ECOMAPUÁ AMAZON REDD PROJECT

Document Written By Sustainable Carbon – Projetos Ambientais Ltda.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

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[1], 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[2], adding to the importance of the present project.

The primary objective of the Ecomapuá Amazon REDD Project is to avoid the unplanned deforestation (AUD) of a subsection of the 86,269.84ha project area, which is within a private property on Marajó Island, owned by Ecomapuá Conservação Ltda. (hereafter, Ecomapuá Ltda. or "the company"). The company is a private Brazilian sustainable development firm engaged in renewable energy and carbon finance projects, with the mission of conserving the environment and improving living standards of isolated communities on the island. Ecomapuá Ltda. was created on 19-July-2001, with the following goal described in their Social Contract[3]: "development of sustainable development projects, clean development mechanisms, carbon sequestration". The diagnostic study of the project area, published on 01-September-2002, was the first action of the company in terms of initiating the present REDD project, and is thus the designated project start date.

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

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: illegal timber harvesting; extraction of palm heart; and subsistence farming relying on slash and burn practices for cultivation[4], which supplements the income and subsistence from the latter activities.

During the monitoring period from 01-January-2003 to 31-December-2012, the present REDD project avoided around 3,350 ha of deforestation, resulting in 1,448,333 tCO_2e in emissions reductions. This figure of emissions reductions is after subtractions for buffer and project emissions. 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] Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano De Desenvolvimento Territorial Sustentável Do Arquipélago Do Marajó."
[2] 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*.
[3] São Paulo, 19.07.01 - "Instrumento particular de Alteração de Contrato Social, Santana Madeiras Ltda.".
[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

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

Organization name	Agência Verde
Role in the project	GIS Mapping services
Contact person	Eliane Seiko Maffi Yamada
Title	Coordinator
Address	Rua Cardeal ArcoVerde, 1749, bloco II, Conjunto 36 Postal Code: 05508-000 São Paulo – SP, Brazil
Telephone	+55 11 2597 0008
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1.5 Project Start Date

In accordance with version 02 of the VCS PD[5], the project start date is 01-September-2002 because an initial diagnostic study of the area, commissioned by Ecomapuá Ltda., was published on this date, analyzing the risk of deforestation over the next 30 years[6].

1.6 Project Crediting Period

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

1.7 Project Location

The Ecomapuá Amazon REDD Project is situated on Marajó Island (Ilha de Marajó) in Pará state in the north of Brazil, which is in the lower Amazon Basin.

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, the project includes only areas qualifying as "'forest"[7] 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

[5] Document available at: <https://vcsprojectdatabase2.apx.com/myModule/Interactive.asp?Tab=Projects&a=2&i=1094&lat=%2D1%2E15207177017&lon=%2D49%2E8915135928&bp=1>. Last visited on 17/10/2013.

[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] 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

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 project's geodetic coordinates utilizing Datum WGS84 are provided in Appendix I.

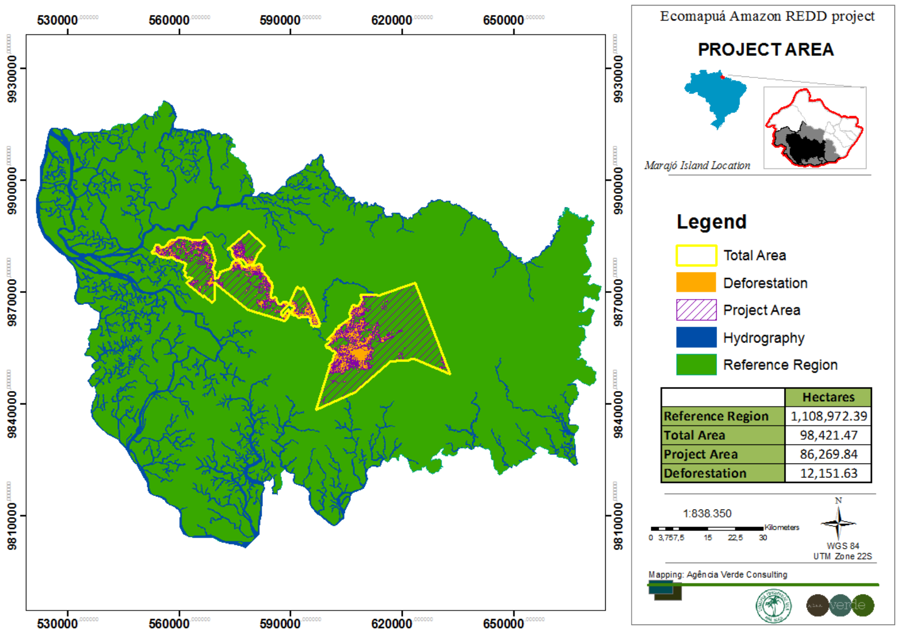

Figure 1. REDD area, showing in orange the areas to be excluded, not being defined as forest 10 years prior to project start date

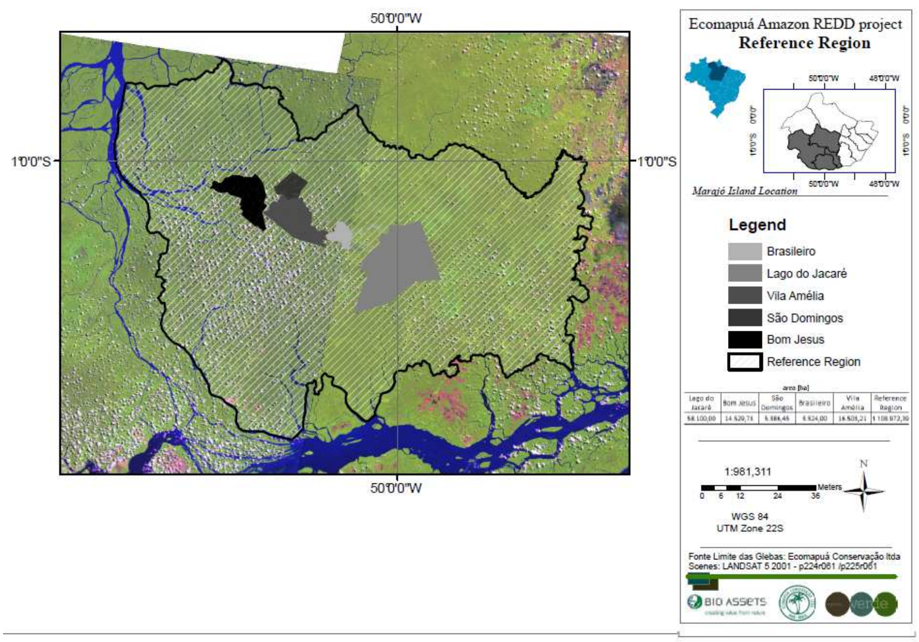

Figure 2. Ecomapuá REDD project's five properties and reference region

1.8 Title and Reference of Methodology

The project applies a methodology approved under the Verified Carbon Standard, as follows:

VCS Methodology VM0015: Methodology for Avoided Unplanned Deforestation, version 1.1[8].

The SOCIALCARBON Methodology[9] is being applied as a sustainability tool in association with VCS Standard, version 3.4.

1.9 Other Programs

- Emission Trading Programs and Other Binding Limits: The project activity is not included in an emission trading program or any other mechanism that includes GHG allowance trading.
- Other Forms of Environmental Credit: The project activity is not creating any other form of environmental credit under any specific program.
- Participation under Other GHG Programs: This project is not requesting registration in any other GHG Programs nor has the project been rejected by any other GHG programs.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The VCS PD was validated by the Designated Operational Entity TÜV Rheinland (China) Ltd. and this present monitoring report is being verified by RINA Services S.p.A.

The project has been fully operational since the starting date of the crediting period. The project activities include banning of logging, social education and supervision of deforestation by three supervisors from within the project area communities.

The monitoring data was kept according to the monitoring plan described in the project description document. This Monitoring Report refers to the first monitoring period of this project, and includes data from 01-January-2003 to 31-December-2012.

The general picture of deforestation pressure in the State of Pará, where the project is located, is that it has decreased 73% since 2004, reaching an average of 2,725 km²/year in the 2010-2013 period. The annual deforestation areas from 2004 to 2013 in the State of Pará and in the Legal Amazon can be seen in the Figure below. The State of Pará increased its participation in the deforestation of the Amazon Biome, from around 32% in 2004 to around 45% in the 2010-2013 period, making it the primary deforester of all Legal Amazon States since 2006[10].

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[8] This methodology is available at: <http://www.v-c-s.org/methodologies/VM0015>. Last visited on 17/10/2013.

[9] SOCIALCARBON Methodology was developed by Ecológica Institute (www.ecologica.org.br). It was founded on the principle that transparent assessment and monitoring of the social and environmental performance of projects improves their long-term effectiveness. The methodology uses a set of analytical tools that assess the social, environmental and economic conditions of communities affected by the project, and demonstrates through continuous monitoring the project's contribution to sustainable development.

[10] PRODES Project - Brazilian Amazon Forest Monitoring through Satellite. Instituto Nacional de Pesquisas Espaciais (INPE). Available at: <http://www.obt.inpe.br/prodes/index.php>. Last visited on 09/01/2014

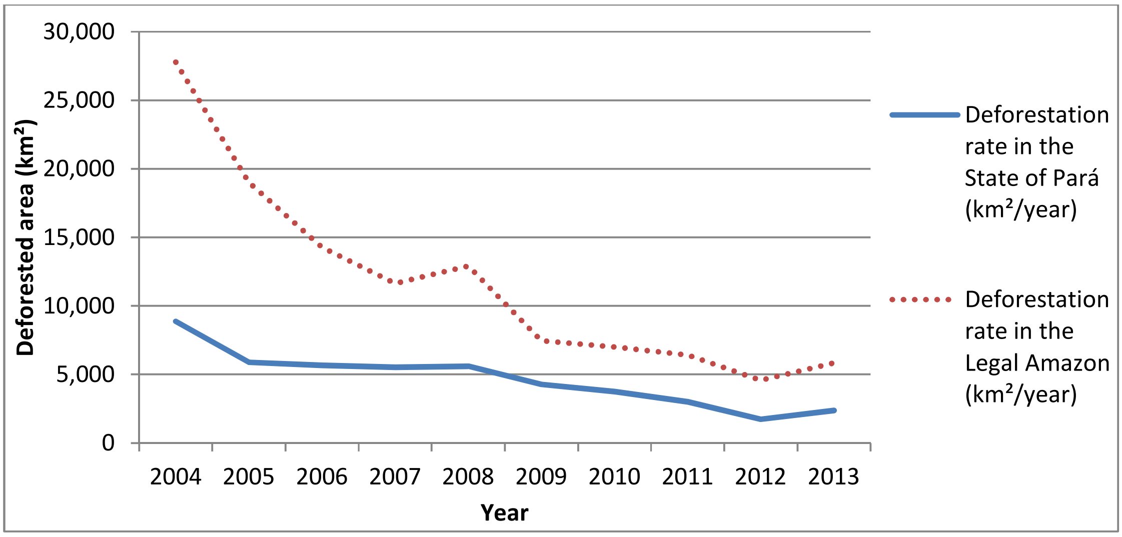


Figure 3. Comparison between the annual deforestation rate in the State of Pará and in the Legal Amazon from 2004 to 2013
Source: PRODES (INPE)

However, although the deforestation rate in the State of Pará has shown a constant decrease over the analyzed period, the last year of this analysis showed an increase trend in the deforestation. This was overwhelmingly concentrated in illegal deforestation activities, increasing by 151% between 2010 and 2012, which is the deforestation type most likely to affect the present project[11].

According to the VCS PD, the deforestation in the project region involves three spatially overlapping activities: firstly, extraction of commercially valuable tree species by resident families for sale to timber. 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.

Studies of the project area and surroundings[12,13] show that subsistence agriculture is an important component of the deforestation dynamic, as the products – being primarily manioc used to produce flour – are mainly for subsistence purposes.

An analysis of agents and drivers of deforestation revealed that during the first baseline period (01-January-2003 to 31-December-2012), the primary economic activities in Furos de Breves, which is the micro-region within the Marajó archipelago where the project areas are located, continued to be extraction of timber and non-timber forest products (NTFPs), specifically palm heart[14]. The graphs of production of logged timber and palm heart in the municipalities of the reference region are presented in the Figures below.

[11] Instituto do Homem e Meio Ambiente da Amazônia (Imazon): <http://envolverde.com.br/noticias/imazon-desmatamento-ilegal-cresce-151/>. Last visited on 09/01/2014.
[12] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/Pa, Diagnóstico Socio-Econômico'.
[13] Herrera (2003) – Dinâmica e desenvolvimento da agricultura familiar: o caso de Vila Amélia – Breves/ Pará
[14] Instituto Brasileiro de Geografia e Estatística (IBGE). Available at: <http://cidades.ibge.gov.br/xtras/uf.php?lang=&coduf=15&search=para>. Last visited on 09/01/2014.

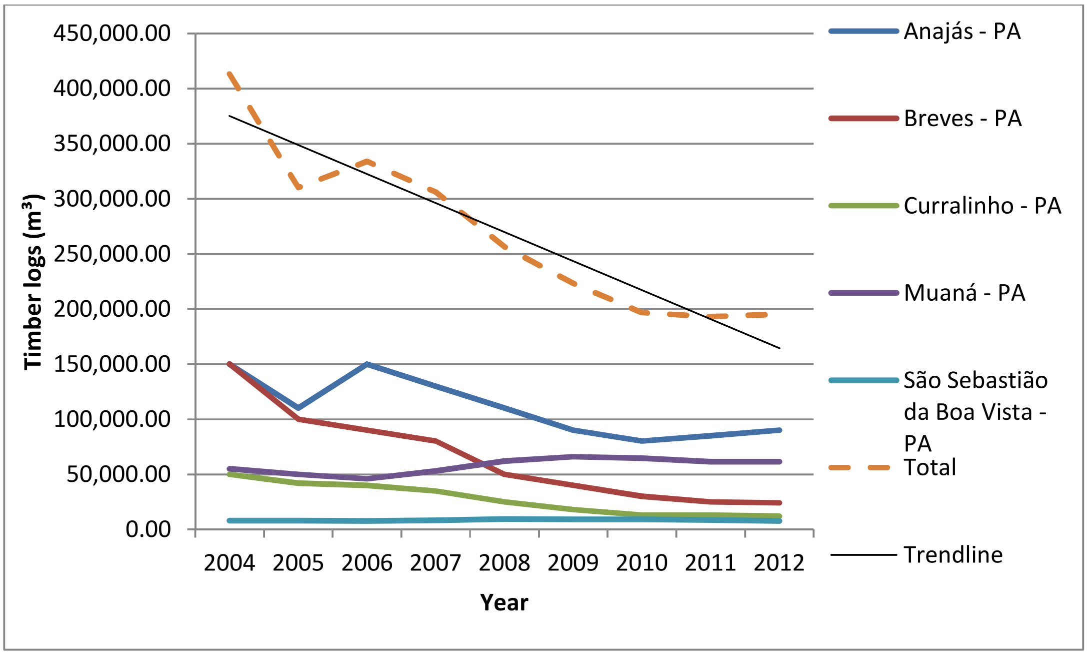


Figure 4. Log production in the municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

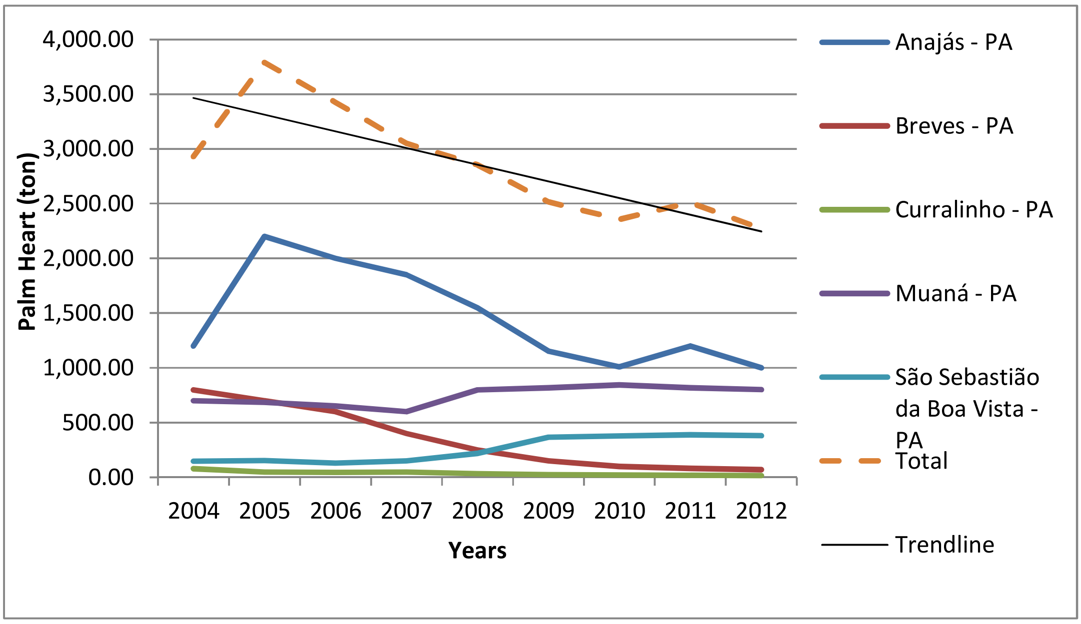


Figure 5. Palm heart production in municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

The Figures 4 and 5 above show, most importantly, a reduction in wood production in the project reference region during the analyzed period. Similarly, palm-heart production reduced over the observed period. These trends are in accordance with the observed reduction in deforestation in the project area (Table 1 below).

The main increase verified in the economic activities in the region was açaí berries, which is a NTFP. Açaí is produced mainly for subsistence, being an integral and traditional part of the daily diet[15]. Açaí is not considered a significant element of the deforestation dynamic; in fact, açaí production has been positively correlated with forest conservation in a study of Pará state[16].

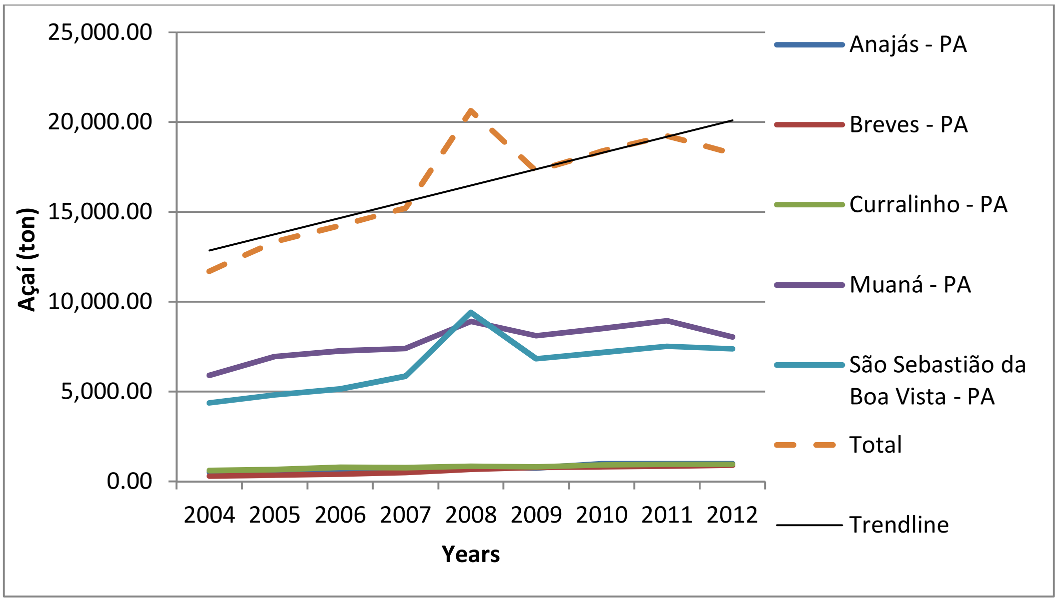


Figure 6. Açaí berry production in the municipalities where the reference region is located
Source: Instituto Brasileiro de Geografia e Estatística (IBGE)

In addition, according to the VCS PD, timber harvesting was the only deforestation agent considered possible for leakage to occur, due to the following considerations:

- Implementation of the present project in 2002 led to the banning of timber activities in the areas belonging to Ecomapuá Ltda. Given that subsistence agriculture was not prohibited by the project proponent, açaí activities are not considered to be susceptible to leakage.
- Wood production is the most lucrative of the three activities[17].

Thus, it is inferred that timber harvesting is the most probable activity to have leaked outside the project area. Leakage was monitored by the third party mapping company, Agência Verde, keeping track of the Leakage within the Leakage Belt through GIS monitoring methods.

As well as wood production reducing in the reference region, a study of values of standing timber between 1993 and 1997[18], carried out in the vicinity of the reference region, revealed a strong decreasing trend from 1993 to 1997, and from then onwards the prices remained stable at practically the same level until 2008. For these reasons, leakage is considered to be 0 in the present monitoring period. This conclusion is corroborated by the measured results, showing that deforestation in the leakage belt was far below the levels predicted in the baseline (better detailed in sections 4.1 – Baseline Emissions and 4.2 – Project Emissions).

[15] Fundação de Amparo e Desenvolvimento da Pesquisa (FADESP) (2002), 'Comunidades Agroextrativistas do Rio Mapuá – Breves/PA, Diagnóstico Socio-Econômico'.
[16] 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.
[17] Instituto Brasileiro de Geografia e Estatística (IBGE). Available at: <http://cidades.ibge.gov.br/xtras/uf.php?lang=&codufs=15&search=para>. Last visited on 09/01/2014.
[18] SANTANA et al. (2010), "Preço da madeira em pé, valor econômico e mercado de madeira nos contratos de transição do estado do Pará".

Furthermore, no events, such as forest fire or catastrophic events, which significantly decreased carbon stocks or increased GHG emissions occurred.

The GIS mapping carried out showed that 1,579.58 ha of accumulated deforestation took place during the first baseline period within the project area. The deforestation activities caused the transformation from the initial land use/ land cover (LULC) class of riparian dense tropical rainforest to the final class of non-forest. The annual deforestation values in the Project Area during the current monitoring period can be seen in the Table 1 below.

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2003	86,146.93	122.91	122.91	0.07%
2004	85,741.44	405.49	528.40	0.47%
2005	85,380.42	361.02	889.42	0.42%
2006	85,318.19	62.23	951.65	0.07%
2007	85,291.56	26.63	978.28	0.03%
2008	84,956.59	334.97	1,313.25	0.39%
2009	84,902.69	53.90	1,367.15	0.06%
2010	84,895.60	7.09	1,374.24	0.01%
2011	84,730.46	165.15	1,539.38	0.19%
2012	84,690.26	40.20	1,579.58	0.05%
Total deforestation 2003 - 2012 (ha)		**1,579.58**	**Average deforestation rate 2003 - 2012**	**0.18%**

Table 1. Annual deforestation, cumulative deforestation and R in the project area during the monitoring period

As can be seen in the table above, the project area displayed an annual average deforestation rate of 0.18% per year during the 2003 – 2012 period (applying R: annual rate of change of forest cover[19]). Comparing to what occurred during the 1993 – 2001 period (historical reference period), when the annual average deforestation rate was of 1.07%, the deforestation rate in the project area decreased around 83%, which can be seen in the Figure 7 below. Therefore, a decrease tendency in the deforestation rate could be noted, which probably represents the results from the Ecomapuá activities in the project area. The main social activities developed by Ecomapuá within the project area are listed below. More detailed information can be found in the respective SOCIALCARBON Report – Point Zero.

- Community capacity building about family agricultural production, developed in partnership with the Federal Rural University of Amazônia (UFRA), Petrobrás Company, and the Support Foundation of Research, Extension and Education in Agricultural Sciences (FUNPEA). This project lasted from 2005 to 2007;
- Community capacity building about family agricultural production, developed in partnership with the Federal Rural University of Amazônia, and Petrobras Company. This project lasted from 2005 to 2007, and was called Petrobrás Fome Zero;

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

- Construction of a support home and refurbishment of the local school, both located within the leakage management area;
- Construction of an aviculture structure, vegetable gardens, fish tanks and apiaries;
- Building of a forestry nursery in the leakage management area;
- Donation of a motor boat to the community transportation.

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

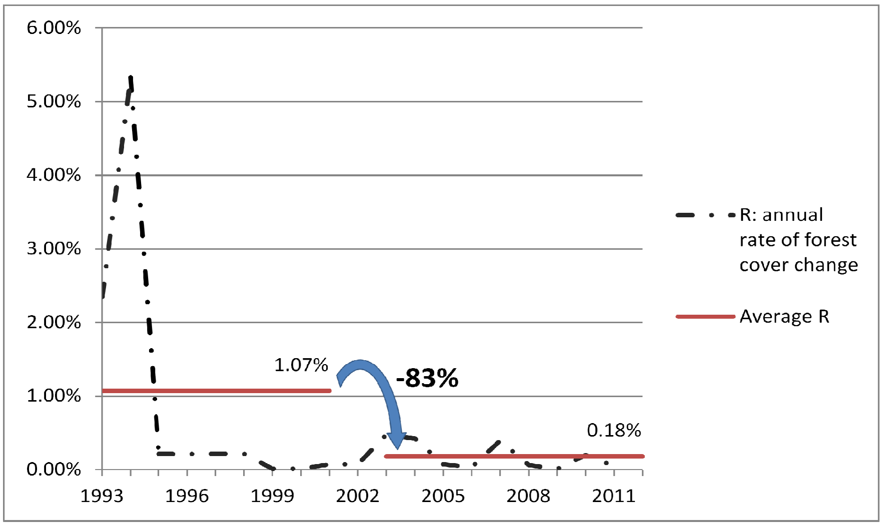


Figure 7. Comparison between the deforestation rates during the historical period and the current monitoring period

According to the baseline scenario, the predicted area that would be deforested within the project area during this monitoring period from 2003 - 2012 would be of 4,929.03 ha, which would mean an annual average deforestation rate of 0.59% per year. Comparing to the actual classified deforestation area during the same analyzed period, as detailed in the Table 1 above, the present REDD project avoided 3,349.44 ha of deforestation, which can be seen in the Table 2 below.

Cumulative deforestation during the 2003 – 2012 period	Area (ha)
Simulated deforestation area (baseline scenario)	4,929.03
Classified deforestation area (project scenario)	1,579.58
Credit area	**3,349.44**

Table 2. Comparison between the simulated and classified deforestation area within the project area during the 2003-2012 period

The comparison between these two scenarios is displayed in Figure 8 below, showing the conservation of forest areas and the consequent emission reduction provided by the REDD mechanism in the project area. The baseline scenario (solid line), which was calculated through the deforestation projected in the VCS PD, was compared to the project scenario (dashed line).

The area between these two lines is exactly the avoided deforestation area by this REDD project, which was of 3,349.44 ha over the 10 year monitored period.

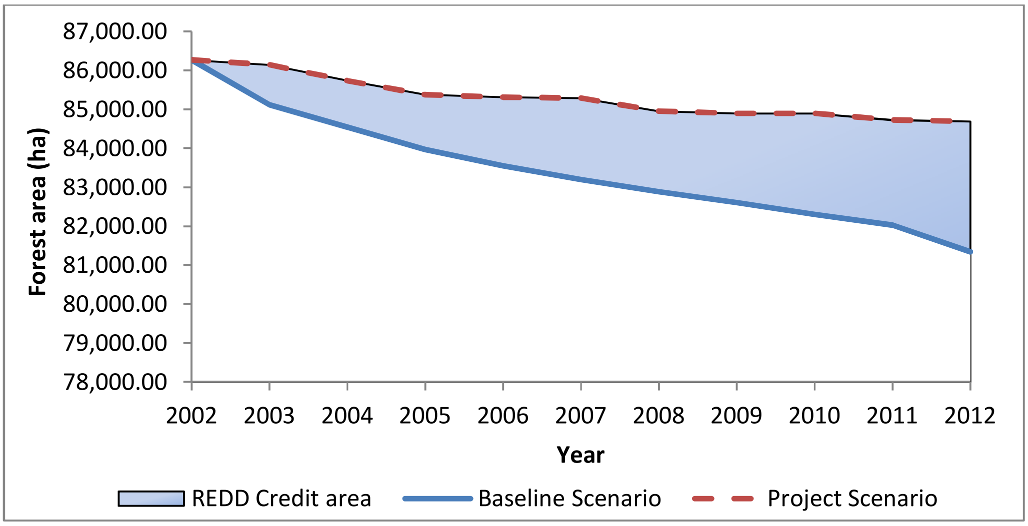


Figure 8. REDD credit area formed by the comparison between the baseline and project scenarios

Figure 9 below shows a comparison between these two different deforestation scenarios within the Project Area for this monitoring period: the baseline (projection) versus the project scenario (classification). In addition, this Figure also illustrates that the deforestation in the Project Area is not concentrated in any specific area. Despite the deforestation not occurring exactly where the applied baseline model had predicted, a homogenous distribution of the phenomenon in the vicinity of the areas predicted by the simulation is noted.

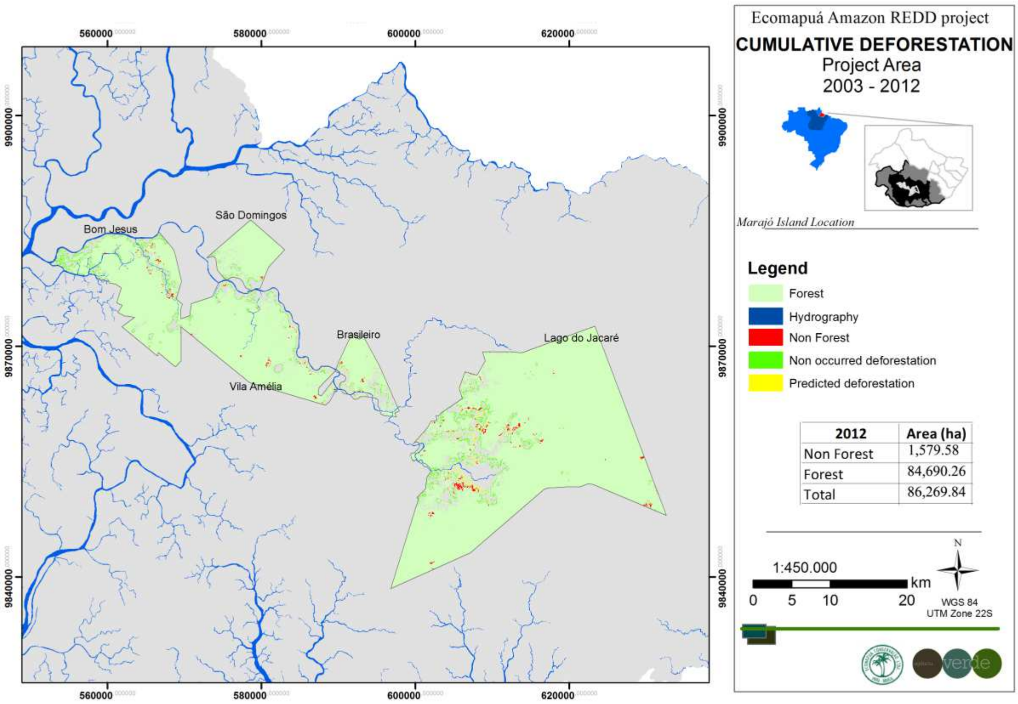


Figure 9. Spatial comparison between the projection (baseline) and classification (monitoring period) in the Project Area for the 2003 – 2012 period

In addition, the Figure 9 above also shows the distribution of the areas that were considered as "forest" and "non-forest" within the project area in 2012. In 2012, the forested areas still corresponded to around 98% of the original project area at the time of the project start date, summing up to 84,690.26 ha.

Looking now at the Reference Region, during the 2003 – 2012 period, areas classified as "non-forest" are of greater concentration and larger in the south-western portion of the latter. The Figure 10 below shows the cumulative deforestation within the reference region.

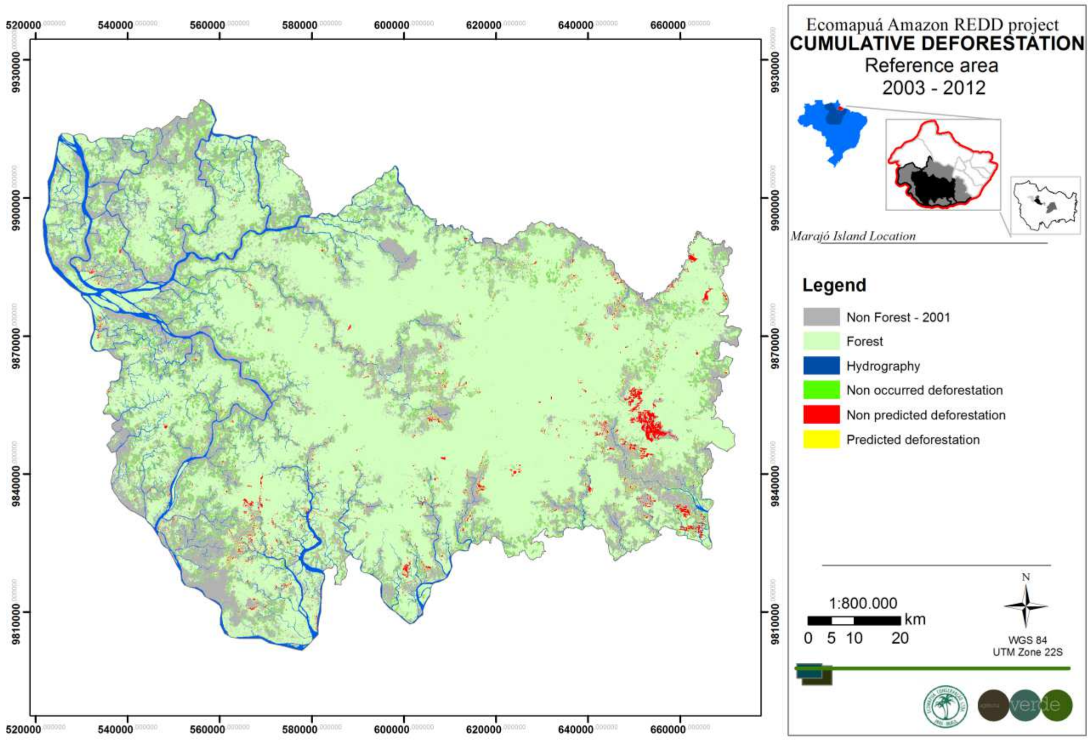


Figure 10. Cumulative deforestation in the Reference Area between 2003 and 2012

Furthermore, it can be noted that the classification carried out identified deforestation with linear patterns indicating possible road creation (Figure 11). The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation.

Meanwhile, it is observed that this pressure comes from the South of the Reference Region and appears to originate from outside the latter, not influencing the dynamics of land-use change either in the Leakage Belt or in the Project Area.

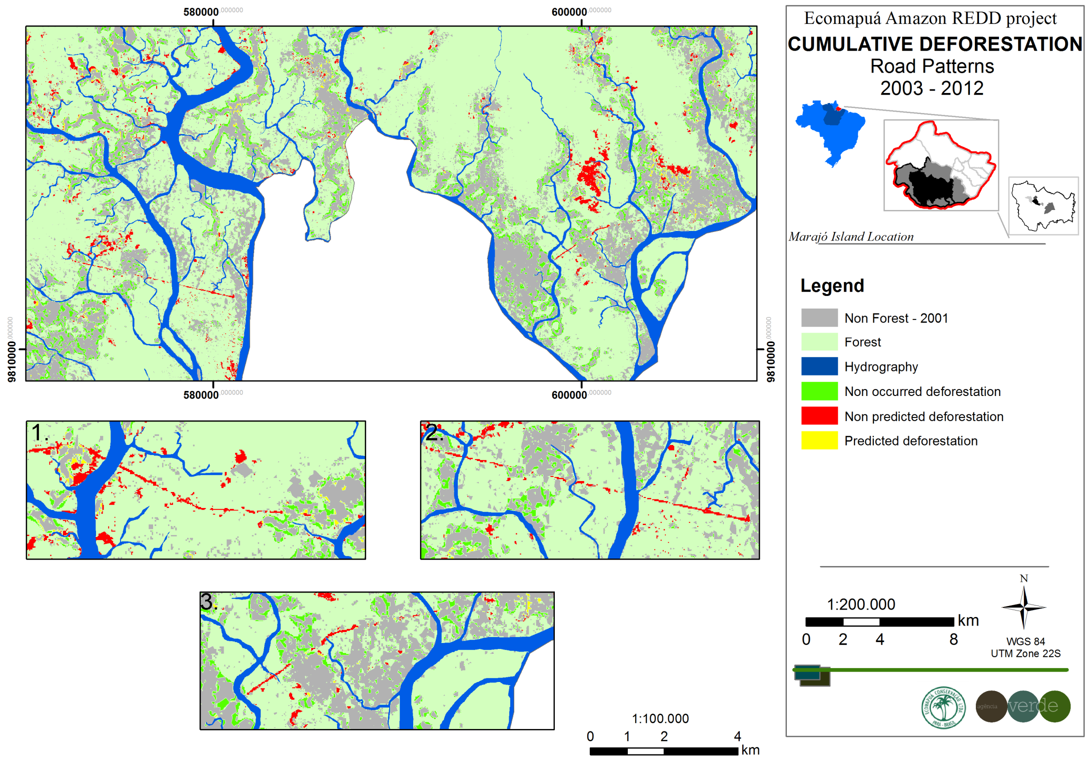


Figure 11. Deforestation in linear patterns indicating possible presence of roads

The annual evolution of the deforestation in the Reference Region can be seen at the Figure 12 below, which illustrates that the deforestation pressure mainly comes from outside the Project Area and Leakage Belt.

From 2003 to 2012, the forested areas within the reference region decreased by around 3%, which corresponds to an accumulated deforestation of 23,669.77 ha. Comparing to what occurred during the 1993 – 2001 period (historical reference period), when the annual average deforestation rate was of 2.25%, the deforestation rate within the reference region decreased around 87%, reaching around 0.29%/year. However, as mentioned above, the construction of new roads in the region can be an important deforestation agent, as there is a direct relation between the deforestation and the creation of new paved or unpaved roads, mainly when within 100km, which is the project area case[20].

[20] PFAFF, Alexander et al. Road investments, spatial spillovers, and deforestation in the Brazilian Amazon. **Journal of Regional Science.** Malden, USA, p. 109-123. 2007. Available at: <https://fds.duke.edu/db/attachment/309>. Last visited on: 15/01/2014

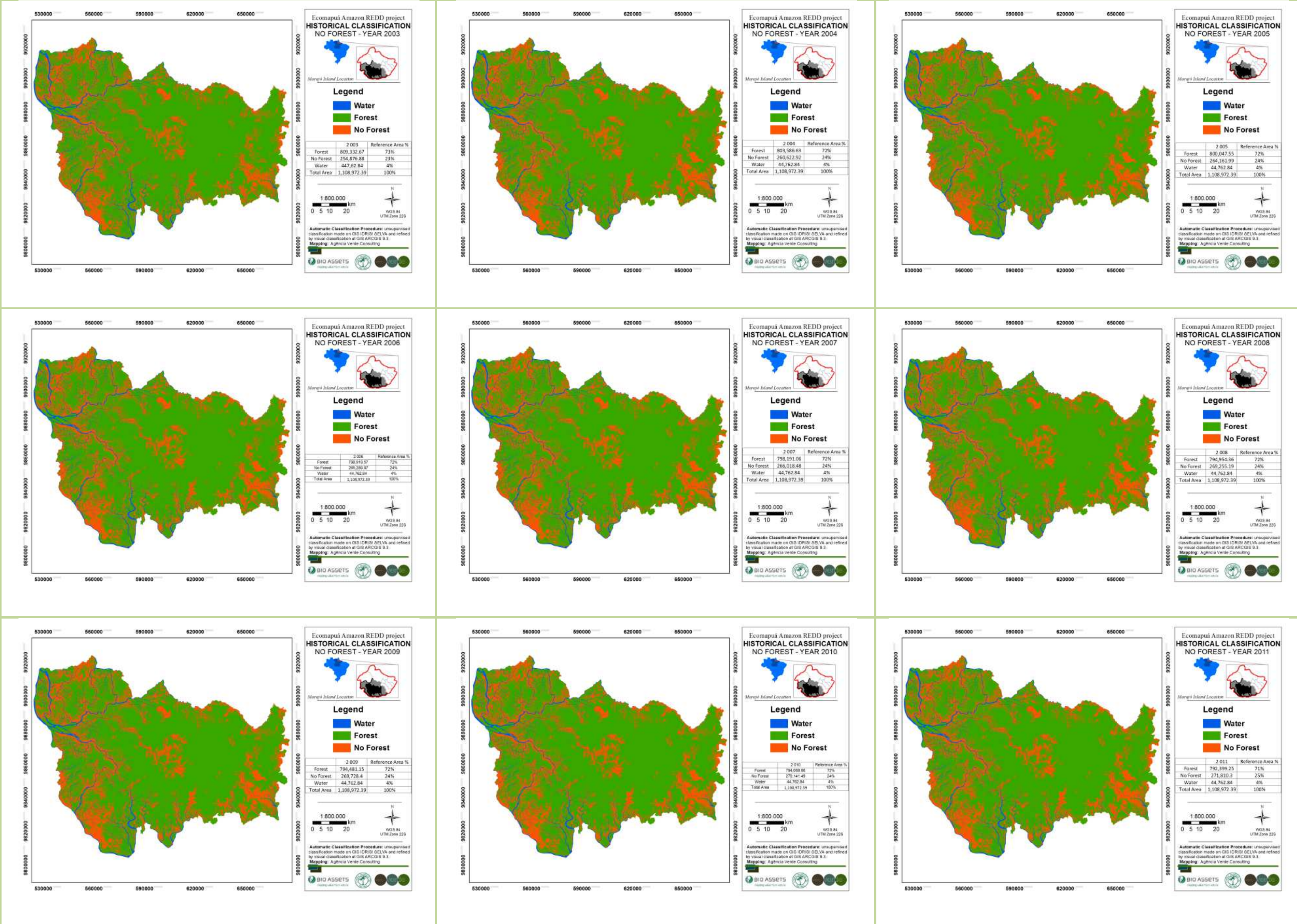


Figure 12. Evolution of the deforestation within the reference region between 2003 and 2011

Observing the deforestation patterns in the Leakage Belt, it is noted that it did not diverge from that predicted in the VCS PD, showing, however, greater intensity in its western portion, nearer to the main watercourses (Figure 13). This observation does not represent a substantial alteration in the predicted baseline, and reinforces the importance of rivers in impacting land-use changes.

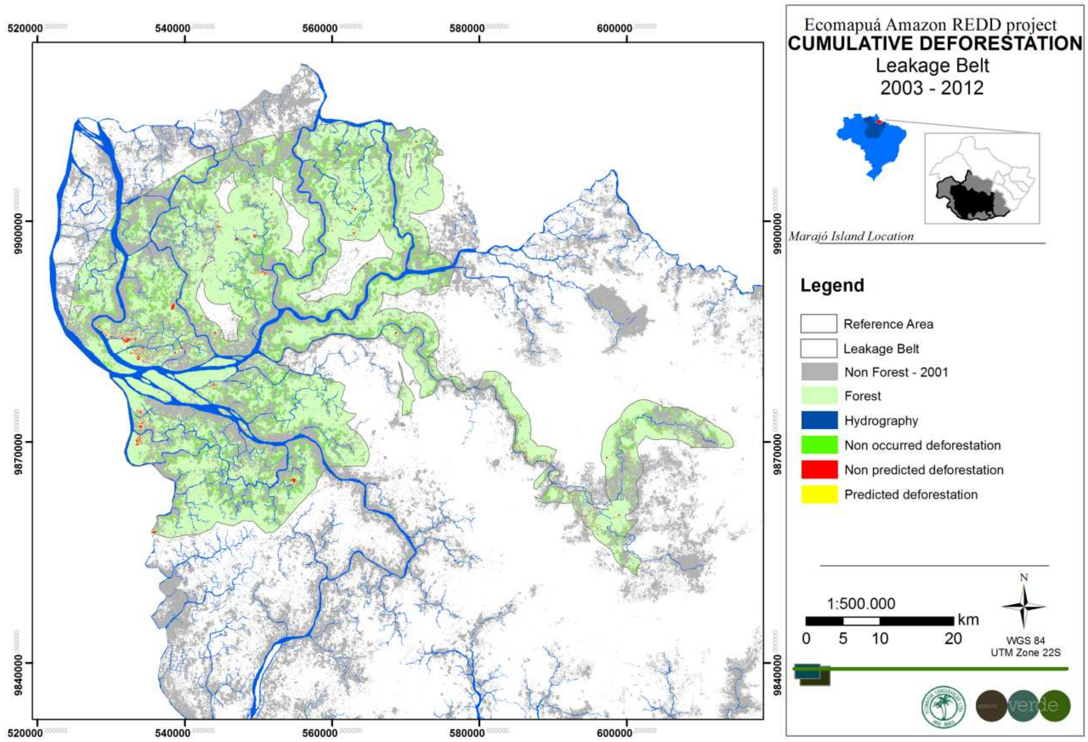


Figure 13. Cumulative deforestation in the Leakage Belt between 2003 and 2012

The leakage belt presented the major decrease in the deforestation during this monitored period. Furthermore, the deforestation rate within the leakage belt was lower than in the reference region or even than in the project area. From 2003 to 2012, there was a forest cover decrease of around 2% within the leakage belt, which corresponds to an accumulated deforestation of 2,254.84 ha during this period.

The GIS analysis led to the conclusion that the increase in deforestation in the south-southwest of the Reference Region is not associated with the initiation of the project; and that there were no significant changes in the predicted patterns of deforestation in the Leakage Belt.

The map showing the cumulative deforestation from 2003 to 2012 within the Reference Region, Project Area and Leakage Belt is illustrated in the Figure 14 below. This Figure also shows a general comparison between the baseline scenario (predicted deforestation) and the project scenario (classification).

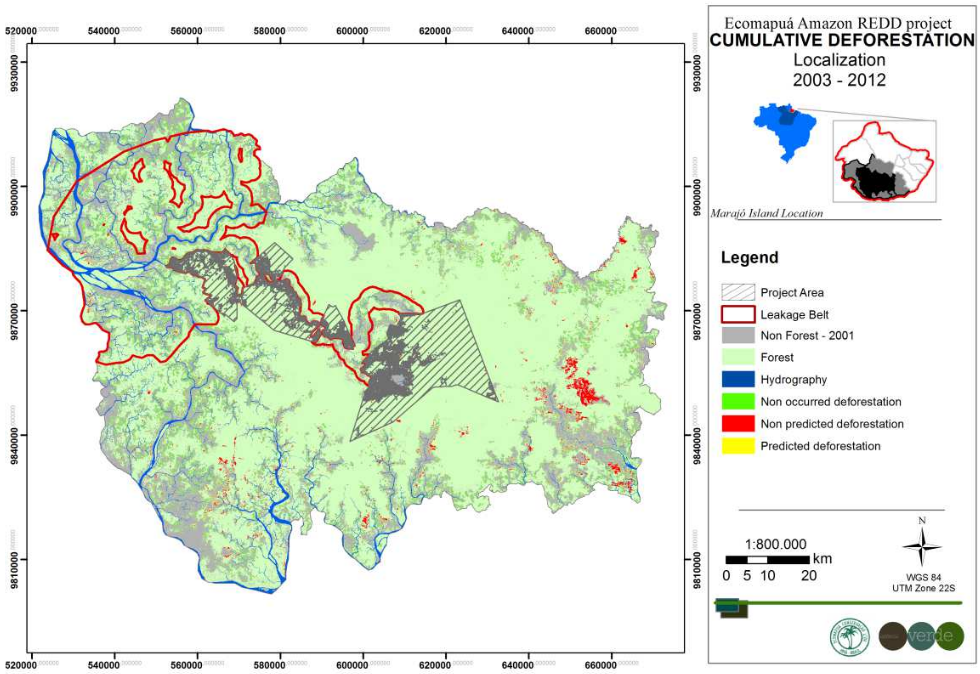


Figure 14. Cumulative deforestation from 2003 to 2012 in the Reference Region, Project and Leakage Belt

Besides forest conservation, the present project aims to improve and quantify its social and environmental benefits through application of the SOCIALCARBON® Methodology, which is being carried out during this 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.

2.2 Deviations

2.2.1 Methodology Deviations

During the analysis of the current monitoring period, an adaptation of the annual deforestation calculation was deemed to be necessary, as there were no good-quality images for the years 2002 and 2012. The Landsat images from 2002 had cloud cover obstructing over 80% of the scene, making classification impossible. Therefore, the classification of the images as of the year 2001 was carried out. Given this situation, for the current monitoring period, the deforestation values were quantified based on the deforestation in the 2001 – 2003 period. In order to be conservative, the deforestation in 2002 was assumed to be zero and the deforestation value in the year 2003 was considered as being the accumulated in the 2001-2003 period. The year of 2003 is within the project crediting period, thereby the emission reductions within the current monitoring period were reduced.

In addition, a similar situation applied to the year 2012. During this year, an error with the Landsat satellite sensor occurred, resulting in images also being unavailable for this year. The deforestation values in 2012 were quantified based on the average deforestation in the 2011 –

2013 period, noting that satellite images from Landsat 8 were available for the year 2013, which is a more recent satellite. Thus, the procedure applied was to divide the deforestation in the 2011 – 2013 period into equal parts in order to distribute it equally among the years 2012 and 2013.

Moreover, as detailed in the VCS PD, the creation of Table 10 (VM0015 v1.1) in the VCS PD was judged not to be necessary as the data utilized to formulate the deforestation scenarios included the area history. However, at the time of the VCS PD development, the spatial variables that most likely represent the patterns of baseline deforestation in the reference region were identified, and the digital maps representing the spatial features of each variable were created. Therefore, the Table 10 from VM0015 v1.1 was filled and presented in this MR together with the digital maps. For more information, please see Section 2.2.2 – Project Description Deviations, below.

2.2.2 Project Description Deviations

During development of the Monitoring Report, while comparing the classification and projections in the VCS PD, a discrepancy was noted between the areas represented in the tables in the VCS PD and those found in the final *shapefiles* of the baseline referring to the Project Area, used for comparison purposes in the present monitoring phase. Following exhaustive checking of all the files used to generate data used in the VCS PD, it was realized that the *shapefile* from which the projected areas were derived did not exclude areas considered to be "non-forest" in 2001, but only those from 1993, having a different border from the final file. In this way, the numerical data presented in the tables in the VCS PD differed from the official spatial file, and the VCS PD made an error in projecting a lower figure than it should have for future deforestation. The source of the discrepancy having been identified, it was necessary to update the values for "forest" and "non-forest" for each simulated year, in accordance with the perimeters of the official *shapefile*.

In order to correct the previously validated VCS PD and to carry out the revision of the 2nd baseline period, it was deemed necessary to revise the process regarding the year 2002. As mentioned above, there were no good-quality images for the year 2002, making classification impossible. After a great many analyses, the conclusion was reached that the most conservative and realistic way to project the deforestation in the 1st baseline period would be to exactly replicate the map from 2001 in order to represent 2002, in other words, the deforestation from 2001 to 2002 was considered to be 0 (zero). Thus, the starting year of the projection was altered in the current monitoring process, starting from the year of 2003 instead of 2002. This decision was judged to be more conservative than projecting the year 2002, because it decreased the deforestation rate during the historical reference period, which was then utilized to project the deforestation in the 2003 – 2012 period.

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

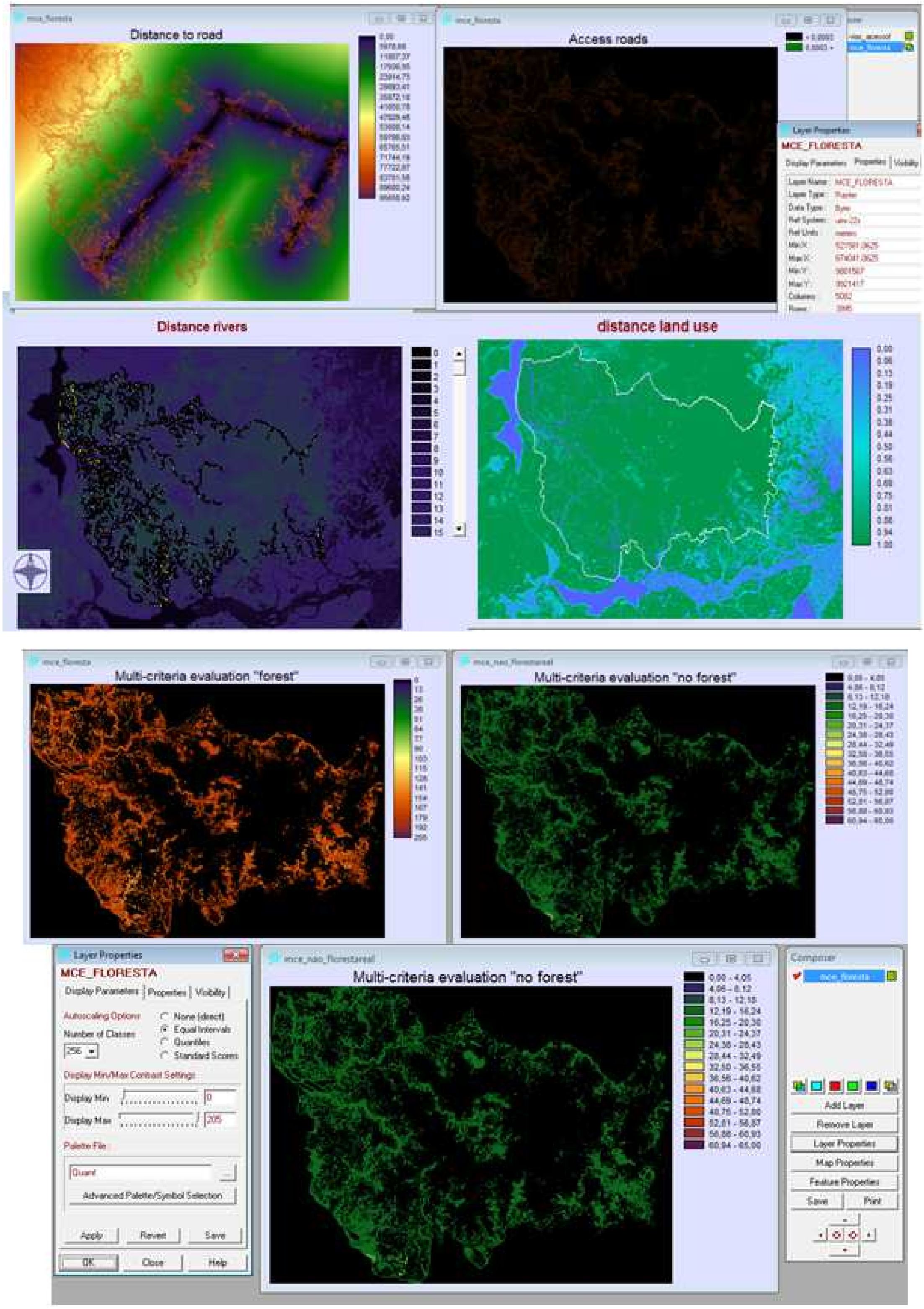
However, in order to be conservative, a correction factor was applied to the new simulated deforestation values obtained for the 2003 – 2012 period. The accuracy assessment was carried out using Kappa statistics, through comparison of the real map from 2001 with the projection of the same year. As mentioned above, there were no good-quality images for the year 2002, thus the year 2001 was considered as the final year of this analysis. The Kappa index achieved between these two figures was of 0.7105.

Therefore, the correction factor was calculated by considering the 28.95% error resulted from the Kappa index analysis (100%-71.05%), which was applied to the simulated deforestation values obtained for the 2003 – 2012 period, resulting in a total predicted deforestation of 4,929.03 ha. These updated values were used to calculate the cumulative areas for carbon credit generation in the present monitoring period. The newly-calculated baseline tables are presented in section 4.1 of the present Monitoring Report.

Moreover, as detailed in the VCS PD, the creation of Table 10 (VM0015 v1.1) in the VCS PD was judged not to be necessary as the data utilized to formulate the deforestation scenarios included the area history. However, at the time of the VCS PD development, the spatial variables that most likely represent the patterns of baseline deforestation in the reference region were identified, and the digital maps representing the spatial features of each variable were created. Therefore, the Table 10 of VM0015 v1.1 and the digital maps are presented below.

Factor Map		Source	Variable represented		Meaning of the categories or pixel value		Other Maps and Variables used to create the Factor Map		Source	Algorithm or equation used	Comments
ID	File Name		Unit	Description	Range	Meaning	ID	File Name			
1	Deforested land 1993	Satellite image - Landsat 1993	Pixel	Classification	0-256	According to satellite image categories	6	Road Network	DNIT, 2010	LCM (Idrisi) – identifying drivers: Transition Potentials - distance	Paved and deployed road
2	Deforested land 1994	Satellite image – Landsat 1994	Pixel	Classification	0-256		7	Hydrography	ANA, 2010	LCM (Idrisi) – identifying drivers: Transition Potentials - distance	Hydrography navigable
3	Deforested land 1995	Satellite image - Landsat 1995	Pixel	Classification	0-256		8	Exploration wood/land use - distance	Terraclass, 2010	LCM (Idrisi) – identifying drivers: Transition Potentials - distance	Potential logging according to land use
4	Deforested land 1999	Satellite image – Landsat 1999	Pixel	Classification	0-256		9	MCE – Multi-criteria: forest and no forest	Classification	MCE	evaluation classes
5	Deforested land 2001	Satellite image – Landsat2001	Pixel	Classification	0-256		10	MDET	SRTM	MDET	Model digital elevation
							11	Slope	SRTM	slope	slope which favors LU/LC

Table 3. List of variables, maps and factor maps


Distance to road
Access roads
Distance rivers
distance land use
Multi-criteria evaluation "forest"
Multi-criteria evaluation "no forest"
Layer Properties
MCE_FLORESTA
Display Parameters
Properties
Visibility
Autoscaling Options
None (direct)
Equal Intervals
Quantiles
Standard Scores
Number of Classes
Display Min/Max Contrast Settings
Display Min
Display Max
Palette File
Advanced Palette/Symbol Selection
Apply
Revert
Save
OK
Close
Help
Multi-criteria evaluation "no forest"
Composer
Add Layer
Remove Layer
Layer Properties
Map Properties
Feature Properties
Save
Print

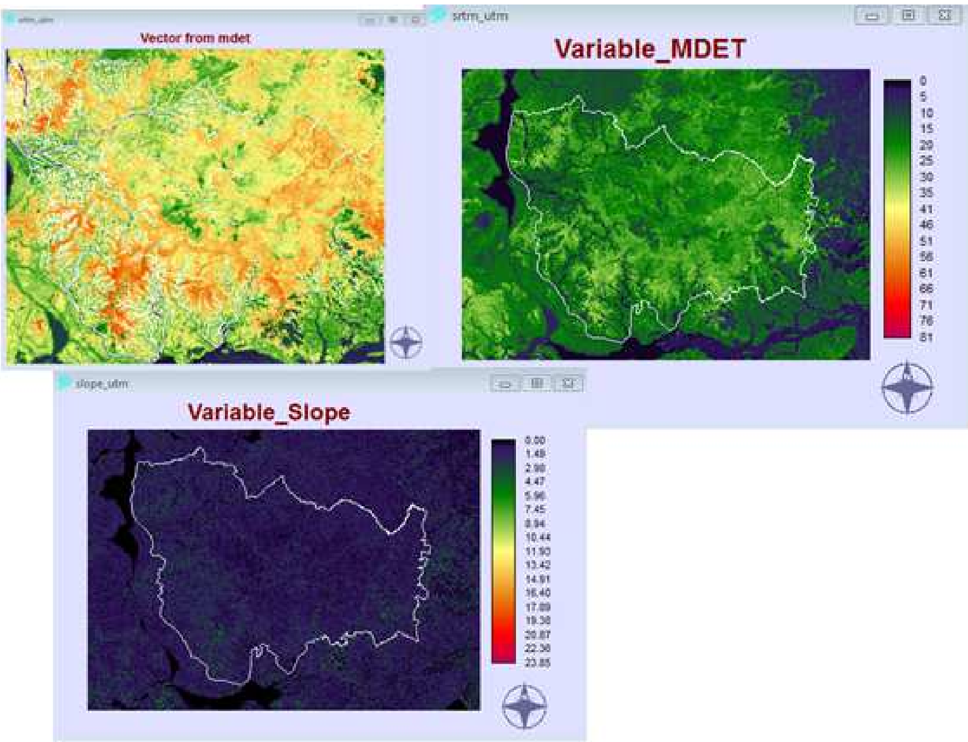


Figure 15. Maps representing the spatial features of each variable within the reference region

The variables and deforestation patterns presented in Table 3 and Figure 15 above were analyzed together to produce the risk map. It is important to note that the deforestation risk map illustrates the probability of a forest area becoming a non forest area. This map was generated through the analysis of all the variables and deforestation patterns measured over the years during the baseline period, which were obtained through the satellite image classification. For this purpose, the IDRISI software and the Land-Use Change Modeler software – LCM were utilized, which analyzed all the variables and deforestation patterns together to produce the risk map.

The transition probability matrix was generated using the LCM software, using logistic regression to calculate the potential transition, which is an algorithm capable of estimating the environmental implications according to the chosen variable and its distance. This algorithm evaluates the probability of a given pixel belonging to a most likely category based on the proximity to other pixels from the listed category. Therefore, this algorithm determines the probability of a pixel from the forest class becoming non-forest within the reference region.

The LCM software generated distance maps based on the deforestation likelihood, which was estimated through the percentage of pixels that were deforested during the historical reference period (based on the presence of forest and non-forest). Thus, the deforestation likelihood is the probability of a forest area becoming a non-forest area based on the distance from non-forest areas. After the generation of distance maps, the LCM identified land use and land cover transitions according to the deforestation drivers. For example, the presence and distance from roads is very often a potential indicator of deforestation, in the same way as the proximity to markets or municipal centers contributes to the timber commercialization.

The flowchart below illustrates the LCM modelling steps, showing how the risk map was generated.

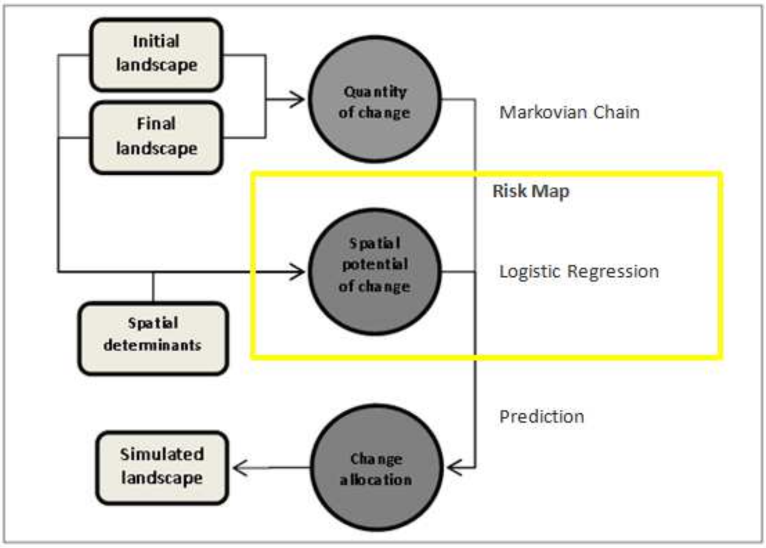


Figure 16. LCM modeling steps focusing on the creation of the deforestation risk map

Therefore, all the variables and deforestation patterns were analyzed together to produce the risk map. Table 10 of VM0015 describing the list of variables, maps and factor maps was filled and presented above. In addition, the maps representing the spatial features of each variable were also presented. Thus, the deforestation risk map available in the VCS PD, Section 2.4 – Baseline Scenario (Figure 25) was produced based on the information above, in accordance with the steps required by the methodology VM0015 v1.1. The deforestation risk map is presented below, which is the same map available at the VCS PD.

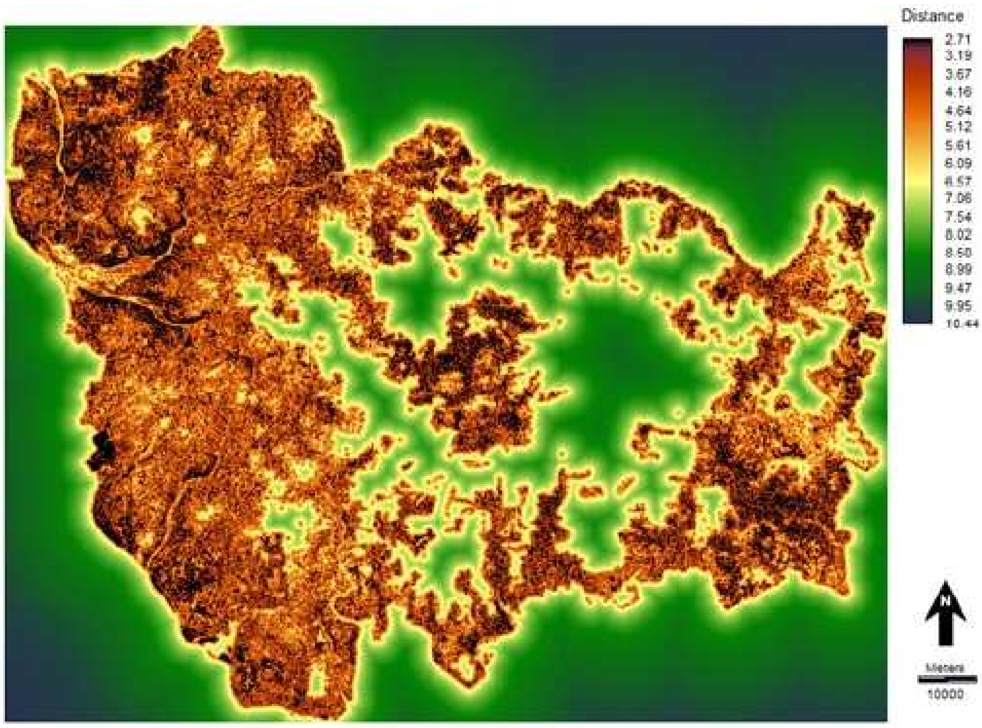


Figure 17. Deforestation risk map of the reference region

2.3 Grouped Project

This is not a grouped project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	**CF**
Data unit	tC/tdm
Description	Default value of carbon fraction in biomass
Source of data	Values from the literature (e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>).
Value applied:	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default value was used to be more conservative.
Purpose of the data	This parameter was used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an estimate of the carbon content of the vegetation biomass within the project reference region.
Comments	If new and more accurate carbon fraction data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	**ab**
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	Following a literature search, the above-ground biomass values of this study were used as they were determined to accurately

measurement methods and procedures applied	represent the values of the vegetation within the project reference region.
Purpose of the data	This parameter was used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an average of the biomass stock per hectare in the above-ground biomass within the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	**bb**
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.
Purpose of the data	This parameter was used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an average of the biomass stock per hectare in the below-ground biomass within the project reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	**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.
Value applied:	17.85
Justification of choice of data or description of measurement methods and procedures applied	Following a literature search, the calculation of 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.
Purpose of the data	This parameter was used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation.
Comments	*Ex post* monitoring of the project area was done to determine deforestation rate and the project emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	**DLF**
Data unit	%
Description	Displacement Leakage Factor
Source of data	- 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.
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.
Purpose of the data	This parameter was used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the

	project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt was done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	**∆CBSLLKt**
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
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Remote sensing and GIS
Purpose of the data	This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented.
Comments	*Ex post* monitoring of the leakage management area was done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	**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.
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.

Purpose of the data	This parameter was used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an *ex ante* estimation.
Comments	*Ex post* monitoring of forest fires and non-CO_2 emissions was done to determine GHG emissions within the project area (when the forest fire was significant). This parameter will be updated at each renewal of fixed baseline period.

3.2 Data and Parameters Monitored

Data / 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	In addition to remote sensing data and GIS, which can identify the area affected by catastrophic events, the measurement of this parameter was also based in national database at each monitoring period: - INMET[21] - INPE[22] Moreover, periodic reports from area supervisor, a community member who lives inside the project area, could also confirm the data obtained from remote sensing and GIS measurement.
Frequency of monitoring/recording	At each time a catastrophic event occurs
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Periodic reports from area supervisor
Purpose of the data	This parameter was used to calculate project emissions in the project scenario. Provides an *ex post* estimation of

[21] INMET. Instituto Nacional de Meteorologia. http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_conv_graf
[22] INPE. Instituto Nacional de Pesquisas Espaciais. http://www.inpe.br/queimadas/abasFogo.php

	the area affected by catastrophic events within the project area
Calculation method	Remote sensing and GIS
Comments	N/A

Data / 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 can be considered activity displacement leakage. Activity data for the leakage belt area was determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value monitored:	225.48 (annual average deforestation in the leakage belt during the current monitoring period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
Comments	The detected deforestation in the leakage belt was not attributed to the project activity, as described in the section 2.1 above, and detailed in section 4.3 below. Thus, this deforestation was not considered leakage.

Data / 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 was monitored through assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually

Value monitored:	157.96 (annual average deforestation in the project area during the current monitoring period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate project emissions in the project scenario. Provides the *ex post* value of the deforested area within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / 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 can be considered activity displacement leakage. Activity data for the leakage belt area was determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The detected decrease in carbon stocks in the leakage belt was not attributed to the project activity, as described in the section 2.1 above, and detailed in section 4.3 below. Thus, this deforestation was not considered leakage.

Data / 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 resulted in carbon stock decrease were subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate project emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	There were no planned activities in the project area that resulted in forest loss during the current monitored period.

Data / 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 resulted in carbon stock increase were subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate project emissions in the project scenario. Provides the *ex post* value of the increase in carbon stocks due to planned activities in the project area, which could reduce the decrease in carbon stocks in the project area.

Calculation method	Depends on the planned activity.
Comments	There were no planned activities in the project area that resulted in increase in carbon stocks during the current monitored period.

Data / Parameter	**ΔCPSLKt**
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 resulted in carbon stock decrease were subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	There were no activities in the leakage management area that resulted in changes in carbon stocks during the current monitored period.

Data / Parameter	**ΔCUDdPAt**
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	Forest cover change due to unplanned deforestation was monitored through assessment of classified satellite

applied	imagery covering the project area.
Frequency of monitoring/recording	Annually
Value monitored:	98,675.85 (annual average decrease in carbon stocks due to unavoided unplanned deforestation during the current monitoring period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the data	This parameter was used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	N/A

Data / Parameter	**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 are subjected to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, periodic reports from area supervisor, a community member who lives inside the project area, could also confirm the data obtained.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of the data	This parameter was used to calculate non-CO_2 emissions due to forest fires within the project area in the project scenario, providing an *ex post* value.
Calculation method	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant.
Comments	There were no significant forest fires in the project area

	during the current monitored period.

Data / 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	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) were subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of the data	This parameter was used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	There were no activities in the leakage management area that resulted in GHG emissions during the current monitored period.

Data / Parameter	**EADLKt**
Data unit	tCO_2e
Description	Total *ex post* increase in GHG emissions due to displaced forest fires at year t.
Source of data	Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	Forest fires in the leakage belt area can be considered activity displacement leakage. GHG emissions due displaced forest fires were subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually

Value monitored:	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of the data	This parameter was used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The detected forest fires in the leakage belt were not attributed to the project activity, as described in the section 2.1 above, and detailed in section 4.3 below. Thus, this deforestation was not considered leakage.

Data / Parameter	**RFt**
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report_Ecomapuá Amazon REDD Project, - Remote sensing data and GIS, - Supervisor report. - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report were used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value monitored:	30
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of the data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the AFOLU Non-Permanence Risk Tool. All the risk factors described in the VCS Non-Permanence Risk Report were assessed.
Comments	N/A

3.3 Monitoring Plan

For the present monitoring period, Landsat 5 images were classified from 2003 to 2011, and Landsat 8 for 2013, both having 30m resolution. The classification method was the same as used for the project baseline in the VCS PD, in order to maintain coherency of methods and results.

Automatic classification was used for images cropped from the reference area, employing the *cluster* method from IDRISI 17.0 Selva software. Automatic classification is necessarily followed by interpretation and refinement by analysts, in order to match the automatic results with the reality of the landscape. Using the same methodology as employed in the VCS PD, the process of accumulating “Non Forest” areas was adopted, in such a way that areas classified as “Non Forest” in one year were necessarily included in the same category in the following year.

Classification was first conducted for the whole Reference Region and subsequently cropped to the Leakage Belt and Project Area.

In order to compare the projection and the classification, GIS software was used, specifically the *Identity* tool, to combine the land-use file from the projection of baseline deforestation with the classification obtained from satellite images in the current monitoring phase, excluding the areas deforested in 2001, the last year classified because, as previously described, deforestation in 2002 was assumed to be zero. In this way, a hybrid file was generated which allowed a “projection x classification” matrix to be created, which indicated the accumulated deforestation dynamics from 2003 – 2012, compared to the scenario stipulated in the VCS PD.

Based on the results obtained, the following matrix was developed for identification of the deforestation dynamics in a given period:

PROJECTION	CLASSIFICATION	WHAT OCCURRED	LABEL APPLIED
Non-Forest	Forest	The deforestation predicted in the VCS PD was avoided	Avoided deforestation
Forest	Forest	The forest was conserved as predicted	Forest
Non Forest	Non Forest	Deforestation occurred where it had been predicted	Predicted deforestation
Forest	Non Forest	Deforestation occurred where it had not been predicted	Non-predicted deforestation

Table 4. Matrix for identification of LULC change during comparison of projection versus classification

Given the data obtained by combining these files, analysis of two aspects for project monitoring was possible: quantitative aspects relating to the total avoided deforestation area in the monitored period and the consequent generation of credits; and qualitative aspects relating to the spatial distribution of these areas.

The data relating to generation of carbon credits in the area during the monitoring period can be inferred from a numerical comparison of the *projected* and *classified* deforestation in the Project Area, regardless of spatial distribution.

In fact, the analysis of the spatial distribution of deforestation and the comparison with what was projected is fundamental to evaluating the deforestation patterns during the monitoring period. It allows the identification of concentration of activity in certain regions, construction of roads or possible changes in the dynamics of deforestation agents, drawing attention to necessary project adjustments.

In the case of the Reference Region and the Leakage Belt, the emphasis was put upon spatial analysis in order to understand the dynamics surrounding the Project Area and analyze possible changes in the observed deforestation patterns and possible relationships with the Project Area.

Turning to the Project Area, it was analyzed spatially as well as numerically, in order to calculate the avoided deforestation in the period eligible for carbon credit generation.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emission

The quantity of baseline LU/LC-change was projected in the reference region, project area, and leakage belt. In the reference region, the 1993 – 2001 period displayed an annual average deforestation of 2.25% per year as depicted in Table 5 below, noting that 1995 was the year with the highest annual deforestation rate with 10%. Table 5 also shows the projected annual deforestation in the reference region for the current monitoring period. The total projected deforestation would be of 89,698.53 ha from 2003 to 2012, which would be around 44% lower than the average verified in the 10 previous years (historical reference period).

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	r: annual rate of forest cover change
Historical reference period	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	815,023.03	0.00	160,634.82	0.00%
Monitoring period	2003	798,286.13	16,736.90	177,371.73	2.07%
	2004	783,118.88	15,167.24	192,538.97	1.92%
	2005	771,328.03	11,790.85	204,329.83	1.52%
	2006	761,395.68	9,932.35	214,262.18	1.30%
	2007	756,027.37	5,368.31	219,630.49	0.71%
	2008	750,159.29	5,868.08	225,498.56	0.78%
	2009	745,136.99	5,022.30	230,520.87	0.67%
	2010	740,048.34	5,088.65	235,609.51	0.69%
	2011	734,276.17	5,772.17	241,381.68	0.78%
	2012	725,324.50	8,951.67	250,333.35	1.23%
	Total deforestation (ha) 2003 - 2012		**89,698.53**	**Average deforestation rate 2003 - 2012**	**1.17%**

Table 5. Projected annual deforestation, cumulative deforestation and R in the reference region during the monitoring period in the baseline assessment

Regarding the project area, the 1993 – 2001 period displayed an annual average deforestation rate of 1.07%. As well as in the reference region, the year of 1995 had also the greatest observed rate of deforestation, as depicted in the Table 6 below. This Table also shows the projected annual deforestation within the project area for the current monitoring period. According to the baseline projections of the present project, the accumulated deforestation from 2003 – 2012 in the Ecomapuá Amazon REDD project area would sum to 4,929.03 ha, which would be around 36% lower than the average verified in the 10 previous years (historical reference period).

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
Historical reference period	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	86,269.84	0.00	7,703.38	0.00%

Monitoring period	2003	85,119.82	1,150.02	8,853.40	1.34%
	2004	84,550.12	569.70	9,423.09	0.67%
	2005	83,974.72	575.40	9,998.50	0.68%
	2006	83,545.47	429.25	10,427.75	0.51%
	2007	83,200.44	345.03	10,772.78	0.41%
	2008	82,886.38	314.05	11,086.83	0.38%
	2009	82,605.14	281.24	11,368.08	0.34%
	2010	82,300.69	304.45	11,672.53	0.37%
	2011	82,028.43	272.26	11,944.79	0.33%
	2012	81,340.81	687.62	12,632.40	0.84%
	Total deforestation (ha) 2003 - 2012		**4,929.03**	**Average deforestation rate 2003 - 2012**	**0.59%**

Table 6. Projected annual deforestation, cumulative deforestation and R in the project area during the monitoring period in the baseline assessment

Table 7 below displays the annual deforestation occurred within the leakage belt during the 1993 – 2001 period, as well as the projected annual deforestation for the current monitoring period.

	Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
Historical reference period	1993	165,967.81			
	1994	146,998.12	18,969.69	18,969.69	12.14%
	1995	120,969.01	26,029.11	44,998.80	19.49%
	1999	119,139.84	457.29	46,827.97	0.38%
	2001	119,037.32	51.26	46,930.49	0.04%
	2002	119,037.32	0.00	46,930.49	0.00%
Monitoring period	2003	113,879.68	5,157.63	52,088.13	4.43%
	2004	109,262.38	4,617.31	56,705.44	4.14%
	2005	106,995.02	2,267.36	58,972.80	2.10%
	2006	104,442.60	2,552.42	61,525.22	2.41%
	2007	102,694.26	1,748.34	63,273.55	1.69%
	2008	101,365.60	1,328.66	64,602.21	1.30%
	2009	100,019.50	1,346.10	65,948.31	1.34%
	2010	98,770.41	1,249.09	67,197.40	1.26%
	2011	97,411.40	1,359.01	68,556.41	1.39%
	2012	94,704.57	2,706.83	71,263.24	2.82%
	Total deforestation (ha) 2003 - 2012		**24,332.75**	**Average deforestation rate 2003 - 2012**	**2.29%**

Table 7. Projected annual deforestation, cumulative deforestation and R in the leakage belt during the monitoring period in the baseline assessment

Based on the projection of annual deforestation during the monitoring period as well as on the average carbon stock per hectare of initial forest class *icl*, the estimation of the baseline carbon stock changes in the above and below ground biomass could be calculated. Thus, the baseline carbon stock changes in the project area and leakage belt are found in Tables 8 and 9 below.

	Initial class					
ID 1	Riparian (Aluvial) Dense Tropical Rainforest					
Project year	$ABSLPA_{i,t}$	Cab*icl*	Δcbb*icl*	Totat Cab*icl*	Total Cbb*icl*	Total tCO_2e
	ha	tCO_2e/ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e
2003	1,150.02	-548.72	-11.28	631,036.28	12,966.50	644,002.78
2004	569.70	-548.72	-22.55	312,601.70	19,389.82	331,991.52
2005	575.40	-548.72	-33.83	315,733.83	25,877.50	341,611.33
2006	429.25	-548.72	-45.10	235,535.22	30,717.27	266,252.49
2007	345.03	-548.72	-56.38	189,325.40	34,607.52	223,932.91
2008	314.05	-548.72	-67.65	172,327.15	38,148.48	210,475.63
2009	281.24	-548.72	-78.93	154,322.16	41,319.49	195,641.65
2010	304.45	-548.72	-90.20	167,057.58	44,752.18	211,809.76
2011	272.26	-548.72	-101.48	149,392.61	47,821.89	197,214.49
2012	687.62	-548.72	-112.75	377,306.51	55,574.76	432,881.27

Table 8. Baseline carbon stock change in the project area

	Initial class					
ID 1	Riparian (Aluvial) Dense Tropical Rainforest					
Project year	$ABSLLK_{i,t}$	Cab*icl*	Δcb*icl*	Totat Cab*icl*	Total Cbb*icl*	Total tCO_2e
	ha	tCO_2e/ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e
2003	5,157.63	-548.72	-11.28	2,830,080.18	58,152.33	2,888,232.52
2004	4,617.31	-548.72	-22.55	2,533,593.92	110,212.48	2,643,806.40
2005	2,267.36	-548.72	-33.83	1,244,138.69	135,776.98	1,379,915.67
2006	2,552.42	-548.72	-45.10	1,400,554.94	164,555.50	1,565,110.44
2007	1,748.34	-548.72	-56.38	959,341.53	184,268.00	1,143,609.53
2008	1,328.66	-548.72	-67.65	729,055.45	199,248.59	928,304.04
2009	1,346.10	-548.72	-78.93	738,629.69	214,425.91	953,055.60
2010	1,249.09	-548.72	-90.20	685,396.69	228,509.41	913,906.10
2011	1,359.01	-548.72	-101.48	745,711.82	243,832.25	989,544.07
2012	2,706.83	-548.72	-112.75	1,485,280.74	274,351.72	1,759,632.46

Table 9. Baseline carbon stock change in the leakage belt

The resulting baseline carbon stock changes for initial forest class for the project area and leakage belt during the current monitoring period are shown in tables 10 and 11 below.

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	631,036.28	12,966.50	644,002.78	644,002.78
2004	312,601.70	19,389.82	331,991.52	975,994.30
2005	315,733.83	25,877.50	341,611.33	1,317,605.63
2006	235,535.22	30,717.27	266,252.49	1,583,858.13
2007	189,325.40	34,607.52	223,932.91	1,807,791.04
2008	172,327.15	38,148.48	210,475.63	2,018,266.67
2009	154,322.16	41,319.49	195,641.65	2,213,908.32
2010	167,057.58	44,752.18	211,809.76	2,425,718.08
2011	149,392.61	47,821.89	197,214.49	2,622,932.57
2012	377,306.51	55,574.76	432,881.27	3,055,813.84

Table 10. Baseline carbon stock change in the project area

LEAKAGE BELT				
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*** annual	**ΔCbbBSLLK*icl,t*** annual	**annual**	**cumulative**
	tCO_2e	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	2,830,080.18	58,152.33	2,888,232.52	2,888,232.52
2004	2,533,593.92	110,212.48	2,643,806.40	5,532,038.92
2005	1,244,138.69	135,776.98	1,379,915.67	6,911,954.59
2006	1,400,554.94	164,555.50	1,565,110.44	8,477,065.03
2007	959,341.53	184,268.00	1,143,609.53	9,620,674.56
2008	729,055.45	199,248.59	928,304.04	10,548,978.61
2009	738,629.69	214,425.91	953,055.60	11,502,034.21
2010	685,396.69	228,509.41	913,906.10	12,415,940.30
2011	745,711.82	243,832.25	989,544.07	13,405,484.37
2012	1,485,280.74	274,351.72	1,759,632.46	15,165,116.83

Table 11. Baseline carbon stock change in the leakage belt area

4.2 Project Emissions

The ex-post verified deforestation in the reference region, project area, and leakage belt during the monitoring period are displayed in the tables below.

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2001	815,023.03			
2003	809,332.67	5,690.36	5,690.36	0.70%
2004	803,586.63	5,746.04	11,436.40	0.71%
2005	800,047.55	3,539.07	14,975.48	0.44%
2006	798,919.57	1,127.98	16,103.46	0.14%
2007	798,191.06	728.51	16,831.96	0.09%
2008	794,954.36	3,236.71	20,068.67	0.41%
2009	794,481.15	473.21	20,541.88	0.06%
2010	794,068.06	413.09	20,954.97	0.05%
2011	792,399.25	1,668.81	22,623.78	0.21%
2012	791,353.26	1,045.98	23,669.77	0.13%
Total deforestation (ha) 2003 - 2012		**23,669.77**	**Average deforestation rate 2003 - 2012**	**0.29%**

Table 12. Ex-post measured annual deforestation, cumulative deforestation and R in the reference region during the monitoring period

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2001	86,269.84			
2003	86,146.93	122.91	122.91	0.14%
2004	85,741.44	405.49	528.40	0.47%
2005	85,380.42	361.02	889.42	0.42%
2006	85,318.19	62.23	951.65	0.07%
2007	85,291.56	26.63	978.28	0.03%
2008	84,956.59	334.97	1,313.25	0.39%
2009	84,902.69	53.90	1,367.15	0.06%
2010	84,895.60	7.09	1,374.24	0.01%
2011	84,730.46	165.15	1,539.38	0.19%
2012	84,690.26	40.20	1,579.58	0.05%
Total deforestation (ha) 2003 - 2012		**1,579.58**	**Average deforestation rate 2003 - 2012**	**0.18%**

Table 13. Ex-post measured annual deforestation, cumulative deforestation and R in the project area during the monitoring period

Year	Riparian (Aluvial) Dense Tropical Rainforest (ha)	Annual deforestation (ha)	Cumulative deforestation (ha)	R: annual rate of forest cover change
2001	119,037.32			
2003	118,048.66	988.66	988.66	0.83%
2004	117,859.44	189.22	1,177.88	0.16%
2005	117,403.26	456.17	1,634.05	0.39%
2006	117,321.80	81.46	1,715.52	0.07%
2007	117,225.21	96.59	1,812.11	0.08%
2008	116,991.44	233.77	2,045.88	0.20%
2009	116,971.51	19.93	2,065.81	0.02%
2010	116,968.68	2.83	2,068.64	0.00%
2011	116,888.22	80.46	2,149.10	0.07%
2012	116,782.48	105.74	2,254.84	0.09%
Total deforestation 2003 - 2012 (ha)		**2,254.84**	**Average deforestation rate 2003 - 2012**	**0.19%**

Table 14. Ex-post measured annual deforestation, cumulative deforestation and R in the leakage belt during the monitoring period

As described in the VCS PD, the only "forest" stratum used consisted of riparian dense tropical rainforest, which is represented by stratum i. The Tables 15 – 17 below show the annual areas of deforestation in the sole stratum of "forest" in the reference region, project area and leakage belt across the monitoring period.

Project year t	Stratum i in the reference region (ha)	Total (ha)	
	$ABSLRR_{i,t}$	Annual $ABSLRR_t$	Cumulative ABSLRR
2003	5,690.36	5,690.36	5,690.36
2004	5,746.04	5,746.04	11,436.40
2005	3,539.07	3,539.07	14,975.48
2006	1,127.98	1,127.98	16,103.46
2007	728.51	728.51	16,831.96
2008	3,236.71	3,236.71	20,068.67
2009	473.21	473.21	20,541.88
2010	413.09	413.09	20,954.97
2011	1,668.81	1,668.81	22,623.78
2012	1,045.98	1,045.98	23,669.77

Table 15. Annual areas of deforestation in the reference region

Project year t	Stratum i in project area (ha)	Total (ha)	
	$ABSLPA_{i,t}$	Annual $ABSLPA_t$	Cumulative ABSLPA
2003	122.91	122.91	122.91
2004	405.49	405.49	528.40
2005	361.02	361.02	889.42
2006	62.23	62.23	951.65
2007	26.63	26.63	978.28
2008	334.97	334.97	1,313.25
2009	53.90	53.90	1,367.15
2010	7.09	7.09	1,374.24
2011	165.15	165.15	1,539.38
2012	40.20	40.20	1,579.58

Table 16. Annual areas of deforestation in the project area

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	$ABSLLK_{i,t}$	Annual $ABSLLK_t$	Cumulative ABSLLK
2003	988.66	988.66	988.66
2004	189.22	189.22	1,177.88
2005	456.17	456.17	1,634.05
2006	81.46	81.46	1,715.52
2007	96.59	96.59	1,812.11
2008	233.77	233.77	2,045.88
2009	19.93	19.93	2,065.81
2010	2.83	2.83	2,068.64
2011	80.46	80.46	2,149.10
2012	105.74	105.74	2,254.84

Table 17. Annual areas of deforestation in the leakage belt

The annual values of deforestation per initial forest class *icl* within the Reference Region, Project Area and Leakage Belt can be seen in the Tables 18 – 20 below.

Area deforested per forest class *icl* within the reference region		Total deforestation in the reference region	
IDicl	**1**	**Annual $ABSLRR_t$ (ha)**	**$ABSLRR_t$ cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year t	**ha**		
2003	5,690.36	5,690.36	5,690.36
2004	5,746.04	5,746.04	11,436.40
2005	3,539.07	3,539.07	14,975.48
2006	1,127.98	1,127.98	16,103.46
2007	728.51	728.51	16,831.96
2008	3,236.71	3,236.71	20,068.67
2009	473.21	473.21	20,541.88
2010	413.09	413.09	20,954.97
2011	1,668.81	1,668.81	22,623.78
2012	1,045.98	1,045.98	23,669.77

Table 18. Annual areas deforested per forest class *icl* within the reference region

Area deforested per forest class *icl* within the project area		Total deforestation in the project area	
IDicl	**1**	**Annual $ABSLPA_t$ (ha)**	**$ABSLPA_t$ cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year t	**ha**		
2003	122.91	122.91	122.91
2004	405.49	405.49	528.40
2005	361.02	361.02	889.42
2006	62.23	62.23	951.65
2007	26.63	26.63	978.28
2008	334.97	334.97	1,313.25
2009	53.90	53.90	1,367.15
2010	7.09	7.09	1,374.24
2011	165.15	165.15	1,539.38
2012	40.20	40.20	1,579.58

Table 19. Annual areas deforested per forest class *icl* within the project area

Area deforested per forest class *icl* within the leakage belt		Total deforestation in the leakage belt area	
IDicl	**1**	**Annual $ABSLLK_t$ (ha)**	**$ABSLLK_t$ cumulative (ha)**
Name	Riparian (Aluvial) Dense Tropical Rainforest		
Project year *t*	**ha**		
2003	988.66	988.66	988.66
2004	189.22	189.22	1,177.88
2005	456.17	456.17	1,634.05
2006	81.46	81.46	1,715.52
2007	96.59	96.59	1,812.11
2008	233.77	233.77	2,045.88
2009	19.93	19.93	2,065.81
2010	2.83	2.83	2,068.64
2011	80.46	80.46	2,149.10
2012	105.74	105.74	2,254.84

Table 20. Annual areas deforested per forest class *icl* within the leakage belt

According to the VCS PD, the LU/LC-change caused by deforestation consisted of the initial class of riparian dense tropical rainforest being converted to the final LU/LC class of "non-forest". As the entire initial class was transformed into non-forest (final post-deforestation class), the annual deforestation area values for the final class are equal to those for the initial class. Tables 21 – 23 below depict post-deforestation forest class in the reference region, project area, and leakage belt, respectively.

Area established after deforestation per zone within the reference region		Total deforestation in the reference region	
ID*ct*	**2**	**$ABSLRR_t$**	**$ABSLRR_t$**
Name	**Non forest**	**Annual**	**Cumulative**
Project year	**ha**	**ha**	**ha**
2003	5,690.36	5,690.36	5,690.36
2004	5,746.04	5,746.04	11,436.40
2005	3,539.07	3,539.07	14,975.48
2006	1,127.98	1,127.98	16,103.46
2007	728.51	728.51	16,831.96
2008	3,236.71	3,236.71	20,068.67
2009	473.21	473.21	20,541.88
2010	413.09	413.09	20,954.97
2011	1,668.81	1,668.81	22,623.78
2012	1,045.98	1,045.98	23,669.77

Table 21. Annual areas deforested in each zone within the reference region

Area established after deforestation per zone within the project area		Total deforestation in the project area	
ID*ct*	**2**	$ABSLPA_t$	$ABSLPA_t$
Name	**Non forest**	**annual**	**cumulative**
Project year	**ha**	**ha**	**ha**
2003	122.91	122.91	122.91
2004	405.49	405.49	528.40
2005	361.02	361.02	889.42
2006	62.23	62.23	951.65
2007	26.63	26.63	978.28
2008	334.97	334.97	1,313.25
2009	53.90	53.90	1,367.15
2010	7.09	7.09	1,374.24
2011	165.15	165.15	1,539.38
2012	40.20	40.20	1,579.58

Table 22. Annual areas deforested in each zone within the project area

Area established after deforestation per zone within the leakage belt		Total deforestation in the leakage belt	
ID*ct*	**2**	$ABSLLK_t$	$ABSLLK_t$
Name	**Non forest**	**annual**	**cumulative**
Project year	**ha**	**ha**	**ha**
2003	988.66	988.66	988.66
2004	189.22	189.22	1,177.88
2005	456.17	456.17	1,634.05
2006	81.46	81.46	1,715.52
2007	96.59	96.59	1,812.11
2008	233.77	233.77	2,045.88
2009	19.93	19.93	2,065.81
2010	2.83	2.83	2,068.64
2011	80.46	80.46	2,149.10
2012	105.74	105.74	2,254.84

Table 23. Annual areas deforested in each zone within the leakage belt

The carbon stock change factors for initial forest classes in above and below-ground carbon pools were applied to calculate the *ex post* carbon stock changes, multiplying them by the annual deforested area of initial forest class *icl*. The resulting changes in carbon stock for initial forest class for the project area is shown in Table 24 below.

	Initial class					
ID 1	**Riparian (Aluvial) Dense Tropical Rainforest**					
Project year	**Annual deforestation area within the project area**	**Δcabicl**	**Δcbb*icl***	**Totat Cab*icl***	**Total Cbb*icl***	**Total tCO_2e**
	ha	**tCO_2e/ha**	**tCO_2e/ha**	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	122.91	-548.72	-11.28	67,441.90	1,385.79	68,827.69
2004	405.49	-548.72	-22.55	222,500.66	5,957.72	228,458.38
2005	361.02	-548.72	-33.83	198,098.06	10,028.23	208,126.29
2006	62.23	-548.72	-45.10	34,144.74	10,729.84	44,874.58
2007	26.63	-548.72	-56.38	14,613.65	11,030.12	25,643.76
2008	334.97	-548.72	-67.65	183,802.76	14,806.89	198,609.64
2009	53.90	-548.72	-78.93	29,577.68	15,414.65	44,992.32
2010	7.09	-548.72	-90.20	3,888.17	15,494.54	19,382.71
2011	165.15	-548.72	-101.48	90,618.13	17,356.56	107,974.69
2012	40.20	-548.72	-112.75	22,058.66	17,809.82	39,868.47

Table 24. *Ex post* carbon stock per hectare of initial forest classes *icl* existing in the project area

Therefore, the total carbon stock change for initial forest class in the project area could be calculated, by summing the carbon stock changes in the above and below ground biomass pools, as depicted in Table 25 below.

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	67,441.90	1,385.79	68,827.69	68,827.69
2004	222,500.66	5,957.72	228,458.38	297,286.08
2005	198,098.06	10,028.23	208,126.29	505,412.36
2006	34,144.74	10,729.84	44,874.58	550,286.94
2007	14,613.65	11,030.12	25,643.76	575,930.71
2008	183,802.76	14,806.89	198,609.64	774,540.35
2009	29,577.68	15,414.65	44,992.32	819,532.67
2010	3,888.17	15,494.54	19,382.71	838,915.38
2011	90,618.13	17,356.56	107,974.69	946,890.07
2012	22,058.66	17,809.82	39,868.47	986,758.54

Table 25. *Ex post* total net carbon stock changes in the project area

During this monitoring period, there were no planned deforestation within the project area; however there was a total carbon stock decrease of 986,758.54 tCO_2e due to unplanned deforestation within the project area, as depicted in Table 26 below.

Project year	Areas of planned deforestation x Carbon stock change (decrease) in the project area				Areas of unplanned deforestation x Carbon stock change (decrease) in the project area				Total carbon stock decrease due to planned and unplanned deforestation in the project area	
	ID cl			1	*ID cl*			1		
	$APDPA_t$	$\Delta Ctot_{icl,t}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$ABSLPA_t$	$\Delta Ctot_{icl,t}$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	Annual	Cumulative
			Annual	Cumulative			Annual	Cumulative		
	ha	tCO_2e/ha	tCO_2e	tCO_2e	ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	559.99	0.00	0.00	122.91	559.99	68,827.69	68,827.69	68,827.69	68,827.69
2004	0.00	571.27	0.00	0.00	405.49	571.27	228,458.38	297,286.08	228,458.38	297,286.08
2005	0.00	582.54	0.00	0.00	361.02	582.54	208,126.29	505,412.36	208,126.29	505,412.36
2006	0.00	593.82	0.00	0.00	62.23	593.82	44,874.58	550,286.94	44,874.58	550,286.94
2007	0.00	605.09	0.00	0.00	26.63	605.09	25,643.76	575,930.71	25,643.76	575,930.71
2008	0.00	616.37	0.00	0.00	334.97	616.37	198,609.64	774,540.35	198,609.64	774,540.35
2009	0.00	627.64	0.00	0.00	53.90	627.64	44,992.32	819,532.67	44,992.32	819,532.67
2010	0.00	638.92	0.00	0.00	7.09	638.92	19,382.71	838,915.38	19,382.71	838,915.38
2011	0.00	650.19	0.00	0.00	165.15	650.19	107,974.69	946,890.07	107,974.69	946,890.07
2012	0.00	661.47	0.00	0.00	40.20	661.47	39,868.47	986,758.54	39,868.47	986,758.54

Table 26. *Ex post* carbon stock decrease due to planned and unplanned deforestation in the project area

Furthermore, there were no planned activities that resulted in carbon stock increase during this monitoring period, as detailed in Table 27 below.

Project year	Total carbon stock increase due to growth without harvest		Total carbon stock increase due to planned logging activities		Total carbon stock increase due to planned fuel-wood and charcoal activities		Total carbon stock increase due to planned activities	
	$\Delta CPNiPA_t$	$\Delta CPNiPA$	$\Delta CPLiPA_t$	$\Delta CPLiPA$	$\Delta CPFiPA_t$	$\Delta CPFiPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 27. Total *ex post* carbon stock increase due to planned activities in the project area

As detailed above, no events, such as forest fire or catastrophic events, which significantly decreased carbon stocks or increased GHG emissions occurred within the project area. In addition, as mentioned above, no planned activities were carried out, thus not affecting the carbon stock within the project area. This information is summarized in the Table 28 below, which shows the *ex post* estimated net carbon stock change in the project area under the project scenario.

Project year	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to fires and catastrophic events		Total carbon stock increase due to fires and catastrophic events		Total *ex post* carbon stock change in the project case	
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAiPA_t$	ΔCPAiPA	$\Delta CFCdPA_t$	ΔCFCdPA	$\Delta CFCiPA_t$	ΔCFCiPA	$\Delta CPSPA_t$	ΔCPSPA
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 28. *Ex post* estimated net carbon stock change in the project area under the project scenario

Therefore, the results of all *ex post* estimations in the project area are summarized in Table 29 below. As detailed in this Table, the major cause of project emissions within the project area during this monitoring period was the carbon stock decrease due to unavoided unplanned deforestation, corresponding to an average annual value of 98,675.85 tCO_2e/year. Nevertheless, this type of project emissions will probably decrease, as the future trend of unavoided unplanned deforestation within the project area will most likely be decreasing.

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 post* actual non-CO_2 emissions from forest fires in the project area	
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAiPA_t$	ΔCPAiPA	$\Delta CUDdPA_t$	ΔCUDdPA	$\Delta CPSPA_t$	ΔCPSPA	$EBBPSPA_t$	EBBPSPA
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	68,827.69	68,827.69	68,827.69	68,827.69	0.00	0.00
2004	0.00	0.00	0.00	0.00	228,458.38	297,286.08	228,458.38	297,286.08	0.00	0.00
2005	0.00	0.00	0.00	0.00	208,126.29	505,412.36	208,126.29	505,412.36	0.00	0.00
2006	0.00	0.00	0.00	0.00	44,874.58	550,286.94	44,874.58	550,286.94	0.00	0.00
2007	0.00	0.00	0.00	0.00	25,643.76	575,930.71	25,643.76	575,930.71	0.00	0.00
2008	0.00	0.00	0.00	0.00	198,609.64	774,540.35	198,609.64	774,540.35	0.00	0.00
2009	0.00	0.00	0.00	0.00	44,992.32	819,532.67	44,992.32	819,532.67	0.00	0.00
2010	0.00	0.00	0.00	0.00	19,382.71	838,915.38	19,382.71	838,915.38	0.00	0.00
2011	0.00	0.00	0.00	0.00	107,974.69	946,890.07	107,974.69	946,890.07	0.00	0.00
2012	0.00	0.00	0.00	0.00	39,868.47	986,758.54	39,868.47	986,758.54	0.00	0.00

Table 29. Total ex-post estimated actual net changes in carbon stocks and emissions of GHG gases in the project area

4.3 Leakage

According to the VCS Methodology VM0015, version 1.1, two sources of leakage are potentially subject to monitoring, which are:

a. Decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage; and
b. Decrease in carbon stocks and increase in GHG emissions associated with leakage prevention activities.

Regarding the first leakage source, activities that cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the current monitoring period than those predicted *ex-ante* would indicate displacement of deforestation activities due to the project.

Table 30 below shows the *ex post* annual deforestation area within the leakage belt, the carbon stock per hectare for the above and below ground biomass of initial forest class *icl*, and the consequent changes in carbon stock.

It is important to note that activity data for the leakage belt area was determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage due to displacement activity was monitored by mapping forest cover change in the leakage belt.

	Initial class					
ID 1	**Riparian (Aluvial) Dense Tropical Rainforest**					
Project year	**Annual deforestation area within the leakage belt**	**Δcab*icl***	**Δcbb*icl***	**Totat Cab*icl***	**Total Cbb*icl***	**Total tCO_2e**
	ha	**tCO_2e/ha**	**tCO_2e/ha**	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	988.66	-548.72	-11.28	542,493.79	11,147.13	553,640.92
2004	189.22	-548.72	-22.55	103,830.66	13,280.64	117,111.30
2005	456.17	-548.72	-33.83	250,308.39	18,423.96	268,732.36
2006	81.46	-548.72	-45.10	44,701.03	19,342.48	64,043.51
2007	96.59	-548.72	-56.38	53,000.51	20,431.53	73,432.04
2008	233.77	-548.72	-67.65	128,274.35	23,067.30	151,341.65
2009	19.93	-548.72	-78.93	10,933.43	23,291.96	34,225.39
2010	2.83	-548.72	-90.20	1,553.08	23,323.87	24,876.96
2011	80.46	-548.72	-101.48	44,151.19	24,231.09	68,382.28
2012	105.74	-548.72	-112.75	58,020.94	25,423.30	83,444.24

Table 30. *Ex post* carbon stock per hectare of initial forest class *icl* existing in the leakage belt

Therefore, the *ex post* total carbon stock change for initial forest class in the leakage belt could be calculated by summing the carbon stock changes in the above and below ground biomass pools, as depicted in Table 31 below.

LEAKAGE BELT				
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* annual**	**ΔCbbBSLLK*icl,t* annual**	**annual**	**cumulative**
	tCO_2e	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	542,493.79	11,147.13	553,640.92	553,640.92
2004	103,830.66	13,280.64	117,111.30	670,752.22
2005	250,308.39	18,423.96	268,732.36	939,484.58
2006	44,701.03	19,342.48	64,043.51	1,003,528.09
2007	53,000.51	20,431.53	73,432.04	1,076,960.13
2008	128,274.35	23,067.30	151,341.65	1,228,301.78
2009	10,933.43	23,291.96	34,225.39	1,262,527.17
2010	1,553.08	23,323.87	24,876.96	1,287,404.13
2011	44,151.19	24,231.09	68,382.28	1,355,786.41
2012	58,020.94	25,423.30	83,444.24	1,439,230.65

Table 31. *Ex post* total net carbon stock changes in the leakage belt

As defined in the VCS Methodology VM0015 v1.1, deforestation above the baseline in the leakage belt area will be considered activity displacement leakage. Thus, leakage emissions due to activity displacement were calculated as the difference between the *ex ante* and the *ex post* assessment, detailed in the Table 32 below.

Project year	**Total *ex ante* net baseline carbon stock change**		**Total *ex post* net actual carbon stock change**		**Total *ex post* leakage**	
	$\Delta CADLK_t$ annual	**ΔCADLK cumulative**	**$\Delta CADLK_t$ annual**	**ΔCADLK cumulative**	**$\Delta CADLK_t$ annual**	**ΔCADLK cumulative**
	tCO_2e	**tCO_2e**	**tCO_2e**	**tCO_2e**	**tCO_2e**	**tCO_2e**
2003	2,888,232.52	2,888,232.52	553,640.92	553,640.92	0.00	0.00
2004	2,643,806.40	5,532,038.92	117,111.30	670,752.22	0.00	0.00
2005	1,379,915.67	6,911,954.59	268,732.36	939,484.58	0.00	0.00
2006	1,565,110.44	8,477,065.03	64,043.51	1,003,528.09	0.00	0.00
2007	1,143,609.53	9,620,674.56	73,432.04	1,076,960.13	0.00	0.00
2008	928,304.04	10,548,978.61	151,341.65	1,228,301.78	0.00	0.00
2009	953,055.60	11,502,034.21	34,225.39	1,262,527.17	0.00	0.00
2010	913,906.10	12,415,940.30	24,876.96	1,287,404.13	0.00	0.00
2011	989,544.07	13,405,484.37	68,382.28	1,355,786.41	0.00	0.00
2012	1,759,632.46	15,165,116.83	83,444.24	1,439,230.65	0.00	0.00

Table 32. Total net carbon stock change in the leakage belt

The total ex-post actual net carbon stock changes (i.e. above the baseline) in the leakage belt during the monitoring period are shown Table 32 above. Leakage was calculated as the difference between the *ex ante* and *ex post* the assessments. According to the methodology, as the result was >0, the total *ex post* leakage was set to zero. Therefore no credits were discounted due to activity displacement leakage during this monitoring period.

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

The second leakage source is related to carbon stock changes and GHG emissions associated to leakage prevention activities. During this monitoring period, leakage prevention actions did not include measures to enhance cropland and/or grazing land areas, thus no reduction in carbon stocks nor an increase in GHG emissions occurred.

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.

Tables 33 and 34 below report the *ex post* carbon stock change within the leakage management area.

Project year	Carbon stock changes in leakage management area in the project case			
	ID_{fcl}	1	annual	cumulative
	APSLKfcl,t	$Ctot_{fcl,t}$	ΔCPSLKt	ΔCPSLK
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00

Table 33. *Ex post* carbon stock change in leakage management area

As defined in the VCS Methodology VM0015 v1.1, calculations of total net carbon stock changes in leakage management area use the ex ante estimated baseline carbon stock changes and the measured ex post carbon stock changes within the leakage management area. If the cumulative value of the carbon stock change within a Fixed Baseline Period is > 0, the carbon stock decrease due to leakage prevention measures ($ΔCLPMLK_t$) shall be set to zero.

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	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLLK_t$	$\Delta CBSLLK$	$\Delta CPSLK_t$	$\Delta CPSLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00

Table 34. *Ex post* net carbon stock change in leakage management area

Thus, the *ex post* estimation of net carbon stock changes and GHG emissions from leakage prevention activities is shown in Table 35 below.

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex post* GHG emissions from increased grazing activities		Total ex post increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00

Table 35. *Ex post* net carbon stock changes and GHG emissions from leakage prevention activities

The results of all *ex post* estimations of leakage are summarized in Table 36 below. As there was no decrease in carbon stocks and/or increase in GHG emissions associated with leakage prevention activities or due to activity displacement leakage, no credits were discounted due to leakage during this monitoring period.

Project year	Total ex post GHG emissions from increased grazing activities		Total ex post increase in GHG emissions due to displaced forest fires		Total ex post decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	EgLK	$EADLK_t$	EADLK	$\Delta CADLK_t$	ΔCADLK	$\Delta CLPMLK_t$	ΔCLPMLK	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 36. Total ex post estimated leakage

4.4 Net GHG Emission Reductions and Removals

The *ex post* 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 post* net anthropogenic greenhouse gas emission reductions 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 post* 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 post* actual GHG emissions from biomass burning in the project area at year *t*; tCO_2e

$\Delta CLKt$ Sum of *ex post* leakage carbon stock changes in the leakage belt 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 post* leakage GHG 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*; tCO_2e

$\Delta REDDt$ *Ex post* net anthropogenic greenhouse gas emission reductions attributable to the AUD project activity at year *t*; tCO_2e

$VBCt$ Number of Buffer Credits deposited in the VCS Buffer at time *t*; tCO_2e

$\Delta CBSLPAt$	Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e
$\Delta CPSPAt$	Sum of *ex post* carbon stock changes in the project area at year *t*; tCO_2e
RF_t	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … *T,* a year of the proposed project crediting period; dimensionless.

The RF_t was estimated using the most recent version of the *VCS-approved AFOLU Non-Permanence Risk Tool* and the resulting value of RF_t was 30%.

The specific summary of GHG reductions and removals in the Ecomapuá Amazon REDD project is included in Table 37 below. The latter Table includes estimates of *ex post* GHG emissions reduction ($REDD_t$), calculations of buffer and leakage, and the resulting calculation of tradable Verified Carbon Units (VCU_t).

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex post project carbon stock changes		Ex post project GHG emissions from biomass burning		Ex post leakage carbon stock changes within the leakage belt		Ex post leakage GHG emissions		Ex post net anthropogenic GHG emission reductions		Ex post VCUs tradable		Ex post buffer credits	
	annual	cumulative	annual	cumulative	annual	cumula-tive	annual	cumulative	annual	cumu-lative	annual	cumu-lative	annual	cumulative	annual	cumula-tive	annual	cumula-tive
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	EBBBSLPA	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	EBBPSPA	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2003	644,003	644,003	0	0	68,828	68,828	0	0	0	0	0	0	575,175	575,175	402,622	402,622	172,553	172,553
2004	331,992	975,994	0	0	228,458	297,286	0	0	0	0	0	0	103,533	678,708	72,473	475,095	31,060	203,612
2005	341,611	1,317,606	0	0	208,126	505,412	0	0	0	0	0	0	133,485	812,193	93,439	568,534	40,046	243,658
2006	266,252	1,583,858	0	0	44,875	550,287	0	0	0	0	0	0	221,378	1,033,571	154,964	723,498	66,413	310,071
2007	223,933	1,807,791	0	0	25,644	575,931	0	0	0	0	0	0	198,289	1,231,860	138,802	862,300	59,487	369,558
2008	210,476	2,018,267	0	0	198,610	774,540	0	0	0	0	0	0	11,866	1,243,726	8,306	870,606	3,560	373,118
2009	195,642	2,213,908	0	0	44,992	819,533	0	0	0	0	0	0	150,649	1,394,376	105,454	976,060	45,195	418,313
2010	211,810	2,425,718	0	0	19,383	838,915	0	0	0	0	0	0	192,427	1,586,803	134,698	1,110,758	57,728	476,041
2011	197,214	2,622,933	0	0	107,975	946,890	0	0	0	0	0	0	89,240	1,676,043	62,467	1,173,225	26,772	502,813
2012	432,881	3,055,814	0	0	39,868	986,759	0	0	0	0	0	0	393,013	2,069,055	275,108	1,448,333	117,904	620,717

Table 37. *Ex post* net anthropogenic GHG emission reductions and VCUs

The net GHG emission reductions and removals in the Ecomapuá Amazon REDD project are summarized in the Table 38 below.

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Ex post buffer credits (tCO2e)	Net GHG emission reductions or removals (tCO_2e)
2003	644,003	68,828	0	172,553	402,622
2004	331,992	228,458	0	31,060	72,473
2005	341,611	208,126	0	40,046	93,439
2006	266,252	44,875	0	66,413	154,964
2007	223,933	25,644	0	59,487	138,802
2008	210,476	198,610	0	3,560	8,306
2009	195,642	44,992	0	45,195	105,454
2010	211,810	19,383	0	57,728	134,698
2011	197,214	107,975	0	26,772	62,467
2012	432,881	39,868	0	117,904	275,108
Total	3,055,814	986,759	0	620,717	**1,448,333**

Table 38. Summary of net GHG Emission Reductions and Removals

APPENDIX I: PROJECT AREA 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