023	337,111	337,111	3,102,743	2023	98,797	98,797	882,654	1,629,876	17,497,296
	2024	1,388,653	1,388,653	16,665,860	2024	336,411	336,411	3,439,155	2024	99,940	99,940	982,594	1,625,125	19,122,420
	2025	1,385,745	1,385,745	18,051,605	2025	335,713	335,713	3,774,868	2025	99,733	99,733	1,082,327	1,621,725	20,744,145
	2026	1,382,954	1,382,954	19,434,559	2026	335,018	335,018	4,109,886	2026	99,526	99,526	1,181,853	1,618,446	22,362,592
	2027	1,380,045	1,380,045	20,814,605	2027	334,324	334,324	4,444,210	2027	99,320	99,320	1,281,173	1,615,050	23,977,641
	2028	1,377,196	1,377,196	22,191,800	2028	333,630	333,630	4,777,840	2028	99,114	99,114	1,380,287	1,611,712	25,589,353
	2029	1,374,346	1,374,346	23,566,146	2029	332,939	332,939	5,110,779	2029	98,908	98,908	1,479,195	1,608,377	27,197,730
	2030	1,371,437	1,371,437	24,937,583	2030	332,248	332,248	5,443,027	2030	98,703	98,703	1,577,899	1,604,982	28,802,712
	2031	1,368,706	1,368,706	26,306,289	2031	331,561	331,561	5,774,589	2031	98,499	98,499	1,676,397	1,601,769	30,404,481
	2032	1,365,797	1,365,797	27,672,087	2032	330,875	330,875	6,105,463	2032	98,295	98,295	1,774,692	1,598,377	32,002,857

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		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area		Total net carbon stock change in the project area	
	ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$	ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$	ID_{lz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$	$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Second baseline period	2013	80,798	80,798	80,798	2013	16,183	16,183	16,183	2013	4,403	4,403	4,403	92,579	92,579
	2014	72,012	72,012	152,811	2014	16,995	16,995	33,178	2014	4,798	4,798	9,200	84,210	176,788
	2015	75,277	75,277	228,088	2015	18,262	18,262	51,440	2015	5,038	5,038	14,239	88,501	265,289
	2016	62,929	62,929	291,017	2016	18,893	18,893	70,333	2016	5,414	5,414	19,653	76,408	341,697
	2017	65,185	65,185	356,202	2017	16,733	16,733	87,066	2017	5,601	5,601	25,254	76,317	418,014
	2018	83,470	83,470	439,672	2018	17,692	17,692	104,758	2018	4,961	4,961	30,214	96,201	514,215
	2019	66,491	66,491	506,163	2019	17,415	17,415	122,173	2019	5,245	5,245	35,459	78,662	592,877
	2020	53,312	53,312	559,475	2020	14,057	14,057	136,230	2020	5,163	5,163	40,622	62,206	655,083
	2021	47,375	47,375	606,849	2021	15,029	15,029	151,259	2021	4,167	4,167	44,790	58,236	713,319
	2022	63,285	63,285	670,135	2022	16,083	16,083	167,342	2022	4,455	4,455	49,245	74,913	788,232
Third baseline period	2023	43,872	43,872	714,007	2023	15,197	15,197	182,539	2023	4,768	4,768	54,013	54,301	842,533
	2024	48,325	48,325	762,332	2024	14,629	14,629	197,168	2024	4,505	4,505	58,518	58,448	900,981
	2025	54,796	54,796	817,127	2025	14,137	14,137	211,305	2025	4,337	4,337	62,855	64,596	965,577
	2026	45,831	45,831	862,959	2026	13,727	13,727	225,031	2026	4,191	4,191	67,046	55,367	1,020,944
	2027	48,325	48,325	911,283	2027	13,322	13,322	238,353	2027	4,069	4,069	71,116	57,577	1,078,521
	2028	36,451	36,451	947,735	2028	12,194	12,194	250,547	2028	3,949	3,949	75,065	44,695	1,123,216
	2029	45,297	45,297	993,032	2029	11,685	11,685	262,232	2029	3,615	3,615	78,680	53,367	1,176,583
	2030	40,073	40,073	1,033,105	2030	11,367	11,367	273,599	2030	3,464	3,464	82,144	47,976	1,224,559
	2031	46,603	46,603	1,079,708	2031	11,349	11,349	284,947	2031	3,370	3,370	85,514	54,582	1,279,141
	2032	43,457	43,457	1,123,164	2032	10,873	10,873	295,820	2032	3,364	3,364	88,878	50,965	1,330,106

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		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		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt		Total net carbon stock change in the leakage belt	
	ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$	ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$	ID_{iz}	1	$\Delta CBSLLK_{z,t}$	$\Delta CBSLLK_{z}$	$\Delta CBSLLK_{t}$	$\Delta CBSLLK$
	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Riparian (Aluvial) Dense Tropical Rainforest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Second baseline period	2013	121,049	121,049	121,049	2013	25,625	25,625	25,625	2013	7,538	7,538	7,538	139,137	139,137
	2014	119,387	119,387	240,436	2014	26,410	26,410	52,035	2014	7,597	7,597	15,135	138,200	277,337
	2015	122,355	122,355	362,792	2015	28,278	28,278	80,314	2015	7,830	7,830	22,964	142,804	420,141
	2016	122,474	122,474	485,266	2016	30,720	30,720	111,034	2016	8,383	8,383	31,348	144,811	564,952
	2017	130,964	130,964	616,229	2017	27,436	27,436	138,470	2017	9,107	9,107	40,455	149,292	714,244
	2018	110,719	110,719	726,949	2018	28,612	28,612	167,082	2018	8,134	8,134	48,589	131,197	845,442
	2019	130,192	130,192	857,141	2019	26,876	26,876	193,958	2019	8,482	8,482	57,071	148,586	994,028
	2020	106,029	106,029	963,170	2020	26,154	26,154	220,111	2020	7,968	7,968	65,039	124,216	1,118,243
	2021	136,425	136,425	1,099,596	2021	27,738	27,738	247,850	2021	7,754	7,754	72,792	156,410	1,274,653
	2022	135,832	135,832	1,235,427	2022	29,650	29,650	277,500	2022	8,223	8,223	81,015	157,259	1,431,912
Third baseline period	2023	150,436	150,436	1,385,863	2023	30,356	30,356	307,855	2023	8,790	8,790	89,806	172,001	1,603,913
	2024	135,950	135,950	1,521,814	2024	30,753	30,753	338,608	2024	8,999	8,999	98,805	157,704	1,761,617
	2025	149,249	149,249	1,671,062	2025	31,398	31,398	370,007	2025	9,117	9,117	107,922	171,530	1,933,147
	2026	151,623	151,623	1,822,686	2026	32,098	32,098	402,105	2026	9,308	9,308	117,230	174,413	2,107,560
	2027	151,683	151,683	1,974,368	2027	32,595	32,595	434,700	2027	9,516	9,516	126,746	174,762	2,282,323
	2028	140,284	140,284	2,114,653	2028	33,305	33,305	468,005	2028	9,663	9,663	136,409	163,926	2,446,248
	2029	147,111	147,111	2,261,764	2029	33,711	33,711	501,716	2029	9,874	9,874	146,283	170,949	2,617,197
	2030	149,961	149,961	2,411,725	2030	34,765	34,765	536,482	2030	9,994	9,994	156,277	174,732	2,791,930
	2031	159,044	159,044	2,570,769	2031	35,308	35,308	571,790	2031	10,307	10,307	166,584	184,046	2,975,975
	2032	171,571	171,571	2,742,340	2032	36,166	36,166	607,956	2032	10,467	10,467	177,051	197,269	3,173,244

Table 60. Baseline carbon stock change in the leakage belt

Baseline non-CO_2 emissions from forest fires

As described in baseline scenario, slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. It is worth mentioning that the effect of fire on CO_2 emissions is counted in the estimation of carbon stock changes; therefore, CO_2 emissions from biomass burning were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest fires ($EBBBSLPA_t$) were quantified and included as baseline emissions, as follows.

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

Where,

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

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

Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
NCR	Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
ER_{N2O}	Emission ratio for N_2O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N_2O (IPCC default value = 310 for the first commitment period)[169]

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

Where,

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

[169] According to the VCS Standard 4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for N_2O = 298). However, the default value from the applied methodology was used (GWP for N_2O = 310) because it resulted in lower values of $EBBtot_{icl,t}$ (33.29 tCO_2e/ha instead of 38.93 tCO_2e/ha) and consequently, more conservative values of GHG emission reductions.

ER_{CH4}	Emission ratio for CH_4 (IPCC default value = 0.012)
GWP_{CH4}	Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period) [170]

$$EBBCO2_{icl,t} = Fburnt_{icl} * \sum_{p=1}^{P} (C_{picl,t} * Pburnt_{p,icl} * CE_{p,icl})$$

Where,

$EBBCO2_{icl,t}$	Per hectare CO_2 emission from biomass burning in the forest class icl at year t; tCO_2e/ha
$Fburnt_{icl}$	Proportion of forest area burned during the historical reference period in the forest class icl; %
$C_{picl,t}$	Average carbon stock per hectare in the carbon pool p burnt in the forest class icl at year t; tCO_2e/ha
$Pburnt_{p,icl}$	Average proportion of mass burnt in the carbon pool p in the forest class icl; %
$CE_{p,icl}$	Average combustion efficiency of the carbon pool p in the forest class icl; dimensionless (IPCC default of 0.5)
p	Carbon pool that could burn, above-ground biomass

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

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

Where,

$EBBBSLPA_t$	Total actual non-CO_2 emissions from forest fire at year t in the project area in the baseline scenario; tCO_2e/ha
$ABSLPA_{icl,t}$	Annual area of deforestation of initial forest classes icl in the project area at year t; ha
$EBBtot_{icl,t}$	Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha

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

[170] According to the VCS Standard v4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for CH_4 = 25). However, the default value from the applied methodology was used (GWP for CH_4 = 21) because it resulted in lower values of $EBBtot_{icl,t}$ (33.29 tCO_2e/ha instead of 38.93 tCO_2e/ha) and consequently, more conservative values of GHG emission reductions.

Initial Forest Class		Parameters								
IDcl	Name	$Fburnt_{icl}$	Cab	$Pburnt_{ab,icl}$	$CE_{ab,icl}$	ECO2-ab	EBBCO2-tot	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
		%	tCO2e/ha	%	%	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
1	Riparian (Aluvial) Dense Tropical Rainforest	100%	659.63	100%	100%	329.82	329.82	3.07	30.22	33.29

Table 61. Parameters used to calculate non-CO_2 emissions from forest fires

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

	Project year *t*	Emissions of non-CO_2 gasses from baseline forest fires		Total baseline non-CO_2 emissions from forest fires in the project area	
		ID_{cl} = 1 Riparian (Aluvial) Dense Tropical Rainforest		annual	cumulative
		$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	EBBBSLPA
		ha	tCO_2e/ha	tCO_2e	tCO_2e
Second baseline period	2013	122.49	33.29	4,077.75	4,077.75
	2014	109.17	33.29	3,634.32	7,712.08
	2015	114.12	33.29	3,799.11	11,511.19
	2016	95.40	33.29	3,175.91	14,687.10
	2017	98.82	33.29	3,289.77	17,976.87
	2018	126.54	33.29	4,212.58	22,189.45
	2019	100.80	33.29	3,355.68	25,545.13
	2020	80.82	33.29	2,690.54	28,235.67
	2021	71.82	33.29	2,390.92	30,626.59
	2022	95.94	33.29	3,193.89	33,820.48
Third baseline period	2023	66.51	33.29	2,214.15	36,034.63
	2024	73.26	33.29	2,438.86	38,473.49
	2025	83.07	33.29	2,765.44	41,238.93
	2026	69.48	33.29	2,313.02	43,551.96
	2027	73.26	33.29	2,438.86	45,990.82
	2028	55.26	33.29	1,839.63	47,830.45
	2029	68.67	33.29	2,286.06	50,116.51
	2030	60.75	33.29	2,022.40	52,138.91
	2031	70.65	33.29	2,351.97	54,490.88
	2032	65.88	33.29	2,193.18	56,684.06

Table 62. Baseline non-CO_2 emissions from forest fires in the project area

4.2 Project Emissions

The present REDD project does not include planned deforestation and planned logging activities within the project area. Nevertheless, some unplanned deforestation may happen in the project area despite the implemented REDD project activity. The level at which deforestation will actually be reduced in the project case depends on the effectiveness of the proposed activities, which cannot be measured *ex ante*. *Ex post* measurements of the project results will be important to determine actual emission reductions.

To allow *ex ante* projections to be made, a conservative assumption was made about the effectiveness of the proposed project activities in order to define the Effectiveness Index (EI). The estimated value of EI is used to multiply the baseline projections by the factor (1 - EI) and the result was considered to be the *ex ante* estimated emissions from unplanned deforestation in the project case. This is calculated as follows:

$$\Delta CUDdPA_t = \Delta CBSLPA_t * (1 - EI)$$

Where,

$\Delta CUDdPA_t$	Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e
$\Delta CBSLPA_t$	Total baseline carbon stock change in the project area at year t; tCO_2e
EI	*Ex ante* estimated Effectiveness Index; %
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless

The calculation of the effectiveness index was based on the comparison of deforestation activity between the baseline scenario and project scenario during the first baseline period (2003-2012). The first monitoring period was developed for the entire first baseline period, which was verified by an accredited VVB.

During the first monitoring period (2003-2012), the following values were obtained for deforestation within the project area:

- Baseline scenario (projected deforestation): 4,929.03 ha
- Project scenario (real deforestation): 1,579.58 ha
- Avoided deforestation: 3,349.44 ha

The Effectiveness Index (EI) was calculated as the effectiveness of the project in countering deforestation during the first monitoring period:

EI = 3,349.44 / 4,929.03 = 67.95%

The EI value was defined as 67.95% for the 2nd and 3rd baseline periods. It was then applied to the *ex-ante* estimate of net carbon stock change in the project area under the project scenario, shown in the table below.

Furthermore, the *ex ante* estimated actual carbon stock changes in the project area was calculated according to the formula below.

$$\Delta CPSPA_t = \Delta CPAdPA_t + \Delta CUDdPA_t - \Delta CPAiPA_t$$

Where,

$\Delta CPSPA_t$ Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO_2e

$\Delta CPAdPA_t$ Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_2e

$\Delta CUDdPA_t$ Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e

$\Delta CPAiPA_t$ Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

	Project year	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	
		ΔCPAdPAt annual tCO_2e	ΔCPAdPA cumulative tCO_2e	ΔCPAiPAt annual tCO_2e	ΔCPAiPA cumulative tCO_2e	ΔCUDdPAt annual tCO_2e	ΔCUDdPA cumulative tCO_2e	ΔCPSPAt annual tCO_2e	ΔCPSPA cumulative tCO_2e
Second baseline period	2013	0	0	0	0	29,671.50	29,671.50	29,671.50	29,671.50
	2014	0	0	0	0	26,989.20	56,660.70	26,989.20	56,660.70
	2015	0	0	0	0	28,364.48	85,025.18	28,364.48	85,025.18
	2016	0	0	0	0	24,488.79	109,513.97	24,488.79	109,513.97
	2017	0	0	0	0	24,459.56	133,973.53	24,459.56	133,973.53
	2018	0	0	0	0	30,832.48	164,806.01	30,832.48	164,806.01
	2019	0	0	0	0	25,211.02	190,017.03	25,211.02	190,017.03
	2020	0	0	0	0	19,936.94	209,953.96	19,936.94	209,953.96
	2021	0	0	0	0	18,664.75	228,618.71	18,664.75	228,618.71
	2022	0	0	0	0	24,009.61	252,628.32	24,009.61	252,628.32
Third baseline period	2023	0	0	0	0	17,403.52	270,031.84	17,403.52	270,031.84
	2024	0	0	0	0	18,732.56	288,764.40	18,732.56	288,764.40
	2025	0	0	0	0	20,702.99	309,467.39	20,702.99	309,467.39
	2026	0	0	0	0	17,745.08	327,212.47	17,745.08	327,212.47
	2027	0	0	0	0	18,453.52	345,665.99	18,453.52	345,665.99
	2028	0	0	0	0	14,324.88	359,990.87	14,324.88	359,990.87
	2029	0	0	0	0	17,104.11	377,094.99	17,104.11	377,094.99
	2030	0	0	0	0	15,376.22	392,471.21	15,376.22	392,471.21
	2031	0	0	0	0	17,493.46	409,964.67	17,493.46	409,964.67
	2032	0	0	0	0	16,334.26	426,298.94	16,334.26	426,298.94

Table 63. *Ex ante* estimated net carbon stock change in the project area under the project scenario

As forest fires were included in the baseline scenario, non-CO_2 emissions from biomass burning should also be included in the project scenario. This is done by multiplying the baseline emissions by the factor (1 – EI), as follows.

$$EBBPSPA_t = EBBBSPA_t * (1 - EI)$$

Where,

$EBBPSPA_t$ Total *ex ante* actual non-CO_2 emissions from forest fire due to unavoided unplanned deforestationat at year t in the project area; tCO_2e/ha

$EBBBSPA_t$ Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e

EI *Ex ante* estimated Effectiveness Index; %

t 1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

Furthermore, it is conservatively assumed that all unplanned deforestation within the project area will involve fire and all above ground biomass will be burnt. It is worth mentioning that the effect of fire on CO_2 emissions is counted in the estimation of carbon stock changes in the parameter $\Delta CUDdPA_t$; therefore, CO_2 emissions from forest fires should be ignored to avoid double counting.

	Project year *t*	Total *ex ante* estimated actual non-CO_2 emissions from forest fires in the Project area	
		$EBBPSPA_t$ annual tCO_2e	EBBPSPA cumulative tCO_2e
Second baseline period	2013	1,306.92	1,306.92
	2014	1,164.80	2,471.72
	2015	1,217.62	3,689.34
	2016	1,017.88	4,707.22
	2017	1,054.37	5,761.59
	2018	1,350.13	7,111.72
	2019	1,075.50	8,187.21
	2020	862.32	9,049.53
	2021	766.29	9,815.82
	2022	1,023.64	10,839.46
Third baseline period	2023	709.64	11,549.10
	2024	781.66	12,330.75
	2025	886.32	13,217.08
	2026	741.32	13,958.40
	2027	781.66	14,740.06
	2028	589.60	15,329.66
	2029	732.68	16,062.34
	2030	648.18	16,710.52
	2031	753.81	17,464.33
	2032	702.91	18,167.24

Table 64. Total *ex ante* estimated actual emissions of non-CO_2 gases due to forest fires in the project area

<u>Total *ex ante* estimations for the project area</u>

The expected *ex ante* net carbon stock changes and non-CO_2 emissions in the Project area is summarized in the table below.

	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	cumulat.	annual	cumul.	annual	cumulat	annual	cumulat.	annual	cumul.
		$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
		tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
Second baseline period	2013	0	0	0	0	29,671	29,671	29,671	29,671	1,307	1,307
	2014	0	0	0	0	26,989	56,661	26,989	56,661	1,165	2,472
	2015	0	0	0	0	28,364	85,025	28,364	85,025	1,218	3,689
	2016	0	0	0	0	24,489	109,514	24,489	109,514	1,018	4,707
	2017	0	0	0	0	24,460	133,974	24,460	133,974	1,054	5,762
	2018	0	0	0	0	30,832	164,806	30,832	164,806	1,350	7,112
	2019	0	0	0	0	25,211	190,017	25,211	190,017	1,075	8,187
	2020	0	0	0	0	19,937	209,954	19,937	209,954	862	9,050
	2021	0	0	0	0	18,665	228,619	18,665	228,619	766	9,816
	2022	0	0	0	0	24,010	252,628	24,010	252,628	1,024	10,839
Third baseline period	2023	0	0	0	0	17,404	270,032	17,404	270,032	710	11,549
	2024	0	0	0	0	18,733	288,764	18,733	288,764	782	12,331
	2025	0	0	0	0	20,703	309,467	20,703	309,467	886	13,217
	2026	0	0	0	0	17,745	327,212	17,745	327,212	741	13,958
	2027	0	0	0	0	18,454	345,666	18,454	345,666	782	14,740
	2028	0	0	0	0	14,325	359,991	14,325	359,991	590	15,330
	2029	0	0	0	0	17,104	377,095	17,104	377,095	733	16,062
	2030	0	0	0	0	15,376	392,471	15,376	392,471	648	16,711
	2031	0	0	0	0	17,493	409,965	17,493	409,965	754	17,464
	2032	0	0	0	0	16,334	426,299	16,334	426,299	703	18,167

Table 65. Total *ex ante* estimated actual net carbon stock changes and emissions of non-CO_2 gases in the project area

4.3 Leakage

This step provides an *ex ante* estimate of the possible decrease in carbon stock and increase in GHG emissions (other than carbon stock change) due to leakage. According to the applied methodology, two sources of leakage are considered: a) decrease in carbon stocks and increase in GHG emissions associated with leakage prevention measures; and b) decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage.

***Ex ante* estimation of decrease in carbon stocks and increase in GHG emissions due to leakage prevention measures**

To reduce the risk of activity displacement leakage, baseline deforestation agents could participate in activities within the project area and leakage management area that together will replace baseline income, product generation and livelihood of the agents as much as possible, so that deforestation will be reduced and the risk of displacement minimized. As such, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. If this decrease in carbon stock or increase in GHG emission is significant, it must be accounted, and *ex post* monitoring will be required.

Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. In order to calculate the net carbon stock changes that the planned leakage prevention measures are expected to occasion during the project crediting period, the projected carbon stocks shall be estimated in the leakage management area under the baseline case and project scenario.

The following activities in leakage management areas could occasion a decrease in carbon stocks or an increase in GHG emissions:

- Carbon stock changes due to activities implemented in leakage management areas;
- Methane (CH_4) and nitrous oxide (N_2O) emissions from livestock intensification (involving a change in the animal diet and/or animal numbers).

$$\Delta CLPMLK_t = \Delta CBSLLK_t - \Delta CPSLK_t$$

Where,

$\Delta CLPMLK_t$	Carbon stock decrease due to leakage prevention measures at year t; tCO_2e
$\Delta CBSLLK_t$	Annual carbon stock changes in leakage management areas in the baseline case at year t; tCO_2e
$\Delta CPSLK_t$	Annual carbon stock change in leakage management areas in the project case; tCO_2e

If the net sum of carbon stock changes within a monitoring period is more than zero, leakage prevention measures are not causing any carbon stock decrease. The net increase shall conservatively be ignored in the calculation of net GHG emission reductions of the project activity. Nevertheless, if the net sum is negative, it must be accounted if significant.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

$EgLK_t$	Emissions from grazing animals in leakage management areas at year t; tCO_2e/year
ECH_4ferm_t	CH_4 emissions from enteric fermentation in leakage management areas at year t; tCO_2e/year
ECH_4man_t	CH_4 emissions from manure management in leakage management areas year t; tCO_2e/year
EN_2Oman_t	N_2O emissions from manure management in leakage management areas at year t; tCO_2e/year
t	1, 2, 3, … T years of the project crediting period; dimensionless

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

$ELPMLK_t$	Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_2e

According to the planned interventions proposed by Ecomapuá Amazon REDD Project, no decrease in carbon stocks and/or increase in GHG emissions due to activities implemented in the leakage management area were identified. The leakage prevention measures proposed by the present project do not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. However, if such activities are implemented in the future, changes in carbon stock will be monitored, and if significant, will be accounted.

Therefore, the total *ex ante* estimated carbon stock changes and increases in GHG emissions due to leakage prevention measures are shown in the table below.

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
2013	0	0	0	0	0	0
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

Table 66. *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 baseline rate of deforestation within the leakage belt is shown in the variable ABSLLK. The *ex ante* activity displacement leakage is calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This is done by multiplying the estimated baseline carbon stock changes for the project area by a “Displacement Leakage Factor” (DLF) representing the percent of deforestation expected to be displaced outside the project boundary. It is calculated as follows:

$$\Delta CADLK_t = \Delta CBSLPA_t * DLF$$

Where,

$\Delta CADLK_t$	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
DLF	Displacement leakage factor; %

The activity likely to be involved in leakage was timber extraction, as the other activities – palm heart and subsistence agriculture deforestation – are unlikely to travel significant distances[171,172].

Similarly to calculation of the effectiveness index above, the calculation of the displacement leakage factor was based on the comparison of deforestation activity within the leakage belt between the baseline scenario and project scenario during the first baseline period (2003-2012). The first monitoring period was developed for the entire first baseline period, which was verified by an accredited VVB.

During the first monitoring period (2003-2012), the following values were obtained for deforestation within the leakage belt:

- Baseline scenario (projected deforestation): 24,332.75 ha
- Project scenario (real deforestation): 2,254.84 ha

Deforestation above the baseline scenario in the leakage belt may be considered activity displacement leakage. Thus, leakage emissions due to activity displacement were calculated as the difference between the *ex ante* and the *ex post* assessment during the first monitoring period.

As the result was >0, DFL = 0%. Therefore, it is assumed that no activity displacement leakage occurred during the first baseline period.

However, to reduce the risk of activity displacement leakage, baseline deforestation agents may participate in activities within the project area and leakage management area, so that deforestation will be reduced, and the risk of displacement minimized. This is monitored by SOCIALCARBON report, which analyzes education and training programs, alternative income sources and the extent of social activities to local communities.

Furthermore, the *ex ante* emissions from forest fires due to activity displacement leakage was calculated by multiplying baseline forest fire emissions in the project area by the same DLF used to estimate the decrease in carbon stocks, as follows.

171 Interview: D. Meneses 23.11.12.

172 Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa: Diagnóstico Socio-Econômico. Convênio UFPA/FADESP/NOVA AMAFRUTAS, 2002."

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

$EADLKt_t$	Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_2e
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
DLF	Displacement leakage factor; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

The actual calculated values for *ex ante* estimated leakage due to activity displacement, annually and cumulatively, across the 2nd and 3rd baseline periods are shown in the table 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 ΔCADLK*t* tCO_2e	cumulative ΔCADLK tCO_2e	annual EADLK*t* tCO_2e	cumulative EADLK*t* tCO_2e
Second baseline period	2013	0	0	0	0
	2014	0	0	0	0
	2015	0	0	0	0
	2016	0	0	0	0
	2017	0	0	0	0
	2018	0	0	0	0
	2019	0	0	0	0
	2020	0	0	0	0
	2021	0	0	0	0
	2022	0	0	0	0
Third baseline period	2023	0	0	0	0
	2024	0	0	0	0
	2025	0	0	0	0
	2026	0	0	0	0
	2027	0	0	0	0
	2028	0	0	0	0
	2029	0	0	0	0
	2030	0	0	0	0
	2031	0	0	0	0
	2032	0	0	0	0

Table 67. *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:

$$\Delta CLK_t = \Delta CADLK_t + \Delta CLPMLK_t$$

Where,

ΔCLK_t	Total decrease in carbon stocks within the leakage belt at year t; tCO_2e
$\Delta CADLK_t$	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
$\Delta CLPMLK_t$	Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

To reduce the risk of activity displacement leakage, baseline deforestation agents shall participate in activities within the project area and leakage management area, so that deforestation will be reduced, and the risk of displacement minimized.

If leakage prevention activities include measures to enhance cropland and grazing land areas, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. The reduction in carbon stocks ($\Delta CLPMLK_t$) shall be calculated as explained above. However, leakage emissions due to leakage prevention measures implemented by the project activity shall be calculated as follows:

$$ELK_t = EgLK_t + EADLK_t$$

Where,

ELK_t	Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_2e
$EgLK_t$	Emissions from grazing animals in leakage management areas at year t; tCO_2e
$EADLK_t$	Total *ex ante* increase in GHG emissions due to displaced forest fires at year t; tCO_2e

No displaced forest fires nor increase in GHG emissions due to activities implemented in the leakage management area are expected to occur, such as emissions from grazing animals, fertilizer or fuel use.

The calculated values of ΔCLK_t and ELK_t in the present project are shown in the table 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 within the leakage belt		Total net increase in emissions due to leakage	
	annual EgLKt	cumulat. EgLK	annual EADLKt	cumulat. EADLK	annual $\Delta CADLK_t$	cumulat. $\Delta CADLK$	annual $\Delta CLPMLK_t$	cumulat. $\Delta CLPMLK$	annual $\Delta CLKt$	cumulative ΔCLK	annual ELK_t	cumulat. ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0	0	0

Table 68. *Ex ante* estimated total leakage

4.4 Net GHG Emission Reductions and Removals

The net anthropogenic GHG emission reduction of the proposed AUD project activity is calculated as follows:

$$\Delta REDD_t = (\Delta CBSLPA_t + EBBBSLPA_t) - (\Delta CPSPA_t + EBBPSPA_t) - (\Delta CLK_t + ELK_t)$$

Where:

$\Delta REDD_t$ — *Ex ante* estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; 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 each year is calculated as follows:

$$VCU_t = \Delta REDD_t - VBC_t$$

$$VBC_t = (\Delta CBSLPA_t - \Delta CPSPA_t) * RF_t$$

Where:

VCU_t — Number of Verified Carbon Units that can be traded at time t; t CO_2e

$\Delta REDD_t$ — *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; t CO_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 2nd baseline assessment was 10%.

The net GHG emission reductions and removals in the Ecomapuá Amazon REDD project are summarized in the table below.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	*Ex ante* buffer credits (tCO_2e)	Estimated net GHG emission reductions or removals[173] (tCO_2e)
2013	96,657	30,978	0	6,291	59,387
2014	87,844	28,154	0	5,722	53,967
2015	92,300	29,582	0	6,014	56,704
2016	79,584	25,507	0	5,192	48,885
2017	79,607	25,514	0	5,186	48,906
2018	100,414	32,183	0	6,537	61,694
2019	82,017	26,287	0	5,345	50,385
2020	64,896	20,799	0	4,227	39,870
2021	60,627	19,431	0	3,957	37,239
2022	78,107	25,033	0	5,090	47,983
2023	56,515	18,113	0	3,690	34,712
2024	60,887	19,514	0	3,972	37,401
2025	67,361	21,589	0	4,389	41,382
2026	57,680	18,486	0	3,762	35,431
2027	60,016	19,235	0	3,912	36,868
2028	46,535	14,914	0	3,037	28,583
2029	55,653	17,837	0	3,626	34,189
2030	49,998	16,024	0	3,260	30,713
2031	56,934	18,247	0	3,709	34,977
2032	53,158	17,037	0	3,463	32,657
Total	**1,386,790**	**444,466**	**0**	**90,381**	**851,933**

Table 69. Summary of net GHG Emission Reductions and Removals

The specific summary of GHG reductions and removals in the Ecomapuá Amazon REDD project is included in the table below, which includes estimates of GHG emissions reduction ($REDD_t$), calculations of buffer and leakage, and the calculation of tradable Verified Carbon Units (VCU_t).

173 Due to conservativeness, values in this column were rounded down.

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 within the leakage belt		*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	Cumulat.	annual	Cumul.	annual	cumulative	annual	Cumul.	annual	cumulative	annual	cumulative	annual	Cumulat
	ΔCBSLPAt	ΔCBSLPA	ΔEBBB SLPAt	ΔEBBBS LPA	ΔCPSLPAt	ΔCPSLPA	ΔEBBB SPAt	ΔEBBBS PA	ΔCLKt	ΔCLK	ELKt	ELK	ΔREDDt	ΔREDD	ΔVCUt	ΔVCU	ΔVBCt	ΔVBC
	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
2013	92,579	92,579	4,078	4,078	29,671	29,671	1,307	1,307	0	0	0	0	65,678	65,678	59,387	59,387	6,291	6,291
2014	84,210	176,788	3,634	7,712	26,989	56,661	1,165	2,472	0	0	0	0	59,690	125,368	53,967	113,354	5,722	12,013
2015	88,501	265,289	3,799	11,511	28,364	85,025	1,218	3,689	0	0	0	0	62,718	188,086	56,704	170,058	6,014	18,026
2016	76,408	341,697	3,176	14,687	24,489	109,514	1,018	4,707	0	0	0	0	54,077	242,163	48,885	218,943	5,192	23,218
2017	76,317	418,014	3,290	17,977	24,460	133,974	1,054	5,762	0	0	0	0	54,093	296,256	48,906	267,849	5,186	28,404
2018	96,201	514,215	4,213	22,189	30,832	164,806	1,350	7,112	0	0	0	0	68,231	364,487	61,694	329,543	6,537	34,941
2019	78,662	592,877	3,356	25,545	25,211	190,017	1,075	8,187	0	0	0	0	55,731	420,218	50,385	379,928	5,345	40,286
2020	62,206	655,083	2,691	28,236	19,937	209,954	862	9,050	0	0	0	0	44,097	464,315	39,870	419,798	4,227	44,513
2021	58,236	713,319	2,391	30,627	18,665	228,619	766	9,816	0	0	0	0	41,196	505,511	37,239	457,037	3,957	48,470
2022	74,913	788,232	3,194	33,820	24,010	252,628	1,024	10,839	0	0	0	0	53,074	558,585	47,983	505,020	5,090	53,560
2023	54,301	842,533	2,214	36,035	17,404	270,032	710	11,549	0	0	0	0	38,402	596,987	34,712	539,732	3,690	57,250
2024	58,448	900,981	2,439	38,473	18,733	288,764	782	12,331	0	0	0	0	41,373	638,359	37,401	577,133	3,972	61,222
2025	64,596	965,577	2,765	41,239	20,703	309,467	886	13,217	0	0	0	0	45,772	684,131	41,382	618,515	4,389	65,611
2026	55,367	1,020,944	2,313	43,552	17,745	327,212	741	13,958	0	0	0	0	39,193	723,325	35,431	653,946	3,762	69,373
2027	57,577	1,078,521	2,439	45,991	18,454	345,666	782	14,740	0	0	0	0	40,781	764,106	36,868	690,814	3,912	73,286
2028	44,695	1,123,216	1,840	47,830	14,325	359,991	590	15,330	0	0	0	0	31,621	795,726	28,583	719,397	3,037	76,323
2029	53,367	1,176,583	2,286	50,117	17,104	377,095	733	16,062	0	0	0	0	37,816	833,543	34,189	753,586	3,626	79,949
2030	47,976	1,224,559	2,022	52,139	15,376	392,471	648	16,711	0	0	0	0	33,974	867,516	30,713	784,299	3,260	83,209
2031	54,582	1,279,141	2,352	54,491	17,493	409,965	754	17,464	0	0	0	0	38,686	906,203	34,977	819,276	3,709	86,918
2032	50,965	1,330,106	2,193	56,684	16,334	426,299	703	18,167	0	0	0	0	36,121	942,324	32,657	851,933	3,463	90,381

Table 70. *Ex ante* estimated net anthropogenic GHG emission reductions ($REDD_t$) and verified carbon units (VCU_t)

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	CF
Data unit	tC/tdm
Description	Default value of carbon fraction in biomass.
Source of data	Values from the literature (e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.)
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default value was used to be more conservative.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an estimate of the carbon content of the vegetation biomass within the project reference region.
Comments	If new and more accurate carbon fraction data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	ab
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the above-ground biomass in Riparian dense tropical rainforest were taken from the following study: CUNHA, Denise de Andrade. **Dinâmica e produtividade em florestas de igapó e várzea na Amazônia Oriental.** 2018. 144 f. Tese (Doutorado) - Curso de Doutorado do Programa de Pós-

	graduação em Biodiversidade e Biotecnologia, Rede Bionorte, Museu Paraense EmÍlio Goeldi, Belém, 2018.
Value applied	359.80
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 were used as they were determined to accurately represent the values of the vegetation within the Project reference region.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an 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
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Value applied	86.35
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.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an 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	$Ctot_{fcl}$
Data unit	tCO_2e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in tCO_2e/ha
Source of data	Long-term average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region were taken from the following study: FEARNSIDE, Philip M. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996.
Value applied	46.93
Justification of choice of data or description of measurement methods and procedures applied	Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas.
Purpose of Data	This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	First monitoring report from Ecomapuá Amazon REDD Project covering the first baseline period (2003-2012).
Value applied	67.95%
Justification of choice of data or description of measurement methods and procedures applied	The calculation of the effectiveness index was based on the estimated deforestation activity during the first monitoring period in the baseline case compared to that in the project case within the project area.
Purpose of Data	This parameter is used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon

	stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation.
Comments	*Ex post* monitoring of the project area will be done to determine deforestation rate and the project emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	First monitoring report from Ecomapuá Amazon REDD Project covering the first baseline period (2003-2012).
Value applied	0%
Justification of choice of data or description of measurement methods and procedures applied	The DLF was calculated based on the estimated deforestation activity during the first monitoring period within the leakage belt, comparing the baseline case to the project case.
Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$\Delta CBSLLK_t$
Data unit	tCO_2e
Description	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data	Planned interventions proposed by the project proponent;

	Remote sensing and GIS.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.
Purpose of Data	This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented.
Comments	*Ex post* monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$EBBtot_{icl,t}$
Data unit	tCO_2e/ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Source of data	Calculated according to methodology VM0015 v1.1. GWP for CH_4 and N2O were extracted from the applied methodology VM0015 v1.1.
Value applied	33.29
Justification of choice of data or description of measurement methods and procedures applied	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the deforested area in which fire was used (Fburnt), and the average proportion of mass burnt in each carbon pool ($Pburnt_{,p}$) were estimated to be 100% either for the baseline and project case. These average percentage values are assumed to remain the same in the future, according to the applied methodology.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage non-CO_2 emissions from biomass burning occurred in the baseline and project scenarios

Comments	The only considered carbon pool in this parameter was the above ground biomass. According to the VCS Standard v4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100-year global warming potentials (GWP) derived from the IPCC's Fourth Assessment Report (GWP for CH_4 = 25 and for N_2O = 298). However, default values from the applied methodology were used (GWP for CH_4 = 21 and for N_2O = 310) because a lower value of $EBBtot_{icl,t}$ was achieved (33.29 tCO_2e/ha instead of 38.93 tCO_2e/ha), which consequently resulted in more conservative GHG emission reductions.

5.2 Data and Parameters Monitored

Data / Parameter	$ACPA_t$
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.
Source of data	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - INMET[174] - Periodic reports from area supervisor INPE[175]
Frequency of monitoring/recording	At each time a catastrophic event occurs.
Value applied	The value will be calculated *ex-post* each time a catastrophic event occurs, when significant.
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE

174 INMET. Instituto Nacional de Meteorologia. Availableat: <http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_conv_graf>.

175 INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://sigma.cptec.inpe.br/queimadas/index_old.php>.

	Periodic reports from area supervisor
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an *ex post* estimation of the area affected by catastrophic events within the project area
Calculation method	Remote sensing and GIS
Comments	Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$ABSLLK_t$
Data unit	Ha
Description	Annual area of deforestation within the leakage belt at year t.
Source of data	- Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	207.87 (Annual average projected deforestation in the leakage belt during the 2nd and 3rd baseline periods)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.

Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	$ABSLPA_t$
Data unit	Ha
Description	Annual area of deforestation in the project area at year t
Source of data	- Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation is monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	85.14 (Annual average projected deforestation in the project area during the 2nd and 3rd baseline periods)
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 ante* and *ex post* values of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Source of data	- Remote sensing and GIS.

Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is 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 are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	$\Delta CPAdPA_t$
Data unit	tCO_2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Source of data	- Documents, remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0

Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	$\Delta CPAiPA_t$
Data unit	tCO_2e
Description	Total increase in carbon stock due to all planned activities at year t in the project area
Source of data	- Documents, remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock increase will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the *ex post* value of the increase in carbon stocks due to planned activities in the project area, which could reduce the decrease in carbon stocks in the project area.
Calculation method	Depends on the planned activity.

Comments	N/A

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case
Source of data	- Activities report related to leakage prevention measures. - Field assessment. - Remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e

Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Source of data	Remote sensing and GIS. Supervisors reports.
Description of measurement methods and procedures to be applied	Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	21,314.95 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the 2^{nd} and 3^{rd} baseline periods)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project 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	N/A

Data / Parameter	$EBBBSLPA_t$
Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO_2 emissions from forest fire at year t in the project area
Source of data	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied	Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt.

Frequency of monitoring/recording	Annually
Value applied	2,834.20 (Annual average non-CO_2 emissions in the baseline scenario due to biomass burning within the project area during the 2nd and 3rd baseline periods)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an *ex ante* estimation.
Calculation method	Non-CO_2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area to subsistence agriculture. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario ($ABSLPA_{icl,t}$) times the total GHG emission from biomass burning in initial forest classes ($EBBtot_{icl,t}$).
Comments	*Ex post* monitoring of forest fires and non-CO_2 emissions ($EBBPSPA_t$) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) actual non-CO_2 emissions from forest fire at year t in the project area
Source of data	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, periodic reports from area supervisor, a community member who lives inside the project area, could also confirm the data obtained.

Frequency of monitoring/recording	Annually
Value applied	908.36 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the 2nd and 3rd baseline period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the project scenario, providing an *ex post* value.
Calculation method	Non-CO_2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. If forest fires occur due to the clearance of the area to subsistence agriculture, these non-CO_2 emissions will be subject to monitoring and accounting, considering that all above ground biomass will be burnt. Therefore, this parameter is calculated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the project scenario times the total GHG emission from biomass burning in initial forest classes ($EBBtot_{icl,t}$).
Comments	N/A

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	- Activities report related to leakage prevention measures. - Field assessment. - Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually

Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	There are no predicted activities in the leakage management area that will result in GHG emissions during the crediting period.

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex ante* and *ex post* increase in GHG emissions due to displaced forest fires at year t.
Source of data	Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	Forest fires in the leakage belt area may be considered activity displacement leakage. GHG emissions due displaced forest fires will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter is used to calculate leakage emissions in the baseline and project scenario. Provides the *ex ante* and *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt.

Calculation method	GHG emissions from biomass burning are estimated by multiplying the detected area of forest loss in the leakage belt times the total GHG emission from biomass burning in initial forest classes. This is done separately for the baseline and project scenarios.
Comments	Where strong evidence can be collected that forest fires in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation and biomass burning will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report - Ecomapuá Amazon REDD Project; - Remote sensing data and GIS; - Supervisor report; - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	10
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event.
Purpose of data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors

	described in the VCS Non-Permanence Risk Report will be assessed.
Comments	N/A

5.3 Monitoring Plan

This monitoring plan has been developed according to the VCS Methodology VM0015, v. 1.1.

Revision of the baseline

The current baseline is valid for 10 years, i.e. through December 2022. The baseline will be reassessed every 10 years, and it will be validated at the same time as the subsequent verification. If an applicable sub-national or national jurisdictional baseline becomes available, the baseline shall be used for the subsequent period.

Information on agents, drivers and underlying causes of deforestation in the reference region will be collected at the end of each fixed baseline period, as these are essential for improving future deforestation projections and the design of the project activity. In addition, in the same frequency, the projected annual areas of baseline deforestation for the reference region will be revisited and eventually adjusted for the subsequent fixed baseline period.

Furthermore, the location of the projected baseline deforestation will be reassessed using the adjusted projections for annual areas of baseline deforestation and spatial data. All areas credited for avoided deforestation in past fixed baseline periods will be excluded from the revisited baseline projections as these areas cannot be credited again.

Monitoring Deforestation and Project Emissions

Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

The project boundary, as set out in the PD, will serve as the initial "forest cover benchmark map" against which changes in forest cover will be assessed over the interval of the monitoring period.

The entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event.

The increase or decrease in carbon stocks due to planned activities in the project area will also be monitored through documents and periodic assessment of classified satellite imagery covering the project area. In case of planned deforestation, emissions are estimated by multiplying the area of forest loss by the average forest carbon stock per unit area.

The results of monitoring shall be reported by creating *ex post* tables of activity data per stratum; per initial forest class *icl*; and per post-deforestation zone *z*, for the reference region, project area and leakage belt.

In addition, a map showing Cumulative Areas Credited within the project area shall be updated and presented to VCS verifiers at each verification event. The cumulative area cannot generate additional VCUs in future periods.

Monitoring of non-CO_2 emissions from forest fires

Non-CO2 emissions from forest fires and biomass burning were included in the baseline scenario. Therefore, if forest fires and biomass burning occur during the project scenario, 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 due to leakage prevention measures, which will probably take place inside the leakage management area, will be monitored through documents and field assessment.

In areas undergoing carbon stock enhancement, the project conservatively assumes stable stocks and no biomass monitoring is conducted.

- Carbon stock decrease and increases in GHG emissions due to activity displacement leakage

Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. Furthermore, GHG emissions from displaced forest fires within the leakage belt will also be accounted, if significant.

Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Monitoring of Natural Disturbance and catastrophic events

The carbon stock losses within the project area will be estimated as soon as possible after the natural event, e.g. uncontrolled forest fires and other catastrophic events.

Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, flooding, drought, fires or storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring, when significant. If the area (or a sub-set of it) affected by natural disturbances or man-made events generated VCUs in past verifications, the total net change in carbon stocks and GHG emissions in the area(s) that generated VCUs will be estimated, and an equivalent amount of VCUs will be cancelled from the VCS buffer. No VCUs can be issued for the project until all carbon stock losses and increases in GHG emissions have been offset.

Updating Forest Carbon Stocks Estimates

If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period, according to the requirements established by the applied methodology VM0015. New data on carbon stocks will only be used if they are validated by an accredited VCS verifier. If new data are updated during a 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 Ecomapuá Conservação Ltda.'s parent company: Bio Assets, at its office in São Paulo, Brazil.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VCS verifiers at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

Monitored data will be kept for two years after the end of the crediting period or the last issuance of carbon credits for this project activity, whichever occurs later. For this purpose, the authority for the registration, monitoring, measurement and reporting will be *Mr. Lap Tak Chan*. Monitored parameters are described in Section 5.2 and will be monitored with the frequency described further below.

Quality Assurance/Quality Control

To ensure consistency and quality of results, spatial analysts carrying out the image processing, interpretation, and change detection procedures will strictly adhere to the steps detailed in the Methodology.

All of this reliable data, which will be collected and documented, will be used as a technical support tool for decision-making in order to improve project outcomes, and to adapt the project according to the current needs and realities. Project activities implemented within the project area must be consistent with the management 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)[176] and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

The management structure will also rely on the local community to help monitor the area. There are supervisors from within the project area communities, who deliver 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 Section 5.2 above, as requested in the VCS Methodology VM0015, version 1.1.

With the carbon credits income, in order to complement the monitoring of the project area and its surroundings, the project proponent intends to improve the remote sensing methods and data used, which meet the accuracy assessment requirements laid out in the methodology.

[176] Available at: http://www.obt.inpe.br/prodes/index.php.

Ecomapuá Conservação Ltda. will also implement the sustainability report following the SOCIALCARBON methodology, which was developed by *Instituto Ecológica* and focus on implementing environmental and social activities within the project area. This methodology follows the SOCIALCARBON Guidelines available at: http://www.socialcarbon.org/documents/.

In addition, the SOCIALCARBON Reports will be available on the VCS Registry once the project is registered.

Procedures for handling internal auditing and non-conformities

The procedures for handling internal auditing and non-conformities are going to be established by both project developer and project proponent. All the necessary taskforce and procedures will be in place to meet the highest levels of control.

A General Manager at Bio Assets Ltda. has the reduction of non-conformities risks as part of his responsibilities.

A project information quality management system was implemented, the main purpose of which is to minimize the risk of error, obtaining reliable data on which to base the monitoring results, and thus, minimizing non-conformities. It includes the Training of general staff in the different roles to play within the framework of the Ecomapuá Amazon REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and; Review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of the General Manager.

If non-conformities exist during the internal or external auditing processes, the data should be reviewed, and the non-conformities addressed.

Organizational structure, responsibilities and competencies

Monitoring will be done by the project proponent and outsourced to a third party having sufficient capacities to perform the monitoring tasks. To ensure the operation of the monitoring activities, the operational and managerial structure will be established according to the table below.

For all aspects of project monitoring, Ecomapua Conservação Ltda. 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. Lap Tak Chan*.

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Every 10 years
Monitoring Deforestation and Project Emissions	Ecomapuá Conservação Ltda. together with Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Ecomapuá Conservação Ltda. together with Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring Leakage emissions	Ecomapuá Conservação Ltda. together with Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of Natural Disturbance and catastrophic events	Ecomapuá Conservação Ltda.	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Ecomapuá Conservação Ltda.	At least, every 10 years, only if necessary.

Table 71. Type of Monitoring and Party Responsible for Monitoring

APPENDIX I – PROJECT AREA CONTOUR COORDINATES

Project Area Contour Coordinates																							
UTM 22S, Datum WGS84																							
#	X	Y	#	X	Y	#	X	Y	#	X	Y	#	X	Y	#	X	Y	#	X	Y	#	X	Y
1	566667	9884887	249	578345	9876903	497	584105	9873243	745	586569	9867183	993	594666	9863308	1241	589055	9865233	1489	554255	9882753	1737	578915	9877413
2	566842	9884680	250	578345	9876933	498	584105	9873183	746	586618	9867117	994	594365	9863361	1242	589085	9865233	1490	554315	9882753	1738	578885	9877413
3	567335	9884084	251	578405	9876933	499	584165	9873183	747	586625	9867113	995	594365	9863373	1243	589085	9865263	1491	554315	9882723	1739	578885	9877383
4	567335	9884073	252	578405	9876963	500	584165	9873153	748	586625	9867093	996	594335	9863373	1244	589145	9865263	1492	554375	9882723	1740	578825	9877383
5	567345	9884073	253	578465	9876963	501	584195	9873153	749	586655	9867093	997	594335	9863403	1245	589145	9865293	1493	554375	9882693	1741	578825	9877353
6	567365	9884048	254	578465	9876993	502	584195	9873123	750	586655	9867093	998	594305	9863403	1246	589097	9865293	1494	554465	9882693	1742	578795	9877353
7	567365	9884043	255	578495	9876993	503	584225	9873123	751	586655	9867033	999	594305	9863371	1247	589246	9865489	1495	554465	9882663	1743	578795	9877323
8	567369	9884043	256	578495	9877023	504	584225	9873093	752	586685	9867033	1000	594228	9863384	1248	589265	9865508	1496	554495	9882663	1744	578765	9877323
9	568557	9882608	257	578555	9877023	505	584255	9873093	753	586685	9867003	1001	593586	9863435	1249	589265	9865413	1497	554495	9882633	1745	578765	9877293
10	568819	9881740	258	578555	9877053	506	584255	9873063	754	586715	9867003	1002	593282	9863454	1250	589295	9865413	1498	554525	9882633	1746	578735	9877293
11	569597	9878457	259	578585	9877053	507	584285	9873063	755	586715	9866973	1003	593255	9863456	1251	589295	9865293	1499	554525	9882603	1747	578735	9877275
12	569105	9876858	260	578585	9877083	508	584285	9873033	756	586775	9866973	1004	593255	9863493	1252	589265	9865293	1500	554585	9882603	1748	578668	9877280
13	569105	9876933	261	578615	9877083	509	584405	9873033	757	586775	9866943	1005	593225	9863493	1253	589265	9865263	1501	554585	9882573	1749	578099	9877551
14	569045	9876933	262	578615	9877113	510	584405	9873003	758	586835	9866943	1006	593225	9863458	1254	589295	9865263	1502	554615	9882573	1750	577907	9877690
15	569045	9876903	263	578675	9877113	511	584435	9873003	759	586835	9866913	1007	593165	9863462	1255	589295	9865173	1503	554615	9882543	1751	577749	9877961
16	569015	9876903	264	578675	9877143	512	584435	9872973	760	586925	9866913	1008	593165	9863523	1256	589325	9865173	1504	554645	9882543	1752	577577	9878358
17	569015	9876873	265	578705	9877143	513	584495	9872973	761	586942	9866901	1009	593225	9863523	1257	589325	9865143	1505	554645	9882513	1753	577431	9878576
18	568985	9876873	266	578705	9877173	514	584495	9872943	762	587323	9866889	1010	593225	9863553	1258	589355	9865143	1506	554705	9882513	1754	577325	9878659
19	568985	9876813	267	578735	9877173	515	584525	9872943	763	587458	9867003	1011	593255	9863553	1259	589385	9865143	1507	554705	9882483	1755	577325	9878673
20	569091	9876813	268	578735	9877190	516	584525	9872913	764	587465	9867003	1012	593255	9863583	1260	589385	9865083	1508	554735	9882483	1756	577355	9878673
21	569045	9876662	269	578762	9877203	517	584585	9872913	765	587465	9866943	1013	593225	9863583	1261	589415	9865083	1509	554735	9882453	1757	577355	9878703
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208	577415	9876970	456	583295	9874503	704	586025	9868323	952	597185	9861633	1200	590645	9864333	1448	553685	9880503	1696	579395	9885633	1944	606215	9865713
209	577445	9876959	457	583325	9874503	705	586055	9868323	953	597125	9861633	1201	590555	9864333	1449	553671	9880503	1697	579395	9885543	1945	606155	9865713
210	577445	9876933	458	583325	9874473	706	586055	9868023	954	597125	9861603	1202	590555	9864363	1450	553642	9880516	1698	579485	9885543	1946	606155	9865773
211	577505	9876933	459	583385	9874473	707	586083	9868023	955	597095	9861603	1203	590495	9864363	1451	553475	9880591	1699	579485	9885603	1947	606117	9865773
212	577505	9876903	460	583385	9874443	708	586085	9868015	956	597095	9861573	1204	590495	9864393	1452	553475	9880593	1700	579455	9885603	1948	606450	9866680
213	577608	9876903	461	583505	9874443	709	586085	9867903	957	597035	9861573	1205	590282	9864393	1453	553472	9880593	1701	579455	9885633	1949	608000	9866280
214	577645	9876890	462	583505	9874413	710	586115	9867903	958	597035	9861543	1206	590264	9864424	1454	553446	9880605	1702	579425	9885633	1950	608037	9866343
215	577655	9876889	463	583565	9874413	711	586115	9867783	959	596945	9861543	1207	590196	9864601	1455	553445	9880604	1703	579425	9885663	1951	608045	9866343
216	577655	9876873	464	583565	9874383	712	586145	9867783	960	596945	9861513	1208	590147	9864734	1456	553445	9880623	1704	579395	9885663	1952	608045	9866313
217	577745	9876873	465	583625	9874383	713	586145	9867723	961	596855	9861513	1209	590143	9865000	1457	553385	9880623	1705	579395	9885693	1953	608105	9866313
218	577745	9876843	466	583625	9874353	714	586175	9867723	962	596855	9861483	1210	590192	9865210	1458	553385	9880653	1706	579425	9885693	1954	608105	9866283
219	577985	9876843	467	583655	9874353	715	586175	9867778	963	596735	9861483	1211	590417	9865352	1459	553325	9880653	1707	579425	9885723	1955	608165	9866283
220	577985	9876813	468	583655	9874323	716	586255	9867633	964	596735	9861453	1212	590608	9865378	1460	553325	9880623	1708	579451	9885723	1956	608165	9866253
221	578045	9876813	469	583685	9874323	717	586235	9867633	965	596675	9861453	1213	590811	9865505	1461	553295	9880623	1709	582991	9882568	1957	608195	9866253
222	578045	9876783	470	583685	9874263	718	586235	9867663	966	596675	9861483	1214	590815	9865523	1462	553295	9880593	1710	580920	9880312	1958	608195	9866223
223	578015	9876783	471	583715	9874263	719	586205	9867663	967	596585	9861483	1215	590869	9865549	1463	553235	9880593	1711	580203	9878523	1959	608255	9866223
224	578015	9876753	472	583715	9874233	720	586205	9867603	968	596585	9861513	1216	590926	9865775	1464	553235	9880563	1712	580175	9878523	1960	608255	9866253
225	577985	9876753	473	583745	9874233	721	586235	9867603	969	596495	9861513	1217	590926	9865924	1465	553085	9880563	1713	580175	9878493	1961	608225	9866253
226	577985	9876693	474	583745	9874143	722	586235	9867543	970	596495	9861543	1218	590849	9866098	1466	553085	9880533	1714	580145	9878493	1962	608225	9866343
227	577955	9876693	475	583775	9874143	723	586265	9867543	971	596405	9861543	1219	590696	9866197	1467	552862	9880533	1715	580145	9878463	1963	608195	9866343
228	577955	9876663	476	583775	9874053	724	586265	9867513	972	596405	9861573	1220	590691	9866204	1468	552836	9880535	1716	580175	9878463	1964	608195	9866373
229	577925	9876663	477	583805	9874053	725	586295	9867513	973	596255	9861573	1221	590678	9866209	1469	552652	9880617	1717	580175	9878453	1965	608255	9866373
230	577925	9876603	478	583805	9873933	726	586295	9867483	974	596255	9861603	1222	590502	9866328	1470	552544	9880776	1718	579926	9877833	1966	608255	9866463
231	577955	9876603	479	583835	9873933	727	586345	9867483	975	596045	9861603	1223	590309	9866428	1471	552485	9880780	1719	579875	9877833	1967	608195	9866463
232	577955	9876633	480	583835	9873843	728	586355	9867470	976	596045	9861573	1224	590245	9866443	1472	552485	9880786	1720	579875	9877773	1968	608195	9866523
233	577985	9876633	481	583865	9873843	729	586355	9867453	977	595925	9861573	1225	590234	9866458	1473	552518	9880782	1721	579902	9877773	1969	608144	9866523
234	577985	9876663	482	583865	9873693	730	586368	9867453	978	595925	9861543	1226	590135	9866503	1474	552614	9880840	1722	579842	9877623	1970	609071	9868087
235	578015	9876663	483	583895	9873693	731	586385	9867430	979	595775	9861543	1227	590135	9866553	1475	552766	9880922	1723	579808	9877603	1971	608745	9869278
236	578015	9876753	484	583895	9873603	732	586385	9867393	980	595775	9861513	1228	590105	9866553	1476	552950	9881049	1724	579639	9877518	1972	612780	9869272
237	578105	9876753	485	583925	9873603	733	586412	9867393	981	595595	9861513	1229	590105	9866523	1477	553147	9881201	1725	579438	9877539	1973	613775	9869168
238	578105	9876783	486	583925	9873513	734	586415	9867389	982	595595	9861543	1230	590093	9866523	1478	553236	9881379	1726	579425	9877541	1974	614161	9869272
239	578075	9876783	487	583955	9873513	735	586415	9867363	983	595412	9861543	1231	589903	9866610	1479	553344	9881602	1727	579425	9877563			
240	578075	9876813	488	583955	9873423	736	586435	9867363	984	595409	9861638	1232	589572	9866760	1480	553363	9882033	1728	579365	9877563			
241	578075	9876871	489	583985	9873423	737	586445	9867349	985	595383	9861829	1233	589626	9866907	1481	553490	9882275	1729	579365	9877548			
242	578085	9876873	490	583985	9873363	738	586445	9867333	986	595276	9862013	1234	589548	9866811	1482	553623	9882618	1730	579269	9877560			
243	578135	9876873	491	584015	9873363	739	586457	9867333	987	595129	9862235	1235	587448	9864633	1483	553712	9882700	1731	579259	9877503			
244	578135	9876843	492	584015	9873303	740	586475	9867309	988	595136	9862324	1236	587360	9863747	1484	553871	9882808	1732	579005	9877503			
245	578165	9876843	493	584045	9873303	741	586475	9867303	989	595123	9862559	1237	587777	9863551	1485	554125	9882813	1733	579005	9877473			
246	578165	9876873	494	584045	9873273	742	586480	9867303	990	595155	9862711	1238	588995	9865158	1486	554195	9882813	1734	578975	9877473			
247	578285	9876873	495	584075	9873273	743	586565	9867188	991	595174	9862991	1239	588995	9865143	1487	554195	9882783	1735	578975	9877443			
248	578285	9876903	496	584075	9873243	744	586565	9867183	992	594971	9863188	1240	589055	9865143	1488	554255	9882783	1736	578915	9877443			

Table 72. Project area contour coordinates

APPENDIX II – ARTICLES OF INCORPORATION OF ECOMAPUÁ CONSERVAÇÃO LTDA.

INSTRUMENTO PARTICULAR DE ALTERAÇÃO DE CONTRATO SOCIAL
SANTANA MADEIRAS LTDA.
CNPJ N° 05.086.970/0001-75

Pelo presente instrumento particular de alteração de contrato social, os abaixo assinados:

A. **CHAN LAP TAK**, chinês, casado, comerciante, portador da cédula de identidade de estrangeiro RNE n.° W-068507-4 SE/DPMAF/DPF e devidamente inscrito no CPF/M.F. sob o n.° 113.201.238-48, residente e domiciliado em São Paulo, Capital, na Rua Adalívia de Toledo, n.° 310 – apto. n.° 74, Bairro Morumbi, CEP 05683-000;

B. **2/90 COMUNICAÇÕES LTDA.** sociedade organizada e existente de acordo com as leis do Brasil, com sede na Rua Wellcome, n.° 320, sala 12, na Cidade de Cotia, Estado de São Paulo, inscrita no CNPJ/MF sob o n.° 03.557.460/0001-03 e com seus atos constitutivos devidamente arquivados na Junta Comercial do Estado de São Paulo sob o n.° NIRE 35216047730 em 30/11/1999, neste ato representada por seus sócios gerentes, Sr. Chan Lap Tak, acima qualificado e Sra. BIANCA YUMI TOMITA, casada, administradora de empresas, portadora da cédula de identidade RG n.° 9.705.213 SSP/SP e devidamente inscrita no CPF/M.F. sob o n.° 256.659.078-80, residente e domiciliado em São Paulo, Capital, na Rua Adalívia de Toledo, n.° 310 – apto. n.° 74, Bairro Morumbi, CEP 05683-000;

Únicos sócios quotistas da sociedade por quotas de responsabilidade limitada denominada ***SANTANA MADEIRAS LTDA.***, com sede social na Cidade de Belém, Estado do Pará, na Avenida Gentil Bittencourt, n.° 1.390, Loja B 4, Bairro Nazaré, CEP 66040-000, inscrita no C.N.P.J. sob o n.° 05.086.970/0001-75 e com seus atos constitutivos devidamente arquivados na Junta Comercial do Estado do Pará, sob NIRE 152.0052545.2, em sessão de 08/07/1993 e último documento arquivado sob o número 20000015089 em 18 de Outubro de 2000, resolvem de comum acordo alterar seu contrato social como segue:

ARTIGO 1° -

A sociedade girará sob a denominação social de: **"ECOMAPUÁ CONSERVAÇÃO LTDA."** com sede à Avenida Gentil Bittencourt, n.° 1.390, Loja B-4, Bairro Nazaré, CEP 66040-000, na Cidade de Belém, Estado do Pará.
Parágrafo Único – A sociedade poderá, a critério dos sócios, abrir e extinguir filiais, depósitos e escritórios de vendas, bem como transferir sua sede social, em qualquer parte do território nacional.

ARTIGO 2° -
A sociedade terá por objetivos:

I. Preservação de florestas;
II. Florestamento e reflorestamento;
III. Pesquisas e desenvolvimento de produtos primitivos das florestas de sistemas agroflorestais (SAFs);
IV. Engenharia florestal e de eco-sistemas;
V. Elaboração de projetos de desenvolvimento sustentável, mecanismos para desenvolvimento limpo, seqüestro de carbono.
VI. Projetos e estudos de viabilidade econômica-financeira a ser criada e executada que envolvam:
   i) extração de produtos florestais;
   ii) extração, comercialização, troca de mercadorias, industrialização, importação e exportação de produtos e subprodutos da floresta, tais como: madeiras em geral em bruto ou beneficiadas, frutas, polpas de frutas e demais produtos alimentícios e bebidas, resinas, óleos, produtos para higiene pessoal e éticos, móveis e utensílios para casa;
   iii) serviços de turismo e eco-turismo, inclusive alojamento para viajantes;
   iv) realização de trabalhos comunitários ligados a educação, higiene, saúde e outros serviços sociais;
   v) geração de energia com biomassa;

- 1 -

Figure 51. Amended articles of incorporation from Santana Madeiras Ltda. to Ecomapuá Conservação Ltda.

REGISTRO DE IMÓVEIS
COMARCA DE BREVES

MATRÍCULA N.º 3.577 | FOLHA N.º 61

LIVRO 2-O — REGISTRO GERAL

IMÓVEL: Sorte de Terras denominada **"BOM JESUS"**, situada na margem direita do Rio Mapuá, Município de Breves-PA., com uma área de 14.417ha.(QUATORZE MIL, QUATROCENTOS E DEZESSETE HECTARES), limitando-se pelo lado direito com terras dos herdeiros de Raimundo Nonato Farias, pelo lado esquerdo com terras que são ou foram de Joaquim das Merces Paranhos e pelos fundos com terras devolutas.-

PROPRIETÁRIO: SANTANA MADEIRAS LTDA., com sede em Belém, Capital deste Estado, à Rua 15 de Novembro nº 226, inscrita no C.G.C (MF) sob o Nº 05.086.970/0001-75, conforme transformação da SANTANA MADEIRAS S/A., de acordo com o Instrumento Particular de Contrato Social, regido pela Lei 3.708, de 10/01/19 e, pelas cláusulas e condições constantes do referido Instrumento, devidamente arquivado na JUCEPA, sob o nº 152.00525452.93.-

TÍTULO AQUISITIVO: Transcrição nº 4.303, Livro 3-AE, às fls. 151/156.-

FORMA DO TÍTULO: Escritura Pública de Cessão de Direitos, Assunção de Dívidas e de Venda e Compra, outorgada por Superfine Madeiras S.A., em 11 de outubro de 1.975, tomada pela Tabeliã Zilda Ferreira Lins, 2º Ofício desta Comarca, Livro 26, fls. 123/136.-

VALOR: Cr$=7.108.130,00 (SETE MILHÕES, CENTO E OITO MIL E CENTO E TRINTA CRUZEIROS), pagos pela totalidade dos imóveis que envolvem 22 (VINTE E DUAS) glebas.-

CONDIÇÕES: Não havendo condições especiais.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-1-M-3.577 - DATA: 03 DE DEZ. 1997 - RESERVA LEGAL -

Procede-se esta Averbação para fazer constar o expresso compromisso de SANTANA MADEIRAS LTDA., já individualizada de fazer a RESERVA LEGAL de mais 30% (TRINTA POR CENTO), além dos 50% (CINQÜENTA POR CENTO), já compromissados pela Averbação constante à margem da transcrição nº 4.303, do Livro 3-AE, fls. 151/156, em 30.06.92, totalizando 80% (OITENTA POR CENTO) da vegetação nativa existente no imóvel objeto da presente matrícula, onde não será permitido o corte raso, sendo vedada a alteração de sua destinação nos casos de transmissão de qualquer título, ou desmembramento, de acordo com o que estatui o art. 44 da Lei nº 4.771/65 e seu § único acrescido pelo inciso V do art. 1º da Lei nº 7.803, de 18 de julho de 1.989.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-2-M-3.577-DATA: 06-MAR-2.006 -MUDANÇA DE DENOMINAÇÃO-

Procede-se esta averbação nos termos do Instrumento Particular de Alteração de Contrato Social, datado de 19 de julho de 2.001, enviado por **SANTANA MADEIRAS LTDA.**, devidamente arquivado na **JUCEPA** sob o nº 20000029041, em 03.08.2.001, assinado pelo Secretário Geral, Dr. Dilermando Guedes Cabral, para fazer constar a mudança de seu

Vide-Verso

Contrato Social, **no qual passa a denominar-se ECOMAPUÁ CONSERVAÇÃO LTDA.,** com sede à Av. Gentil Bittencurt, nº 1.390, Loja B-4, Bairro Nazaré, CEP: 66.040-000, na Cidade de Belém, Estado do Pará, portadora do CNPJ/MF sob o nº 05.086.970/0001-75., tudo em conformidade com o Instrumento Particular de Alteração de Contrato Social, supracitado, cuja cópia fica arquivada neste serviço para fins de direito. – **DOU FÉ.** –

Breves-Pa., 06 de março de 2.006

O Oficial

PORTO POR FÉ que a presente CERTIDÃO extraída nos termos do art. 19, § 1º da Lei nº 6.015, de 31.12.73, está conforme e confere com o respectivo original.

Breves, 06 de março de 2006

Selo de Segurança
Certidão

RAIMUNDO S. FILHO
TITULAR
BREVES-PARÁ

O OF. DE REG. CIVIL DAS PESSOAS NATURAIS DO 13º SUBDISTRITO DO BUTANTÃ - S. PAULO - SP.
DR. EVANDRO CUNHA - OFICIAL
AUTENTICO ESTA CÓPIA EXTRAÍDA, PELO CARTÓRIO, CONFORME COM O ORIGINAL, DOU FÉ.

23 JAN. 2008

POR AUTENTICAÇÃO R$ 1,85

RICARDO DE OLIVEIRA RAMOS - ESCR. AUT.
NADIA PEREIRA ARAÚJO - ESCR. AUT.
VÁLIDO SOMENTE C/O SELO DE AUTENTICIDADE

1021AI554257

Figure 52. Property registry of Bom Jesus Farm

REGISTRO DE IMÓVEIS
COMARCA DE BREVES
LIVRO 2-O — REGISTRO GERAL

MATRÍCULA	FOLHA
N.º 3.572	N.º 56

IMÓVEL: Sorte de Terras denominada **"BRASILEIRO"**, situada na margem esquerda do Rio Mapuá, Município de Breves-PA., com uma área de 1.504ha.(UM MIL, QUINHENTOS E QUATRO HECTARES). limitando-se pelo lado direito com terras da sorte "Santo Antônio", de propriedade de Expedito Gresson do Nascimento e irmãos, pelo lado esquerdo com a sorte de terras "Santa Izabel", aqui discriminada e pelos fundos com terras devolutas.-

PROPRIETÁRIO: SANTANA MADEIRAS LTDA., com sede em Belém, Capital deste Estado, à Rua 15 de Novembro nº 226, inscrita no C.G.C (MF) sob o Nº 05.086.970/0001-75, conforme transformação da SANTANA MADEIRAS S/A., de acordo com o Instrumento Particular de Contrato Social, regido pela Lei 3.708, de 10/01/19 e. pelas cláusulas e condições constantes do referido Instrumento, devidamente arquivado na JUCEPA, sob o nº 152.005[illegible].

TÍTULO AQUISITIVO: Transcrição nº 4.303, Livro 3-AE, às fls. 151/156.

FORMA DO TÍTULO: Escritura Pública de Cessão de Direitos, Assunção de Dívidas e de Venda e Compra, outorgada por Superfine Madeiras S.A., em 11 de outubro de 1.975, tomada pela Tabelia Zilda Ferreira Lins, 2º Ofício desta Comarca, Livro 26, fls. 123/136.-

VALOR: Cr$=7.108.130,00 (SETE MILHÕES, CENTO E OITO MIL E CENTO E TRINTA CRUZEIROS), pagos pela totalidade dos imóveis que envolvem 22 (VINTE E DUAS) glebas.-

CONDIÇÕES: Não havendo condições especiais.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-1-M-3.572 - DATA: 03 DE DEZ. 1997 - RESERVA LEGAL -

Procede-se esta Averbação para fazer constar o expresso compromisso de SANTANA MADEIRAS LTDA., já individualizada de fazer a RESERVA LEGAL de mais 30% (TRINTA POR CENTO), além dos 50% (CINQÜENTA POR CENTO), já compromissados pela Averbação constante à margem da transcrição nº 4.303, do Livro 3-AE, fls. 151/156, em 30.06.92, totalizando 80% (OITENTA POR CENTO) da vegetação nativa existente no imóvel objeto da presente matrícula, onde não será permitido o corte raso, sendo vedada a alteração de sua destinação nos casos de transmissão de qualquer título, ou desmembramento, de acordo com o que estatui o art. 44 da Lei nº 4.771/65 e seu § único acrescido pelo inciso V do art. 1º da Lei nº 7.803, de 18 de julho de 1.989.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-2-M-3.572-DATA: 06-MAR-2.006 -MUDANÇA DE DENOMINAÇÃO-

Procede-se esta averbação nos termos do Instrumento Particular de Alteração de Contrato Social, datado de 19 de julho de 2.001, enviado por **SANTANA MADEIRAS LTDA.**, devidamente arquivado na **JUCEPA** sob o nº 20000029041, em 03.08.2.001, assinado pelo Secretário Geral, Dr. Dilermando Guedes Cabral, para fazer constar a mudanca de seu

Contrato Social, **no qual passa a denominar-se ECOMAPUÁ CONSERVAÇÃO LTDA.,** com sede à Av. Gentil Bittencurt, nº 1.390, Loja B-4, Bairro Nazaré, CEP: 66.040-000, na Cidade de Belém, Estado do Pará, portadora do CNPJ/MF sob o nº 05.086.970/0001-75., tudo em conformidade com o Instrumento Particular de Alteração de Contrato Social, supracitado, cuja cópia fica arquivada neste serviço para fins de direito. – **DOU FÉ**. –

Breves-Pa., 06 de março de 2.006

O Oficial

PORTO POR FÉ que a presente CERTIDÃO extraída aos termos do art 19, § 1º da Lei nº 6.015, de 31.12.73, está conforme e confere com o respectivo original.

Breves, 06 de março de 2006

Selo de Segurança
Certidão
Estado do Pará
Poder Judiciário
00075 1093

Cartório ... Furtado
Registros Públicos
1º Ofício
Raimundo S. Filho
Titular
Breves-Pará

Figure 53. Property registry of Brasileiro Farm

MATRÍCULA N.º 3.589 | FOLHA N.º 73

REGISTRO DE IMÓVEIS
COMARCA DE
LIVRO 2-O — REGISTRO GERAL

IMÓVEL: Sorte de Terras denominada "LAGO DO JACARÉ" ou "JACARÉ", situada na margem esquerda do braço direito do Rio Mapuá, descendo o Rio no Lago denominado "Jacaré", Município de Breves-PA., limitando-se pelo lado de cima com lugar denominado "Chato", por onde contina com terras que pertenceram à José dos Santos Cerdeira, pelo lado de baixo no Igarapé denominado "Pernambuco" por onde confina com terras que pertenceram a Máximino de Miranda Portugal e pelos fundos com o mesmo José dos Santos Cerdeira.-

PROPRIETÁRIO: SANTANA MADEIRAS LTDA., com sede em Belém, Capital deste Estado, à Rua 15 de Novembro nº 226, inscrita no C.G.C (MF) sob o Nº 05.086.970/0001-75, conforme transformação da SANTANA MADEIRAS S/A., de acordo com o Instrumento Particular de Contrato Social, regido pela Lei 3.708, de 10/01/19 e, pelas cláusulas e condições constantes do referido Instrumento, devidamente arquivado na JUCEPA. sob o nº 152.00525452/93 -

TÍTULO AQUISITIVO: Transcrição nº 4.303, Livro 3-AE, às fls. 151/156.-

FORMA DO TÍTULO: Escritura Pública de Cessão de Direitos, Assunção de Dívidas e de Venda e Compra, outorgada por Superfine Madeiras S.A., em 11 de outubro de 1.975, tomada pela Tabeliã Zilda Ferreira Lins, 2º Ofício desta Comarca, Livro 26, fls. 123/136.-

VALOR: Cr$=7.108.130,00 (SETE MILHÕES. CENTO E OITO MIL E CENTO E TRINTA CRUZEIROS), pagos pela totalidade dos imóveis que envolvem 22 (VINTE E DUAS) glebas.-

CONDIÇÕES: Não havendo condições especiais.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-1-M-3.589 - DATA: 03 DE DEZ. 1997 - RESERVA LEGAL -

Procede-se esta Averbação para fazer constar o expresso compromisso de SANTANA MADEIRAS LTDA., já individualizada de fazer a RESERVA LEGAL de mais 30% (TRINTA POR CENTO), além dos 50% (CINQÜENTA POR CENTO), já compromissados pela Averbação constante à margem da transcrição nº 4.303, do Livro 3-AE. fls. 151/156, em 30.06.92. totalizando 80% (OITENTA POR CENTO) da vegetação nativa existente no imóvel objeto da presente matrícula, onde não será permitido o corte raso, sendo vedada a alteração de sua destinação nos casos de transmissão de qualquer título, ou desmembramento, de acordo com o que estatui o art. 44 da Lei nº 4.771/65 e seu § único acrescido pelo inciso V do art. 1º da Lei nº 7.803, de 18 de julho de 1.989.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-2-M-3.589 - DATA: 14-ABR-2.003 - MUDANÇA DE DENOMINAÇÃO -

Procede-se esta averbação nos termos do Instrumento Particular de Alteração de Contrato Social, datado de 19 de julho de 2.001, enviado por **SANTANA MADEIRAS LTDA.**, devidamente arquivado na

Vide-Verso

OF. DE REG. CIVIL DAS PESSOAS NATURAIS DO 3º SUBDISTRITO DO BUTANTÃ - S. PAULO - SP. DR. EVANDRO CUNHA - OFICIAL AUTENTICO ESTA CÓPIA EXTRAÍDA DO CARTÓRIO, CONFORME COM O ORIGINAL, DOU FÉ.
3 JAN. 2008
POR AUTENTICAÇÃO R$ 1,85
RICARDO DE OLIVEIRA RAMOS - ESCR. AUT.
NÁDIA PEREIRA ARAÚJO - ESCR. AUT.
C/ O SELO DE AUTENTICIDADE

JUCEPA sob o n.° 20000029041, em 03.08.2.001, assinado pelo Secretário Geral, Dr. Dilermando Guedes Cabral, para fazer constar a mudança de seu Contrato Social, a qual passa a denominar-se **ECOMAPUÁ CONSERVAÇÃO LTDA**,. Com sede à Av. Gentil Bittencurt, n.° 1.390, Loja B-4, Bairro Nazaré, CEP: 66.040.-000, na cidade de Belém, Estado do Pará, portadora do **CNPJ/MF** sob o n.° 05.086.970/0001-75., tudo em conformidade com o Instrumento Particular de Alteração de Contrato Social, supracitado, cuja cópia fica arquivada neste Serviço para fins de direito.- **DOU FÉ**.-

Breves-Pa., 14 de abril de 2.003

Oficial

PORTO POR FÉ que a presente CERTIDÃO extraída nos termos do art 19, § 1º da Lei nº 6.015, de 31.12.73, está conforme e confere com o respectivo original.

Breves, 06 de março de 2006

CARTÓRIO DÁRIO FILHO – Selo de Segurança – Certidão – 000751110 – RAIMUNDO – TITULAR – BREVES

O OF. DE REG. CIVIL DAS PESSOAS NATURAIS DO 13º SUBDISTRITO DO BUTANTÃ – S. PAULO – SP.
DR. EVANDRO CUNHA – OFICIAL
AUTENTICO ESTA CÓPIA EXTRAÍDA, PELO CAPITÓRIO, CONFORME COM O ORIGINAL, DOU FÉ.
23 JAN. 2008
POR AUTENTICAÇÃO R$ 1,85
1021AI554415 AUTENTICAÇÃO
RICARDO DE OLIVEIRA RAMOS - ESCR. AUT.
NADIA PEREIRA ARAÚJO - ESCR. AUT.
VALIDO SOMENTE C/ O SELO DE AUTENTICIDADE

Figure 54. Property registry of Lago do Jacaré Farm

REGISTRO DE IMÓVEIS
COMARCA DE BREVES

MATRÍCULA N.º 3.580 | FOLHA N.º 64

LIVRO 2-O — REGISTRO GERAL

IMÓVEL: Sorte de Terras denominada **"SÃO DOMINGOS"**, situada na margem esquerda do Rio Mapuá, Município de Breves-PA., com uma área de 3.597ha.(TRÊS MIL, QUINHENTOS E NOVENTA E SETE HECTARES), limitando-se pelo lado direito com terras "Cardoso", descrita nesta Escritura, pelo lado de cima com terras "São Gabriel" pertencentes a Antônio Joaquim do Nascimento, e pelos fundos com terras devolutas.-

PROPRIETÁRIO: SANTANA MADEIRAS LTDA., com sede em Belém, Capital deste Estado, à Rua 15 de Novembro nº 226, inscrita no C.G.C (MF) sob o Nº 05.086.970/0001-75, conforme transformação da SANTANA MADEIRAS S/A., de acordo com o Instrumento Particular de Contrato Social, regido pela Lei 3.708, de 10/01/19 e, pelas cláusulas e condições constantes do referido Instrumento, devidamente arquivado na JUCEPA, sob o nº 152.00525452/93.-

TÍTULO AQUISITIVO: Transcrição nº 4.303, Livro 3-AE, às fls. 151/156.-

FORMA DO TÍTULO: Escritura Pública de Cessão de Direitos, Assunção de Dívidas e de Venda e Compra, outorgada por Superfine Madeiras S.A., em 11 de outubro de 1.975, tomada pela Tabeliã Zilda Ferreira Lins, 2º Ofício desta Comarca, Livro 26, fls. 123/136.-

VALOR: Cr$=7.108.130,00 (SETE MILHÕES, CENTO E OITO MIL E CENTO E TRINTA CRUZEIROS), pagos pela totalidade dos imóveis que constituem 22 (VINTE E DUAS) glebas.-

CONDIÇÕES: Não havendo condições especiais.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-1-M-3.580 - DATA: 03 DE DEZ. 1997 - RESERVA LEGAL -

Procede-se esta Averbação para fazer constar o expresso compromisso de SANTANA MADEIRAS LTDA., já individualizada de fazer a RESERVA LEGAL de mais 30% (TRINTA POR CENTO), além dos 50% (CINQÜENTA POR CENTO), já compromissados pela Averbação constante à margem da transcrição nº 4.303, do Livro 3-AE, fls. 151/156, em 30.06.92, totalizando 80% (OITENTA POR CENTO) da vegetação nativa existente no imóvel objeto da presente matrícula, onde não será permitido o corte raso, sendo vedada a alteração de sua destinação nos casos de transmissão de qualquer título, ou desmembramento, de acordo com o que estatui o art. 44 da Lei nº 4.771/65 e seu § único acrescido pelo inciso V do art. 1º da Lei nº 7.803, de 18 de julho de 1.989.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-2-M-3.580-DATA: 06-MAR-2.006 -MUDANÇA DE DENOMINAÇÃO-

Procede-se esta averbação nos termos do Instrumento Particular de Alteração de Contrato Social, datado de 19 de julho de 2.001, enviado por **SANTANA MADEIRAS LTDA.**, devidamente arquivado na **JUCEPA** sob o nº 20000029041, em 03.08.2.001, assinado pelo Secretário Geral, Dr. Dilermando Guedes Cabral, para fazer constar a mudança de seu

Vide-Verso

Contrato Social, **no qual passa a denominar-se ECOMAPUÁ CONSERVAÇÃO LTDA.,** com sede à Av. Gentil Bittencurt, nº 1.390, Loja B-4, Bairro Nazaré, CEP: 66.040-000, na Cidade de Belém, Estado do Pará, portadora do CNPJ/MF sob o nº 05.086.970/0001-75., tudo em conformidade com o Instrumento Particular de Alteração de Contrato Social, supracitado, cuja cópia fica arquivada neste serviço para fins de direito. – **DOU FÉ**. –

Breves-Pa., 06 de março de 2.006

O Oficial

PORTO POR FÉ que a presente CERTIDÃO extraída nos termos do art 19, § 1º da Lei nº 6.015, de 31 12.73, está conforme e confere com o respectivo original.

Breves, 06 de março de 2006

Selo de Segurança
Certidão
Estado do Pará
Poder Judiciário
000751101

Figure 55. Property registry of São Domingos Farm

REGISTRO DE IMÓVEIS
COMARCA DE BREVES

MATRÍCULA N.º 3.591 — FOLHA N.º 75

LIVRO 2-O — REGISTRO GERAL

Cartório de Registro de Imóveis 1º Ofício Breves-Pará

IMÓVEL: Sorte de Terras denominada **"VILA AMÉLIA"**, situada na margem esquerda do Rio Mapuá, Município de Breves-PA., com uma área de 4.402ha. (QUATRO MIL, QUATROCENTOS E DOIS HECTARES).-
PROPRIETÁRIO: SANTANA MADEIRAS LTDA., com sede em Belém Capital deste Estado, à Rua 15 de Novembro nº 226, inscrita no C.G.C (MF) sob o Nº 05.086.970/0001-75. conforme transformação da SANTANA MADEIRAS S/A.. de acordo com o Instrumento Particular de Contrato Social, regido pela Lei 3.708, de 10/01/19 e, pelas cláusulas e condições constantes do referido Instrumento, devidamente arquivado na JUCEPA, sob o nº 152.00525452/93.-
TÍTULO AQUISITIVO: Transcrição nº 4.303, Livro 3-AE, às fls. 151/156.-
FORMA DO TÍTULO: Escritura Pública de Cessão de Direitos, Assunção de Dívidas e de Venda e Compra, outorgada por Superfine Madeiras S.A., em 11 de outubro de 1.975, tomada pela Tabeliã Zilda Ferreira Lins, 2º Ofício desta Comarca, Livro 26, fls. 123/136.-
VALOR: Cr$=7.108.130,00 (SETE MILHÕES, CENTO E OITO MIL E CENTO E TRINTA CRUZEIROS), pagos pela totalidade dos imóveis que envolvem 22 (VINTE E DUAS) glebas.-
CONDIÇÕES: Não havendo condições especiais.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-1-M-3.591 - DATA: 03 DE DEZ. 1997 - RESERVA LEGAL -

Procede-se esta Averbação para fazer constar o expresso compromisso de SANTANA MADEIRAS LTDA., já individualizada de fazer a RESERVA LEGAL de mais 30% (TRINTA POR CENTO), além dos 50% (CINQÜENTA POR CENTO), já compromissados pela Averbação constante à margem da transcrição nº 4.303, do Livro 3-AE, fls. 151/156, em 30.06.92, totalizando 80% (OITENTA POR CENTO) da vegetação nativa existente no imóvel objeto da presente matrícula, onde não será permitido o corte raso, sendo vedada a alteração de sua destinação nos casos de transmissão de qualquer título, ou desmembramento, de acordo com o que estatui o art. 44 da Lei nº 4.771/65 e seu § único acrescido pelo inciso V do art. 1º da Lei nº 7.803, de 18 de julho de 1.989.- DOU FÉ.-

Breves-PA., 03 de dezembro de 1.997.-

Oficial Substituto

AV-2-M-3.591-DATA: 06-MAR-2.006 -MUDANÇA DE DENOMINAÇÃO-

Procede-se esta averbação nos termos do Instrumento Particular de Alteração de Contrato Social, datado de 19 de julho de 2.001, enviado por **SANTANA MADEIRAS LTDA.**, devidamente arquivado na **JUCEPA** sob o nº 20000029041, em 03.08.2.001, assinado pelo Secretário Geral, Dr. Dilermando Guedes Cabral, para fazer constar a mudança de seu Contrato Social, **no qual passa a denominar-se ECOMAPUÁ CONSERVAÇÃO LTDA.**, com sede à Av. Gentil Bittencurt, nº 1.390, Loja B-4, Bairro Nazaré, CEP: 66.040-000, na Cidade de Belém, Estado do Pará,

VIDE-VERSO

portadora do CNPJ/MF sob o nº 05.086.970/0001-75., tudo em conformidade com o Instrumento Particular de Alteração de Contrato Social, supracitado, cuja cópia fica arquivada neste serviço para fins de direito. – DOU FÉ. –

Breves-Pa., 06 de março de 2.006

O Oficial

PORTO POR FÉ que a presente CERTIDÃO extraída nos termos do art. 19, § 1º da Lei nº 6.015, de 31.12.73, está conforme e confere com o respectivo original.

Breves, 06 de março de 2006

CARTÓRIO DARIO FURTADO

000751112

O OF. DE REG. CIVIL DAS PESSOAS NATURAIS DO 13º SUBDISTRITO DO BUTANTÃ - S. PAULO - SP. DR. EVANDRO CUNHA - OFICIAL AUTENTICO ESTA CÓPIA EXTRAÍDA, NESTE CARTÓRIO, CONFORME COM O ORIGINAL. DOU FÉ.

23 JAN. 2008

POR AUTENTICAÇÃO R$ 1,85

1021AA155424

RICARDO DE OLIVEIRA RAMOS - ESCR. AUT.

NADIA PEREIRA ARAÚJO - ESCR. AUT.

VÁLIDO SOMENTE C/ O SELO DE AUTENTICIDADE

Figure 56. Property registry of Vila Amélia Farm

APPENDIX III – DEFINITION OF THE PROJECT AREA

The project area is the areas under the control of the project proponent where the project activities will be undertaken. The project area must contain only areas qualifying as forest 10 years prior to project start date, as defined in the VCS VM0015 Methodology v1.1. The areas of the present project fall into the following five properties: Bom Jesus, Brasileiro, Lago do Jacaré, São Domingos and Vila Amélia, belonging to the company Ecomapuá Ltda. The definition of the project area and its boundaries was carried out through the following steps:

1- Vectorization of the project boundaries

The project area borders used in the Ecomapuá Amazon REDD Project were extracted from technical appraisals (Portuguese: Laudos) registered at an official notary and at INCRA[177]. The appraisals include topographic plans, descriptive notes and definition of the perimeter coordinates of the properties. The table below describes the sources of information used to correct the property boundaries, as described in the following sections.

	Source of information	Original projection	Conversion
Hydrography	Hydrography was extracted from the automatic classification and corrected through interpretation of images	WGS84 Z22S	LatLong SAD 69
Properties	Technical appraisal of the Fazenda Lago do Jacaré property, Breves/PA 2005	LatLong SAD 69	WGS84 Z22S
	Technical appraisal of the Fazenda Brasileiro property, Breves/PA 2004	LatLong SAD 69	WGS84 Z22S
	Technical appraisal of the Fazenda Vila Amélia property, Breves/PA 2000	LatLong SAD 69	WGS84 Z22S
	Technical appraisal of the Fazenda São Domingos property, Breves/PA 2002	LatLong SAD 69	WGS84 Z22S
	Technical appraisal of the Fazenda Bom Jesus property, Breves/PA 2000	LatLong SAD 69	WGS84 Z22S

Table 73. Sources of information

2- Standardization of geographical coordinates, azimuths and distances.

a. Editing polygons through azimuths

The polygons were edited through geographical information software ArcGIS, specifically using the editing tool COGO. In order to do this, a polygon *shape* was created in ArcCatalog with the system of geographic

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

coordinates, *Datum* SAD-69. The latter *shape* was imported into ArcMap. The target was defined in the polygon of the property being corrected using the editor function and the angular units function (under *option >Units> Angular Units> Direction Types: North Azimuth e Direction Units: Degrees Minutes Seconds*). The coordinate M1 was defined as the starting point and then the COGO> *Traverse* tool was activated, into which azimuths and distances were imported. During this initial process the points corresponding to hydrography were not adjusted.

b. Editing of polygons using geographical coordinates

The editing of polygons through geographical coordinates was carried out in ArcGIS geographical information software using the *editor* tool. For this purpose, a shape of points was created where geographical coordinates (latitude and longitude) had been inserted, in *Degrees Minutes Seconds*. Once the geographical reference points were defined by the coordinates, ArcCatalog was used – specifically the *Create New Feature* editing tool with the *Snapping* feature switched on – to make a new polygon shape from which coordinates comprising the property boundaries were selected.

c. Azimuths VS Geographical coordinates

The figure below demonstrates the difference between the two methods: editing polygons and use of geographical coordinates. The geographical coordinates were defined as the best method for correcting property boundaries. This is because the latitudes and longitudes are unique within the hemisphere, while azimuths can be influenced by other factors, which can affect their accuracy.

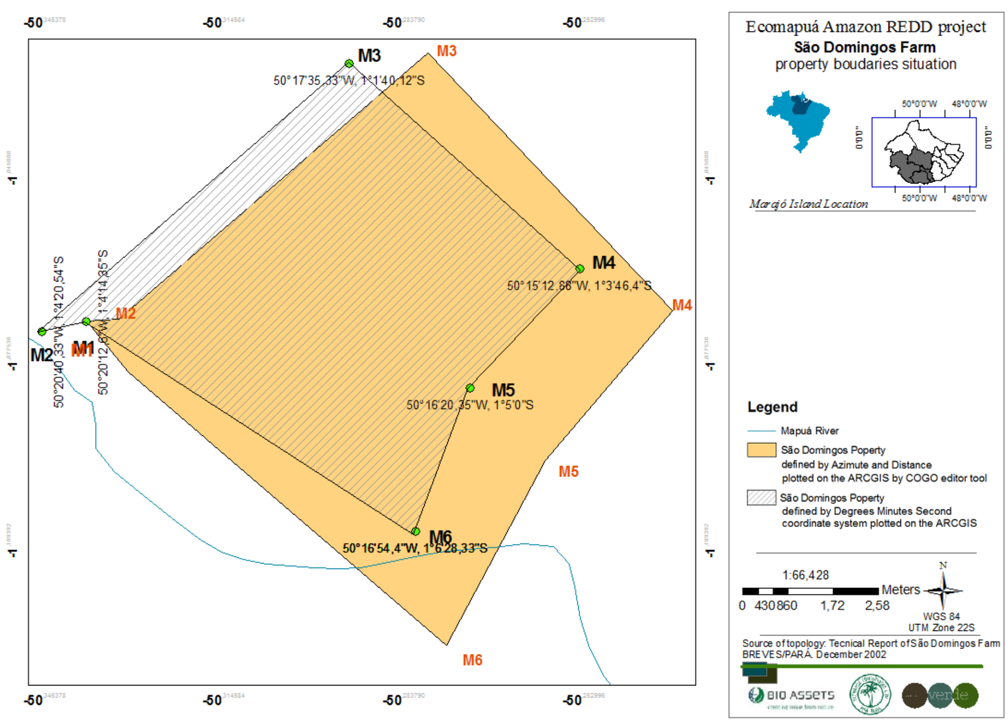

Figure 57. Map of the issues involving property boundaries of Ecomapuá Ltda. Properties

d. Adjustment of coordinates relating to rivers

All perimeters of bodies of water were corrected in their entirety using the hydrography extracted from the automatic classification and the interpretation carried out through the 1:10,000 mapping window and the final scale of 1:15,000. The geographic coordinates coinciding with bodies of water (*i.e.* Fazenda Bom Jesus and Fazenda Vila Amélia) were edited using the *editor>Cut Polygon Feature* function. Because the descriptive notes in the appraisals specified that property limits corresponded to rivers, in cases where properties boundaries did not fall in the proximity of riverbanks (e.g. São Domingos, Lago do Jacaré and Brasileiro properties), the coordinate M1 was moved to the riverbanks in order to then apply the function: *editor>Cut Polygon Feature.*

e. *Allowable error and results*

The table below illustrates the difference in area between the appraisals and the areas used in the present project. The error was deemed allowable since there were errors in the values of the azimuths and possibly in the geographic coordinates, furthermore the appraisal did not define either the projection for definition of the project boundaries, or the measuring method.

Property		Agência Verde		Appraisal		Difference	
Property	Municipality	Area	Perimeter	Area	Perimeter	Area	Perimeter
Bom Jesus	Breves, PA	14,469.01	64,979.96	14,529.73	64,352.65	-60.71	627.31
Brasileiro	Breves, PA	4,281.68	32,395.81	3,524.00	16,934.50	757.68	15,461.31
Lago Jacaré	Breves, PA Curralinho, PA São Sebastião da Boa Vista, PA	58,617.44	124,189.20	42,856.12	95,316.84	15,761.31	28,872.35
São Domingos	Breves, PA	4,796.83	29,532.65	5,386.45	30,729.11	-589.61	-1,196.46
Vila Amélia	Breves, PA	16,303.64	67,701.32	15,999.01	64,291.75	304.63	3,409.57

Table 74. Differences in perimeter and area values encountered in the official appraisals and corrected values

Following the steps described above, the properties were plotted on a map, the properties sum to 98,421.46ha and the project area comes to 97,007.22ha (Figure below). Thus, the deforested areas inside all the properties, including those deforested within 10 years prior to project start date, sum to 1,414.25ha.

The properties are located in the municipalities of Breves, Curralinho and São Sebastião da Boa Vista.

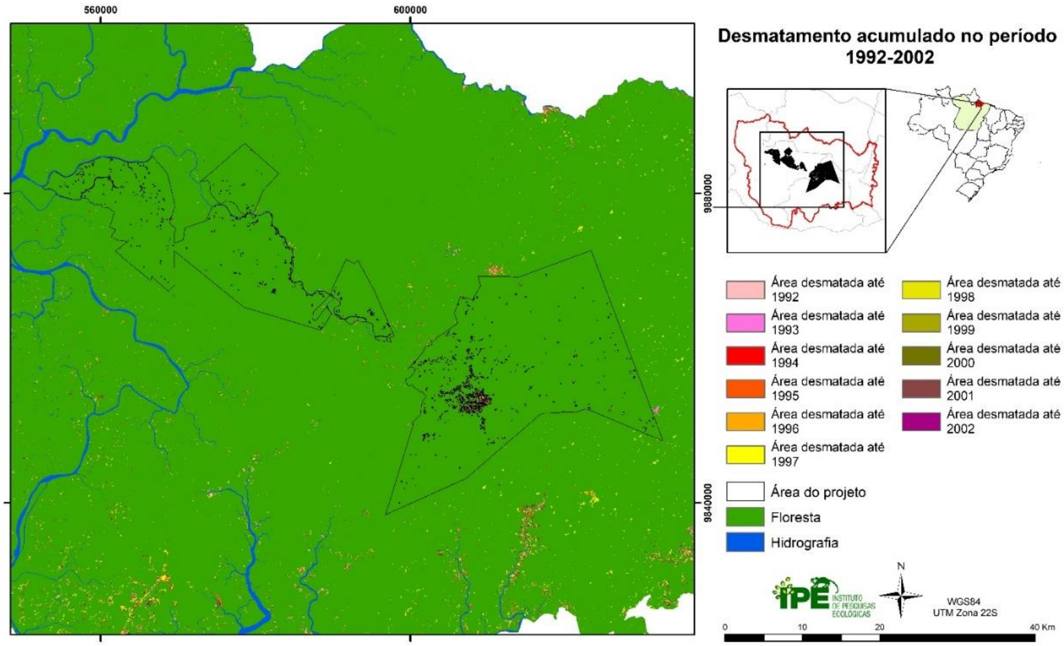

Figure 58. Project area

APPENDIX IV – METHODOLOGICAL PROCEDURES FOR LU/LC-CHANGE ANALYSIS

According to the applied methodology, in order to achieve a consistent time-series of LU/LC-change data over the crediting period, the detailed methodological procedures used in pre-processing, classification, post classification processing, and accuracy assessment of the remotely sensed data shall be carefully documented in the VCS PD. Therefore, the information below describes the methodological procedures applied during the reassessment of the second baseline period.

Data sources and pre-processing

The historic deforestation of the reference region should be analyzed through maps from MapBiomas (version 4.0, which was the last available version), available in raster format, which can be downloaded from the http://mapbiomas.org/ website. MapBiomas is a multi-institutional initiative of the Greenhouse Gas Emissions Estimation System (SEEG - http://seeg.eco.br/en/) promoted by the Climate Observatory. MapBiomas co-creation involves NGO’s, universities and technology companies.

Furthermore, at least two Landsat scenes per year should be necessary to compose the entire reference region (orbit/point: 224/61 and 225/61). The final mapping resolution should be 30m.

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	DD/MM/YY	Path	Row
Satellite	Landsat TM	30	0.45 – 2.35	34,225	2003 - 2012	224	61
Satellite	Landsat TM	30	0.45 – 2.35	34,225	2003 - 2012	225	61

Table 75. Source of the remotely sense data used for historical reference period

The forest dynamics data, the deforestation vectors and other base data from the studied region, which were used for the project’s baseline construction, should be organized in a spatialized database. For this purpose, the software used in this baseline reassessment was the File Geodatabase format from ArcGIS 10.6. The files are stored in vector and matrix format (raster). In order to standardize spatial references, all data has been projected for the UTM and Datum WGS84, Zone 22S projection.

The MapBiomas methodology for land use classification uses 104 input variables, including the original Landsat bands, indexes, fractional and textural information derived from these bands, which are detailed in the table below.

			Reducer						
	band or index name	formula	median	median_dry	median_wet	amplitude	std Dev	min	Reference
bands	blue	B1 (L5 e L7); B2 (L8)							
	green	B2 (L5 e L7); B3 (L8)							
	red	B3 (L5 e L7); B4 (L8)							
	nir	B4 (L5 e L7); B5 (L8)							
	swir1	B5 (L5 e L7); B6 (L8)							
	swir2	B7 (L5); B8 (L7); B7 (L8)							
	temp	B6 (L5 e L7); B10 (L8)							
index	ndvi	(nir - red)/(nir + red)							
	evi2	(2.5 * (nir - red)/(nir + 2.4 * red + 1)							
	cai	(swir2 / swir1)							
	ndwi	(nir - swir1)/(nir +							
		swir1)							
	gcvi	(nir / green - 1)							
	hall_cover	(-red*0.017 - nir*0.007 - swir2*0.079 + 5.22)							
	pri	(blue - green)/(blue + green)							
	savi	(1 + L) * (nir - red)/(nir + red + 0,5)							
	textG	('median_green') .entropy(ee.Kernel .square({radius: 5}))							
fraction	gv	fractional abundance of green vegetation within the pixel							
	npv	fractional abundance of non-photosynthetic vegetation within the pixel							
	soil	fractional abundance of soil within the pixel							
	cloud	fractional abundance of cloud within the pixel							
	shade	100 - (gv + npv + soil + cloud)							
MEM index	gvs	gv / (gv + npv + soil + cloud)							
	ndfi	(gvs - (npv + soil))/(gvs + (npv + soil))							
	sefi	(gv+npv_s - soil)/(gv+npv_s + soil)							
	wefi	((gv+npv) - (soil+shade)) /((gv+npv) + (soil+shade))							
	fns	((gv+shade) - soil) / ((gv+shade) + soil)							
slope		ALOS DSM: Global 30m							

Table 76. List, description and reference of bands, fractions and indexes available in the feature space[178]

[178] Source: MapBiomas. Description of each column below.

Where,

Median - Median of the pixel values of the best mapping period defined by each biome.

Median_dry = median of the quartile of the lowest pixel NDVI values.

Median_wet = median of the quartile of the highest pixel NDVI values.

Amplitude = amplitude of variation of the index considering all the images of each year.

stdDev = standard deviation of all pixel values of all images of each year.

Min = lower annual value of the pixels of each band.

In addition, Landsat Images used in MapBiomas were accessible via Google Earth Engine, and most of them are composed by the Collection 1 Tier 1 from USGS. This is the highest quality Level-1 products suitable for pixel-level time series analysis. These images are radiometrically calibrated and orthorectified using ground control points (GCPs) and digital elevation model (DEM) data to correct for relief displacement.

Data classification and post-processing

The LU/LC classes defined for this project activity were: Forest (Riparian (Aluvial) Dense Tropical Rainforest), Non-Forest and Hydrography. In addition, the established LU/LC-change categories were:

a) Forested areas that remains as forested areas (Conservation);

b) Forest that are converted to non-forested areas (Deforestation); or

c) Non-forested areas that remains as non-forested areas.

The image classification methodology for each year involves all Landsat images available for each period (Landsat 5 [L5] and Landsat 7 [L7] or other sensor available) with a cloud cover less than or equal to 50%. Thus, a representative mosaic of each year could be generated, selecting cloud free pixels from the available images. Metrics should be extracted for each pixel that describes its behavior during the year and could contain up to 105 layers of information. The mapping should be done with an artificial intelligence classifier, such as the Randon Forest. The Landsite images acquisition could be made through Google Earth Engine, with data from NASA and USGS (U.S. Geological Survey).

The algorithm may use samples obtained by reference maps, stable collections from previous MapBiomas series and/or direct collection by visual interpretation of Landsat images in order to classify a single map per class. This classification should then go through spatial filter, applying neighborhood rules and temporal filters to reduce spatial and temporal inconsistencies. The software used in this baseline reassessment was the ArcGIS 10.6. In addition, high resolution images from Google Earth software (https://earth.google.com/) were also utilized to perform some LU/LC-change analysis.

Classification accuracy assessment

The MapBiomas results go through an accuracy evaluation, which remains in 95% for the entire Amazon Biome. However, to meet the particularities of the project's region, an independent evaluation should be carried out for the reference region.

Thus, in order to assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix should be generated calculating the percentages of user and producer correctness, as well as omission and commission errors.

A total of 210 random points were drawn on the reference region (70 points for each land use class – Forest, Non-Forest and Hydrography) and the degree of correctness of the classification was verified. High resolution images from Google Earth should also be used as reference, in which land use was visually possible at the drawn points.

During the second baseline reassessment, the final classification accuracy assessment averaged 89% for the 2003-2012 period. The table below shows the final accuracy analysis carried out for each year and each land use class during the analyzed reference period.

	Producer accuracy			User accuracy		
Year	Forest	Hydrography	Deforestation	Forest	Hydrography	Deforestation
2003	85.90%	98.55%	95.24%	95.71%	97.14%	85.71%
2004	79.22%	98.46%	85.29%	87.14%	91.43%	82.86%
2005	78.21%	100.00%	81.82%	87.14%	94.29%	77.14%
2006	74.70%	98.55%	84.48%	88.57%	97.14%	70.00%
2007	85.14%	100.00%	88.41%	90.00%	95.71%	87.14%
2008	80.77%	95.71%	91.94%	90.00%	95.71%	81.43%
2009	83.78%	98.57%	89.39%	88.57%	98.57%	84.29%
2010	83.33%	100.00%	85.29%	85.71%	100.00%	82.86%
2011	78.48%	100.00%	87.50%	88.57%	95.71%	80.00%
2012	86.57%	95.71%	86.30%	82.86%	95.71%	90.00%

Table 77. Summary of confusion matrices from the evaluation of MapBiomas from 2003 to 2012