ECOMAPUÁ AMAZON REDD PROJECT

GHG EMISSION REDUCTIONS FROM AVOIDED UNPLANNED DEFORESTATION

Document Written By Sustainable Carbon – Projetos Ambientais Ltda.

Contact Information

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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, as described in section 1.9 and 1.10 of the present VCS-PD.

The primary objective of the Ecomapuá Amazon REDD AUD Project is to avoid the unplanned deforestation (AUD) of an 86,269.84ha area within a private property on Marajó island, totalling 98,362ha, 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. 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 implemented in the *Fazenda Bom Jesus* and *Vila Amélia* Ecomapuá properties.

The present REDD project will avoid a predicted 4,253.14ha of deforestation, equating to around 2,745,350 tCO_2e in emissions reductions across the project crediting period (01/01/2003 – 31/12/2032), not including reductions for the project's efficiency, non-permanence risk buffer and displacement leakage factor. Subtracting the aforementioned parameters, the emissions avoided by the Ecomapuá Amazon REDD AUD Project are expected to be 1,432,278 tCO_2e over the 30 year project lifetime. The dynamic of deforestation within the project's reference region involves overlapping agents, which cannot be separated in terms of deforestation location. Specifically, the agents are: timber harvesters, acting both legally and illegally; subsistence farming relying on slash and burn practices for cultivation[4]; and extraction of palm heart, which supplements the income and subsistence from latter activity.

Revenue from the sale of VCUs is essential for the project activity to compete with the profitable alternative land-use scenarios, namely timber production, and palm-heart extraction.

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

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.

1.3 Project Proponent

Project Developer and Project Proponent

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.

This Project Description Document was completed on 22/02/2013 by David Swallow, Marcelo Hector Sabbagh Haddad and Thiago de Avila Othero, from Sustainable Carbon – Projetos Ambientais Ltda.

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1.4 Other Entities Involved in the Project

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1.5 Project Start Date

The project start date is 01/09/2002 because an initial diagnostic study of the area, commissioned by Ecomapuá Ltda., was published on this date, analyzing 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 19/07/2001, 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.

1.6 Project Crediting Period

The project has a crediting period of 30 years, from 01/01/2003 until 31/12/2032.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	X
Mega-project	

Table 1 – Indication of "project" or "mega-project" scale

[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.".

Years	Estimated GHG emission reductions (tCO_2e)
2003	62,338
2004	57,017
2005	42,743
2006	72,363
2007	70,306
2008	74,014
2009	71,967
2010	71,954
2011	57,864
2012	93,784
2013	80,542
2014	65,796
2015	7,392
2016	83,986
2017	60,999
2018	30,024
2019	245,055
2020	13,602
2021	126,862
2022	55,929
2023	72,423
2024	90,405
2025	112,758
2026	10,162
2027	122,071
2028	67,736
2029	51,245
2030	77,690
2031	112,625
2032	8,487
Total estimated ERs	2,170,138
Total number of crediting years	30
Average annual ERs	72,338

Table 2 – Estimated total and average annual gross ERs

1.8 Description of the Project Activity

The principal objective of the present REDD project is the conservation of 86,269.84ha of forest area within the five Ecomapuá properties described in section 1.9 of the present VCS PD. This will be achieved through avoidance of unplanned deforestation, the ex-ante estimate for avoided deforestation over the 30 year project lifetime being 4,253.14ha. The avoided emissions due to the Ecomapuá Amazon REDD AUD Project are expected to be 1,432,278 tCO_2e across the project crediting period (01/01/2003 – 31/12/2032), 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 section 2.5, additionality, 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 the 38 families living in the Bom Jesus and Vila Amélia 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.

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.

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

1.9 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 2). In accordance with V-C-S requirements, stipulated in Approved VCS Methodology VM0015, version 1.1 (hereafter “the

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[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”

[10] WWF (2008), “The Encyclopedia of Earth”: http://www.eoearth.org/article/Maraj%C3%B3_varzea

methodology"), they are areas which 'include only "forest"[11] for a minimum of ten years prior to the project start date'. As shown in Figure 1 below, the size of the areas that were considered as "non-forest" within the project area was 12,151.63ha. This was excluded from the initial area of 98,421.47ha, resulting in 86,269.84ha, which was then defined as project area.

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 (see Table 3 below). The full contour coordinates of the project area are found in Annex I. The northern boundary of the property is constituted by the delta of the Arama 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.

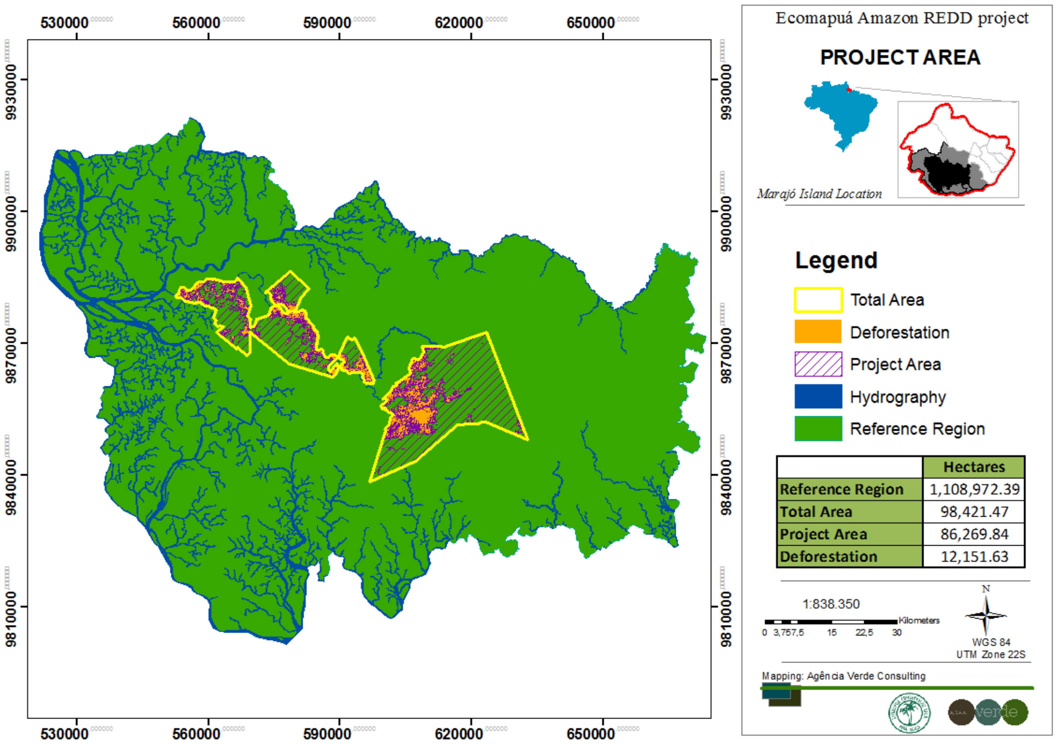


Figure 1 – REDD area, showing in orange the areas to be excluded, not being defined as forest 10 years prior to PSD

[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

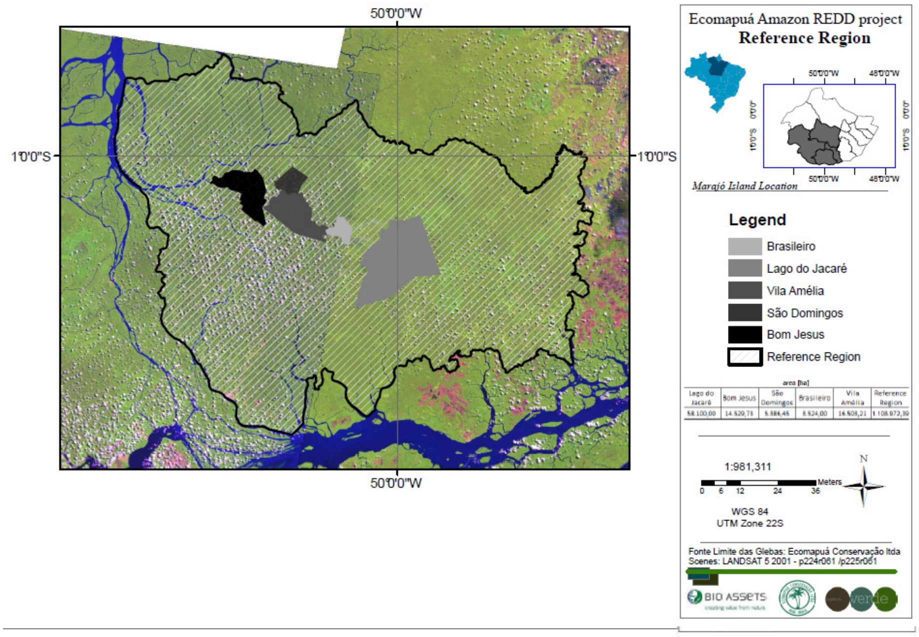


Figure 2 – Ecomapuá REDD project's five properties and reference region

MUNICIPALITY	PROPERTY	FOREST HECTARES/ MUNICIPALITY	PERCENTAGE PROJECT AREA / TOTAL AREA
Breves, PA	Bom Jesus	12,378.67	14%
Breves, PA	Brasileiro	3,018.69	3%
Breves,PA	Lago do Jacaré	52,459.60	61%
Curralinho, PA			
São Sebastião da Boa Vista, PA			
Breves, PA	Sao Domingos	4,184.22	5%
Breves, PA	Vila Amelia	14,228.65	16%
TOTAL		**86,269.83**	**100%**

Table 3 – Ecomapuá REDD Project areas per municipalities

Definition of the property 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[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].

[12] Instituto Nacional de Colonização e Reforma Agrária (INCRA): http://www.incra.gov.br/
[13] Full process described Annex IV

The Reference Region

The reference region (RR) (see Figure 1) is an analytical domain through which information on rates, agents, drivers and underlying causes (or "distal drivers"[14]) 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 4 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, being some 86,269.84ha of project area. 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[15,16]. 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 4 – Reference Region areas and percentages

Definition of the Leakage Belt

Considering baseline activity, subsequent sections of the present PD have established that the deforestation in the region involves three spatially overlapping activities: 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

[14] COP 17 (2011), "GOFC – GOLD Sourcebook COP17, Version 1" (p.2 – 109)
[15] 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'.
[16] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Sócio-Econômico".

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 explained in section 2.4 of the present VCS-PD, it was concluded that deforestation was lucrative for at least one product, namely timber.

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 an 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;

[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."

[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).

\$/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 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	1,139
Labour	5,058
Purchase of logs	5,883
Transport of logs	1,721
Cost of capital	89
Total cost of production	14,795
Value of production	17,550
Liquid income	2,755
Profit margin	17%

Table 5 – 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	

[24] BARROS, A. C.; UHL, C. (1996), "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.

e)	Average boat transport journey time (h)	2.75 h	11 km / 4 km.h
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 6 – 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 7 – Calculations for distance corresponding to profitability ≥ 1 in leakage scenario 1)

In scenario 1, 17.60km (item n. in Table 7), 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 8 - Calculations for distance corresponding to profitability ≥1 in leakage scenario 2)

In scenario 2, 27.60km (item y in table 8), 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 3 below) was defined by quantitative parameters (Table 9) of feasible distance in terms of: (1) a sawmill could have access to 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**	Using ArcGIS, 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 in ArcGIS, surround 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 9 – Adjustment criteria used in defining the leakage belt

[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."

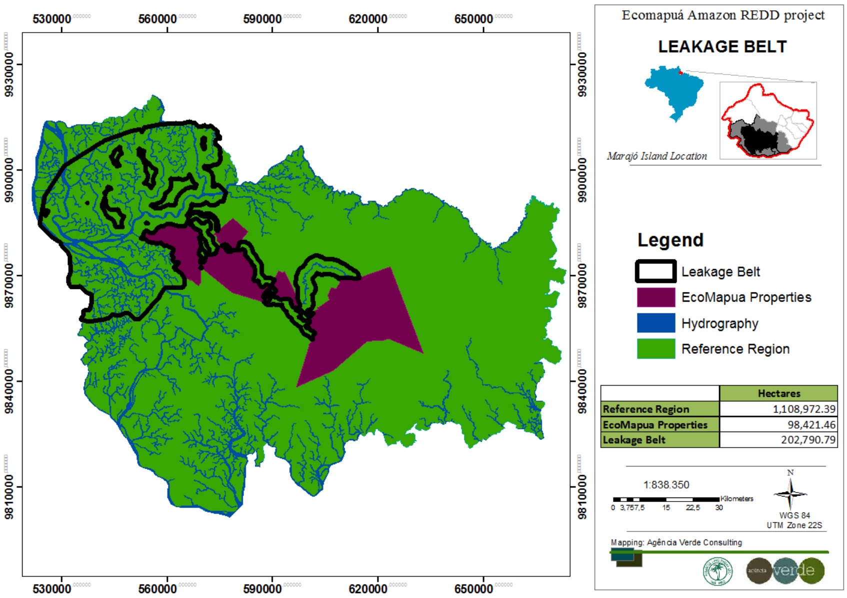


Figure 3 – Leakage belt of the Ecomapuá Amazon REDD project

<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.

The Ecomapuá Amazon REDD Project's leakage management area is located within the *Fazenda Bom Jesus*, specifically the areas which were deforested prior to project start date (Figure 4). This area was 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 involve the residents of both the Bom Jesus and Vila Amélia properties, being 38 families and 38% of the population in the project area (see table 11, section 1.9).

The following activities take place in the leakage management area:

- A technical school and tree nursery to benefit all members of the two communities, currently and continuously active in the leakage management area[28];
- 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 in the communities[29]. 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.

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

[29] 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"

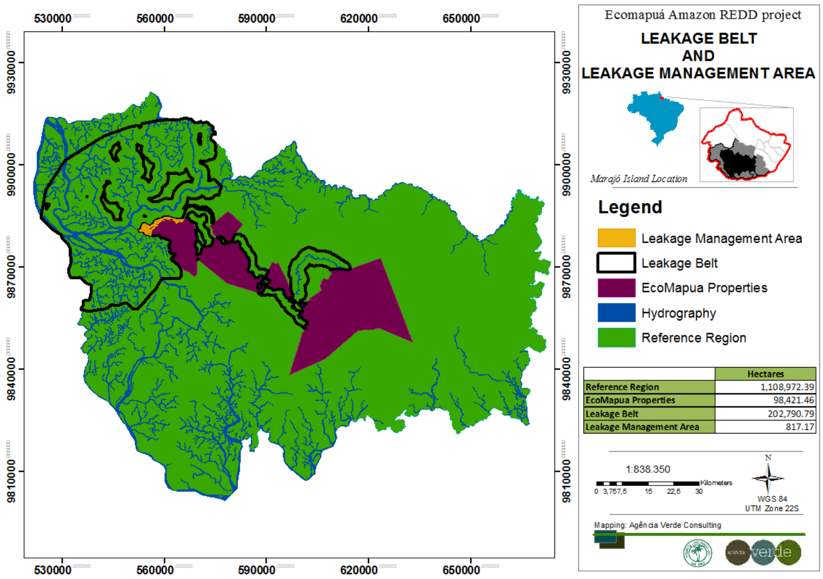


Figure 4 – The Project's leakage management area within the Bom Jesus property

General characteristics of the project area and reference region

Climate

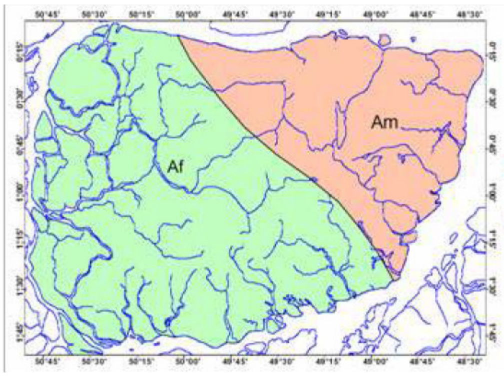


Figure 5 - Marajó Island divided into climate type[30]

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].

These conditions combined make excellent conditions for biomass to thrive, leading to the high levels of biomass described in section 1.10. The Af climate type is defined as follows:

[30] 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."
[31] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928. Wall-map 150cmx200cm (link)
[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).

1) The driest month having average rainfall >60mm

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

This classification is in accordance with the findings of a 2004 study by the Brazilian Executive Secretary of Science, Technology and the Environment[34], 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[35]. 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[36].

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[37], clearly shown in Figure 6, 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.

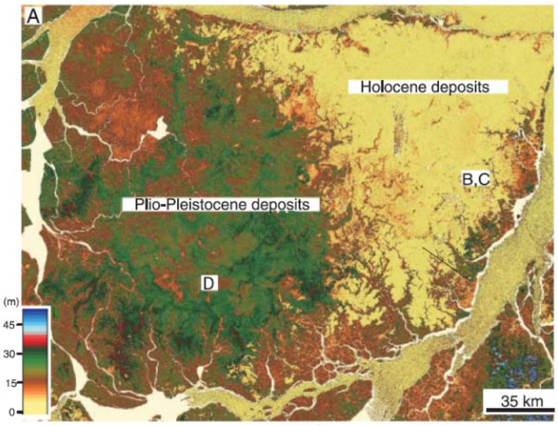


Figure 6 - The contrast in geology between west and eastern sides of Marajó island[38]

Soil types across the project area were characterised by influence of water, in a pilot forest inventory[39] 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.

[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.”

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

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

[37] 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.

[38] 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.*

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

Regarding soil content, the soils are described as being of gley type, therefore distinct from peat[40], therefore meeting applicability conditions of the methodology. For example, in the Fazenda Bom Jesus by Morris et al. [41]: "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."

Socio-economic conditions

Industrial activity in the Furos de Breves micro-region is concentrated in timber production, the main competitors in the market being palm heart and açaí berries. In the three municipalities in which the project is located, almost 83% of the total value of production from these three products was represented by logged timber at the project start date, while around 17% was represented by palm heart and less than 1% by acai berries (Table 10 below, and figures 11 – 14 section 2.4). Adding to the dominance of timber in the local market, a considerable proportion of the timber production in Brazil is illegal, 36% according to the SFB[42], 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[43], the product remains the most important commercial product in the micro-region.

	Açaí	Palm heart	Timber Logs	TOTAL
Breves	69,333	573,132,636	3,355,960,545	
Curralinho	127,500	176,438,909	405,673,364	
São Sebastião da Boa Vista	930,000	59,021,545	130,646,545	
Total production (R$)	1,126,833	808,593,091	3,892,280,455	4,702,000,379
Percentage total value of production	0.02%	17.20%	82.78%	

Table 10 - Annual average values of production in municipalities of project area (1992 - 2002) (R$)[44]

While palm heart is a largely commercial product, açaí is produced mainly for subsistence, being an integral and traditional part of the daily diet[45]. Thus it forms only a small part of the commercial values above, while weights produced are higher than that of palm heart (Figure 7). Açaí is not considered a significant element of the deforestation dynamic as it does not require deforestation for its production[46]. In fact, açaí production has been positively correlated with forest conservation in a study of Pará state municipalities[47].

Aspects of Furos de Breves' demography are presented in Table 12. 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[48]. The main NTFPs extracted from the forest are acai berries and palm-heart, while crops planted include manioc, corn, and

[40] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'
[41] Morris et al., 'Land Use and Soil Change on Fazenda Bom Jesus, Ilha Marajó , Pará, Brazil'.
[42] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras"
[43] SFB & IMAZON (2010), "A atividade madeireira na Amazônia brasileira: produção, receita e mercados".
[44] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE).
[45] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.
[46] Interview: D. Meneses 23.11.12.
[47] 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.
[48] Herrera, J. A. (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves, PA." Dissertação de mestrado. Universidade Federal do Pará.

banana[49]. Figure 7 below shows the tendency of commercial production in açaí berries and palm heart in the municipalities of Furos de Breves.

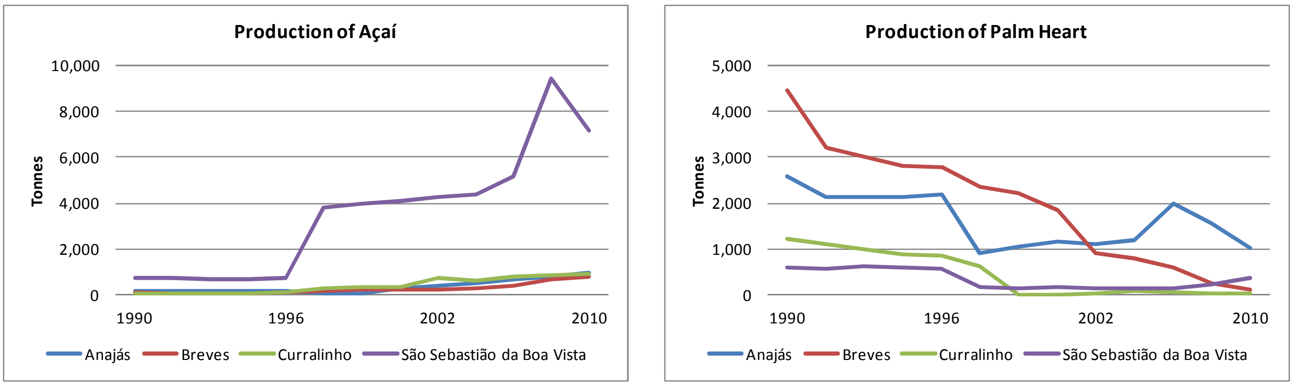


Figure 7 - (1992 - 2010) tendency in production of açaí and palm heart in the main reference region municipalities

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 11 – Families located in project areas and numbers interviewed[50]

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[51,52], confirming the predominance of this mode of life. 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.

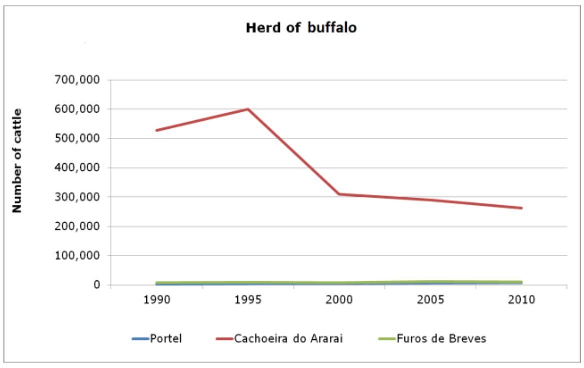
Municipalities: Furos de Breves Micro-region	Area (Km^2)	Urban population	Rural population	Total population	Population growth rate (2000-2010)	Population density (inhabitants/Km^2)
Anajás	6,922	9,494	15,265	24,759	3.06	3.58
Breves	9,551	46,560	46,300	92,860	1.48	9.72
Curralinho	3,617	10,930	17,619	28,549	3.63	7.89

[49] Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano de desenvolvimento territorial sustentável do arquipélago do Marajó."
[50] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".
[51] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".
[52] 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'.

São Sebastião da Boa Vista	1,632	9,902	13,002	22,904	2.62	14.03
Afuá	8,372.80	9,478	25,564	35,042	1.73	4.19
Furos de Breves micro-region	30,095	86,364	117,750	204,114	2.5	7.9

Table 12 – Demographic statistics on the Furos de Breves micro-region[53]

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 in section 1.10.



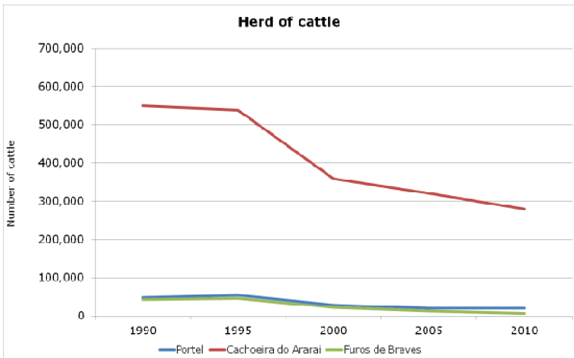


Figure 8 – Distribution of buffalo and cattle herds across the micro-regions of Marajó Island[54]

The economic context of the Project is therefore one of poverty, characterised by inequality, and low social indicators (Table 13). 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	82,6	17	19,5
Anajás	81,4	16	26,1
Breves	78,4	18	31,6
Curralinho	78,5	13	25,4
São Sebastião da Boa Vista	77,0	32	32,5
Estado do Pará	27,7	36	22,9

Table 13 - Social indicators in the municipalities of the reference region[55]

The socio-economic climate described is integrated into the Ecomapuá Amazon REDD Project's goals, as the future application of SOCIALCARBON® Standards, and the planned collaboration with a government

[53] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE), 2010; PODM, 2010.
[54] Source: Instituto Brasileiro de Geografia e Estatística (IBGE)
[55] Sources: IBGE (2009;2010); PODM (2009; 2010)

environmental body[56], aims to deliver appropriate, integrated and quantifiable ecological and socio-economic benefits to the population of the project area.

Biodiversity

The Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included Marajó Island in its 2003 survey of Brazil's 900 priority areas for conservation[57]. 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[58]. The island stands out as particularly important in relation to birdlife[59]: 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*[60].

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 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*) and pumas (*Puma concolor*)[62].

Notable marine life includes mammals, such as the American manatee (*Trichechus manatus*), which is classed as Vulnerable[63], the Amazonian manatee (*Trichechus inunguis*), the Costelo sea dolphin (*Sotalia guianensis),* Tucuxi dolphin (*Sotalia fluviatilis*), and Boto Amazon River Dolphin (*Inia geoffrensis*)[64].

The characteristically large river fish include various freshwater stingrays (*Plesiotrygon*, *Paratrygon*, and *Potamotrygon* spp.)[65], Pacus (*Metynnis* and *Mylossoma* spp.), Tambaqui *(Colossoma macropomum)*, Arapaima *(Arapaima gigas)*, and Sardines *(Triportheus angulatus)*.

1.10 Conditions Prior to Project Initiation

Vegetation Cover

56 Currently under negotiation
57 MMA (2003): http://www.mma.gov.br/estruturas/chm/_arquivos/maparea.pdf
58 Congresso Brasileiro de Ornitologia 29 Jun – 04 Julho 2008. 'A Ornitologia no Cerrado e Ecótonos do Brasil'.
59 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.
60 WWF (2008), "The Encyclopedia of Earth": http://www.eoearth.org/article/Maraj%C3%B3_varzea
62 Source, WWF: http://www.worldwildlife.org/science/wildfinder/profiles/nt0138.html
63 Source: http://www.iucnredlist.org
64 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'.
65 '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

The vegetation in the present project was mapped on the basis of SIVAM Amazônia information sources[66]. 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[67] of riparian dense tropical forest, and that all vegetation cover types identified by the Museo Emílio Goeldi study[68] 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 9).

Marajó Island's vegetation is characterised by the seasonal flooding and sedimentary deposits of the island[69]. As indicated in the previous sections of geology and climate, rainforest is principally located in the western portion of Marajó island[70], 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[71];
- 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.

Carbon stocks

The utilized carbon stocks in the Project were calculated on the basis of biomass values from the study presented in Table 14 below. An average of biomass values from Nogueira (2008) for riparian dense tropical rainforest was used.

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. A detailed description of this is included in Annex V (Definition of Carbon Stocks).

Vegetation	Aboveground Biomass (Mg ha^{-1})	Belowground Biomass (Mg ha^{-1})	Total biomass (Mg ha^{-1})
Riparian Dense Tropical Rainforest	299.3	61.5	360.8

Table 14 – Biomass values used for the class "forest"[72]

[66] Sistema de vigilância da Amazônia: SIVAM
[67] IBGE (1992), "Manual Técnico Da Vegetação Brasileira"
[68] 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'.
[69] 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'.
[70] Eliana da C. Segundo (2009) 'Estudo de Energia Eólica Para a Ilha de Marajó - PA'. *INPE*.
[71] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'.
[72] Nogueira, E.M. (2008), "Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira." 151 p, INPA, Manaus.

The biomass values presented in Table 14 were not accompanied with standard deviations, as they were not directly measured but estimated values, however the standard deviation values for the DAP and dry biomass which underlie the biomass were known, and these were integrated in the biomass values above.

In order to convert biomass into carbon, and carbon into carbon-dioxide (see Table 16), the conversion factors defined in table 15 were used.

Conversion Factors	
Biomass to Carbon	0.5
C to CO_2	3.666666667

Table 15 - Biomass to CO_2 conversion factors[73]

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	548.72	112.75	661.47

Table 16 – Average CO_2 stock per hectare in the Brazilian Amazon (90% CI) "forest" class, calculated based on Table 14

Pilot Forest Inventory of the Project Area

The vegetation within the project area itself was assessed in a 2001 pilot forest inventory[74], 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[75], 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.

The species list from the pilot forest inventory is provided in Table 17 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%

[73] 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
[74] A. Ribeiro de Barros (2001), 'Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará'.
[75] WWF (2008), "The Encyclopedia of Earth": http://www.eoearth.org/article/Maraj%C3%B3_varzea

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 17 - Species found within the project area[76]

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

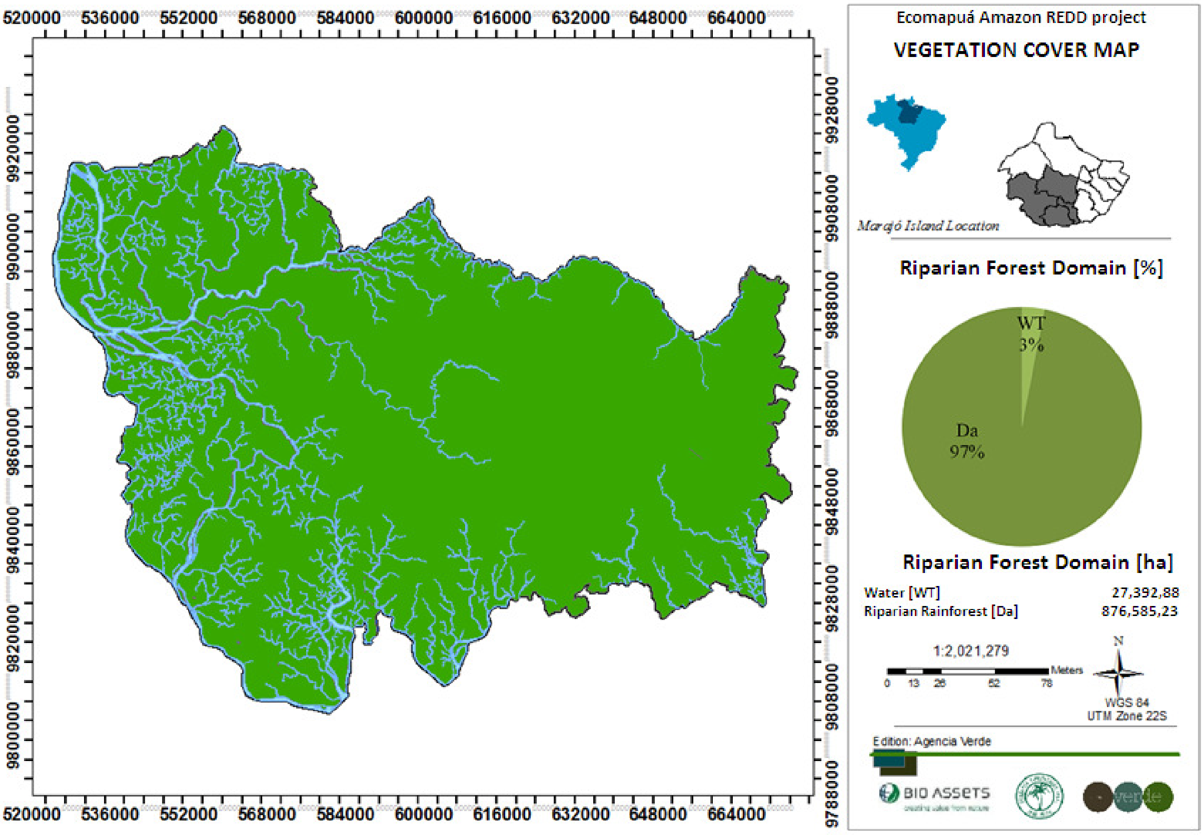


Figure 9 – Vegetation cover of the reference region and project area

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

In order to analyse land use and land cover (LU/LC) prior to project initiation, described in the present section, remote sensing satellite analysis was carried out, which is described below.

<u>Historical reference period</u>

The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. Due to the availability of satellite images, the historical reference period for the present project comprised analysis of images from 1993, 1994, 1995, 1999 and 2001 (Table 18 below). In accordance with the methodology, this period does not exceed 10 – 15 years in span and it ends as close as possible to the REDD project start date (≤2 years). Due to the conditions of the region, some satellite images covering the reference region at the year of 1992 were missing and not available, thus not being possible to complete the whole series. In addition, there was a high cloud-cover level in the available images of this year. Thus, this year was not included into the analysis. The year of 1993 was then utilized to exclude from the project area, forests that are less than 10 years old at the project start date.

<u>Image classification</u>

The first step of the automatic classification of land-use in the reference area was done on Idrisi 17.0 Selva software, using images from the Landsat 5 satellite, and in accordance with its 30m resolution – and that of

PRODES[77] and SIVAM, which were image sources used in classification, and also have 30m resolution – the minimum mapping unit was defined at 30x30m (0.09ha), therefore falling easily to the methodology requirement that the MMU cannot be larger than 1ha. The images were downloaded from the Brazilian National Space Research Institute catalogue[78]. The project reference region is located between scenes 225/061 and 224/061, of the Landsat 5 satellite.

Tests using supervised classification yielded poor quality results in terms of high variation of pixel colour for a single land use, and poor distinction between different land-uses. Therefore unsupervised classification was opted for, using the *cluster* method of the Idrisi software, which identifies land uses by grouping histogram values into their most common values. The results of the unsupervised classification were studied by an analyst in order to identify the land-use classes represented by each group. As satellite scenes are registered on different days, the scenes were classified separately in order to avoid confusion caused by varying weather and atmospheric conditions.

After various unsatisfactory tests using various permutations of bands 1 – 5, good results were obtained using only band 4, clearly showing the forest – non-forest distinction, across practically all scenes and all years concerned. Therefore this was adopted as the methodology for the present project.

A post-classification refinement process was necessary, which involved manual adjustment to remedy cloud obstruction of images, comparing images with previous and subsequent years to determine whether obscured areas were forest or not. This was also necessary to remove "debris", or isolated pixels, left behind by the unsupervised classification method[79].

Finally, the hydrography of the whole region was drawn in a 1:10,000 visualization window based on the Landsat satellite (30m resolution). This same hydrography was applied for each mapped year, as the hydrography itself was invariable.

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	DD/MM/YY	Path	Row
LANDSAT 5	TM	30	0,45 - 12,5	31,820	09/06/1993	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	04/09/1993	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	30/07/1994	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	23/09/1994	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	19/09/1995	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	12/10/1995	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	11/11/1997	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	02/11/1997	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	28/07/1999	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	03/07/1999	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	05/12/2000	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	07/09/2000	225	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	09/07/2001	224	61
LANDSAT 5	TM	30	0,45 - 12,5	31,820	01/08/2001	225	61

Table 18 - Data used for historical reference period

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 maps in figure 10 below.

[77] PRODES weblink: http://www.dpi.inpe.br/prodesdigital/prodes.php
[78] INPE: http://www.dgi.inpe.br/CDSR/

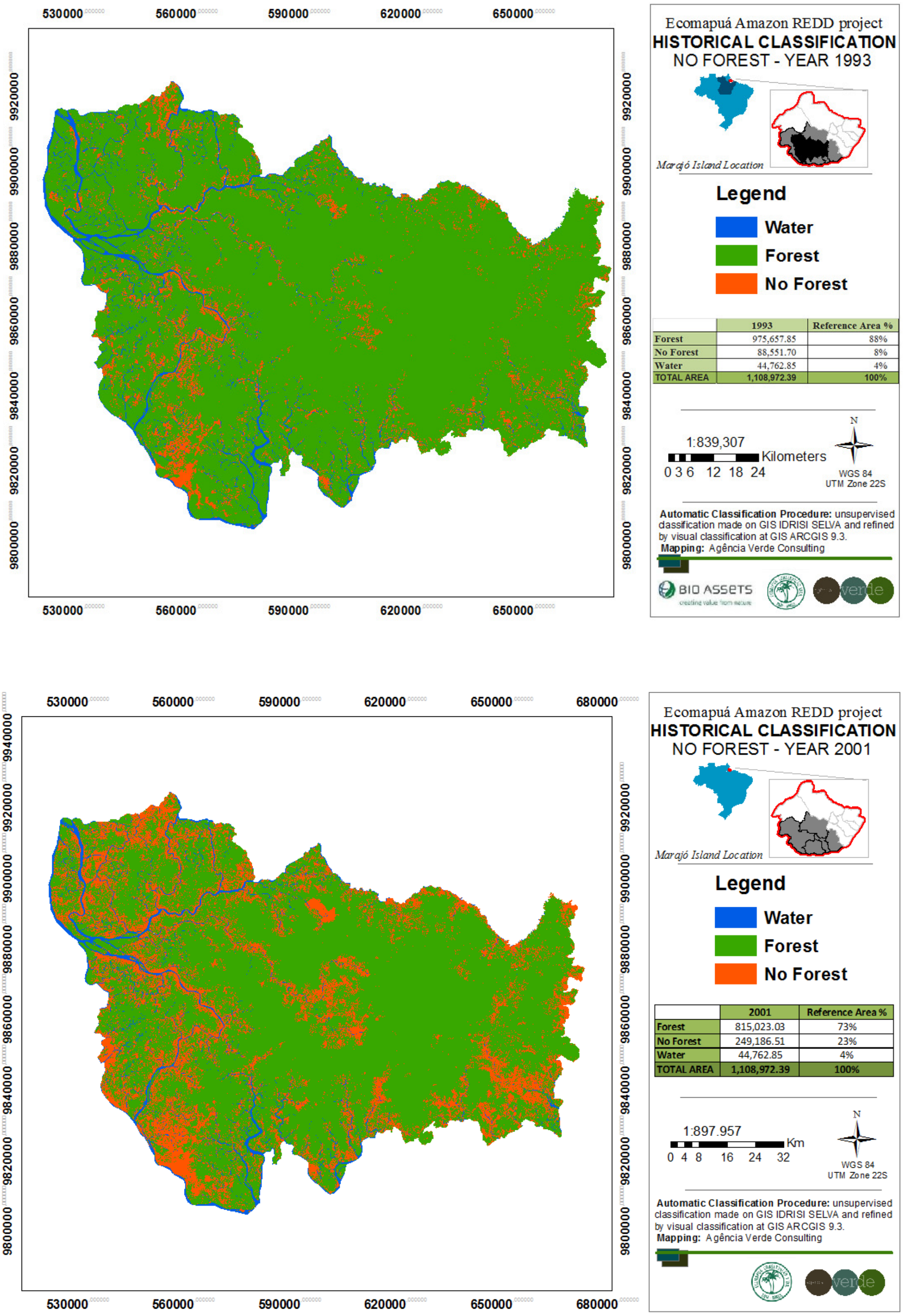


Figure 10 – Forest cover benchmark maps from 1993 and 2001

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law Nº 4.771, 15/09/1965 - D.O.U. of 16/09/65[80]), all rural estates located in forest zones should have:

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

II - Legal Reserve (LR): an area located within a rural property or possession, except for the permanent preservation, necessary for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[81], 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[82].

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[83].

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

1.12 Ownership and Other Programs

1.12.1 Proof of Title

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 Annex II and Annex III.

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[80] BRASIL. Law nº. 4.771, of 15 September 1965. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 16 de set. 1965.

[81] 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.

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

[83] 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.

1.12.2 Emissions Trading Programs and Other Binding Limits

Not applicable.

1.12.3 Participation under Other GHG Programs

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

1.12.4 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, and no VCUs have been assigned to the project area so far.

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

1.12.5 Projects Rejected by Other GHG Programs

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

1.13 Additional Information Relevant to the Project

Eligibility Criteria

This is not a grouped project.

Leakage Management

The leakage management plan and maps of the leakage management area are located in section 1.9, Project Location, of the present VCS-PD.

Commercially Sensitive Information

N/A.

Further Information

N/A.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

Approved VCS Methodology VM0015, version 1.1

Methodology for Avoided Unplanned Deforestation

2.2 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 planned deforestation under the VCS AFOLU Requirements v3.1. 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 section 1.10 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 1993 – 10 years prior to project start date – all of which conformed to the FAO definition of forest [84]. This was ascertained using satellite images, as described in section 1.10 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 section 1.9 of the present VCS-PD, all soil types are mineral, as they are in the entirety of Marajó Island [85,86,87]. Therefore, none of the project area grows on peat, satisfying this applicability criterion.

[84] 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

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

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

[87] 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.*

2.3 Project Boundary

The project area is composed of five properties as described in section 1.9. Given that the coordinates represented by these properties are extensive, the area contour coordinates of the *fazendas* composing the Ecomapuá Amazon REDD Project are presented in Annex 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 Figure 3 (section 1.9), these do not form part of the REDD project.

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 Table 19 below.

Name	Net Forest Area (ha)
Project Area	86,269.83
Leakage Belt	119,037.32

Table 19 – Forested areas within the PA and LK

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	included	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	Not significant.
Harvested wood products	Excluded	Not significant.
Litter	Excluded	Not to be measured according to VCS Program Update of May 24th, 2010
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 Program Update of May 24th, 2010.

Table 20 - 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 section 3.1, baseline emissions.

Sources	Gas	Included/TBD/ excluded	Justification / Explanation of choice
Biomass burning	CO_2	Excluded	No biomass burning increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
	CH_4	Excluded	As above.
	N_2O	Excluded	Considered insignificant according to VCS Program Update of May 24th, 2010.

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.

Table 21 - Sources and GHG included or excluded within the boundary of the proposed AUD project activity

2.4 Baseline Scenario

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 additionality (section 2.5), 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” (section 1.10);
- Non-availability of widely accepted methods for quantifying and monitoring with confidence[88] of the expected type of degradation, which is local fuelwood collection[89,90], via remote sensing, being the method used in the present project.

ANALYSIS OF AGENTS, DRIVERS AND UNDERLYING CAUSES OF DEFORESTATION

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

Importantly, in terms of analysing deforestation patterns, the agents 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. The historical pattern of colonization in the area and available field studies show that the resident families practicing agricultural, commercial timber harvest, and extractivist activities are mainly responsible for deforestation in the area [94,95,96]. The resident families feed the supply chain for all the products concerned[97]. The three agents identified as composing the dynamic of deforestation, therefore, are:

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88 COP 17 (2011), “GOFC – GOLD Sourcebook COP17, Version 1” (p.2 – 110, p.1 – 5)

89 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’

90 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.”

94 Interview: D. Meneses 23.11.12.

95 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.”

- Timber harvesting, both legal and illegal;
- Extraction of palm-heart;
- Deforestation for subsistence agriculture land;

The agents composing the dynamic of deforestation are discussed below:

Timber harvesting

Economic data[107] sources between 1994 and 2010 (see figures 11 – 14 below), show that timber stands out as having the highest values of annual production in the project area municipalities of Breves and Curralinho (figures 11 – 14 below)[108,] where 75% of the project area is located.

The large-scale commercial logging for timber which occurs on Marajó Island is sold on local, national and international markets[109]. The economic demand for timber peaked in Breves municipality in the 1970 and 1980 decades, and has declined since 2000 due to environmentalist pressure[110].However, beyond the high production level shown in official data (figures 11 – 14 below), the production of timber continues to be conducted illegally: studies' estimate that 36% of Brazil's timber production is illegal[111]. Illegal wood harvesting is known to take place within the reference region and project area[112], as shown in Figure 15 below by large quantities of illegal timber 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[113]. This increased the facility and incentive for residents of the project area to carry out deforestation and sale of timber in the baseline case.

Therefore, timber production coupled with subsistence agriculture and extraction of non-timber forest products is the key alternative land use to the project, which would have predominated in the baseline. This contributes to the Project's additionality, as discussed further in section 2.5.

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 olerácea*), 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

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96 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"

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

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

108 Source: IBGE Cidades: http://www.ibge.gov.br/cidadesat/topwindow.htm?1

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

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

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

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

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

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], and the average monthly production of the four municipalities of the project area is 102 tons of palm heart.

Family/ subsistence agriculture

Subsistence agriculture is the foundation of the livelihood of project area and reference region residents[120,121]. Studies of the project area and surroundings[122,123] 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[124].

Degraded and deforested areas within the project have been linked primarily to subsistence farming, specifically planting of manioc[125]. Key aspects of the land use cycle are as follows: approximately 4 hectares are required per family over three years[126,127]. Thus, the agricultural cycle involves the clearing of an approximately 4 hectare plot of land per family to be used for three years, followed by 12 years fallow, and subsequent re-use of the same area[128,129]. 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[130]. 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[137]. The number of families living within the project area itself is estimated at 99, with some 188 families known to be in the reference region.

Thus although subsistence farming is not present in the economic figures (figures 11 – 14 below) due to not participating in the market economy, it is a key component of the deforestation dynamic in the area.

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[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'.

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

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

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

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

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

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

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

[129] 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"

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

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

Annual values of production of agricultural and forest products in the four municipalities of the reference region[140]

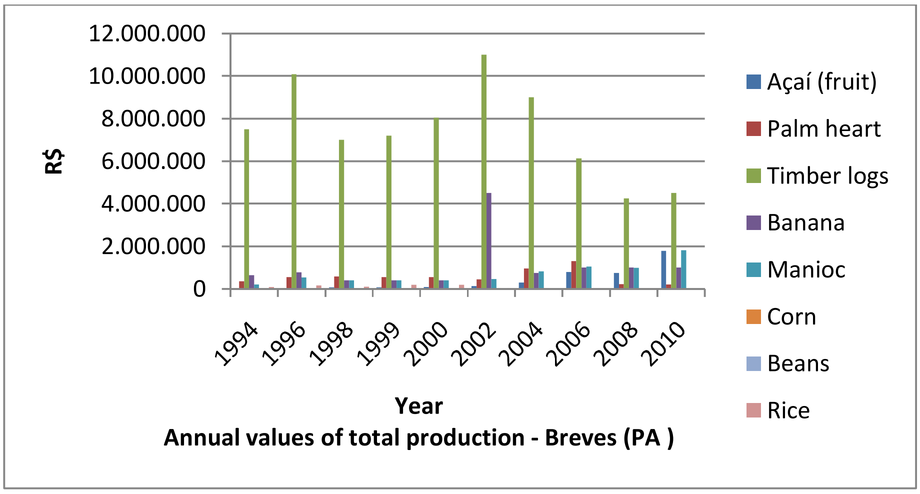


Figure 11 – Annual values of total production in the municipality of Breves (PA)[141]

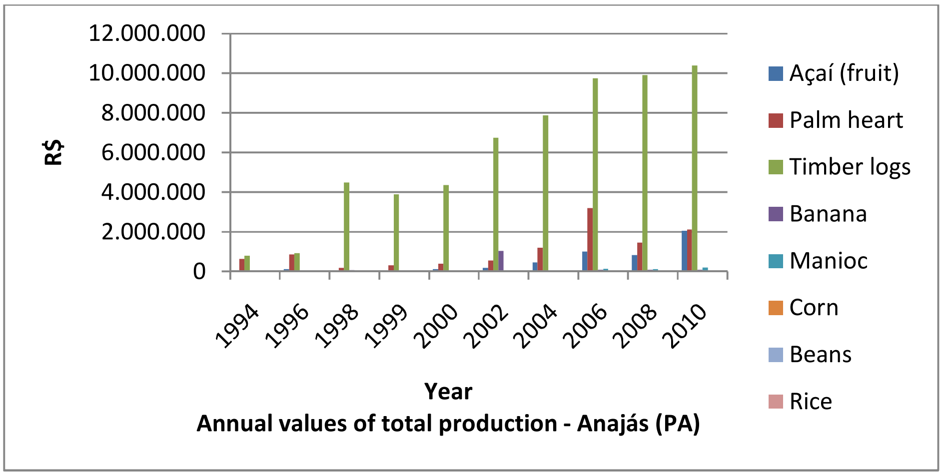


Figure 12 - Annual values of total production in the municipality of Anajás (PA)[142]

[140] Source: IBGE Cidades: http://www.ibge.gov.br/cidadesat/topwindow.htm?1
[141] Source: IBGE Cidades: http://www.ibge.gov.br/cidadesat/topwindow.htm?1
[142] Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

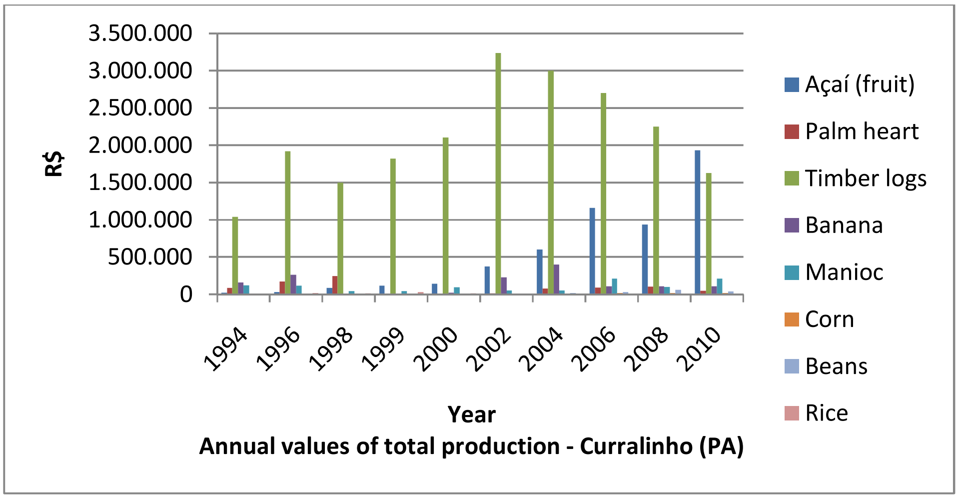


Figure 13 - Annual values of total production in the municipality of Curralinho (PA)[143]

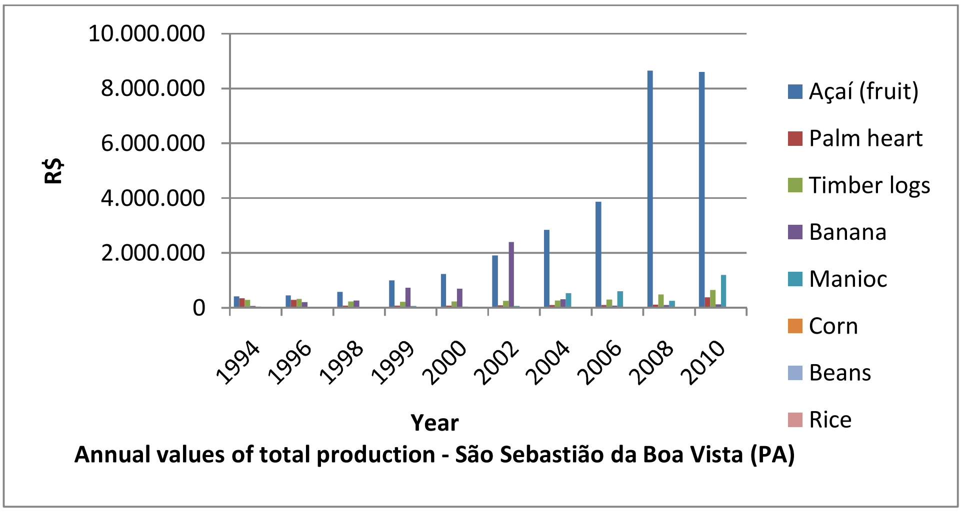


Figure 14 - Annual values of total production in the municipality of São Sebastião da Boa Vista (PA)[144]

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

Figure 15 – *Jangada* tugboat transporting load of illegal logs[145]

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. The predicted completion date of the road is between 2011 and 2015[146], however it has not yet been carried out and the precise date is not known. 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[147]. Figure 16 below shows the PA-159 road connecting the municipalities of Breves and Anajás[148]. This map is from official sources in 2005, displaying the PA-159 road's status as "planned" (Portuguese: planejado).

[145] Photo: Lap Chan
[146] Transportation department of Pará State. Available at: http://www.setran.pa.gov.br/PELT/carteira/arquivos/A%20Carteira%20de%20Projetos%20do%20PELT-Par%C3%A1.pdf
[147] CASARIM, F. et al. (WINROCK International) (2010), "Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil".
[148] Transportation department of Pará State. Available at: http://www.setran.pa.gov.br/img/para_rodovias.pdf

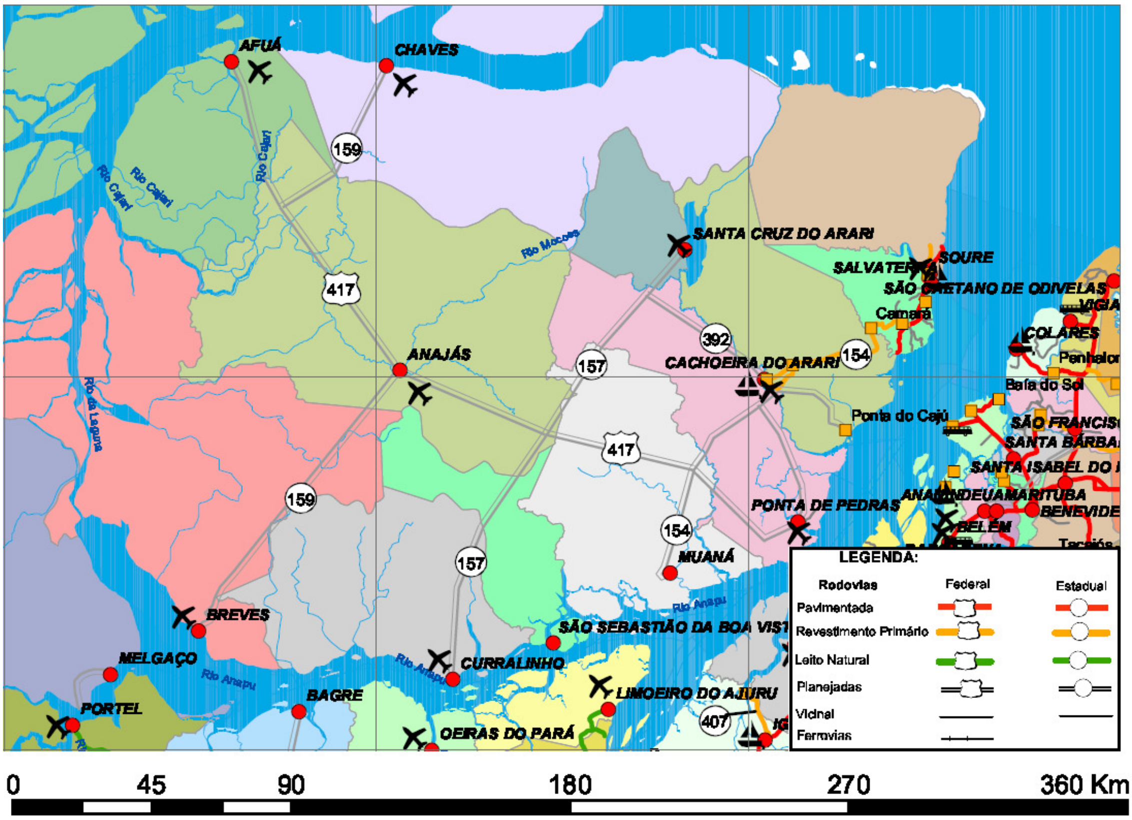


Figure 16. Roads conditions in the Marajó island, year 2005

Description of baseline scenario adopted:

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[149], 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[150]. 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[151,152,153].

The average annual rate of deforestation predicted in the project area over the project crediting period (2003 – 2032) is 0.17%, resulting in the deforestation of a predicted 5% of the Ecomapuá Amazon REDD project area by the end of 2032.

[149] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras".
[150] FADESP (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA: Diagnóstico Socio-Econômico."
[151] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), "Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".
[152] CASARIM, F. et al. (WINROCK International) (2010), "Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil".
[153] 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.

Identification of Drivers of Deforestation

Driver Variables Explaining the Quantity of Deforestation:

As described under the "projection of the location of future deforestation" section below, a regression was carried out between currently deforested areas and future deforestation, which yielded a significant result. This was used in step 4.2 of the methodology which carried out the projection used for calculation of GHG reductions. Brazilian geography and statistics data[154] were used to carry out a regression analysis between the population growth and deforestation rates in the reference region over the historical reference period.
The annual averages of the population growth rate from the municipalities comprising significant proportions of the reference area were gathered. The period analyzed begins in 1994, which was the earliest year with available deforestation data from LANDSAT 5 satellite, and the end of the historical reference period determined the end year of the analysis, 2001.

Year	a) Reference region deforestation (ha)
1994	57,534.52
1995	87,348.97
1999	3,750.26
2001	375.15

Year	Population	b) Average annual population growth rate (%/year)
1991	116,554	
1996	124,015	1.25%
2000	136,160	2.36%
2010	169,062	2.19%

Table 22 – Reference region average population growth rate used to determine correlation with deforestation[155]

As can be seen in Table 22 above, in addition to the decrease in deforestation within the reference region, a slowing down in the population growth rate from the main municipalities comprising the reference region was also verified. This is better shown in Figure 17 below. The population growth rate had increased by 89.3% from 1996 to 2000, and afterwards, it decreased 7.4% from 2000 to 2010.

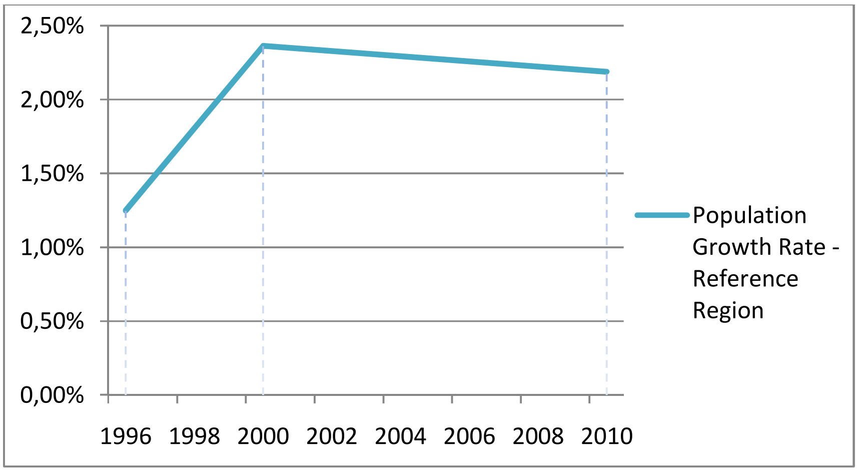


Figure 17. Slowing down of the population growth rate in the reference region

Thus, a correlation between the variables was carried out. It was shown that a significant correlation between the decreasing deforestation and the slowing down population growth rate existed. The deforestation variable

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

was transformed to a log basis, and then, it was compared to the variance of the population growth rate in the same period.

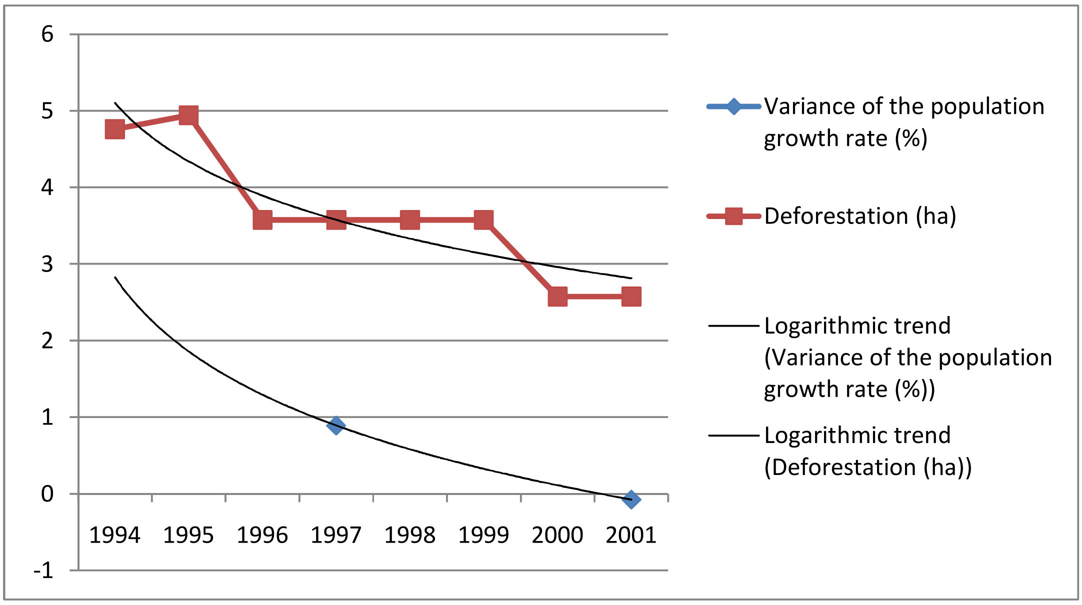


Figure 18 – Reference period trends in: deforestation; variance of the population growth rate

It was concluded from this that population is a variable which significantly predict quantity of future deforestation in a direct relationship. 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 decrease, this variable was used in the selection of the baseline approach, described below, as it suggested that future deforestation would continue to decrease. Another important factor that contributed to the decrease in deforestation in the reference region was the transference of people to urban areas. Between the periods analyzed, the inhabitants who live in urban areas in the region increased from 27% to 42.5%. Moreover, an analysis of the human development index improvement in the municipalities covering the reference region shows a significant increase of more than 40% in the period 1991 – 2000, mainly in the income and education of the population. These can be factors that explain the decrease in the population growth rate in the region[156].

<u>Driver Variables Explaining the Location of Deforestation</u>

As explained below in "projection of future deforestation", Markov chains enabled the calculation of the probability of conversion of a pixel from "forest" to "non-forest" class. The probability of "non-forest" at time t+1 in this methodology depends upon the arrangement of cells of "forest" and "non-forest" at time t. Thus the presence of "non-forest" is a driver variable predicting quantity and location of future deforestation.
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 NTFPs and timber. To this day the 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[157]. This data from

[156] Projeto desenvolvimento sustentável e gestão estratégica dos territórios rurais no estado do Pará. Relatório Analítico do Território do Marajó. Belém: Universidade Federal do Pará, 2012. 79p. Available at: <http://sit.mda.gov.br/download/ra/ra129.pdf>.
[157] Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano De Desenvolvimento Territorial Sustentável Do Arquipélago Do Marajó."

literature, and the projection of the location of future deforestation described below, suggest that proximity to rivers is correlated to the location of deforestation.
Referring to the projection of location of future deforestation step below, the key variable used is presence of “non-forest”. Non-forest itself, in turn, is related to the location of cities, as shown in Figure 19 below.

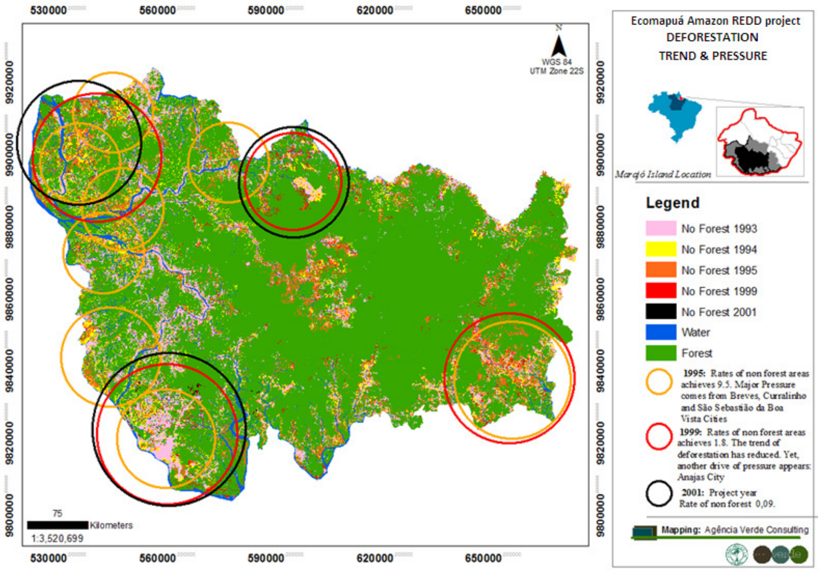


Figure 19 –Deforestation driver pressure from cities

Therefore, conclusive evidence from this analysis of agents and drivers has been found that the future trend in deforestation in the project area will most likely be decreasing.

Analysis of Historical Land Use and Land Cover Change

Up until 2001 the deforestation rate was very high and therefore there is a large proportion of deforested areas in the 2001 land-use and land-cover map (Figure 23 below).

In the reference region, the 1990 – 2000 period displayed an annual average deforestation of 2.36% per year as depicted in Table 23 below (applying r: annual rate of change of forest cover[158], which was also used in deforestation rates below). This is approximately eight times greater than average annual deforestation from 2000 – 2010 (0.3% per year). 1995 was the year with the highest annual deforestation rate with 10%. The tendency in r in the reference region is shown in Figure 20 below.

Meanwhile, in the project area, the greatest observed rate of deforestation was also 1995, the deforestation rate being 5.3% (Table 24 and Figure 21 below). Similarly to the above, comparing the decade of 1990 – 2000 (annual average 1.24%) with that of 2000 – 2010 (0.16% annual average), the deforestation rate declined by 7 times.

Year	Riparian Dense Tropical Rainforest (ha)	Annual deforestation RR (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
1993	975,657.85			
1994	918,123.34	57,534.52	57,534.52	6.08%
1995	830,774.37	87,348.97	144,883.48	10.00%
1999	815,773.34	3,750.26	159,884.52	0.46%
2001	815,023.03	375.15	160,634.82	0.05%
2002	814,064.10	958.93	161,593.75	0.12%

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

2003	811,137.50	2,926.60	164,520.35	0.36%
2004	808,932.00	2,205.50	166,725.85	0.27%
2005	806,783.80	2,148.20	168,874.05	0.27%
2006	804,034.80	2,749.00	171,623.05	0.34%
2007	801,527.50	2,507.30	174,130.35	0.31%
2008	798,764.40	2,763.10	176,893.45	0.35%
2009	795,929.70	2,834.70	179,728.15	0.36%
2010	793,596.90	2,332.80	182,060.95	0.29%
2011	791,301.40	2,295.50	184,356.45	0.29%
2012	788,510.10	2,791.30	187,147.75	0.35%
2013	785,847.30	2,662.80	189,810.55	0.34%
2014	783,728.46	2,118.84	191,929.39	0.27%
2015	783,312.30	416.16	192,345.55	0.05%
2016	780,737.00	2,575.30	194,920.85	0.33%
2017	778,502.70	2,234.30	197,155.15	0.29%
2018	777,867.20	635.50	197,790.65	0.08%
2019	770,595.46	7,271.74	205,062.39	0.94%
2020	769,850.40	745.06	205,807.45	0.10%
2021	765,536.60	4,313.80	210,121.25	0.56%
2022	763,427.10	2,109.50	212,230.75	0.28%
2023	761,291.95	2,135.15	214,365.91	0.28%
2024	758,519.38	2,772.56	217,138.47	0.36%
2025	755,581.01	2,938.37	220,076.85	0.39%
2026	754,915.80	665.21	220,742.05	0.09%
2027	750,691.17	4,224.63	224,966.69	0.56%
2028	748,577.04	2,114.12	227,080.81	0.28%
2029	746,512.96	2,064.09	229,144.90	0.28%
2030	743,853.05	2,659.91	231,804.81	0.36%
2031	740,864.70	2,988.35	234,793.16	0.40%
2032	740,277.80	586.90	235,380.05	0.08%
Average (2002 - 2032)				**0.32%**

Table 23 – Annual deforestation, cumulative deforestation and R in the reference region during historical reference and crediting periods

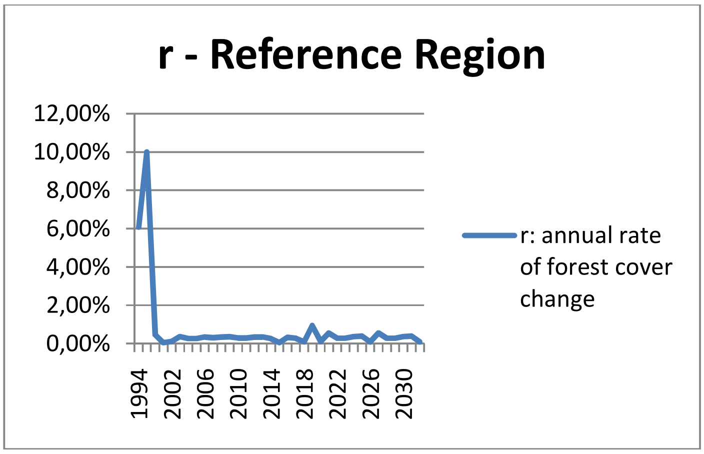


Figure 20 - "r" – annual rate of forest cover change in the reference region for 1993 - 2032

Year	Riparian Dense Tropical Rainforest (ha)	Annual deforestation PA (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
1993	93,973.22			
1994	91,796.06	2,177.15	2,177.15	2.34%
1995	87,033.66	4,762.40	6,939.56	5.33%
1999	86,292.46	185.30	7,680.76	0.21%
2001	86,269.84	11.31	7,703.38	0.01%
2002	86,134.75	135.09	7,838.47	0.16%
2003	85,993.92	140.83	7,979.29	0.16%
2004	85,867.66	126.26	8,105.56	0.15%
2005	85,774.84	92.82	8,198.38	0.11%
2006	85,620.68	154.16	8,352.54	0.18%
2007	85,473.69	146.99	8,499.53	0.17%
2008	85,321.78	151.91	8,651.44	0.18%
2009	85,176.73	145.05	8,796.49	0.17%
2010	85,034.26	142.47	8,938.96	0.17%
2011	84,921.67	112.58	9,051.54	0.13%
2012	84,742.31	179.36	9,230.91	0.21%
2013	84,588.27	154.04	9,384.94	0.18%
2014	84,462.44	125.84	9,510.78	0.15%
2015	84,448.30	14.14	9,524.91	0.02%
2016	84,287.68	160.62	9,685.54	0.19%
2017	84,171.02	116.66	9,802.20	0.14%
2018	84,113.60	57.42	9,859.62	0.07%
2019	83,644.93	468.67	10,328.29	0.56%
2020	83,618.91	26.01	10,354.30	0.03%
2021	83,376.29	242.62	10,596.93	0.29%
2022	83,269.33	106.96	10,703.89	0.13%
2023	83,130.82	138.51	10,842.40	0.17%
2024	82,957.92	172.90	11,015.30	0.21%
2025	82,742.27	215.65	11,230.95	0.26%
2026	82,722.83	19.43	11,250.38	0.02%
2027	82,489.37	233.46	11,483.85	0.28%
2028	82,359.82	129.55	11,613.39	0.16%
2029	82,261.82	98.01	11,711.40	0.12%
2030	82,113.24	148.58	11,859.98	0.18%
2031	81,897.84	215.40	12,075.38	0.26%
2032	81,881.61	16.23	12,091.61	0.02%
Average 2002 – 2032				**0.17%**

Table 24 - Annual deforestation, cumulative deforestation and R in the project area during historical reference and crediting periods

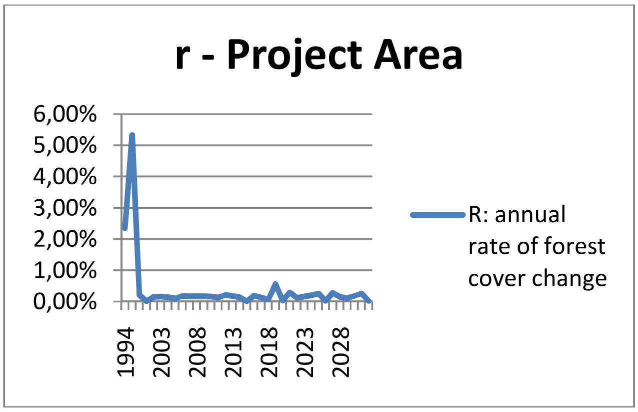
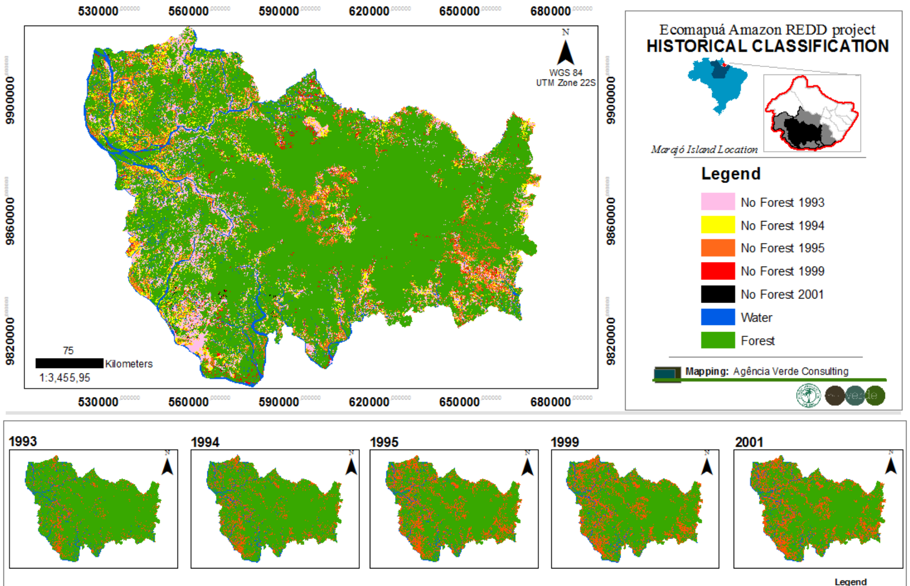


Figure 21 – "r" annual rate of forest cover change in the Project Area from 1993 – 2032

The annual deforestation of years analysed within the historical reference period are also represented in the deforestation map below (Figure 22).



	1993	Reference Area %	1994	Reference Area %	1995	Reference Area %	1999	Reference Area %	2001	Reference Area %
Forest	975,657.85	88%	918,123.34	83%	830,774.37	75%	815,773.34	74%	815,023.03	73%
No Forest	88,551.70	8%	146,086.21	13%	233,435.18	21%	248436.21	22%	294,186.52	27%

Figure 22 - Deforestation map of within reference region over the historical reference period

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

The classes of LU/LC were defined as "forest" and "non-forest" in accordance with the procedures described in section 1.10. These classes are the minimum classes to be considered in the present REDD project as stipulated by the methodology. As such, degradation was not a factor.

As described in section 1.10, stratification was not carried out in either class, and therefore the categories "forest" and "non-forest" have homogenous carbon stocks. Satellite images from 2001, chosen because of image quality, were used to generate the land-use and land-cover map at project start date shown in Figure 23, which meets methodology requirements of being within 2 years ≤ of the latter date.

The LU/LC classes present in the project area, reference region and leakage belt at the project start date are listed in Table 25, which specifies whether logging, fuel wood collection or charcoal production are occurring in the baseline case.

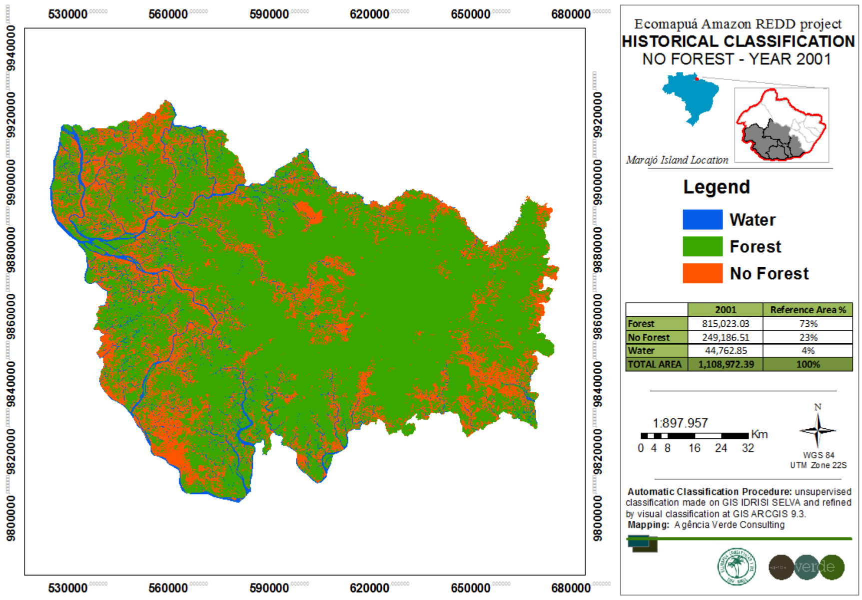


Figure 23 - Land-Use and Land-Cover Map at project start date[159]

Class identifier		Trend in carbon stock[160]	Presence in	Baseline activity			Description (including criteria for unambiguous boundary definition)
IdcI	**Name**			**LG[161]**	**FW**	**CP**	
1	Riparian (Aluvial) Dense Tropical Rainforest	decreasing	RR, PA, LK[162]	no	no	no	The categories were defined through: Analysis of the histogram of bands used, identifying its peaks and using them as a reference for grouping the most common values, associating them with the most common LU/LC types, followed by refinement through visual interpretation of the results.
2	Non forest	increasing	RR, PA, LK	no	no	no	Same as above.

Table 25 – 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 classes 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 project crediting period, in both the baseline and project case, are identified in the potential LU/LC-change matrix (Table 26) and the list of LU/LC-change categories during the project crediting period are shown in (Table 27).

Table 26 shows that deforestation could occur in the baseline and project scenarios within both the PA and LK areas, the hectares in brackets show 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-

[159] Year 2001 meets methodology requirements: ≤ 2 years of project start date
[160] The methodology specifies: Note if “decreasing”, “constant”, or “increasing”.
[161] LG = Logging, FW = Fuel-wood collection; CP = Charcoal Production (yes/no).
[162] RR – Reference region, LK – Leakage belt, LM – Leakage management Areas, PA – Project area.

change map (Figure 24). It is important to note that while the latter shows only deforestation from 1995 – 2001, Table 26 displays deforestation across the whole reference period.

As shown in table 27, degradation was not considered in any of the LU/LC classes, for reasons described at the beginning of the present section. Table 27 also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

		Initial LU/LC class	
Final Class	**Idcl**	**Riparian (Aluvial) Dense Tropical Rainforest in the PA**	**Riparian (Aluvial) Dense Tropical Rainforest in the LK**
	Riparian Dense Tropical Rainforest in the PA	I1/F1 (81,881.61ha)[163]	-
	Riparian Dense Tropical Rainforest in the LK	-	I2/F2 (99,122.46ha)
	Non Forest in the PA	I1/F3 (4,253.14ha)	-
	Non Forest in the LK	-	I2/F4 (19,421.06ha)

Table 26 – Potential land-use and land-cover change matrix showing associated conversion levels over the historical reference period

IDct	Name	Trend in carbon stock	Presence in	Activity in the baseline case			Name	Trend in carbon stock	Presence in	Activity in the project case		
				LG	FW	CP				LG	FW	CP
I1/F1	PA Riparian Dense Tropical Rainforest permanent	constant	PA	no	no	no	PA Riparian Dense Tropical Rainforest permanent	constant	PA	no	no	no
I1/F3	PA Riparian Dense Tropical Rainforest converted	decreasing	PA	no	no	no	PA Riparian Dense Tropical Rainforest converted	decreasing	PA	no	no	no
I2/ F2	LK Riparian Dense Tropical Rainforest permanent	constant	LK	no	no	no	LK Riparian Dense Tropical Rainforest permanent	constant	LK	no	no	no
I2/F4	LK Riparian Dense Tropical Rainforest converted	decreasing	LK	no	no	no	LK Riparian Dense Tropical Rainforest converted	decreasing	LK	no	no	no

Table 27 – List of LU/LC-change categories which could occur in PA and LK during project crediting period

[163] The methodology specifies: Each class shall have a unique identifier (IDcl). The notation I1, I2, etc. indicates "initial" (pre-deforestation) classes, which are all forest classes; and F1, F2 etc. to indicate final" (post-deforestation) classes.

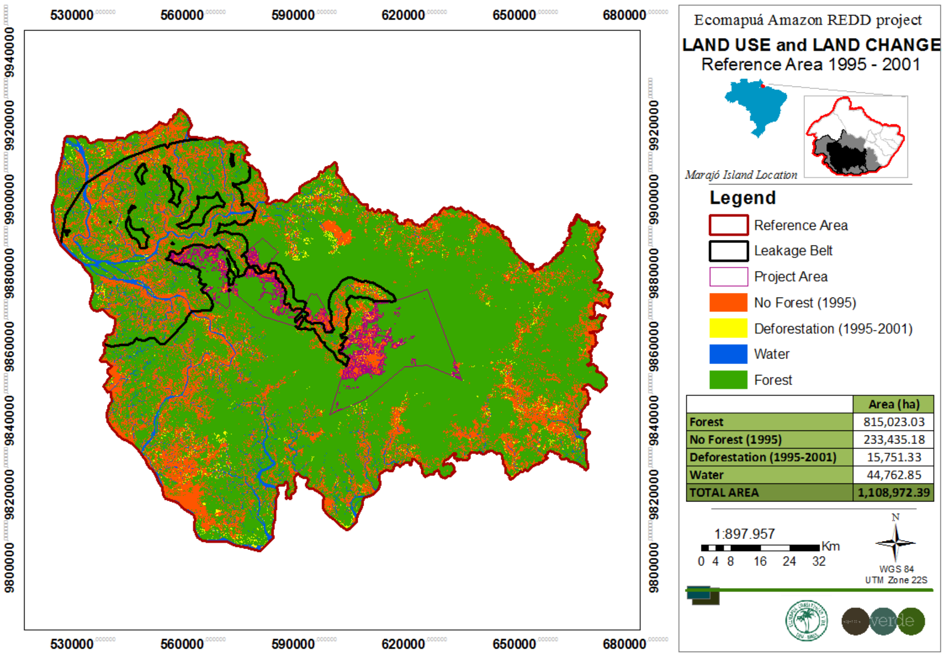


Figure 24 – (1995-2001) LU/LC-change map period in the project area and leakage belt

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.

The "forest" class in each of these areas contains only one stratum, because it consists of only one vegetation type as described in section 1.10, no stratification was carried out.

Selection of Baseline Approach

As shown in Figure 20 (above) a clear decreasing trend in deforestation during the historical reference period within the reference region is present. As explained earlier in section 2.4, conclusive evidence from the analysis of the deforestation dynamic was found to suggest that this trend would continue in the future.

For this reason, approach b., Time function, was adopted to create the baseline.

Regression Analysis

The distance to areas currently deforested was analysed as a predictor of the probability of future deforestation. Thus, the correlation between the following two variables was analysed: i) annual forest/ non-forest map and ii) the map of relative distance between non-forest from 1993 and 2001. The analysis of these variables generated data on, respectively: i) annual deforestation; and ii) difference in historical deforestation.

The variables are inter-dependent, being that the cumulative difference in deforestation is a consequence of the annual deforestation. The sample from 2001 represents the accumulated deforestation across the historical reference period, and therefore this was the input map for the data.

The regression was carried out in a GIS environment (i.e. software IDRISI Selva), and the model of best fit was found to be the non-linear logistical logit regression:

$$R = a + b \times \ln(e)$$

Where,

a = 63.1299

b = -20.881982

The results of the regression are reported below:

Variable/ Statistic name	Mean	Standard Deviation
VDTRF_NF_NATLOG_2	5.10	1.78
BORALA_Train_Flore_to_Nao	0.16	0.37
Pseudo R Square	0.60	-
Receiver Operating Characteristic (ROC)[164]	0.94	-

Table 28 – Results of non-linear logistical logit regression

Table 28 indicates that, the closer an area within the class "forest" is to an area of "non-forest", the higher its probability of deforestation.

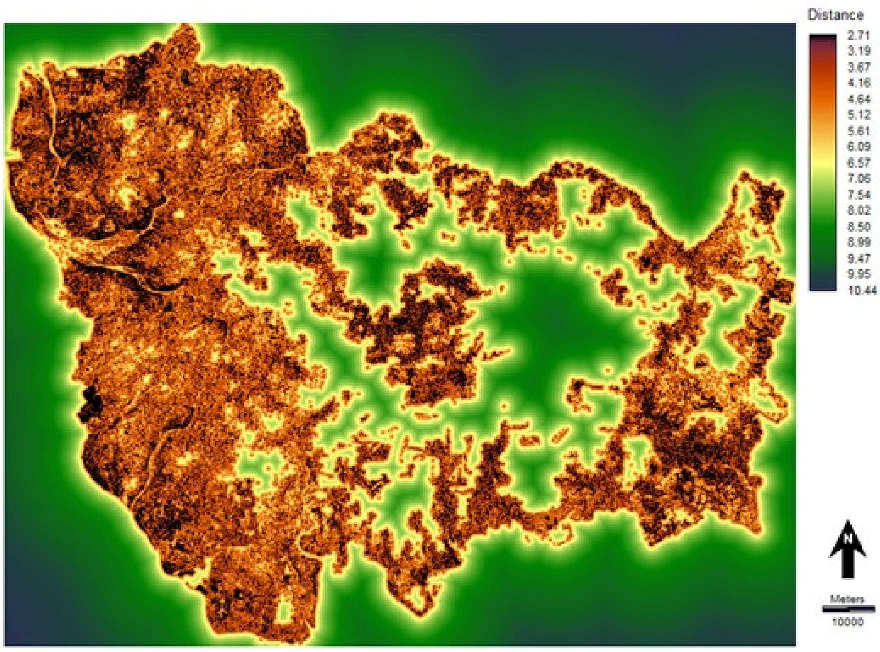


Figure 25 – Deforestation risk map of the reference region, based on distance to "non-forest"

The map above (Figure 25) illustrates the probability of forest becoming non-forest within the reference region, based on the distance to currently deforested areas, generated by the regression described above.

Projection of the quantity and location of future deforestation

Markov chains enabled the modelling of landscape dynamics based on a transition matrix[168]. This technique simulates the landscape state at time t+1 by using the landscape state at time t and taking account of two variables, which were generated year per year: a) transition probabilities and; b) the current distribution of land states in time t. The variable a) transition probabilities – represents the probability of each pixel of a specific class to whether change or not to other class in the period analyzed. The variable b) distribution of land states in time t – represents the landscape state in time t. The Markov chains are linked to these variables, according to the formula below:

$$\Pi(t+1) = Pn \times \Pi(t)$$

Where,

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

$\Pi(t)$ Landscape state at time *t;*

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

In order to fix the problem of the presence of individual pixels in the landscape which did not fit with their surrounding pixels, the technique of cellular automatons was implemented[169], using the *ca_Markov* module of the IDRISI 17.0 Selva software environment. The module employs the following rules governing transition of neighbouring cells:

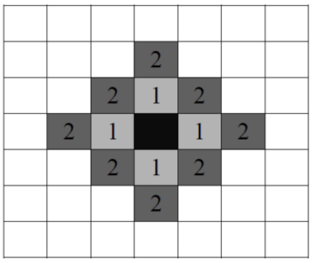


Figure 26 – Von Neumann neighbourhood rules governing pixel transition

According to Figure 26, the state of pixels of at time t+1 is determined by the transition values – which are deterministic rules – corresponding to each pixel[170], i.e., knowing the state of the surrounding pixels, the future state of the analyzed pixel can be predicted.

Thus, in order to project the quantity and location of future deforestation, the following sequence of functions was applied in the GIS Idrisi 17.0 environment to determine the land use scenario from 2003 – 2032: Markov chains; followed by Markov chains coupled with a cellular automata algorithm. Thus, the *ca_Markov* model combines the changing cells concept from cellular automatons with the change probability from Markov chains. According to Pereira (2011), this method provides consistent results when utilized to project the land use change[171].

In order to simulate the scenarios, the land-use maps from 1993 and 2001 were used, as well as the maps generated by the simulation itself, corresponding to the following years: 2009; 2017 and 2025 (see Table 29).

168 MOREIRA, D.A. (2007), "Pesquisa Operacional - Curso Introdutório." Thomson, 23x16x2, e.1, 356pp.
169 VIDICA, P.M. (2007), "Novas abordagens na evolução de autômatos celulares aplicados ao escalonamento de tarefas em multiprocessadores." 236f: il. 2007. Dissertação (mestrado em Ciências da Computação) - Universidade Federal de Uberlândia.
170 WU, F.; WEBSTER, C.J. (2000), "Simulating artificial cities in a GIS environment: urban growth under alternative regulation regimes." Int. j. Geographical Information Science, v.14, n.7, p.625-648.
171 PEREIRA, Gabriel Henrique de Almeida. Simulação do Crescimento das Áreas Antropizadas utilizando Cadeia de Markov e Autômata Celular em Ambiente SIG. Curitiba: Universidade Federal do Paraná, 2011. Available at: <http://www.egal2011.geo.una.ac.cr/index.php?option=com_remository&Itemid=180&func=fileinfo&id=129>.

1993 and 2001 were the maps previously generated through unsupervised classification and subsequent visual refinement as described in section 1.10 "image classification". These maps were in *.tiff* format and contained the previously defined LU/LC classes, namely "forest" and "non-forest". In this way, the simulation was based on the LU/LC maps previously generated.

Input Year 1	Input Year 2	Number of iterations	Year simulated
1993	2001	1	2002
1993	2001	2	2003
1993	2001	3	2004
1993	2001	4	2005
1993	2001	5	2006
1993	2001	6	2007
1993	2001	7	2008
1993	2001	8	2009
2001	2009	1	2010
2001	2009	2	2011
2001	2009	3	2012
2001	2009	4	2013
2001	2009	5	2014
2001	2009	6	2015
2001	2009	7	2016
2001	2009	8	2017
2009	2017	1	2018
2009	2017	2	2019
2009	2017	3	2020
2009	2017	4	2021
2009	2017	5	2022
2009	2017	6	2023
2009	2017	7	2024
2009	2017	8	2025
2017	2025	1	2026
2017	2025	2	2027
2017	2025	3	2028
2017	2025	4	2029
2017	2025	5	2030
2017	2025	6	2031
2017	2025	7	2032

Table 29 – Input maps, iterations and simulated year created by Markov chain and cellular automata procedures

The pixel dimension used was 30 x 30m, determined by the LANDSAT image resolution. The interval between the two input maps for the Markov module was 9 years.

The output of the latter module was:

- A matrix of transition probability expressing the probability of each pixel of a given class changing (or not) to another stipulated category;
- A matrix of transition areas expressing the total area in pixels for the determined study period; and
- A group of conditional probability images, that is, images that represent the probability of each pixel of the study area falling into each of the defined categories in the future.

The following step was to apply the 5 x 5 cellular automata Standard contiguity filter, which follows the Kernel filter. The goal of this filter is to match the pixels to the defined classes. The output of that module is the simulated LU/LC scenario.

Selection of most accurate deforestation risk map

In order to select the most accurate deforestation risk map, "calibration" of the output of the previous step was carried out. 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[172]. The maps from years 1995, 1999 and 2001 were used as the maps to be simulated, as the LU/LC maps corresponding to these years had already been created, as previously described. The Kappa correspondence index in the Idrisi 17.0 software was used for in order to carry out this comparison.

Map accuracy assessment

The comparison of difference between the "real" scenario and the scenarios generated by the classifications was carried out using Kappa statistics, found in the "Crosstab" module of the Idrisi 17.0 Selva software. Specifically, the equation below was used.

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

Where:

K: Kappa index of agreement

N: Number of total observations (e.g. pixels)

c: Number of classes analysed (matrix c x c)

i: number of the column or row (representing the class being analysed)

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

$x_{i+} = \sum_j x_{ij}$: sum of the values of row i (totals row)

$x_{+i} = \sum_j x_{ji}$: sum of the values of column i (totals column)

[172] 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.

The "real" scenario had the reference region as the matrix, which was combined with the maps of waterways as previously described, as well as with the deforestation data from 1976, 1987, 1991, 2000 and 2001, sourced from the Brazilian MMA[173]. These data were compiled in such a way that 2001 was the map closest to the "real" scenario. Therefore, areas of the reference region not classified as deforestation or bodies of water were considered "forest". Using the 2001 map as a reference, the Kappa index was calculated for each year simulated for the Project. This same process was carried out for the classification maps which were visually refined.

The results of the above process are shown in Table 30 below, which specifically show the values of the Kappa calculation for maps from all years, when compared with the "real" 2001 scenario. Initially, a low correspondence level between the 2001 scenario and the various years mapped was found, which was judged to be due to high cloud-cover, making the classification process difficult.

	1994	1995	1999	2001	2001 Scenario
1993	0.2491	0.2750	0.2780	0.2969	0.2259
1994		0.2673	0.1689	0.3395	0.2246
1995			0.2245	0.3563	0.2562
1999				0.2672	0.1549
2001					0.2768

Table 30 – Values found by the Kappa index by comparing two maps created through unsupervised classification

After the refinement, which happened post unsupervised classification, as described under "image classification" above, the maps were again compared using the Kappa index. It was observed that, the nearer the years being compared were to each other, the greater the similarity between them, showing the mapping of the time series was correct. This time, the maps showed much greater similarity when compared with the reference point of 2001, however the values remain largely below 50%. This is most likely due to a discrepancy between the scales used during the classification process:

- Scale used in mapping of the present PD: 1: 10,000
- Scale used for mapping by PRODES[174] : 10: 250,0000

The persisting somewhat low similarity level shown in Table 30, was attributed to two main factors: the large scale used by PRODES, which engenders the generation of large number of polygons; and PRODES's use of different satellites other than LANDSAT in high cloud conditions.

Given the circumstances explained above, the post-refinement average similarity value of 0.38 (Table 31) were considered satisfactory.

	1994	1995	1999	2001	2001 Scenario
1993	0.8001	0.5947	0.5672	0.5659	0.3511
1994		0.7749	0.7432	0.7416	0.3842
1995			0.9661	0.9644	0.3511
1999				0.9983	0.4037
2001					0.4034

Table 31 - Values found by the Kappa índex by comparing two maps created through refinement, post-unsupervised classification

[173] Ministério do Meio Ambiente (MMA): http://mapas.mma.gov.br/i3geo/datadownload.htm
[174] PRODES weblink: http://www.dpi.inpe.br/prodesdigital/prodes.php

The calibration, as described, was carried out through comparison of maps from 1995, 1999 and 2001, with the projection of these same years. The map from 1995 showed a similarity of 71% while 1999 and 2001 both showed 93%. These values were considered highly satisfactory, given that the first three years of the historical reference period, were those showing the highest deforestation rates, which makes the fidelity of the projection challenging.

Beyond the Kappa index, the difference between the years was also checked via the spatial analysis of difference shown in Figure 27. The “non-forest” and “forest” classes were represented by the numbers 1 and 2, respectively, the latter class being predominant in the landscape. Through this analysis, the coherence between the maps was confirmed.

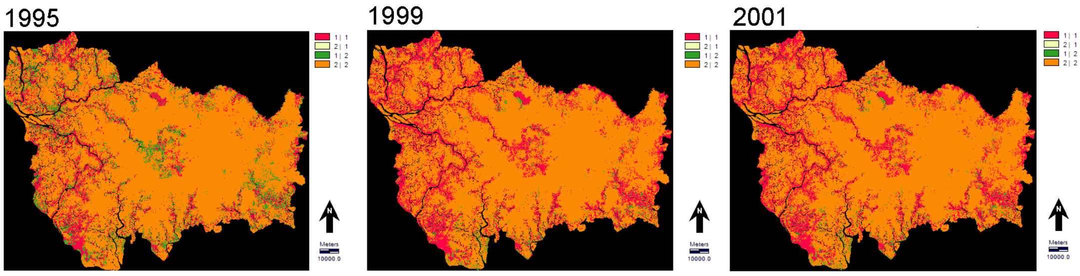


Figure 27 – spatial analysis of coincidence of LU/LC classes in the three years used for calibration. The “non-forest” and “forest” classes were represented by the numbers 1 and 2, respectively

The goal of the above procedures was the simulation of the location of deforestation within the reference region across the project crediting period. This was achieved by applying the Markov chains, generating a probabilities matrix of change from one land-use to another (Table 32), a matrix representing transition from “forest” to “non-forest” in pixels (Table 33) and images of Markovian conditional probabilities (Figure 28)

		2002		
		Non-Forest	Forest	Total
2032	Non-Forest	23.68%	6.83%	30.52%
	Forest	0%	69.48%	69.48%
	Total	23.68%	76.32%	100%

Table 32 – Transition probability matrix from “forest” to “non-forest” from 2002 to 2032

		2002		
		Non-Forest	Forest	Total
2032	Non-Forest	2,800,229	808,073	3,608,302
	Forest	0	8,216,137	8,216,137
	Total	2,800,229	9,024,210	11,824,439

Table 33 – Matrix representing transition from “forest” to “non-forest” in pixels

According to the transition probability matrix (Table 32), there is 0 probability of forest regeneration from 2002 to 2032, being that all transition probability represented deforestation. The same can be confirmed in the matrix of transition (Table 33) in which no pixels moved from the category “non forest” to “forest”.

Based on the Markovian conditional probability maps (Figure 28), it is possible to visualize the spatial information and conduct analyses of the probability of a given land-use being present in a given location at a given year. As only two LU/LC classes were considered, and the input maps (1995 and 2001) showed constant annual deforestation rates, the conditional probability images were exhibited in a binary format, in which there is either 100% or 0% chance of forest being present in a given location, given that there were no other land-uses to undergo change.

The Markovian conditional probability maps enabled the premise of expansion towards "non-forest" areas to be confirmed, that is, the more a region is deforested, the greater the probability of deforestation of adjacent areas. Therefore, following the patterns of anthropic pressure within the reference region, deforestation tends to occur at a constant rate, concentrating along the banks of bodies of water.

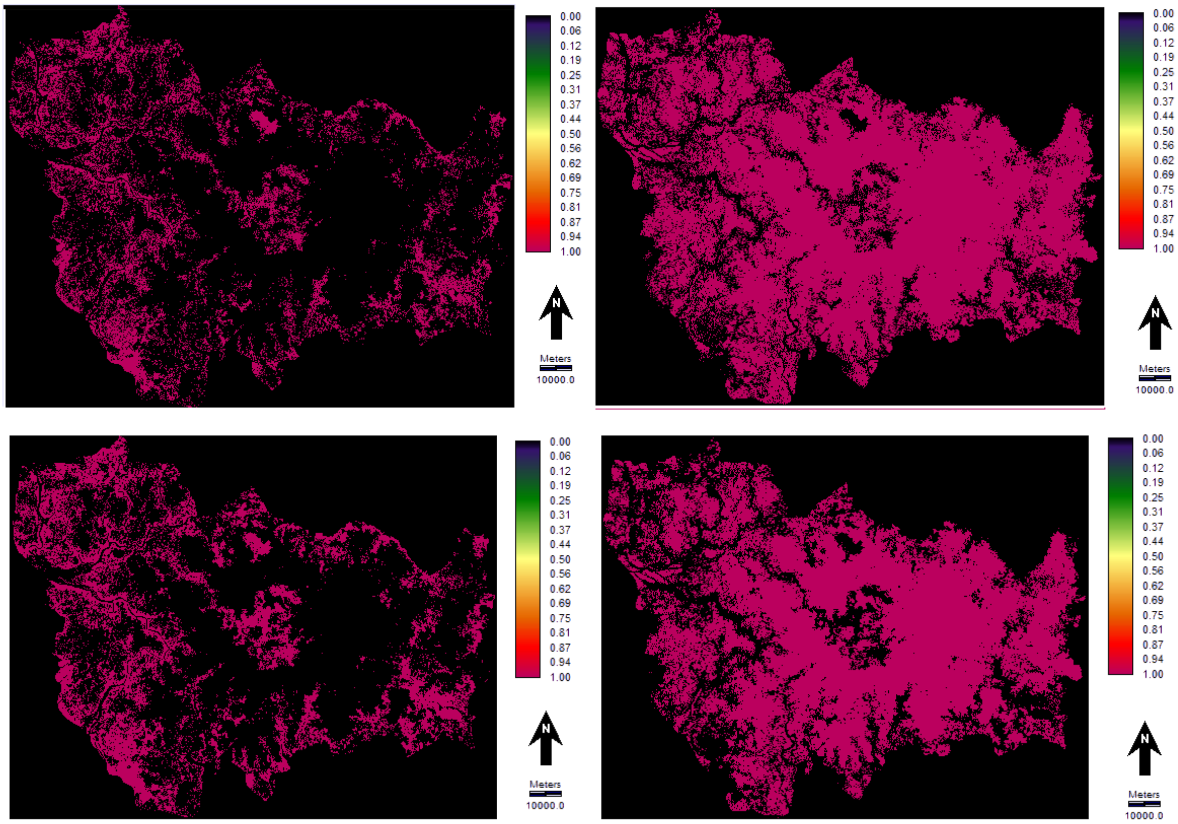


Figure 28 – Markovian conditional probability maps showing (above), conditional probabilities of being: (left) non-forest in 2002; and (right) forest in 2002; and (below): (left) probability of being "non-forest" in 2032; and (right) probability of being "forest" in 2032

An analysis of the projection of future deforestation across the project crediting period was subsequently carried out, using the Kappa index once again. This demonstrated that only 18% of the landscape underwent change from 2002 to 2032. It was observed that the annual rates of change were practically constant from year to year. When the LU/LC-change was analysed at ten year intervals, it was observed that the rate was approximately 8%, always being a transition from "forest" to "non-forest".

In accordance with the location analysis, achieved through the regression procedure described above, the quantity of baseline LU/LC-change was projected throughout the crediting 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. The baseline deforestation within the reference region per stratum is provided in Table 34 below. 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)	
	$ABSLRR^{175}_{i,t}$	Annual ABSLRR t	Cumulative ABSLRR
2003	2,926.60	2,926.60	2,926.60
2004	2,205.50	2,205.50	5,132.10
2005	2,148.20	2,148.20	7,280.30
2006	2,749.00	2,749.00	10,029.30
2007	2,507.30	2,507.30	12,536.60
2008	2,763.10	2,763.10	15,299.70
2009	2,834.70	2,834.70	18,134.40
2010	2,332.80	2,332.80	20,467.20
2011	2,295.50	2,295.50	22,762.70
2012	2,791.30	2,791.30	25,554.00
2013	2,662.80	2,662.80	28,216.80
2014	2,118.84	2,118.84	30,335.64
2015	416.16	416.16	30,751.80
2016	2,575.30	2,575.30	33,327.10
2017	2,234.30	2,234.30	35,561.40
2018	635.50	635.50	36,196.90
2019	7,271.74	7,271.74	43,468.64
2020	745.06	745.06	44,213.70
2021	4,313.80	4,313.80	48,527.50
2022	2,109.50	2,109.50	50,637.00
2023	2,135.15	2,135.15	52,772.15
2024	2,772.56	2,772.56	55,544.72
2025	2,938.37	2,938.37	58,483.09
2026	665.21	665.21	59,148.30
2027	4,224.63	4,224.63	63,372.93
2028	2,114.12	2,114.12	65,487.06
2029	2,064.09	2,064.09	67,551.14
2030	2,659.91	2,659.91	70,211.05
2031	2,988.35	2,988.35	73,199.40
2032	586.90	586.90	73,786.30

Table 34 – Annual areas of baseline deforestation in the reference region across the project crediting period

Table 35 below shows the projected annual deforestation in the sole stratum of “forest” in the project area across the project crediting period, represented by the variable *ABSLPA.*

[175] Annual area of baseline deforestation in stratum *i* within the reference region at year *t*.

Project year t	Stratum i in project area (ha)	Total (ha)	
	ABSLPAi,t[176]	Annual ABSLPAt	Cumulative ABSLPA
2003	140.83	140.83	140.83
2004	126.26	126.26	267.09
2005	92.82	92.82	359.91
2006	154.16	154.16	514.07
2007	146.99	146.99	661.06
2008	151.91	151.91	812.97
2009	145.05	145.05	958.02
2010	142.47	142.47	1,100.49
2011	112.58	112.58	1,213.08
2012	179.36	179.36	1,392.44
2013	154.04	154.04	1,546.48
2014	125.84	125.84	1,672.31
2015	14.14	14.14	1,686.45
2016	160.62	160.62	1,847.07
2017	116.66	116.66	1,963.73
2018	57.42	57.42	2,021.15
2019	468.67	468.67	2,489.82
2020	26.01	26.01	2,515.84
2021	242.62	242.62	2,758.46
2022	106.96	106.96	2,865.42
2023	138.51	138.51	3,003.93
2024	172.90	172.90	3,176.83
2025	215.65	215.65	3,392.48
2026	19.43	19.43	3,411.92
2027	233.46	233.46	3,645.38
2028	129.55	129.55	3,774.93
2029	98.01	98.01	3,872.93
2030	148.58	148.58	4,021.51
2031	215.40	215.40	4,236.91
2032	16.23	16.23	4,253.14

Table 35 – Annual areas of baseline deforestation in the project area

Table 36 below shows the projected annual deforestation in the sole stratum of “forest” in the leakage belt across the project crediting period, represented by the variable *ABSLLK.*

[176] Annual area of baseline deforestation in stratum i within the project area at year t

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	$ABSLLK_{i,t}$[177]	Annual $ABSLLK_t$	Cumulative ABSLLK
2003	769.25	769.25	769.25
2004	586.75	586.75	1,356.00
2005	569.13	569.13	1,925.13
2006	722.48	722.48	2,647.61
2007	650.05	650.05	3,297.66
2008	722.84	722.84	4,020.51
2009	782.64	782.64	4,803.15
2010	550.40	550.40	5,353.55
2011	635.31	635.31	5,988.85
2012	702.74	702.74	6,691.60
2013	617.78	617.78	7,309.38
2014	538.47	538.47	7,847.84
2015	153.73	153.73	8,001.57
2016	685.52	685.52	8,687.09
2017	582.55	582.55	9,269.64
2018	113.17	113.17	9,382.81
2019	1,838.13	1,838.13	11,220.94
2020	255.50	255.50	11,476.44
2021	1,117.90	1,117.90	12,594.34
2022	502.09	502.09	13,096.43
2023	622.29	622.29	13,718.72
2024	717.39	717.39	14,436.11
2025	775.39	775.39	15,211.49
2026	240.43	240.43	15,451.92
2027	1,036.36	1,036.36	16,488.28
2028	603.15	603.15	17,091.43
2029	550.90	550.90	17,642.33
2030	708.11	708.11	18,350.44
2031	860.22	860.22	19,210.66
2032	210.40	210.40	19,421.06

Table 36 - Annual areas of baseline deforestation in the leakage belt

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 number of hectares deforested in each forest class, within the reference region, project area and leakage belt are found in tables 37 – 39 below.

[177] Annual area of baseline deforestation in stratum i within the Leakage Belt at year t

According to the baseline projections of the present project, accumulated deforestation from 2002 – 2032 in the Ecomapuá Amazon REDD project area will sum to 4,253.14ha (Table 38 below). 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".

Area deforested per forest class *icl* within the reference region		**Total baseline deforestation in the reference region**	
Idicl	**1**	**Annual ABSLRRt (ha)**	**ABSLRRt cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year *t*	**ha**		
2003	2,926.60	2,926.60	2,926.60
2004	2,205.50	2,205.50	5,132.10
2005	2,148.20	2,148.20	7,280.30
2006	2,749.00	2,749.00	10,029.30
2007	2,507.30	2,507.30	12,536.60
2008	2,763.10	2,763.10	15,299.70
2009	2,834.70	2,834.70	18,134.40
2010	2,332.80	2,332.80	20,467.20
2011	2,295.50	2,295.50	22,762.70
2012	2,791.30	2,791.30	25,554.00
2013	2,662.80	2,662.80	28,216.80
2014	2,118.84	2,118.84	30,335.64
2015	416.16	416.16	30,751.80
2016	2,575.30	2,575.30	33,327.10
2017	2,234.30	2,234.30	35,561.40
2018	635.50	635.50	36,196.90
2019	7,271.74	7,271.74	43,468.64
2020	745.06	745.06	44,213.70
2021	4,313.80	4,313.80	48,527.50
2022	2,109.50	2,109.50	50,637.00
2023	2,135.15	2,135.15	52,772.15
2024	2,772.56	2,772.56	55,544.72
2025	2,938.37	2,938.37	58,483.09
2026	665.21	665.21	59,148.30
2027	4,224.63	4,224.63	63,372.93
2028	2,114.12	2,114.12	65,487.06
2029	2,064.09	2,064.09	67,551.14
2030	2,659.91	2,659.91	70,211.05
2031	2,988.35	2,988.35	73,199.40
2032	586.90	586.90	73,786.30

Table 37 – 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**	
IDicl	**1**	**Annual ABSLPAt (ha)**	**ABSLPAt cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year *t*	**(ha)**		
2003	140.83	140.83	140.83
2004	126.26	126.26	267.09
2005	92.82	92.82	359.91
2006	154.16	154.16	514.07
2007	146.99	146.99	661.06
2008	151.91	151.91	812.97
2009	145.05	145.05	958.02
2010	142.47	142.47	1,100.49
2011	112.58	112.58	1,213.08
2012	179.36	179.36	1,392.44
2013	154.04	154.04	1,546.48
2014	125.84	125.84	1,672.31
2015	14.14	14.14	1,686.45
2016	160.62	160.62	1,847.07
2017	116.66	116.66	1,963.73
2018	57.42	57.42	2,021.15
2019	468.67	468.67	2,489.82
2020	26.01	26.01	2,515.84
2021	242.62	242.62	2,758.46
2022	106.96	106.96	2,865.42
2023	138.51	138.51	3,003.93
2024	172.90	172.90	3,176.83
2025	215.65	215.65	3,392.48
2026	19.43	19.43	3,411.92
2027	233.46	233.46	3,645.38
2028	129.55	129.55	3,774.93
2029	98.01	98.01	3,872.93
2030	148.58	148.58	4,021.51
2031	215.40	215.40	4,236.91
2032	16.23	16.23	4,253.14

Table 38 – 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**	
IDicl	**1**	**Annual ABSLLKt (ha)**	**ABSLLKt cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**ha**		
2003	769.25	769.25	769.25
2004	586.75	586.75	1,356.00
2005	569.13	569.13	1,925.13
2006	722.48	722.48	2,647.61
2007	650.05	650.05	3,297.66
2008	722.84	722.84	4,020.51
2009	782.64	782.64	4,803.15
2010	550.40	550.40	5,353.55
2011	635.31	635.31	5,988.85
2012	702.74	702.74	6,691.60
2013	617.78	617.78	7,309.38
2014	538.47	538.47	7,847.84
2015	153.73	153.73	8,001.57
2016	685.52	685.52	8,687.09
2017	582.55	582.55	9,269.64
2018	113.17	113.17	9,382.81
2019	1,838.13	1,838.13	11,220.94
2020	255.50	255.50	11,476.44
2021	1,117.90	1,117.90	12,594.34
2022	502.09	502.09	13,096.43
2023	622.29	622.29	13,718.72
2024	717.39	717.39	14,436.11
2025	775.39	775.39	15,211.49
2026	240.43	240.43	15,451.92
2027	1,036.36	1,036.36	16,488.28
2028	603.15	603.15	17,091.43
2029	550.90	550.90	17,642.33
2030	708.11	708.11	18,350.44
2031	860.22	860.22	19,210.66
2032	210.40	210.40	19,421.06

Table 39 – 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 as the initial class in tables 40 – 42 below, which depict baseline activity data per post-deforestation forest class in the reference region, project area, and leakage belt, respectively.

The maps of annually deforested areas per class across the project crediting period in the project scenario are also shown in figures 29 – 31 below, which correspond to values in tables 40 to 42.

Area established after deforestation per zone within the reference region		**Total baseline deforestation in the reference region**	
ID*ct*	**2**	**ABSLRRt**	**ABSLRRt**
Name	Non forest	**annual**	**cumulative**
Project year	**ha**	**ha**	**ha**
2003	2,926.60	2,926.60	2,926.60
2004	2,205.50	2,205.50	5,132.10
2005	2,148.20	2,148.20	7,280.30
2006	2,749.00	2,749.00	10,029.30
2007	2,507.30	2,507.30	12,536.60
2008	2,763.10	2,763.10	15,299.70
2009	2,834.70	2,834.70	18,134.40
2010	2,332.80	2,332.80	20,467.20
2011	2,295.50	2,295.50	22,762.70
2012	2,791.30	2,791.30	25,554.00
2013	2,662.80	2,662.80	28,216.80
2014	2,118.84	2,118.84	30,335.64
2015	416.16	416.16	30,751.80
2016	2,575.30	2,575.30	33,327.10
2017	2,234.30	2,234.30	35,561.40
2018	635.50	635.50	36,196.90
2019	7,271.74	7,271.74	43,468.64
2020	745.06	745.06	44,213.70
2021	4,313.80	4,313.80	48,527.50
2022	2,109.50	2,109.50	50,637.00
2023	2,135.15	2,135.15	52,772.15
2024	2,772.56	2,772.56	55,544.72
2025	2,938.37	2,938.37	58,483.09
2026	665.21	665.21	59,148.30
2027	4,224.63	4,224.63	63,372.93
2028	2,114.12	2,114.12	65,487.06
2029	2,064.09	2,064.09	67,551.14
2030	2,659.91	2,659.91	70,211.05
2031	2,988.35	2,988.35	73,199.40
2032	586.90	586.90	73,786.30

Table 40 – Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data zone)

Area established after deforestation per zone within the project area		Total baseline deforestation in the project area	
ID*ct*	**2**	**ABSLPAt**	**ABSLPAt**
Name	Non forest	**annual**	**cumulative**
Project year	**ha**	**ha**	**ha**
2003	140.83	140.83	140.83
2004	126.26	126.26	267.09
2005	92.82	92.82	359.91
2006	154.16	154.16	514.07
2007	146.99	146.99	661.06
2008	151.91	151.91	812.97
2009	145.05	145.05	958.02
2010	142.47	142.47	1,100.49
2011	112.58	112.58	1,213.08
2012	179.36	179.36	1,392.44
2013	154.04	154.04	1,546.48
2014	125.84	125.84	1,672.31
2015	14.14	14.14	1,686.45
2016	160.62	160.62	1,847.07
2017	116.66	116.66	1,963.73
2018	57.42	57.42	2,021.15
2019	468.67	468.67	2,489.82
2020	26.01	26.01	2,515.84
2021	242.62	242.62	2,758.46
2022	106.96	106.96	2,865.42
2023	138.51	138.51	3,003.93
2024	172.90	172.90	3,176.83
2025	215.65	215.65	3,392.48
2026	19.43	19.43	3,411.92
2027	233.46	233.46	3,645.38
2028	129.55	129.55	3,774.93
2029	98.01	98.01	3,872.93
2030	148.58	148.58	4,021.51
2031	215.40	215.40	4,236.91
2032	16.23	16.23	4,253.14

Table 41 - Annual areas deforested in each zone within the project area in the baseline case (baseline activity data zone)

Area established after deforestation per zone within the leakage belt		**Total baseline deforestation in the leakage belt**	
ID*ct*	**2**	**ABSLLKt**	**ABSLLKt**
Name	Non forest	**annual**	**cumulative**
Project year	**ha**	**ha**	**ha**
2003	769.25	769.25	769.25
2004	586.75	586.75	1,356.00
2005	569.13	569.13	1,925.13
2006	722.48	722.48	2,647.61
2007	650.05	650.05	3,297.66
2008	722.84	722.84	4,020.51
2009	782.64	782.64	4,803.15
2010	550.40	550.40	5,353.55
2011	635.31	635.31	5,988.85
2012	702.74	702.74	6,691.60
2013	617.78	617.78	7,309.38
2014	538.47	538.47	7,847.84
2015	153.73	153.73	8,001.57
2016	685.52	685.52	8,687.09
2017	582.55	582.55	9,269.64
2018	113.17	113.17	9,382.81
2019	1,838.13	1,838.13	11,220.94
2020	255.50	255.50	11,476.44
2021	1,117.90	1,117.90	12,594.34
2022	502.09	502.09	13,096.43
2023	622.29	622.29	13,718.72
2024	717.39	717.39	14,436.11
2025	775.39	775.39	15,211.49
2026	240.43	240.43	15,451.92
2027	1,036.36	1,036.36	16,488.28
2028	603.15	603.15	17,091.43
2029	550.90	550.90	17,642.33
2030	708.11	708.11	18,350.44
2031	860.22	860.22	19,210.66
2032	210.40	210.40	19,421.06

Table 42 – Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

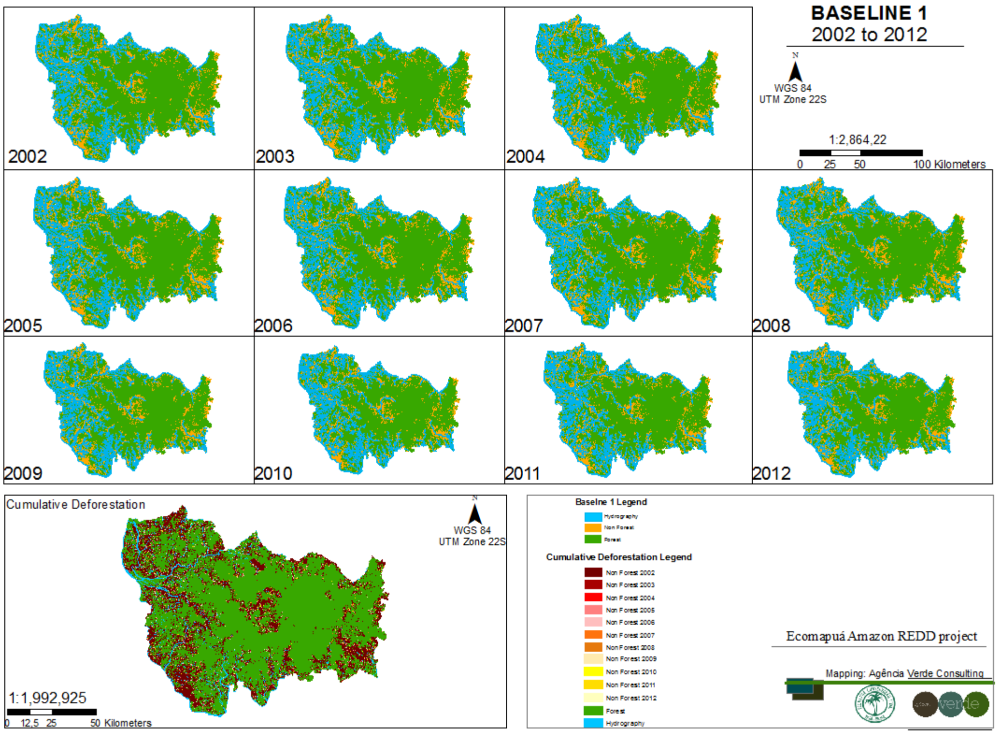


Figure 29 - Maps of baseline deforestation, annual projections in the first fixed baseline period, and cumulative deforestation at the end of the first fixed baseline period

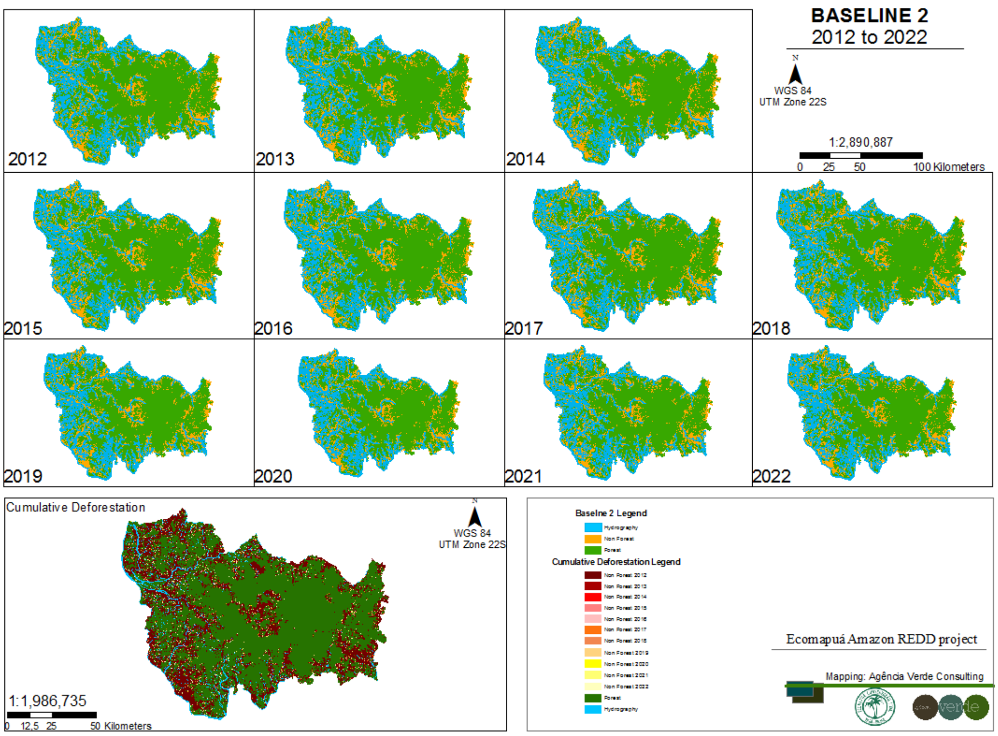


Figure 30 - Maps of baseline deforestation, annual projections in the second baseline period, and cumulative deforestation at the end of the second fixed baseline period

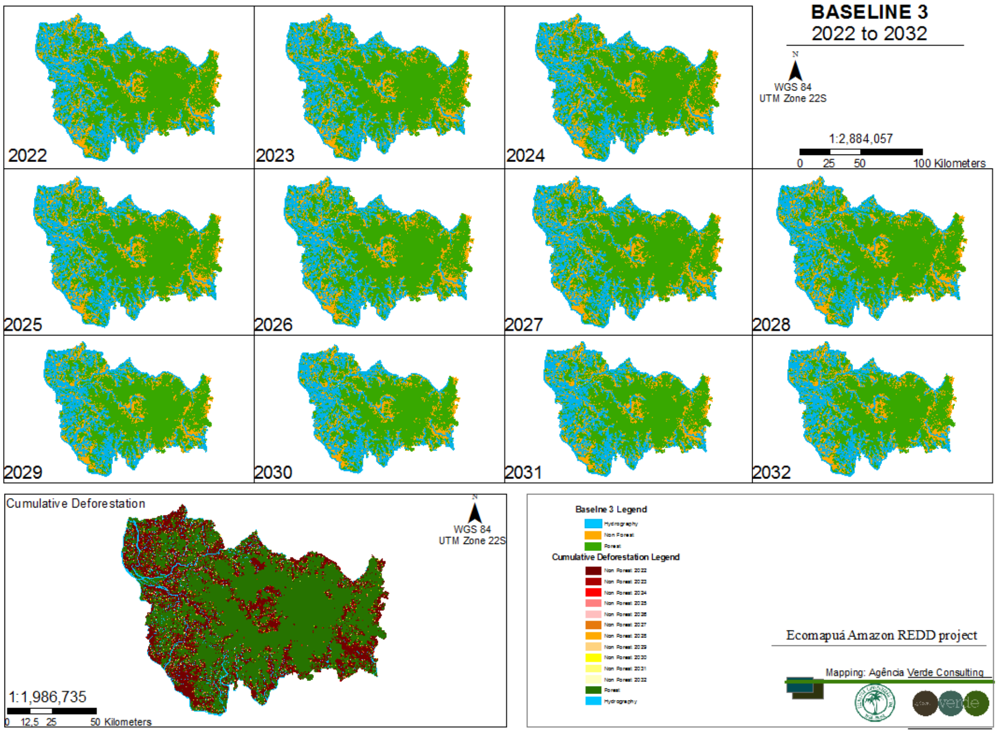


Figure 31 - Maps of baseline deforestation, annual projections in the third baseline period, and cumulative deforestation at the end of the project crediting period

ESTIMATION OF BASELINE CARBON STOCK CHANGES AND NON-CO_2 EMISSIONS

The following is in accordance with step 6 of the methodology, specifically, 6.1.1 Estimation of the average carbon stocks of each LU/LC class, the goal of which is to finalize the baseline assessment by calculating the baseline carbon stock changes.

Thus the Carbon stocks per hectare of initial forest classes *icl* existing in the project area and leakage belt are found in tables 43 – 44 below. To conclude this step, the area-weighted average carbon stocks of the post-deforestation LU/LC classes existing within each zone are displayed in table 45.

Project year	Initial class					
		Name	Riparian Dense Tropical Rainforest			
		IDcl	1			
	Average carbon stock per hectare +- 90% CI					
	Cab*icl*		Cbb*icl*		Ctot*icl*	
	C stock	±90%	C stock	±90%	C stock	±90%
	tCO_2e	tCO_2e/ha	tCO_2e	tCO_2e/ha	tCO_2e	tCO_2e/ha
2003	77,273.69	548.72	15,878.15	112.75	93,151.84	661.47
2004	69,282.49	548.72	14,236.13	112.75	83,518.62	661.47
2005	50,932.73	548.72	10,465.63	112.75	61,398.36	661.47
2006	84,590.85	548.72	17,381.68	112.75	101,972.53	661.47
2007	80,654.54	548.72	16,572.85	112.75	97,227.39	661.47
2008	83,355.71	548.72	17,127.89	112.75	100,483.60	661.47
2009	79,593.43	548.72	16,354.81	112.75	95,948.24	661.47
2010	78,175.00	548.72	16,063.36	112.75	94,238.35	661.47
2011	61,776.99	548.72	12,693.90	112.75	74,470.89	661.47
2012	98,419.11	548.72	20,223.10	112.75	118,642.21	661.47
2013	84,522.45	548.72	17,367.63	112.75	101,890.08	661.47
2014	69,048.35	548.72	14,188.02	112.75	83,236.37	661.47
2015	7,757.06	548.72	1,593.92	112.75	9,350.98	661.47
2016	88,136.72	548.72	18,110.29	112.75	106,247.01	661.47
2017	64,014.26	548.72	13,153.61	112.75	77,167.87	661.47
2018	31,507.50	548.72	6,474.14	112.75	37,981.64	661.47
2019	257,165.91	548.72	52,842.31	112.75	310,008.22	661.47
2020	14,273.84	548.72	2,932.98	112.75	17,206.83	661.47
2021	133,132.28	548.72	27,355.95	112.75	160,488.23	661.47
2022	58,693.11	548.72	12,060.23	112.75	70,753.34	661.47
2023	76,002.17	548.72	15,616.89	112.75	91,619.06	661.47
2024	94,872.56	548.72	19,494.36	112.75	114,366.92	661.47
2025	118,331.22	548.72	24,314.63	112.75	142,645.85	661.47
2026	10,663.96	548.72	2,191.22	112.75	12,855.18	661.47
2027	128,104.38	548.72	26,322.82	112.75	154,427.20	661.47
2028	71,084.14	548.72	14,606.33	112.75	85,690.47	661.47
2029	53,777.92	548.72	11,050.26	112.75	64,828.18	661.47
2030	81,529.61	548.72	16,752.66	112.75	98,282.27	661.47
2031	118,190.86	548.72	24,285.79	112.75	142,476.65	661.47
2032	8,906.09	548.72	1,830.02	112.75	10,736.11	661.47

Table 43 – Carbon stocks per hectare of initial forest classes (icl) existing in the project area

Project year	Initial class					
		Name	Riparian Dense Tropical Rainforest			
		IDcl	1			
	Average carbon stock per hectare +- 90% CI					
	Cab*icl*		Cbb*icl*		Ctot*icl*	
	C stock	±90%	C stock	±90%	C stock	±90%
	tCO_2e	tCO_2e/ha	tCO_2e	tCO_2e/ha	tCO_2e	tCO_2e/ha
2003	422,098.60	548.72	86,732.59	112.75	508,831.19	661.47
2004	321,961.16	548.72	66,156.40	112.75	388,117.56	661.47
2005	312,290.17	548.72	64,169.21	112.75	376,459.39	661.47
2006	396,439.04	548.72	81,460.08	112.75	477,899.12	661.47
2007	356,693.37	548.72	73,293.16	112.75	429,986.53	661.47
2008	396,636.13	548.72	81,500.58	112.75	478,136.71	661.47
2009	429,447.90	548.72	88,242.72	112.75	517,690.62	661.47
2010	302,014.12	548.72	62,057.70	112.75	364,071.82	661.47
2011	348,603.67	548.72	71,630.89	112.75	420,234.56	661.47
2012	385,606.52	548.72	79,234.22	112.75	464,840.74	661.47
2013	338,985.41	548.72	69,654.54	112.75	408,639.95	661.47
2014	295,466.73	548.72	60,712.34	112.75	356,179.07	661.47
2015	84,354.21	548.72	17,333.06	112.75	101,687.27	661.47
2016	376,155.70	548.72	77,292.27	112.75	453,447.96	661.47
2017	319,655.45	548.72	65,682.63	112.75	385,338.07	661.47
2018	62,096.75	548.72	12,759.61	112.75	74,856.35	661.47
2019	1,008,611.01	548.72	207,248.84	112.75	1,215,859.85	661.47
2020	140,198.94	548.72	28,808.00	112.75	169,006.95	661.47
2021	613,411.69	548.72	126,043.50	112.75	739,455.19	661.47
2022	275,503.90	548.72	56,610.39	112.75	332,114.30	661.47
2023	341,459.65	548.72	70,162.94	112.75	411,622.59	661.47
2024	393,643.28	548.72	80,885.61	112.75	474,528.89	661.47
2025	425,467.21	548.72	87,424.77	112.75	512,891.98	661.47
2026	131,927.26	548.72	27,108.34	112.75	159,035.60	661.47
2027	568,666.15	548.72	116,849.21	112.75	685,515.36	661.47
2028	330,957.35	548.72	68,004.93	112.75	398,962.28	661.47
2029	302,287.81	548.72	62,113.93	112.75	364,401.74	661.47
2030	388,553.87	548.72	79,839.84	112.75	468,393.70	661.47
2031	472,018.91	548.72	96,990.19	112.75	569,009.10	661.47
2032	115,449.68	548.72	23,722.54	112.75	139,172.22	661.47

Table 44 – Carbon stocks per hectare of initial forest classes icl existing in the leakage belt

Table 15 b. Of the methodology, which is related to the above tables was not created for the following reason: This table is not applicable due no necessary discounts for uncertainties.

Post – deforestation LU/LC-classes fcl	
Name	Non Forest
IDfcl	2
Cab*fcl* C stock $tCO_2e\ ha^{-1}$	Cbb*fcl* C stock $tCO_2e\ ha^{-1}$
0	0

Table 45 – Long-term (20-years) area weighted average carbon stock per zone

2.5 Additionality

For the purpose of the present analysis the VCS Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities (VT0001) Version 3.0 was applied (hereafter, "the additionality tool").

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

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

As described in section 1.8 of the present VCS-PD, 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[178], timber and palm-heart being the products with the highest average production values in the four municipalities of the project area, as described in detail under section 1.8 of the present VCS-PD. Furthermore, these products are cited as the principal products in studies analysing the economy of the project area specifically[179].

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[180].

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[181]. 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[182].

[178] Source: IBGE Cidades: http://www.ibge.gov.br/cidadesat/topwindow.htm?1
[179] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.
[180] São Paulo, 19.07.01 - "Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.".
[181] Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará.
[182] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.

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[183].

Studies argue that a large proportion of timber activity in Brazil is illegal, for instance SFB argued 36% in 2011[184]. 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[185]. 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[186]. 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[187, 188].

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

[183] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.
[184] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras
[185] IMAZON (2011), "Sistema prevê desmate na Amazônia": http://www.imazon.org.br/imprensa/imazon-na-midia/sistema-preve-desmate-na-amazonia
[186] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.
[187] Herrera (2003), "Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará."
[188] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico".

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 Table 46 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 46 – 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. As described in section 1.8 of the present VCS-PD, 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/index.php/conheca-os-projetos-mapeados

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.**

2.6 Methodology Deviations

- Creation of Table 10 (VM0015 v1.1) was judged not to be necessary as the data utilized to formulate the deforestation scenarios included the area history. Specifically, the procedure did not employ detailed information to develop the scenarios. For example, the presence of communities was not employed as a specific variable to create the factor map, however it was embedded in the deforested area variable and was considered for creation of the scenarios. In this sense, the absence of data relating to certain variables, such as the location of communities, roads and other factors, precluded the possibility of filling out Table 10 and creation of the risk map, the latter being based on the deforestation history.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

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

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

Where,

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

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

Where,

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

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

$$\boldsymbol{\Delta CBSLPAt = \Delta CabBSLPAicl, t + \Delta CbbBSLPAicl, t}$$

Where,

$\Delta CBSLPAt$	Total baseline carbon stock changes in the project area at year *t*; tCO_2e
$\Delta CabBSLPAicl, t$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO_2e
$\Delta CbbBSLPAicl, t$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO_2e

$$\boldsymbol{\Delta CabBSLPAicl, t = ABSLPAicl, t \times \Delta Cabicl}$$

Where,

$\Delta CabBSLPAicl,t$ Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO_2e

$ABSLPAicl,t$ Area of initial forest class *icl* deforested at time *t* within the project area in the baseline case; ha

$\Delta Cabicl$ Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class *icl*; $tCO_2e\ ha^{-1}$

$$\Delta \boldsymbol{CbbBSLPAicl,t} = \boldsymbol{ABSLPAicl,t} \times \Delta \boldsymbol{Cbbicl}$$

Where,

$\Delta CbbBSLPAicl,t$ Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO_2e

$ABSLPAicl,t$ Area of initial forest class *icl* deforested at time *t* within the project area in the baseline case; ha

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

The Methodology step 6.1.3 stipulates that various change factors must be applied to the baseline case initial and post-deforestation classes in above-ground and below ground biomass. The carbon stocks in various pools are stipulated in section 2.3 of the present VCS-PD. As such, tables 47 – 49 below show carbon stock change factors for initial forest classes in above and below-ground carbon pools, which were then applied to calculate baseline carbon stock changes in various classes and pools shown in tables 50 – 57.

Year after deforestation		ΔCbb*icl,t*
		tCO_2e/ha
1	t*	-11.28
2	t*+1	-11.28
2	t*+2	-11.28
4	t*+3	-11.28
5	t*+4	-11.28
6	t*+5	-11.28
7	t*+6	-11.28
8	t*+7	-11.28
9	t*+8	-11.28
10	t*+9	-11.28
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*+20	0
22	t*+21	0
23	t*+22	0
24	t*+23	0
25	t*+24	0
26	t*+25	0
27	t*+26	0
28	t*+27	0
29	t*+28	0
30	t*+29	0

Table 47 – Carbon stock change factors for initial forest classes (icl) in below-ground carbon stocks (Method 1)

Year after deforestation		$\Delta Cab_{icl,t}$
		tCO_2e/ha
1	t*	-548.72
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*+20	0
22	t*+21	0
23	t*+22	0
24	t*+23	0
25	t*+24	0
26	t*+25	0
27	t*+26	0

28	t*+27	0
29	t*+28	0
30	t*+29	0

Table 48 – Carbon stock change factors for initial forest classes icl, above-ground carbon stocks (Method 1)

Year after deforestation		ΔCabf*cl,t* (tCO_2e/ha)	ΔCbbf*cl,t* (tCO_2e/ha)
1	t*	0	0
2	t*+1	0	0
2	t*+2	0	0
4	t*+3	0	0
5	t*+4	0	0
6	t*+5	0	0
7	t*+6	0	0
8	t*+7	0	0
9	t*+8	0	0
10	t*+9	0	0
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21	t*+20	0	0
22	t*+21	0	0
23	t*+22	0	0
24	t*+23	0	0
25	t*+24	0	0
26	t*+25	0	0
27	t*+26	0	0
28	t*+27	0	0
29	t*+28	0	0
30	t*+29	0	0

Table 49 – Carbon stock change factors for final classes fcl or zones z (Method 1)

The resulting changes in carbon stock for initial (pre-deforestation) forest classes for the reference region, project area and leakage belt are shown in tables 50 – 57 below.

Carbon stock change in the above-ground biomass per initial forest class			
IDcl	**1**	**Total carbon stock change in the above-ground biomass of initial forest class in the reference region**	
Name	Riparian Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCabBSLRR*icl,t* Annual (tCO_2e)**	**ΔCabBSLRR*icl* Cumulative (tCO_2e)**
2003	1,605,874.20	1,605,874.20	1,605,874.20
2004	1,210,194.61	1,210,194.61	2,816,068.80
2005	1,178,753.14	1,178,753.14	3,994,821.95
2006	1,508,422.12	1,508,422.12	5,503,244.06
2007	1,375,797.30	1,375,797.30	6,879,041.36
2008	1,516,159.02	1,516,159.02	8,395,200.38
2009	1,555,447.14	1,555,447.14	9,950,647.52
2010	1,280,046.24	1,280,046.24	11,230,693.76
2011	1,259,579.11	1,259,579.11	12,490,272.87
2012	1,531,632.83	1,531,632.83	14,021,905.70
2013	1,461,122.74	1,461,122.74	15,483,028.44
2014	1,162,642.82	1,162,642.82	16,645,671.26
2015	228,353.93	228,353.93	16,874,025.19
2016	1,413,110.03	1,413,110.03	18,287,135.22
2017	1,225,997.65	1,225,997.65	19,513,132.87
2018	348,709.44	348,709.44	19,861,842.31
2019	3,990,123.78	3,990,123.78	23,851,966.10
2020	408,827.99	408,827.99	24,260,794.09
2021	2,367,053.96	2,367,053.96	26,627,848.04
2022	1,157,517.37	1,157,517.37	27,785,365.41
2023	1,171,594.86	1,171,594.86	28,956,960.27
2024	1,521,351.30	1,521,351.30	30,478,311.57
2025	1,612,335.17	1,612,335.17	32,090,646.75
2026	365,011.27	365,011.27	32,455,658.02
2027	2,318,126.88	2,318,126.88	34,773,784.90
2028	1,160,055.26	1,160,055.26	35,933,840.16
2029	1,132,598.60	1,132,598.60	37,066,438.75
2030	1,459,536.90	1,459,536.90	38,525,975.65
2031	1,639,756.26	1,639,756.26	40,165,731.91
2032	322,040.67	322,040.67	40,487,772.58

Table 50 - Baseline carbon stock change in the above-ground biomass in the reference region

Carbon stock change in the below-ground biomass per initial forest class			
IDcl	**1**	Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCbbBSLRR*icl,t*** Annual (tCO_2e)	**ΔCbbBSLRR*icl*** Cumulative (tCO_2e)
2003	32,997.41	32,997.41	32,997.41
2004	49,734.03	49,734.03	82,731.44
2005	72,662.86	72,662.86	155,394.30
2006	123,979.90	123,979.90	279,374.20
2007	141,349.04	141,349.04	420,723.24
2008	186,923.71	186,923.71	607,646.96
2009	223,728.70	223,728.70	831,375.66
2010	210,418.56	210,418.56	1,041,794.22
2011	232,935.86	232,935.86	1,274,730.08
2012	314,719.08	314,719.08	1,589,449.15
2013	300,230.70	300,230.70	1,889,679.85
2014	238,899.21	238,899.21	2,128,579.06
2015	46,922.04	46,922.04	2,175,501.10
2016	290,365.08	290,365.08	2,465,866.18
2017	251,917.33	251,917.33	2,717,783.50
2018	71,652.63	71,652.63	2,789,436.13
2019	819,888.45	819,888.45	3,609,324.58
2020	84,005.75	84,005.75	3,693,330.33
2021	486,380.95	486,380.95	4,179,711.28
2022	237,846.03	237,846.03	4,417,557.31
2023	240,738.67	240,738.67	4,658,295.98
2024	312,606.43	312,606.43	4,970,902.41
2025	331,301.75	331,301.75	5,302,204.16
2026	75,002.32	75,002.32	5,377,206.48
2027	476,327.44	476,327.44	5,853,533.92
2028	238,367.52	238,367.52	6,091,901.44
2029	232,725.74	232,725.74	6,324,627.18
2030	299,904.84	299,904.84	6,624,532.02
2031	336,936.22	336,936.22	6,961,468.24
2032	66,172.74	66,172.74	7,027,640.98

Table 51 – Baseline carbon stock change in the below-ground biomass in the reference region

Carbon stock change in the above-ground biomass per initial forest class			
IDcl	**1**	**Total carbon stock change in the above-ground biomass of initial forest class in the project area**	
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCabBSLPA*icl,t* Annual (tCO_2e)**	**ΔCabBSLPA*icl* Cumulative (tCO_2e)**
2003	77,273.69	77,273.69	77,273.69
2004	69,282.49	69,282.49	146,556.18
2005	50,932.73	50,932.73	197,488.91
2006	84,590.85	84,590.85	282,079.75
2007	80,654.54	80,654.54	362,734.29
2008	83,355.71	83,355.71	446,090.00
2009	79,593.43	79,593.43	525,683.43
2010	78,175.00	78,175.00	603,858.43
2011	61,776.99	61,776.99	665,635.42
2012	98,419.11	98,419.11	764,054.52
2013	84,522.45	84,522.45	848,576.98
2014	69,048.35	69,048.35	917,625.33
2015	7,757.06	7,757.06	925,382.40
2016	88,136.72	88,136.72	1,013,519.12
2017	64,014.26	64,014.26	1,077,533.37
2018	31,507.50	31,507.50	1,109,040.87
2019	257,165.91	257,165.91	1,366,206.78
2020	14,273.84	14,273.84	1,380,480.62
2021	133,132.28	133,132.28	1,513,612.90
2022	58,693.11	58,693.11	1,572,306.01
2023	76,002.17	76,002.17	1,648,308.19
2024	94,872.56	94,872.56	1,743,180.75
2025	118,331.22	118,331.22	1,861,511.97
2026	10,663.96	10,663.96	1,872,175.92
2027	128,104.38	128,104.38	2,000,280.30
2028	71,084.14	71,084.14	2,071,364.44
2029	53,777.92	53,777.92	2,125,142.37
2030	81,529.61	81,529.61	2,206,671.97
2031	118,190.86	118,190.86	2,324,862.83
2032	8,906.09	8,906.09	2,333,768.92

Table 52 – Baseline carbon stock change in the above-ground biomass in the project area

Carbon stock change in the below-ground biomass per initial forest class			
IDcl	**1**	**Total carbon stock change in the below-ground biomass of initial forest class in the project area**	
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCbbBSLPA*icl,t* Annual (tCO_2e)**	**ΔCbbBSLPA*icl* Cumulative (tCO_2e)**
2003	1,587.82	1,587.82	1,587.82
2004	2,847.23	2,847.23	4,435.04
2005	3,139.69	3,139.69	7,574.73
2006	6,952.67	6,952.67	14,527.40
2007	8,286.43	8,286.43	22,813.83
2008	10,276.73	10,276.73	33,090.56
2009	11,448.37	11,448.37	44,538.93
2010	12,850.68	12,850.68	57,389.61
2011	11,424.51	11,424.51	68,814.12
2012	20,223.10	20,223.10	89,037.23
2013	17,367.63	17,367.63	106,404.86
2014	14,188.02	14,188.02	120,592.87
2015	1,593.92	1,593.92	122,186.79
2016	18,110.29	18,110.29	140,297.08
2017	13,153.61	13,153.61	153,450.69
2018	6,474.14	6,474.14	159,924.83
2019	52,842.31	52,842.31	212,767.14
2020	2,932.98	2,932.98	215,700.13
2021	27,355.95	27,355.95	243,056.07
2022	12,060.23	12,060.23	255,116.30
2023	15,616.89	15,616.89	270,733.19
2024	19,494.36	19,494.36	290,227.55
2025	24,314.63	24,314.63	314,542.18
2026	2,191.22	2,191.22	316,733.41
2027	26,322.82	26,322.82	343,056.22
2028	14,606.33	14,606.33	357,662.55
2029	11,050.26	11,050.26	368,712.81
2030	16,752.66	16,752.66	385,465.47
2031	24,285.79	24,285.79	409,751.26
2032	1,830.02	1,830.02	411,581.28

Table 53 – Baseline carbon stock change in the below-ground biomass in the project area

Carbon stock change per initial forest class				
IDcl	1		**Total carbon stock change of initial forest class in the project area**	
Name	Riparian (Aluvial) Dense Tropical Rainforest			
Project year	**ΔCabBSLPA*icl,t*** annual	**ΔCbbBSLPA*icl,t*** annual	**annual**	**cumulative**
	tCO_2e	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	77,273.69	1,587.82	78,861.50	78,861.50
2004	69,282.49	2,847.23	72,129.72	150,991.22
2005	50,932.73	3,139.69	54,072.42	205,063.64
2006	84,590.85	6,952.67	91,543.52	296,607.16
2007	80,654.54	8,286.43	88,940.96	385,548.12
2008	83,355.71	10,276.73	93,632.44	479,180.56
2009	79,593.43	11,448.37	91,041.80	570,222.36
2010	78,175.00	12,850.68	91,025.68	661,248.04
2011	61,776.99	11,424.51	73,201.50	734,449.54
2012	98,419.11	20,223.10	118,642.21	853,091.75
2013	84,522.45	17,367.63	101,890.08	954,981.83
2014	69,048.35	14,188.02	83,236.37	1,038,218.21
2015	7,757.06	1,593.92	9,350.98	1,047,569.19
2016	88,136.72	18,110.29	106,247.01	1,153,816.19
2017	64,014.26	13,153.61	77,167.87	1,230,984.06
2018	31,507.50	6,474.14	37,981.64	1,268,965.71
2019	257,165.91	52,842.31	310,008.22	1,578,973.92
2020	14,273.84	2,932.98	17,206.83	1,596,180.75
2021	133,132.28	27,355.95	160,488.23	1,756,668.98
2022	58,693.11	12,060.23	70,753.34	1,827,422.32
2023	76,002.17	15,616.89	91,619.06	1,919,041.37
2024	94,872.56	19,494.36	114,366.92	2,033,408.30
2025	118,331.22	24,314.63	142,645.85	2,176,054.15
2026	10,663.96	2,191.22	12,855.18	2,188,909.33
2027	128,104.38	26,322.82	154,427.20	2,343,336.53
2028	71,084.14	14,606.33	85,690.47	2,429,027.00
2029	53,777.92	11,050.26	64,828.18	2,493,855.18
2030	81,529.61	16,752.66	98,282.27	2,592,137.45
2031	118,190.86	24,285.79	142,476.65	2,734,614.09
2032	8,906.09	1,830.02	10,736.11	2,745,350.21

Table 54 – Total baseline carbon stock change of initial forest class in project area

Carbon stock change in the above-ground biomass per initial forest class			
IDcl	**1**	**Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt**	
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCabBSLLK*icl,t* Annual (tCO_2e)**	**ΔCabBSLLK*icl* Cumulative (tCO_2e)**
2003	422,098.60	422,098.60	422,098.60
2004	321,961.16	321,961.16	744,059.76
2005	312,290.17	312,290.17	1,056,349.93
2006	396,439.04	396,439.04	1,452,788.98
2007	356,693.37	356,693.37	1,809,482.35
2008	396,636.13	396,636.13	2,206,118.48
2009	429,447.90	429,447.90	2,635,566.38
2010	302,014.12	302,014.12	2,937,580.51
2011	348,603.67	348,603.67	3,286,184.18
2012	385,606.52	385,606.52	3,671,790.70
2013	338,985.41	338,985.41	4,010,776.11
2014	295,466.73	295,466.73	4,306,242.84
2015	84,354.21	84,354.21	4,390,597.06
2016	376,155.70	376,155.70	4,766,752.76
2017	319,655.45	319,655.45	5,086,408.20
2018	62,096.75	62,096.75	5,148,504.95
2019	1,008,611.01	1,008,611.01	6,157,115.96
2020	140,198.94	140,198.94	6,297,314.90
2021	613,411.69	613,411.69	6,910,726.60
2022	275,503.90	275,503.90	7,186,230.50
2023	341,459.65	341,459.65	7,527,690.15
2024	393,643.28	393,643.28	7,921,333.44
2025	425,467.21	425,467.21	8,346,800.65
2026	131,927.26	131,927.26	8,478,727.91
2027	568,666.15	568,666.15	9,047,394.06
2028	330,957.35	330,957.35	9,378,351.41
2029	302,287.81	302,287.81	9,680,639.22
2030	388,553.87	388,553.87	10,069,193.09
2031	472,018.91	472,018.91	10,541,212.00
2032	115,449.68	115,449.68	10,656,661.68

Table 55 – Baseline carbon stock change in the above-ground biomass in the leakage belt area

Carbon stock change in the below-ground biomass per initial forest class			
IDcl	**1**	**Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt**	
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year	**tCO_2e**	**ΔCbbBSLLK*icl,t*** Annual (tCO_2e)	**ΔCbbBSLLK*icl*** Cumulative (tCO_2e)
2003	8,673.26	8,673.26	8,673.26
2004	13,231.28	13,231.28	21,904.54
2005	19,250.76	19,250.76	41,155.30
2006	32,584.03	32,584.03	73,739.33
2007	36,646.58	36,646.58	110,385.91
2008	48,900.35	48,900.35	159,286.26
2009	61,769.90	61,769.90	221,056.16
2010	49,646.16	49,646.16	270,702.32
2011	64,467.80	64,467.80	335,170.12
2012	79,234.22	79,234.22	414,404.34
2013	69,654.54	69,654.54	484,058.88
2014	60,712.34	60,712.34	544,771.22
2015	17,333.06	17,333.06	562,104.28
2016	77,292.27	77,292.27	639,396.54
2017	65,682.63	65,682.63	705,079.17
2018	12,759.61	12,759.61	717,838.77
2019	207,248.84	207,248.84	925,087.61
2020	28,808.00	28,808.00	953,895.61
2021	126,043.50	126,043.50	1,079,939.11
2022	56,610.39	56,610.39	1,136,549.50
2023	70,162.94	70,162.94	1,206,712.45
2024	80,885.61	80,885.61	1,287,598.05
2025	87,424.77	87,424.77	1,375,022.82
2026	27,108.34	27,108.34	1,402,131.16
2027	116,849.21	116,849.21	1,518,980.37
2028	68,004.93	68,004.93	1,586,985.31
2029	62,113.93	62,113.93	1,649,099.24
2030	79,839.84	79,839.84	1,728,939.08
2031	96,990.19	96,990.19	1,825,929.26
2032	23,722.54	23,722.54	1,849,651.80

Table 56 – Baseline carbon stock change in the below-ground biomass in the leakage belt area

Carbon stock change per initial forest class				
IDcl	**1**		**Total carbon stock change of initial forest class in the leakage belt**	
Name	Riparian (Aluvial) Dense Tropical Rainforest			
Project year	**ΔCabBSLLK*icl,t***	**ΔCbbBSLLK*icl,t***	**annual**	**cumulative**
	annual	**annual**		
	tCO_2e	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	422,098.60	8,673.26	430,771.86	430,771.86
2004	321,961.16	13,231.28	335,192.44	765,964.30
2005	312,290.17	19,250.76	331,540.94	1,097,505.24
2006	396,439.04	32,584.03	429,023.07	1,526,528.31
2007	356,693.37	36,646.58	393,339.95	1,919,868.26
2008	396,636.13	48,900.35	445,536.48	2,365,404.74
2009	429,447.90	61,769.90	491,217.81	2,856,622.55
2010	302,014.12	49,646.16	351,660.28	3,208,282.83
2011	348,603.67	64,467.80	413,071.47	3,621,354.30
2012	385,606.52	79,234.22	464,840.74	4,086,195.04
2013	338,985.41	69,654.54	408,639.95	4,494,834.99
2014	295,466.73	60,712.34	356,179.07	4,851,014.06
2015	84,354.21	17,333.06	101,687.27	4,952,701.33
2016	376,155.70	77,292.27	453,447.96	5,406,149.30
2017	319,655.45	65,682.63	385,338.07	5,791,487.37
2018	62,096.75	12,759.61	74,856.35	5,866,343.72
2019	1,008,611.01	207,248.84	1,215,859.85	7,082,203.57
2020	140,198.94	28,808.00	169,006.95	7,251,210.52
2021	613,411.69	126,043.50	739,455.19	7,990,665.71
2022	275,503.90	56,610.39	332,114.30	8,322,780.01
2023	341,459.65	70,162.94	411,622.59	8,734,402.60
2024	393,643.28	80,885.61	474,528.89	9,208,931.49
2025	425,467.21	87,424.77	512,891.98	9,721,823.47
2026	131,927.26	27,108.34	159,035.60	9,880,859.07
2027	568,666.15	116,849.21	685,515.36	10,566,374.43
2028	330,957.35	68,004.93	398,962.28	10,965,336.72
2029	302,287.81	62,113.93	364,401.74	11,329,738.46
2030	388,553.87	79,839.84	468,393.70	11,798,132.16
2031	472,018.91	96,990.19	569,009.10	12,367,141.26
2032	115,449.68	23,722.54	139,172.22	12,506,313.48

Table 57 - Total baseline carbon stock change of initial forest class in leakage belt

3.2 Project Emissions

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

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

$$\Delta \boldsymbol{CUDdPAt} = \Delta \boldsymbol{CBSLPAt} \times (\mathbf{1} - \boldsymbol{EI})$$

Where:

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

$$\Delta \boldsymbol{CPSPAt} = (\Delta \boldsymbol{CPAdPAt} + \Delta \boldsymbol{CUDdPAt}) - \Delta \boldsymbol{CPAiPAt}$$

Where,

$\Delta CPSPAt$	Sum of *ex ante* estimated actual carbon stock changes in the project area at year *t*; tCO_2e
$\Delta CPAdPAt$	Total decrease in carbon stock due to all planned activities at year *t* in the project area; tCO_2e
$\Delta CUDdPAt$	Total *ex ante* actual carbon stock change due to unavoided unplanned deforestation at year *t* in the project area; tCO_2e
$\Delta CPAiPAt$	Total increase in carbon stock due to all planned activities at year *t* in the project area; tCO_2e

The calculation of the effectiveness index was based on the estimated deforestation activity due to the resident families in the baseline case (1993 – 2001) compared to that in the project case (2002 – 2032).

The baseline estimate involved: the general requirement of four hectares of land per family[190,191], which was assumed to include all aspects involved in the dynamic of deforestation (subsistence crops, palm heart, and timber); multiplied by the 99 families known to be resident in the project area[192] including a factor of 2.5% population growth in Furos de Breves[193]; finally the agricultural cycle was taken into account, specifically of clearing of cropland followed by three years of use, a subsequent 12 year fallow period, and then a return to the same area for re-use[194,195].

This was compared to a project scenario calculation which employed a reduction factor owing to the environmental education activities carried out in the project case. These activities currently involve 38 families (38% of project total), which, with the expansion of the social project, was expected to evolve as follows:

[190] 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"
[191] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'
[192] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'.
[193] Source: Instituto Brasileiro de Geografia e Estatística (IBGE)
[194] Casarim, F. et al. (WINROCK International) (2010), "Assessing the potential for generating carbon offsets in the EcoMapuá Conservação properties in the Marajó Island, Brazil".
[195] 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"

- 1st baseline period: 38% of families benefitted
- 2nd baseline period: 63% of families benefitted
- 3rd baseline period: 88% of families benefitted

Applying these reduction factors, the EI, was as follows:

$$EI = \frac{\text{Average annual deforestation in project case (ha)}}{\text{Average annual deforestation in baseline case (ha)}}$$

EI = 17.85%

The **EI** value was defined as 17.85%. It was then applied to the ex-ante estimate of net carbon stock change in the project area under the project scenario, shown in Table 58 below.

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		Total ex ante estimated actual non-CO_2 emissions from forest fires in the project area	
	ΔCPAdPAt annual	ΔCPAdPA cumulative	ΔCPAiPAt annual	ΔCPAiPA cumulative	ΔCUDdPAt annual	ΔCUDdPA cumulative	ΔCPSPAt annual	ΔCPSPA cumulative	EBBPSPAt annual	EBBPSPA cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0	0	0	0	14,074.69	14,074.69	14,074.69	14,074.69	0	0
2004	0	0	0	0	12,873.25	26,947.94	12,873.25	26,947.94	0	0
2005	0	0	0	0	9,650.50	36,598.43	9,650.50	36,598.43	0	0
2006	0	0	0	0	16,338.10	52,936.53	16,338.10	52,936.53	0	0
2007	0	0	0	0	15,873.61	68,810.14	15,873.61	68,810.14	0	0
2008	0	0	0	0	16,710.91	85,521.05	16,710.91	85,521.05	0	0
2009	0	0	0	0	16,248.55	101,769.60	16,248.55	101,769.60	0	0
2010	0	0	0	0	16,245.68	118,015.28	16,245.68	118,015.28	0	0
2011	0	0	0	0	13,064.53	131,079.81	13,064.53	131,079.81	0	0
2012	0	0	0	0	21,174.50	152,254.30	21,174.50	152,254.30	0	0
2013	0	0	0	0	18,184.68	170,438.99	18,184.68	170,438.99	0	0
2014	0	0	0	0	14,855.49	185,294.48	14,855.49	185,294.48	0	0
2015	0	0	0	0	1,668.90	186,963.38	1,668.90	186,963.38	0	0
2016	0	0	0	0	18,962.28	205,925.66	18,962.28	205,925.66	0	0
2017	0	0	0	0	13,772.42	219,698.08	13,772.42	219,698.08	0	0
2018	0	0	0	0	6,778.72	226,476.80	6,778.72	226,476.80	0	0
2019	0	0	0	0	55,328.26	281,805.06	55,328.26	281,805.06	0	0
2020	0	0	0	0	3,070.96	284,876.03	3,070.96	284,876.03	0	0
2021	0	0	0	0	28,642.90	313,518.93	28,642.90	313,518.93	0	0
2022	0	0	0	0	12,627.60	326,146.53	12,627.60	326,146.53	0	0
2023	0	0	0	0	16,351.58	342,498.11	16,351.58	342,498.11	0	0
2024	0	0	0	0	20,411.47	362,909.58	20,411.47	362,909.58	0	0
2025	0	0	0	0	25,458.51	388,368.09	25,458.51	388,368.09	0	0
2026	0	0	0	0	2,294.31	390,662.40	2,294.31	390,662.40	0	0
2027	0	0	0	0	27,561.17	418,223.56	27,561.17	418,223.56	0	0
2028	0	0	0	0	15,293.48	433,517.05	15,293.48	433,517.05	0	0
2029	0	0	0	0	11,570.11	445,087.16	11,570.11	445,087.16	0	0
2030	0	0	0	0	17,540.78	462,627.94	17,540.78	462,627.94	0	0
2031	0	0	0	0	25,428.31	488,056.26	25,428.31	488,056.26	0	0
2032	0	0	0	0	1,916.11	489,972.37	1,916.11	489,972.37	0	0

Table 58 – Total ex ante estimated actual net carbon stock changes and emissions of non-CO_2 gases in the project area

3.3 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 calculated value of which is shown in table 59, below. The ex ante activity displacement leakage was calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This was done by multiplying the estimated baseline carbon stock changes for the project area by a "Displacement Leakage Factor" (*DLF*) representing the percent of deforestation expected to be displaced outside the project boundary. It is calculated as follows:

$$\Delta \boldsymbol{CADLKt} = \Delta \boldsymbol{CBSLPAt} \times \boldsymbol{DLF}$$

Where,

$\Delta CADLKt$ Total decrease in carbon stocks due to displaced deforestation at year *t*; tCO_2e

DLF Displacement leakage factor; %

The actual calculated values for $\Delta CADLKt$, annually and cumulatively, across the project crediting period are shown in Table 65 below.

Leakage prevention activities generating a decrease in carbon stocks should be estimated ex ante and accounted. According to the planned interventions, the projected carbon stocks were estimated in the leakage management areas under the baseline case and project scenario.

$$\Delta \boldsymbol{CLPMLKt} = \Delta \boldsymbol{CBSLLKt} + \Delta \boldsymbol{CPSLKt}$$

Where,

$\Delta CLPMLKt$ Carbon stock decrease due to leakage prevention measures at year *t*; tCO_2e

$\Delta CBSLLKt$ Annual carbon stock changes in leakage management areas in the baseline case at year *t*; tCO_2e

$\Delta CPSLKt$ Total annual carbon stock change in leakage management areas in the project case; tCO_2e

No decrease in carbon stocks due to activities implemented in the leakage management area was identified.

$$\Delta \boldsymbol{CLKt} = \Delta \boldsymbol{CADLKt} + \Delta \boldsymbol{CLPMLKt}$$

Where:

$\Delta CLKt$ Total decrease in carbon stocks within the leakage belt at year *t*; tCO_2e

$\Delta CADLKt$ Total decrease in carbon stocks due to displaced deforestation at year *t*; tCO_2e

$\Delta CLPMLKt$ Carbon stock decrease due to leakage prevention measures at year *t*; tCO_2e

The calculated value of $\Delta CLKt$ in the present project is shown in Table 65 below.

Calculation of displacement leakage factor (DLF)

The displacement leakage factor was based on the following assumptions:

- 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[199,200].
- The proportion of commercial timber per hectare: based on 40 m³/ha of estimated commercial timber within the project area[201] of a total wood volume of 472.08 m³/ha in the region[202] = 8.47%

On the latter assumptions, a baseline scenario of annual leakage was developed applying 8.47% of total baseline deforestation in the project area, which was considered conservative as it applied the factor to all hectares deforested.

To create the project scenario leakage, reduction factors were applied to baseline leakage levels, taking into account environmental education programs implemented by the project. The applied reduction factors were the same as described above in the EI section:

- 1st baseline period: 38% of families benefitted
- 2nd baseline period: 63% of families benefitted
- 3rd baseline period: 88% of families benefitted

Thus the DLF was calculated as:

$$DLF = \frac{\text{Project scenario leakage (ha)}}{\text{Total deforestation within the project area (ha)}}$$

DLF = 3.10%

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 ($\Delta\text{CLPMLKt}$) shall be calculated as explained above. The leakage emissions due to the project activity shall be calculated as follows:

$$\boldsymbol{ELKt = EgLKt + EADLKt}$$

Where:

$ELKt$	Sum of ex ante estimated leakage emissions at year *t*; tCO_2e
$EgLKt$	Emissions from grazing animals in leakage management areas at year *t*; tCO_2e
$EADLKt$	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, such as emissions from grazing animals, fertilizer, or fuel use, were identified.

[199] Interview: D. Meneses 23.11.12.
[200] 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."
[201] A. Ribeiro de Barros (2001), "Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará."
[202] Nogueira, E.M. (2008), "Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira." 151 p, INPA, Manaus

Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
IDct	2	ABSLLKt	ABSLLKt
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2003	769.25	769.25	769.25
2004	586.75	586.75	1,356.00
2005	569.13	569.13	1,925.13
2006	722.48	722.48	2,647.61
2007	650.05	650.05	3,297.66
2008	722.84	722.84	4,020.51
2009	782.64	782.64	4,803.15
2010	550.40	550.40	5,353.55
2011	635.31	635.31	5,988.85
2012	702.74	702.74	6,691.60
2013	617.78	617.78	7,309.38
2014	538.47	538.47	7,847.84
2015	153.73	153.73	8,001.57
2016	685.52	685.52	8,687.09
2017	582.55	582.55	9,269.64
2018	113.17	113.17	9,382.81
2019	1,838.13	1,838.13	11,220.94
2020	255.50	255.50	11,476.44
2021	1,117.90	1,117.90	12,594.34
2022	502.09	502.09	13,096.43
2023	622.29	622.29	13,718.72
2024	717.39	717.39	14,436.11
2025	775.39	775.39	15,211.49
2026	240.43	240.43	15,451.92
2027	1,036.36	1,036.36	16,488.28
2028	603.15	603.15	17,091.43
2029	550.90	550.90	17,642.33
2030	708.11	708.11	18,350.44
2031	860.22	860.22	19,210.66
2032	210.40	210.40	19,421.06

Table 59 – Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

Project year	Carbon stock change in leakage management areas in the baseline case			
	IDc*li* = 1		annual	cumulative
	ABSLLK*icl, t* (ha)	Ctot*icl,t* tCO_2e	ΔCBSLLKt tCO_2e	ΔCBSLLK tCO_2e
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
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
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 60 - Ex ante estimated carbon stock change in leakage management areas in the baseline case

Project year	Carbon stock change in leakage management areas in the project case			
	IDc*li* = 1		annual	cumulative
	APSLKfcl,t (ha)	Ctot*icl,t* tCO_2e	ΔCPSLLKt tCO_2e	ΔCPSLLK tCO_2e
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
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
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 61 – Ex ante estimated carbon stock change in leakage management areas in the project case

Project year	Total stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual ΔCBSLLKt tCO_2e	cumulative ΔCBSLLK tCO_2e	annual ΔCPSLKt tCO_2e	cumulative ΔCPSLK tCO_2e	annual ΔCLPMLKt tCO_2e	cumulative ΔCLPMLK tCO_2e
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
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 62 – Ex ante estimated net carbon stock change in leakage management areas

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total ex ante increase in GHG emissions due to leakage prevention measures	
	annual $\Delta CLPMLK_t$ tCO_2e	cumulative $\Delta CLPMLK$ tCO_2e	annual EgLKt tCO_2e	cumulative EgLK tCO_2e	annual ELPMLKt tCO_2e	cumulative ELPMLK tCO_2e
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
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 63 – Ex ante estimated total emissions above the baseline from leakage prevention activities

Project year	Total ex ante estimated decrease in carbon stocks due to displaced deforestation		Total ex ante estimated increase in GHG emissions due to displaced forest fires	
	Annual	Cumulative	Annual	Cumulative
	ΔCADLK*t*	ΔCADLK*t*	ΔEADLK*t*	ΔEADLK*t*
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	2,448.55	2,448.55	0	0
2004	2,239.54	4,688.09	0	0
2005	1,678.88	6,366.98	0	0
2006	2,842.31	9,209.29	0	0
2007	2,761.51	11,970.80	0	0
2008	2,907.17	14,877.97	0	0
2009	2,826.74	17,704.71	0	0
2010	2,826.24	20,530.94	0	0
2011	2,272.82	22,803.76	0	0
2012	3,683.70	26,487.46	0	0
2013	3,163.56	29,651.02	0	0
2014	2,584.39	32,235.41	0	0
2015	290.34	32,525.74	0	0
2016	3,298.84	35,824.58	0	0
2017	2,395.97	38,220.55	0	0
2018	1,179.28	39,399.83	0	0
2019	9,625.38	49,025.21	0	0
2020	534.25	49,559.46	0	0
2021	4,982.96	54,542.42	0	0
2022	2,196.80	56,739.23	0	0
2023	2,844.66	59,583.89	0	0
2024	3,550.95	63,134.84	0	0
2025	4,428.98	67,563.82	0	0
2026	399.14	67,962.96	0	0
2027	4,794.78	72,757.73	0	0
2028	2,660.58	75,418.32	0	0
2029	2,012.84	77,431.15	0	0
2030	3,051.54	80,482.70	0	0
2031	4,423.73	84,906.42	0	0
2032	333.34	85,239.77	0	0

Table 64 – Ex ante estimated leakage due to activity displacement

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 tCO_2e	cumulative EgLK tCO_2e	annual EADLKt tCO_2e	cumulative EADLK tCO_2e	annual $\Delta CADLK_t$ tCO_2e	cumulative ΔCADLK tCO_2e	annual $\Delta CLPMLK_t$ tCO_2e	cumulative ΔCLPMLK tCO_2e	annual ΔCLKt tCO_2e	cumulative ΔCLK tCO_2e	annual ELK_t tCO_2e	cumulative ELK tCO_2e
2003	0	0	0	0	2,448.55	2,448.55	0	0	2,448.55	2,448.55	0	0
2004	0	0	0	0	2,239.54	4,688.09	0	0	2,239.54	4,688.09	0	0
2005	0	0	0	0	1,678.88	6,366.98	0	0	1,678.88	6,366.98	0	0
2006	0	0	0	0	2,842.31	9,209.29	0	0	2,842.31	9,209.29	0	0
2007	0	0	0	0	2,761.51	11,970.80	0	0	2,761.51	11,970.80	0	0
2008	0	0	0	0	2,907.17	14,877.97	0	0	2,907.17	14,877.97	0	0
2009	0	0	0	0	2,826.74	17,704.71	0	0	2,826.74	17,704.71	0	0
2010	0	0	0	0	2,826.24	20,530.94	0	0	2,826.24	20,530.94	0	0
2011	0	0	0	0	2,272.82	22,803.76	0	0	2,272.82	22,803.76	0	0
2012	0	0	0	0	3,683.70	26,487.46	0	0	3,683.70	26,487.46	0	0
2013	0	0	0	0	3,163.56	29,651.02	0	0	3,163.56	29,651.02	0	0
2014	0	0	0	0	2,584.39	32,235.41	0	0	2,584.39	32,235.41	0	0
2015	0	0	0	0	290.34	32,525.74	0	0	290.34	32,525.74	0	0
2016	0	0	0	0	3,298.84	35,824.58	0	0	3,298.84	35,824.58	0	0
2017	0	0	0	0	2,395.97	38,220.55	0	0	2,395.97	38,220.55	0	0
2018	0	0	0	0	1,179.28	39,399.83	0	0	1,179.28	39,399.83	0	0
2019	0	0	0	0	9,625.38	49,025.21	0	0	9,625.38	49,025.21	0	0
2020	0	0	0	0	534.25	49,559.46	0	0	534.25	49,559.46	0	0
2021	0	0	0	0	4,982.96	54,542.42	0	0	4,982.96	54,542.42	0	0
2022	0	0	0	0	2,196.80	56,739.23	0	0	2,196.80	56,739.23	0	0
2023	0	0	0	0	2,844.66	59,583.89	0	0	2,844.66	59,583.89	0	0
2024	0	0	0	0	3,550.95	63,134.84	0	0	3,550.95	63,134.84	0	0
2025	0	0	0	0	4,428.98	67,563.82	0	0	4,428.98	67,563.82	0	0
2026	0	0	0	0	399.14	67,962.96	0	0	399.14	67,962.96	0	0
2027	0	0	0	0	4,794.78	72,757.73	0	0	4,794.78	72,757.73	0	0

2028	0	0	0	0	2,660.58	75,418.32	0	0	2,660.58	75,418.32	0	0
2029	0	0	0	0	2,012.84	77,431.15	0	0	2,012.84	77,431.15	0	0
2030	0	0	0	0	3,051.54	80,482.70	0	0	3,051.54	80,482.70	0	0
2031	0	0	0	0	4,423.73	84,906.42	0	0	4,423.73	84,906.42	0	0
2032	0	0	0	0	333.34	85,239.77	0	0	333.34	85,239.77	0	0

Table 65 – Ex ante estimated total leakage

3.4 Summary of GHG Emission Reductions and Removals

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

$$\Delta \boldsymbol{REDDt} = (\Delta \boldsymbol{CBSLPAt} + \boldsymbol{EBBBSLPAt}) - (\Delta \boldsymbol{CPSPAt} + \boldsymbol{EBBPSPAt}) - (\Delta \boldsymbol{CLKt} + \boldsymbol{ELKt})$$

Where:

$\Delta REDDt$	*Ex ante* estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year *t*; tCO_2e
$\Delta CBSLPAt$	Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e
$EBBBSLPAt$	Sum of baseline emissions from biomass burning in the project area at year *t*; tCO_2e
$\Delta CPSPAt$	Sum of *ex ante* estimated actual carbon stock changes in the project area at year *t*; tCO_2e **Note:** If $\Delta CPSPAt$ represents a net increase in carbon stocks, a negative sign before the absolute value of $\Delta CPSPAt$ shall be used. If $\Delta CPSPAt$ represents a net decrease, the positive sign shall be used.
$EBBPSPAt$	Sum of (*ex ante* estimated) actual emissions from biomass burning in the project area at year *t*; tCO_2e
$\Delta CLKt$	Sum of *ex ante* estimated leakage net carbon stock changes at year *t*; tCO_2e **Note:** If the cumulative sum of $\Delta CLKt$ within a fixed baseline period is > *0*, $\Delta CLKt$ shall be set to zero.
$ELKt$	Sum of *ex ante* estimated leakage emissions at year *t*; tCO_2e
t	1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

The number of Verified Carbon Units (VCUs) to be generated through the proposed AUD project activity at year *t* is calculated as follows:

$$\boldsymbol{VCUt} = \Delta \boldsymbol{REDDt} - \boldsymbol{VBCt}$$

$$\boldsymbol{VBCt} = (\Delta \boldsymbol{CBSLPAt} - \Delta \boldsymbol{CPSPAt}) \times \boldsymbol{RFt}$$

Where:

$VCUt$	Number of Verified Carbon Units that can be traded at time *t*; t CO_2-e
$\Delta REDDt$	*Ex ante* estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year *t*; tCO_2e
$VBCt$	Number of Buffer Credits deposited in the VCS Buffer at time *t*; t CO_2-e
$\Delta CBSLPAt$	Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e
$\Delta CPSPAt$	Sum of *ex ante* estimated actual carbon stock changes in the project area at year *t*; tCO_2-e ha^{-1}
RFt	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

The RF*t* was estimated using the most recent version of the *VCS-approved AFOLU Non-Permanence Risk Tool* and the resulting value of RFt was 34%.

The specific summary of GHG reductions and removals in the Ecomapuá Amazon REDD project is included in table 66 below. The latter table includes estimates of GHG emissions reduction (REDDt), calculations of buffer and leakage, and the resulting calculation of tradable Verified Carbon Units (VCUt).

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex ante project carbon stock changes		Ex ante project GHG emissions from biomass burning		Ex ante leakage carbon stock changes 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	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCBSLPAt	ΔCBSLPA	ΔEBBBSLPAt	ΔEBBBSLPA	ΔCPSLPAt	ΔCPSLPA	ΔEBBBSPAt	ΔEBBBSPA	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
2003	78,862	78,862	0	0	14,075	14,075	0	0	2,449	2,449	0	0	62,338	62,338	41,143	41,143	21,195	21,195
2004	72,130	150,991	0	0	12,873	26,948	0	0	2,240	4,688	0	0	57,017	119,355	37,631	78,774	19,386	40,581
2005	54,072	205,064	0	0	9,650	36,598	0	0	1,679	6,367	0	0	42,743	162,098	28,210	106,984	14,533	55,113
2006	91,544	296,607	0	0	16,338	52,937	0	0	2,842	9,209	0	0	72,363	234,461	47,759	154,743	24,603	79,717
2007	88,941	385,548	0	0	15,874	68,810	0	0	2,762	11,971	0	0	70,306	304,767	46,401	201,144	23,904	103,621
2008	93,632	479,181	0	0	16,711	85,521	0	0	2,907	14,878	0	0	74,014	378,782	48,849	249,993	25,165	128,786
2009	91,042	570,222	0	0	16,249	101,770	0	0	2,827	17,705	0	0	71,967	450,748	47,497	297,490	24,469	153,254
2010	91,026	661,248	0	0	16,246	118,015	0	0	2,826	20,531	0	0	71,954	522,702	47,489	344,979	24,464	177,719
2011	73,202	734,450	0	0	13,065	131,080	0	0	2,273	22,804	0	0	57,864	580,566	38,190	383,169	19,674	197,392
2012	118,642	853,092	0	0	21,174	152,254	0	0	3,684	26,487	0	0	93,784	674,350	61,897	445,066	31,887	229,279
2013	101,890	954,982	0	0	18,185	170,439	0	0	3,164	29,651	0	0	80,542	754,892	53,157	498,223	27,384	256,663
2014	83,236	1,038,218	0	0	14,855	185,294	0	0	2,584	32,235	0	0	65,796	820,688	43,425	541,648	22,371	279,034
2015	9,351	1,047,569	0	0	1,669	186,963	0	0	290	32,526	0	0	7,392	828,080	4,878	546,526	2,513	281,547
2016	106,247	1,153,816	0	0	18,962	205,926	0	0	3,299	35,825	0	0	83,986	912,066	55,430	601,956	28,555	310,102
2017	77,168	1,230,984	0	0	13,772	219,698	0	0	2,396	38,221	0	0	60,999	973,065	40,259	642,215	20,740	330,842
2018	37,982	1,268,966	0	0	6,779	226,477	0	0	1,179	39,400	0	0	30,024	1,003,089	19,815	662,030	10,208	341,050
2019	310,008	1,578,974	0	0	55,328	281,805	0	0	9,625	49,025	0	0	245,055	1,248,144	161,736	823,766	83,319	424,369
2020	17,207	1,596,181	0	0	3,071	284,876	0	0	534	49,559	0	0	13,602	1,261,745	8,977	832,743	4,625	428,993
2021	160,488	1,756,669	0	0	28,643	313,519	0	0	4,983	54,542	0	0	126,862	1,388,608	83,729	916,472	43,133	472,127
2022	70,753	1,827,422	0	0	12,628	326,147	0	0	2,197	56,739	0	0	55,929	1,444,537	36,913	953,385	19,016	491,142
2023	91,619	1,919,041	0	0	16,352	342,498	0	0	2,845	59,584	0	0	72,423	1,516,959	47,799	1,001,184	24,624	515,766
2024	114,367	2,033,408	0	0	20,411	362,910	0	0	3,551	63,135	0	0	90,405	1,607,364	59,666	1,060,850	30,738	546,504
2025	142,646	2,176,054	0	0	25,459	388,368	0	0	4,429	67,564	0	0	112,758	1,720,122	74,420	1,135,270	38,338	584,842

2026	12,855	2,188,909	0	0	2,294	390,662	0	0	399	67,963	0	0	10,162	1,730,284	6,706	1,141,976	3,455	588,297
2027	154,427	2,343,337	0	0	27,561	418,224	0	0	4,795	72,758	0	0	122,071	1,852,355	80,567	1,222,543	41,504	629,801
2028	85,690	2,429,027	0	0	15,293	433,517	0	0	2,661	75,418	0	0	67,736	1,920,092	44,706	1,267,249	23,030	652,831
2029	64,828	2,493,855	0	0	11,570	445,087	0	0	2,013	77,431	0	0	51,245	1,971,337	33,821	1,301,070	17,423	670,255
2030	98,282	2,592,137	0	0	17,541	462,628	0	0	3,052	80,483	0	0	77,690	2,049,027	51,275	1,352,345	26,415	696,669
2031	142,477	2,734,614	0	0	25,428	488,056	0	0	4,424	84,906	0	0	112,625	2,161,651	74,332	1,426,677	38,292	734,961
2032	10,736	2,745,350	0	0	1,916	489,972	0	0	333	85,240	0	0	8,487	2,170,138	5,601	1,432,278	2,885	737,847

Table 66 - Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and Verified Carbon Units (VCUt)

4 MONITORING

4.1 Data and Parameters Available at Validation

Data Unit / 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.
Any comment:	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 Unit / 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: Nogueira, E.M. (2008), “Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira.” 151 p, INPA, Manaus.
Value applied:	299.3
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.
Any comment:	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 Unit / 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 in Riparian dense tropical rainforest were taken from the following study: Nogueira, E.M. (2008), "Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira." 151 p, INPA, Manaus.
Value applied:	61.5
Justification of choice of data or description of measurement methods and procedures applied:	Following a literature search, the below-ground biomass values of this study were used as they were determined to accurately represent the values of the vegetation within the Project reference region.
Any comment:	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 Unit / Parameter:	**EI**
Data unit:	%
Description:	Ex ante estimated effectiveness index
Source of data:	- Instituto Brasileiro de Geografia e Estatística (IBGE). - Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico', 2002. - Instituto Amazônia Sustentável. Submission of proposal to Nike Mata no Peito Program. São Paulo, 2005. 32 p.
Frequency of monitoring/recording:	In each renewal of fixed baseline period.
Value applied:	17.85
Justification of choice of data or	Following a literature search, the calculation of

description of measurement methods and procedures applied:	the effectiveness index was based on the estimated deforestation activity due to the resident families in the baseline case compared to that in the project case.
Any comment:	Ex post monitoring of the project area will be done to determine deforestation rate and the project emissions.

Data Unit / Parameter:	**DLF**
Data unit:	%
Description:	Displacement Leakage Factor
Source of data:	- Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico', 2002. - A. Ribeiro de Barros (2001), "Inventário Florestal Amostral para empresa Santana Madeiras Ltda. no Município de Breves – Pará." - Nogueira, E.M. (2008), "Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira." 151 p, INPA, Manaus.
Frequency of monitoring/recording:	In each renewal of fixed baseline period.
Value applied:	3.10
Justification of choice of data or description of measurement methods and procedures applied:	The DLF was calculated by assuming that 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.
Any comment:	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.

Data Unit / Parameter:	**ΔCBSLLKt**
Data unit:	tCO_2e
Description:	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data:	Remote sensing and GIS.
Frequency of monitoring/recording:	At each renewal of fixed baseline period.

Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	Remote sensing and GIS.
Any comment:	N/A

Data Unit / Parameter:	**EBBBSLPAt**
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.
Frequency of monitoring/recording:	At each renewal of fixed baseline period.
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.
Any comment:	N/A

4.2 Data and Parameters Monitored

Data Unit / Parameter:	**ACPAt**
Data unit:	Ha
Description:	Annual area within the Project Area affected by catastrophic events at year t.
Source of data:	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied:	The following sources will be monitored: - INMET[205] - Periodic reports from area supervisor - INPE[206]
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.
Calculation method:	Remote sensing and GIS

[205] INMET. Instituto Nacional de Meteorologia. *http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_conv_graf*

[206] INPE. Instituto Nacional de Pesquisas Espaciais. http://www.inpe.br/queimadas/abasFogo.php

Any comment:	N/A

Data Unit / Parameter:	**ABSLLKt**
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 will 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:	647.37 (Annual average deforestation in the leakage belt during the project crediting period)
Monitoring equipment:	Remote sensing and GIS
QA/QC procedures to be applied:	Best practices in remote sensing.
Calculation method:	Analysis of satellite images and maps.
Any comment:	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 Unit / Parameter:	**ABSLPAt**
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:	141.77 (Annual average deforestation in the project area during the project crediting period)
Monitoring equipment:	Remote sensing and GIS
QA/QC procedures to be applied:	Best practices in remote sensing.

Calculation method:	Analysis of satellite images and maps.
Any comment:	N/A

Data Unit / Parameter:	**∆CADLKt**
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 will 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:	2,841 (Annual average decrease in carbon stocks due to displaced deforestation during the project crediting period)
Monitoring equipment:	Remote sensing and GIS.
QA/QC procedures to be applied:	Best practices in remote sensing.
Calculation method:	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Any comment:	N/A

Data Unit / Parameter:	**∆CPAdPAt**
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.
Calculation method:	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

Any comment:	N/A

Data Unit / Parameter:	**∆CPAiPAt**
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.
Calculation method:	Depends on the planned activity.
Any comment:	N/A

Data Unit / Parameter:	**∆CPSLKt**
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.
Calculation method:	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Any comment:	N/A

Data Unit / Parameter:	**∆CUDdPAt**

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.
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:	16,332 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation during the project crediting period)
Monitoring equipment:	Remote sensing and GIS
QA/QC procedures to be applied:	Best practices in remote sensing.
Calculation method:	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Any comment:	N/A

Data Unit / Parameter:	**EBBPSPAt**
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.
Frequency of monitoring/recording:	Areas burnt will be monitored every 5 years or if verification occurs on a frequency of less than every 5 years, examination will occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Remote sensing and GIS
QA/QC procedures to be applied:	Best practices in remote sensing and GIS.
Calculation method:	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.
Any comment:	N/A

Data Unit / Parameter:	**EgLKt**
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:	When significant, GHG emissions due activities implemented in the leakage management area will be monitored, such as emissions from grazing animals, fertilizer, or fuel use.
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.
Calculation method:	Described in the methodology, section 8.1.2: *Ex ante* estimation of CH_4 and N2O emissions from grazing animals.
Any comment:	N/A

Data Unit / Parameter:	**EADLKt**
Data unit:	tCO_2e
Description:	Total ex ante 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:	When significant, GHG emissions due displaced forest fires will be monitored.
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.
Calculation method:	Analysis of satellite images and maps.
Any comment:	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 will not be attributed to the project activity, thus not considered leakage.

Data Unit / Parameter:	**RFt**
Data unit:	%
Description:	Risk factor used to calculate VCS buffer credits
Source of data:	- VCS Non-Permanence Risk Report (v3.1)_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:	34
Monitoring equipment:	Remote sensing and GIS.
QA/QC procedures to be applied:	Best practices in remote sensing and GIS.
Calculation method:	All the risk factors described in the VCS Non-Permanence Risk Report were assessed.
Any comment:	N/A

4.3 Description of the Monitoring Plan

This monitoring plan has been developed according to the VCS Methodology VM0015, version 1.1.

A map showing Cumulative Areas Credited within the project area shall be updated and presented to VCS verifiers at each verification event. The cumulative area cannot generate additional VCUs in future periods.

Revision of the baseline

The current baseline is valid for 10 years, i.e. through December 2012. The baseline will be reassessed every 10 years, and it will be validated at the same time as the subsequent verification. If an applicable sub-national or national jurisdictional baseline becomes available, the baseline will be reassessed earlier and it will be used for the subsequent period.

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.

Monitoring of non-CO_2 emissions from forest fires

If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.

Monitoring Leakage

The most recent VCS guidelines on this subject matter shall be applied. Furthermore, as the leakage belt was determined using Option 1 (Opportunity cost analysis), the boundary of the leakage belt will have to be reassessed at the end of each fixed baseline period using the same methodological approaches used in the first period.

The calculation procedure for estimating leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

- Carbon stock changes and GHG emissions associated with leakage prevention activities.

The carbon stock decrease 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 will be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Monitoring of Natural Disturbance and catastrophic events

The carbon stock losses within the project area will be estimated as soon as possible after the natural event, e.g. uncontrolled forest fires and other catastrophic events.

Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, flooding, drought, fires or storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring, when significant. If the area (or a sub-set of it) affected by natural disturbances or man-made events generated VCUs in past verifications, the total net change in carbon stocks and GHG emissions in the area(s) that generated VCUs will be estimated, and an equivalent amount of VCUs will be cancelled from the VCS buffer. No VCUs can be issued for the project until all carbon stock losses and increases in GHG emissions have been offset.

Updating Forest Carbon 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. For the current fixed baseline period, new data on carbon stocks will only be used if they are validated by an accredited VCS verifier. If new data are used in the current fixed baseline period, the baseline will be recalculated using the new data.

Methods for generating, recording, aggregating, collating and reporting data on monitored parameters

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by 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 4.2 and will be monitored with the frequency described in Table 67.

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)[207] and LANDSAT 5, which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

[207] Available at: http://www.obt.inpe.br/prodes/index.php.

The management structure will also rely on the local community to help monitor the area. There are three 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 Table 67, 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.

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 Markit Environmental Registry /SOCIALCARBON 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 task-force and procedures will be in place to meet the highest levels of control.

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 Table 67.

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
Revision of the baseline	Sustainable Carbon and Agência Verde or another external institutions qualified for the monitoring	Every 10 years
Monitoring Deforestation and Project Emissions	Ecomapuá Conservação Ltda. together with Sustainable Carbon and Agência Verde or another external institutions qualified for the monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Ecomapuá Conservação Ltda. together with Sustainable Carbon and Agência Verde or another external institutions qualified for the monitoring	Prior to each verification
Monitoring Leakage	Ecomapuá Conservação Ltda. together with	Prior to each verification

	Sustainable Carbon and Agência Verde or another external institutions qualified for the monitoring	
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 67. Type of Monitoring and Party Responsible for Monitoring

5 ENVIRONMENTAL IMPACT

Deforestation and the associated GHG emissions is 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[208]. 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[209]. 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[210].

The Second Brazilian Inventory of Anthropogenic Greenhouse Gas Emissions[211] 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 68 below:

[208] 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/monitorabiomas/index.htm>.
[209] 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>.
[210] 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>.
[211] 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: <http://www.mct.gov.br/upd_blob/0214/214061.pdf>.

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
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 68. 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, as explained above, 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[212]. 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.

6 STAKEHOLDER COMMENTS

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

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

by one of the project supervisors who lives in the Bom Jesus community of the project area. This invitation letter is shown in Figure 33 below.

The local stakeholders' consultation was held on 07/02/2013 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 is conducting 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 is 30 days from the presentation date, and it can be done by phone or e-mail, both of which were provided in the presentation and explanatory letters. If no answer is obtained within 30 days, it will be 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 shown in Figure 32 below.

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 Associação Amorama (Rio Mapuá)
Conselheira da Associação Amorama (Rio Mapuá)
Vereador do Município 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 da forma resumida as atividades propostas de implantação e monitoramento do projeto, inclusive o pontencial de 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.

05/03/13

Bio Assets Ativos Ambientais Ltda.
Rua Drácsio, 193, Sala 3
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Av. Genil Bittencourt, 1390, Cj. B4
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Belém, Pará
Tel/Fax: (091) 3224-1763
www.ecomapua.com.br

Figure 32. 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 iniciativa, 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.

Bio Assets Ativos Ambientais Ltda.
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www.ecomapua.com.br

Figure 33. Explanatory letter sent to the stakeholders

ANNEXES

ANNEX I – PROJECT AREA CONTOUR COORDINATES

Project Area Contour Coordinates											
UTM 22S, Datum WGS84											
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1	623329.756	9872637.285	102	583779.603	9874267.233	203	590690.833	9866203.854	304	553490.042	9882274.599
2	632642.805	9847990.678	103	583912.953	9873905.282	204	590678.316	9866208.984	305	553623.392	9882617.500
3	623069.826	9852041.712	104	583976.453	9873632.232	205	590502.317	9866327.593	306	553712.293	9882700.050
4	622455.316	9852106.654	105	584109.803	9873238.531	206	590308.686	9866428.444	307	553871.043	9882808.000
5	621891.414	9851901.206	106	584471.754	9872990.881	207	590244.588	9866442.918	308	554207.593	9882814.350
6	621325.954	9851700.623	107	584732.105	9872844.830	208	590233.633	9866457.857	309	554436.194	9882738.150
7	619726.504	9851755.906	108	584776.555	9872711.480	209	589903.433	9866610.259	310	554779.095	9882484.150
8	619135.448	9851651.523	109	584782.905	9872279.679	210	589572.048	9866760.419	311	555312.496	9882211.099
9	617346.140	9851588.268	110	584827.355	9872044.729	211	589625.986	9866907.466	312	555826.847	9882172.999
10	616773.675	9851445.075	111	584922.605	9871765.328	212	589547.942	9866811.359	313	556341.198	9882452.399
11	607128.596	9843120.258	112	584814.655	9870292.125	213	587448.317	9864632.798	314	556811.099	9882788.950
12	596787.768	9838465.608	113	584795.605	9869847.624	214	587360.377	9863747.174	315	556976.199	9883214.401
13	600409.370	9850258.196	114	584668.604	9869733.324	215	587776.797	9863551.047	316	557268.300	9883627.152
14	600312.331	9850232.986	115	584547.954	9869536.474	216	589246.014	9865488.880	317	557611.200	9883798.602
15	600177.231	9850344.110	116	584528.904	9869238.023	217	589312.433	9865555.295	318	558011.251	9883951.002
16	601282.666	9851431.502	117	584573.354	9868939.572	218	589316.814	9865358.165	319	558424.002	9884027.203
17	601471.150	9852970.136	118	584700.354	9868672.872	219	589494.614	9864996.215	320	558735.153	9884122.453
18	602058.791	9853809.642	119	584865.455	9868552.222	220	589621.614	9864723.164	321	559205.053	9884332.003
19	602051.536	9853809.642	120	585195.655	9868501.422	221	589801.158	9864508.587	322	559541.604	9884503.454
20	602037.609	9853806.353	121	585481.406	9868552.222	222	589749.856	9864421.589	323	559763.855	9884617.754
21	602053.845	9853864.128	122	585646.506	9868622.072	223	589586.220	9864129.483	324	560290.906	9884662.204
22	601824.884	9853929.297	123	585868.757	9868622.072	224	589565.015	9864091.629	325	561421.208	9884598.704
23	601620.434	9854264.750	124	586008.457	9868520.472	225	588877.058	9862863.554	326	562126.059	9884547.904
24	601453.469	9854343.511	125	586084.657	9868317.271	226	588318.973	9862346.146	327	562970.611	9884211.353
25	601216.871	9854298.393	126	586065.607	9868082.321	227	578480.262	9865291.907	328	563467.944	9884052.411
26	600876.456	9854702.028	127	586129.107	9867860.070	228	569528.706	9872561.950	329	563479.714	9884064.100
27	600398.179	9854967.708	128	586319.608	9867517.170	229	569540.086	9868139.049	330	563857.179	9884026.530
28	600270.887	9855238.977	129	586618.058	9867117.119	230	568771.401	9867340.456	331	563872.313	9884027.203
29	600132.536	9855306.991	130	586941.909	9866901.218	231	566584.535	9869208.641	332	564774.015	9884078.003
30	599971.388	9855180.012	131	587322.910	9866888.518	232	566454.377	9868727.062	333	565104.215	9884046.253
31	599797.666	9855076.413	132	587526.110	9867059.969	233	561854.642	9872537.783	334	565656.666	9884046.253
32	599587.834	9855241.127	133	587691.210	9867244.119	234	563486.860	9873767.556	335	565910.667	9884128.803
33	599388.431	9855727.493	134	587805.511	9867390.169	235	562493.373	9873958.978	336	566285.318	9884363.753
34	599383.928	9855858.585	135	588091.261	9867383.819	236	562245.081	9873935.533	337	566545.668	9884630.454
35	599374.857	9855939.955	136	588497.662	9867358.419	237	561334.786	9874429.059	338	566666.318	9884884.454
36	599438.588	9856039.380	137	588796.113	9867352.069	238	561900.262	9875320.108	339	566667.324	9884886.936
37	599478.171	9856069.442	138	589037.413	9867244.119	239	561181.320	9875674.209	340	566841.948	9884679.795
38	599746.703	9856150.650	139	589310.464	9867123.469	240	561765.900	9877608.926	341	568557.231	9882607.990
39	599895.023	9856158.219	140	589462.864	9867015.519	241	561002.156	9878113.853	342	568818.643	9881739.762
40	600171.023	9856486.614	141	589632.999	9866926.584	242	560250.274	9878219.038	343	569596.859	9878457.323
41	600250.826	9856566.416	142	589971.263	9867848.763	243	560123.988	9878462.836	344	568888.890	9876155.052
42	600275.988	9856559.995	143	591673.613	9871475.274	244	560109.840	9878490.150	345	569711.836	9875488.459
43	600294.511	9856586.459	144	592722.995	9870924.508	245	560046.705	9878612.032	346	569522.546	9874955.988
44	600503.283	9856901.505	145	593223.110	9871318.183	246	559862.558	9878514.158	347	569526.079	9873583.029
45	600553.426	9857083.925	146	595322.238	9867481.057	247	559815.909	9878489.364	348	570649.961	9873993.395
46	600520.120	9857307.838	147	597899.642	9861566.163	248	559768.632	9878464.237	349	570876.354	9875557.245
47	600336.567	9857498.634	148	597281.220	9861351.344	249	559675.215	9878550.565	350	573638.526	9876482.647
48	600102.889	9857556.765	149	597533.306	9860812.208	250	559634.633	9878588.067	351	574373.959	9878286.839
49	600011.073	9857540.212	150	597383.722	9860819.008	251	559545.449	9878670.482	352	574377.170	9878293.141

50	599881.906	9857499.195	151	597129.722	9860907.910	252	559181.194	9878560.891	353	574417.746	9878293.141
51	599708.524	9857318.424	152	596958.272	9860939.660	253	559157.729	9878553.832	354	574484.228	9878299.731
52	601521.854	9859377.242	153	596488.371	9860888.862	254	559136.036	9878577.487	355	574517.354	9878293.141
53	602031.027	9860255.190	154	596431.221	9860965.063	255	559047.400	9878674.142	356	574527.634	9878293.141
54	602818.343	9860398.051	155	596221.671	9860965.063	256	559004.371	9878721.064	357	574528.517	9878293.551
55	602657.934	9860970.274	156	596050.221	9860946.014	257	558875.821	9878861.243	358	574705.434	9878375.691
56	603057.689	9860949.376	157	595459.671	9861250.817	258	558611.850	9878851.835	359	574972.135	9878502.692
57	603369.868	9861328.681	158	595415.222	9861460.368	259	558608.459	9878857.346	360	575219.786	9878540.792
58	606098.818	9863212.831	159	595408.872	9861638.169	260	558595.452	9878864.642	361	575391.236	9878547.142
59	605665.036	9864540.678	160	595383.473	9861828.670	261	558462.102	9879105.943	362	575594.436	9878534.442
60	606450.262	9866680.129	161	595275.524	9862012.821	262	558462.102	9879213.893	363	575924.637	9878439.191
61	607999.706	9866279.955	162	595129.474	9862235.072	263	558471.121	9879211.075	364	576172.287	9878318.541
62	609070.751	9868087.419	163	595135.825	9862323.973	264	558433.908	9879306.190	365	576419.938	9878058.191
63	608744.863	9869278.454	164	595123.126	9862558.924	265	558385.902	9879328.193	366	576527.888	9877785.140
64	612780.132	9869272.460	165	595154.876	9862711.324	266	557630.436	9879445.848	367	576743.789	9877391.439
65	613775.008	9869168.297	166	595173.927	9862990.725	267	557474.441	9879342.567	368	577042.239	9877099.339
66	614161.423	9869272.125	167	594970.728	9863187.577	268	557302.550	9879235.875	369	577645.490	9876889.788
67	623329.756	9872637.285	168	594665.928	9863308.228	269	557298.237	9879241.509	370	577975.691	9876858.038
68	582990.891	9882568.262	169	594227.777	9863384.430	270	557166.699	9879163.093	371	578210.641	9876889.788
69	580920.328	9880311.598	170	593586.427	9863435.233	271	556944.449	9879175.793	372	578261.442	9877048.539
70	579841.965	9877622.662	171	593281.626	9863454.284	272	556963.499	9879251.993	373	578331.292	9877131.089
71	579808.295	9877602.621	172	592913.326	9863479.686	273	556855.549	9879283.743	374	578528.142	9877124.739
72	579638.960	9877517.954	173	592722.825	9863371.736	274	556728.549	9879226.593	375	578680.542	9877162.839
73	579437.876	9877539.121	174	592449.774	9863136.786	275	556391.998	9879264.693	376	578886.776	9877264.010
74	579268.542	9877560.288	175	592233.873	9863111.387	276	556124.948	9879307.612	377	578667.934	9877279.831
75	579241.991	9877395.540	176	592043.373	9863149.488	277	556124.849	9879310.780	378	578099.078	9877551.031
76	579486.994	9877334.289	177	591978.051	9863175.049	278	556088.714	9879310.786	379	577907.254	9877689.938
77	579814.267	9877235.116	178	591970.676	9863185.105	279	556073.188	9879315.930	380	577748.504	9877961.138
78	579963.864	9877195.735	179	591805.284	9863350.500	280	556036.397	9879321.843	381	577576.525	9878358.015
79	580255.346	9877137.439	180	591631.823	9863576.404	281	555718.897	9879429.793	382	577431.004	9878576.297
80	580579.196	9877188.239	181	591478.532	9863693.391	282	555280.746	9879544.094	383	577100.274	9878834.268
81	580972.897	9877353.339	182	591305.071	9863749.867	283	554798.145	9879690.144	384	576584.334	9878966.561
82	581233.248	9877505.740	183	591171.949	9863770.038	284	554563.194	9879829.844	385	576081.623	9878979.792
83	581391.998	9877581.940	184	590849.231	9863794.243	285	554359.994	9879874.294	386	575817.038	9878814.427
84	581582.498	9877581.940	185	590732.245	9863810.379	286	554264.744	9880007.645	387	575479.693	9878662.292
85	581861.899	9877531.140	186	590441.104	9864143.116	287	554163.143	9880280.695	388	575162.192	9878860.731
86	581963.499	9877410.489	187	590441.799	9864145.202	288	553642.442	9880515.646	389	574765.316	9879297.296
87	582109.549	9877277.139	188	590357.086	9864262.188	289	553445.592	9880604.546	390	574295.679	9879839.696
88	582185.749	9876978.688	189	590264.305	9864423.548	290	553261.442	9880502.946	391	574183.232	9880137.353
89	582204.799	9876711.988	190	590195.728	9864601.044	291	552835.991	9880534.696	392	574143.545	9880481.313
90	582198.449	9876438.937	191	590147.321	9864734.166	292	552651.840	9880617.246	393	574150.160	9880845.117
91	582166.699	9876172.237	192	590143.288	9865000.410	293	552543.890	9880775.996	394	574090.630	9881096.472
92	582192.099	9875943.636	193	590191.696	9865210.178	294	552379.855	9880788.147	395	574037.713	9881440.432
93	582293.700	9875816.636	194	590416.709	9865352.464	295	552380.144	9880795.734	396	573812.817	9881632.256
94	582509.600	9875619.786	195	590608.280	9865378.351	296	552518.490	9880782.346	397	573723.745	9881696.728
95	582674.700	9875600.736	196	590811.480	9865505.351	297	552613.740	9880839.496	398	573729.393	9881715.753
96	582833.451	9875429.285	197	590815.441	9865523.172	298	552766.141	9880922.046	399	573705.073	9881710.242
97	582973.151	9875092.735	198	590869.407	9865549.031	299	552950.291	9881049.047	400	573591.108	9881684.418
98	583011.251	9874806.984	199	590925.884	9865774.934	300	553147.141	9881201.447	401	572870.075	9881521.035
99	583163.651	9874584.734	200	590925.884	9865924.192	301	553236.042	9881379.247	402	573288.146	9881883.028
100	583449.402	9874508.534	201	590849.239	9866097.654	302	553343.992	9881601.498	403	573369.290	9881953.287
101	583627.202	9874445.033	202	590696.153	9866197.161	303	553363.042	9882033.299	404	578599.287	9886481.684
									405	582990.891	9882568.262

Table 69. Project area contour coordinates

ANNEX II – LAND REGISTRY DOCUMENTS

Fazenda Bom Jesus

MEMORIAL DESCRITIVO

GLEBA: **MUNICIPIO**: BREVES **UF**: PA

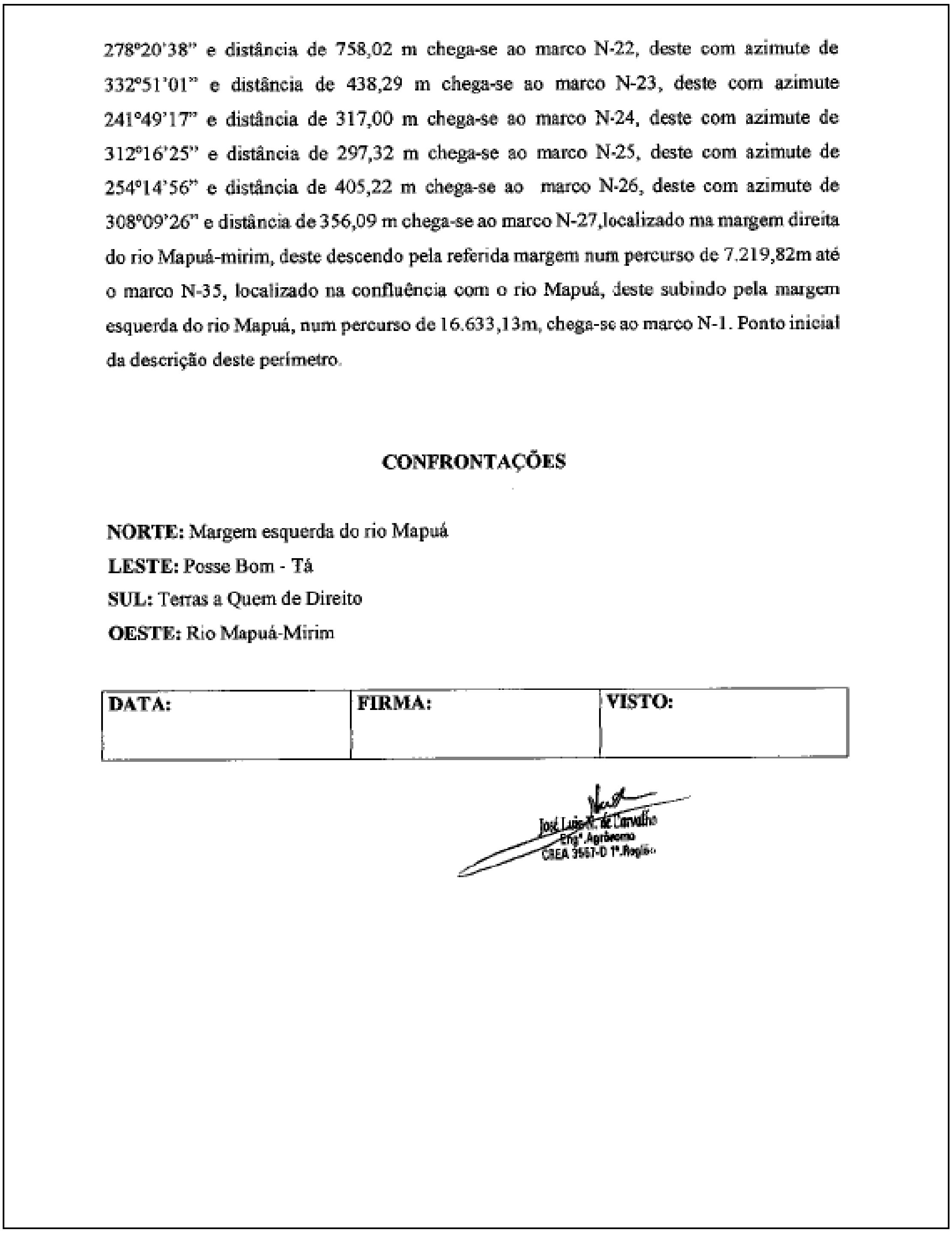
IMÓVEL: FAZENDA BOM JESUS

ÁREA (ha): 14.529,7371 **PERÍMETRO (m)**: 64.352,65 **LOTE Nº**:

DESCRIÇÃO DO PERÍMETRO

Partindo do marco N-1 de coordenadas geográficas de 01°02'28,19" S e 50°24'02,30" WGr, deste com azimute de 131°53'21" e distância de 289,60 m chega-se ao marco N-2, deste com azimute 140°34'33" e distância de 2.692,68 m chega-se ao marco N-3, deste com azimute de 162°34'12" e distância de 901,39 m chega-se ao marco N-4, deste com azimute 166°47'19" e distância de 3.369,17 m chega-se ao marco N-5, deste com azimute de 196°55'39" e distância de 2.404,16 m chega-se ao marco N-6, deste com azimute de 130°25'34" e distância de 1.064,05 m chega-se ao marco N-7, deste com azimute de 196°26'06" e distância de 537,59 m chega-se ao N-8, deste com azimute de 179°54'58" e distância de 6.820,01 m chega-se ao marco N-9, deste com azimute 223°54'19" e distância de 1.110,36 m chega-se ao marco N-10, deste com azimute de 310°37'23" e distância de 2.872,16 m chega-se ao marco N-11, deste com azimute 194°34'27" e distância de 516,62 m chega-se ao marco N-12, deste com azimute de 309°39'32" e distância de 6.001,11 m chega-se ao marco N-13, deste com azimute 53°21'16" e distância de 2.044,02 m chega-se ao marco N-14, deste com azimute 281°25'16" e distância de 1.010,00 m chega-se ao marco N-15, deste com azimute de 265°15'24" e distância de 250,80 m chega-se ao marco N-16, deste com azimute de 300°57'50" e distância de 10.049,57 m chega-se ao marco N-17, deste com azimute de 32°44'07" e distância de 998,60 m chega-se ao marco N-18, deste com azimute 297°36'47" e distância de 733,55 m chega-se ao marco N-19, deste com azimute 22°18'22" e distância de 2.107,72 m chega-se ao marco N-20, deste com azimute de 295°40'37" e distância de 1.135,95 m chega-se ao marco N-21, deste com azimute de

Figure 34. Specifications of Fazenda Bom Jesus property (part. 1)



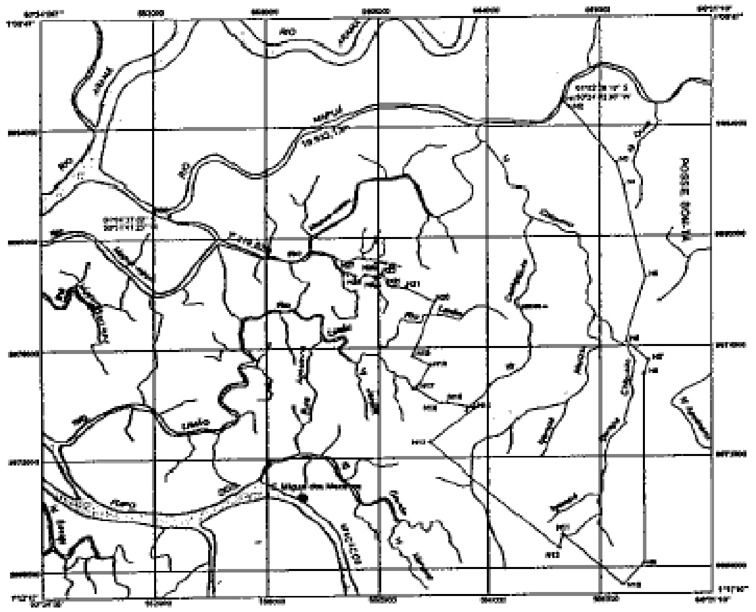
278°20'38" e distância de 758,02 m chega-se ao marco N-22, deste com azimute de 332°51'01" e distância de 438,29 m chega-se ao marco N-23, deste com azimute 241°49'17" e distância de 317,00 m chega-se ao marco N-24, deste com azimute de 312°16'25" e distância de 297,32 m chega-se ao marco N-25, deste com azimute de 254°14'56" e distância de 405,22 m chega-se ao marco N-26, deste com azimute de 308°09'26" e distância de 356,09 m chega-se ao marco N-27,localizado ma margem direita do rio Mapuá-mirim, deste descendo pela referida margem num percurso de 7.219,82m até o marco N-35, localizado na confluência com o rio Mapuá, deste subindo pela margem esquerda do rio Mapuá, num percurso de 16.633,13m, chega-se ao marco N-1. Ponto inicial da descrição deste perímetro.

CONFRONTAÇÕES

NORTE: Margem esquerda do rio Mapuá
LESTE: Posse Bom - Tá
SUL: Terras a Quem de Direito
OESTE: Rio Mapuá-Mirim

DATA:	FIRMA:	VISTO:

Figure 35. Specifications of Fazenda Bom Jesus property (part. 2)



COORDENADAS GEOGRÁFICAS

MARCO	LATITUDE	LONGETUDE
N1	01°02'28,19"	50°24'02,30"
N2	01°02'34,48"	50°23'55,32"
N3	01°03'42,21"	50°22'59,98"
N4	01°04'10,22"	50°22'51,24"
N5	01°05'57,04"	50°22'26,30"
N6	01°07'11,95"	50°23'48,84"
N7	01°07'34,42"	50°22'22,72"
N8	01°07'51,03"	50°22'28,22"
N9	01°11'33,14"	50°22'27,65"
N10	01°11'59,20"	50°22'52,76"
N11	01°10'58,32"	50°24'03,31"
N12	01°11'14,60"	50°24'07,51"
N13	01°09'09,90"	50°26'37,03"
N14	01°08'38,15"	50°25'43,97"
N15	01°08'23,64"	50°26'16,01"
N16	01°08'24,30"	50°26'24,10"
N17	01°08'06,72"	50°26'53,22"
N18	01°07'39,35"	50°26'35,75"
N19	01°07,26,29"	50°26'56,79"
N20	01°06'24,77"	50°26'30,91"
N21	01°06'06,49"	50°27'04,57"
N22	01°06'04,92"	50°27'28,64"
N23	01°06'52,22"	50°27'35,31"
N24	01°05'57,10"	50°27'44,37"
N25	01°05'50,59"	50°27'51,49"
N26	01°05'54,17"	50°28'04,11"
N27	01°05'47,01"	50°28'13,17"

MARCO	AZIMUTE	DISTÂNCIA (m)
N1 - N2	131°53'21"	289,60
N2 - N3	140°34'33"	2.692,66
N3 - N4	162°34'12"	901,39
N4 - N5	166°47'19"	3.369,17
N5 - N6	196°55'39"	2.404,16
N6 - N7	130°25'34"	1.054,05
N7 - N8	198°26'06"	537,59
N8 - N9	179°54'58"	6.830,01
N9 - N10	223°54'19"	1.110,36
N10 - N11	310°37'28"	2.872,19
N11 - N12	194°34'27"	516,62
N12 - N13	309°39'32"	6.001,11
N13 - N14	53°21'16"	2.044,02
N14 - N15	281°25'16"	1.010,00
N15 - N16	265°13'24"	250,60
N16 - N17	300°57'50"	1.049,57
N17 - N18	32°44'07"	998,60
N18 - N19	297°36'47"	733,55
N19 - N20	22°18'22"	2.107,72
N20 - N21	296°40'37"	1.153,95
N21 - N22	276°20'38"	758,03
N22 - N23	332°51'01"	438,29
N23 - N24	241°49'17"	317,60
N24 - N25	312°16'25"	297,32
N25 - N26	254°14'56"	405,22
N26 - N27	308°09'26"	356,09
N27 - N01	Rio	24364,85

IMÓVEL: BOM JESUS

PROPRIETÁRIO: SANTANA MADEIRAS LTDA.

ÁREA: 14.529,7371ha

PERIMETRO: 64.352,65 m

REGISTRO / CÓDIGO

DATA: OUT. / 2000

MUNICÍPIO / UF: BREVES / PA

ESCALA: 1:200.000

DESENHO

RESPONSÁVEL TÉCNICO

CONFERE

VISTO: José Luiz M. de Carvalho, Eng° Agrônomo, CREA ... 1ª Região

Figure 36. Specifications of Fazenda Bom Jesus property (part. 3)

Fazenda Vila Amélia

MEMORIAL DESCRITIVO

GLEBA: **MUNICIPIO**: BREVES **UF**: PA

IMÓVEL: FAZENDA LOBATO OU VILA AMÉLIA

ÁREA (ha): 15.999,0166 **PERÍMETRO (m)**: 64.291,75 **LOTE Nº**:

DESCRIÇÃO DO PERÍMETRO

Partindo do marco JL-08 de coordenadas geográficas de 01°06'02,80" S e 50°19'51,92" WGr,localizado na margem esquerda do rio Mapuá, deste subindo o referido rio por uma distancia de 25.350,65m até chegarão marco JL-40, deste com azimute de 256°45'00" e distância de 2.000,00 m chega-se ao marco -A, deste com azimute 185°1500" e distância de 920,00 m chega-se ao marco -B, deste com azimute de 115°30'00" e distância de 450,00 m chega-se ao marco JL-20, deste com azimute 250°00'00" e distância de 600,00 m chega-se ao marco -C, deste com azimute de 58°30'00" e distância de 800,00 m chega-se ao marco JL-43, localizado na margem esquerda do Rio Mapuá, deste, seguindo pelo referido rio por uma distancia de 1.193,89m até chegar a foz do igarapé São Remédio, marco JL-45, deste subindo pelo referido igarapé por uma distancia de 2.114,24m, chega-se ao marco JL-1, deste com azimute de 227°38'05" e distância de 773,05m chega-se ao marco JL-2, deste com azimute de 286°42'43" e distância de 10.259,66 m chega-se ao JL-3, deste com azimute de 309°03'53" e distância de 12.648,06 m chega-se ao marco JL-4, deste com azimute 69°57'24" e distância de 2.116,23 m chega-se ao marco JL-5, deste com azimute de 8°24'33" e distância de 1.585,97 m chega-se ao marco JL-6, deste com azimute 71°31'03" e distância de 2.907,70 m chega-se ao marco JL-7, deste com azimute de 22°08'35" e distância de 1.945,35 m chega-se ao marco JL-8. Ponto inicial da descrição deste perímetro.

Figure 37. Specifications of Fazenda Vila Amélia property (part. 1)

CONFRONTAÇÕES

NORTE: Margem esquerda do rio Mapuá

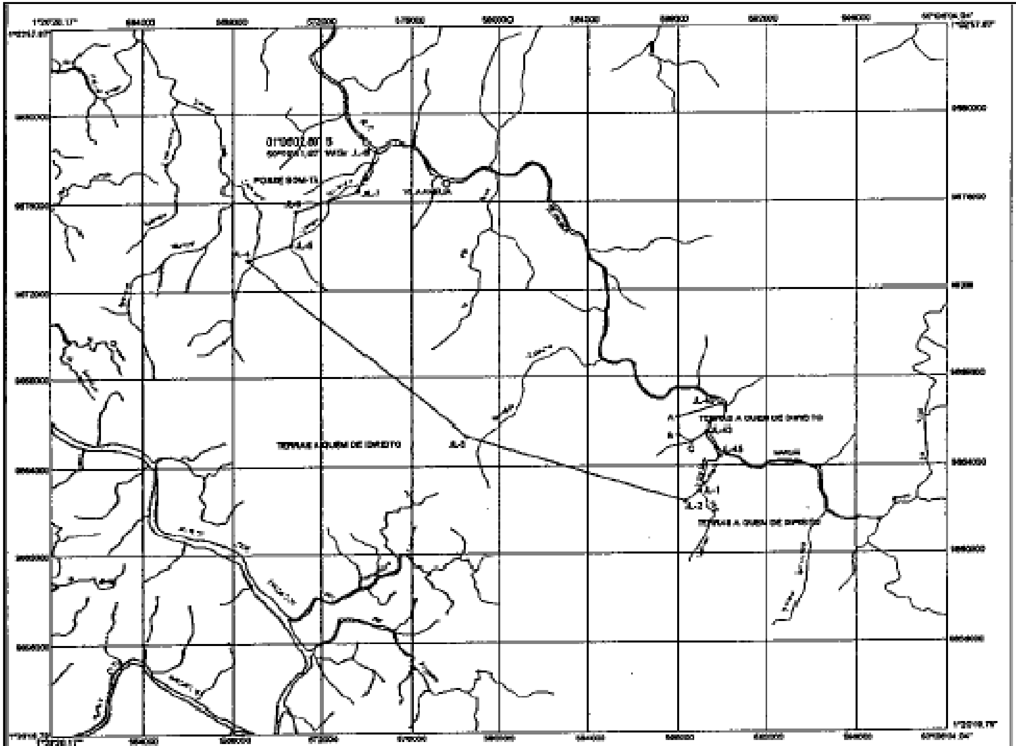
LESTE: Terras a Quem de Direito e igarapé São Remédio

SUL: Terras a Quem de Direito

OESTE: Posse Bom – Ta

DATA:	FIRMA:	VISTO:

Figure 38. Specifications of Fazenda Vila Amélia property (part. 2)



COORDENADAS GEOGRÁFICAS

MARCO	LATITUDE (S)	LONGITUDE (W)
JL-1	1°14'24,80"	50°12'02,40"
JL-2	1°14'41,77"	50°12'20,88"
JL-3	1°13'03,78"	50°17'28,83"
JL-4	1°08'46,26"	50°22'36,67"
JL-5	1°08'22,63"	50°21'52,35"
JL-6	1°07'31,53"	50°21'44,86"
JL-7	1°07'01,49"	50°20'13,63"
JL-8	1°06'02,80"	50°19'31,92"
JL-40	1°12'16,29"	50°11'40,70"
A	1°13'27,24"	50°12'48,53"
B	1°13'56,08"	50°12'51,24"
C	1°14'02,38"	50°12'38,10"
JL-43	1°12'59,61"	50°11'50,40"
JL-45	1°13'34,45"	50°11'34,21"
JL-1	1°14'24,80"	50°12'02,40"

MARCOS	AZIMUTES	DISTÂNCIAS
1 - 2	227°38'05"	773,05 m
2 - 3	288°42'43"	10.259,66 m
3 - 4	309°03'59"	12.648,06 m
4 - 5	69°57'24"	2.116,23 m
5 - 6	8°24'33"	1.585,97 m
6 - 7	71°31'03"	2.907,70 m
7 - 8	22°08'35"	1.945,35 m
8 - 40	RIO	25.360,65 m
40 - A	256°45'00"	2.000,00 m
A - B	185°15'00"	920,00 m
B - C	115°30'00"	450,00 m
C - 43	56°30'00"	800,00 m
43 - 45	RIO	1.193,89 m
45 - 1	RIO	2.114,24 m

IMÓVEL
LOBATO OU VILA AMÉLIA

PROPRIETÁRIO
SANTANA MADEIRAS LTDA.

ÁREA 15.999,01 66 ha

PERIMETRO 64.291,75 m

REGISTRO / CÓDIGO

DATA OUT. / 2000

MUNICÍPIO / UF BREVES / PA

ESCALA 1:250.000

DESENHO

RESPONSÁVEL TÉCNICO

CONFERE

VISTO José Luiz N. de Carvalho Engº Agrônomo CREA 3551-D 1ª Região

Figure 39. Specifications of Fazenda Vila Amélia property (part. 3)

Fazenda Brasileiro

MEMORIAL DESCRITIVO

NOME DO PROPRIETÁRIO: ECOMAPUÁ CONSERVAÇÃO LTDA
(SANTANA MADEIRAS LTDA)

NOME DO IMÓVEL: SANTA ISABEL / BRASILEIRO

ÁREA: 3.524,00 ha.

PERÍMETRO: 16.934,50 m.

MUNICÍPIO: BREVES

ESTADO: PARÁ

DESCRIÇÃO DO PERÍMETRO

Partindo do marco M-1, de Coordenada Geográfica, Latitude – 01°12'19"s e Longitude - 50°11'40"wgr situado na margem direita do Rio Mapuá, deste segue confrontando com as terras da ROBCO madeiras com azimute 193°15'00" e uma distância de 1.800,00m até o marco M-2 de Coordenada Geográfica Latitude – 01°11'43"s e Longitude – 50°11'27"wgr, deste segue confrontando ainda com as terras da ROBCO Madeiras com azimute 36°05'00" e uma distância de 4.000,00m até o marco M-3, de Coordenada Geográfica Latitude – 01°09'45"s e Longitude – 50°10'32"wgr, deste segue confrontando com as terras de Quem de Direito com azimute 128°30'00" e uma distância de 1.240,00m até o marco M-4, de Coordenada Geográfica Latitude – 01°10'03"s e Longitude – 50°09'58"wgr, deste segue confrontando com as terras de Quem de Direito com azimute 58°30'00" e uma distância de 600,00m até o marco M-5, de Coordenada Geográfica Latitude – 01°09'50"s e Longitude – 50°09'42"wgr deste segue confrontando com as terras de Quem de Direito com azimute 162°00'00" e uma distância de 4.390,00m até o marco M-6 de Coordenada Geográfica Latitude – 01°11'55"s e Longitude – 50°08'34"wgr, deste segue confrontando com as terras de Quem de Direito com azimute 192°00'00" e uma distância de 4.572,00m até o marco M-7, de Coordenada Geográfica Latitude – 01°15'08"s e Longitude – 50°07'10"wgr deste segue confrontando com as terras de Quem de Direito com azimute 192°00'00" e uma distância de 246,00m até o marco M-8 de Coordenada Geográfica Latitude – 01°15'15"s e Longitude – 50°07'30" deste segue confrontando com as terras de Quem de Direito com azimute 210°30'00" e uma distância de 86,50m até o marco M-9 de Coordenada Geográfica Latitude – 01°08'50"s e Longitude – 50°07'14" deste segue-se margeando o Rio Mapuá até o marco M-1; ponto inicial da descrição deste perimetro.

LIMITES E CONFRONTAÇÕES

NORTE: QUEM DE DIREITO.
LESTE: QUEM DE DIREITO.
SUL: RIO MAPUÁ.
OESTE: ROBCO MADEIRAS.

Resp. Técnico:

Artemas [illegible] Júnior
Engenheiro Florestal
CREA-[illegible]

Belém-PA, 10 de setembro de 2004.

Figure 40. Specifications of Fazenda Brasileiro property (part. 1)

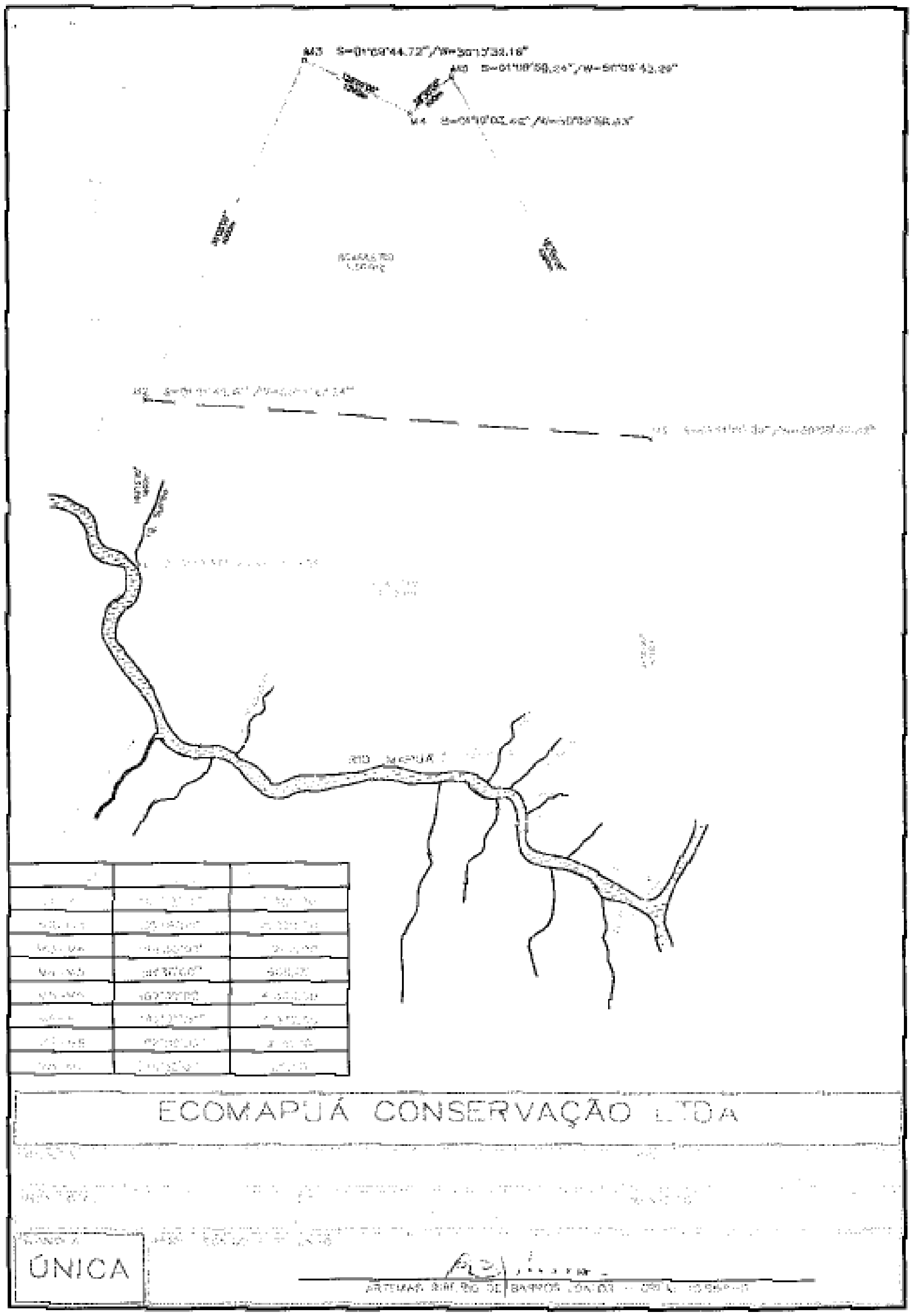


Figure 41. Specifications of Fazenda Brasileiro property (part. 2)

Fazenda São Domingos

MEMORIAL DESCRITIVO

NOME DO PROPRIETÁRIO: ECOMAPUÁ CONSERVAÇÃO LTDA (SANTANA MADEIRAS LTDA).

NOME DO IMÓVEL: SÃO DOMINGOS

ÁREA: 5.386,450 ha. **PERÍMETRO: 30.729,115 m.**

MUNICÍPIO: BREVES **ESTADO: PARÁ**

DESCRIÇÃO DO PERÍMETRO

Partindo do marco M-1, de Coordenada Geográfica, Latitude – 01°04'14.35"s e Longitude - 50°20'12.6"wgr situado na margem direita do Rio Mapuá, deste segue-se com azimute 87°30'00" e uma distância de 550,00m até o marco M-2, de Coordenada Geográfica Latitude – 01°04'20.54"s e Longitude - 50°20'40.33"wgr; deste segue confrontando com terras de Quem de direito com azimute 49°15'00" e uma distância de 7.000,00m até o marco M-3 de Coordenada Geográfica Latitude – 01°01'40.12"s e Longitude – 50°17'35.33"wgr; deste segue com azimute 136°30'00" e uma distância de 6.100,00m até o marco M-4, de Coordenada Geográfica Latitude – 01°03'46.40"s e Longitude – 50°15'12.88"wgr deste segue confrontando com terras de Quem de direito com azimute 220°30'00" e uma distância de 3.360,00m até o marco M-5 de Coordenada Geográfica Latitude – 01°05'00"s e Longitude – 50°16'20.35"wgr; deste segue confrontando com terras de Quem de direito com azimute 208°05'00 " e uma distância de 3.590,00m até o marco M-6 de Coordenada Geográfica Latitude – 01°06'28.33"s e Longitude – 50°16'54.40"wgr, deste segue confrontando com a margem direita do Rio Mapuá com azimute 310°37'28" e uma distância de 7.200,00m até o marco M-1 ponto inicial da descrição deste perímetro.

LIMITES E CONFRONTAÇÕES

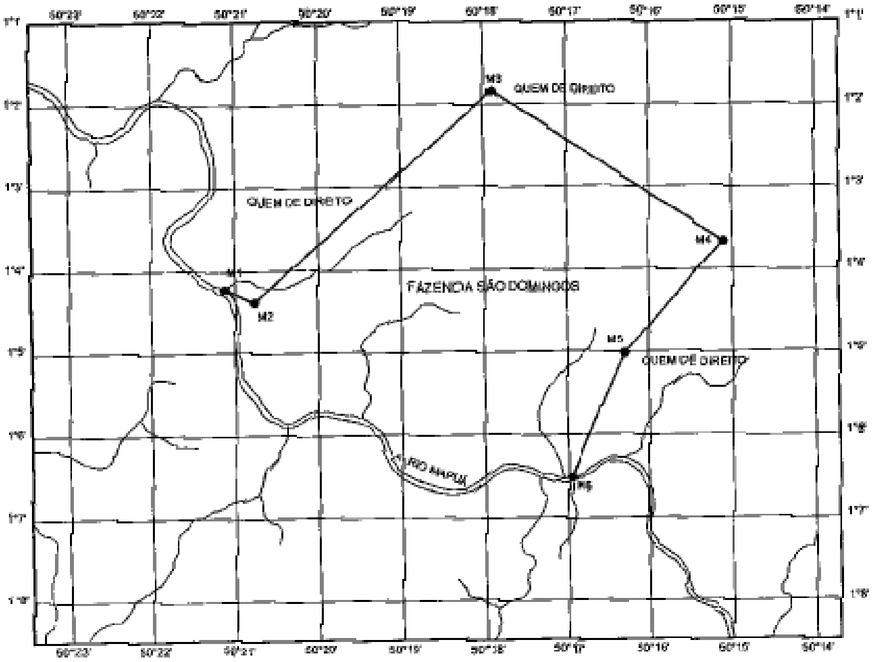
NORTE: QUEM DE DIREITO.
LESTE: QUEM DE DIREITO.
SUL: . MARGEM DIREITA DO RIO MAPUÁ.
OESTE: QUEM DE DIREITO.

CREA-PA JAN 2003

Belém-PA, 30 de dezembro de 2002.

Resp. Técnico: Artemas Ribeiro de Barros Júnior
Engenheiro Florestal
CREA - 10.888-D

Figure 42. Specifications of Fazenda São Domingos property (part. 1)



LATITUDE	LONGITUDE	MARCO
1°4'14,35"	50°20'12,6"	M1
1°4'20,54"	50°20'40,35"	M2
1°1'40,12"	50°17'35,33"	M3
1°3'46,4"	50°15'12,86"	M4
1°5'0"	50°16'20,35"	M5
1°6'28,33"	50°16'54,4"	M6

AZIMUTE	DISTÂNCIA(m)	MARCO
67°30'0"	550	M1-M2
49°15'0"	7.000	M2-M3
136°30'0"	6.100	M3-M4
220°30'0"	3.360	M4-M5
208°5'0"	3.590	M5-M6
310°37'28"	7.200	M6-M1

DISCRIMINAÇÃO	MAPA DA PROPRIEDADE				
PROPRIETÁRIO	ECOMAPUÁ CONSERVAÇÃO LTDA				
NOME DO IMÓVEL	SÃO DOMINGOS				
ÁREA	5.386,45ha	PERÍMETRO	30.729,115m	REG. CÓDIGO	
DATA	DEZ/2002	MUNICÍPIO/UF	BREVES/PA	ESCALA	1:125.000
FONTE	CARTA DA DSG ESCALA 1:100.000 E DADOS EM CAMPO COM GPS	RESP. TÉCNICO / DESENHO	ARTEMAS RIBEIRO DE BARROS JÚNIOR CREA/PA: 10.669-D		

Figure 43. Specifications of Fazenda São Domingos property (part. 2)

Fazenda Lago do Jacaré

MEMORIAL DESCRITIVO

GLEBA: **MUNICIPIO**: BREVES **UF**: PA

IMÓVEL: FAZENDA LAGO DO JACARÉ

ÁREA (ha): 42.856,1281 **PERÍMETRO (m)**: 95.316,84 **LOTE Nº**:

DESCRIÇÃO DO PERÍMETRO

Partindo do marco JL-17 de coordenadas geográficas de 01°10'10,80" S e 49°56'07,64" WGr, deste com azimute de 160° 30'00" e distância de 19.650,00 m chega-se ao marco JL-18, deste com azimute 266°00'00" e distância de 2.000,00 m chega-se ao marco JL-19, deste com azimute de 277°00'00" e distância de 600,00 m chega-se ao marco JL-20, deste com azimute 250°00'00" e distância de 600,00 m chega-se ao marco JL-21, deste com azimute de 250°30'00" e distância de 600,00 m chega-se ao marco JL-22, deste com azimute de 272°00'00" e distância de 1.600,00 m chega-se ao marco JL-23, deste com azimute de 260°00'00" e distância de 600,00 m chega-se ao JL-24, deste com azimute de 268°00'00" e distância de 1.790,00 m chega-se ao marco JL-25, deste com azimute 256°00'00" e distância de 590,00 m chega-se ao marco JL-26, deste com azimute de 230°30'00" e distância de 10.320,00 m chega-se ao marco JL-27, deste com azimute 253°30'00" e distância de 11.425,00 m chega-se ao marco JL-28, deste com azimute de 16°30'00" e distância de 9.000,00 m chega-se ao marco JL-29, deste com azimute 255°30'00" e distância de 100,00 m chega-se ao marco JL-30, deste com azimute 309°30'00" e distância de 175,00 m chega-se ao marco JL-31, deste com azimute de 45°30'00" e distância de 1.550,00 m chega-se ao marco JL-32, deste com azimute de 7°00'00" e distância de 1.500,00 m chega-se ao marco JL-33, deste com azimute de 36°55'20" e distância de 1.231,00 m chega-se ao marco JL-34, localizado na margem direita do braço do Igarapé Jacaré, afluente do rio Mapuá, deste descendo pela referida margem num percurso de 4.857,00 m até chegar ao marco JL-01 com a mesma localização, deste com azimute 42°00'00" e distância de 2.590,00 m chega-se ao marco JL-02, deste

Figure 44. Specifications of Fazenda Lago do Jacaré property (part. 1)

com azimute 30°00'00" e distância de 1.000,00 m chega-se ao marco JL-03, deste com azimute de 80°00'00" e distância de 820,00 m chega-se ao marco JL-04, deste com azimute de 342°30'00" e distância de 600,00 m chega-se ao marco JL-05, deste com azimute de 93°00'00" e distância de 400,00 m chega-se ao marco JL-06, deste com azimute 37°00'00" e distância de 500,00 m chega-se ao marco JL-07, deste com azimute de 56°00'00" e distância de 3.300,00 m chega-se ao marco JL-08, deste com azimute de 342°00'00" e distância de 1.390,00 m chega-se ao marco JL-09, deste com azimute de 20°00'00" e distância de 2.300,00 m chega-se ao marco JL-10, deste com azimute 104°30'00" e distância de 1.600,00 m, chega-se ao marco JL-11, deste com azimute 31°00'00" e distância de 2.090,00 m chega-se ao marco JL-12, deste com azimute de 345°00'00" e distância de 1.250,00 m chega-se ao marco JL-13, deste com azimute de 90°30'00" e distância de 4.025,00 m chega-se ao marco JL-14, deste com azimute de 96°30'00" e distância de 1.000,00 m chega-se ao marco JL-15, deste com azimute 75°00'00" e distância de 400,00 m, chega-se ao marco JL-16, deste com azimute 70°30'00" e distância de 4.850,00 m, chega-se ao marco JL-17. Ponto inicial da descrição deste perímetro.

CONFRONTAÇÕES

NORTE: Terras a Quem de Direito
LESTE: Terras a Quem de Direito
SUL: Terras a Quem de Direito
OESTE: Terras a Quem de Direito

DATA:	FIRMA:	VISTO:

José Luiz N. de Carvalho
Engº Agrônomo
CREA 3663-D 1ª Região

Figure 45. Specifications of Fazenda Lago do Jacaré property (part. 2)

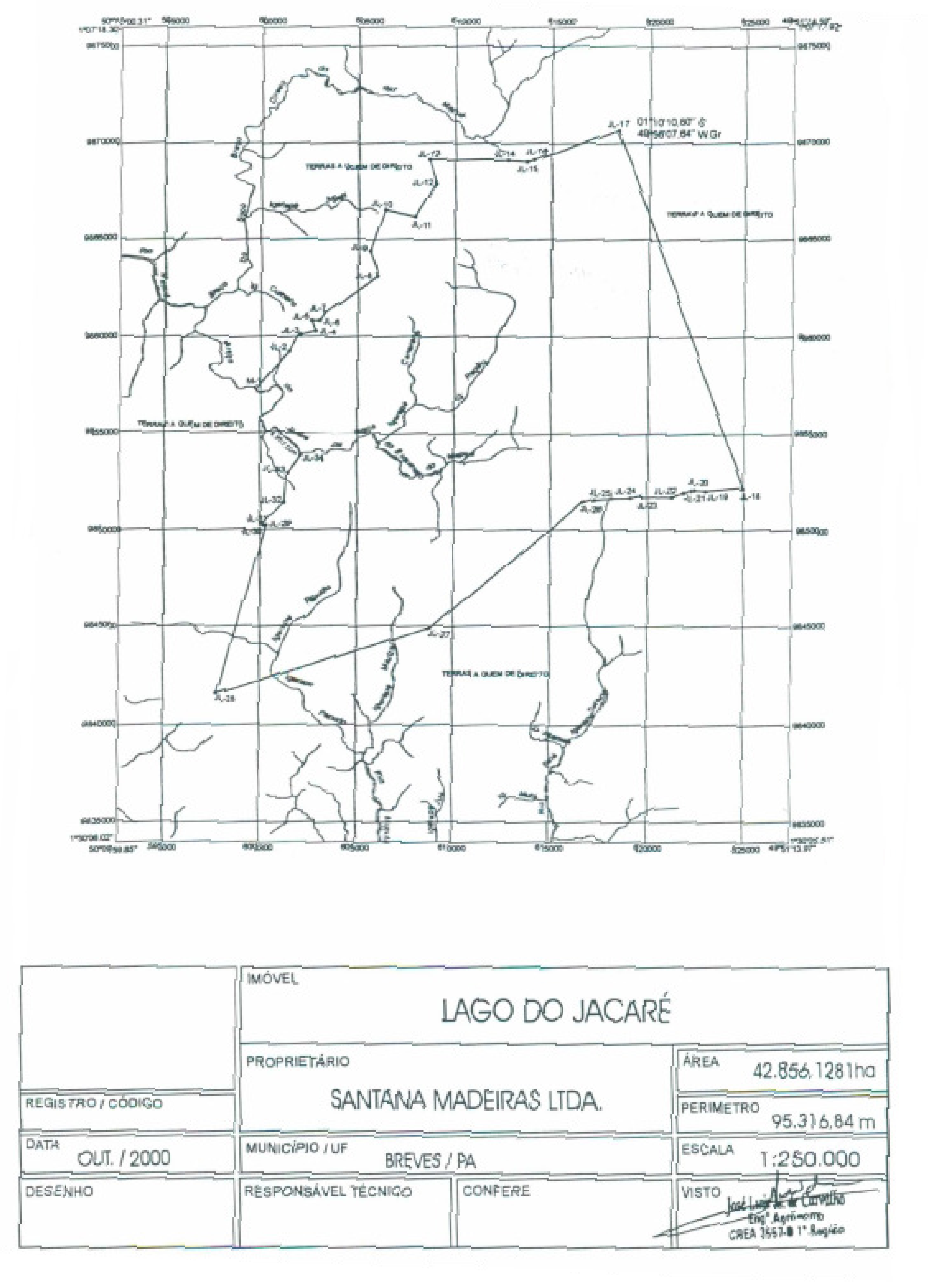


Figure 46. Specifications of Fazenda Lago do Jacaré property (part. 3)

ANNEX III – ARTICLES OF INCORPORATION OF ECOMAPUÁ CONSERVAÇÃO LTDA.

INSTRUMENTO PARTICULAR DE ALTERAÇÃO DE CONTRATO SOCIAL
SANTANA MADEIRAS LTDA.
CNPJ Nº 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.º W-068507-4 SE/DPMAF/DPF e devidamente inscrito no CPF/M.F. sob o n.º 113.201.238-48, residente e domiciliado em São Paulo, Capital, na Rua Adalivia de Toledo, n.º 310 – apto. n.º 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.º 320, sala 12, na Cidade de Cotia, Estado de São Paulo, inscrita no CNPJ/MF sob o n.º 03.557.460/0001-03 e com seus atos constitutivos devidamente arquivados na Junta Comercial do Estado de São Paulo sob o n.º 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.º 9.705.213 SSP/SP e devidamente inscrita no CPF/M.F. sob o n.º 256.659.078-80, residente e domiciliado em São Paulo, Capital, na Rua Adalívia de Toledo, n.º 310 – apto. n.º 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.º 1.290, Loja B 1, Bairro Nazaré, CEP 66040-000, inscrita no C.N.P.J. sob o n.º 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 1º -

A sociedade girará sob a denominação social de: **"ECOMAPUÁ CONSERVAÇÃO LTDA."** com sede à Avenida Gentil Bittencourt, n.º 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 2º -

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 47. Amended articles of incorporation from Santana Madeiras Ltda. to Ecomapuá Conservação Ltda.

ANNEX IV – DEFINITION OF 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[213]. The appraisals include topographic plans, descriptive notes and definition of the perimeter coordinates of the properties. Table 70 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 by Agência Verde employees	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 70 - 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 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

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

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*

Figure 48 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.

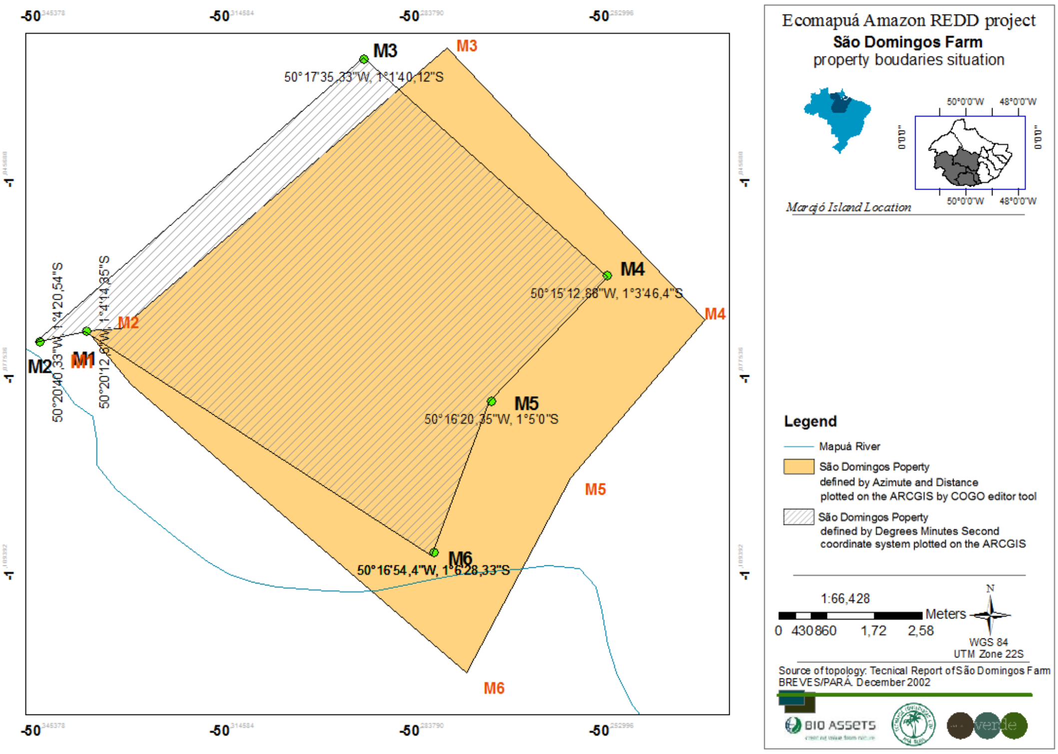


Figure 48. Map of the issues involving property boundaries of Ecomapuá Ltda. properties

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 by Agência Verde 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***

Table 71 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.

<table>
<tr><th colspan="2">PROPERTY</th><th colspan="2">AGÊNCIA VERDE</th><th colspan="2">APPRAISAL</th><th colspan="2">DIFFERENCE</th></tr>
<tr><th>Property</th><th>Municipality</th><th>Area</th><th>Perimeter</th><th>Area</th><th>Perimeter</th><th>Area</th><th>Perimeter</th></tr>
<tr><td>Bom Jesus</td><td>Breves, PA</td><td>14,469.01</td><td>64,979.96</td><td>14,529.73</td><td>64,352.65</td><td>-60.71</td><td>627.31</td></tr>
<tr><td>Brasileiro</td><td>Breves, PA</td><td>4,281.68</td><td>32,395.81</td><td>3,524.00</td><td>16,934.50</td><td>757.68</td><td>15,461.31</td></tr>
<tr><td rowspan="3">Lago Jacaré</td><td>Breves, PA</td><td rowspan="3">58,617.44</td><td rowspan="3">124,189.20</td><td rowspan="3">42,856.12</td><td rowspan="3">95,316.84</td><td rowspan="3">15,761.31</td><td rowspan="3">28,872.35</td></tr>
<tr><td>Curralinho, PA</td></tr>
<tr><td>São Sebastião da Boa Vista, PA</td></tr>
<tr><td>São Domingos</td><td>Breves, PA</td><td>4,796.83</td><td>29,532.65</td><td>5,386.45</td><td>30,729.11</td><td>-589.61</td><td>-1,196.46</td></tr>
<tr><td>Vila Amélia</td><td>Breves, PA</td><td>16,303.64</td><td>67,701.32</td><td>15,999.01</td><td>64,291.75</td><td>304.63</td><td>3,409.57</td></tr>
</table>

Table 71 – Differences in perimeter and area values encountered in the official appraisals and corrected values from Agência Verde

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 86,269.84ha (Figure 49). Thus, the deforested areas inside all the properties, including those deforested within 10 years prior to project start date, sum to 12,151.63ha.

The properties are located in the municipalities of Breves, Curralinho and São Sebastião da Boa Vista. Table 72 shows the percentages of properties in each of the municipalities concerned.

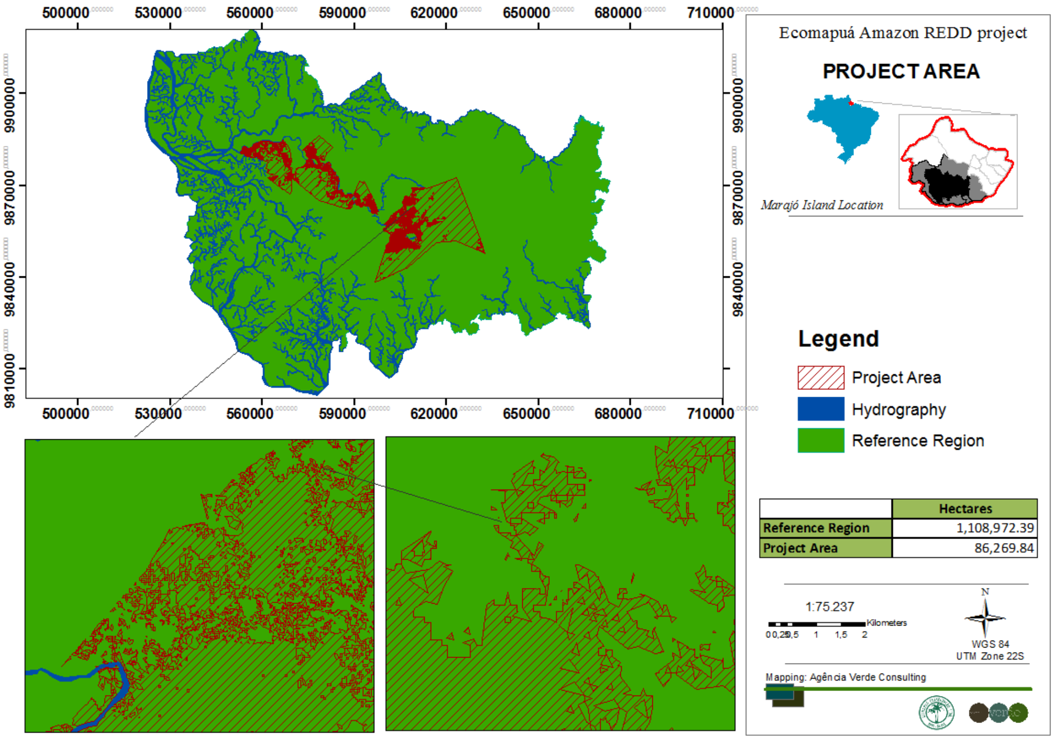


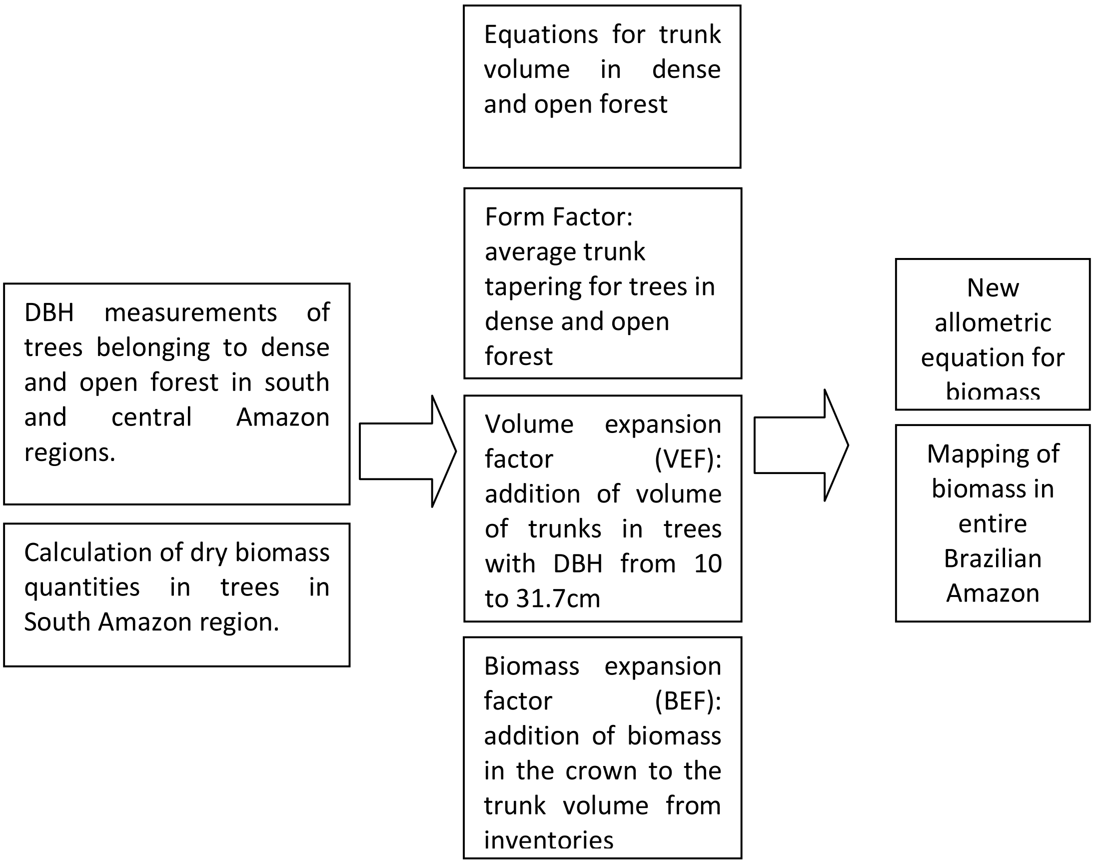
Figure 49. Project area

<table>
<tr><th>Municipality</th><th>Property</th><th>%</th></tr>
<tr><td rowspan="5">Breves</td><td>Bom Jesus</td><td>100</td></tr>
<tr><td>Brasileiro</td><td>100</td></tr>
<tr><td>São Domingos</td><td>100</td></tr>
<tr><td>Vila Amélia</td><td>100</td></tr>
<tr><td rowspan="3">Lago do Jacaré</td><td>30</td></tr>
<tr><td>Curralinho</td><td>29</td></tr>
<tr><td>São Sebastião da Boa Vista</td><td>41</td></tr>
</table>

Table 72 – Percentages of properties in each municipality

ANNEX V – DEFINITION OF CARBON STOCKS

Carbon stock changes in the present project were calculated taking into account the carbon stocks of the defined forest type in the project area – namely Riparian Dense Tropical Rainforest (Portuguese: Floresta Ombrófila Densa Aluvial) – which would be released into the atmosphere through deforestation predicted in the baseline scenario. The carbon stocks were calculated using the average biomass figures for riparian dense tropical rainforest specified by Nogueira (2008)[214]. This study was selected because, following a thorough literature search, the biomass values were deemed to be most accurate for the vegetation cover of the project's reference region. The author combined two main methods for estimation of biomass in Amazon rainforest: allometric equations and wood volumes from inventories. The study therefore involved data collected from two Amazon regions: South and Central, corresponding to open and dense forest types. Nogueira (2008) used these data to adjust certain factors (form factor, volume expansion factor and biomass expansion factor) and thus propose a new equation for biomass calculation, which was used to calculate the average biomass/ha of the entire Brazilian Amazon. The procedure was as depicted in the following diagram:



In the study, the values referring to average biomass per ha in a given vegetation type did not have corresponding standard deviations because they are estimates and not direct measurements. The author calculated the standard deviation for the average DBH and dry matter values which were the basis the adjustment to the factors mentioned above and the development of the new biomass calculation formula. The latter was used to calculate and develop a biomass map of the entire Brazilian Amazon. According to Nogueira

[214] Nogueira, E.M. (2008), "Densidade da Madeira e Alometria de Arvores em Florestas do Arco do Desmatamento: Implicações para Biomassa e Emissão de Carbono a Partir de Mudanças no Uso da Terra na Amazônia Brasileira." 151 p, INPA, Manaus.

(2008), the average above and below-ground biomass value for riparian dense tropical rainforest is 360.8 Mg/ha (Table 73). In order to convert biomass to carbon and carbon to CO_2, IPCC (2003)[215] values were used (Table 74 and Table 75)

Vegetation	Above ground biomass (ab) Mg ha^{-1}	Below ground biomass (bb) Mg ha^{-1}	Total biomass Mg ha^{-1}
Riparian Dense Tropical Rainforest	299.3	61.5	360.8

Table 73. Average biomass for riparian dense tropical rainforest

Conversion Factors	
Biomass to Carbon	0.5
Carbon (C) to CO_2	3.666666667

Table 74. Conversion factors

Name	Riparian Dense Tropical Rainforest	
IDcl	1	
Average carbon stock per hectare ± 90% CI		
Cab*icl* C stock $tCO_2e\ ha^{-1}$	Cbb*icl* C stock $tCO_2e\ ha^{-1}$	Ctot*icl* C stock $tCO_2e\ ha^{-1}$
548.72	112.75	661.47

Table 75. Average carbon stock values for riparian dense tropical rainforest

[215] 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