ZERO CARBON HOLDINGS REDD PROJECT

Document Prepared by Zero Carbon Holdings

Contact Information

Project Title	*Zero Carbon Holdings REDD Project*
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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Project

The Zero Carbon Holdings REDD Project (ZCH Project) will reduce emissions derived from planned deforestation and forest degradation in a large tract of privately owned Amazonian tropical rain forest. The project proponent is Zero Carbon Holdings Environmental, LLC. The project focuses on activities designated as Avoided Planned Deforestation (APD) and is built on the VCS VM0007 methodology.

The project's geographical boundary comprises a parcel named Mata-Mata II, situated in the municipality of Manicoré, State of Amazonas (60º 56' 40.73'' W, 6º 33' 50.02'' S). The project boundary is 153,985 hectares (ha) of primary tropical rainforest. Of the total area, 123,766 ha is Dense Lowland Forest, 2,512 hectares of Dense Alluvial Forest, 3,287 ha of Dense Submontane Forest, and 23.626 ha of low cover vegetation classified as *Alluvial Ombrophillous Open Forest* and *Pioneer Formation with fluvial and/or herbaceous lacustrine influence*, according to the IBGE classification[1]. Under Brazilian legislation, owners have the right to convert up to 20% (in this case, 26,883 ha) of their total land holdings into alternative uses. This constitutes the baseline condition. In that regard, the project will be conserving a large tract of intact forest in a region under severe threat of deforestation, primarily for logging followed by cattle-ranching, and to a lesser extent agriculture and other human activities (mining, hydroelectric plants, road building, etc.). A total of 13,705,917 tonnes of CO2e emission will be avoided over the 30-year project lifespan, representing an annual average emission reduction of 456,864 t CO2e. For the first monitoring reporting, including January 1[rst] 2021 to December 31[st], 2022, the total credits requested for issuance are 1,301,887 tCO_2e.

1.2 Sectoral Scope and Project Type

The Project applies to VCS sectoral scope 14 – Agriculture, Forestry and Other Land Use (AFOLU). The project category is REDD+ (Reduced Emissions from Deforestation and Degradation), with project activities conducted in accordance with VM0007, v.1.6, Avoided Planned Deforestation (APD). This is not a grouped project.

1.3 Project Eligibility

The Scope of the VCS Program (VCS Standard v.4.2) includes:

- The six Kyoto Protocol greenhouse gases, one which (CO_2) is included here.

[1] https://bdiaweb.ibge.gov.br/#/consulta/vegetacao

- Ozone-depleting substances. Not applicable here.
- Project activities supported by a methodology approved under the VCS Program through the methodology approval process. This project is subject to activities described in the VCS REDD methodology VM0007, v.1.6, Avoided Planned Conversion (APD).
- Project activities supported by a methodology approved under an approved GHG program unless explicitly excluded. Not applicable here.
- Jurisdictional REDD+ programs and nested REDD+ projects. Not applicable here.

With respect to VCS Standard v.4.2. Appendix 1, REDD project category eligibility:

- The Project Area meets FAO's forest definition: "*Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use*." (FAO, 2012).[2]
- The Project Area qualifies as forest for a minimum of 10 years before the start date (see section 1.12, *Project Area definition*).
- The Project Activity reduces net GHG emissions by reducing planned deforestation on 20% of the project area, an activity legally permissible under the Brazilian Forest Code (Law 12,651/2012)

1.4 Project Design

The Project has been designed to include a single location and so is not developed as a grouped project.

1.5 Project Proponent

Table 1 - Project Proponent Information

Organization name	Zero Carbon Holdings, LCC
Contact person	Jay Rogers
Title	Chief Executive Officer (CEO)
Address	109 E. 17th Street, Suite 450 - Cheyenne, WY 82001 – United States of America

[2] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO). FRA 2015 Terms and Definitions. Rome, 2012. 36p. Available at: FRA 2015 Terms and Definitions (fao.org)

Telephone	+1-310-993-9952
Email	jay@fourthirteenllc.com

1.6 Other Entities Involved in the Project

Organization name	Radicle
Role in the project	Technical consultancy for baseline determination, additionality demonstration, calculations.
Contact person	
Title	
Address	Rua Cônego Eugênio Leite, 933 – Sala 131, São Paulo – SP - Brazil
Telephone	
Email	contato@radiclebrasil.com.br

1.7 Ownership

Project ownership is defined in accordance with VCS Standard v.4.2, item 6: "An enforceable and irrevocable agreement with the holder of the statutory, property or contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions or removals which vests project ownership in the project proponent".

Land ownership is attributed to Transmaranata Transportes Ltda., through land tenure for the Mata Mata II property, according to Brazilian available documentation, issued by the Registry of Novo Aripuanã City.[3]

Proof of right is defined by agreements signed between Zero Carbon Holdings, Midiageo Group and the landowner, as described in Section 1.8. The documents are available for consultation during validation and verification.

A Due Diligence report on ownership is available in **Appendix 1**, prepared by the legal team of Vieira Rezende, which conclusion is: "*it is our opinion that the property has a valid registry with the proper Real Estate Registry Office showing Transmaranata as the lawful owner*".

[3] Certificates available for Land Title no. 2926.

1.8 Project Start Date

VCS Standard v4.2. states that *"the project start date of an AFOLU project is the date on which activities that led to the generation of GHG emission reductions or removals are implemented".* In that regard, the project start date is January 1rst, 2021. The sequence of events with respect to the project start date and subsequent follow-up agreements is as follows:

- **May 28, 2020:** a 30-year agreement was signed between the "Mata Mata II" landowner, the company Transmaranata Transportes Ltda. and Midiageo Grupo Ltda., with the latter granted a right of extension for another 30-year term. As per the agreement, Transmaranata granted carbon rights to Midiageo, in exchange for compensation and a promise that the allowable land use change would not be undertaken. Specifically, Transmaranata agreed to preserve the existing forested vegetation on the Mata Mata II property in exchange for periodic payments and a share of the future carbon credit revenue anticipated from the project.
- The May 28, 2020 agreement was amended on **April 23, 2021**, while maintaining these original terms.
- **September 21, 2020:** an agreement was signed between MidiaGeo Grupo Ltda, MidiaGeo Technologia Ltda, and Anderson Alexandre (collectively, the "Seller"), and Zero Carbon Holdings LCC (the "Buyer"), whereby the seller agrees to transfer their carbon credit ownership certificates to the buyer for each vintage year from 2012 to 2020, and for each year thereafter through year 2050.
- The September 21, 2020 agreement was first amended on **April 21, 2021**, and again on **March 31, 2022**. The latter amendment grants Zero Carbon Holdings LCC (the "Buyer") the exclusive right to generate, validate, purchase, and resell credits from a carbon project on the Mata Mata II property.
- **June 23, 2022:** payment receipt issued by MidiaGeo Grupo Ltda and signed by Transmaranata Transportes Ltda. documenting payments received by the latter as per the April 23, 2021 agreement.
- **August 01, 2022:** letter from Carlton Fields, legal counsel to Zero Carbon Holdings LCC, confirming that payments were received by MidiaGeo Grupa Ltda, as per the April 21, 2021 agreement and amendments.

Since the initial agreements were signed in 2020, on different dates, the chosen start date was January 1rst, 2021, when evidence already showed the beginning of the activities, and also for better organization of the monitoring periods.

1.9 Project Crediting Period

The project crediting period is 30 years, starting January 1st, 2021 and ending December 31st, 2050.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Expected annual emissions reductions exceed 300,000 tCO_2e. This is a Large Project.

Project Scale	
Project	
Large project	x

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021	639,609
2022	662,276
2023	684,944
2024	707,612
2025	730,279
2026	752,947
2027	775,614
2028	798,282
2029	820,949
2030	843,617
2031	845,135
2032	846,654
2033	849,973
2034	853,292
2035	856,612
2036	797,832
2037	219,471
2038	198,322
2039	177,173
2040	156,024
2041	133,356

Year	Estimated GHG emission reductions or removals (tCO_2e)
2042	110,689
2043	86,220
2044	61,752
2045	37,283
2046	15,037
2047	13,518
2048	12,000
2049	10,482
2050	8,963
Total estimated ERs	**13,705,917**
Total number of crediting years	**30**
Average annual ERs	**456,864**

1.11 Description of the Project Activity

The main purpose of the project is conservation of 26,883 ha of native dense rainforest located on private land in the Amazonian biome, through avoided planned deforestation. The resulting carbon credits will provide income generation for landowners and projects participants (the "Project Activity").

The project baseline is in accordance with the Brazilian Forest Code (Law no. 12,165) on privately owned land which, in the Legal Amazon, allows for deforestation of 20% of the parcel. The region in which the property is located is under pressure from logging and cattle ranching, which comprise the baseline activity within the Project.

The core purpose of the Project Activity is the signing of agreements for forest conservation, along with the provision of financial resources for the landowner to not deforest. Transmaranata Transportes Ltda. is the landowner, and is represented by Midiageo group, a company with experience in the Amazon and that has been providing land regulation services for Transmaranata. Midiageo has signed contracts with Transmaranata, who agreed to transfer credits rights to Midiageo. Zero Carbon Holdings is the investor of the Project and also Project Proponent, as it has agreements with Midiageo for any carbon offsets that can be generated from the conservation activities, in exchange for fixed payments, as well as the credits shares agreed to in the agreements.

The agreements also stipulate the use of a percentage of the carbon credit revenues for local development. During the Local Stakeholders Consultation Process, no immediate communities were identified inside or in the surroundings of the Project Area. However, Zero Carbon Holdings has been working with a regional foundation (*Fundação Amazônia Sustentável – FAS)*, to identify the better ways to identify local development opportunities. Prospective local developments include:

- Building and improving regional capacity for REDD.
- Building and improving regional capacity for sustainable use of natural resources.
- Training and environmental education for the stakeholders in the surroundings, such as the municipality of Manicoré.
- Employment of locals when developing project monitoring activities, such as forestry inventories campaigns, social and environmental monitoring pools, etc.
- Partnerships with local institutions, such as the Manicoré City and its Departments, to facilitate current and new initiatives, such as sanitation, education, health, sustainable development, and sustainable agriculture.

1.12 Project Location

The Mata Mata II land parcel is located in the municipality of Manicoré, within the Madeira micro-region, in the State of Amazonas, Brazil (**Figure 1, Table 2**).

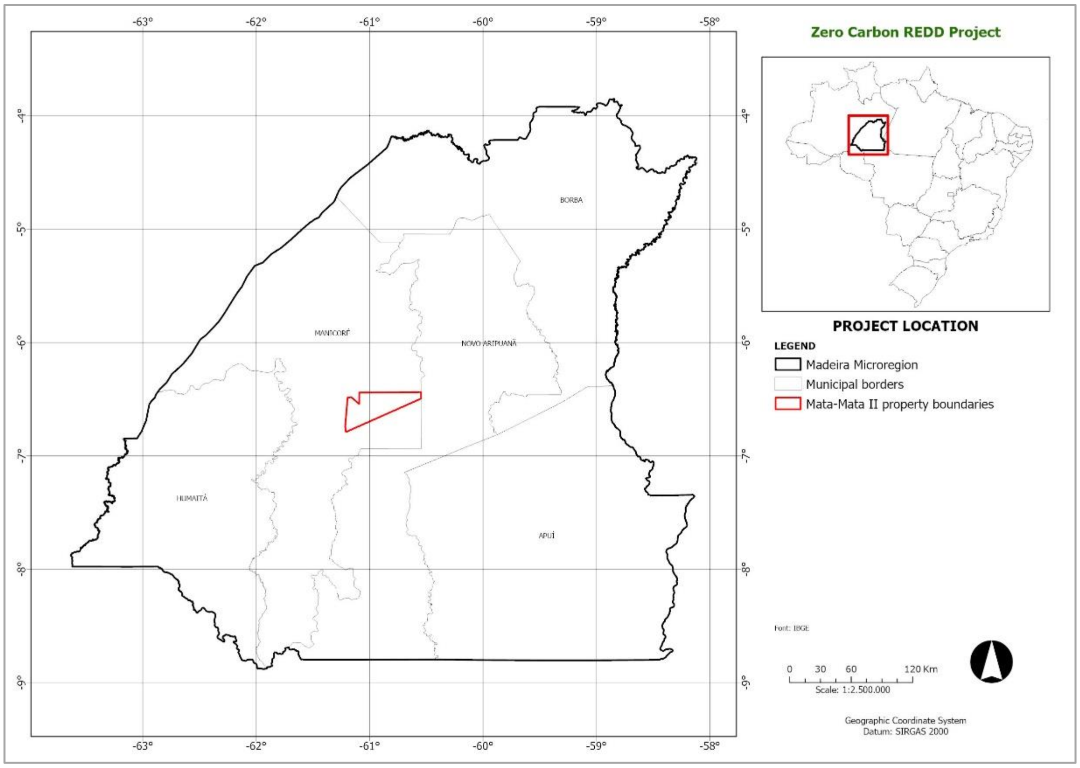


Figure 1 - Location of the Mata Mata II land parcel, within which the project area is located

Eligible Area

The total area of the Mata-Mata II land parcel is 153,985 ha. As permitted by the Brazilian Forest Code (Law 12,651/2012), the eligible area comprises the 20% of the property that the landowner can legally convert to other land uses, such as cattle grazing or agriculture, totaling 29,414 ha, according to the Environmental Rural Registry (CAR). This area is located at the western part of the property, with access by the Manicoré River or the Atininga River, the latter on the rainy season (Figure 2, Table 2). The remainder of the parcel is comprised of Legal Reserve, Permanent Protection Areas, or permanent water bodies.

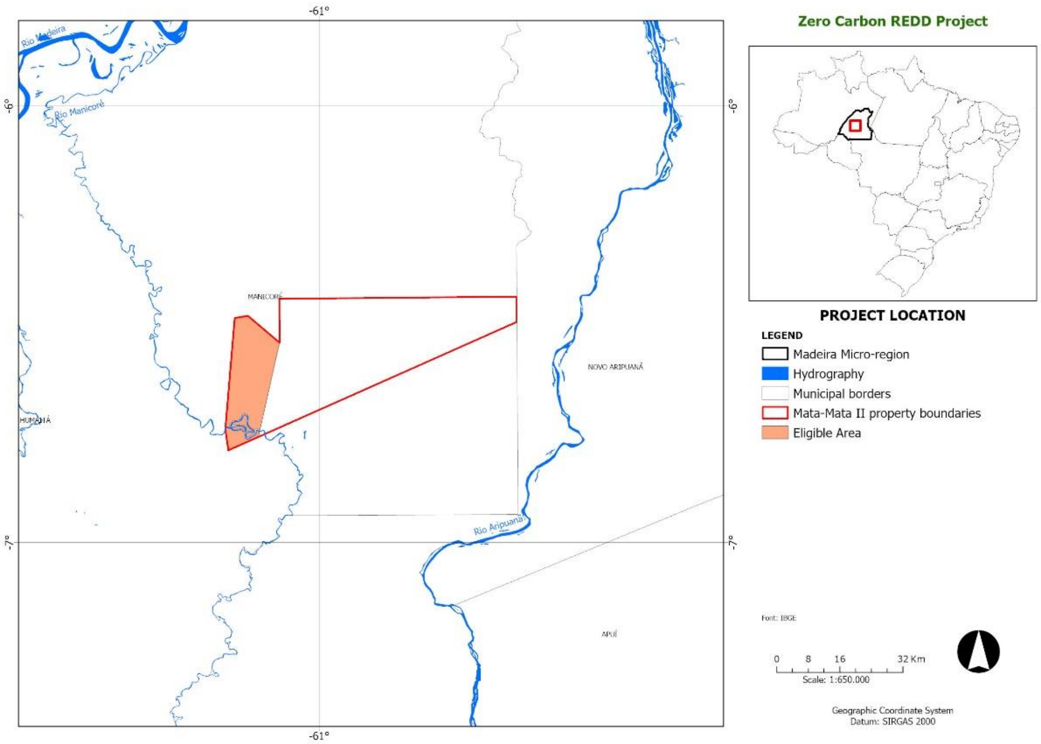


Figure 2 – The project eligible area and its approximate location within Brazil

Table 2 - Central geodetic coordinates and total parcel area

Land Parcel	Coordinates (GCS SIRGAS 2000 – EPSG 4674)		Area (hectares)
	Long	Lat	
Mata-Mata II	060° 56' 40.73" W	06° 33' 50.02" S	153,985

Project Area definition

To obtain the final Project Area, it was necessary to exclude the following layers from the eligible area:

- Hydrology layer from IBGE[4]
- Deforested areas from PRODES (2012-2021)[5]

[4] Continuous Cartographic Base of Brazil, scale 1:250,000 - BC250: https://www.ibge.gov.br/geociencias/downloads-geociencias.html?caminho=cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2021/

[5] http://terrabrasilis.dpi.inpe.br/en/download-2/

- Non-Forest from MapBiomas col.6 classification (2012)[6]
- Non-Forest from land use classification using Google Earth Engine (2021)[7]

The objective of such exclusions was to exclusively consider dense forest cover existing for at least 10 years prior to project start date. The final Project Area is 26,883 ha (**Figure 3**).

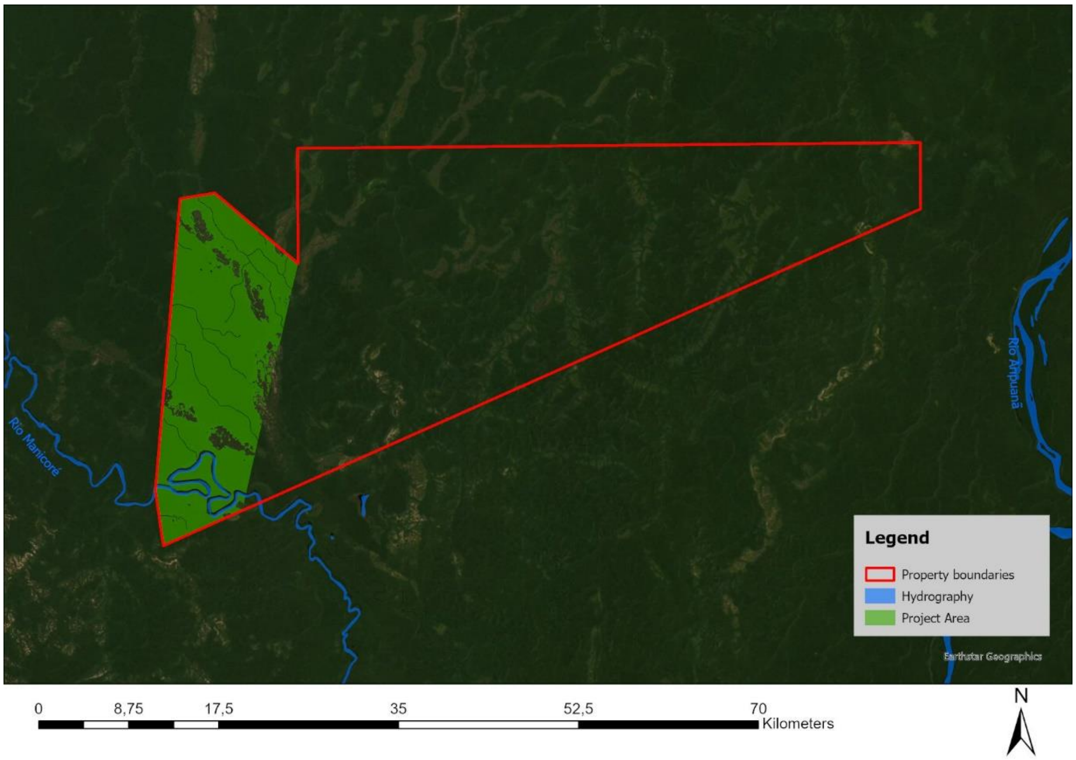


Figure 3 – Final Project Area after exclusions

1.13 Conditions Prior to Project Initiation

The project was implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction. This is substantiated by the landowner's commitment (and contractual obligation – such as the implementation of an environmental easement) to the conservation of the project area and implementation of activities which result in the preservation of forest within the property area.

The property is essentially 100% tropical forest that has not changed in the ten years prior to the project start year (2012) and up to the present. This can be confirmed from Landsat satellite imagery taken on both dates and publicly available on the Brazilian Space Agency (INPE) website. Vegetation on the Mata-Mata II parcel is predominantly classified as Dense Lowland Tropical Rain

[6] MapBiomas Project- Collection 6 of the Annual Series of Land Use and Land Cover Maps of Brazil

[7] See attached Brazil 413 Carbon Project Landcover Classification Report.

Forest (Db, Floresta Ombrófila Densa de Terras Baixas). Dense Alluvial Tropical Rain Forest (Da) is confined to river edges and water streams, with frequent ("Igapó") or partial ("Várzea") flooding during the rainy season.

Dense lowland rainforest (Db) is characterized as evergreen with a canopy up to 50 m tall. It is structurally complex with different vertical strata, and hundreds of canopy and understory species, including lianas and epiphytes. With respect to its biodiversity, sixty-eight species within this region are considered endangered and/or critically endangered. Five key species were specially selected for specific research and genetic conservation projects: two trees, Brazilian giant nut tree (Bertholletia excelsa) and Brazilian rosewood (Aniba roseaodora), and three animals, Black-faced black spider monkey (Ateles chamek), Belem Curassow (Crax pinima), and the Pirarucu Amazonian giant fish (Arapaima gigas).

Protected Areas

The project land parcel is situated in a region where several federal and state officially protected areas were formally created by law, some for integral protection and others for sustainable use, according to the Brazilian System of Protected Areas. Activities allowed in the integral protection units are much more limited when compared to sustainable use units. The surrounding protected areas are shown in **Figure 4.** The Mata-Mata II land parcel borders the RDS Juma (Sustainable Development Reserve) and Aripuanã National Forest to the east, and the Manicoré Biological Reserve to the south.

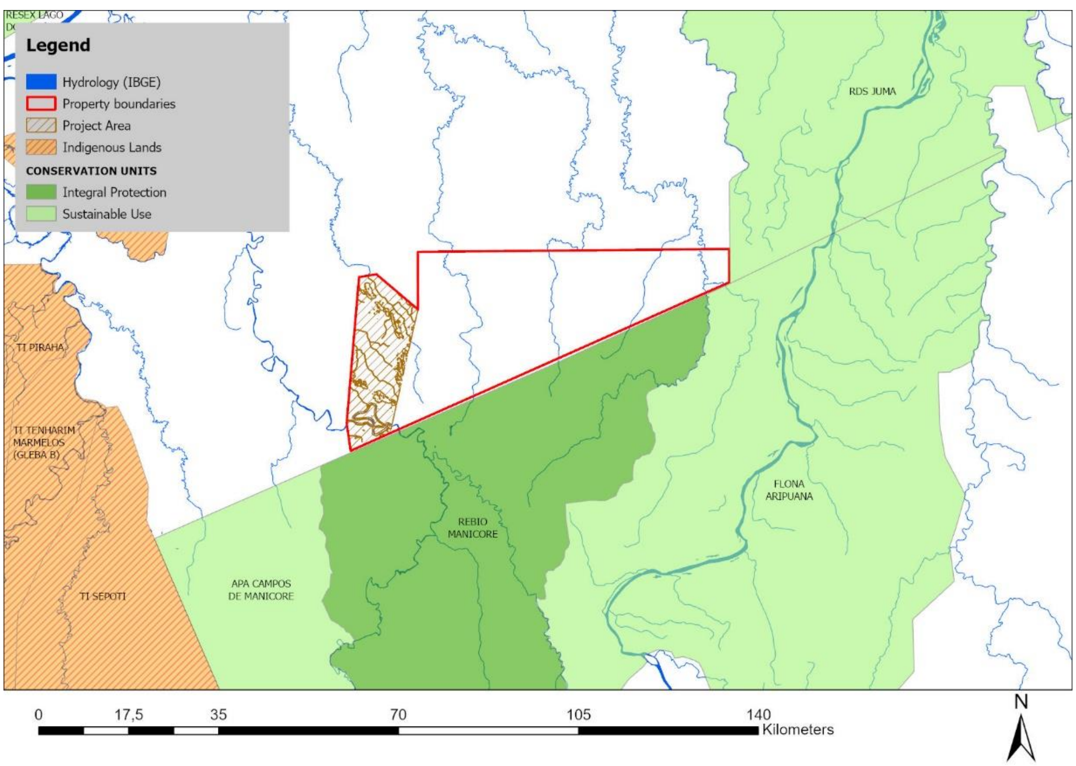


Figure 4 – Protected areas surrounding the Project Area

Even though the region comprises several protected areas, there are still many private or unofficially public areas that are highly vulnerable to deforestation and forest degradation. Protecting these areas is fundamental to creating a preserved continuum of native vegetation, maintaining the integrity of ecological processes, protecting biodiversity, climate stability, and guaranteeing traditional and indigenous communities' activities.

Land-use change and deforestation

The Madeira micro-region is highly threatened by deforestation and forest degradation due to land-use change from logging and cattle ranching. Four of the five municipalities that make up the micro-region, including Manicoré and Novo Aripuanã, are listed as priority municipalities for prevention, monitoring and deforestation control by the Ministry of Environment per a list established in 2007 by the decree 6.321/2007, and updated in 2021 (Ministry of Environment)[8].

According to MapBiomas historical land-use classification, in the municipalities of Manicoré, Novo Aripuanã and Apuí, from 2010 to 2020, over 325,400 ha of forest were converted to anthropic land-use (pasture, agriculture and urban areas), 99% of which having pasture as the final land-use.

Figure 5 pictures the PRODES official deforestation data from 2012 to 2021[9], provided by the National Space Research Institute (INPE) in the Madeira micro-region. The deforestation surrounding the project area is mainly driven by roads or rivers access.

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

[9] http://terrabrasilis.dpi.inpe.br/en/download-2/

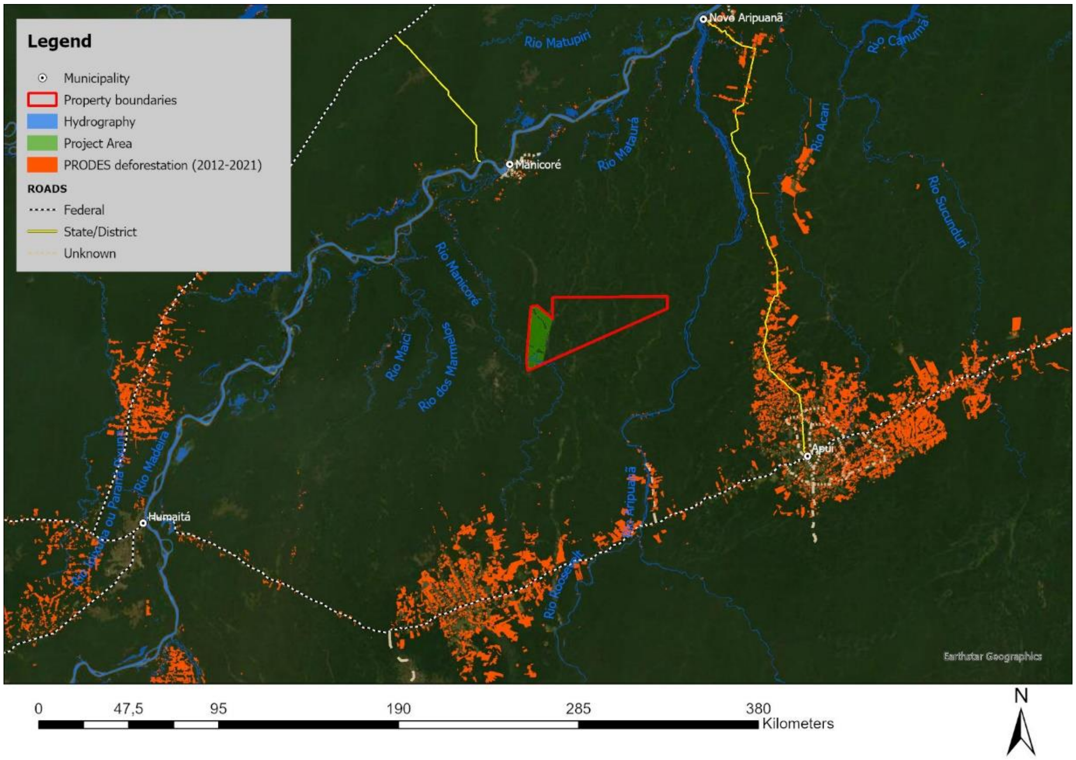


Figure 5 – Deforestation in the project region (2012 – 2021) – PRODES

Riverine Communities and Indigenous Lands

During the Local Stakeholders Consultation Process, no immediate communities were identified inside or in the surroundings of the Project Area.

Hydrology

The project is located in the Madeira hydrographic sub-basin, one of the main tributaries on the right bank of the Amazon River. The project area is cut to the south by the Manicoré River and to the north by the Atininga River. Both rivers flow into the Madeira River and are used by local communities in its downstream sections as the main transport route for people and goods.

The Madeira River is the second most important waterway in the Amazon region, connecting the capital of Rondônia State, Porto Velho, to its mouth in the Amazonas River, in the city of Itacoatiara. This waterway is the main way of transporting the grain production of the Brazilian Midwest, as well as products from recent deforestation in the Amazon such as wood and cattle. The river is navigable throughout the year, allowing the traffic of convoys of cargo barges with up to 18 thousand tonnes (DNIT)[10].

The hydrographic features in the region can be seen in **Figure 6**.

[10] https://www.gov.br/dnit/pt-br/assuntos/aquaviario/old/hidrovia-do-madeira

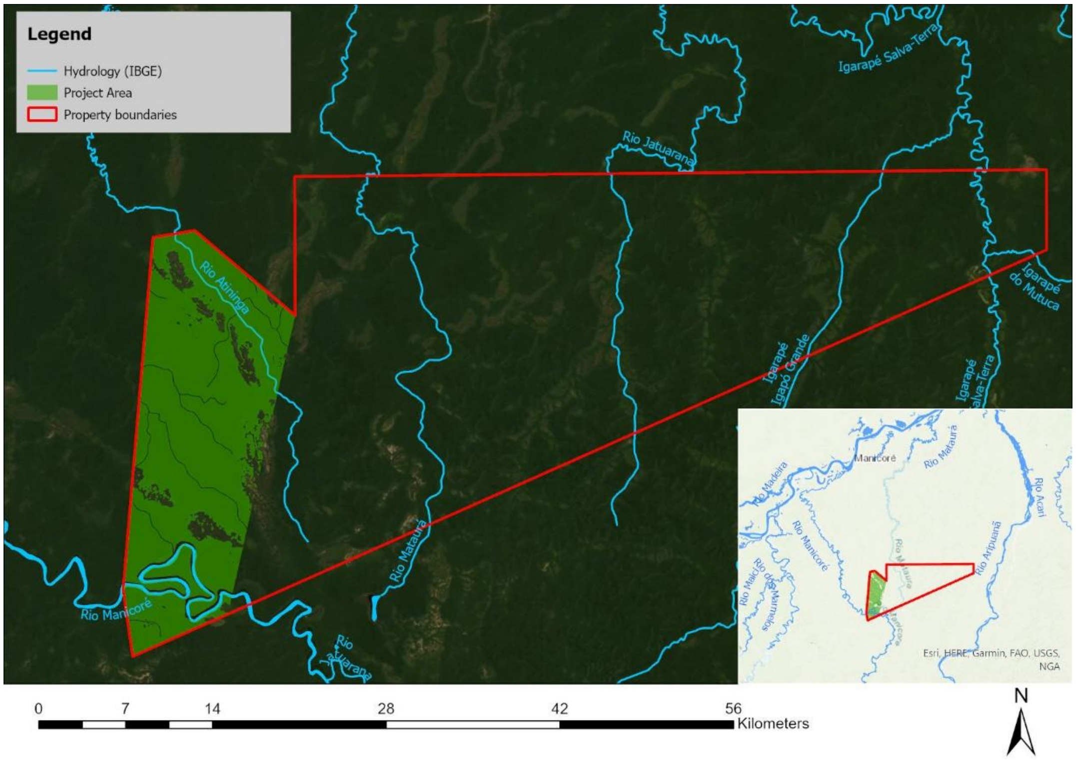


Figure 6 – Regional hydrology

Climate

According to the Brazilian Institute of Geography and Statistics (IBGE) 2002 classification[11], the Project Area is located in the Equatorial Climate Zone, characterized by warm temperatures, with an average temperature higher than 18°C throughout the year (**Figure 7**).

[11] https://www.ibge.gov.br/geociencias/cartas-e-mapas/informacoes-ambientais/15817-clima.html?=&t=downloads

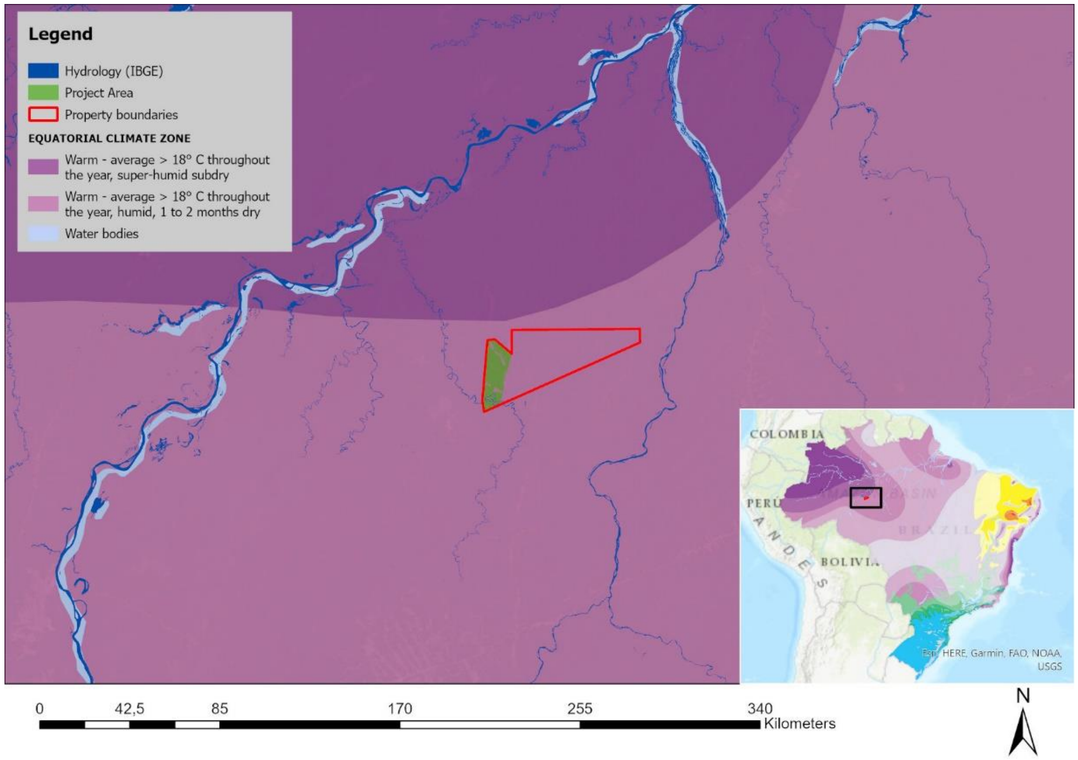


Figure 7 – Climate classification in the project region (IBGE)

The entire property is considered humid with one or two dry months. However, there is seasonal precipitation variation. According to the historical data registered by the Manicoré weather station from 1991 to 2020, the rainy season extends from November to April and the dry season from June to September (INMET)[12]. The average accumulated precipitation in the region reaches 2,500 mm.year^{-1} and the mean annual temperature is 26.6ºC with an average maximum of 32.8ºC and a minimum of 22.7ºC.

Soils

The predominant soil class in the project region is Yellow Oxisol (*Latossolo Amarelo* in the Brazilian Soil Classification System), according to the IBGE 1:250,000 scale soils mapping (2021)[13] (**Figure 8**).

[12] https://portal.inmet.gov.br/normais

[13] https://bdiaweb.ibge.gov.br/#/consulta/pedologia

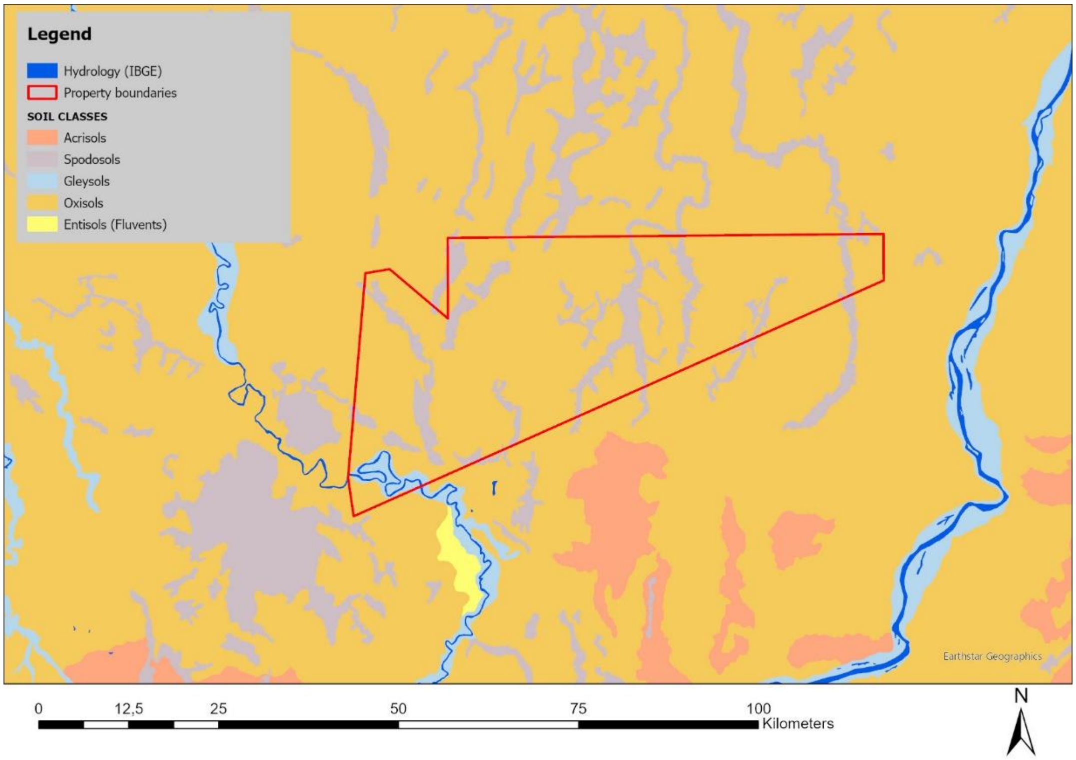


Figure 8 – Soils classification in the project region (IBGE 1:250,000 scale mapping)

Oxisols are formed in intense and prolonged weathering environments, which conditioned the substantial disintegration of the matrix rock and almost total decomposition of the primary minerals. Although they usually have a low saturation of exchangeable cations (Ca, Mg, K), they can still sustain exuberant forests, such as the Tropical Amazon Forest. This capacity resides in three factors: they exhibit an excellent physical structure, deep enough to provide robustness to rooting, good drainage to support aeration and water percolation (essential for root respiration), and reasonable retention of water on the surface of clay minerals (essential provision for plants).

Spodosols occur at a lower extent, especially along depressions in the terrain and riverbanks. Developed under conditions of high humidity, in flat or gently undulating relief, the spodosols present a sandy texture and, in the Amazon region, are associated with characteristic low cover vegetation known as *Campinarana* (EMBRAPA, 2018)[14].

Restricted to the south of the property, Gleysols – *Gleissolos Háplicos*, according to the Brazilian Soil Classification System – can be found along the Manicoré River floodplain.

Elevation

Elevation data is derived from the SRTM mission with a spatial resolution of 30 m, made available by the Google Earth Engine platform. The rasters were downloaded with a 28km buffer from the

[14] EMBRAPA. Sistema Brasileiro de Classificação de Solos. 5. ed. rev. e ampl. - Brasília, DF. 2018. 356 p.

total property area to better contextualize the region. Errors on negative elevation data were corrected and recalculated to zero.

The altimetric values in the region range from 0 to 147 m above sea level, with an average altitude of 54 m (**Figure 9**).

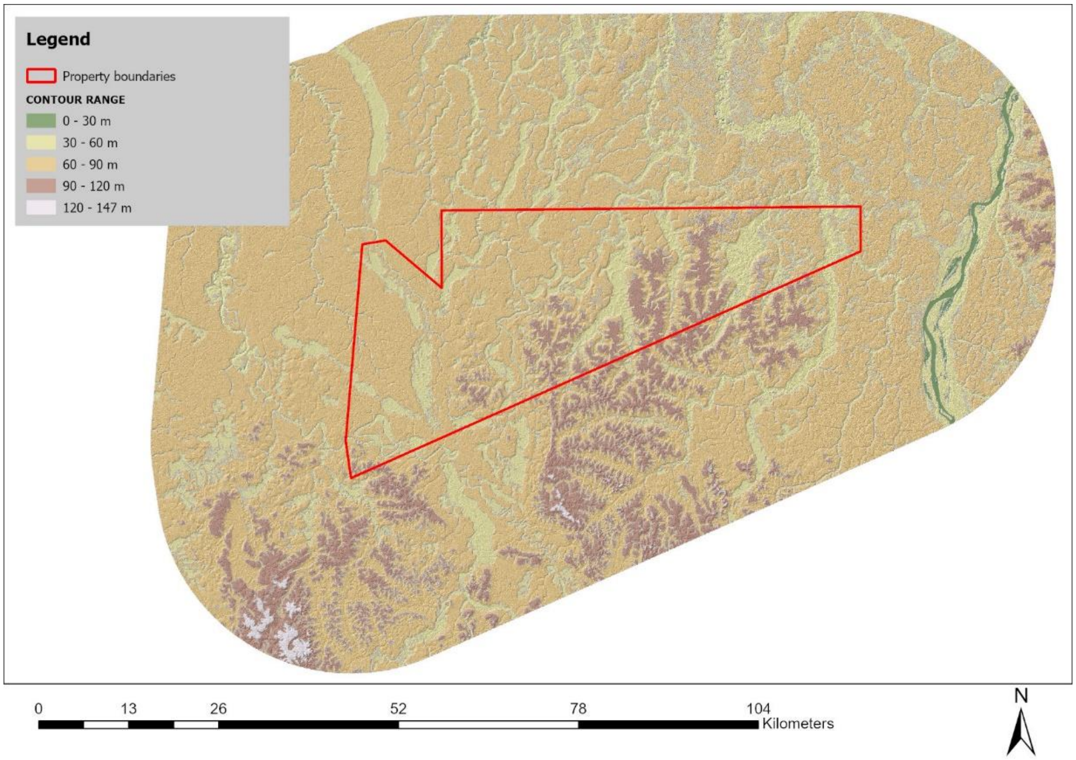


Figure 9 – Elevation in the project region (28 km buffer)

The higher altitudes are located to the south of the property, conditioning the drainage network of the main rivers to run in meanders in a south-north direction towards the Madeira River channel.

Slope

Even though the slope values range from 0 to 144%, as a consequence of the low altitude variation across the region, the distribution of values is concentrated between *flat* (< 3%) to *wavy* (8 – 20%). The mean slope for the entire region is 5.81% (**Figure 10**), considered *smooth wavy* by the EMBRAPA slope classification for the national territory. The rare points with a slope greater than 20% are located on the banks of water courses.

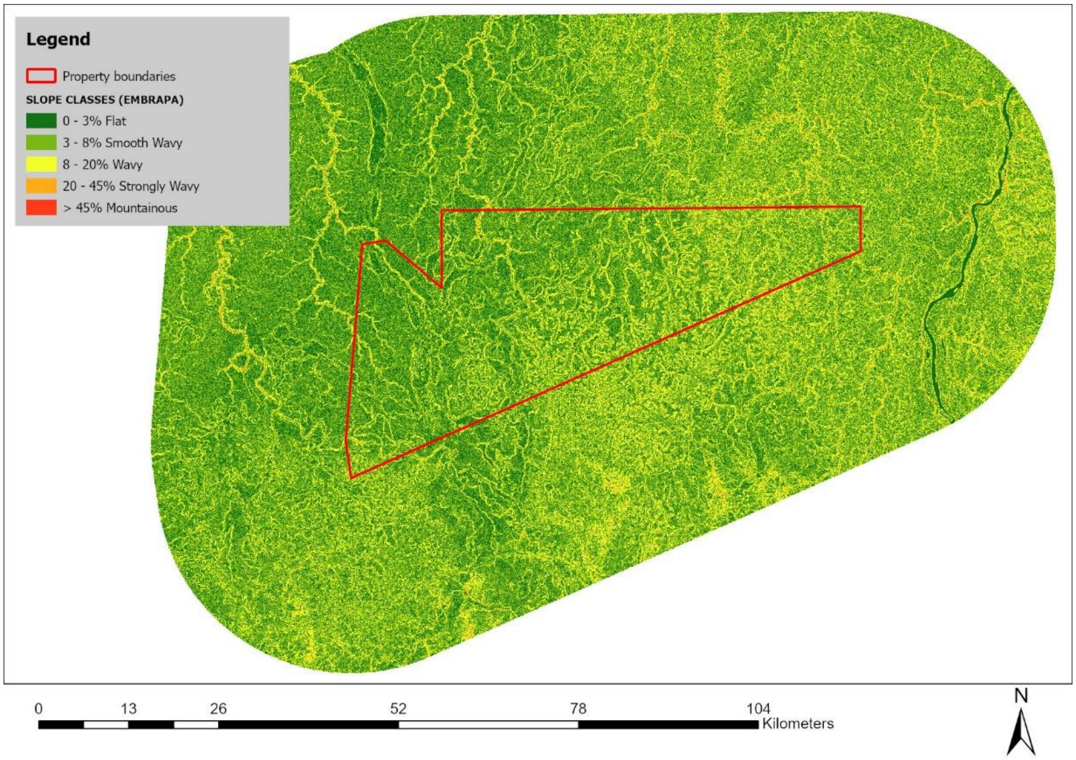


Figure 10 – Slope in the project region (28 km buffer)

Vegetation

Entirely located in the Amazon Biome, the predominant vegetation type in the project buffer area is the Lowland Ombrophyllous Dense Forest, according to the IBGE 1:250,000 scale mapping for the entire national territory (2021)[15]. **Figure 11** shows that the vegetation distribution is strongly correlated to the IBGE soils classification.

[15] https://bdiaweb.ibge.gov.br/#/consulta/vegetacao

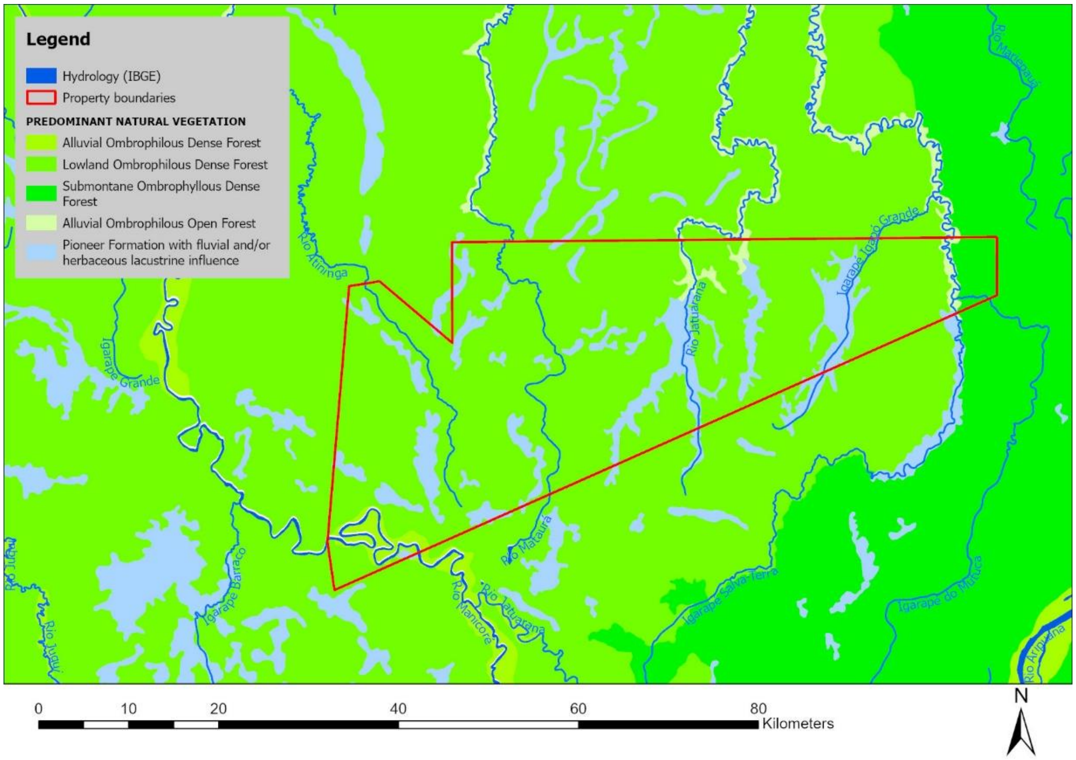


Figure 11 – Vegetation in the project region (IBGE 1:250,000 scale mapping)

In the property area, *Lowland Ombrophilous Dense Forest* and *Submontane Ombrophyllous Dense Forest* grow where Oxisols occur. Following the stains of Spodosols, low cover vegetation can be observed, classified as *Alluvial Ombrophillous Open Forest* and *Pioneer Formation with fluvial and/or herbaceous lacustrine influence*. Lastly, the Gleysols of the floodplains of the main rivers are occupied by *Alluvial Ombrophillous Dense Forest.*

For the stratification of the Project and Proxy Areas vegetation cover, the *Lowland Ombrophyllous Dense Forest* and *Submontane Ombrophyllous Dense Forest* were grouped into one stratum as *Dense Forest.* The *Pioneer Formation with fluvial and/or herbaceous lacustrine influence* was excluded from the accounting area and the forestry inventory.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The Legal Amazon region

The Legal Amazon is more than five million square kilometers, comprising the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, and Amapá as well as regions north of latitude 13° S in the states of Goiás and Tocantins, and west of longitude 44° W in the state of Maranhão. The region was created by Brazilian federal law in order to promote special protection and development policies for the Amazon.

All project activities are undertaken in conjunction with relevant environmental laws and regulatory frameworks. These are listed in **Table 3** along with details of project compliance.

Table 3 - Applicable laws to the Project and related compliance

Law	Context/Relevance	Compliance
Brazilian Constitution, Chapter 6, art. 225, Paragraph 4:	The Brazilian Amazonian Forest, the Atlantic Forest, the Serra do Mar, the Pantanal Mato-Grossense and the coastal zone are part of the national patrimony, and are applicable, as provided by law, under conditions which ensure the preservation of the environment.	The Project and its activities are in compliance with the Brazilian Constitution regarding preservation of the Amazon Forest.
Brazilian Constitution, Chapter 2, arts. 7- 11 and art. 243	The Constitution codifies a wide range of Social Rights: minimum wage, regular working hours, guidance on vacation and weekly leave, guidance on maternity leave, recognition of collective bargaining; prohibition of any form of discrimination.	The Project and its activities will meet, or exceed, all applicable labor laws and regulations and the Project Proponent will inform all workers of their rights.
National Policy of Environment ("PNMA") General Guidelines Law 6,938/81	Among the main guidelines of the PNMA, is the preservation and restoration of environmental resources, and their rational use and permanent availability. The PNMA also recognizes the compatibility of economic and social development with ecological preservation.	This Project reinforces the guidelines of the PNMA through the sale of carbon credits.
	PNMA establishes that responsible construction, installation, expansion and operation of establishments and activities that use environmental resources are subject to environmental licensing.	The Project Proponent and Landowners shall abide by, and satisfy, all environmental licensing requirements
Forest Code Chapter II: PPA: Section IV -CAR	All rural properties located in forest zones must have areas of permanent protection (APP). APPs are areas that are physically and ecologically fragile. They serve to preserve water resources, landscape features, geological stability, biodiversity, gene flow of plants and animals, and soil protection. Rural Environmental Registry (CAR): The central tool for rural properties to become compliant with Forest Code requirements. All rural property owners must register their lands in CAR, including the location of APPs, Legal Reserves, and other elements. CAR is regulated by the National System of Information on the Environment (SINIMA).	The APP is well defined, planned and respected. The property is registered within CAR.
Forest Code Chapter IV- LR:	All rural properties located in the Legal Amazon must keep at least 80% of the area as a Legal Reserve (LR; RL in Portuguese). LRs are areas where vegetation is protected. All rural	The Project has maintained 80% of forest cover as an LR.

Law	Context/Relevance	Compliance
	properties must maintain an LR and register it in the CAR.	
Forest Code Chapter V-Alternative Land Use	Native vegetation removal in Amazonas as per any proposed land use change requires prior authorization from the Amazon Environmental Protection Institute (IPAAM).	Not applicable. The Project does not permit any deforestation.
Forest Code Chapter X – Program to support and encourage the preservation and recovery of the environment	The Forest Code allows payments or incentives, whether monetary or not, for the conservation and improvement of ecosystems and environmental services, as well as the conservation of biodiversity, climate regulation, preservation of APPs and LRs.	Project will provide financial payments to ensure permanent protection of the forest.
National Policy for Climate Change ("PNMC") Law 12,187/2009	The PNMC enables voluntary actions for the mitigation of greenhouse gas (GHG) emissions. Its main objectives are (i) preservation, conservation and recovery of environmental resources, with particular attention to the great natural biomes, such as the Amazon Forest; and the (ii) consolidation and expansion of legally protected areas. It also highlights the use of financial and economic instruments to promote climate change mitigation and adaptation.	The Project complies with this law, given its contribution to emission reductions and deforestation.
National Policy of Payments for Environmental Services ***("PNSPSA")*** Law 14,119/2021	Under the PNPSA, those who benefit from environmental services, such as water supply, oxygen production, stability of climatic conditions, among others, must pay for them through a voluntary transaction. On the other hand, those who provide such services must be rewarded for their contribution. "Payers" can be public authorities, civil society organizations or private agents, individuals, or legal entities, whether national or international. The "providers," of those services can be private individuals or legal entity established under public or private law, or even a family or community groups.	The project constitutes a provider of ecosystem services, particularly those related to carbon credit generation. The resulting credits benefit the payer.
Amazonas State Policy for Climate Change, Environmental Conservation and Sustainable Development	This Law and its amendments approve the State Policy on climate change, environment conservation and sustainable development. Among its main purposes is the promotion and creation of market instruments that enable the execution of projects to reduce emissions from deforestation.	The Project complies given its goals of reducing GHG emissions and avoiding deforestation using market instruments.

Law	Context/Relevance	Compliance
Law 3,135/2007 Amended: Law. No. 3.184/2007 Amended: Law No. 4.266 (2015)		
Amazonas State Policy of the Amazon Environmental Services, their Management System, and creating the State Fund for Climate Change, Environmental Conservation and Environmental Services. State Law 4,266/2015	Broad ranging in scope, its principle objectives are the protection and conservation of forests and their environmental services while promoting socio-economic development and welfare of local populations.	Project goals of reducing GHG emissions and avoiding deforestation using market instruments are consistent with the principles of this State law.
ILO Convention No. 169 on Indigenous and Tribal Peoples Decree 6,040/2007	The International Labour Organization (ILO) is an agency of the United Nations dedicated to improving working conditions of the citizens of its member states. In 1957, the ILO developed and ratified Indigenous and Tribal Populations Convention, 1957 (No. 107), an international instrument dedicated to improving the living conditions of Indigenous peoples worldwide. In 1989, ILO Convention 107 was revised and renamed Indigenous and Tribal Peoples Convention, 1989 (No. 169). Convention 169 recognizes Indigenous peoples' right to self-determination within a nation-state, while setting standards for national governments regarding Indigenous peoples' economic, socio-cultural and political rights, including the right to a land base. The convention is law within the nation-states that have ratified it, one of which is Brazil.	The Project Proponent acknowledges and respects the provisions of ILO Convention 169. There is, however, no overlap with indigenous lands or land claims within or around the project area.

1.15 Participation under Other GHG Programs

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

The Project is not registered or seeking registration under other GHG Programs.

1.15.2 Projects Rejected by Other GHG Programs

The Project has not been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

Brazil does not have a national, legally binding limit on greenhouse gas (GHG) emissions, nor does it possess, or is affiliated with, a compliance emissions trading program that accepts REDD credits.

1.16.2 Other Forms of Environmental Credit

The project has not sought or received any other form of GHG-related environmental credit. It may be eligible for domestic JNR-related programs should they be developed.

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

The Project Activities will directly contribute to sustainable development (SD), as per **Table 4.** SD will be monitored within the project based on indicators proposed by the United Nations[16] Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development. Reports will be generated at each verification period.

Table 4 - Sustainable Development Goals and contributions of the Project

Sustainable Development Goal		Project Activities Related/Expected Results
	End poverty in all its forms, everywhere	The State of Amazonas has one of the lowest per capita incomes in Brazil (25 of 27 States). The Human Development Indexes (DHI) of Manicoré is located are 0.582, 23rd position in the Amazonas State. A share of the carbon revenues will be directed to social activities.

[16] https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202022%20refinement_Eng.pdf

Sustainable Development Goal		Project Activities Related/Expected Results
2 ZERO HUNGER	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Zero Hunger. The proposed REDD project could address issues of hunger by contributing a fixed portion of its carbon revenue to the Bolsa Floresta program or alternative activities that would improve local communities' livelihoods and access to food via monthly stipends.
3 GOOD HEALTH AND WELL-BEING	Ensure healthy lives and promote well-being for all at all ages	Local stakeholder consultation and community outreach were conducted as part of the planning process to ensure project benefits contribute to healthy lives and promote community well-being.
4 QUALITY EDUCATION	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	The proposed REDD project could address the need for better educational opportunities for indigenous people by contributing a fixed portion of its carbon revenue to the Bolsa Floresta program or alternative activities that would improve local schools and hire more teachers.
5 GENDER EQUALITY	Achieve gender equality and empower all women and girls	It is widely acknowledged that gender equality and women's empowerment are catalysts for reaching sustainable development, including in REDD projects. As primary users and managers of forest products in many communities, women play a crucial role in the sustainable management of forests as well as in other productive and reproductive activities at the household and community levels. This project can contribute to SDG 5 by empowering women and girls in local communities through its project activities through the shared benefits contribution.
8 DECENT WORK AND ECONOMIC GROWTH	Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all	In rural areas, such as the Aripuanã River Valley, there is a scarcity of sustainable livelihood opportunities. The proposed REDD project can promote low emissions economic growth and diversification through hiring locals for forest monitoring.
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	The proposed REDD project could address issues of lack of infrastructure in rural areas of Amazonas poverty by contributing a fixed portion of its carbon revenue to the Bolsa Floresta program whose financial contributions would improve local communities' livelihoods which enables them to attract industry and to develop the necessary infrastructure to support commerce.

Sustainable Development Goal		Project Activities Related/Expected Results
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Ensure sustainable consumption and production patterns	Sustainable resource management is a core feature of the proposed REDD project. Avoiding potentially unsustainable and irresponsible agriculture production in the project area contributes directly to SDG 12.
13 CLIMATE ACTION	Take urgent action to combat climate change and its impacts	Forest protection is one of the most important means of mitigating the impacts of climate change. The project will protect 26,883 hectares of the Amazon Rainforest.
15 LIFE ON LAND	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.	The Amazon is the single largest remaining tropical rainforest in the world, and it is home to at least 10% of global biodiversity, including endangered flora and fauna. At 26,883 hectares, the project protects and promotes sustainably managed forest, halts land degradation and biodiversity loss.
17 PARTNERSHIPS FOR THE GOALS	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	Private sector finance is a critical part of the SDG framework. By impacting all of the SDGs listed above through private sector finance and multi-stakeholder partnerships, the proposed REDD project contributes significantly to SDG 17.

1.17.2 Sustainable Development Contributions Activity Monitoring

Table 5 presents monitored SDGs during the Project monitoring period.

Table 5 - Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By conserving 26,883 ha of tropical rainforest, ZCH Project has prevented the release of 1,301,887 tonnes of carbon into the atmosphere during the monitoring period.	Prevented the release of 1,301,887 tonnes of carbon into the atmosphere
2)	15.0	Forest area as a proportion of total land area	Implemented activities to increase	Prevented the deforestation of 3,394 ha of the Amazon rainforest.	Prevented the deforestation of 3,394 ha of the Amazon rainforest.

1.18 Additional Information Relevant to the Project

Leakage Management

The landowner has no additional properties to which activity shifting leakage might occur. The proponents have no authority to directly regulate activities conducted outside the project boundaries regarding planned or unplanned deforestation. However, provisions for income generation and distribution from project activities will be implemented to reduce leakage risk. Outreach to local communities regarding project activities and benefits and avoidance of market leakage will be conducted.

Commercially Sensitive Information

Commercially sensitive information regarding financial amounts and conditions specified in signed agreements between Parties to the project has been excluded from the public version of the PD.

Further Information

N/A.

2 SAFEGUARDS

2.1 No Net Harm

The project activity will mostly promote conservation actions, with low potential for impacts, considering the social and environmental aspects. The proponent has engaged a professional organization (*Fundação Amazônia Sustentável - FAS*) to undertake an engagement process that includes socioeconomic and cultural surveys, and to make a concerted effort to obtain prior and informed consent of the project's activities. No direct impact communities were identified at this process; however, regional stakeholders will be encouraged to discuss the perceived benefits, costs, and risks, of the project from their own perspectives. Efforts will be made to eliminate or mitigate potential negative impacts through dialogue and benefit sharing with involved actors.

2.2 Local Stakeholder Consultation

Stakeholders Consultation

The Local Stakeholders Consultation (LSC) process was carried out through the assistance of FAS, a non-governmental organisation with almost 15 years of experience in the Amazon FAS conducts activities that aim at the sustainable development of the area, while protecting the rainforest and promoting benefits to the traditional communities that live there.

The procedure for identifying the project stakeholders started with research for local communities directly or indirectly affected by the project area. This assessment was conducted initially throughout geo-analysis, in which evidence of human use were spotted and calculated in a straight-line distance. In this sense, no human activity was observed in at least 19km from the area. In addition, during field visits carried out for forest inventory purposes, no community use of the area was identified.

Thus, the stakeholder consultation was carried out with related agencies, institutions, and municipal and state departments, on three different dates and locations.

The first consultation was carried out in the municipality of Novo Aripuanã, even though the project area only involves the municipality of Manicoré. However, because they are interconnected, and a neighbouring project is being developed simultaneously (413 Environmental REDD Project), the project proponents chose to implement the two consultations (413 and Zero Carbon) at the same time. The differences between the projects was explained during the consultations.

Consultations were held in three different cities (Novo Aripuanã, Manicoré and Manaus), in which the following stakeholders were involved:

- Townhall, City Council and Secretaries of Novo Aripuanã.
- Townhall, City Council and Secretaries of Manicoré.
- Institute of Sustainable Agriculture and Forestry – IDAM.
- Environmental Agency of the Amazonas State (IPAAM).
- State University of Amazonas (UEA).
- Federal University of Amazonas (UFAM).
- Environmental Police.
- Chico Mendes Institute of Conservation and Biodiversity (ICMBio).
- Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA).
- National Institute of Colonization and Land Reform (INCRA).
- State Secretary of Rural Production (SEPROR).
- National Institute of Amazon Research (INPA).
- Institute of the Amazon Sustainable Development (IDESAM).
- Social and Environmental Institute (ISA).
- Public Ministry.
- Association of Residents and Friends of the Sustainable Development Reserve of Juma (AMARJUMA).
- Association of the Agroextractive Producers of the Sustaible Development Reserve of Madeira River (APRAMAD).
- Cooperative of the Extractivists, Farmers and Producers of Cassava Flour and its Derivates of the Sustainable Development Reserve of Juma (COOPEA).

The consultation dates, location and quorum were:

- Novo Aripuanã city - July 6th, 2022 - Municipal School "Dioneia Alves Mittouzo, from 9 a.m. to 1 p.m, 21 participants.
- Manicoré city - July 11th, 2022 - was held at the City Council, 08 participants.
- Manaus - July 13th, 2022 - FAS headquarters, 2 p.m. to 5 p.m., 13 participants.

In all cases, consultations were developed by using approachable visual resources, such as slides presentations and pressed banners, which included: project context, project description, ownership, preliminary quantification, explanations about the shared benefits, the process for carbon projects and overall questions.

The only specific question regarding Zero Carbon came from IPAAM and related to understanding the safeguard metrics for the project, to which the response was that Verra's most updated methods were being used, as well as FAS expertise in the creation of indicators.

FAS' report on the Local Stakeholders Consultations, as well as related evidence for participation, photos and other are available for consultation (Appendix 3).

The invitations for the meeting were sent by two methods: e-mails and Whatsapp messages. This second approach was chosen since it is more approachable to some of the involved Stakeholders. Invitation evidence are available for consultation (Appendix 3).

Communication:

The established procedure for ongoing communication with Stakeholders during the project crediting period involves three main channels:

- Written communication: printed copies of the PD, monitoring reports and supporting files will be made available in Portuguese for the Manicoré Townhall, as well as the IPAAM agencies, both at Manicoré and Manaus, . Simplified reports will also be prepared and delivered to those locations.
- Online communication: project files and reports will be available for consultation at both the Verra website, and also a specific project website, where information such as project implementation status and credit generation will be transparent for stakeholders. A project e-mail will be available to receive any questions regarding the project.
- On-site communication: annual visits will occur at the sites, where the main stakeholders will be communicated with about the project status, as well as present results on carbon credits generation and activities implemented.

Any validation and verification activities will be communicated through the processes mentioned above.

2.3 Environmental Impact

An Environmental Management System (EMS) was designed during the Project Implementation phase in support of an environmental impact assessment, based on the principles of ISO 14,001/2015. Details are provided in

Table 6, and the full Zero Carbon REDD Project EMS file is provided in **Appendix 2.**

Table 6 - Aspects, impacts and control measures of the project, as per the Environmental Management System

Aspect	Impact	Control Measures
Environmental Service and Support	Positive. Maintenance of biodiversity and genetic heritage.	Ensure preservation of the existing forest.
Environmental Service and Regulation	Positive. Maintain a stable ecosystem and ecosystem processes including, carbon sequestration, air purification, the hydrological cycle, flood mitigation and minimizing erosion.	Ensure preservation of the existing forest.
Environmental Service and Products	Positive. Sustainable supply of environmental goods and services used by locals.	Ensure preservation of the existing forest.

Aspect	Impact	Control Measures
Environmental Service and Products	Negative. Displacement of activities to areas outside the project boundary causing pressure on forest resources.	Community engagement to ensure project benefits are articulated. Ongoing monitoring within and beyond the project boundary.
Culture	Positive. Co-benefits related to cultural identity, spiritual and aesthetic values.	Community engagement to ensure opportunities to maintain traditional practices and lifestyle.
Community	Positive overall. Positive community benefits and co-benefits. Potential conflict with competing landowners who may have misaligned competing interests.	Community engagement to articulate benefits and co-benefits. Communication with other local landowners as to project benefits and the advantages of their participation in future carbon projects.

The EMS will be used to structure internal annual audits of project performance, both remote (desktop review) and in the field. Audits will be performed against a checklist of ISO requirements. For each item on the checklist, the internal audit shall indicate whether the parameter is in conformance, non-conformance and/or requires specific attention.

Internal Audit results will be taken to the Executive Manager who will coordinate Action Plans to resolve any issues.

2.4 Public Comments

This section will be concluded after the Public Comments period.

2.5 AFOLU-Specific Safeguards

As per Section 2.2., no directly impacted communities or stakeholders were identified through the process. For that reason, the main stakeholder considered in the Project is the city of Manicoré, which was consulted during the consultation visits, and will continue to be involved in the Project, through the Townhall and the City's Secretaries, who will contribute to the local development.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The Project is in accordance with VCS Standard, v.4.2.

The methodology used in the project scope:

- VM0007 REDD+ Methodology Framework (REDD+MF), v1.6

The following set of modules and tools is mandatory for the project activities:

- VMD0001 - Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools (CP-AB), v1.1.
- VMD0002 Estimation of carbon stocks in the dead-wood pool (CP-D), v1.0.
- VMD0005 Estimation of carbon stocks in the long-term wood products pool (CP-W), v1.1.
- VMD0006 - Estimation of baseline carbon stock changes and greenhouse gas emissions from planned deforestation/forest degradation and planned wetland degradation (BL-PL), v1.3.
- VMD0009 Estimation of emissions from activity shifting for avoiding planned deforestation/forest degradation and avoiding planned wetland degradation (LK-ASP), v1.3.
- VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning (E-BPB), v1.2
- VMD0015 - Methods for monitoring of greenhouse gas emissions and removals (M-REDD), v2.2
- VMD0016 Methods for stratification of the project area (X-STR), v1.2.
- VMD0017 - Estimation of uncertainty for REDD project activities (X-UNC), v2.2.
- VT0001 Tool for the demonstration and assessment of additionality in VCS agriculture, forestry, and other land use (AFOLU) project activities (T-ADD), v3.0.
- VCS AFOLU Non-Permanence Risk Tool (T-BAR), v4.0
- CDM Tool for testing significance of GHG emissions in A/R CDM project activities (T-SIG) v1.0

3.2 Applicability of Methodology

The Project Activity is designed to reduce emissions from avoided planned deforestation (APD) and is defined as a REDD activity type, as per section 1.3. A description of how the Project activity meets the applicability conditions of VM0007 v1.6 and the associated tools and modules, is provided in Table 7.

Table 7 - Applicability of Project activities to the VM0007 methodology

Condition	Explanation
CDM or other GHG program	No land within the project area is registered under the CDM or any other GHG program.
Land in the project area has qualified as forest (following the definition used by VCS) for at least the 10 years prior to the project start date.	All lands located within the project areas are covered and qualified as forest for at least the 10 years prior to the project start date, as documented in sections 1.13 and 3.5.
If land within the project area is peatland or tidal wetlands and emissions from the SOC pool are deemed significant, the relevant WRC modules (see VM0007 v1.6 Table 3) must be applied alongside other relevant modules.	No applicable lands within the Project Area.
Baseline deforestation and forest degradation in the project area fall within one or more of the following categories: i. Unplanned deforestation (VCS category AUDD), ii. Planned deforestation/degradation (VCS category APD), iii. Degradation through extraction of wood for fuel (fuelwood and charcoal production) (VCS category AUDD).	The baseline in the project area is categorized as planned deforestation, VCS category APD (section 3.5).
Leakage avoidance activities must not include: i. Agricultural lands that are flooded to increase production, ii. Intensifying livestock production through use of feed-lots and/or manure lagoons.	These leakage avoidance activities are not present on the project area (section 1.18).

Condition	Explanation
For APD, the conversion of forest lands to a deforested condition must be legally permitted on the project area.	Conversion of forest lands to deforested condition as per the baseline scenario is legally permitted (section 3.5). This excludes any legal reserve and permanent preservation area requirements, in accordance with Brazilian legislation.

The applicability of the applied modules is described in **Table 8.**

Table 8 - Applicability of the modules

Module	Condition/Explanation
VMD0001, v1.1	**Condition:** This module is applicable to all forest types and age classes and is used to calculate the aboveground tree biomass pool. Non-tree aboveground biomass is not included as part of the project boundary. **Explanation:** Inclusion of the aboveground tree biomass pool as part of the project boundary is mandatory as per the framework module REDD-MF. Non-tree aboveground biomass is not included as part of the project boundary because: • Stocks of non-tree aboveground biomass will be lower in the baseline than in the project scenario, and • Non-tree aboveground biomass was determined to be non-significant using the T-SIG module (Appendix 7).
VMD0002, v1.0	**Condition:** Applicable to all forest types and age classes if the dead wood pool is included as part of the project boundary. **Explanation:** Dead wood is included in the project because: i. Dead wood stocks are greater in the baseline than in the project scenario (in conformance with REDD-MF), and ii. Dead wood was determined to be significant using the T-SIG module (Appendix 7).

Module	Condition/Explanation
VMD0005, v1.1	**Condition:** Applicable to all cases where wood is harvested for conversion to wood products *for* commercial markets. **Explanation:** This module is applicable in the baseline because the wood products pool is included as part of the project boundary as per applicability criteria in the framework module REDD-MF, specifically: i. Timber harvest occurs prior to or in the process of deforestation, and timber is destined for commercial markets, ii. The wood products pool is determined to be significant using T-SIG (Appendix 7).
VMD0006, v1.3	**Condition:** Estimating baseline emissions on forest lands (usually privately or government owned) that are legally authorized and documented to be converted to non-forest land. **Explanation:** The Project Area is defined as a private forest that can be legally converted to non-forest land (section 3.5).
VMD0009 v1.3	**Condition:** Estimating leakage emissions due to activity shifting from forest lands that are legally authorized and documented to be converted to non-forest land. **Explanation:** The Project Area is defined by forest that would be legally converted to non-forest land, as described under the BL-PL module. This module is mandatory.
VMD0013 v1.2	**Condition:** Applicable to REDD project activities with emissions from biomass burning. **Explanation:** The module is mandatory.

Module	Condition/Explanation
VMD0015, v2.2	**Condition:** Where selective logging is taking place in the project case: i. Emissions from logging may be omitted if it can be demonstrated the emissions are de minimis using Tool T-SIG (Appendix 7); ii. If emissions from logging are not omitted as de minimis, logging may only take place within forest management areas that possess and maintain a Forest Stewardship Council (FSC) certificate for the years when the selective logging occurs; iii. Logging operations may only conduct selective logging that maintains a land cover that meets the definition of forest within the project boundary; iv. All trees cut for timber extraction during logging operations must have a DBH greater than 30 cm; v. During logging operations, only the bole/log of the felled tree may be removed. The top/crown of the tree must remain within the forested area;. vi. The logging practices cannot include the piling and/or burning of logging slash; vii. Volume of timber harvested must be measured and monitored. **Explanation:** Mandatory for REDD project activities. However, emissions from selective logging were demonstrated to be de minimis using Tool T-SIG (Appendix 7).
VMD0016, v1.2	**Condition:** Any module referencing strata must be used in combination with this module. In case of REDD, aboveground biomass stratification is only used for pre-deforestation forest classes, and strata are the same in the baseline and the project scenario. Post-deforestation land uses are not stratified. Instead, average post-deforestation stock values (e.g., simple or historical area-weighted approaches are used, as per Module *BL-UP*). **Explanation:** A single stratum was applicable to the Zero Carbon Project based on the vegetation types given by the official Brazilian Vegetation Map published by IBGE (2018)[17]. In the project, the planned deforestation baseline is applied exclusively to the dense rainforest.

[17] Derived from Instituto Brasileiro de Geografia e Estatística (IBGE) – Brazilian Vegetation.

Module	Condition/Explanation
VMD0017, v2.2	**Condition:** Applicable for estimating the uncertainty of estimates of emissions and removals of CO2-e generated from REDD project activities. The module focuses on the following sources of uncertainty: i. Determination of rates of deforestation and degradation, ii. Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks, and iii. Uncertainty in assessment of project emissions. **Explanation:** Mandatory when using methodology REDD+ MF.
VT0001, v3.0	**Condition:** The tool is applicable under the following conditions: i. AFOLU activities which are the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced; ii. The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario. Project proponent(s) proposing new baseline methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity. **Explanation:** The activities in the proposed project boundary do not lead to violation of any applicable law even if the law is not enforced. Section 3.6 provides a stepwise approach to justify determination of the most plausible baseline scenario.
AFOLU Non-Permanence Risk Tool, v4.0	**Condition:** Applicable in all circumstances. **Explanation:** The tool was used to determine the non-permanence risk rating, the number of buffer credits that an AFOLU project shall deposit into the AFOLU pooled buffer account (see appendix III for calculations).
CDM “Tool for testing significance of GHG emissions in A/R CDM project activities” (Version 01) T-SIG	**Condition:** This tool facilitates the determination of which GHG emissions by sources, possible decreases in carbon pools, and leakage emissions are insignificant. **Explanation:** The sum of decreases in carbon pools and increases in emissions that may be neglected shall be less than 5% of the total decreases in carbon pools and increases in emissions, or less than 5% of net anthropogenic removals by sinks, whichever is lower.

3.3 Project Boundary

The geographical boundary of the Project is a situated in the municipality of Manicoré, in the southeastern Amazonas State, northern Brazil (**Figure 1**). The total area of the Mata-Mata II property is 153,985 ha, of which 26,883 ha (17.5%) is delimited as the project area (see section 1.12).

Proxy Areas

APD projects require a minimum of 6 proxy areas (PAs) in cases where a valid verifiable plan does not exist for the rate at which deforestation is projected to occur (as per VMD0006). PAs are not required to be managed by the same deforestation agent as the project area baseline.

The Madeira micro-region was selected as representing a suitable area for locating PAs. The rationale is that most deforestation activity is anticipated to come from east of the project area; the northern micro-region is protected by access limitations and the existence of large, protected areas (see section 1.12 for supporting evidence).

A total of 6 PAs were identified within the reference area (Figure 12) after taking account of the following:

1. Must be located on private land. These were identified using the National Registry of Public Forests (Brazilian Forest Service), a regional, publicly available data layer, which identifies public forests along with protection status[18]. Private lands were identified as those remaining after public lands were removed.
2. The size of a given PA should be within the range of the management areas identified in the project area.
3. Forest cover (with dense rainforest types) should be similar to the project management areas.
4. Proximity to roads and waters should be reasonably consistent between project areas and the PAs.

Once the initial proxy areas were identified, statistical summaries were created for each area. The following regional data were added to the reference region to ensure appropriate similarity and context:

a. Hydrology layers from IBGE.[19]

[18] https://www.gov.br/agricultura/pt-br/assuntos/servico-florestal-brasileiro/cadastro-nacional-de-florestas-publicas

[19] Continuous Cartographic Base of Brazil, scale 1:250,000 - BC250: https://www.ibge.gov.br/geociencias/downloads-geociencias.html?caminho=cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2021/

b. Transportation layers from IBGE.[20]

c. Cities and towns from IBGE.[21]

d. Municipal boundaries from IBGE.[22]

e. Forest vegetation mapping was added to identify areas with similar forest types to the project areas using the national vegetation data layer for Brazil [23]. Areas within the reference area that contained significant coverage of dense rainforest (*Floresta Ombrófila Densa*) were identified as eligible.

f. Elevation and Slope data: A digital elevation model (DEM) was downloaded for the reference region using Google Earth Engine based on the NASA NASADEM Digital Elevation 30m dataset. [24]

g. Regional soils data from IBGE.[25]

Figure 12 shows the location of proxy areas, and **Table 9** their similarity with vegetation, soil type, and topography compared to the project area.

[20] *idem*

[21] *idem*

[22] *idem*

[23] https://bdiaweb.ibge.gov.br/#/consulta/vegetacao

[24] See more on GEE's NASA NASADEM datasets.

[25] https://bdiaweb.ibge.gov.br/#/consulta/pedologia

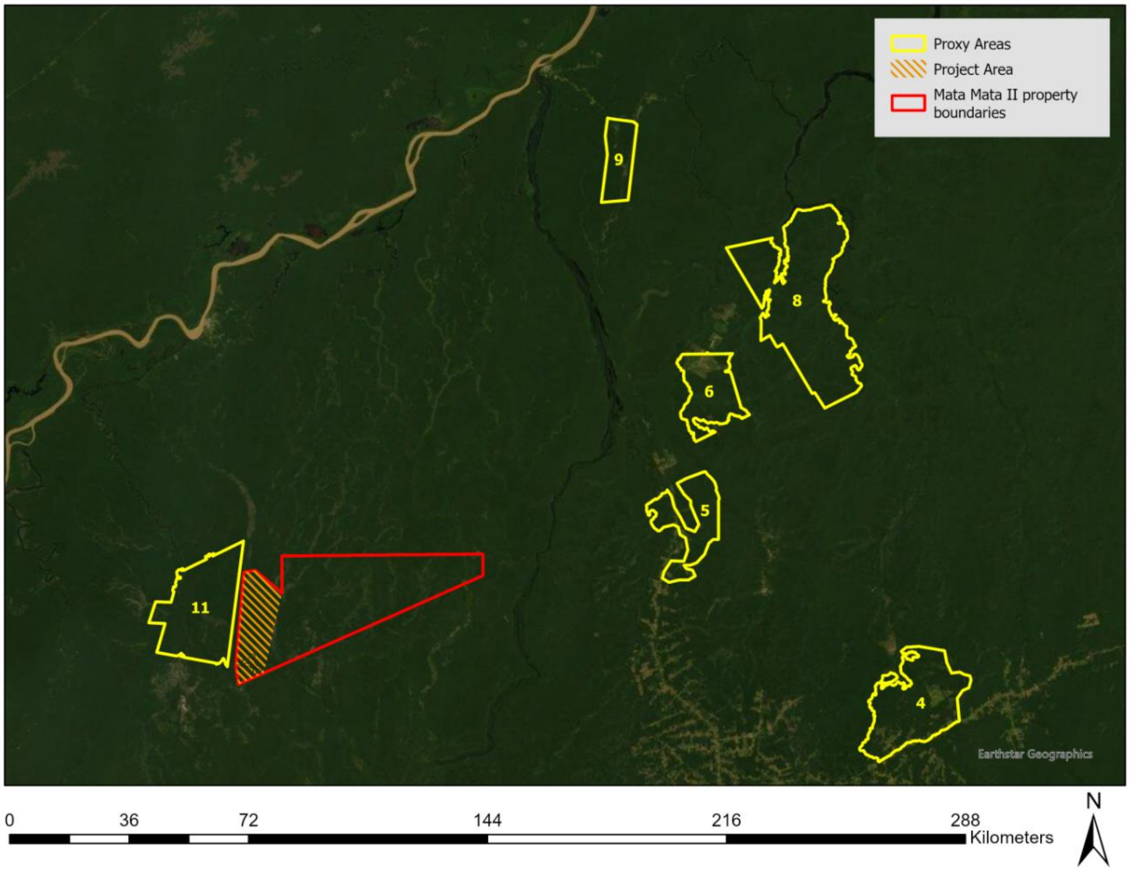
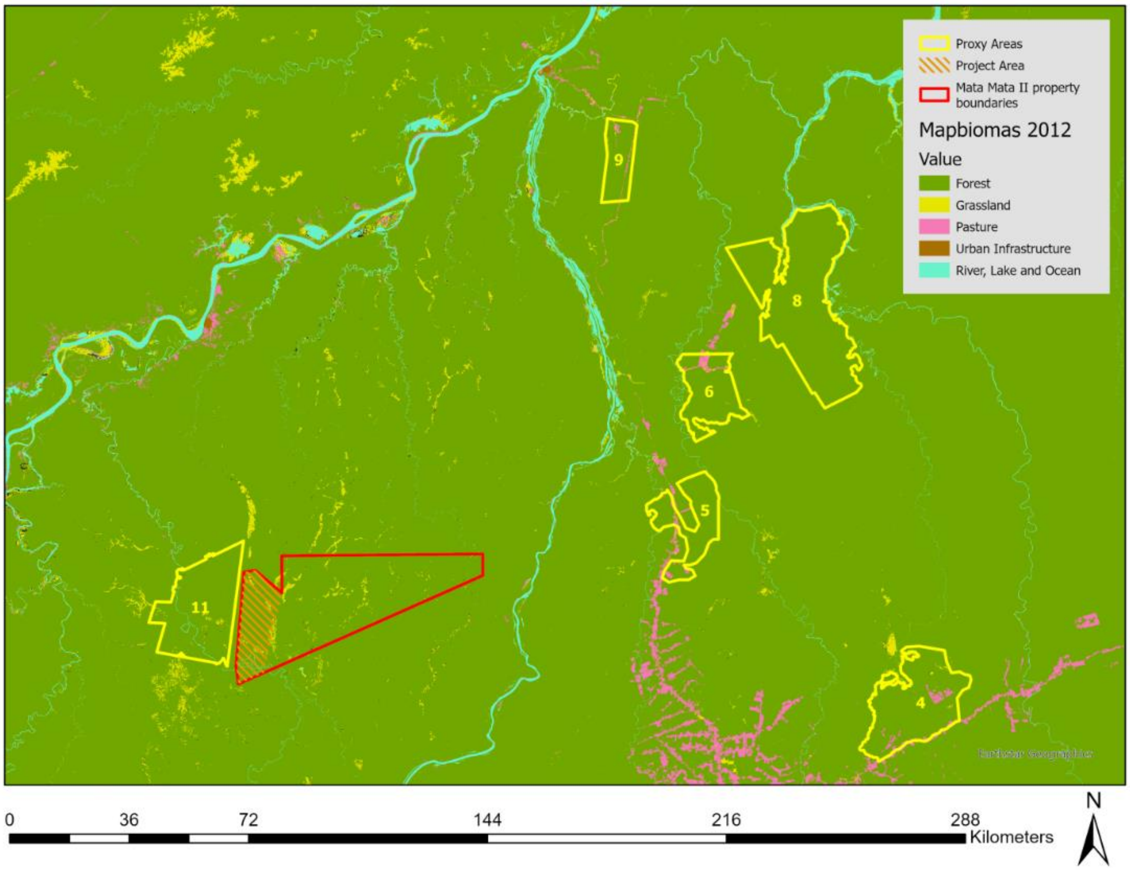


Figure 12 - Map of the project area and 6 proxy sites

Table 9 - Comparison of vegetation, soil type, and topography of the project area and proxy sites

Factors Assessed	Category	Project Area	P_4	P_5	P_6	P_8	P_9	P_11
Vegetation (%)								
	Dense Forest	88.6%	96.9%	99.7%	99.3%	99.8%	100.0%	93.1%
	Other	11.4%	3.1%	0.3%	0.7%	0.2%	0.0%	6.9%
Elevation (%)								
	0-500m	100%	100%	100%	100%	100%	100%	100%
Slope Class (%)								
	Gentle (<15%)	98.8%	95.1%	86.5%	91.4%	85.0%	94.3%	97.5%
	Steep (=>15%)	1.2%	4.9%	13.5%	8.6%	15.0%	5.7%	2.5%
Soil Type (%)								
	ARGISSOLO	0%	0%	3%	0%	0%	0%	0%
	ESPODOSSOLO	15%	3%	0%	0%	0%	0%	14%

Factors Assessed	Category	Project Area	P_4	P_5	P_6	P_8	P_9	P_11
	GLEISSOLO	6%	0%	4%	0%	0%	0%	4%
	LATOSSOLO	79%	97%	93%	100%	99%	100%	82%



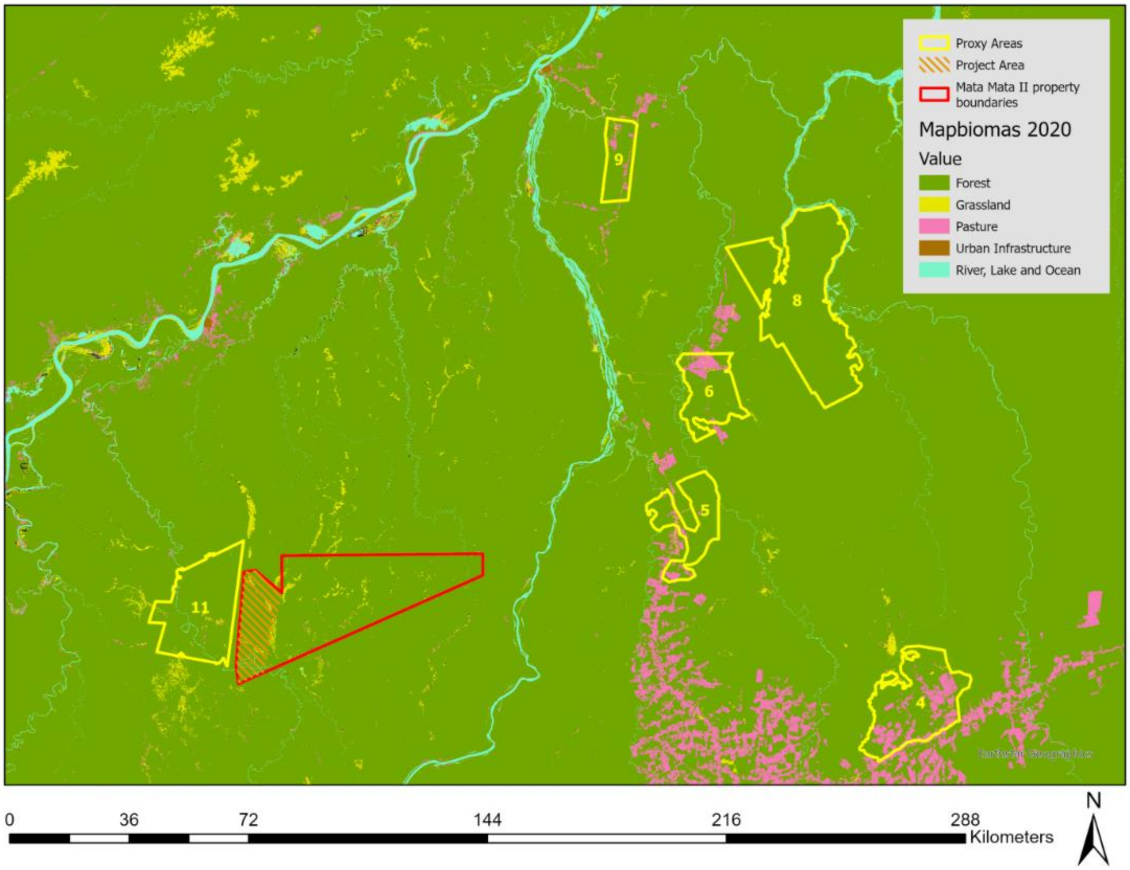


Figure 13 - MAPBIOMAS land use and land cover transitions in proxy areas

Figure 13 and **Table 10** illustrate the land use changes that occurred between the years 2012 and 2020 on the proxy areas.

Table 10 - Land use change in proxy areas, according to MAPBIOMAS

Proxy areas land use transition 2012 - 2020	Area (ha)	Area (%)
Forest cover or non-forestry natural areas to agriculture or non-vegetated areas	19,112	5.8
Agricultural classes or non-vegetated areas to forest cover or non-forest natural areas	605	0.2

3.4 Carbon sinks and reservoirs

Carbon sinks and reservoirs included or excluded within the boundary of the proposed project activity are listed in **Table 11.**

Table 11 - Carbon sinks and reservoirs

Carbon Pool	Included/Excluded	Justification/Explanation
Aboveground tree biomass	Included	Mandatory as per VM0007 v1.6, Table 4.
Belowground tree biomass	Included	Mandatory as per VM0007 v1.6, Table 4.
Deadwood	Included	Mandatory for the given project activity if this carbon pool is greater in baseline (post-deforestation/degradation) than project scenario and significant.
Litter	Excluded	The litter pool is considered an insignificant source in REDD projects, and inclusion of the litter pool as part of the project boundary is optional, as per VM0007 v1.6, Table 4.
Soil Organic Carbon	Excluded	Optional, as per VM0007 v1.6, Table 4.
Harvested Wood Products	Included	Mandatory when the process of the deforestation involves timber harvesting for commercial markets, as per VM0007 v1.6, Table 4.

3.4.1 Sources of GHG Emissions

GHG sources within the boundary of the proposed APD project activity, as well as the respective justification/explanation, are listed in **Table 12.**

Table 12 - Sources and GHG included or excluded within the boundary of the APD project

Source		Gas	Included?	Justification/Explanation
Baseline	Carbon stock changes	CO_2	Yes	Stock changes were included since they are mandatory in the methodology

Source		Gas	Included?	Justification/Explanation
		CH_4	No	Not applicable.
		N_2O	No	Not applicable.
		Other	No	Not applicable
	Biomass burning	CO_2	No	CO_2 emissions are already considered in carbon stock changes.
		CH_4	Yes	CH_4 emissions are included because fire is often used for land preparation in cattle ranching in the region.
		N_2O	No	Not relevant
		Other	No	No relevant source identified.
	Fossil fuel combustion	CO_2	No	Fully optional for the given project activity, as per VM0007, Table 4. No significant fossil fuel combustion is anticipated.
		CH_4	No	
		N_2O	No	
		Other	No	
	Fertilizer use	CO_2	No	Fully optional for the given project activity, as per VM0007, Table 4. No fertilizer use is anticipated.
		CH_4	No	
		N_2O	No	
		Other	No	
	Enteric fermentation	CO_2	No	Excluded. GHG emissions from enteric fermentation in baseline scenario is not significant, based on the T-SIG module (less than 5% of baseline emissions).
		CH_4	No	
		N_2O	No	
		Other	No	
Project	Carbon stock changes	CO_2	Yes	Stock changes were included since they are mandatory in the methodology

Source		Gas	Included?	Justification/Explanation
		CH_4	No	Not applicable.
		N_2O	No	Not applicable.
		Other	No	Not applicable.
	Biomass burning	CO_2	No	Not expected to occur in the project case.
		CH_4	No	
		N_2O	No	
		Other	No	
	Fossil fuel combustion	CO_2	No	Not expected to occur in the project case.
		CH_4	No	
		N_2O	No	
		Other	No	
	Fertilizer use	CO_2	No	Not expected to occur in the project case.
		CH_4	No	
		N_2O	No	
		Other	No	
	Enteric fermentation	CO_2	No	Not expected to occur in the project case.
		CH_4	No	
		N_2O	No	

3.5 Baseline Scenario

The baseline scenario was derived in accordance with VMD0006 v1.3 guidelines. This module provides a stepwise approach for estimating GHG emissions related to planned deforestation. Project additionality is then derived in section 3.6 as per the tool VT0001.

3.5.1 Agent of Planned Deforestation

The landowner, Transmaranata is identified as the agent of planned deforestation in the baseline.

3.5.2 Area of Deforestation

The area of deforestation ($A_{planned,i}$) is defined as follows:

Legal permissibility for deforestation:

According to Brazil Federal Law N°12,651/2012, Art.12, every rural property must maintain an area with native vegetation coverage. That includes an area of native vegetation such as the Legal Reserve, in addition to the Permanent Preservation Area, observing minimum percentages in relation to the property area. For properties located in the Legal Amazon, this percentage is equal to 80%. Thus, the legal area permissible for deforestation is 20% of the project area.

Suitability of project area for conversion to alternative non forest land use:

This analysis evaluates opportunities to implement alternative land use practices related to the livestock sector and timber harvesting, as opposed to conserving the area as a standing forest. The following three perspectives were evaluated: i. Environmental/legal feasibility assessment - the suitability of a particular crop or activity, livestock or timber harvesting in accordance with a Sustainable Forest Management Plan (PMFS[26]) in relation to climate, soils, and the legal framework in the region; ii. Logistical feasibility – if the region has facilities to support the production flow; and iii. Economic feasibility – a financial comparison between livestock activity and logging.

<u>Environmental/legal feasibility:</u>

The southern region of the State of Amazonas and the municipality of Novo Aripuanã have few limitations with respect to climate and soil regarding cattle production or harvesting. In fact, the region has become an important center for cattle production. According to the IBGE Agricultural Census, in Novo Aripuanã alone, the size of the herd grew 140% in the period from 2006 to 2017. In Manicoré, the herd increase was 107% over the same period[27].

According to IBGE, between 2018 and 2020 Novo Aripuanã and Manicoré were the main producers of wood products in the southern Amazonas region. There has been a significant increase in annual deforestation rates in recent years, according to data from PRODES from INPE[28] and of the MAPBIOMAS data [29]. Detailed information on deforestation rates is provided in Section 3.5.3.

<u>Logistical feasibility:</u>

[26] According to Brazilian legislation (Annex II, Resolution 294/01), companies require a PMFS to operate legally in the Brazilian Amazon. The PMFS specifies harvest methods and activities that accord with ecological, economic, and social objectives to promote sustainability.

[27] Derived from IBGE - <u>Census of Agriculture.</u> For more information refer to Biodendro__Estudo_Viabilidade 02junho2022_Rev1.docx.pdf (p.21)

[28] Deforestation rates were derived from PRODES - Desflorestamento nos Municipios - DPI/INPE.

[29] Land use transition for the state of Novo Aripuanã, Manicoré and Apuí derived from <u>Mapbiomas v7.0.</u>

This element was evaluated by assessing the potential flow of goods across the region, both by river and overland. The Madeira River is the second most important transport route in the Amazon, and it is used extensively to transport a broad range of products, including timber. Transport by land is more precarious, with few roads and restricted traffic conditions, especially in the rainy season.

Economic viability:

The project area is located in the Amazonas state in a region dominated by livestock production, the main economic activity driving deforestation[30]. Cattle are raised with minimal investment in pastureland management or herd quality. No effort is made to preserve soil nutrients or feed nutritional value. Once the productive capacity of an area has been depleted, farmers simply deforest new areas and move their cattle, abandoning the old pastures. These extensive pastural systems are employed because, at R$ 200 to R$ 500 (~$38.5 to 96.3 USD) per ha[31], they are much cheaper than intensive systems (R$ 1,500 to 5,000 per ha; ~ $ 288.9 to 963.2 USD). Once established, the profitability of livestock farming is estimated at R$ 61.00 /ha/year (~$11.75 USD)[32]. Timber removal itself also has value; in 2021, the region produced 54,000 m^3 of round wood, with a value of R$ 4,428,000 (~$849,240 USD) (IBGE, 2022)[33].

Government approval for deforestation:

The Mata-Mata II property owner has filed the deforestation request to the environmental agency to the proposed baseline land use change, which is in accordance with VMD0006 requirements:

"If government approval is required for deforestation to occur, the intention to deforest within the project area must be demonstrated by evidence:

- *Recent approval from relevant government department (local to national) for conversion of forest to an alternative land use;*
- *Documentation that a request for approval has been filed with the relevant government department for permission to deforest and convert to alternative land use".*

In the ZCH Project, this requested has been filled with IPAAM and it is available for consultation (**Appendix 4**).

30 Veiga, J. B., Tourrand, J. F., Poccard-Chapuis, R., & Piketty, M. G. (2002). Cattle ranching in the amazon rainforest. In *Proc. Aust. Soc. Anim. Prod* (Vol. 24, pp. 253-256).
31 IDESAM, 2014. For more details, refer to Biodendro Estudo Viabilidade 02junho2022_Rev1.docx.pdf.
32 Cenamo and Carrero 2012. Reducing Emissions from Deforestation and Forest Degradation (REDD) in Apuí, Southern Amazonas: Challenges and Caveats Related to Land Tenure and Governance in the Brazilian Amazon
33 Brazilian Institute of Geography and Statistics. (2022, Sep 8).
Currency exchange rate of 1 USD to 5.21 R$, published on 2022-09-08

Intent to deforest:

Intent to deforest is demonstrated by the documented history of similar planned deforestation within the previous five years by this class of agents, as follows.

Under IBAMA Normative Instruction No. 21/2014: 7th, II (native forest; collection)[34], landowners with market access (i.e., access to major roads and navigable rivers) have deforested at least 20% of their properties. This is substantiated from the PRODES dataset of deforestation around the project area (Figure 5). The neighboring Alexandre III property was added into the analysis to further demonstrate recent deforestation activities on a nearby private property (**Figure 14**).

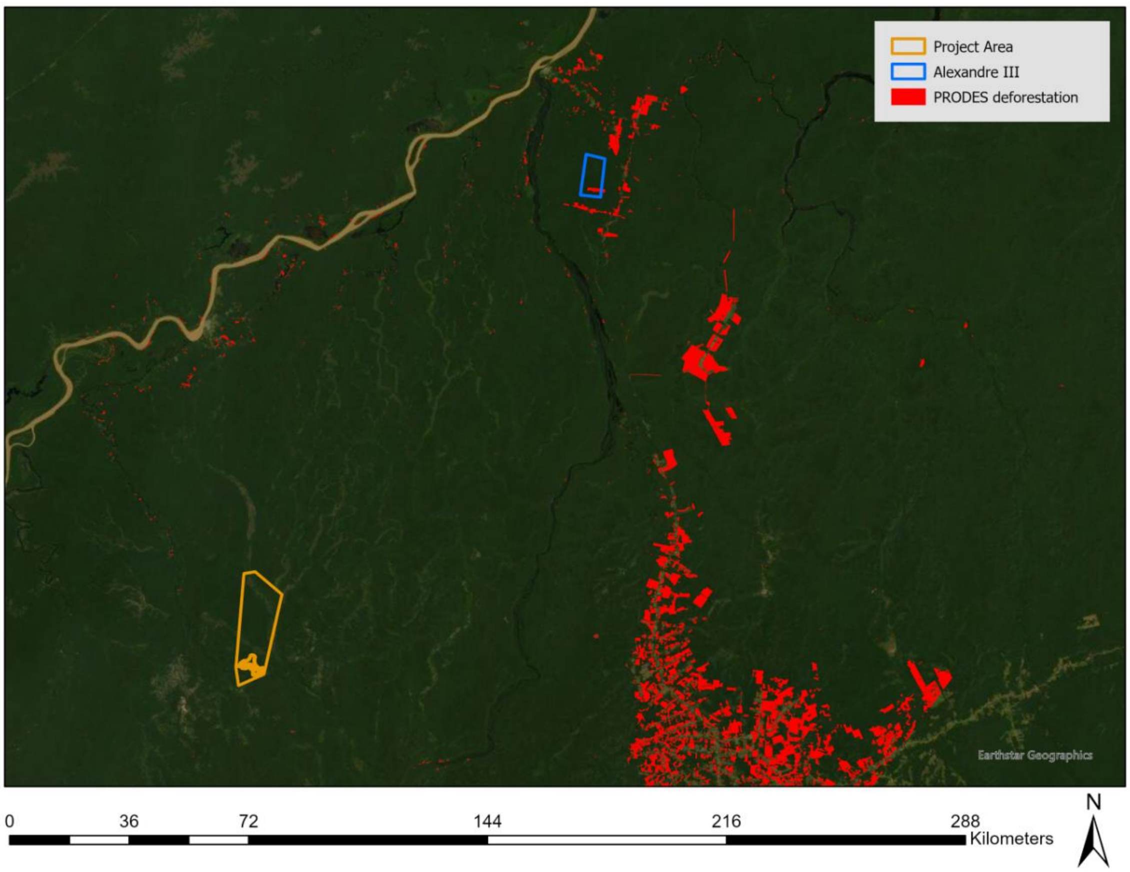


Figure 14 - PRODES deforestation areas with outline of Project Area and Alexandre III property

[34] Derived from CTF proof of registration.

Brazilian studies also identify the advances of the deforestation frontiers into the South of the Amazonas State, for example, the municipality of Novo Aripuanã (Soares, 2022).[35]

3.5.3 Rate of Deforestation

The deforestation rate was established from proxy areas (see section 3.4). Proxy areas were overlain with PRODES data to estimate their annual deforestation rates over the previous 10 years, from which an average deforestation rate was calculated. The expected loss rate was determined by multiplying the rate obtained from the proxy areas by the total area of dense forest in the project area (**Table 13**). The average deforestation rate per annum was 1.2%.

Table 13 - Annual proportion of land deforested (Def) on proxy areas

Proxy ID	Total Forest Area (ha)	Net Forest Area (ha)	Total Def (ha)	% Def	Years of Def	%Def/yr
P_4	61,270	59,796	17,282	28.9%	10	2.9%
P_5	32,771	32,114	2,206	6.9%	9	0.8%
P_6	32,784	31,680	5,910	18.7%	9	2.1%
P_8	118,477	118,468	35	0.0%	1	0.0%
P_9	19,970	19,735	2,761	14.0%	10	1.4%
P_11	58,773	58,762	11	0.0%	2	0.0%
					Avg	**1.2%**

A graphical representation of land use conversion within proxy areas in years 2012 compared to year 2020 is shown in **Figure 13** (section 3.3).

3.5.4 Likelihood of Deforestation, L-Di

In accordance with VMD0006, v1.3, the likelihood of deforestation ($L\text{-}D_i$) is 100%, because the project area is not under government control and is zoned for planned deforestation.

3.5.5 Risk of Abandonment

Risk of abandonment is based on proxy areas that have had the same class of deforestation agent over the previous 10-year interval. **Table 14** shows the relative land use transition in the period of 2012-2020 from MAPBIOMAS land-use mapping for all proxy areas in Manicoré, Apuí and Novo Aripuanã.

[35] SOARES, P.G. "Trajetórias de ocupação e expansão da fronteira agropecuária no Projeto de Assentamento do Rio Juma. Dissertação (Mestrado). Universidade de São Paulo – Escola Superior de Agricultura Luiz de Queiroz e Centro de Energia Nuclear da Agricultura. Piracicaba, 2022.

Table 14 - Land abandonment in proxy areas

Proxy areas land use transition 2012 - 2020	Area (ha)	Area (%)
Forest cover or non-forestry natural areas to agriculture or non-vegetated areas	19,112	5.8
Agricultural classes or non-vegetated areas to forest cover or non-forest natural areas	605	0.2

3.5.6 Annual Area of Deforestation

The annual area of deforestation in the baseline and project case is in accordance with the rate of deforestation from proxy areas (**Table 15**).

Table 15 - Calculation of the annual area of planned deforestation in the baseline, based on a 1.2% average rate of deforestation

Baseline			Project		
Year	forest loss (ha/yr)	cumulative loss (ha)	Year	forest loss (ha/yr)	cumulative loss (ha)
2021	1,697	1,697	2021	0	0
2022	1,697	3,395	2022	0	0
2023	1,697	5,092	2023	0	0
2024	1,697	6,789	2024	0	0
2025	1,697	8,487	2025	0	0
2026	1,697	10,184	2026	0	0
2027	1,697	11,881	2027	0	0
2028	1,697	13,579	2028	0	0
2029	1,697	15,276	2029	0	0
2030	1,697	16,973	2030	0	0
2031	1,697	18,671	2031	0	0
2032	1,697	20,368	2032	0	0
2033	1,697	22,066	2033	0	0
2034	1,697	23,763	2034	0	0
2035	1,697	25,460	2035	0	0

	Baseline			Project	
Year	forest loss (ha/yr)	cumulative loss (ha)	Year	forest loss (ha/yr)	cumulative loss (ha)
2036	1,533	26,993	2036	0	0
2037	0	26,993	2037	0	0
2038	0	26,993	2038	0	0
2039	0	26,993	2039	0	0
2040	0	26,993	2040	0	0
2041	0	26,993	2041	0	0
2042	0	26,993	2042	0	0
2043	0	26,993	2043	0	0
2044	0	26,993	2044	0	0
2045	0	26,993	2045	0	0
2046	0	26,993	2046	0	0
2047	0	26,993	2047	0	0
2048	0	26,993	2048	0	0
2049	0	26,993	2049	0	0
2050	0	26,993	2050	0	0

3.6 Additionality

Additionality was assessed in accordance with the VCS tool VT0001 v3.0 "Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities". It provides a stepwise approach to demonstrating additionality in VCS AFOLU projects, as follows.

3.6.1 Step 1. Identification of Alternative Land Use Scenarios to the proposed AFOLU Project Activity

Credible alternative land use scenarios are:

1. **Forest cover conservation on 20% of the property area, where land use conversion is allowed by law[36] resulting in financial returns other than from a REDD+ APD project.** The landowner has thus far retained the entire property as primary tropical rainforest. Ongoing avoidance of the 20% land use conversion on the project area, however, would be highly unlikely because this option has no real and consequential financial returns. Property ownership carries an

[36] As per Law 12.651, the landowner is allowed to convert up to 20% of forest from rural properties within the Amazon biome, to other land uses for economic purposes.

annual fee and tax burden[37]. In addition, forest maintenance and protection against illegal activities (see Scenario 3) requires direct costs of surveillance, as well as fire monitoring and suppression. These direct costs, along with the opportunity cost incurred by revenue forgone from land use conversion (Scenario 2), is a strong disincentive to pursuing this option.

2. **Logging followed by conversion to pasture.** As per Brazil's Forest Code (see footnote 13), private property owners must set aside a minimum 80% of their land area for native vegetation in a protected legal reserve. As much as 20% then can be legally converted to an alternative land use. Conversion of native forest to pasture is common practice in the region. Large swathes of Legal Amazonia have been cleared, first for cattle, then later for soy (Barona et al., 2010, Zalles et al., 2019)[38].

3. **Continuation of the pre-project land use with an unabated threat of illegal deforestation exceeding 20% of the property area.** While the pre-project land use was tropical rainforest, this is unlikely to be sustained given current and historical land use change and deforestation pressures in the immediate area (see Figure 6). Evidence suggests that most deforestation in Brazil is illegal (Azevedo et al., 2020; Valdiones et al., 2019)[39]. Deforestation is illegal when its agents are not the legal landowner and/or do not possess the necessary documentation and permits. Unfortunately, illegal deforestation is rarely prosecuted by authorities making the likelihood of this scenario plausible.

   All land use scenarios identified above are compliant with applicable legal and regulatory requirements, except Scenario 3, which represents illegal deforestation not undertaken by the landowners or project proponents. **Scenario 2 is considered the most plausible baseline scenario because of its positive economic returns and the fact that conversion is legally authorised.**

3.6.2 Step 2. Investment Analysis

The project area will be managed for conservation purposes only, rather than for commercial timber production, livestock, or crop production. As such, the proposed VCS AFOLU project activity produces no financial benefits other than VCS-related income. Costs to bring credits to issuance are significant and include project development, validation, verification, and registration and issues fees. Ongoing management will incur costs related to inventory updating, forest patrols, and stakeholders' engagement.

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[37] Law No. 9,393 (December 19, 1996).

[38] Barona, Elizabeth & Ramankutty, Navin & Hyman, Glenn & Coomes, Oliver. (2010). The role of pasture and soybean in deforestation of the Brazilian Amazon. Environmental Research Letters. 5. 024002. 10.1088/1748-9326/5/2/024002. Viviana Zalles, Matthew C. Hansen, Peter V. Potapov, Stephen V. Stehman, Alexandra Tyukavina, Amy Pickens, Xiao-Peng Song, Bernard Adusei, Chima Okpa, Ricardo Aguilar, Nicholas John, and Selena Chavez. Near doubling of Brazil's intensive row crop area since 2000. By Proceedings of the National Academy of Sciences Jan 2019, 116 (2) 428-435; DOI: 10.1073/pnas.1810301115

[39] AZEVEDO, T., ROSA, M. R., SHIMBO, J. Z., OLIVEIRA, M. G. 2020. RELATÓRIO ANUAL DO DESMATAMENTO NO BRASIL. Relatório Anual do Desmatamento no Brasil 2020 - São Paulo, Brasil - MapBiomas, 2021 - 93 páginas. VALDIONES, A. P., SILGUEIRO, V., CARDOSO, B., BERNASCONI, P. THUAULT, A. 2019. CARACTERÍSTICAS DO DESMATAMENTO NA AMAZÔNIA MATO- GROSSENSE EM 2019. – Mato Grosso, Brasil – ICV, 2019, 08 páginas.

As the project activity generates no financial benefit to the project proponents other than VCS-related income, a simple cost analysis is justified (VT0001, sub-steps 2a, 2b). The next step is therefore a common practice analysis (VT0001, step 4).

3.6.3 Step 4. Common practice analysis

Public land conservation in the Amazonas State occurs on national, state, and municipal properties, as well as indigenous reserves. Public Conservation Units (UCs – Unidades de Conservação in Portuguese) and Indigenous Reserves (Terras Indígenas in Portuguese - TI) belong to the official network of reserves aimed at protecting natural ecosystems and associated socio environmental attributes.

In terms of public land conservation units, the Amazonas State Government utilizes the *Bolsa Floresta Program* (2007) and the Federal Government *Bolsa Verde Program* (2011). Both are aimed at properties located within established Conservation Units (UCs), while *Bolsa Verde* also includes residents of agrarian reform settlements. These programs provide social assistance to individuals employed in formerly extractive occupations and to low-income traditional family farmers. They are not targeted to supporting conservation-based voluntary carbon projects. It is also important to note that while they have had success at maintaining forest cover, an essential distinction between these initiatives and the project area is that the latter is privately owned. As such, it is not eligible to access the government resources used to finance and manage these non-extractive land use programs.

Conservation of privately owned forest land in the Amazonas State, including the project area and proxy areas, is limited to the system of legal reserves and designated areas of permanent protection (APP)[40]. To prevent legal deforestation within rural private properties, the rural environmental registry (CAR – Cadastro Ambiental Rural) must be utilized, which requires all owners or “possessors'' of rural properties to register their lands with the state environmental agency, delineating the georeferenced legal area and a management plan stipulating how they plan to comply with the environmental law, and to serve as the basis for monitoring compliance. One flexibility mechanism included in the 2012 law is the option for landowners to “compensate” for any legal reserve deficits on one property with legal reserve surpluses located on other properties. This compensation could be done directly by purchase of permanent or temporary forest easements on another property or through the acquisition of environmental reserve quotas (CRA – cotas de reserva ambiental). As these titles are a commercial product, the mechanism could be understood as incentives similar to a REDD APD project. However, CRAs can only be traded in the same biome and to specific stakeholders, which means they are very scarce. The CRA mechanism also applies only to forest cover and not forest carbon stocks per se, and thus has no pertinence with respect to offsetting GHG emissions. Finally, Brazil was the first country to introduce an ecological fiscal transfers program (ICMS-E) to compensate municipalities for

[40] For a more complete description, consult Annex II of Resolution 294/01, Section 4.

land-use restrictions imposed by protected areas.[41] In the Amazonas State the ICMS-E came into force in 2021. Although it has been seen as an incentive to create new protected areas, the mechanism increases tax income for municipalities but does not serve to remunerate landowners for conservation of native vegetation on their properties.

3.6.4 Results of the Additionality Analysis

Without revenue from carbon credits, the project activity is highly unlikely to occur and is not a common practice in the region. The project therefore brings additionality.

3.7 Methodology Deviations

No methodology deviations were applied to the Project.

[41] Peter H. May, Maria Fernanda Gebara, Bruna Rancão Conti, Guilherme Rodrigues Lima. 2012. The "Ecological" Value Added Tax (*ICMS-Ecológico*) in Brazil and its effectiveness in State biodiversity conservation: a comparative analysis. *Paper presented at 12th Biennial Conference of the International Society for Ecological Economics ISEE 2012: ECOLOGICAL ECONOMICS AND RIO +20. Panel session: "The role of economic instruments in the conservation policy mix"* (accessed from: https://www.isecoeco.org/conferences/isee2012-versao3/pdf/sp33.pdf)

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The baseline emissions calculated in the project are a result of the conversion of forest to pasture. In the Amazon biome, Brazilian law permits 20% of private property to be converted from forest to another land-use. The total area of the property parcel is 153,985. The defined managed area, selected for conversion in the baseline scenario has a total area of 29,414 ha with a total dense forest area of 26,883 ha at the project start date (Jan 1, 2021) (**Table 16**).

Table 16 - Areas of strata within the Zero Carbon Project boundary

Area	Acronym	Description	Area (ha)
1	Df	Dense forest*	142,155
2	Bs	Deforestation/Bare Soil	61
3	Lf	Low cover Forest	11,493
4	Wt	Water	276
		Total	**153,985**

*From satellite classified forest cover layer developed using supervised classification in Google Earth Engine (see attached Brazil Zero Carbon Carbon Project Landcover Classification Report)[42].

The VCS module, VMD0006-BL-PL, applied to an avoided planned deforestation activity requires knowledge of the rate at which the area will be deforested. The deforestation rate (1.2%) was determined from sixproxy areas, as outlined in section 3.5.3.

Baseline net GHG emissions for REDD planned deforestation are determined from module VMD006 v1.3, equation 1, as per below (Equation 1).

Equation 1 (Baseline net GHG emissions):

$$\Delta C_{\mathrm{BSL,planned}} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(\Delta C_{\mathrm{BSL},i,t} + \mathrm{GHG}_{\mathrm{BSL-E,i,t}} \right)$$

[42] See attached Brazil 413 Carbon Project Landcover Classification Report.

Where:

$\Delta C_{\text{BSL,planned}}$ = Net greenhouse gas emissions in the baseline from planned deforestation up to year $t*$; t CO_2-e

$\Delta C_{BSL_{i,t}}$= Net carbon stock changes in all pools in the baseline stratum *i* in year *t*; t CO_2-e

$GHG_{BSL-E,i,t}$= Greenhouse gas emissions from deforestation activities within the project boundary in the baseline stratum *i* in year *t*; t CO_2-e yr^{-1}

i = 1, 2, 3, … *M* strata

t = 1, 2, 3, … $t*$ years elapsed since the projected start of the project activity.

These calculations are described in the following sections, and further details are provided in the supporting Microsoft Excel® file "ZC calcs v1.4.xlsx" and associated tabs.

4.1.1 Estimation of Carbon Stocks by Carbon Pools

Three carbon pools were used to calculate baseline emissions: 1. Aboveground biomass (stems, branches, and foliage - AGB), 2. Belowground biomass (roots - BGB), both from trees and non-tree vegetation, and 3. Dead wood (DW). Litter, soil and non-tree biomass pools were excluded, as per the APD methodology. This is a conservative measure from the perspective of carbon credit calculations.

Forest carbon values were derived from the inventory reports generated by a specialized service provided (Biondendro[43]), while pasture values in the municipality of Novo Aripuanã were obtained from Nogueira et al. (2008)[44]. Values for AGB ,BGB, DW ($CAB_{tree+nontree_i}, CBB_{tree+nontree_i}, CDW_i$), respectively, and the corresponding land conversion (to pasture) values ($CAB_{post,i}, CBB_{post,i}, CDW_{post,i}$) are listed in **Table 17.**

Table 17 - Carbon Pools for calculation of the baseline scenario

C_{pre} Baseline in the forest stratum			
Parameter	**Description**	**Unit**	**Value**
$C_{AB_{pre,i}}$	Aboveground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	526.9
$C_{BB_{pre,i}}$	Belowground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	125.0
$C_{DW_{pre,i}}$	Deadwood (DW)	$tCO_2\text{eha}^{-1}$	50.6

[43] Brazilian consultant company http://www.biodendro.com.br/

[44] Nogueira, E. M., Fearnside, P. M., Nelson, B. W., Barbosa, R. I., & Keizer, E. W. H. (2008). Estimates of forest biomass in the Brazilian Amazon: new allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management, 256(11), 1853-1867.

C_{preBSL}	Total	tCO_2eha^{-1}	702.5
C_{post} Baseline in pasture			
$C_{AB_{post,i}}$	Aboveground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	5.2
$C_{BB_{post,i}}$	Belowground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	6.3
$C_{DW_{post,i}}$	Deadwood (DW)	$tCO_2\text{eha}^{-1}$	7.4
$C_{postBSL}$	Total	tCO_2eha^{-1}	19.0
Difference between forest and pasture			
$C_{AB_{pre,i}} - C_{AB_{post,i}}$	Aboveground Biomass (AGB)	tCO_2eha^{-1}	521.7
$C_{BB_{pre,i}} - C_{BB_{post,i}}$	Belowground Biomass (AGB)	tCO_2eha^{-1}	118.7
$C_{DW_{pre,i}} - C_{DW_{post,i}}$	Deadwood (DW)	tCO_2eha^{-1}	43.2
ΔC_{BSL}	Total	tCO_2eha^{-1}	683.6

Carbon stock changes in the baseline were determined as per Equation 2 (see VMD0006 v1.3, Equation 13).

Equation 2 (Carbon stock changes in the baseline):

$$\Delta C_{BSL_{i,t}} = AA_{planned_{i,t}} * \left(\Delta C_{ABtree_i} + \Delta C_{ABnon-tree_i} + \Delta C_{LI_i}\right) + \sum_{t-10}^{t}\left(AA_{planned_{i,t}} * \left(\Delta C_{BBtree_i} + \Delta C_{BBnon-tree_i} + \Delta C_{DW_i}\right) * \frac{1}{10}\right) + \sum_{t-20}^{t}\left(AA_{planned_{i,t}} * \left(C_{WP100_i} + \Delta C_{SOC_i}\right) * \frac{1}{20}\right)$$

Annual BGB stock change was calculated from Equation 3 (see VMD0006 v1.3, Equation 8).

Equation 3 (BGB stock change):

$$\Delta C_{BBtree+nontree_{i,t}} = AA_{planned_{i,t}} * \left(CBB_{tree+nontree_i} - CBB_{\text{post},i}\right) * {}^{1}/_{10}$$

Annual deadwood stock change was calculated using Equation 4 (see VMD0006 v1.3, equation 10).

Equation 4 (Deadwood stock change):

$$\Delta C_{DW_t} = AA_{planned_{i,t}} * \left(CDW_{tree+nontree} - CDW_{post,i}\right) * {}^{1}/_{10}$$

Annual baseline stock change from planned deforestation in aboveground and belowground biomass, deadwood, extracted biomass and its decomposition, are listed in **Table 18** (see "ZC calcs v1.4.xlsx, tab 'Baseline_stockchg GHG'", for calculations).

Table 18 -Annual baseline carbon stock change (△CBSL) from planned deforestation in aboveground and belowground biomass (AG+BB, respectively), deadwood (DW), extracted biomass ($XB_{sawnwood}$), and its decomposition ($XB_{sawnwood}$ Decom)

Year	$AA_{planned}$ (ha/y)	ΔC_{AB} (tCO_2e)	ΔC_{BB} (tCO_2e)	ΔC_{DW} (tCO_2e)	$C_{XB_{sawnwood}}$ (tCO_2e)	$C_{XB_{sawnwood}}$ Decom (tCO_2e)	ΔC_{BSL} (tCO_2e)
2021	1,697	885,557	20,141	7,326	-45,227	1,972	869,768
2022	1,697	885,557	40,281	14,651	-45,227	3,944	899,206
2023	1,697	885,557	60,422	21,977	-45,227	5,916	928,644
2024	1,697	885,557	80,563	29,303	-45,227	7,888	958,083
2025	1,697	885,557	100,704	36,629	-45,227	9,860	987,521
2026	1,697	885,557	120,844	43,954	-45,227	11,831	1,016,960
2027	1,697	885,557	140,985	51,280	-45,227	13,803	1,046,398
2028	1,697	885,557	161,126	58,606	-45,227	15,775	1,075,836
2029	1,697	885,557	181,266	65,932	-45,227	17,747	1,105,275
2030	1,697	885,557	201,407	73,257	-45,227	19,719	1,134,713
2031	1,697	885,557	201,407	73,257	-45,227	21,691	1,136,685
2032	1,697	885,557	201,407	73,257	-45,227	23,663	1,138,657
2033	1,697	885,557	202,483	74,520	-45,227	25,635	1,142,968
2034	1,697	885,557	203,559	75,783	-45,227	27,607	1,147,279
2035	1,697	885,557	204,635	77,046	-45,227	29,579	1,151,589
2036	1,533	799,820	203,657	77,477	-40,848	31,360	1,071,466
2037	0	0	183,517	70,152	0	31,360	285,028
2038	0	0	163,376	62,826	0	31,360	257,561
2039	0	0	143,235	55,500	0	31,360	230,095
2040	0	0	123,095	48,174	0	31,360	202,628
2041	0	0	102,954	40,849	0	29,388	173,190
2042	0	0	82,813	33,523	0	27,416	143,752

Year	$AA_{planned}$ (ha/y)	ΔC_{AB} (tCO_2e)	ΔC_{BB} (tCO_2e)	ΔC_{DW} (tCO_2e)	$C_{XB_{sawnwood}}$ (tCO_2e)	$C_{XB_{sawnwood}}$ Decom (tCO_2e)	ΔC_{BSL} (tCO_2e)
2043	0	0	61,596	24,934	0	25,444	111,974
2044	0	0	40,380	16,346	0	23,472	80,197
2045	0	0	19,163	7,757	0	21,500	48,420
2046	0	0	0	0	0	19,528	19,528
2047	0	0	0	0	0	17,556	17,556
2048	0	0	0	0	0	15,584	15,584
2049	0	0	0	0	0	13,612	13,612
2050	0	0	0	0	0	11,641	11,641

4.1.2 Estimation of GHG Emissions from burning in the Baseline

Burning remaining biomass after deforestation is a common practice. Emissions from biomass burning were calculated from procedures and equations listed in VMD0006 v1.3, as per Equation 5. See **Table 19** and **Table 20**, for equation input values, and **Table 21** for output values (see "ZC calcs v1.4.xlsx, tab 'Baseline Emissions burn'", for calculations).

Equation 5 (Emissions from biomass burning):

$$GHG_{BSL-E,i,t} = E_{BionmassBurn,i,t} = \sum_{g=1}^{G}\left(\left(\left(A_{Burn,i,t} * B_{i,t} * COMF_i * G_{g,i}\right) * 10^{-3}\right) * GWP_g\right)$$

Table 19 - Parameters values as per Equation 5

Parameter	Description	Unit	Justification
$GHG_{BSL-E,i,t}$	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum *i* during project year *t*	$t\ CO_2eyear^{-1}$	Calculated below.
$E_{BionmassBurn,i,t}$	Greenhouse emissions due to biomass burning as part of deforestation activities in stratum *I* in year *t*	$t\ CO_2e$ of each $GHG\ (CO_2, CH_4, N_2O)$	Calculated below. Biomass burning is expected to occur in the project case.
$A_{Burn,i,t}$	Area burnt for stratum *i* in year *t*	ha	-
$B_{i,t}$	Average aboveground biomass stock before burning stratum *i* in year *t*	$tonnes\ d.m.ha^{-1}$	-

Parameter	Description	Unit	Justification
$COMF_i$	Combustion factor for stratum *i*	dimensionless	Default value derived from Table 2.6 of (IPCC, 2006)[45]
$G_{g,i}$	Emission factor for stratum *i* for gas g	$kg\ t^{-1}$ dry matter burnt	Default value derived from Table 2.6 of (IPCC, 2006)
GWP_g	Global warming potential for gas g	$t\ CO_2/t$ gas g	Default values from IPCC AR5 (IPCC, 2014)[46]: $CO_2 = 1$; $CH_4 = 25$; $N_2O = 298$
g	Number of greenhouse gases	-	-
i	Number of strata	-	-
t	Years elapsed since the start of the REDD	-	-

Table 20 - GHG-specific parameters values used to calculate baseline emissions from biomass burning

Gas	COMF	G	GWP
N_2O	0.59	0.2	273
CH_4	0.59	6.8	28

Source: IPCC (2006), AR6 Chap. Table 7.15

Table 21 - Calculation of $E_{BiomassBurn,i,t}$ emission from biomass burning for the baseline scenario accounting for N_2O and CH_4

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	$GHG_{BSL,E}$ (tCO_{2e})
2021	1,697	285.2	54,380	15,594	69,974
2022	1,697	285.2	54,380	15,594	69,974
2023	1,697	285.2	54,380	15,594	69,974
2024	1,697	285.2	54,380	15,594	69,974
2025	1,697	285.2	54,380	15,594	69,974
2026	1,697	285.2	54,380	15,594	69,974
2027	1,697	285.2	54,380	15,594	69,974

[45] IPCC (2006). Guidelines for National Greenhouse Gas Inventories. Chapter 4 AFOLU (Agriculture, Forestry and Other Land-use).

[46] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	$GHG_{BSL,E}$ (tCO_{2e})
2028	1,697	285.2	54,380	15,594	69,974
2029	1,697	285.2	54,380	15,594	69,974
2030	1,697	285.2	54,380	15,594	69,974
2031	1,697	285.2	54,380	15,594	69,974
2032	1,697	285.2	54,380	15,594	69,974
2033	1,697	285.2	54,380	15,594	69,974
2034	1,697	285.2	54,380	15,594	69,974
2035	1,697	285.2	54,380	15,594	69,974
2036	1,533	285.2	49,115	14,084	63,199
2037	0	285.2	0	0	0
2038	0	285.2	0	0	0
2039	0	285.2	0	0	0
2040	0	285.2	0	0	0
2041	0	285.2	0	0	0
2042	0	285.2	0	0	0
2043	0	285.2	0	0	0
2044	0	285.2	0	0	0
2045	0	285.2	0	0	0
2046	0	285.2	0	0	0
2047	0	285.2	0	0	0
2048	0	285.2	0	0	0
2049	0	285.2	0	0	0
2050	0	285.2	0	0	0

4.1.3 Estimation of Carbon Sequestered in Long-Lived Wood Products

Carbon sequestered in long-lived wood products is calculated using module VMD0005 v1.1 CP-W Option 2, Commercial Inventory Estimation. This option is applicable when an approved harvest plan is not available. Estimate of carbon stocks in the long-term wood products pool is estimated in four steps.

Step 1. Calculate the biomass carbon of the commercial volume extracted prior to or in the process of deforestation:

$$C_{XB_i} = CAB_{tree_i} * {}^{1}/_{BEF} * Pcom_i$$ **Equation 6**

Step 2. Identify the wood product class(es) (*ty*; defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other) that are the anticipated end use of the extracted carbon calculated in Step 1. Harvested trees would have been turned into sawnwood as is typical practice for the tropical hardwood species in the region (IBGE, 2022). Hence, only one product class (sawnwood, "s") is extracted due to harvesting in the baseline. Harvested trees would have been turned into sawnwood as is typical practice for the tropical hardwood species in the region (IBGE, 2022). Hence, only one product class (sawnwood, "s") is extracted due to harvesting in the baseline.

Step 3: Calculate the biomass carbon entering the wood products pool at the time of deforestation.

$$C_{WP_i} = \sum_{ty=s,w,oir,p,o} C_{XB_{ty i}} * \left(1 - WWs_{t_y}\right) \quad \text{Equation 7}$$

Step 4: Calculate the amount of wood products entering the pool at the time of deforestation (*CWP,i*, calculated in C-WP) that is expected to be emitted over a 100-year timeframe.

$$C_{WP100_i} = C_{WP_i} - C_{WP_i} * (1 - SLFp) * \left(1 - OF_p\right) \quad \text{Equation 8}$$

Variable descriptions for equations 6-8 and associated values are described in **Table 22**; see "ZC calcs v1.4.xlsx, tabs 'HWP_initial' and HWP_base'", for detailed calculations).

Table 22 - Parameters and values used to estimate carbon stocks entering the long-term wood products pool

Parameter	Description	Unit	Value	Justification
CAB_{tree_i}	Carbon stock in aboveground biomass tree in stratum *i;*	$t\,CO_2e/ha$	526.9	Calculated from forest inventory data.
BEF	Biomass Expansion Factor for conversion of volume to total aboveground tree biomass	dimensionless	1.79	BEF Calculated using data from Goodman et al. 2014[47]
$Pcom_i$	Commercial volume as a percent of total aboveground volume in stratum *i*	dimensionless	0.120	1.Commercial portion of a tree (0.56 x 104.9 tonnes aboveground biomass for commercial species, forest, inventory; 2. 526.9 tonnes, average t CO2e/ha aboveground biomass, forest inventory
$C_{XB_{sawnwood}}$	Mean stock of extracted biomass carbon by class	$t\,CO_2e/ha$	35.4	Equation 6

[47] Goodman, R.C., Phillips, O.L., Baker, T.R., 2014. The importance of crown dimensions to improve tropical tree biomass estimates. Ecol. Appl. 24, 680–698. https://doi.org/ 10.1890/13-0070.1.

Parameter	Description	Unit	Value	Justification
	of wood product $t_y$from stratum			
WW_s	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product	dimensionless	0.24	default value for developing countries from CP-W module, VMD0005
C_{WP_i}	Carbon stock entering the wood products pool from stratum *i*	$t\,CO_2e/ha$	26.9	Equation 7
$SLFs$	SLFty Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product *ty*	dimensionless	0.2	Default for sawnwood from CP-W module, From VMD0005, pg 13
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product *ty*	dimensionless	0.84	Default for sawnwood in Tropical forests from previous version of methodology module CP-W (VMD0005 Version 1.0 REDD Methodological Module)
C_{WP100_i}	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum *i*	$t\,CO_2e/ha$	23.5	Equation 8

4.2 Project Emissions

Estimates of the net carbon stock change and GHG emissions in the project scenario were derived from Module *M-REDD*, as per VM0007 specifications. Ex-ante projections of deforestation in the project case assume no planned deforestation and forest degradation have taken place once the project proponent has committed to not undertake these activities. An assumption of unplanned (illegal) deforestation at a rate of 52 ha year^{-1} for 11 years (to year 2031), along with associated biomass burning, is included in the carbon balance.

For REDD project activities (non-wetland), the net GHG emissions in the project case are equal to the sum of stock changes due to deforestation and forest degradation plus the total GHG emissions minus any eligible forest carbon stock enhancement (Equation 9).

Equation 9 (Net GHG emissions in the REDD project scenario (see VMD0015 v2.2, equation 1.)):

$$\Delta C_{WPS-REDD}=\sum_{t=1}^{t^*}\sum_{i=1}^{M}\left(\Delta C_{P,DefPA_{i,t}}+\Delta C_{P,Deg_{i,t}}+\Delta C_{P,DitPA_{i,t}}+GHG_{P-E_{i,t}}-\Delta C_{P,Enh_{i,t}}\right)$$

Where:

$\Delta C_{WPS-REDD}$	Net GHG emissions in the REDD project scenario up to year t^*; tCO_{2e};
$\Delta C_{P,DefPA_{i,t}}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$\Delta C_{P,Deg_{i,t}}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$\Delta C_{P,DitPA_{i,t}}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$GHG_{P-E_{i,t}}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; tCO_{2e};
$\Delta C_{P,Enh_{i,t}}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline[2] in stratum *i* in year *t*; tCO_{2e};
i	1, 2, 3, …*M* strata;
t	1, 2, 3, …t^* years elapsed since the start of the REDD VCS project activity.

When significant, non-CO_2 gas greenhouse emissions, $GHG_{P,E_{i,t}}$, occurring within the project boundary must be evaluated. For example, where deforestation or degradation occur within the project boundaries or in the leakage belt and fire is used as a means of forest clearance the non-CO_2 emissions may be significant. The Tool T-SIG was used to determine which emissions were included in the calculations as a minimum. Emissions were then calculated through applying Modules E-BPB, E-FCC and E-NA.

Equation 10 (Non-CO2 gas greenhouse emissions):

$$GHG_{P,E_{i,t}}=E_{FC_{i,t}}+E_{BiomassBurn_{i,t}}+N_2O_{direct-N_{i,t}}$$

Where:

$GHG_{P,E_{i,t}}$	Greenhouse gas emissions as a result of deforestation activities within the project area in the project case in stratum *i* in year *t*; t CO_{2e}
$E_{FC_{i,t}}$	Emission from fossil fuel combustion in stratum *i* within the project area in year *t*; t CO_{2e}

$E_{BiomassBurn_{i,t}}$	Non-CO_2 emissions due to biomass burning in stratum i in year t; t CO_{2e}
$N_2O_{direct-N_{i,t}}$	Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* within the project area in year *t*; t CO_{2e}
i	1, 2, 3, …*M* strata
t	1, 2, 3, …$t*$ years elapsed since the start of the REDD VCS project activity

Net GHG emissions under the project scenario (as per equation 9) are zero.

One component of net GHG emissions are non-CO_2 GHG emissions occurring in the project case within the project boundary (as per equation 10). These are shown in **Table 23.** Complete calculations are provided in "ZC calcs v1.4, tab '10b. Proj Emissions burn'".xlsx.

Table 23 - Non-CO_2 GHG emissions occurring in the project case within the project boundary

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	E_{FC} (tCO_{2e})	N_2O_{Direct} (tCO_{2e})	$GHG_{P,E}$ (tCO_{2e})
2021	0	285.2	0	0	0	0	0
2022	0	285.2	0	0	0	0	0
2023	0	285.2	0	0	0	0	0
2024	0	285.2	0	0	0	0	0
2025	0	285.2	0	0	0	0	0
2026	0	285.2	0	0	0	0	0
2027	0	285.2	0	0	0	0	0
2028	0	285.2	0	0	0	0	0
2029	0	285.2	0	0	0	0	0
2030	0	285.2	0	0	0	0	0
2031	0	285.2	0	0	0	0	0
2032	0	285.2	0	0	0	0	0
2033	0	285.2	0	0	0	0	0
2034	0	285.2	0	0	0	0	0
2035	0	285.2	0	0	0	0	0
2036	0	285.2	0	0	0	0	0
2037	0	285.2	0	0	0	0	0
2038	0	285.2	0	0	0	0	0

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	E_{FC} (tCO_{2e})	N_2O_{Direct} (tCO_{2e})	$GHG_{P,E}$ (tCO_{2e})
2039	0	285.2	0	0	0	0	0
2040	0	285.2	0	0	0	0	0
2041	0	285.2	0	0	0	0	0
2042	0	285.2	0	0	0	0	0
2043	0	285.2	0	0	0	0	0
2044	0	285.2	0	0	0	0	0
2045	0	285.2	0	0	0	0	0
2046	0	285.2	0	0	0	0	0
2047	0	285.2	0	0	0	0	0
2048	0	285.2	0	0	0	0	0
2049	0	285.2	0	0	0	0	0
2050	0	285.2	0	0	0	0	0

4.3 Leakage

Leakage emissions from displacement of planned deforestation are estimated as per the VCS REDD methodology VM0007, LK-ASP and LK-ME modules. These modules account for activity shifting leakage resulting from displacement of deforestation activities by the agent of deforestation, and GHG emissions caused by market-effects resulting from the cessation of timber harvesting.

Activity Shifting Leakage

Activity shifting leakage due to displacement of planned deforestation was assessed using the equations provided in the LK-ASP tool, as per VM007 requirements. Parameters, values used, and their justification are given in **Table 24.**

Equation 11 (Leakage from displacement of planned deforestation; VMD0007 v1.6, equation 1):

$$\Delta C_{LK-AS_{planned}} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(LKA_{planned,i,t} \times \Delta C_{BSL,i}\right) + GHG_{LK,E,i,t}$$

Where:

$C_{LK-AS_{planned}}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation up to year t*; t CO_{2e}
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum *i in year t*; ha
$\Delta C_{BSL,i}$	Net carbon stock changes in all pre-deforestation pools in baseline stratum *i*; t CO_{2e} ha^{-1}

$GHG_{LK,E,i,t}$	Greenhouse gas emission as a result of leakage of avoiding deforestation activities in stratum *i* in year *t*; t CO_{2e}
i	1, 2, 3, …*M* strata; unitless
t	1, 2, 3, …*t** time elapsed since the start of project activity; years

No activity shifting leakage is anticipated to occur because the deforestation agent does not own any additional lands. Hence, $LKA_{planned,i,t}$, and $GHG_{LK,E,i,t}$ are set to zero, and activity shifting leakage is as per **Table 24.**

Table 24 - Activity shifting leakage

Year	$LKA_{planned}$ (ha)	$\Delta C_{BSL,i}$ (tCO_{2e}/ha)	$GHG_{LK\text{-}E,i,t}$ (tCO_{2e})	LK_{peat} (tCO_{2e})	$\Delta C_{LK-AS_{planned}}$ (tCO_{2e})
2021	0	683.55	0	0	0
2022	0	683.55	0	0	0
2023	0	683.55	0	0	0
2024	0	683.55	0	0	0
2025	0	683.55	0	0	0
2026	0	683.55	0	0	0
2027	0	683.55	0	0	0
2028	0	683.55	0	0	0
2029	0	683.55	0	0	0
2030	0	683.55	0	0	0
2031	0	683.55	0	0	0
2032	0	683.55	0	0	0
2033	0	683.55	0	0	0
2034	0	683.55	0	0	0
2035	0	683.55	0	0	0
2036	0	683.55	0	0	0
2037	0	683.55	0	0	0
2038	0	683.55	0	0	0
2039	0	683.55	0	0	0
2040	0	683.55	0	0	0
2041	0	683.55	0	0	0
2042	0	683.55	0	0	0
2043	0	683.55	0	0	0

Year	$LKA_{planned}$ (ha)	$\Delta C_{BSL,i}$ (tCO_{2e}/ha)	$GHG_{LK-E,i,t}$ (tCO_{2e})	LK_{peat} (tCO_{2e})	$\Delta C_{LK-AS_{planned}}$ (tCO_{2e})
2044	0	683.55	0	0	0
2045	0	683.55	0	0	0
2046	0	683.55	0	0	0
2047	0	683.55	0	0	0
2048	0	683.55	0	0	0
2049	0	683.55	0	0	0
2050	0	683.55	0	0	0

4.3.1 Market-effects Leakage

Total leakage due to market effects is equal to the sum of market effects leakage through decreased timber harvest and decreased harvest for fuelwood / charcoal production. In this project, the latter is not practiced on the project area to any significant degree. Hence, market-effects leakage is calculated as (from VMD0011-LK-ME, equation 2):

Equation 12 (Market-effects leakage calculation):

$$LK_{ME,T} = \sum_{i=1}^{M} \left(LF_{ME} * AL_{T,i} \right)$$

Where:

$LK_{ME,T}$ Total GHG emissions due to market- effects leakage through decreased timber harvest; t CO_2-e

LF_{ME} Leakage factor for market-effects calculations; dimensionless

$AL_{T,I}$ Summed emissions from timber harvest in stratum *i* in the baseline case potentially displaced through implementation of carbon project; t CO_2-e

Each project must calculate within each stratum the proportion of total biomass in commercial species that is merchantable (*PMPi*). This shall then be compared to mean proportion of total biomass that is merchantable for each forest type (*PMLFT*). Merchantable biomass is defined as *"Total gross biomass (including bark) of a tree 40 cm DBH or larger from a 30 cm stump to a minimum 10 cm top of the central stem"*. The following deduction factors (LFME) must be used:

PML_{FT} is equal (± 15%) to PMP_i $LF_{ME} = 0.4$

PML_{FT} is > 15% less than PMP_i $LF_{ME} = 0.7$

PML_{FT} is > 15% greater than PMP_i $LF_{ME} = 0.2$

Where:

PML_{FT}	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type; %
PMP_i	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundaries; %
LF_{ME}	Leakage factor for market-effects calculations; dimensionless

The next step was to estimate the emissions associated with the displaced logging activity. This was based on the total volume that would have been logged in the baseline in the project area across strata and time periods:

$$AL_{T,i} = \sum_{t=1}^{t} \left(C_{BSL,XBT_{i,t}}\right)$$

Where:

$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project; t CO2-e
$C_{BSL,XBT_{i,t}}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in time t; t CO2-e
i	1, 2, 3, …M strata
t	1, 2, 3, … t* years elapsed since the projected start of the REDD project activity

Carbon emission due to the displaced logging has two components: the biomass carbon of the extracted timber (see also module CP-W which uses the same equation) and the biomass carbon in the forest damaged in the process of timber extraction (see VMD0011 v1.0 equation 4):

$$C_{BSL,XBT_{i,t}} = \left(\left[V_{BSL,XE_{i,t}} * D_{mn} * CF\right] + \left[V_{BSL,XE_{i,t}} * LDF\right] + \left[V_{BSL,XE_{i,t}} * LIF\right]\right)$$

Where:

$C_{BSL,XBT_{i,t}}$	Carbon emission due to timber harvests in the baseline scenario in stratum i at time t; t CO2-e
$V_{BSL,XE_{i,t}}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i at time t; m^3

D_{mn}	Mean wood density of commercially harvested species; t d.m.m-3. The value must be the same as that used in the module CP-W if this pool is included in the baseline.
CF	Carbon fraction of biomass for commercially harvested species j; t C t d.m.-1 . The value must be the same as that used in the module CP-W if this pool is included in the baseline.
LDF	Logging damage factor; t C m-3 (default 0.53 t C m^{-3} for broadleaf and mixed forests; 0.25 t C m^{-3} for coniferous forests)
LIF	Logging infrastructure factor; t C m^{-3} (default 0.29 t C m^{-3})
i	1, 2, 3, …M strata
t	1, 2, 3, … t* years elapsed since the projected start of the REDD project activity

Market leakage from decreased timber harvest and its component values is shown in

Table 25, and total annual combined leakage (activity-shifting and market leakage) in

Table 26. Detailed calculations underpinning

Table 25 are reported in "ZC calcs v1.4, tab '12b. Leakage_ME'".xlsx.

Table 25 - Market leakage

Year	C_{XB_t} (tCO2e)	$V_{BSL,XE_{i,t}}$ (m³)	$C_{BSL,XBT_{i,t}}$ (tCO2e)	$AL_{T,i}$ (tCO2e)	$LK_{ME,T,i}$ (tCO2e)	$LK_{ME,FW\&}$ (tCO2e)	$\Delta C_{LK-ME,t}$ (tCO2e)
2021	59,509	50,046	209,980	209,980	83,992	0	83,992
2022	59,509	50,046	209,980	209,980	83,992	0	83,992
2023	59,509	50,046	209,980	209,980	83,992	0	83,992
2024	59,509	50,046	209,980	209,980	83,992	0	83,992
2025	59,509	50,046	209,980	209,980	83,992	0	83,992
2026	59,509	50,046	209,980	209,980	83,992	0	83,992
2027	59,509	50,046	209,980	209,980	83,992	0	83,992
2028	59,509	50,046	209,980	209,980	83,992	0	83,992
2029	59,509	50,046	209,980	209,980	83,992	0	83,992
2030	59,509	50,046	209,980	209,980	83,992	0	83,992
2031	59,509	50,046	209,980	209,980	83,992	0	83,992
2032	59,509	50,046	209,980	209,980	83,992	0	83,992

Year	C_{XB_t} (tCO2e)	$V_{BSL,XE_{i,t}}$ (m³)	$C_{BSL,XBT_{i,t}}$ (tCO2e)	$AL_{T,i}$ (tCO2e)	$LK_{ME,T,i}$ (tCO2e)	$LK_{ME,FW\&}$ (tCO2e)	$\Delta C_{LK-ME,t}$ (tCO2e)
2033	59,509	50,046	209,980	209,980	83,992	0	83,992
2034	59,509	50,046	209,980	209,980	83,992	0	83,992
2035	59,509	50,046	209,980	209,980	83,992	0	83,992
2036	53,748	45,201	189,651	189,651	75,860	0	75,860
2037	0	0	0	0	0	0	0
2038	0	0	0	0	0	0	0
2039	0	0	0	0	0	0	0
2040	0	0	0	0	0	0	0
2041	0	0	0	0	0	0	0
2042	0	0	0	0	0	0	0
2043	0	0	0	0	0	0	0
2044	0	0	0	0	0	0	0
2045	0	0	0	0	0	0	0
2046	0	0	0	0	0	0	0
2047	0	0	0	0	0	0	0
2048	0	0	0	0	0	0	0
2049	0	0	0	0	0	0	0
2050	0	0	0	0	0	0	0

Table 26 - Total net GHG emissions due to activity-shifting and market leakage

Year	$\Delta C_{LK-AS,planned}$ (tCO2e)	$\Delta C_{LK-ME,t}$ (tCO2e)	$\Delta C_{LK,t}$ (tCO2e)
2021	0	83,992	83,992
2022	0	83,992	83,992
2023	0	83,992	83,992
2024	0	83,992	83,992
2025	0	83,992	83,992
2026	0	83,992	83,992
2027	0	83,992	83,992
2028	0	83,992	83,992
2029	0	83,992	83,992
2030	0	83,992	83,992
2031	0	83,992	83,992
2032	0	83,992	83,992

Year	$\Delta C_{LK-AS,planned}$ (tCO2e)	$\Delta C_{LK-ME,t}$ (tCO2e)	$\Delta C_{LK,t}$ (tCO2e)
2033	0	83,992	83,992
2034	0	83,992	83,992
2035	0	83,992	83,992
2036	0	75,860	75,860
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	0	0	0
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0
2046	0	0	0
2047	0	0	0
2048	0	0	0
2049	0	0	0
2050	0	0	0

4.4 Estimated Net GHG Emission Reductions and Removals

Uncertainty

Uncertainties were calculated for the baseline and project scenarios based upon the VMD0017 v2.2 X-UNC module. There are two sources of uncertainty in the baseline, the rate of deforestation, and emissions and removals. For the project case, only uncertainty in emissions and removals was considered because no deforestation is expected to occur.

Per the X-UNC module, uncertainty in the projected baseline rate of deforestation, $Uncertainty_{BSL-RATE}$, equals 2.55%. This value is the 95% confidence interval as a percentage of the mean of the area deforested in each proxy (*D%pn*) divided by the number of years over which deforestation occurred in each proxy (*Yrspn*) (see "ZC calcs v1.4, tab '13. Uncertainty'".xlsx. for calculations).

Total uncertainty in emissions and removals ($Uncertainty_{BSL-SS}$) is estimated as per VMD0017 v2.2 X-UNC equation 4, and is expressed as the 95% confidence interval half width as a percentage of the mean carbon stock or GHG source for each pool. $Uncertainty_{BSL-SS}$ is estimated to be 6.91% (calculations detailed in "ZC calcs v1.4, tab '13. Uncertainty'".xlsx.).

Total uncertainty is calculated as per Equation 13 and equals 7.37%.

Equation 13 (Total uncertainty (see VMD0017 v2.2 equation 5)):

$$Uncertainty_{REDD-BSL,t^*} = \sqrt{{Uncertainty_{BSL-RATE,t^*}}^2 + {Uncertainty_{REDD-BSL,SS}}^2}$$

Where:

$Uncertainty_{REDD-BSL,t^*}$	Cumulative uncertainty in REDD baseline scenario up to year t^* (%);
$Uncertainty_{BSL-RATE,t^*}$	Cumulative uncertainty in the baseline rate of deforestation up to year *t* (%);
$Uncertainty_{REDD-BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline scenario (%);
t	1, 2, 3, … t^* time elapsed since the start of the project activity (years).

The allowable uncertainty in methodology *REDD+ MF* is +/- 15% of *NERREDD+* at the 95% confidence level. Where this precision level is met then no deduction should result for uncertainty, which is the case here (7.37%).

To estimate the number of Verified Carbon Units (VCUs) for the monitoring period *T* = *t2-t1*, the following equation is used as per VM0007, equation 19:

$VCU_t = Adjusted\_NER_{REDD+,t2} - Adjusted\_NER_{REDD+,t1}) - Buffer_{Total}$

Where:

VCU_t	Number of Verified Carbon Units at year $t = t_2 - t_1$ (VCU)
$Adjusted\_NER_{REDD+,t2}$	Total net GHG emission reductions of the REDD+ project activity up to year t_2 and adjusted to account for uncertainty (t CO_2e)
$Adjusted\_NER_{REDD+,t1}$	Total net GHG emission reductions of the REDD+ project activity up to year t_1 and adjusted to account for uncertainty (t CO_2e):

Over its 30-year project length (2021-2050), the Zero Carbon project is expected to generate net GHG emission reductions of 13,705,917 tonnes of CO_{2e} (**Table 27** and **Table 28**).

Table 27 - Ex-ante annual estimation of net emission reduction credits

2050 Year	Estimated baseline emissions or removals $\Delta C_{BSL,planned}$ (tCO_2e)	Estimated project emissions or removals $\Delta C_{WPS,REDD}$ (tCO_2e)	Estimated leakage emissions $\Delta C_{LK,t}$ (tCO_2e)	Risk buffer (%)	AFOLU pooled buffer account (tCO_2e)	GHG credits eligible for issuance as VCUs (tCO_2e)
2021	939,742	0	83,992	23	216,141	639,609
2022	969,180	0	83,992	23	222,911	662,276
2023	998,618	0	83,992	23	229,682	684,944
2024	1,028,057	0	83,992	23	236,453	707,612
2025	1,057,495	0	83,992	23	243,224	730,279
2026	1,086,933	0	83,992	23	249,995	752,947
2027	1,116,372	0	83,992	23	256,766	775,614
2028	1,145,810	0	83,992	23	263,536	798,282
2029	1,175,249	0	83,992	23	270,307	820,949
2030	1,204,687	0	83,992	23	277,078	843,617
2031	1,206,659	0	83,992	23	277,532	845,135
2032	1,208,631	0	83,992	23	277,985	846,654
2033	1,212,942	0	83,992	23	278,977	849,973
2034	1,217,252	0	83,992	23	279,968	853,292
2035	1,221,563	0	83,992	23	280,960	856,612
2036	1,134,666	0	75,860	23	260,973	797,832
2037	285,028	0	0	23	65,556	219,471
2038	257,561	0	0	23	59,239	198,322
2039	230,095	0	0	23	52,922	177,173
2040	202,628	0	0	23	46,605	156,024
2041	173,190	0	0	23	39,834	133,356
2042	143,752	0	0	23	33,063	110,689
2043	111,974	0	0	23	25,754	86,220
2044	80,197	0	0	23	18,445	61,752
2045	48,420	0	0	23	11,137	37,283
2046	19,528	0	0	23	4,491	15,037
2047	17,556	0	0	23	4,038	13,518
2048	15,584	0	0	23	3,584	12,000
2049	13,612	0	0	23	3,131	10,482

2050 Year	Estimated baseline emissions or removals $\Delta C_{BSL,planned}$ (tCO_2e)	Estimated project emissions or removals $\Delta C_{WPS,REDD}$ (tCO_2e)	Estimated leakage emissions $\Delta C_{LK,t}$ (tCO_2e)	Risk buffer (%)	AFOLU pooled buffer account (tCO2e)	GHG credits eligible for issuance as VCUs (tCO_2e)
2050	11,641	0	0	23	2,677	8,963

Table 28 - Total emissions reductions (tCO2e) and deductions

Estimated emissions and reductions of the Zero Carbon Project	tCO2e
Baseline GHG emissions and reductions	19,534,622
Project emissions and reductions	0
Leakage emissions	1,335,742
Buffer pool discount	4,492,963
Total Net Emission Reductions (VCUs)	13,705,917

5 MONITORING

5.1. Data and Parameters Available at Validation

Data / Parameter	$AA_{planned,i,t}$
Data unit	ha
Description	Annual area of baseline planned deforestation for stratum i in year t.
Source of data	Calculated based on VMD0006 v1.3 equation 5.
Value applied	See the values applied in table 16.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on total area of planned deforestation over the baseline period for stratum I ($A_{planned,i}$), the projected annual proportion of land that will be deforested in stratum i during year t ($D_{\%planned,i,t}$) and the Likelihood of deforestation for stratum I (L-Di).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$A_{planned,i}$
Data unit	ha
Description	Total area of planned deforestation over the fixed baseline period for stratum i.
Source of data	Remote sensing
Value applied	26.883
Justification of choice of data or description of measurement methods and procedures applied	Determined according to what is recognized as an immediate site-specific threat of deforestation, which is a function of the legal permissibility for deforestation, the suitability of the project area for conversion to alternative non-forest land use, the government approval for deforestation and an intention to deforest the project area. See section 3.4 for a complete description of measurement methods and procedures applied.
Purpose of Data	Calculation of baseline emissions.

Comments	Identified as dense forest area of the project property.

Data / Parameter	$D_{\%planned,i,t}$
Data unit	% $year^{-1}$
Description	Projected annual proportion of land that will be deforested in stratum i at year t.
Source of data	Proxy areas
Value applied	See the values applied in the table 14.
Justification of choice of data or description of measurement methods and procedures applied	Where a valid verifiable plan exists for rate at which deforestation is projected to occur, this rate must be used. In this case, no verifiable plan exists, and so the rate was established by examining proxy areas (see section 3.3).
Purpose of Data	Determination of baseline scenario.
Comments	-

Data / Parameter	$L\text{-}D_i$
Data unit	%
Description	Likelihood of deforestation in stratum i.
Source of data	Analysis of Land Tenure.
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	L-Di is equal to 100% for all planned deforestation areas that are not both under Government control and zoned for deforestation, according to VMD0006 v1.3, section 1.4.
Purpose of Data	Determination of baseline scenario.
Comments	-

Data / Parameter	$\Delta C_{AB\_tree+non\text{-}tree,i}$
Data unit	t CO2e ha^{-1}

Description	Baseline carbon stock change in aboveground tree biomass in stratum i;
Source of data	Calculated based on VMD0006 v1.3 equation 6
Value applied	See the values applied in the Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on the forest carbon stock in aboveground tree biomass in stratum i ($C_{AB_{pre,i}}$) and the post-deforestation carbon stock in aboveground tree biomass in stratum i ($C_{AB_{post,i}}$).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$\Delta C_{BB\_tree+non\text{-}tree,i}$
Data unit	t CO2e ha^{-1}
Description	Baseline carbon stock change in belowground tree biomass in stratum i.
Source of data	Calculated based on VMD0006 v1.3 equation 8.
Value applied	See the values applied in the Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on the forest carbon stock in aboveground tree biomass in stratum I ($C_{BB_{pre,i}}$) and the post-deforestation carbon stock in aboveground tree biomass in stratum I ($C_{BB_{post,i}}$).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$\Delta C_{DW,i}$
Data unit	t CO2e ha^{-1}
Description	Baseline carbon stock change in dead wood in stratum i.
Source of data	Calculated based on VMD0006 v1.3 equation 10.
Value applied	See the values applied in the Table 18.

Justification of choice of data or description of measurement methods and procedures applied	Estimated based on forest carbon stock in deadwood in stratum ($C_{DW_{pre,i}}$) and post-deforestation carbon stock in deadwood in stratum i ($C_{DW_{post,i}}$).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$C_{AB\_tree+nontree,i}$
Data unit	t CO_2e ha^{-1}
Description	Carbon stock in aboveground tree biomass in the baseline in stratum i
Source of data	Forest inventory with field data and direct measurement. The mean carbon stock in aboveground tree biomass per unit area per stratum is estimated using sample fixed area plots and regional allometric equation for tree component.
Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Forest Inventory is performed according to VMD0001 v1.1 and VMD0016 v1.6 criteria
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$C_{BB\_tree+nontree,i}$
Data unit	t CO_2e ha^{-1}
Description	Carbon stock in belowground tree biomass in the baseline in stratum i
Source of data	Inventory (0.24). IPCC, 2006[48].

[48] Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 4: Forest Land

Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$C_{DW,i}$
Data unit	t CO_2e ha^{-1}
Description	Carbon stock in deadwood in the baseline in stratum i
Source of data	Inventory
Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$C_{AB_{post,i}}$
Data unit	t CO_2e ha^{-1}
Description	Post-deforestation carbon stock in aboveground tree biomass in stratum i.

Source of data	Secondary data from peer-reviewed literature (Nogueira et al. 2008)[49]
Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Post-deforestation carbon stocks can be measured in proxy areas or values can be taken from credible and representative literature sources (e.g., the peer-reviewed literature or data published by the IPCC or the FAO), according to methodology VMD0006, version 1.3.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$C_{BB_{post,i}}$
Data unit	t CO_2e ha^{-1}
Description	Post-deforestation carbon stock in belowground tree biomass in stratum i.
Source of data	Secondary data from peer-reviewed literature (Nogueira et al. 2008)
Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Post-deforestation carbon stocks can be measured in proxy areas or values can be taken from credible and representative literature sources (e.g., the peer-reviewed literature or data published by the IPCC or the FAO), according to methodology VMD0006, version 1.3.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$C_{DW_{post,i}}$

[49] Nogueira, E. M., Fearnside, P. M., Nelson, B. W., Barbosa, R. I., & Keizer, E. W. H. (2008). Estimates of forest biomass in the Brazilian Amazon: new allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management, 256(11), 1853-1867.

Data unit	t CO_2e ha^{-1}
Description	Post-deforestation carbon stock in deadwood in stratum i.
Source of data	Secondary data from peer-reviewed literature (Nogueira et al. 2008)
Value applied	See values applied in Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Post-deforestation carbon stocks can be measured in proxy areas or values can be taken from credible and representative literature sources (e.g., the peer-reviewed literature or data published by the IPCC or the FAO), according to methodology VMD0006, version 1.3.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$\Delta C_{BSL,i,t}$
Data unit	t CO2e
Description	Sum of the baseline carbon stock change in all terrestrial pools in stratum i in year t
Source of data	Calculated based on VMD0006 v1.3 equation 13.
Value applied	See the values applied in the Table 18.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on the annual area of baseline planned deforestation for stratum i in year t ($AA_{planned,i,t}$), the baseline carbon stock change in aboveground tree biomass in stratum i ($\Delta C_{AB\_tree+nontree}$,i), the baseline carbon stock change in belowground tree biomass in stratum I ($\Delta C_{BB\_tree+nontree}$,i), the baseline carbon stock change in wood products in stratum I ($\Delta C_{WP,i}$), the baseline carbon stock change in dead wood in stratum i ($\Delta C_{DW,I}$).
Purpose of Data	Calculation of baseline emissions.
Comments	The baseline carbon stock change in litter and the baseline carbon stock change in soil organic carbon in stratum were excluded from the analysis due to lack of significance.

Data / Parameter	$\Delta C_{BSL,planned}$
Data unit	t CO2e
Description	Net greenhouse gas emissions in the baseline from planned deforestation.
Source of data	Calculated based on VMD0006 v1.3 equation 1
Value applied	See the values applied in the Table 19.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on the net carbon stock changes in all pools in the baseline ($\Delta C_{BSL,i,t}$) and GHG emissions as a result of deforestation activities within the project boundary in the baseline stratum i in year t ($GHG_{BSL\text{-}E,i,t}$)
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$C_{wp,i}$
Data unit	t CO2e ha^{-1}
Description	Baseline carbon stock change in in wood products in stratum i
Source of data	Calculated based on VMD0005 v1.1 equation 2
Value applied	See the values applied in the Table 23.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on mean stock of extracted biomass carbon by class of wood product ty from stratum I ($C_{XB_{sawnwood}}$) and the wood waste (the fraction immediately emitted through mill inefficiency by class of wood product) (WW_s).
Purpose of Data	Calculation of leakage emissions.
Comments	-

Data / Parameter	$\boldsymbol{C_{XB_{sawnwood}}}$
Data unit	t CO2-e
Description	Carbon emission due to displaces timber harvests in the baseline scenario in stratum in time t
Source of data	Calculated based on VMD0005 v1.1 equation 4.

Value applied	See the values applied in the Table 19 and Table 23.
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on commercial volume extracted prior to or in the process of deforestation by mean aboveground biomass carbon stock in stratum I $\Delta C_{AB\_tree,I}$, biomass conversion and expansion factor (BEF) for conversion of merchantable volume to total aboveground tree biomass, and commercial volume as a percent of total aboveground volume in stratum (P_{com_i}).
Purpose of Data	Calculation of leakage emissions.
Comments	0.56 is the proportion of commercial stem of aboveground biomass (Goodman et al. 2014)[50]

Data / Parameter	BEF
Data unit	Dimensionless
Description	Biomass expansion factor for conversion of volume to total aboveground tree biomass
Source of data	Calculated using data from Brown & Lugo (1992)[51]
Value applied	1.79
Justification of choice of data or description of measurement methods and procedures applied	BEF calculated using data from the Brazilian Amazon (i.e., country and ecoregion specific).
Purpose of Data	Calculation of baseline emissions Calculation of leakage emissions.
Comments	-

Data / Parameter	$\boldsymbol{P_{com_i}}$
Data unit	Dimensionless

[50] Derived from Goodman, R.C., Phillips, O.L., Baker, T.R., 2014. The importance of crown dimensions to improve tropical tree biomass estimates. Ecol. Appl. 24, 680–698. https://doi.org/ 10.1890/13-0070.1.

[51] Derived from Brown, S., & Lugo, A. E. (1992). Aboveground biomass estimates for tropical moist forests of the Brazilian Amazon. Interciencia. Caracas, 17(1), 8-18.

Description	Commercial volume as a percent of total aboveground volume in strata I
Source of data	Calculated using data from Feldpausch et al. (2006)[52]
Value applied	0.12
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions.
Comments	-

Data / Parameter	WW_s
Data unit	Dimensionless
Description	Wood waste, the fraction immediately emitted through mill inefficiency by class of wood product
Source of data	CP-W module
Value applied	0.24
Justification of choice of data or description of measurement methods and procedures applied	Default value from the CP-W module
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions.
Comments	-

[52] Derived from Feldpausch, T. R., McDonald, A. J., Passos, C. A., Lehmann, J., & Riha, S. J. (2006). Biomass, harvestable area, and forest structure estimated from commercial timber inventories and remotely sensed imagery in southern Amazonia. Forest Ecology and Management, 233(1), 121-132.

Data / Parameter	$C_{WP100,i}$
Data unit	t CO2-e ha^{-1}
Description	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i;
Source of data	Calculated based on VMD0005 v1.1 equation 3.
Value applied	23.5
Justification of choice of data or description of measurement methods and procedures applied	Estimated base on carbon stock entering wood products pool at time of deforestation from stratum I (C_{WP_i}), fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty (SLF), and Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty (OF_S).
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions.
Comments	-

Data / Parameter	OFts
Data unit	Dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest for sawn wood
Source of data	*CP-W module* for tropical sawnwood product class
Value applied	0.84
Justification of choice of data or description of measurement methods and procedures applied	Default value from the CP-W module
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions.
Comments	-

Data / Parameter	SLF
Data unit	Dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest for sawn wood.
Source of data	*CP-W module* for tropical sawnwood product class
Value applied	0.2
Justification of choice of data or description of measurement methods and procedures applied	Default value suggested by VMD0005 v1.1.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions.
Comments	-

Data / Parameter	$GHG_{BSL-E,i,t}$
Data unit	t CO2e yr-1
Description	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum i in year t.
Source of data	Calculated based on VMD0006 v1.3 equation 15.
Value applied	See the values applied in the Table 24.
Justification of choice of data or description of measurement methods and procedures applied	Calculated based on the non-CO2 emissions due to biomass burning in stratum i in year t ($E_{BionmassBurn,i,t}$)
Purpose of Data	Calculation of baseline emissions.
Comments	Net CO2e emission from fossil fuel combustion in stratum i in year t (EFC,i,t) and direct N2O emission as a result of nitrogen application on the alternative land use within the project boundary in stratum i in year t ($N2O_{direct-N,i,t}$) are conservatively excluded from the project scope and the calculation of the baseline estimates following VM0007 v1.6 section 5.4 criteria.

Data / Parameter	$E_{BionmassBurn,i,t}$
Data unit	t CO2e
Description	Greenhouse gas emissions due to biomass burning in stratum i in year t of each GHG (CH4).
Source of data	Calculated based on VMD0013 v1.3 equation 1.
Value applied	See the values applied in the Table 25.
Justification of choice of data or description of measurement methods and procedures applied	Calculated based on area burnt for stratum i in year t (Aburn,i,t), average aboveground biomass stock before burning stratum i, in year t ($B_{i,t}$), combustion factor for stratum i (unitless) ($COMF_i$), emission factor for stratum i for gas g ($G_{g,i}$) and the Global warming potential for gas g (GWP_g)
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$A_{Burn,i,t}$
Data unit	ha
Description	Area burnt for stratum i in year t.
Source of data	Equal to $AA_{planned,i,t}$ in the baseline case.
Value applied	See the values applied in the Table 25.
Justification of choice of data or description of measurement methods and procedures applied	For the calculation of baseline emissions, the burned area is considered equivalent to the annual deforested area, assuming that all deforestation is preceded by a fire to clear the land in the baseline case.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$B_{i,t}$
Data unit	tonnes d.m. ha^{-1}
Description	Average aboveground biomass stock before burning for stratum i, year t.

Source of data	Calculated based on VMD0013 v1.3 equation 2.
Value applied	See the values applied in the Table 25.
Justification of choice of data or description of measurement methods and procedures applied	Calculated based on carbon stock in aboveground biomass in trees in stratum i in year t ($C_{AB\_tree,i,t}$), Mean stock of extracted biomass carbon by class of wood product ($C_{XB_{sawnwood}}$), and Carbon fraction of biomass (CF).
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$COMF_i$
Data unit	Dimensionless
Description	Combustion factor for stratum i.
Source of data	IPCC (2006)[53]
Value applied	0.59
Justification of choice of data or description of measurement methods and procedures applied	Default values from IPCC (2006), available on Chapter 2, Table 2.5.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	$G_{g,i}$
Data unit	kg t^{-1} d.m. burnt
Description	Emission factor for stratum i for gas g
Source of data	IPCC (2006)
Value applied	CH_4=6.8
Justification of choice of data or description of	Default value from IPCC (2006), available on Table 2.5.

[53] Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	GWP_g
Data unit	Dimensionless
Description	Global warming potential for gas g.
Source of data	Default values from IPCC (2022)[54], available at IPCC AR6.
Value applied	CH_4=28
Justification of choice of data or description of measurement methods and procedures applied	Default factor from the latest IPCC Assessment Report.
Purpose of Data	Calculation of baseline emissions.
Comments	-

5.2. Data and Parameters Monitored

Data / Parameter	$A_{DefPA,i,u,t}$
Data unit	ha
Description	Area of recorded deforestation in the project
Source of data	Monitored at each monitoring/verification event through the use of classified satellite imagery and PRODES dataset.
Description of measurement methods and procedures to be applied	Detailed procedures are provided below under monitoring plan description. Monitoring responsibilities are listed in section 5.3, below.

[54] Available at https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf

Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See Table 16.
Monitoring equipment	ArcGIS, Google Earth Engine
QA/QC procedures to be applied	Detailed procedures provided below under monitoring plan description
Purpose of data	Calculation of project emissions
Calculation method	Classified images with information about the area of annual deforestation in Brazil are downloaded from PRODES websites and clipped with the project area spatial limits. Images from Sentinel are downloaded from Google Earth Engine.
Comments	-

Data / Parameter	$C_{post,u,i}$
Data unit	t CO2-e
Description	Carbon stock in all pools in post-deforestation land use u in stratum i.
Source of data	Calculated according to VMD0015 v2.2, equation 6
Description of measurement methods and procedures to be applied	Calculated based on carbon stock in aboveground tree biomass in stratum I ($C_{AB\_tree+nontree,i}$), carbon stock in belowground tree biomass in stratum I ($C_{BB\_tree+nontree,i}$), carbon stock in dead wood in stratum I (CDW,i). Carbon stock in litter and mean post-deforestation stock in soil organic carbon in the post deforestation stratum are excluded from the analysis.
Frequency of monitoring/recording	10 years (in each baseline revalidation)
Value applied	See Table 18.
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions

Calculation method	See VMD0015 v2.2, equation 6.
Comments	-

Data / Parameter	$C_{WP,i}$
Data unit	t CO2e ha^{-1}
Description	Carbon stock sequestered in wood products from harvests in stratum i
Source of data	Calculated
Description of measurement methods and procedures to be applied	See section 5.1.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 10 years.
Value applied	26.9
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage emissions
Calculation method	Uses Equation 2 in the CP-W module
Comments	

Data / Parameter	$\Delta C_{pools,Def,u,i,t}$
Data unit	t CO2-e
Description	Net carbon stock changes in all pools as a result of deforestation in the project case in land use u in stratum i at time t.
Source of data	Calculated according to VMD0015 v2.2, equation 5.
Description of measurement methods	Calculated based on carbon stock in all pools in the baseline case in stratum I ($C_{BSL,i}$), carbon stock in all pools in post-deforestation land

and procedures to be applied	use u in stratum I ($C_{P,post,u,i}$) and carbon stock sequestered in wood products from harvests in stratum I ($C_{WP,i}$)
Frequency of monitoring/recording	10 years (in each baseline revalidation)
Value applied	See the values applied in the Table 19.
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation5.
Comments	-

Data / Parameter	$\Delta C_{P,DefPA,i,t}$
Data unit	t CO2-e
Description	Net carbon stock change as a result of deforestation in the project case in the project area in stratum i at time t.
Source of data	Calculated according to VMD0015 v2.2, equation 3
Description of measurement methods and procedures to be applied	Calculated based on the area of recorded deforestation in the project area stratum i converted to land use u at time t ($A_{DefPA,u,i,t}$) and the net carbon stock changes in all pools in the project case in land use u in stratum i at time t ($\Delta C_{pools,Def,u,i,t}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the Table 19.
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 3.
Comments	-

Data / Parameter	$A_{DegW,i}$
Data unit	ha
Description	Area potentially impacted by degradation processes in stratum i
Source of data	Measured
Description of measurement methods and procedures to be applied	Remote sensing
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	N/A
QA/QC procedures to be applied	Detailed procedures provided below under monitoring plan description.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	

Data / Parameter	$C_{DegW,i,t}$
Data unit	t CO2-e
Description	Biomass carbon of trees cut and removed through degradation process from plots measured in stratum i in year t.
Source of data	Remote sensing
Description of measurement methods and procedures to be applied	Detailed procedures provided below under monitoring plan description. Monitoring responsibilities are listed in section 5.3, below.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0

Monitoring equipment	N/A
QA/QC procedures to be applied	Detailed procedures provided below under monitoring plan description.
Purpose of data	Calculation of project emissions.
Calculation method	As the agent of deforestation, have committed to not deforest, not harvest fuelwood, and not timber in forests in the project area, ex-ante degradation is estimated as zero.
Comments	

Data / Parameter	APi
Data unit	ha
Description	Total area of degradation sample plots in stratum i.
Source of data	Remote sensing
Description of measurement methods and procedures to be applied	PRODES data will be used to monitor forest degradation ($A_{DegW,I}$, $A_{DistPA,i,t}$, $A_{burn,i,t}$) in the project case. Net carbon stock change as a result of degradation in the project area in the project case will be calculating taking in consideration the extraction of trees for illegal timber or fuelwood and charcoal ($\Delta C_{P,DegW,i,t}$), according to VMD0015 v2.2 equation.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	N/A
Monitoring equipment	ArcGIS
QA/QC procedures to be applied	Detailed procedures provided below under monitoring plan description.
Purpose of data	Calculation of project emissions.
Calculation method	N/A
Comments	-

Data / Parameter	$\Delta C_{P,DegW,i,t}$

Data unit	t CO2-e
Description	Net carbon stock changes as a result of degradation in stratum i in the project area in year t.
Source of data	Calculated according to VMD0015 v2.2, equation 8.
Description of measurement methods and procedures to be applied	Calculated based on area potentially impacted by degradation processes in stratum I ($A_{DegW,i}$) and biomass carbon of trees cut and removed through degradation process in stratum i in year t ($C_{DegW,i,t}$) and total area of degradation sample plots in stratum I (APi) estimated using remote sensing.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 8.
Comments	-

Data / Parameter	$A_{DistPA,q,i,t}$
Data unit	ha
Description	Area impacted by natural disturbance in the project stratum i converted to natural disturbance stratum q in year t; ha
Source of data	Monitored at each monitoring/verification event through the use of classified satellite imagery
Description of measurement methods and procedures to be applied	Detailed procedures provided below under monitoring plan description. Monitoring responsibilities are listed in section 5.3, below.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0

Monitoring equipment	ArcGIS
QA/QC procedures to be applied	Detailed procedures provided below under monitoring plan description
Purpose of data	Calculation of project emissions.
Calculation method	N/A
Comments	-

Data / Parameter	$A_{burn,i,t}$
Data unit	ha
Description	Area burnt in post-natural disturbance in stratum i at time t;
Source of data	Equal to $A_{DistPA,q,i,t}$ + $A_{DefPA,i,u,t}$ in the project case.
Description of measurement methods and procedures to be applied	For the calculation of project emissions, the burned area is considered equivalent to burn scars monitored plus annual deforested area monitored, assuming that all deforestation is preceded by a fire to clear the land in the project case.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	N/A
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$C_{P,Dist,q,i}$
Data unit	t CO2-e ha^{-1}
Description	Carbon stock in all pools in post-natural disturbance in baseline stratum i.

Source of data	Calculated according to VMD0015 v2.2, equation 24.
Description of measurement methods and procedures to be applied	Calculated based on the carbon stock in aboveground tree biomass in stratum I ($C_{AB\_tree+nontree,i}$), carbon stock in belowground tree biomass in stratum I ($C_{BB\_tree+nontree,i}$), carbon stock in dead wood in stratum I ($C_{DW,i}$). Carbon stock in litter and mean stock in soil organic carbon in stratum I (CSOC,i) are excluded from the analysis.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	Use equations as stated in the forest inventory, including allometric equations as found in Brown (1997)[55] and a volumetric based palm equation, Cairns et al. (1997)[56], Van Wagner (1968)[57]. Carbon stocks must be measured and estimated using the methods given in module CP-AB and CP-D.
Comments	It can be conservatively assumed that a post-natural disturbance live and dead vegetation pool is equal to zero.

Data / Parameter	$\Delta C_{P,Dist,q,i,t}$
Data unit	t CO2-e ha^{-1}
Description	Net carbon stock changes in pools as a result of natural disturbance in the project case in post-natural disturbance in stratum i in year t.
Source of data	Calculated according to VMD0015 v2.2, equation 23.
Description of measurement methods and procedures to be applied	Calculated based on the carbon stock in all pools in the baseline case in stratum I ($C_{BSL,i}$), carbon stock in pools in post-natural disturbance strata q in stratum I ($C_{P,Dist,q,i}$) and carbon stock sequestered in wood products from harvests following natural disturbance in post-natural

[55] Brown, S., 1997. Estimating biomass and biomass change of tropical forests: A primer. FAO Forestry Paper: vii, 55p.

[56] Cairns, M. A., S. Brown, E. H. Helmer, and G. A. Baumgardner. 1997. Root biomass allocation in the world's upland forests. Oecologia 111, 1-11.

[57] Van Wagner, C.E. (1968). The line intersect method in forest fuel sampling. Forest Science 14: 20-26.

	disturbance stratum q, in stratum I ($C_{Dist, WP,q,i}$), according to VMD0015 v2.2, equation 23.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	Use equations as stated in the forest inventory, including allometric equations as found in Brown (1997) and a volumetric based palm equation, Cairns et al. (1997), Van Wagner (1968). Carbon stocks must be measured and estimated using the methods given in module CP-AB and CP-D.
Comments	-

Data / Parameter	$\Delta C_{P,DistPA,i,t}$
Data unit	t CO2-e
Description	Net carbon stock change as a result of natural disturbance in the project case in the project area in stratum i in year t.
Source of data	Calculated according to VMD0015 v2.2, equation 20.
Description of measurement methods and procedures to be applied	Estimated based on the Area impacted by natural disturbance in post-natural disturbance stratum q in stratum i, in year t ($A_{DistPA,q,i,t}$), and the net carbon stock changes in pools as a result of natural disturbance in post-natural disturbance in stratum i in year t ($\Delta C_{P,Dist,q,i,t}$),according to VMD0015 v2.2, equation 20.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions

Calculation method	Calculated according to VMD0015 v2.2, equation 20.
Comments	-

Data / Parameter	$GHG_{P,E,i,t}$
Data unit	t CO2e yr^{-1}
Description	Greenhouse gas emissions as a result of deforestation activities within the within the project area in the project case stratum i in year t.
Source of data	Calculated based on VMD0006 v1.3 equation 15.
Description of measurement methods and procedures to be applied	Calculated based on the non-CO2 emissions due to biomass burning in stratum i in year t ($E_{BiomassBurn,i,t}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in Table 24.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	Calculated based on VMD0006 v1.3 equation 15.
Comments	Net CO2e emission from fossil fuel combustion and direct N2O emission as a result of nitrogen application on the alternative land use within the project boundary in stratum i in year t are conservatively excluded from the project scope and the calculation of the baseline estimates following VM0007 v1.6 section 5.4 criteria.

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	t CO2e
Description	Greenhouse gas emissions due to biomass burning in stratum i in year t of each GHG (CH_4)
Source of data	Calculated based on VMD0013 v1.3 equation 1.

Description of measurement methods and procedures to be applied	Calculated based on area burnt for stratum i in year t ($A_{burn,i,t}$), average aboveground biomass stock before burning stratum i, in year t ($B_{i,t}$), combustion factor for stratum i (unitless) ($COMF_i$), emission factor for stratum i for gas g ($G_{g,i}$) and the Global warming potential for gas g (GWP_g)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the Table 22.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions.
Calculation method	Calculated based on VMD0013 v1.3 equation 1.
Comments	-

Data / Parameter	$\Delta C_{WPS\text{-}REDD}$
Data unit	t CO2-e
Description	Net GHG emissions in the REDD project scenario up to year t.
Source of data	Calculated according to VMD0015 v2.2, equation 01.
Description of measurement methods and procedures to be applied	Calculated based on net carbon stock change as a result of deforestation in the project area in the project case in stratum i in year t ($\Delta C_{P,DefPA,i,t}$), Net carbon stock change as a result of degradation in the project area in the project case in stratum i in year t ($\Delta C_{P,Deg,i,t}$), Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum i in year t ($\Delta C_{P,DistPA,i,t}$) and Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum i in year t ($GHG_{P\text{-}E,i,t}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the table 24.
Monitoring equipment	N/A

QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 01.
Comments	-

Data / Parameter	$\Delta C_{LK\text{-}REDD}$
Data unit	t CO2e
Description	Net GHG emissions due to leakage from the REDD project activity up to year t
Source of data	Calculated according to VMD0007 v1.6 equation 4.
Description of measurement methods and procedures to be applied	Calculated based on net GHG emissions due to activity shifting leakage for projects preventing planned deforestation up to year t ($\Delta C_{LK\text{-}AS,planned}$), and the Net GHG emissions due to market-effects leakage up to year t*($\Delta C_{LK\text{-}ME}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the table 28.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage.
Calculation method	Calculated according to VMD0007 v1.6 equation 4.
Comments	-

Data / Parameter	$\Delta C_{LK\text{-}AS,planned}$
Data unit	t CO2e
Description	Net GHG emissions due to activity shifting leakage for projects preventing planned deforestation up to year t
Source of data	Calculated according to VMD0009 v1.3, equation 1.

Description of measurement methods and procedures to be applied	Calculated based on the area of activity shifting leakage in stratum i in year t ($LK_{Aplanned,i,t}$), the net carbon stock changes in all pre-deforestation pools in baseline stratum I, ($\Delta C_{BSL,i}$) and the Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum i in year t ($GHG_{LK,E,i,t}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage.
Calculation method	Calculated according to VMD0009 v1.3, equation 1.
Comments	-

Data / Parameter	$LK_{Aplanned,i,t}$
Data unit	ha
Description	The area of activity shifting leakage in stratum i in year t.
Source of data	Calculated according to VMD0009 v1.3, equation 6.
Description of measurement methods and procedures to be applied	Calculated according to the total area of monitored deforestation by the baseline agent of the planned deforestation in stratum i in year t ($A_{defLK,i,t}$), and the New calculated forest clearance by the baseline agent of the planned deforestation in stratum i in year t where no leakage is occurring ($NewR_{i.t}$).
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage.
Calculation method	Calculated according to VMD0009 v1.3, equation 6.

Comments	-

Data / Parameter	$GHG_{LK,E,i,t}$
Data unit	t CO2e
Description	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum i in year t.
Source of data	Calculated according to VMD0009 v1.3, equation 7.
Description of measurement methods and procedures to be applied	Calculated based on Non-CO2 emissions due to biomass burning in stratum i in year t ($E_{biomassburn,i,t}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	Calculated according to VMD0009 v1.3, equation 7
Comments	-

Data / Parameter	ΔC_{LK-ME}
Data unit	t CO2-e
Description	Net greenhouse gas emissions due to market- effects leakage
Source of data	Calculated according to VMD0011 v1.0 equation 1.
Description of measurement methods and procedures to be applied	Calculated based on Total GHG emissions due to market- effects leakage through decreased timber harvest ($LK_{MEf,ti}$). Total GHG emissions due to market leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets ($LK_{ME,FW/C}$) excluded from the analysis.

Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the table 28.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	Calculated according to VMD0011 v1.0 equation 1.
Comments	-

Data / Parameter	$LK_{MEf,ti}$
Data unit	t CO2-e
Description	Total GHG emissions due to market- effects leakage through decreased timber harvest
Source of data	Calculated according to VMD0011 v1.0 equation 2
Description of measurement methods and procedures to be applied	Calculated according to leakage factor for market-effects calculations (LF_{ME}) and summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project ($AL_{T,i}$)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the table 27.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	Calculated according to VMD0011 v1.0 equation 2
Comments	-

Data / Parameter	LF_{ME}
Data unit	Dimensionless
Description	Leakage factor for market-effects calculations.
Source of data	Default data from VMD0011 v1.0
Description of measurement methods and procedures to be applied	A comparison between the proportion of total biomass in commercial species that is merchantable (PMP_i) and the mean proportion of total biomass that is merchantable (PML_{FT}) was performed based on the wood volume to be extracted in project area. The species that would be extracted in the project area are Amazonian species, and could only be sourced from other native forest sites in the Brazilian Amazon. They would also need to be sourced from relatively mature forests where millable size trees (> 40 cm DBH) can be readily found. Stem (merchantable portion) biomass as a percent of total aboveground biomass is fairly constant in mature Amazonian forests, averaging around 66% (Higuchi et al 1998), and is not expected to differ between those mature native forests in the project area and in other parts of the Brazilian Amazon.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0.4
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	-
Comments	-

Data / Parameter	PMP_i
Data unit	%
Description	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundaries
Source of data	
Description of measurement methods	Within each stratum divided the summed merchantable biomass (defined as “Total gross biomass (including bark) of a tree 30 cm

and procedures to be applied	DBH or larger from a 30 cm stump to a minimum 10 cm top DOB of the central stem") by the summed total aboveground tree biomass. Merchantable biomass is equal to merchantable volume multiplied by wood density (Dmn)
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	0.12
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	-
Calculation method	NA
Comments	Ex-ante a time zero measurement shall be made of this factor.

Data / Parameter	$AL_{T,i}$
Data unit	t CO2-e
Description	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project
Source of data	Calculated based on VMD0011 v1.0 equation 2.
Description of measurement methods and procedures to be applied	Calculated based on Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in time t ($C_{BSL,XBT,i,t}$), according to VMD0011 v1.0 equation 2.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	According to VMD0011 v1.0 equation 2.
Comments	-

Data / Parameter	$C_{BSL,XBT,i,t}$
Data unit	t CO2-e
Description	Carbon emission due to timber harvests in the baseline scenario in stratum i at time t
Source of data	Calculated according to VMD0011 v1.0 equation 4
Description of measurement methods and procedures to be applied	Calculated based on the volume of timber projected to be extracted from within the project boundary during the baseline in stratum i at time t ($V_{BSL,EX,i,t}$), the mean wood density of commercially harvested species (same as that used in the module CP-W) (Dmn), the carbon fraction of biomass for commercially harvested species j (CF), the logging damage factor (LDF), and the logging infrastructure factor (LIF), according to VMD0011 v1.0 equation 4.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	Calculated according to VMD0011 v1.0 equation 4.
Comments	-

Data / Parameter	$V_{BSL,EX,i,t}$
Data unit	m^3
Description	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i at time t
Source of data	Pre-exploratory inventories
Description of measurement methods	The volume of commercial wood found in previous inventories carried out to request the deforestation of the project area and the

and procedures to be applied	deforestation in the baseline scenario are considered to estimate market leakage effects.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	-
Comments	-

Data / Parameter	LDF
Data unit	t C m-3
Description	Logging damage factor.
Source of data	Default value provided by VMD0011 v1.0.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	-
Value applied	0.53
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage.
Calculation method	-
Comments	See VMD0011 v1.0 equation 4.

Data / Parameter	LIF
Data unit	t C m-3
Description	Logging infrastructure factor.
Source of data	Default value provided by VMD0011 v1.0.
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	-
Value applied	0.29
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage.
Calculation method	-
Comments	See VMD0011 v1.0 equation 4.

Data / Parameter	$LK_{MarketEffects,FW/C}$
Data unit	t CO2-e
Description	Total GHG emissions due to market leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets
Source of data	Calculated according to VMD0011 v1.0 equation 5.
Description of measurement methods and procedures to be applied	Calculated based on Leakage factor for market effects calculations (LF_{ME}), and the summed emissions from fuelwood/charcoal harvests in stratum i in the baseline case potentially displaced through implementation of carbon ($ALFW/C,i$), according to VMD0011 v1.0 equation 5.

Frequency of monitoring/recording	
Value applied	See the values applied in the table 27.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of leakage
Calculation method	Calculated according to VMD0011 v1.0 equation 5.
Comments	-

Data / Parameter	$Buffer_{planned}$
Data unit	t CO2e
Description	Buffer withholding for avoiding planned deforestation project activities
Source of data	Calculated according to VM0007 v1.6 equation 8.
Description of measurement methods and procedures to be applied	Calculated based on the net greenhouse gas emissions in the baseline from planned deforestation up to year t ($\Delta C_{BSL,planned}$) and the buffer withholding percentage (Buffer%), according to VM0007 v1.6 equation 8.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	See the values applied in the table 29.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of VCUs
Calculation method	Calculated according to VM0007 v1.6 equation 8.
Comments	-

Data / Parameter	$Uncertainty_{REDD-BSL,SS}$
Data unit	%
Description	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline scenario
Source of data	NA
Description of measurement methods and procedures to be applied	Total Baseline Uncertainty is estimated using the UC Module. Uncertainty is determined for the baseline deforestation rate based on proxy areas. For the baseline pools, it is derived from inventory uncertainties. The total uncertainty is within the threshold of +/-15% so no deduction is made to offsets
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied	7.37%
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of VCUs
Calculation method	NA
Comments	

Data / Parameter	VCUt
Data unit	VCU
Description	Number of Verified Carbon Units at year t
Source of data	Calculated according to VMD0017 v2.2 equation 19.
Description of measurement methods and procedures to be applied	Calculated based on the total net GHG emission reductions of the REDD+ project activity up adjusted to account for uncertainty (Adjusted_NERREDD+), and the total permanence risk buffer withholding ($Buffer_{Planned}$), according to VMD0017 v2.2 equation 19.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.
Value applied	See the values applied in the table 25.

Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of VCUs
Calculation method	Calculated according to VMD0017 v2.2 equation19.
Comments	The allowable uncertainty in methodology REDD+ MF is +/- 15% of NERREDD+ at the 95% confidence level. Where this precision level is met then no deduction should result for uncertainty.

5.3. Monitoring Plan

This monitoring plan has been developed based on module VMD0015 of the REDD Methodological Module, "Methods for monitoring of greenhouse gas emissions and removals (M-MON)."

5.3.1. Estimation of Ex-Post Net Carbon Stock Changes and Greenhouse Gas Emissions

Monitoring will follow VMD00015 v2.1 criteria, which established procedures for monitoring deforestation, illegal degradation, natural disturbance, and project emissions *ex-post* in the project and leakage areas. For accounting purposes, the project conservatively assumes stable stocks and no biomass monitoring is conducted in areas undergoing carbon stock enhancement, as permitted in the methodology monitoring module VMD0015. Hence, $C_{P,Enh,i,t}$ is set to 0. Further as no commercial harvest of timber (including FSC selective logging) occurs in the project case, the degradation due to harvest of timber will not be monitored, thus parameter $C_{P,SelLog,i,t}$ is set to 0.

Monitoring of emissions in the project area focuses on:

- Net carbon stock change as a result of deforestation and natural disturbance in the project area;
- The net carbon stock change as a result of illegal degradation in the project area;
- The greenhouse gas emissions as a result of deforestation and degradation activities within the project area

Procedures and responsibilities for monitoring each of the above sources of emissions are detailed below.

1. Monitoring Deforestation and Natural Disturbance

Forest cover change due to deforestation and natural disturbance is monitored through periodic assessment of satellite imagery covering the project area. Emissions ($\Delta C_{P,Def,i,t}$ and $\Delta C_{P,DistPA,i,t}$ for deforestation and natural disturbance, respectively) are estimated by multiplying area of forest loss detected ($A_{DefPA,u,i,t}$ and $A_{DistPA,q,i,t}$, for deforestation and natural disturbance, respectively) by average forest carbon stock per unit area. Note that $A_{DistPA,q,i,t}$,, is limited to the area where credits have been issued. Stock estimates from the initial field inventory completed in 2022 are valid for 10 years (per VM0007). Post 2027, forest carbon stock estimates will be updated for any strata where deforestation or natural disturbance is detected.

For each monitoring/verification date, changes in forest cover ($A_{DefPA,u,i,t}$ and $A_{DistPA,q,i,t}$) will be monitored using PRODES (Program to Calculate Deforestation in the Amazon) data from INPE. Forest cover benchmark maps will be generated and updated as soon as the data are available (in port. Instituto de Pesquisas Espaciais)[58]. The PRODES project carries out satellite monitoring of clear-cut deforestation in the Legal Amazon and produces annual deforestation rates in the region, which are used by the Brazilian government to establish public policies. PRODES uses satellite images of the LANDSAT class (20 to 30 meters spatial resolution and 16-day revisit rate) in a combination that seeks to minimize cloud coverage and ensure interoperability criteria. PRODES estimates are considered reliable by national and international scientists (Kintish, 2007)[59], and has proven to be of great value for planning of public policies in the Amazon. Results from independent expert analyses indicate a level of data accuracy close to 95%. Additional details on pre-processing can be found in the PRODES methodology[60].

Deforestation and natural disturbance will be distinguished using ancillary data which may include but is not limited to high resolution imagery, digital elevation models (to identify steep areas prone to landslides), information from local land managers, etc. In the case deforestation is confirmed by PRODES data it will be used to estimate GHG emissions due to project area deforestation ($A_{DefPA,i,u,t}$) or activity shifting leakage ($A_{DefLK,i,u,t}$) in the project scenario. Net carbon stock change as a result of deforestation in the project area and leakage will be calculated taking in consideration the net carbon stock changes in all pools in the project case ($\Delta C_{pools,Def,u,i,t}$), according to VMD0015 v2.2 equations 3 to 6 (see section 4.2) and VMD0009 v1.3 equations 1 to 7 (see section 4.3).

Should this dataset not be available, ex-post deforestation will be determined by classification of remote sensed imagery and land use change detection procedures. The baseline data used in this case will be Sentinel-2 satellite imagery. A Sentinel-2 cloud free composite was developed in Google Earth Engine (GEE) using a cloud masking algorithm recommended for Sentinel imagery (Google, 2022a)[61]. Additional details can be found in the Brazil 413 Carbon Project Landcover Classification Report.

[58] Derived from INPE.

[59] Improved Monitoring of Rainforests Helps Pierce Haze of Deforestation.

[60] Availalbe at http://www.inpe.br/amazonia1/en/uses_applications.php

[61] Google. (2022a). *Sentinel-2 MSI: MultiSpectral Instrument, Level-1C*. https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S2

Quality Assurance/Quality Control and Data Archiving Procedures

To ensure consistency and quality results, spatial analysts carrying out the imagery processing, interpretation, and change detection procedures will strictly adhere to best practices and good practice guidelines. In addition, all data sources and analytical procedures will be documented and archived.

Overall classification accuracy is set at a 90% minimum. A confusion matrix was generated comparing each land cover map class for the year 2021, the project's start date. A set of 177 random points were distributed within the reference region, with 30 points for each map class, and 50m buffer around each point. Evaluation at each point was carried out using images from Sentinel-2 imagery 2-8a bands, with 20m spatial resolution. The global accuracy of the reference map was on average above 90% (further details in 'Brazil 413 Carbon Project Landcover Classification Report').

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by Zero Carbon.

Information related to monitoring deforestation maintained in the archive will include:

- Forest / non-forest maps;
- Documentation of software type and procedures applied (including all pre-processing steps and corrections, spectral bands used in final classifications, and classification methodologies and algorithms)
- Data used in accuracy assessment - ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) and/or sample points of high resolution imagery

The data archive will be maintained for at least two years beyond the end of the project crediting period. Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

Updating forest carbon stock estimates

The following steps will be undertaken to limit errors in field sampling and data analysis:

1. Trained field crews will carry out all field data collection and adhere to standard operating procedures. Pilot sample plots shall be measured before the initiation of formal measurements to appraise field crews and identify and correct any errors in field measurements. Field crew leaders will be responsible for ensuring that field protocols are followed to ensure accurate and consistent measurements.
2. Field measurement data will be recorded on standard field data sheets and entered into a spreadsheet database for data management and quality control. Potential errors in data

entry (anomalous values) will be verified or corrected by consulting the original data sheets. Original data sheets will be permanently archived in a dedicated long-term electronic archive.

2. Monitoring Illegal Degradation

No timber or fuel wood economic activity was perceived by the project proponent. As opposed to conducting a PRA every two years, as required in VMD0015 v2.2, the project proponent will monitor annually using the protocols established in this monitoring plan. This will generate more accurate estimates of timber and fuel wood extraction.

In the event the remote sensing assessment indicates that illegal logging (degradation) is occurring in the project area, supplemental plots will be allocated to achieve a 3% sample of the area. Biomass will be estimated from measured stump diameters (this is conservative because it assumes stump diameter is equivalent to diameter at breast height) and applying the allometric equations of Higuchi et al (1998). The goal is to maintain consistency with analytical procedures applied in the original inventory. Emissions due to illegal logging ($\Delta C_{P,DegW,i,t}$) will be estimated by multiplying area ($A_{DegW,i}$) by average biomass carbon of trees cut and removed per unit area ($C_{DegW,i,t}$ / AP_i).

The same quality assurance/quality control and archiving procedures as detailed above for updating estimates of forest carbon stocks will be adhered to in the field surveys of potential degradation areas.

3. Monitoring Project Emissions

Project emissions are calculated as the sum of emission from fossil fuel combustion (EFC,i,t), non-CO_2 emissions due to biomass burning ($E_{BiomassBurn,i,t}$), and direct N_2O emissions as a result of nitrogen application ($N_2O_{direct-N,i,t.}$). As stipulated in the methodology, fossil fuel combustion is an optional emission source and was conservatively omitted. Furthermore, no nitrogen is applied in the project case. Project emissions are thus a consequence of $E_{BiomassBurn}$ only. These will be calculated using the VMD0013 module, “Estimation of greenhouse gas emissions from biomass burning (E-BB)”.

The CO_2e emissions from biomass burning are a result of deforestation, and so the total area burnt is equal to the area deforested, $A_{DefPA,u,i,t}$. Area burnt due to natural disturbance is not considered in the analysis since wildfire is not a common natural disturbance within the Amazon region[62].

5.3.2. Revising the baseline for future project crediting periods

[62] Natural fires occur only rarely in undisturbed tropical rain forests. (Goldammer 1990) Goldammer, J. G. (ed). 1990. Fire in the tropical biota. Springer-Verlag, New York

The baseline will be revised every 10 years from the project start date. As the entire project area will have been deforested during the initial baseline period, no new areas will be deforested post 2032 in the baseline. From 2033 onward then, baseline emissions will be a result of decay in the dead wood, below ground biomass, and wood product pools that were generated from the initial baseline period. Should an analysis of proxy areas be warranted to estimate a rate of deforestation, the BL-PL module will be consulted.

5.3.3. Organization and Responsibilities

For all aspects of project monitoring, Zero Carbon Holdings staff will ensure that data collection, processing, analysis, management, and archiving are conducted in accordance with the monitoring plan.

Table 31. Monitoring and responsibilities for actual emissions in the project area

Variables to be monitored	Responsible	Frequency
Monitoring deforestation and natural disturbance	Zero Carbon Holdings	Prior to each verification
Monitoring illegal degradation	Zero Carbon Holdings	Annually
Monitoring project emissions	Zero Carbon Holdings	Prior to each verification
Activity shifting leakage assessment	Zero Carbon Holdings	Prior to each verification
Updating forest carbon stocks estimates	Zero Carbon Holdings	At least every 10 years.
Revision of the baseline	Zero Carbon Holdings	At least every 10 years.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Monitored parameters are the same as the ones presented at Tables as per section 5.2

6.2 Baseline Emissions

6.2.1 Estimation of Carbon Stocks by Carbon Pools

Three carbon pools were used to calculate baseline emissions: 1. Aboveground biomass (stems, branches, and foliage - AGB), 2. Belowground biomass (roots - BGB), both from trees and non-tree vegetation, and 3. Dead wood (DW). Litter, soil and non-tree biomass pools were excluded, as per the APD methodology. This is a conservative measure from the perspective of carbon credit calculations.

Forest carbon values were derived from the inventory reports generated by Biondendro[63], while pasture values in the municipality of Novo Aripuanã were obtained from Nogueira et al. (2008)[64]. Values for AGB ,BGB, DW ($CAB_{tree+nontree_i}, CBB_{tree+nontree_i}, CDW_i$), respectively, and the corresponding land conversion (to pasture) values ($CAB_{post,i}, CBB_{post,i}, CDW_{post,i}$) are listed in **Table 38.**

Table 29 - Carbon Pools for calculation of the baseline scenario

C_{pre} Baseline in the forest stratum			
Parameter	Description	Unit	Value
$C_{AB_{pre,i}}$	Aboveground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	526.9
$C_{BB_{pre,i}}$	Belowground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	125.0
$C_{DW_{pre,i}}$	Deadwood (DW)	$tCO_2\text{eha}^{-1}$	50.6
C_{preBSL}	Total	tCO_2eha^{-1}	702.5
C_{post} Baseline in pasture			
$C_{AB_{post,i}}$	Aboveground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	5.2

63 Brazilian consultant company http://www.biodendro.com.br/

64 Nogueira, E. M., Fearnside, P. M., Nelson, B. W., Barbosa, R. I., & Keizer, E. W. H. (2008). Estimates of forest biomass in the Brazilian Amazon: new allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management, 256(11), 1853-1867.

$C_{BB_{post,i}}$	Belowground Biomass (AGB)	$tCO_2\text{eha}^{-1}$	6.3
$C_{DW_{post,i}}$	Deadwood (DW)	$tCO_2\text{eha}^{-1}$	7.4
$C_{postBSL}$	Total	tCO_2eha^{-1}	19.0
Difference between forest and pasture			
$C_{AB_{pre,i}} - C_{AB_{post,i}}$	Aboveground Biomass (AGB)	tCO_2eha^{-1}	521.7
$C_{BB_{pre,i}} - C_{BB_{post,i}}$	Belowground Biomass (AGB)	tCO_2eha^{-1}	118.7
$C_{DW_{pre,i}} - C_{DW_{post,i}}$	Deadwood (DW)	tCO_2eha^{-1}	43.2
ΔC_{BSL}	Total	tCO_2eha^{-1}	683.6

Carbon stock changes in the baseline were determined as per Equation 2 (see VMD0006 v1.3, Equation 13).

Equation 2 (Carbon stock changes in the baseline):

$$\Delta C_{BSL_{i,t}} = AA_{planned_{i,t}} * \left(\Delta C_{ABtree_i} + \Delta C_{ABnon-tree_i} + \Delta C_{LI_i}\right) + \sum_{t-10}^{t} \left(AA_{planned_{i,t}} * \left(\Delta C_{BBtree_i} + \Delta C_{BBnon-tree_i} + \Delta C_{DW_i}\right) * \frac{1}{10}\right) + \sum_{t-20}^{t} \left(AA_{planned_{i,t}} * \left(C_{WP100_i} + \Delta C_{SOC_i}\right) * \frac{1}{20}\right)$$

Annual BGB stock change was calculated from Equation 3 (see VMD0006 v1.3, Equation 8).

Equation 3 (BGB stock change):

$$\Delta C_{BBtree+nontree_{i,t}} = AA_{planned_{i,t}} * \left(CBB_{tree+nontree_i} - CBB_{\text{post},i}\right) * {}^{1}/_{10}$$

Annual deadwood stock change was calculated using Equation 4 (see VMD0006 v1.3, equation 10).

Equation 4 (Deadwood stock change):

$$\Delta C_{DW_t} = AA_{planned_{i,t}} * \left(CDW_{tree+nontree} - CDW_{post,i}\right) * {}^{1}/_{10}$$

Annual baseline stock change from planned deforestation in aboveground and belowground biomass, deadwood, extracted biomass and its decomposition, are listed in **Table 18** (see "ZC calcs v1.4.xlsx, tab 'Baseline_stockchg GHG'", for calculations).

Table 30 -Annual baseline carbon stock change (∆CBSL) from planned deforestation in aboveground and belowground biomass (AG+BB, respectively), deadwood (DW), extracted biomass ($XB_{sawnwood}$), and its decomposition ($XB_{sawnwood}$ Decom)

Year	$AA_{planned}$ (ha/y)	ΔC_{AB} (tCO_2e)	ΔC_{BB} (tCO_2e)	ΔC_{DW} (tCO_2e)	$C_{XB_{sawnwood}}$ (tCO_2e)	$C_{XB_{sawnwood}}$ Decom (tCO_2e)	ΔC_{BSL} (tCO_2e)
2021	1,697	885,557	20,141	7,326	-45,227	1,972	869,768
2022	1,697	885,557	40,281	14,651	-45,227	3,944	899,206

6.2.1 Estimation of GHG Emissions from burning in the Baseline

Burning remaining biomass after deforestation is a common practice. Emissions from biomass burning were calculated from procedures and equations listed in VMD0006 v1.3, as per Equation 5. See **Table 19** and **Table 32**, for equation input values, and **Table 33** for output values (see "ZC calcs v1.4.xlsx, tab 'Baseline Emissions burn'", for calculations).

Equation 5 (Emissions from biomass burning):

$$GHG_{BSL-E,i,t} = E_{BionmassBurn,i,t} = \sum_{g=1}^{G}\left(\left(\left(A_{Burn,i,t} * B_{i,t} * COMF_i * G_{g,i}\right) * 10^{-3}\right) * GWP_g\right)$$

Table 31 - Parameters values as per Equation 5

Parameter	Description	Unit	Justification
$GHG_{BSL-E,i,t}$	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum *i* during project year *t*	$t\ CO_2 eyear^{-1}$	Calculated below.
$E_{BionmassBurn,i,t}$	Greenhouse emissions due to biomass burning as part of deforestation activities in stratum *I* in year *t*	$t\ CO_2e$ of each $GHG\ (CO_2, CH_4, N_2O)$	Calculated below. Biomass burning is expected to occur in the project case.
$A_{Burn,i,t}$	Area burnt for stratum *i* in year *t*	ha	-

Parameter	Description	Unit	Justification
$B_{i,t}$	Average aboveground biomass stock before burning stratum *i* in year *t*	$tonnes\ d.m.ha^{-1}$	-
$COMF_i$	Combustion factor for stratum *i*	dimensionless	Default value derived from Table 2.6 of (IPCC, 2006)[65]
$G_{g,i}$	Emission factor for stratum *i* for gas g	$kg\ t^{-1}$ dry matter burnt	Default value derived from Table 2.6 of (IPCC, 2006)
GWP_g	Global warming potential for gas g	$t\ CO_2/t$ gas g	Default values from IPCC AR5 (IPCC, 2014)[66]: $CO_2 = 1$; $CH_4 = 25$; $N_2O = 298$
g	Number of greenhouse gases	-	-
i	Number of strata	-	-
t	Years elapsed since the start of the REDD	-	-

Table 32 - GHG-specific parameters values used to calculate baseline emissions from biomass burning

Gas	COMF	G	GWP
N_2O	0.59	0.2	273
CH_4	0.59	6.8	28

Source: IPCC (2006), AR6 Chap. Table 7.15

Table 33 - Calculation of $E_{BiomassBurn,i,t}$ emission from biomass burning for the baseline scenario accounting for N_2O and CH_4

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	$GHG_{BSL,E}$ (tCO_{2e})
2021	1,697	285.2	54,380	15,594	69,974
2022	1,697	285.2	54,380	15,594	69,974

6.2.2 Estimation of Carbon Sequestered in Long-Lived Wood Products

[65] IPCC (2006). Guidelines for National Greenhouse Gas Inventories. Chapter 4 AFOLU (Agriculture, Forestry and Other Land-use).
[66] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Carbon sequestered in long-lived wood products is calculated using module VMD0005 v1.1 CP-W Option 2, Commercial Inventory Estimation. This option is applicable when an approved harvest plan is not available. Estimate of carbon stocks in the long-term wood products pool is estimated in four steps.

Step 1. Calculate the biomass carbon of the commercial volume extracted prior to or in the process of deforestation:

$$C_{XB_i} = CAB_{tree_i} * {}^{1}/_{BEF} * Pcom_i \qquad \textbf{Equation 6}$$

Step 2. Identify the wood product class(es) (*ty*; defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other) that are the anticipated end use of the extracted carbon calculated in Step 1. Harvested trees would have been turned into sawnwood as is typical practice for the tropical hardwood species in the region (IBGE, 2022). Hence, only one product class (sawnwood, "s") is extracted due to harvesting in the baseline. Harvested trees would have been turned into sawnwood as is typical practice for the tropical hardwood species in the region (IBGE, 2022). Hence, only one product class (sawnwood, "s") is extracted due to harvesting in the baseline.

Step 3: Calculate the biomass carbon entering the wood products pool at the time of deforestation.

$$C_{WP_i} = \sum_{t_y=s,w,oir,p,o} C_{XB_{t_y i}} * \left(1 - WWs_{t_y}\right) \qquad \textbf{Equation 7}$$

Step 4: Calculate the amount of wood products entering the pool at the time of deforestation (*CWP,i*, calculated in C-WP) that is expected to be emitted over a 100-year timeframe.

$$C_{WP100_i} = C_{WP_i} - C_{WP_i} * (1 - SLFp) * \left(1 - OF_p\right) \qquad \textbf{Equation 8}$$

Variable descriptions for equations 6-8 and associated values are described in **Table 34**; see "ZC calcs v1.4.xlsx, tabs 'HWP_initial' and HWP_base'", for detailed calculations).

Table 34 - Parameters and values used to estimate carbon stocks entering the long-term wood products pool

Parameter	Description	Unit	Value	Justification
CAB_{tree_i}	Carbon stock in aboveground biomass tree in stratum *i;*	$t\,CO_2e/ha$	526.9	Calculated from forest inventory data.
BEF	Biomass Expansion Factor for conversion of volume to total	dimensionless	1.79	BEF Calculated using data from Goodman et al. 2014[67]

[67] Goodman, R.C., Phillips, O.L., Baker, T.R., 2014. The importance of crown dimensions to improve tropical tree biomass estimates. Ecol. Appl. 24, 680–698. https://doi.org/ 10.1890/13-0070.1.

Parameter	Description	Unit	Value	Justification
	aboveground tree biomass			
$Pcom_i$	Commercial volume as a percent of total aboveground volume in stratum *i*	dimensionless	0.120	1.Commercial portion of a tree (0.56 x 104.9 tonnes aboveground biomass for commercial species, forest, inventory; 2. 526.9 tonnes, average t CO2e/ha aboveground biomass, forest inventory
$C_{XB_{sawnwood}}$	Mean stock of extracted biomass carbon by class of wood product $t_y$from stratum	$t\,CO_2e/ha$	35.4	Equation 6
WW_s	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood proty	dimensionless	0.24	default value for developing countries from CP-W module, VMD0005
C_{WP_i}	Carbon stock entering the wood products pool from stratum *i*	$t\,CO_2e/ha$	26.9	Equation 7
$SLFs$	SLFty Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product *ty*	dimensionless	0.2	Default for sawnwood from CP-W module, From VMD0005, pg 13
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product *ty*	dimensionless	0.84	Default for sawnwood in Tropical forests from previous version of methodology module CP-W (VMD0005 Version 1.0 REDD Methodological Module)
C_{WP100_i}	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum *i*	$t\,CO_2e/ha$	23.5	Equation 8

6.3 Project Emissions

Estimates of the net carbon stock change and GHG emissions in the project scenario were derived from Module *M-REDD*, as per VM0007 specifications. Ex-ante projections of deforestation in the project case assume no planned deforestation and forest degradation have taken place once the project proponent has committed to not undertake these activities. No unplanned (illegal) deforestation is assumed to occur in the project case.

For REDD project activities (non-wetland), the net GHG emissions in the project case are equal to the sum of stock changes due to deforestation and forest degradation plus the total GHG emissions minus any eligible forest carbon stock enhancement (Equation 9).

Equation 9 (Net GHG emissions in the REDD project scenario (see VMD0015 v2.2, equation 1.)):

$$\Delta C_{WPS-REDD}=\sum_{t=1}^{t^*}\sum_{i=1}^{M}\left(\Delta C_{P,DefPA_{i,t}}+\Delta C_{P,Deg_{i,t}}+\Delta C_{P,DitPA_{i,t}}+GHG_{P-E_{i,t}}-\Delta C_{P,Enh_{i,t}}\right)$$

Where:

$\Delta C_{WPS-REDD}$	Net GHG emissions in the REDD project scenario up to year $t*$; tCO_{2e};
$\Delta C_{P,DefPA_{i,t}}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$\Delta C_{P,Deg_{i,t}}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$\Delta C_{P,DitPA_{i,t}}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* within the project area in year *t*; tCO_{2e};
$GHG_{P-E_{i,t}}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; tCO_{2e};
$\Delta C_{P,Enh_{i,t}}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline[2] in stratum *i* in year *t*; tCO_{2e};
i	1, 2, 3, ...*M* strata;
t	1, 2, 3, ...$t*$ years elapsed since the start of the REDD VCS project activity.

When significant, non-CO_2 gas greenhouse emissions, $GHG_{P,E_{i,t}}$, occurring within the project boundary must be evaluated. For example, where deforestation or degradation occur within the project boundaries or in the leakage belt and fire is used as a means of forest clearance the non-CO_2 emissions may be significant. The Tool T-SIG was used to determine which emissions were included in the calculations as a minimum. Emissions were then calculated through applying Modules E-BPB, E-FCC and E-NA.

Equation 10 (Non-CO2 gas greenhouse emissions):

$$GHG_{P,E_{i,t}} = E_{FC_{i,t}} + E_{BiomassBurn_{i,t}} + N_2O_{direct-N_{i,t}}$$

Where:

$GHG_{P,E_{i,t}}$	Greenhouse gas emissions as a result of deforestation activities within the project area in the project case in stratum *i* in year *t*; t CO_{2e}
$E_{FC_{i,t}}$	Emission from fossil fuel combustion in stratum *i* within the project area in year *t*; t CO_{2e}
$E_{BiomassBurn_{i,t}}$	Non-CO_2 emissions due to biomass burning in stratum i in year t; t CO_{2e}
$N_2O_{direct-N_{i,t}}$	Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* within the project area in year *t*; t CO_{2e}
i	1, 2, 3, …*M* strata
t	1, 2, 3, …*t** years elapsed since the start of the REDD VCS project activity

Net GHG emissions under the project scenario (as per equation 9) are shown in Table 35. Complete calculations are provided in "ZC calcs v1.4, tab '9b. Project GHG'".xlsx.

Table 35 - Net GHG emissions under the project scenario

Year	$\Delta C_{P,DefPA,,i,t}$ (tCO_{2e})	$\Delta C_{P,Deg,i,t}$ (tCO_{2e})	$\Delta C_{P,DistPA,i,t}$ (tCO_{2e})	$\Delta C_{P,Enh,i,t}$ (tCO_{2e})	$GHG_{P\text{-}E,i,t}$ (tCO_{2e})	$\Delta C_{WPS\text{-}REDD}$ (tCO_{2e})
2021	0	0	0	0	0	0
2022	0	0	0	0	0	0

One component of net GHG emissions are non-CO_2 GHG emissions occurring in the project case within the project boundary (as per equation 10). These are shown in Table 36. Complete calculations are provided in "ZC calcs v1.4, tab '10b. Proj Emissions burn'".xlsx.

Table 36 - Non-CO_2 GHG emissions occurring in the project case within the project boundary

Year	$A_{Burn,i,t}$ (ha)	$B_{i,t}$ $(tdma/ha)$	E_{BurnCH_4} (tCO_{2e})	E_{BurnN_2O} (tCO_{2e})	E_{FC} (tCO_{2e})	N_2O_{Direct} (tCO_{2e})	$GHG_{P,E}$ (tCO_{2e})
2021	0	285.2	0	0	0	0	0
2022	0	285.2	0	0	0	0	0

6.4 Leakage

Leakage emissions from displacement of planned deforestation are estimated in compliance with the VCS REDD methodology VM0007, specifically the LK-ASP and LK-ME modules. These modules account for activity shifting leakage resulting from displacement of deforestation activities by the agent of deforestation, and GHG emissions caused by market-effects resulting from the cessation of timber harvesting.

Activity Shifting Leakage

Activity shifting leakage due to displacement of planned deforestation was assessed using the equations provided in the LK-ASP tool, as per VM007 requirements. Parameters, values used, and the justification are given in **Table 24.**

Equation 11 (Leakage from displacement of planned deforestation; VMD0007 v1.6, equation 1):

$$\Delta C_{LK-AS_{planned}} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(LKA_{planned,i,t} \times \Delta C_{BSL,i} \right) + GHG_{LK,E,i,t}$$

Where:

$C_{LK-AS_{planned}}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation up to year t^*; t CO_{2e}
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum *i in year t*; ha
$\Delta C_{BSL,i}$	Net carbon stock changes in all pre-deforestation pools in baseline stratum *i*; t CO_{2e} ha^{-1}
$GHG_{LK,E,i,t}$	Greenhouse gas emission as a result of leakage of avoiding deforestation activities in stratum *i* in year *t*; t CO_{2e}
i	1, 2, 3, …*M* strata; unitless
t	1, 2, 3, …t^* time elapsed since the start of project activity; years

No activity shifting leakage is anticipated to occur because the deforestation agent does not own any additional lands. Hence, $LKA_{planned,i,t}$, and $GHG_{LK,E,i,t}$ are set to zero, and activity shifting leakage is as per **Table 37.**

Table 37 - Activity shifting leakage

Year	$LKA_{planned}$ (ha)	$\Delta C_{BSL,i}$ (tCO_{2e}/ha)	$GHG_{LK\text{-}E,i,t}$ (tCO_{2e})	LK_{peat} (tCO_{2e})	$\Delta C_{LK-AS_{planned}}$ (tCO_{2e})
2021	0	683.55	0	0	0
2022	0	683.55	0	0	0

6.5 Net GHG Emission Reductions and Removals

Uncertainty

Uncertainties were calculated for the baseline and project scenarios based upon the VMD0017 v2.2 X-UNC module. There are two sources of uncertainty in the baseline, the rate of deforestation, and emissions and removals. For the project case, only uncertainty in emissions and removals was considered because no deforestation is expected to occur.

Per the X-UNC module, uncertainty in the projected baseline rate of deforestation, $Uncertainty_{BSL-RATE}$, equals 2.55%. This value is the 95% confidence interval as a percentage of the mean of the area deforested in each proxy (*D%pn*) divided by the number of years over which deforestation occurred in each proxy (*Yrspn*) (see "ZC calcs v1.4, tab '13. Uncertainty'".xlsx. for calculations).

Total uncertainty in emissions and removals ($Uncertainty_{BSL-SS}$) is estimated as per VMD0017 v2.2 X-UNC equation 4, and is expressed as the 95% confidence interval half width as a percentage of the mean carbon stock or GHG source for each pool. $Uncertainty_{BSL-SS}$ is estimated to be 6.91% (calculations detailed in "ZC calcs v1.4, tab '13. Uncertainty'".xlsx.).

Total uncertainty is calculated as per Equation 13 and equals 7.37%.

Equation 13 (Total uncertainty (see VMD0017 v2.2 equation 5)):

$$Uncertainty_{REDD-BSL,t^*} = \sqrt{{Uncertainty_{BSL-RATE,t^*}}^2 + {Uncertainty_{REDD-BSL,SS}}^2}$$

Where:

$Uncertainty_{REDD-BSL,t^*}$	Cumulative uncertainty in REDD baseline scenario up to year t^* (%);
$Uncertainty_{BSL-RATE,t^*}$	Cumulative uncertainty in the baseline rate of deforestation up to year t (%);
$Uncertainty_{REDD-BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline scenario (%);
t	1, 2, 3, … t^* time elapsed since the start of the project activity (years).

The allowable uncertainty in methodology *REDD+ MF* is +/- 15% of *NERREDD+* at the 95% confidence level. Where this precision level is met then no deduction should result for uncertainty, which is the case here (7.37%).

To estimate the number of Verified Carbon Units (VCUs) for the monitoring period *T = t2-t1*, the following equation is used as per VM0007, equation 19:

$VCU_t = Adjusted\_NER_{REDD+,t2} - Adjusted\_NER_{REDD+,t1}) - Buffer_{Total}$

Where:

VCU_t	Number of Verified Carbon Units at year $t = t_2 - t_1$ (VCU)
$Adjusted\_NER_{REDD+,t2}$	Total net GHG emission reductions of the REDD+ project activity up to year t_2 and adjusted to account for uncertainty (t CO_2e)
$Adjusted\_NER_{REDD+,t1}$	Total net GHG emission reductions of the REDD+ project activity up to year t_1 and adjusted to account for uncertainty (t CO_2e):

During the first monitoring period (2021-2022), the Zero Carbon project is expected to generate net GHG emission reductions of 1,301,887 tonnes of CO_{2e} (**Table 38** and **Table 39**).

Table 38 - Ex-post annual estimation of net emission reduction credits

2050 Year	Estimated baseline emissions or removals $\Delta C_{BSL,planned}$ (tCO_2e)	Estimated project emissions or removals $\Delta C_{WPS,REDD}$ (tCO_2e)	Estimated leakage emissions $\Delta C_{LK,t}$ (tCO_2e)	Risk buffer (%)	AFOLU pooled buffer account (tCO2e)	GHG credits eligible for issuance as VCUs (tCO_2e)
2021	939,742	0	83,992	23	216,140	639,610
2022	969,180	0	83,992	23	222,911	662,277

Table 39 - Total emissions reductions (tCO2e) and deductions – monitored period

Estimated emissions and reductions of the Zero Carbon Project	tCO2e
Baseline GHG emissions and reductions	1,908,922
Project emissions and reductions	0
Leakage emissions	167,984
Buffer pool discount	439,051
Total Net Emission Reductions (VCUs)	1,301,887

APPENDIX:

Appendix 1: Ownership Due Diligence Legal Opinion

VIEIRAREZENDE
ADVOGADOS

São Paulo, December 08, 2022.

To

Zero Carbon Holdings LLC

Ref.: Fazenda Mata Mata II. Legal Aspects

This legal opinion has been prepared by Vieira Rezende Advogados upon request of Zero Carbon Holdings LLC, in connection with the property ownership of the so-called Fazenda Mata Mata II property, located in the Municipality of Novo Aripuanã, State of Amazonas, duly registered under No. 2,926 before the Real Estate Registry of Novo Aripuanã, State of Amazonas ("Property"). The Property is set to be developed for a carbon credit project.

This legal opinion also provides for all the activities and due diligence carried out since 2020 to attest and confirm the Property ownership.

In connection with of our review, we have made the following assumptions:

1. The authenticity of all undermentioned documents and copies;
2. The veracity of all signatures and legal capacity of all signatories on all the undermentioned documents;
3. The representations and information contained in the undermentioned documents are correct, and have undertook our own due diligence for expressing the opinions set forth herein.

Our legal opinion has been given in light of and in line with Brazilian laws, and we express no legal opinion in connection with the laws of any jurisdiction outside of the Federative Republic of Brazil. This legal opinion and its exhibits contain all relevant information, contingencies and potential litigation regarding the Property and its landowner until December 8, 2022.

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ADVOGADOS

Based on and subject to the foregoing, we are of the opinion that, so far as the current laws of Brazil are concerned:

I. Real Estate Ownership

In Brazil, according to article 1,245 of the Brazilian Civil Code, the ownership of a given real estate property is formalized by a deed of acquisition duly registered with the relevant Real Estate Registry. The registry of the deed of acquisition grants full ownership to the title holders, and legally protects them from any trespassing or violation of rights.

Moreover, real estate property registration provides third parties with all significant land data, such as: (i) identification and description of the area, to include its size, boundaries, land description, geographical coordinates and total area reflected in the title transfer to the current owners; (ii) liens; (iii) lease agreements; (iv) easement or condemnation; and (v) constructions and improvements made to the property. In short, the registry provides relevant data in connection with the rights, obligations, and limits which may affect the property owner and guarantor.

The Real Estate Registry offices are the official depositories of information regarding the legal situation of properties located in Brazil. According to article 172 of the Public Registry Law (Federal Law 6.015/73), the Real Estate Registry Office is responsible for: *the registration and general information of titles or constitutive, declaratory, translative and extinct rights in rem over real estate recognized by law, "inter vivo" or "mortis causa" either for its constitution, transfer and extinction, or for its validity in relation to third parties, or for its availability.*" Each territory has a Real Estate Registry Office which is the official depository of real estate registrations.

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The Property is located in Nova Aripuanã and therefore, our firm obtained directly from the Real Estate Registry Office of Nova Aripuanã - AM, the Property's full content of the real estate registration, as well as the certificates of the chain of ownership, in order to confirm all the title holders since the Property was transferred from the state of Amazonas to a private owner (that is, from the original issue of the title by the State of Amazonas). **Exhibit I**

After reviewing all of the Property's official registration documentation, it is our opinion that the Property is lawfully owned by Transmaranata Transportes Ltda. ("Transmaranata"), enrolled with the Corporate Taxpayers' Register (CNPJ/ME) under No. 04.297.840/0001-19, with whom Zero Carbon Holdings LLC has valid and current agreements for the development of carbon credit projects on that real estate property.

II. Activities carried out since 2020 to attest who owns the Property.

As part of the ongoing Corporate, Contractual, Environmental and Real Estate due diligence of the Property, our firm reviewed updated court certificates and registrations for the years 2020 and 2021. Based on our due diligence we surmised, (i) the property was free and clear of any liens, (ii) the landowner, Transmaranata, had been paying the Property taxes since the acquisition, (iii) the Property was in compliance with laws, (iv) there were no lawsuits involving the Property or any third party claiming ownership and (v) the documents did not contain any information that could indicate any risk to the intended carbon project as provided in the reports attached hereto as **Exhibit II**. Accordingly, we concluded that Transmaranata's title is still valid.

In addition to the abovementioned, the Property owner contacted the Secretary of State for Cities and Territories of Amazonas (SECT) and requested a search in the public files, to provide more official information about the Property. SECT answered by requesting additional documents to update the information regarding the Property in its files, as they could not find

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it in the searches carried out. The requested documents are being collected by Transmaranata, as owner of the Property, to be provided to that public body.

In the absence of further official documentation by SECT, it is our opinion that the property has a valid registry with the proper Real Estate Registry Office showing Transmaranata as the lawful owner. If any other regularization or the filing of a lawsuit becomes necessary for this purpose, the owner has already provided a POA to his lawyers so that they can adopt the measures that may be necessary as provided for in **Exhibit III**.

We hope we have clarified your doubts and remain available for other clarifications.

Best Regards,

DocuSigned by: Lúcia Veloso Aragão | Vieira Rezende
Lúcia Veloso Aragão

DocuSigned by: Ewerton Oliveira
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Ewerton Oliveira

VIEIRA REZENDE ADVOGADOS

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Appendix 1a: Ownership Due Diligence Support Evidence (folder – available for consultation)

Appendix 2: ZCH Environmental Management System (pdf file - available for consultation)

Appendix 3: Local Stakeholder Consultation Reports and Support Files (folder - available for consultation)

Appendix 4: Request to deforest (pdf file - available for consultation).

Appendix 5: Forest inventory (pdf file - available for consultation).

Appendix 6: Risk Tool Assessment (available for consultation)

Appendix 7. Testing significance of GHG emissions in project activities

We used the T-Sig tool Version 01 to determine which GHG emissions by sources, possible decreases in carbon pools, and leakage emissions are insignificant for this project.

Source	Relative Contribution	Rank	Significant?	Description
Timber harvest products	-0.01	7	No	i. Timber harvest occurs in the process of deforestation, and timber is destined for commercial markets (sawnwood).
Direct N_2O emissions due to biomass burning as part of deforestation	0.01	6	No	
Non-tree aboveground biomass	0.02	5	No	The contribution of understory shrubs, vines and herbaceous plants to aboveground mass can be variable but generally very small fraction of the total biomass (**about 3%** or less [Hegarty 1989, Jordan and Ubl 1978, Tanner J 980 as cited in Brown and Lugo, 1992][68])
Direct CH_4 emissions due to biomass burning as part of deforestation	0.04	4	No	
Dead wood	0.06	3	Yes	i. Dead wood stocks are greater in the baseline 1,165027 t(CO2e) than in the project 0 t(CO2e) scenario (in conformance with REDD-MF), and ii. Dead wood was determined to be significant using the T-SIG module.
Belowground biomass	0.16	2	Yes	
Aboveground biomass	0.71	1	Yes	

[68] Brown, S., & Lugo, A.(1992). Aboveground biomass estimates for tropical moist forests of the Brazilian Amazon. *Interciencia. Caracas*, *17*(1), 8-18.