# SEPOTI REDD PROJECT

Document Prepared by Future Forest

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| Project Title | Sepoti REDD Project |
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| Prepared By | Future Forest |
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# 1 PROJECT DETAILS

## 1.1 Summary Description of the Project

In Brazil, 58.39% of its entire 851,029,591.4 ha territory[1] is covered by forests, representing almost 497 million hectares of forest area[2] and putting it in second place for nations with most forest area worldwide. Brazil has also been at times the country with the highest levels of deforestation in the world, having lost almost 15 million hectares of its forest area from 2010 to 2020[3]. The expansion of the agriculture frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The Sepoti REDD Project is located in the municipality of Novo Aripuanã, south of Amazonas state, in the Northern region of Brazil. The region is surrounded by many rivers, its borders having direct contact with three of them: Rio Sucunduri, Rio Camaiú and Rio Camaiuxazinho. The Trans-Amazonian Highway BR-230 is located south of the municipality and, along its route, cattle raising can be found, which is one of the many drivers to deforestation in the region (WWF-Brasil, 2017[4]).

The primary objective of the Sepoti REDD Project is to avoid unplanned deforestation (AUD) of a region within the municipalities of Novo Aripuanã and Borba. The first Project activity instance has 26,062 ha project area, which is within one private properties in Novo Aripuanã, consisting of 100% Amazon rainforest. The purchase of the property by the project proponent and forest conservation actions, on 22-October-2022, was the first action in terms of initiating the present REDD project and has thus designated this date as its project start date. The project's crediting period start is 22-October-2022. However, other REDD project instances could be inserted into this grouped project activity in the future, as long as they comply with the eligibility criteria defined in sections below.

It is expected that, with the carbon project, it will be possible to expand the monitoring of the area, hiring new professionals to work on the farms. In addition to the project's ecological and carbon benefits, a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project region, specifically contributing to improving deforestation control, aiming at the propagation of environmental awareness, generation of alternative sources of income and environmental education actions.

[1] IBGE – Instituto Brasileiro de Geografia e Estatística. Brazil. 2019. Available at: <https://www.ibge.gov.br/cidades-e-estados>.
[2] FAO and UNEP. 2020. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. Available at: <https://doi.org/10.4060/ca8642en>.
[3] FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. Available at: < https://doi.org/10.4060/ca9825en>.

[4] WWF-Brasil. Perfil socioeconômico e ambiental do sul do estado do Amazonas: Subsídios para Análise da Paisagem. 2017. Available at: <https://d3nehc6yl9qzo4.cloudfront.net/downloads/perfil_sul_amazonas.pdf>.

The present REDD project is expected to avoid predicted 1,888 ha of deforestation, equating to 782,072 $tCO_2e$ in emissions reductions over the 30-year project lifetime, with an annual average of 26,069 $tCO_2e$.

## 1.2 Sectoral Scope and Project Type

Sectoral Scope: 14 – Agriculture, Forestry, Land Use

Project Category: Avoided Unplanned Deforestation (AUD Project Activity)

This is a grouped project.

## 1.3 Project Eligibility

According to the VCS Methodology Requirements, v4[5], for Reduced Emissions from Deforestation and Degradation (REDD) projects, eligible activities are those that reduce net GHG emissions by reducing deforestation. Thus, the project is eligible under the scopes of the VCS Program, following the VCS Standard, v4[6], Sections 3.1, 3.2 and Appendix A1.5 – A1.8:

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
|---|---|
| Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1 | The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in the Applicability of Methodology section. |
| Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.13.1 | The applied methodology is VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1. Applicability conditions are detailed in section 3.2. |
| Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced. | The project activity involves the conservation of native mangrove forest. This activity is eligible under the Brazilian law according to conditions set out in sections 1.14 and 3.5. |

[5] Available at <https://verra.org/wp-content/uploads/2022/06/VCS-Methodology-Requirements-v4.2.pdf>
[6] Available at <https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf>

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
|---|---|
| Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document Program Definitions for definition of model), such model shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals). | Not applicable. The Project applies the VM0015 Methodology. |
| Where projects apply methodologies that permit the project proponent its own choice of third party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements. | Not applicable. The Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment. |
| Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline (i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project). | Not applicable. The Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment. |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
|---|---|
| Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence | The Project applies an approved VCS methodology and tool. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program. |
| Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document Program Definitions for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs. | The Project applies an approved VCS methodology and tool. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program. |
| Where Verra issues new requirements relating to projects, registered projects do not need to adhere to the new requirements for the remainder of their project crediting periods (i.e., such projects remain eligible to issue VCUs through to the end of their project crediting period without revalidation against the new requirements). The new requirements shall be adhered to at project crediting period renewal, as set out in Section 3.8.9. | The Project was designed under the VCS Standard, v4 and VM0015, v1.1. Any new requirements shall be adhered to at project crediting period renewal (i.e 30 years, which may be renewed up to 100 years from Project Start Date). |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
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| There are currently six AFOLU project categories eligible under the VCS Program, as defined in Appendix 1 Eligible AFOLU Project Categories below: afforestation, reforestation and revegetation (ARR), agricultural land management (ALM), improved forest management (IFM), reduced emissions from deforestation and degradation (REDD), avoided conversion of grasslands and shrublands (ACoGS), and wetland restoration and conservation (WRC). | This is an eligible AFOLU project category under the VCS Program: Reduced Emissions from Deforestation and Degradation (REDD). |
| Where projects are located within a jurisdiction covered by a jurisdictional REDD+ program, project proponents shall follow the requirements in this document and the requirements related to nested projects set out in the VCS Program document Jurisdictional and Nested REDD+ Requirements. | This Project is not located within a jurisdiction covered by a jurisdictional REDD+ program. |
| Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities with respect to the project, including but not limited to, implementation, management and monitoring of the project, over the project crediting period | Any implementation partners are described on the Project Description, in sections 1.5 and 1.6. |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
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| Activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any ARR, ALM, WRC or ACoGS project areas were not cleared of native ecosystems to create GHG credits (e.g., evidence indicating that clearing occurred due to natural disasters such as hurricanes or floods). Such proof is not required where such clearing or conversion took place at least 10 years prior to the proposed project start date. | This Project does not convert native ecosystems to generate GHG. The project area only contains native forested mangrove for a minimum of 10 years prior to the project start date. |
| Activities that drain native ecosystems or degrade hydrological functions to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any AFOLU project area was not drained or converted to create GHG credits. Such proof is not required where such draining or conversion took place prior to 1 January 2008. | This Project does not occur on wetlands and does not drain native ecosystems or degrade hydrological functions. |
| The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. Where no new project activities have been implemented during a verification period, project proponents shall demonstrate that previously implemented project activities continued to be implemented during the verification period (e.g., forest patrols or improved agricultural practices of community members). | PP will demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
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| For all IFM, APDD (except where the agent is unknown), RWE, APWD, APC, and ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years and have this validated at the same time as the subsequent verification. For all AUDD, APDD (where the agent is unknown), AUC and AUWD project types, the project proponent shall, for the duration of the project, reassess the baseline every six years and have this validated at the same time as the subsequent verification. | The baseline reassessment will be conducted every six years as this is an AUDD project. |
| Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below de minimis or can be conservatively excluded as set out in the VCS Program document VCS Methodology Requirements, in which case the project shall not be subject to the WRC requirements. | Not applicable. The project activity does not occur on wetlands. |
| Projects shall prepare a non-permanence risk report in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool at both validation and verification. In the case of projects that are not validated and verified simultaneously, having their initial risk assessments validated at the time of VCS project validation will assist VCU buyers and sellers by providing a more accurate early indication of the number of VCUs projects are expected to generate. The non-permanence | The Project has conducted a non-permanence risk analysis on validation, according to the VCS Program document *AFOLU Non-Permanence Risk Tool*, v4.0, and shall perform the same report during subsequent verifications. |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
|---|---|
| risk report shall be prepared using the VCS Non-Permanence Risk Report Template, which may be included as an annex to the project description or monitoring report, as applicable, or provided as a stand-alone document. | |
| Eligible REDD activities are those that reduce net GHG emissions by reducing deforestation and/or degradation of forests. The project area shall meet an internationally accepted definition of forest, such as those based on UNFCCC hostcountry thresholds or FAO definitions, and shall qualify as forest for a minimum of 10 years before the project start date. The definition of forest may include mature forests, secondary forests, and degraded forests. Under the VCS Program, secondary forests are considered to be forests that have been cleared and have recovered naturally and that are at least 10-years-old and meet the lower bound of the forest threshold parameters at the start of the project. Forested wetlands, such as floodplain forests, peatland forests and mangrove forests, are also eligible provided they meet the forest definition requirements mentioned above. | The Project Area is composed of 100% native forest. The area is considered forest as per the definition of forest adopted by FAO[7]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. |

[7] Available at <https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predomina>

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
|---|---|
| Activities covered under the REDD project category are those that are designed to stop planned (designated and sanctioned) deforestation or unplanned (unsanctioned) deforestation and/or degradation. Avoided planned degradation is classified as IFM. | The project activity is designed to stop unplanned (unsanctioned) deforestation as described throughout the PD. |
| Activities that stop unsanctioned deforestation and/or illegal degradation (such as removal of fuelwood or timber extracted by non-concessionaires) on lands that are legally sanctioned for timber production are eligible as REDD activities. However, activities that reduce or stop logging only, followed by protection, on forest lands legally designated or sanctioned for forestry activities are included within IFM. Projects that include both avoided unplanned deforestation and/or degradation as well as stopping sanctioned logging activities, shall follow the REDD guidelines for the unplanned deforestation and/or degradation and the IFM guidelines for the sanctioned logging activities, and shall follow the requirements set out in the VCS Program document *VCS Standard*. | In case future project activity instances have areas legally sanctioned for timber production, baseline and project activity shall comprehend unsanctioned deforestation and/or illegal degradation, not the reduction of logging. |
| Eligible REDD activities include:<br><br>1) Avoiding Planned Deforestation and/or Degradation (APDD): This category includes activities that reduce net GHG emissions by stopping or reducing deforestation or degradation on forest lands that are legally authorized and documented for conversion.<br><br>2) Avoiding Unplanned Deforestation and/or Degradation (AUDD): This category includes | The Sepoti REDD Project is within category AUDD: Avoided Unplanned Deforestation and/or Degradation. |

| Eligibility Conditions | Sepoti REDD Project Justification of Eligibility |
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| activities that reduce net GHG emissions by stopping deforestation and/or degradation of degraded to mature forests that would have occurred in any forest configuration. | |

## 1.4 Project Design

The project is a grouped project.

### Eligibility Criteria

A set of eligibility criteria for the inclusion of any new areas as instances willing to participate within the grouped project are described below.

As Sepoti REDD Project is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15 and 3.5.16, as well as the specific AFOLU Projects criteria (3.5.17 and 3.5.18) of the VCS Standard, v4.

In addition, new areas willing to become instances of the project shall comply with the applicability conditions of the selected methodology, including conditions applicable to each activity, as described in Section 3.2.

**Table 1. Grouped Project eligibility criteria**

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| Projects shall meet the applicability conditions set out in the methodology applied to the project. | The GHG emission reductions shall be calculated according to the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020. | Instance 1 complies with this requirement because it adopts the Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020. |

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| Projects shall use the technologies or measures specified in the project description. | All new instances shall use and apply the same technologies or measures specified in the Project description - forest conservation by avoiding unplanned deforestation and planned deforestation, with or without forest management in project scenario. | The Instance 1 project activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Sepoti REDD Project. Also, this instance is in the same reference region described on the VCS PD.<br>Instance 1 applies the same technologies or measures specified on the present Project Description: forest conservation by avoiding unplanned deforestation and planned deforestation, without forest management in project scenario. |
| Projects shall apply the technologies or measures in the same manner as specified in the project description. | | |
| Projects are subject to the baseline scenario determined in the project description for the specified project activity and geographic area. | The Project shall be in accordance with the same baseline scenario established in Section 3.4. of the VCS PD: "In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the reference region, project area and leakage belt. Therefore, the project falls into the AFOLU-REDD". | The Instance 1 Project Activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Sepoti REDD Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD. |
| Projects must have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) | All instances must be additional to be included in the Grouped Project. The project activity must be consistent with Grouped Project Description: forest conservation by avoiding unplanned deforestation and planned deforestation. In this case, the project activity may or may not include Sustainable Forest Management Plan. | Since the PD was developed based on the characteristics, reference region and activity of the initial instance, Instance 1 complies with this additionality criterion.<br>The additionality analysis for Instance 1 was made according to Option I of VCS VT0001 v3.0, as detailed in section 3.5. |

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instances. | In the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v 3.0 tool.<br>1) Instances may or may not include Sustainable Forest Management Plan.<br>2) In case the project activity does not involve Sustainable Forest Management Plan:<br>- The instance should have financial, technical and scale consistent with the described in the VCS PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied.<br>3) In case the project activity includes a Sustainable Forest Management Plan:<br>- A new additionality analysis shall be provided. In this case, the investment comparison analysis (Option II) or the benchmark analysis (Option III) of the Tool VCS VT001 v 3.0 shall be used.<br>- In addition, a new AFOLU non-permanence risk analysis shall be performed. | |
| New Project Activity Instances shall occur within one of the designated geographic areas | Projects must be located within the Reference Region described in Section 3.3 of the VCS PD. The areas to be included must | The project activity within the area referring to instance 1 is located in the project's reference region |

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| specified in the project description. | evidence the ownership of the property in accordance with Brazilian legislation, even if overlapping public areas such as Conservation Units.<br>- As per the VCS Standard, new *AFOLU Non-Permanence Risk* assessments shall be carried out for each geographic area specified in the project description (for requirements related to geographic areas of grouped projects, see the VCS Standard). Where risks are relevant to only a portion of each geographic area, the geographic area shall be further divided such that a single total risk rating can be determined for each geographic area. Where a project is divided into more than one geographic areas for the purpose of risk analysis, the project's monitoring and verification reports shall list the total risk rating for each area and the corresponding net change in the project's carbon stocks in the same area, and the risk rating for each area applies only to the GHG emissions reductions generated by project activity instances within the area. | as described in section 3.3 of the VCS PD. |
| Instances shall comply with at least one complete set of eligibility criteria for the inclusion of new project activity instances. Partial compliance with multiple sets of eligibility criteria is insufficient. | All Instances must comply with the complete set of eligibility criteria for the inclusion of new project activities instances. | Instance 1 complies with all eligibility criteria for the inclusion of a new Project Activity. |

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| Instances must be included in the monitoring report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/verification body. | The Project Activity Instances must be included in the Monitoring Report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/ verification body. | Instance 1 complies with this criterion, as it is included in this VCS PD as the first Project Activity Instance. |
| New Project Activity Instances must be validated at the time of verification against the applicable set of eligibility criteria | The addition of new Project Activity Instances shall be made in the monitoring report for the Grouped Project, being validated at the time of verification. | Instance 1 complies with this criterion, as it is included in this VCS PD as the first Project Activity Instance. |
| New Project Activity Instances must have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions). | All Project Activity instances must provide evidence of Project ownership (land title and related documents) and Project start date (agreements, protection or management plan, or others in accordance with the applicable VCS Standard definitions). | Instance 1 is in accordance with this criterion. The evidence of Project ownership and Project start date were provided, as described in Sections 1.7 and 1.8 of the VCS PD. |
| New Project Activity Instances must have a start date that is the same as or later than the grouped project start date. | The start date of the activity of each instance shall be the same as or after the start date of the grouped project, as established in Section 1.8 of the VCS PD. | Instance 1 project activity has the same start date of the grouped Project, as described in section 1.8 of the VCS PD. |
| Instances shall be eligible for crediting from the start date of the instance through the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals | Instances shall be eligible for crediting from the start date of the instance activity until the end of the grouped project crediting period, i.e., the instance shall not generate credits after the end date of the Grouped Project. Where a new project activity instance starts in a previous | Instance 1 project activity's crediting period has the same start and end dates of the grouped Project, as described in section 1.8 of the VCS PD. |

| VCS Standard Eligibility criteria for the inclusion of new project activity instances | Sepoti REDD Project | Instance 1 |
|---|---|---|
| generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period. | verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period. New instances are eligible for crediting from the start of the next verification period. | |

## 1.5 Project Proponent

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| **Organization name** | Future Carbon Holding S.A. (Future Carbon Group) |
| **Contact person** | Marcelo Hector Sabbagh Haddad<br>Bárbara Silva e Souza<br>Carolina Chiarello de Andrade<br>Carolina Pendl Abinajm<br>Eliane Seiko Maffi Yamada<br>Gabriel Fernandes de Toledo Piza<br>Gabriella Hita Marangom Cesilio<br>Guilherme Lucas Medeiros Prado<br>Laura Cristina Pantaleão<br>Letícia Moraes Teixeira<br>Lyara Carolina Montone Amaral<br>Yara Fernandes da Silva |
| **Title** | Marcelo Hector Sabbagh Haddad – Head of Forest<br>Bárbara Silva e Souza – Technical Analyst<br>Carolina Chiarello de Andrade – Technical Analyst<br>Carolina Pendl Abinajm – Technical Coordinator<br>Eliane Seiko Maffi Yamada – Technical Coordinator<br>Gabriel Fernandes de Toledo Piza – Technical Coordinator<br>Gabriella Hita Marangom Cesilio – Technical Analyst<br>Guilherme Lucas Medeiros Prado – Technical Coordinator<br>Letícia Moraes Teixeira – Technical Analyst<br>Laura Cristina Pantaleão – Technical Analys<br>Lyara Carolina Montone Amaral – Technical Coordinator<br>Yara Fernandes da Silva – Technical Coordinator |
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| **Telephone** | +55 11 3045-3474 |
| **Email** | forest@futurecarbon.com.br |

## 1.6 Other Entities Involved in the Project

| | |
|---|---|
| **Organization name** | Seringal Sepoti |
| **Role in the project** | Owner of Seringal Sepoti, composing Instance 1 |

| | |
|---|---|
| Contact person | Luiz Marcelo Carvalho |
| Title | Owner |
| Address | Seringal Sepoti s/n, Zona Rural, Novo Aripuanã – AM<br>Postal Code: 00000-00 |
| Telephone | - |
| Email | - |

## 1.7 Ownership

Instance 1 is located within the municipality of Novo Ariupuanã. The project area is composed by the following property:

- Seringal Sepoti

The properties composing Instance 1 (hereafter "Instance 1"), are owned by Luiz Marcelo Carvalho.

As per the rules stated at Section 3.6 Ownership of the VCS Standard v.4.3, an enforceable and irrevocable agreement was set between, Luiz Marcelo Carvalho – the holder of the statutory, property and contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions or removals –, and Future Carbon Holding S.A., which vests project ownership in the project proponent (Future Forest[8]). Evidence of such agreement will also be made available at the audit.

The legal documents proving the land title and ownership of the properties will be made available to the auditors during the validation process.

## 1.8 Project Start Date

According to the VCS Standard, "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 (eg, preparing land for seeding, planting, changing agricultural or forestry practices, rewetting, restoring hydrological functions, or implementing management or protection plans)".

The project start date was on 22-October-2022, and it was defined taking into consideration the date on which the project owner acquired the properties and started developing forest conservation activities. Before this date, the farms were abandoned to illegal invasions and no conservation activities were undertaken.

[8] Future Forest (Future Carbon Consultoria e Projetos Florestais Ltda.) is a company controlled by Future Carbon Holding S.A. Therefore, partnership agreements for project developments are signed on behalf of Future Carbon Holding.

Due to the high deforestation pressure in the region, on the project start date the landowner initiated the installation of fences surrounding the properties, hired employees for conducting the surveillance against invasions and deforestation, and acquired equipment and vehicles for monitoring the area. It is important to note that the acquisition of the properties also took into consideration the carbon market, and carbon revenues are a very important component to implement conservation and socioenvironmental activities, as the region has one of the highest deforestation rates of the country.

The documents supporting the project start date will be made available to the auditors during the validation process.

## 1.9 Project Crediting Period

The project has a crediting period of 30 years, starting from 22-October-2022 until 21-October-2052.

According to VCS requirements, the baseline must be reassessed every 10 years for ongoing unplanned deforestation[9] because projections for deforestation are difficult to predict over the long term.

## 1.10 Project Scale and Estimated GHG Emission Reductions or Removals

| Project Scale | |
|---|---|
| Project | X |
| Large project | |

| Year | Estimated GHG emission reductions or removals ($tCO_2e$) |
|---|---|
| 2022 | 30,196 |
| 2023 | 30,420 |
| 2024 | 30,633 |
| 2025 | 30,846 |
| 2026 | 31,058 |
| 2027 | 31,271 |
| 2028 | 28,295 |
| 2029 | 28,654 |
| 2030 | 28,846 |

[9] According to applied methodology VM0007 - REDD+ Methodology Framework (REDD-MF), available at: <https://verra.org/wp-content/uploads/2017/10/VM0007v1.5.pdf>

| | |
|---|---|
| 2031 | 29,037 |
| 2032 | 29,004 |
| 2033 | 28,982 |
| 2034 | 26,091 |
| 2035 | 26,202 |
| 2036 | 26,162 |
| 2037 | 26,122 |
| 2038 | 26,104 |
| 2039 | 26,084 |
| 2040 | 23,482 |
| 2041 | 23,582 |
| 2042 | 23,546 |
| 2043 | 23,510 |
| 2044 | 23,493 |
| 2045 | 23,476 |
| 2046 | 21,133 |
| 2047 | 21,224 |
| 2048 | 21,191 |
| 2049 | 21,158 |
| 2050 | 21,144 |
| 2051 | 21,129 |
| **Total estimated ERs** | **782,072** |
| **Total number of crediting years** | **30** |
| **Average annual ERs** | **26,069** |

## 1.11 Description of the Project Activity

The principal objective of the present grouped REDD project is the conservation of a region within the municipalities of Novo Aripuanã, in the south of Amazonas state. This will be achieved through avoidance of unplanned deforestation. The first instance of this Grouped Project presents a 26,062 ha of forest area within the Seringal Sepoti property. In the future, new instances may be added to the project, expanding the conservation of the forest.

The main mitigation action of the project is to avoid unplanned deforestation through the expansion of monitoring of the area, mapping of deforestation, partnerships with education and research institutions and the insertion of the surrounding communities in the project activities, aiming to minimize invasions and illegal deforestation, offering alternative income, education and professional training.

It is important to note that this grouped project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

The ex-ante estimate for the predicted avoided deforestation within the first instance project area over the 30-year project lifetime would be 1,888 ha. The avoided emissions are expected to 782,072 $tCO_2e$ across the project crediting period (22-October-2022 to 21-October-2052), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

In recent years, the project region has been deforested for the expansion of agricultural and livestock activities, mainly due to the advancement of the so-called arc of deforestation from the south of the Amazon biome. This pressure is expected to continue, given the globalization of markets in the Amazon region and international development policies planned for the region[10].

The area's conservation plan involves increasing satellite monitoring, overflight and/or in person, with monitoring posts in the area, as well as socio-environmental education and community insertion in the project activity through the generation of jobs, such as monitoring agents, as the main way to mitigate illegal actions in the area. This plan will be based on the monitoring parameters.

## 1.12 Project Location

The Sepoti REDD Project is situated in the municipality of Novo Aripuanã, in Amazonas state in the north of Brazil, a region known as Southern Amazon. Belonging to the South-Amazonian Mesoregion and Microregion of Madeira, Novo Ariapuanã and Borba's population, according to the Brazilian Institute of Geography and Statistics (IBGE) in 2019, had about 67,794 inhabitants. Their territorial areas sum up to around 85,415 $km^2$, which makes them among the largest municipalities in Brazil in the territorial area.[11]

The area of the first project activity instance comprehensively belongs to Seringal Sepoti. In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, they are areas which include only "forest"[12] for a minimum of ten years prior to the project start date'. To define the project area, areas within the two properties that were defined as forest for ten years prior to the project start date were identified and utilized to compose the project area. In addition, some non-forest areas were also excluded, such as vegetation classified as non-forest (Pioneer Formations with river influence) and water bodies. Therefore, the total size of the areas that were considered as "non-forest" within the project area at the project start date was 2,250.62 ha. This was excluded from the initial area of 23,811.38 ha, resulting in 26,062 ha, which was then defined as project area.

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[10] Nepstad, D. C.; C. M. Stickler e O. T. Almeida. 2006. Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation. Conservation Biology 20(6):1595-1603.

[11] Brazilian Institute of Geography and Statistics (IBGE) < https://www.ibge.gov.br/cidades-e-estados/am/novo-aripuana.html>

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

Geodetic coordinates of the project location have been submitted separately as a KML file, as the Figure below presents the properties' location:

**Figure 1. Project Location**


## 1.13 Conditions Prior to Project Initiation

Conditions prior to the project initiation as well as general characteristics of the project area and reference region are described below.

**Climate and Hydrography**

The project region is classified as Tropical, dry winter climate type – Aw category – according to the Köppen climate classification[13]. This means that it has a rainy season in summer, from November to April, and a distinct dry season in winter, from May to October (July is the driest month). The average temperature of the coldest month is above 18ºC and annual precipitation is on average 1,724.33 mm.

**Geology, Topography and Soils**

Relief and topography within the project area are from the middle plateau of the Sucunduri River. Plateaus are planed surfaces, characterized by the erosion factor and material deposition. The relief can assume different shapes, as escarpment, saw or plateau.

The municipalities of Novo Aripuanã and Borba consist of Detrito-Lateric Cover geology type. The Detrito-Lateritic Cover is attributed to the post-Cretaceous sedimentary origin, with basal

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

conglomeratic occurrences, covered by layers or levels of sandstones, claystones, make up deep weathering mantles with oxisols red.

Regarding soil content, the soils within the Project Area are described as Oxisols. Oxisols are mineral soils deep and very weathered, whose diagnostic feature is the presence of a B horizon latosol, i.e., a subsurface horizon, at least 50 cm thick, which presents a high degree of weathering, and are practically devoid of primary or secondary minerals less resistant to weathering, in addition to having a low nutrient reserve.[14]

Erosive processes acting for thousands of years on the Southern Amazon Plateau have eroded the main river channels flowing from south to north direction, such as the Aripuanã and Roosevelt Rivers. This process has also produced rapids and waterfalls, such as the Sumaúma Waterfall, on the edge of the aforementioned Plateau. In addition, all the regional rivers run to the Madeira River in the north, being that the largest plains are located at the end of the Guariba River.

The predominant soil types within the project area are clayey latosols, yellow latosols and red-yellow latosols, from the oxisols group within the aluminum-iron complex, together with medium-high acidity clays. These soils are poor in phosphorus and potassium, with low to medium levels of calcium and magnesium. In addition, these soils have medium to high clay content, with sections with low to moderate sand and silt contents. Furthermore, there is a high concentration of organic matter on the surface soil layers resulting from the thick organic layer under the forest litter. Clay and sandy-clayey soils, notably red-yellow podzolic, are also found in the landscape's slopes, which predominate in less than 10% of the total project area, concentrated in its southern portion

Vegetation cover

The vegetation in the present project was mapped based on SIVAM Amazônia information sources[15]. Three vegetation types were found to be present in the project instance area: Dense Alluvial Tropical Rainforest, Dense Submontane Tropical Rainforest, and Dense Lowland Tropical Rainforest.

The Dense Alluvial Tropical Rainforest is a type of vegetation that relates to environments located on the margins of some watercourses, on the outskirts of swamps, as well as in wetlands, and even in temporarily flooded areas. It is also known under the designations of riparian forest, gallery forest and riverside forest.

[14] According to the Territorial plan for sustainable rural development – Madeira Territory, 2010. Available at: <http://sit.mda.gov.br/download/ptdrs/ptdrs_qua_territorio119.pdf>

[15]Sistema de vigilância da Amazônia: SIVAM

It is a vegetation that practically no longer exists, according to field observations, as its geographical location correlates with environments where occupation and agricultural use are very intensive.[16]

The Dense Submontane Tropical Rainforest is a type of vegetation characterized by phanerophytes, precisely by the sub-forms of macro and mesophanerophyte life, in addition to abundant woody and epiphytic lianas, which differentiate it from other classes of formations. However, the main ecological characteristic resides in the ombrophilic environments. Thus, the ombrothermal characteristic of the Dense Ombrophilous Forest is tied to tropical climatic factors of high temperatures (averages of 25º) and high precipitation, well distributed during the year (from 0 to 60 dry days), which determines a bioecological situation practically without biologically dry periods. In addition, dystrophic and, exceptionally, eutrophic oxisols dominate in the environments of these forests, originating from various types of rocks.

The dissection of the mountainous relief and the plateaus with moderately deep soils is occupied by a forest formation that presents phanerophytes with approximately uniform height. The sub-forest is made up of seedlings of natural regeneration, few nanofanerophytes and camphites, in addition to the presence of small palms and herbaceous lianas in greater quantity. Its main characteristics are the high trees, some exceeding 50m.[17]

The Dense Lowland Tropical Rainforest is a formation that generally occupies the coastal plains, covered by Pliopleistocene boards of the Barreiras Group. It occurs from the Amazon, extending throughout the Northeast Region to the vicinity of the São João River, in the State of Rio de Janeiro.

**Biodiversity**

The Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included the project region in its 2018 survey of Brazil's 900 priority areas for conservation[18]. The Project Area is classed within the ministry's "extremely high" and "high" classes, as demonstrated in the Figure 6 below. The report classified the priority actions in the area as "inspection and control of illegal activities" and "regularization of degrading activity."

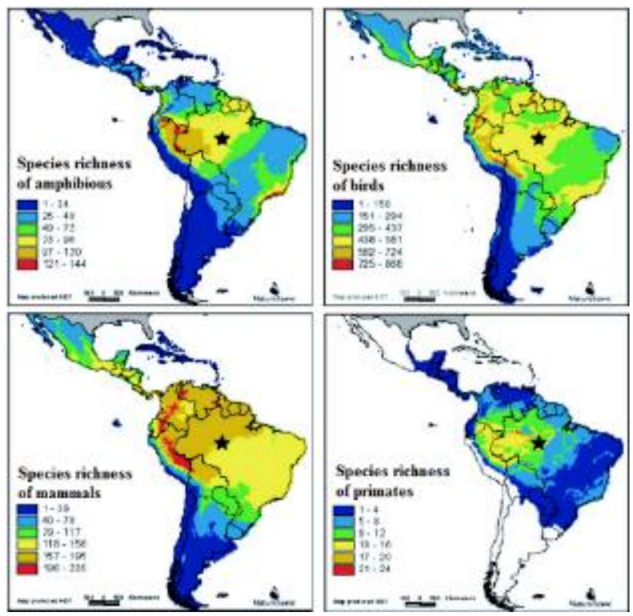
[16] Alluvial Dense Ombrophilous Forest – Embrapa. Available at: <http://www.agencia.cnptia.embrapa.br/gestor/territorio_mata_sul_pernambucana/arvore/CONT000gt7eon7l02wx7ha087apz2tjys6j3.html#:~:text=A%20floresta%20ombr%C3%B3fila%20densa%20aluvial,mesmo%20em%20%C3%A1reas%20alagadas%20temporariamente> Last visited: 05/07/2020.

[17] Dense Ombrophilous Forest. Available at: <https://ambientes.ambientebrasil.com.br/natural/regioes_fitoecologicas/regioes_fitoecologicas_-_floresta_ombrofila_densa.html> Last visited: 05/07/2020

[18] MMA (2018): <http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias> Access on 29/12/2020.

The Southern Amazon Mosaic is located in a well-preserved region within the Legal Amazon, noting its high biological importance. However, this is also one of the least scientifically known regions of Brazil and therefore considered a priority area for wildlife inventories[19].

In the regional context, the Southern Amazon Mosaic is within areas of high richness of birds, mammals and amphibian species, according to Figure 7 below. Although scientific research is scarce in the region, it is very likely that the existing biodiversity assessments underestimate the reality. A recent example was a new primate species found in the region, named Zogue-zogue fire tail (Callicebus miltoni), that only occurs between the rivers Aripuanã and Roosevelt[20].




In addition, it is estimated that there are at least 13 threatened species of fauna, ten of these being mammals. Among those of great conservation interest are the Golden-White Tassel-ear Marmoset (Mico chrysoleucus), the Giant Armadillo (Priodontes maximus), the Brazilian Tapir (Tapirus terrestris), the Red Brocket (Mazama americana), and the Azara's Agouti (Dasyprocta azarae). Furthermore, there are several other species expected to be at some grade of risk, such as the Golden Parakeet (Guaruba guarouba) and the Hyacinth Macaw (Anodorhynchus hyacinthinus), both within the vulnerable category, according to the International Union for Conservation of Nature - IUCN. In addition, the present project contributes to the preservation of

[19] WWF (Brasil). **Mosaico da Amazônia Meridional:** Vencendo limites geográficos e integrando gestão. Brasília-DF: WWF, 2014. 136 p. Available at:

<http://d3nehc6yl9qzo4.cloudfront.net/downloads/mam_livro_vencendo_limites_geograficos_final.pdf>. Access on 29/12/2020

[20] O ESTADO DE SÃO PAULO. Sustentabilidade. Nova espécie de primata é descoberta na Amazônia. March 11th, 2015. Available at: <http://sustentabilidade.estadao.com.br/noticias/geral,nova-especie-de-primata-e-descoberta-na-amazonia,1648925>. Last visit on: July 09th, 2020.

species that require large areas, such as the Jaguar (Panthera onca)[21]. Table 4 below shows the fauna species within the following IUCN categories: vulnerable and endangered. It can be observed that the present project helps to preserve at least 2% of the Brazilian threatened species, most of them being mammals.

Table 2. Species listed by IUCN as vulnerable or endangered categories in Brazil and project region[22].

| Fauna | Threatened species in Brazil | Threatened species in the project region | % of Brazil |
|---|---|---|---|
| Mammals | 181 | 10 | 6% |
| Non-primates | 149 | 8 | 5% |
| Primates | 32 | 2 | 6% |
| Birds | 219 | 2 | 1% |
| Reptiles | 30 | 1 | 3% |
| Amphibians | 257 | 0 | 0% |
| Fish | 54 | 0 | 0% |
| **TOTAL** | **741** | **13** | **2%** |

Regarding flora biodiversity, the presence of the Amazon and Cerrado (Savannah) biomes makes the region a complex environment with a great diversity of species and vegetation types. Three forest inventories have been carried out in protected areas within the region, revealing a great flora biodiversity[23]:

- Sucunduri State Park: a forest inventory was conducted over 5 ha, covering four different vegetation types, resulting in the impressive number of 2,840 trees (DBH>10cm) of 69 families, 218 genders and 365 species;
- Aripuanã Sustainable Development Reserve (where around 18% of the project area is located): a forest inventory was conducted over 3ha, covering two different vegetation types, resulting in 1,419 trees of 39 families and 556 species;
- Guariba Extractive Reserve (encompassing 5% of the project area): two forest inventories were conducted (2ha each), covering four different vegetation types, measuring trees with DBH>10cm.

[21] IUCN 2014. The IUCN Red List of Threatened Species. Version 2014. Available at: <http://www.iucnredlist.org>. Last visit on: July 09th, 2020.

[22] Government of the State of Amazonas. Plano de gestão do mosaico de unidades de conservação do Apuí. Manaus: WWF - Brasil, 2010. 246 p.

[23] Government of the State of Amazonas. Plano de gestão do mosaico de unidades de conservação do Apuí. Manaus: WWF - Brasil, 2010. 246 p.

- Dense tropical rainforest: 527 trees of 38 families and 177 species;
- Open tropical rainforest: 505 trees of 41 families and 145 species
- Savannah: 49 trees of 100 genera and 117 species;
- Floodplain forest: 495 trees of 34 families and 129 species.

Therefore, the current situation indicates that the rainforests of the Southern Amazon are critically endangered, as well as their great biological diversity and presence in several environment types, in addition to the presence of endemic species of extreme importance to the conservation of Amazon biodiversity. Amazonas state has one of the largest priority areas in Brazil, with most of the extremely high priority areas of the country[24].

Socio-economic conditions

Industrial activity in the Novo Aripuanã and Borba micro-region is concentrated in timber production, açaí berries and Brazilian nuts. During the 2008-2018 period, in the municipalities of Novo Aripuanã and Borba, in which the reference region is located, 32% of the total value of production from these three products was represented by logged timber, while around 27% was represented by açaí berries and 18% by Brazilian nuts[25]. In addition, other activities occur such as, copaiba oil extraction (around 11%) and hevea berries (3%), as depicted in the Table below.

## 1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

In a brief context of Brazilian legislation, the Federal Constitution determines that it is concurrent between the Union, Member States and the Federal District the competence to legislate on matters related to the protection of the environment, conservation of nature, defense of the soil, protection of landscape heritage and responsibility for damages to the environment. The same document establishes that municipalities are responsible for legislation at the local level[26]. However, in the absence of a qualified environmental agency or environmental council in the municipality, the state must carry out municipal administrative actions until its creation. In turn, in the absence of a qualified environmental agency or environmental council in the state and municipality, the Union will have to carry out administrative actions until its creation in one of those federative entities[27]. It is also necessary to observe that a municipal law cannot contradict a state law, which in turn cannot contradict a federal law, under penalty of unconstitutionality.

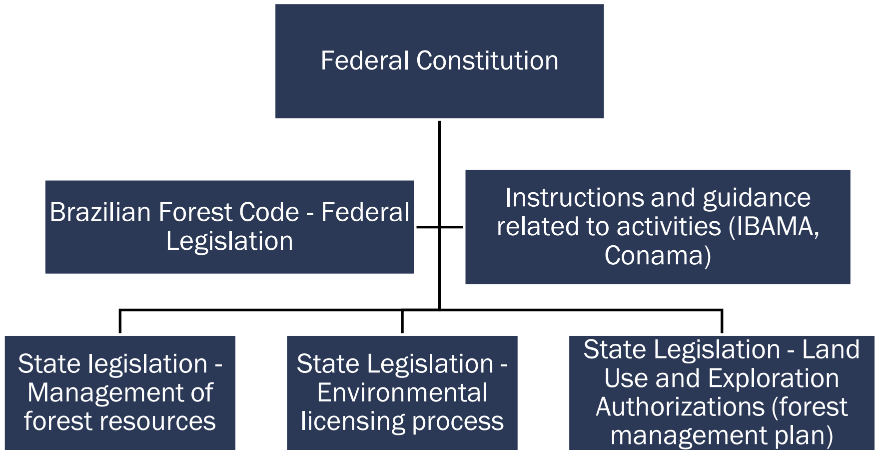
[24] WWF, MMA, 2015.. Áreas Prioritárias para Uso Sustentável e Repartição dois Benefícios da Biodiversidade da Amazônia.

[25] Pesquisa de Extração Vegetal e Silvicultura - Instituto Brasileiro de Geografia e Estatística (IBGE). Available at <https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/16/12705?tipo=grafico> Access on 29/12/2020

[26] Available at http://www.mpsp.mp.br/portal/page/portal/documentacao_e_divulgacao/doc_biblioteca/bibli_servicos_produtos/bibli_boletim/bibli_bol_2006/RDC_07_23.pdf

[27] Available at http://pnla.mma.gov.br/competencias-para-o-licenciamento-ambiental

**Figure 2. Structure of the Brazilian legislation**




Thus, in the state of Mato Grosso, the Secretariat of the Environment (Sema/MT) is the body responsible for environmental licensing, including authorizations for forestry intervention.

- National legislation

  According to the current Brazilian Forest Code (Law Nº 12.651, 25/05/2012[28]), all rural estates located in forest zones shall have:

  I. Permanent Preservation Area (APP): protected areas covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, biodiversity, gene flow of plants and animals, protecting the soil and ensuring the well-being of human population.

  II. Legal Reserve: an area located within a rural property or possession which is required to be segregated, as well as the permanent preservation area, for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[29], eighty percent (80%) of a rural property should be preserved and in the Cerrado Biome, 65%.

There is a clear disregard for legal conservation requirements in the region. Much of the deforestation occurs in areas that should be preserved. Lack of law enforcement by local authorities along with public policies seeking to increase commodities production and encourage land use for agricultural, bio energy and cattle breeding purposes created a scenario of almost complete disregard of the mandatory provisions of the Forest Code. High rates of criminality associated with land disputes usually jeopardize

[28] BRASIL. Law nº. 12.651, of 25 May 2012. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 25 May 2012. < http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>

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

efforts concerning law enforcement improvement. In addition to that, to cover vast distances of areas with low demographic density makes tracking of illegal activities and land surveillance very difficult for the authorities[30]. Accordingly, policies implemented to address illegal deforestation only by means of command-and-control approaches have proven to be ineffective so far.

Given the permanent attempts against the Project Area, the project proponent uses their best efforts to prevent property invasion and to remain in compliance with Brazilian Forest Code.

- State legislation

  Instance 1 does not have Sustainable Forest Management Plan activities. In the state of Mato Grosso, the Secretariat for the Environment (SEMA/MT) is the body responsible for environmental licensing and monitoring.

- Climate change legislation

  Regarding other regulatory frameworks that exist in Brazil, on November 28th, 2019, occurred the approval of the Federal Decree 10,144/2019, which establishes the National Commission for Reducing Emissions of Greenhouse Gases from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+[31].

  The development of this Project is not in conflict with such Decree. In terms of the object, jurisdictionally and scope of the Decree 10,144/2019, it is understood that its application is merely administrative, that is, it merely organizes the functioning of the Federal Government about the REDD+ agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, does not establish duties or obligations to the society.

  Thus, Decree 10,144/2019 only limits the Federal Government's understanding of what shall be accounted for in order to comply with mitigation commitments of other countries to the United Nations Framework Convention on Climate Change. It does not impose a barrier or obstacles to the implementation of REDD projects and the commercialization of carbon assets generated from these projects. This consideration in the Decree does not affect or interfere with the voluntary or regulated carbon market, domestic or international.

  There is no law in Brazil that does not allow or restrict the execution of REDD projects or that does not allow or restrict any commercial transaction of assets resulting from REDD

[30] MOUTINHO, P. *et al*. REDD no Brasil: um enfoque amazônico: fundamentos, critérios e estruturas institucionais para um regime nacional de Redução de Emissões por Desmatamento e Degradação Florestal – REDD. Brasília, DF: Instituto de Pesquisa Ambiental da Amazônia, 2011. < https://ipam.org.br/wp-content/uploads/2015/12/redd_no_brasil_um_enfoque_amaz%C3%B4nico.pdf>

[31] The Decree is available in Portuguese at: < http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm>

projects. On the contrary, such transactions are valid and legally permitted. Thus, there is no contradiction or irregularity between the Sepoti REDD Project and such Decree.

The Table below presents the compliance of the Project with aforementioned laws:

| Law | Content | Compliance |
|---|---|---|
| Federal Legislation | | |
| Law Nº 12.651 | This Law establishes general rules on the protection of vegetation, Permanent Preservation areas and Legal Reserve areas; forest exploitation, the supply of forest raw materials, the control of the origin of forest products and the control and prevention of forest fires and provides economic and financial instruments to achieve its objectives. | Instance 1 complies with the current Federal legislation, as evidenced by the regularity in the CAR and the absence of legal pending issues on environmental matters. |
| Decree 5975 | Provides information for the exploitation of forests and successor formations, comprising the regime of sustainable forest management and the regime of suppression of forests and successor formations for alternative land use. | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Decree does not apply. |
| State Legislation | | |
| Complementary law 233 | Provides information for the Forest Policy of the State of Mato Grosso and other provisions. | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Complementary law does not apply. |
| Decree 1313 | Regulates Forest Management in the State of Mato Grosso and makes other provisions. | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Decree does not apply. |
| Complementary law 668[32] | Amends provisions of Complementary Law No. 592, of May 26, 2017, which provides for the Environmental Regularization Program - PRA, regulates the Rural Environmental Registry - CAR, the Environmental Regularization of Rural Properties and the Environmental Licensing of Polluting Activities or users of natural resources, within the scope of the State of Mato Grosso, and other measures; as well as the provision of Complementary Law No. 233, of December 21, | Instance 1 complies with the current State legislation and does not perform sustainable forest management within its forest area. |

[32] Available at https://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/b88b0eb8f863f223042585b2005f778a?OpenDocument

| | | |
|---|---|---|
| | 2005, which provides for the Forest Policy of the State of Mato Grosso and other measures. | |
| Complementary law 698 | Amends provisions of Complementary Law No. 233, of December 21, 2005, which provides for the Forest Policy of the State of Mato Grosso and other provisions. | Instance 1 complies with the current State legislation and does not perform sustainable forest management within its forest area. |
| IN SEMA 1 | Approves procedural rules for the issuance, use and control of Forestry Guides – GF, in internal and interstate operations. | Instance 1 does not perform sustainable forest management within its forest area; therefore, it does not apply. |
| IN SEMA 2 | Provides for the procedure for transporting forest products and by-products with a vehicle without mandatory license plates for enterprises that consume and transform forest products and by-products, within the scope of the State Secretariat for the Environment - SEMA/MT. | Instance 1 does not perform sustainable forest management within its forest area; therefore, it does not apply. |
| **Standards and guidelines from national agencies** | | |
| Administrative Rule 1 IBAMA | It institutes, within the scope of this autarchy, the technical guidelines for the elaboration of sustainable forest management plans – SFMP mentioned in art. 19 of Law 4,771, of September 15, 1965 | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply. |
| Administrative Rule 5 IBAMA | Provides for technical procedures for the preparation, presentation, execution and technical evaluation of sustainable forest management plans - SFMP in primitive forests and their forms of succession in the legal Amazon, and other measures | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply. |
| Normative Instruction 2 MMA | Amends provisions of normative instruction no. 5, of December 11, 2006, and makes other provisions | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Normative Instruction does not apply. |
| Resolution 406 CONAMA | Establishes technical parameters to be adopted in the preparation, presentation, technical evaluation and execution of a sustainable forest management plan - SFMP for timber purposes, for native forests and their forms of succession in the Amazon biome | Instance 1 does not perform sustainable forest management within its forest area; therefore, this Resolution does not apply. |
| **Legislation on climate change and carbon market** | | |
| Decree 10144 | Establishes the National Commission for the Reduction of Greenhouse Gas Emissions from Deforestation and Forest Degradation, | The development of this Project is not in conflict with such Decree. In terms of the object, jurisdictionally and scope of the |

| | | |
|---|---|---|
| | Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+. | Decree 10,144/2019, it is understood that its application is merely administrative, that is, it merely organizes the functioning of the Federal Government about the REDD+ agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, it does not establish duties or obligations to the society. |
| Decree 11075[33] | Establishes the procedures for the elaboration of Sectoral Plans for Mitigation of Climate Changes, institutes the National System for the Reduction of Greenhouse Gas Emissions | The decree defines the carbon credit as a financial asset, the institution of the National System for the Reduction of Greenhouse Gas Emissions and organizes the functioning of the Government about the carbon agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, it does not establish duties or obligations to the society. |

## 1.15 Participation under Other GHG Programs

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

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

### 1.15.2 Projects Rejected by Other GHG Programs

Not applicable. This project has not requested registration under any other GHG Programs, therefore, the project has not been rejected by any other GHG programs.

## 1.16 Other Forms of Credit

[33] Available at https://presrepublica.jusbrasil.com.br/legislacao/1505298704/decreto-11075-22

### 1.16.1 Emissions Trading Programs and Other Binding Limits

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

### 1.16.2 Other Forms of Environmental Credit

The project area has not sought or received any other form of GHG-related environmental credit, including renewable energy certificates.

### Supply Chain (Scope 3) Emissions

The present REDD project's GHG emission reductions are not part of a supply chain, i.e., there is no network of organizations (e.g., manufacturers, wholesalers, distributors, and retailers) involved in the production, delivery, and sale of a product or service to the consumer. Therefore, there are no organizations upstream nor downstream of the goods and services whose GHGs are impacted by the present REDD project activity.

## 1.17 Sustainable Development Contributions

The primary objective of the Sepoti REDD Project is to avoid the unplanned deforestation (AUD) of its instances, consisting of 100% Amazon biome. The Project also has the function of establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Amazon biodiversity and also to climate regulation in Brazil and South America.

These measures contribute to several nationally stated sustainable development priorities, such as the objectives from the Brazilian Government related to the UN Sustainable Development Goals (SDGs)[34] and the Nationally Determined Contribution (NDC).

In Brazil, the National Commission for Sustainable Development Objectives (CNODS) is responsible for internalizing, disseminating and providing transparency to the process of implementing the 2030 Agenda for Sustainable Development in Brazil[35]. The Commission is made up of eight government representatives (Government Secretariat of the Presidency of the Republic; Civil House of the Presidency of the Republic; Ministry of Foreign Affairs; Ministry of Citizenship; Ministry of Economy; Ministry of Environment; representative of the state/district levels; representative of the municipal level) and by eight representatives of civil society and the private sector. The monitoring of the country's advances in relation to the SDGs established as priorities is carried out by the Institute of Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE), which are also permanent technical advisory bodies.

[34] UN's Sustainable Development Goals and targets available at: https://sdgs.un.org/goals

[35] More information on the CNODS available at < https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/comissao-nacional-para-os-objetivos-do-desenvolvimento-sustentavel-cnods>

There is no monitoring at the specific level of projects, and progress at the national level can be accompanied by the synthesis report carried out by IBGE[36] and by the IPEA reports[37]. In addition, in 2018 there was the SDG Award, an initiative of the Federal Government whose objective is to encourage, value and give visibility to practices that contribute to achieving the goals of the 2030 Agenda throughout the national territory. The first edition of the Award had 1045 entries to compete in four categories: government; for-profit organizations; non-profit organizations; and teaching, research and extension institutions.

The Sepoti REDD Project main planned contributions to the Brazilian Priority Goals are listed below[38]. These contributions are monitored by the parameters defined by the REDD project:

- SDG 1: No poverty

The project positively impacts people in situations of poverty and vulnerability, mainly through investments in the local community that lives in the vicinity of the project area, thus ensuring access to basic and essential services for human development. Thus, the project collaborates with targets such as:

- 1.3 “Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable”;
- 1.4 “By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance”;
- 1.5 “By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters”.

- SDG 2: Zero hunger

The project itself enhances better management of non-timber forest products as, through the carbon credits sales, qualifies investments in the local community training and capacity building programs. Likewise, strengthen ecosystem conservation and preservation. Guideline targets are:

- 2.4“By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality”.

- SDG 3: Good health and well-being

[36] Available at < https://odsbrasil.gov.br/relatorio/sintese>
[37] Available at < https://www.ipea.gov.br/ods/publicacoes.html>
[38] Available at < https://odsbrasil.gov.br>

Via carbon credits income, the project promotes the community's well-being and helps to solve local common issues. Therefore, the project may contribute to the following targets:

- 3.3 “By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases”.

- SDG 4: Quality education

The carbon project encourages the local community to participate in courses regarding technical skills and educational basis. Moreover, the carbon project encourages the development of partnerships with educational entities striving for socioenvironmental scholarly initiatives. The targets determined by the UN that will act as a guideline for monitoring actions are:

- 4.1 “By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes”;

- 4.4 “By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship”;

- 4.5 “By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations”;

- 4.6 “By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy”;

- 4.7 “By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development”.

- SDG 5: Gender equality

The carbon project expects a continuous improvement concerning women's inclusion, such as through sponsoring events and initiatives which promote a gender equality environment. Thus, the project may have initiatives that contribute to the following targets:

- 5.2 “Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation”;

- 5.4 “Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate”.

- SDG 8: Decent work and economic growth

The REDD project aims to offer training and income generation in the project region as a measure to conserve native forest standing and promote economic viability and growth in the local community. Guideline targets are:

- 8.3 “Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small-and medium-sized enterprises, including through access to financial services”;

- 8.6 “By 2020, substantially reduce the proportion of youth not in employment, education or training”.

- SDG 12: Ensure sustainable production and consumption patterns

The carbon project nurtures a better environmental management system since increases stakeholder awareness concerning the climate changes mitigations, and whichever environmental activity the landowners intend to apply. Alongside, the project is based on encouraging sustainable development and maintaining the standing forest, and it aims to optimize access to non-timber forest products and the consumption of local inputs. One of the main objectives is to reduce illegal deforestation and profit from this activity, offering alternatives for income and extraction. The REDD Project has the following target and guidelines:

- 12.6 “Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle”;
- 12.8 “By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature”.

- SDG 13: Take urgent action to combat climate change and its impacts

Another of the main objectives of the REDD project is to reduce greenhouse gas emissions through the conservation of standing forest. Thus, its activity is already an action to combat climate change and its effects. In addition, the project stimulates biodiversity monitoring initiatives in a measure to combat climate changes. The targets and guidelines for this objective are:

- 13.2 “Integrate climate change measures into national policies, strategies and planning”;
- 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

- SDG 15: To protect, restore and promote the sustainable use of terrestrial ecosystems, to manage forests sustainably, to combat desertification, to halt and reverse land degradation, and to halt the loss of biodiversity

The project is based on the conservation and restoration of forests in the Amazon biome, ensuring forest services, preservation of natural resources, and biodiversity. The targets and guidelines related to this objective are:

- 15.1 “By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements";
- 15.5 “Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species”;
- 15.9 “By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts”;
- 15.a “Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems”;
- 15.c “Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities”.

Reducing deforestation and promoting sustainable development in the Amazon and Cerrado is also a key component to Brazil’s Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, Ministério do Meio Ambiente), the implementation of REDD+ activities are an important component to meet the Country’s contribution under the United Nations Framework Convention on Climate Change while preserving natural forest resources[39].

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

- Strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels;
- Strengthening policies and measures with a view to achieve, in the Brazilian Amazon, zero illegal deforestation by 2030 and compensate for greenhouse gas emissions from legal suppression of vegetation by 2030;

## 1.18 Additional Information Relevant to the Project

### Leakage Management

Although there is a risk of leakage, the proponents believe that the project activity will have positive impacts on surrounding areas. This project activity might be a successful benchmark of the following technical and economic aspects:

I. Sustainable management of forest resources generating success and profit;

II. Additional return to forest management, thanks to REDD incentives, which can compensate avoiding deforestation for other activities;

[39] Commitments available in Brazil’s iNDC, from 2016, and reinforced in its update in 2020/2021. Available at <https://www4.unfccc.int/sites/NDCStaging/Pages/Party.aspx?party=BRA>

III. Positive example of sustainable real estate maintenance, in addition to profits with sustainable management plus REDD revenues.

In this context, the project may well stimulate other landowners to adhere to this project concept.

<u>**Leakage Management Plan**</u>

The main objective of the project is to avoid unplanned deforestation. This goal will be achieved through the expansion of monitoring of the area, along with the inclusion of the local community in the project activities, with environmental education and alternative sources of income to minimize risks of invasion and deforestation within the project area and the reference region.

As aforementioned throughout this project description document, the Sepoti REDD Project plans to implement activities and training as a way of providing an alternative income source for the local communities that surround the project area.

The non-timber forest product is still to be chosen, as further study is necessary.

Brazilian law such as Decree No. 6,040 ensures the rights of traditional people and communities of attaining sustainable development, and by this, activities such as collection of forest products are permitted as long as they do not cause any damage to the area in question[40]. Hereupon, the project proponents neither can (by law) or want to prohibit the local communities from collecting NTFP in the project area.

Moreover, the project activities will enable the creation of jobs to monitor the area, prioritizing the hiring of local residents for monitoring of the area, with professional training. Income from the sale of credits will make it possible to invest in the educational and professional training of children and adults in the community.

### Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

### Further Information

No further information to disclose.

# 2 SAFEGUARDS

## 2.1 No Net Harm

[40] Further detailed information about legal guarantees is discussed on sections 1.14 and 2.5 of this document.

The project is designed so that there are no negative impacts. The Table below provides details on the identified potential risks which might affect the project activities and will be monitored.

**Table 3. Project Risks**

| Identified Risk | Potential impact of risk on climate, community and/or biodiversity benefits | Actions needed and designed to mitigate the risk |
|---|---|---|
| Uncertainties relating to standing native vegetation cover in the future | GHG emissions, loss of habitat, ecological interactions and animal and plant species. | Monitoring and supervision to avoid deforestation of forest within the project area. |
| Catastrophic natural and/or human-induced events (e.g. landslides, fire) | Potential risk to community life and permanence, loss of habitat, ecological interactions, animal and plant species. | |
| Illegal activities within the project area | Deforestation, social conflicts, development of parallel and illegal economies, increase in criminality. | Job creation, development of socioeconomic actions involving the community, promotion of formal and environmental education. |
| Increase suppression of native vegetation within the project area | Deforestation, land use change, GHG emissions. | REDD+ Project: the additional income generated by carbon credits aims to mitigate the absence of another economic activity that would be carried out in the forest area. |
| Conflict management with communities in the project area, due to banning of negative impacting/illegal activities | Conflicts with the community can prevent/hinder the implementation of new socioeconomic activities aimed at the local society. | Encouragement and investment in social, economic and environmental aspects in the project region; Increasing independence of the communities in the project area. |

These risks will be monitored as part of the monitoring report described on the section Monitoring Plan of this VCS PD and also as part of the monitoring of the non-permanence risk, which shall be evaluated at each verification event.

## 2.2 Local Stakeholder Consultation

As preconized in the VCS Standard v4 (item 3.17.3), the project proponent will assess the local stakeholders potentially impacted by the project.

Local entities having some influence and activities developed in the Reference Region were chosen through a process to identify them and their possible impact on the Project Activity. Stakeholders chosen for local consultation also include communities and neighbors that might be impacted and set potential partnerships in the future. Thus, the output list of stakeholders from this analysis is described below:

**Table 4. Profile of the stakeholders identified**

| Stakeholder Classification | Justification |
|---|---|
| Government agency and/or representatives -Direct public administration<br>(State and Municipality) | The carbon project is believed to be in the public sector's interest as it can help the state and municipalities achieve their goals of mitigating greenhouse gas emissions and illegal deforestation. In addition, partnerships with the public sector are very important for the development of activities throughout the project. |
| Public Administration Company (Autarchy)<br>• INCRA (National Institute of Colonization and Agrarian Reform)<br>• ICMBio (Chico Mendes Institute for Biodiversity Conservation) | These are agencies that are related to the project activity.<br>INCRA is the institute responsible for regulating all rural properties and public lands in the Union and may also assist in verifying the ownership of properties included in the project.<br>ICMBio is an institution linked to the Ministry of the Environment that works in the administration and conservation of protected areas. Since a REDD project is a conservation project, communication with this type of stakeholder is considered essential. |
| Unions | The participation of unions is important to spread knowledge of the carbon market and include the vision of employees and workers in the region in the development of the project. |
| Universities and Research institutes | It is believed that the participation of education and research institutions throughout the project is important to develop |

| | |
|---|---|
| | partnerships and help in the search for sustainable technological innovations, as well as the development of monitoring of fauna and flora, employees and communities training, carbon stock research, etc. |
| NGOs | NGOs are entities focused on the population's objectives, whether social, environmental or economic, without ties to public governmental entities. Thus, they bring a different point of view to the activity, and communication with these entities brings transparency to the project.<br><br>In addition, they are key agents for the development of partnerships to strengthen the project activity and enhance socio-environmental co-benefits. |
| Private organizations | Organizations responsible for carrying out outsourced activities related to forest conservation and social impact. |
| Local communities | Communities surrounding the Project Area are fundamental agents for the conservation of the region, and the strengthening of their relationship with the property will enhance the generation of socio-environmental co-benefits. Thus, in addition to communicating with the resident families, it is also important to communicate with associations, cooperatives and public health programs that deal directly with the people of the region and can bring insight on the needs of these communities, generating opportunities for improvement with the income from the carbon project. |

As required on the VCS Standard, v.4 item 3.17.15, “the management teams involved in the project have expertise and prior experience implementing land management and carbon projects with community engagement at the project scale”. Information on the Project Management Team will be further detailed as part of the Non-Permanence Risk analysis.

As required on the VCS Standard, v4, item 3.17.17 – Communication and Consultation, for the Local Stakeholder Consultation, a comprehensive project summary will be actively presented to the communities and other stakeholders in Portuguese. The Project Proponent will objectively communicate in a culturally appropriate manner, including language and gender sensitivity, directly with local stakeholders or their legitimate representatives when appropriate:

i) The project design and implementation, including the results of monitoring;

ii) The risks, costs and benefits the project may bring to local stakeholders;

iii) All relevant laws and regulations covering workers' rights in the host country;

iv) The process of VCS Program validation and verification and the validation/verification body's site visit.

The project proponent understands that stakeholders want and need to be involved in the Project design, implementation, monitoring and evaluation throughout the Project's lifetime. Therefore, complying with the VCS Standard v4 (item 3.17.18), a communication channel will be established for stakeholders to continually express their concerns and to solve eventual conflicts and grievances that arise during project planning, implementation, and monitoring.

It is expected that the communication channel will be a mechanism to ensure that the project proponent and all other entities involved in project design and implementation are not involved in or complicit in any form of discrimination or harassment with respect to the project. All complaints will be available to stakeholders and auditors.

The process for receiving, hearing, responding to and attempting to resolve grievances will be performed within a reasonable time period. This Grievance Redress Procedure has three stages (VCS Standard, v4; item 3.17.18):

1) The project proponent shall attempt to amicably resolve all grievances and provide a written response to the grievances in a manner that is culturally appropriate;

2) Any grievances that are not resolved by amicable negotiations shall be referred to mediation by a neutral third party;

3) Any grievances that are not resolved through mediation shall be referred either to a) arbitration, to the extent allowed by the laws of the relevant jurisdiction or b) competent courts in the relevant jurisdiction, without prejudice to a party's ability to submit the grievance to a competent supranational adjudicatory body, if any (the time to accomplish this stage depends on local jurisdiction delays).

The Stakeholder Consultation is going to be divided into two events: a remote meeting and an on-site consultation with the local community that resides near the project area, both to be scheduled throughout the project development process.

Furthermore, the participants will be informed that the period for requesting information and comments about the Sepoti REDD Project was open. The deadline for comments will be 30 days from the presentation date, and it could be done by phone or e-mail, both of which were provided in the presentation and explanatory letters.

## 2.3 Environmental Impact

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

The Amazon Biome, the location of a hugely diverse fauna and flora, spreads over almost 50% of the Brazilian territory[41]. However, the uncontrolled deforestation is breaking up the forest in this habitat and, without necessary care, entire regions with local fauna and ancient habitats of unique species are at risk of complete destruction[42]. To further quantify, this biome holds the biggest variety of species in the world, and deforestation and degradation of tropical forests are the main cause of global biodiversity loss[43].

Another benefit, as mentioned on previous Sections of this VCS PD, is that the Sepoti REDD Project also has the function of establishing a barrier against the advancement of the Brazilian Arc of Deforestation, in addition to protecting the standing forest in a high-pressure cattle ranching region. This creates an urgent situation on which levels of pressure and priority for conservation are high.

## 2.4 Public Comments

The present PD is now being submitted as under validation to the VCS Pipeline Listing in order to start the public comment period.

## 2.5 AFOLU-Specific Safeguards

**Local Stakeholder Identification and Background**

According to the VCS Standard, v4, the project proponent shall conduct a thorough assessment of the local stakeholders that will be impacted by the project, including:

1. The process(es) used to identify the local stakeholders likely impacted by the project and a list of such stakeholders:

   Stakeholders will be identified through research, visits to the project region, and local knowledge from the Instance 1 landowner and management team. As detailed in Section 2.2, stakeholders will be identified considering the communities, government agencies, and educational and research entities, considering relevant Amazonas State and Amazon biome institutions and NGOs within the Reference Region. Sustainable development and rural development agencies will also be contacted. The list is available in the section Local Stakeholders Consultation above.

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

[42] Margulis S. Causas do Desmatamento da Amazônia Brasileira. BANCO MUNDIAL. Brasil. July, 2003. Available at: http://www.terrabrasilis.org.br/ecotecadigital/pdf/causas-do-desmatamento-da-amazonia-brasileira.pdf .

[43] BRASIL. Ministério do Meio Ambiente (MMA). Inter-relações entre biodiversidade e mudanças climáticas: Recomendações para a integração das considerações sobre biodiversidade na implementação da Convenção-Quadro das Nações-Unidas sobre Mudança do Clima e seu Protocolo de Kyoto. Brasília, 2007. 220 p. (Biodiversidade, v.28). Available at:http://www.terrabrasilis.org.br/ecotecadigital/index.php/estantes/diversos/2115-serie-biodiversidade-28-inter-relacoes-entre-biodiversidade-e-mudancas-climaticas .

2. The Project and actions involving local communities will be monitored by SOCIALCARBON indicators or any other applicable social-environmental standard at each verification event to analyze the extent of alternative income generation sources and other programs besides the applied methods for local stakeholders' consultation. Identification of any legal or customary tenure/access rights to the territories and resources, including collective and/or conflicting rights, held by local stakeholders:

   There are no communities living within the Project Area. Instance 1 landowner recognize the presence of the communities near the Project Area and take efforts to maintain a healthy relationship with them. These communities have no rights over the Project Area nor conflicts over land tenure or use rights with the owners.

   On July 13, 2006, the Commission for the Sustainable Development of Traditional Communities was instituted in Brazil by decree[44] and updated in 2016[45], with the objective of implementing a national policy especially directed at such communities.

   The Decree No. 6,040 of February 7, 2007[46], called National Policy for the Sustainable Development of Traditional People and Communities, has the specific objective of promoting the aforementioned "sustainable development" with an emphasis on the recognition, strengthening and guarantee of their territory, social rights, environment, economic and culture. It also advocates the respect and appreciation of the identity of traditional people and communities, as well as their forms of organization and their different institutions[47].

   The Policy is structured around four strategic axes:

   1. Access to Traditional Territories and Natural Resources
   2. Infrastructure
   3. Social Inclusion and
   4. Promotion and Sustainable Production

   As previously described in section 1.17, these are the same goals and guidelines of this REDD Project.

   Article 215 of the Brazilian Constitution determines that the State will guarantee the full exercise of cultural rights. And as distinctive signs of the identity of the different groups that form Brazilian society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[48].

   The REDD methodology and the application of additional standards such as the SOCIALCARBON methodology guarantee and are guidelines for the execution of a forest

[44] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/dnn/dnn10884.htm> Last visit 20/07/2022

[45] Available at <http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Decreto/D8750.htm#art20> Last visit 20/07/2022

[46] Available at <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm> Last visited on 05/01/2021.

[47] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visit 05/01/2021

[48] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visited on 05/01/2021.

conservation project that ensures not only the avoidance of unplanned deforestation, but also the integration and benefits of the traditional communities surrounding the project area.

Thus, the project is neither based on or plans the removal or alteration of this people's way of life, guaranteeing land use and subsistence production, in addition to traditional customs and methods.

3. A description of the social, economic and cultural diversity within local stakeholder groups and the differences and interactions between the stakeholder groups:

   As stated in Item 1, project stakeholders might involve from government agencies to the resident community inside and outside the Project Area. Thus, by applying different forms of consultation, it is considered that the Project covers the social, economic, and cultural diversity of the different stakeholders.

   For government agencies, private companies and NGOs, communication will be carried out remotely, through writing and speaking, with the presentation of the Project, its impacts and monitoring methodologies, accounting for credits and actions in the region. In a different way, for communicating the Project to local communities within the Reference Region, a presentation will be performed considering their particularities, as well as a socioeconomic diagnosis aiming the development of an action plan to be put into practice along the project lifetime.

   These communities have their rights guaranteed by federal, state, and municipal legislation, in addition to assistance from NGOs and various agencies, characterizing the interaction between the groups of stakeholders.

4. Any significant changes in the makeup of local stakeholders over time:

   Any future significant changes will be informed in this Section.

5. The expected changes in well-being and other stakeholder characteristics under the baseline scenario, including changes to ecosystem services identified as important to local stakeholders:

   The risks and impacts of the Project are analyzed at Section “No Net Harm”, designing mitigation strategies for each impact observed. No alteration of communities’ area, methodology or way of life in general is predicted. It is planned that the project's revenue will be invested on more socio-environmental programs to involve the local community in the Project and, therefore, minimize the damage to the environment and illegal deforestation.

### Risks to Local Stakeholders

The Project Proponent understands that some risks are inherent to the Project Activity, and that others may arise from the stakeholder’s point of view. Considering this, the Table below presents potential risks and impacts to local stakeholders and measures taken to mitigate those:

Table 5. Risks to Local Stakeholders

<table>
<tr><th>Identified Risk</th><th>Potential impact of risk on climate, community and/or biodiversity benefits</th><th>Actions needed and designed to mitigate the risk</th></tr>
<tr><td>Uncertainties relating to standing native vegetation cover in the future</td><td>GHG emissions, loss of habitat, ecological interactions and animal and plant species.</td><td rowspan="2">Monitoring and supervision to avoid deforestation of forest within the project area.</td></tr>
<tr><td>Catastrophic natural and/or human-induced events (e.g. landslides, fire)</td><td>Potential risk to community life and permanence, loss of habitat, ecological interactions, animal and plant species.</td></tr>
<tr><td>Illegal activities within the project area</td><td>Deforestation, social conflicts, development of parallel and illegal economies, increase in criminality.</td><td>Job creation, development of socioeconomic actions involving the community, promotion of formal and environmental education.</td></tr>
<tr><td>Increase suppression of native vegetation within the project area</td><td>Deforestation, land use change, GHG emissions.</td><td>REDD+ Project: the additional income generated by carbon credits aims to mitigate the absence of another economic activity that would be carried out in the forest area.</td></tr>
<tr><td>Conflict management with communities in the project area, due to banning of negative impacting/illegal activities</td><td>Conflicts with the community can prevent/hinder the implementation of new socioeconomic activities aimed at the local society.</td><td>Encouragement and investment in social, economic and environmental aspects in the project region; Increasing independence of the communities in the project area.</td></tr>
</table>

**Respect for Local Stakeholder Resources**

The Project recognizes, respects, and supports local stakeholders' customary tenure/access rights to territories and resources. The Project will never encroach on private properties or relocate people off their lands without consent. At present there are not any ongoing or unresolved conflicts over property ownership, usage or resources rights, the Project shall not undertake activities that could exacerbate the conflict or influence the outcome of unresolved disputes.

The Project intends to offer benefits and training for the local community, including health related benefits, in addition to providing education for the local community.

No community member has been or will be removed from their land, on the contrary, communities will be supported through programs and incentives the stimulated by the Project. In addition, the Project did not introduce any invasive species or allow an invasive species to thrive through its implementation.

**Communication and Consultation**

The project will take all appropriate measures to communicate and consult with local stakeholders in an ongoing process for the life of the project. As described above, the project intends to carry out local stakeholder consultations, which will be monitored by the additional standard SOCIALCARBON. Every consultation shall communicate:

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

Grievance redress and conflict management procedures, as well as benefit sharing mechanisms, will be discussed with communities through the stakeholder consultations.

For validation and verification, two consultations will be held, one remotely and the other one on-site, as per described at Section 2.2 – Local Stakeholder Consultation.

Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All the interested parts will received Future Carbon's contact addresses during the Local Stakeholder Consultation. All comments received will be responded, and grievances will be resolved in a suitable time frame whenever possible, taking into account culturally appropriate conflict resolution methods.

# 3 APPLICATION OF METHODOLOGY

## 3.1 Title and Reference of Methodology

This project uses the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012[49].

Furthermore, the following tools were used:

[49] Available athttps://verra.org/methodology/vm0015-methodology-for-avoided-unplanned-deforestation-v1-1/

- VT0001 - Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3, published on 01-February-2012[50];
- AFOLU Non-Permanence Risk Tool v4, published on 19-September-2019[51].

## 3.2 Applicability of Methodology

| VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1 | |
|---|---|
| **Applicability Conditions** | **Justification of Applicability** |
| a) Baseline activities may include planned or unplanned logging for timber, fuelwood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements. | None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4.<br><br>The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvest, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure , such as waterways and roads.<br><br>Therefore, in the baseline scenario, the Project Area would continue to be illegally deforested by the deforestation agents described above. With that said, the present criteria are fulfilled. |
| b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the methodology (table 1 and figure 2). | Within the categories of Table 1 and Figure 2 of the Methodology, the present Project Activity falls within category A, "Avoided Deforestation without Logging". The reason is that the project area contains 100% native vegetation and has never been deforested in |

[50]Available at https://verra.org/methodology/vt0001-tool-for-the-demonstration-and-assessment-of-additionality-in-vcs-agriculture-forestry-and-other-land-use-afolu-project-activities-v3-0/

[51] Available at https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

| | |
|---|---|
| | the past. In addition, it is important to note that degradation is not included neither in the baseline nor in the project scenario. |
| c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agroforestry systems meeting the definition of "forest". | These forest classes composing the Project Area are named as per the Technical Manual for Brazilian Vegetation[52]. The area is considered forest as per the definition of adopted by FAO[53]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ.<br><br>No deforested, degraded or areas otherwise modified by humans were included in the Project Area at the Project Start Date. |
| d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date. | The Project Area consisted of 100% tropical rainforest in 2007 – over 10 years prior to the project start date – all of which according to the Brazilian definition of forest[54]. This was ascertained using satellite images, as described in the section Baseline Scenario of the present VCS PD. |
| e) The project area can include forested wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable. | As described at Section 1.13 of the present VCS PD, the only soil type within the Project Area is the dystrophic Red-Yellow Argosols. Therefore, no peat or peat swamp forests were found within the Project Area, satisfying this applicability criterion. |

[52] Avaliable at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf
[53] Available at < https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses>
[54] Brazil adopts the FAO forest definition: "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity in situ." Available at: <http://www.fao.org/docrep/006/ad665e/ad665e06.htm>.

| VT001 | |
|---|---|
| a) AFOLU activities 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; | The present AFOLU project activity does not involve any economic activity apart from forest conservation, i.e., there are no financial or economic benefits other than VCUs related income. Therefore, it does not lead to violation of any applicable law even if the law is not enforced.<br><br>Sustainable Forest Management Plan is an authorized and endorsed activity in Brazil, and Instances must have all environmental and legal authorizations necessary to conduct the activity, should it be the case for new Instances joining the Project, as Instance 1 does not perform sustainable forest management activities. |
| b) 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. | The Methodology provides a stepwise approach to justify the determination of the most plausible baseline scenario, which is detailed at Section 3.4 – Baseline Scenario, below. |

## 3.3 Project Boundary

- Reference Region

The Reference Region (RR) is an analytical domain through which information on rates, agents, drivers and underlying causes of land-use and land-cover (LU/LC) change are obtained, and subsequently used for future projection and monitoring.

According to the applied Methodology, as no applicable sub-national or national baseline is available, and the country or subnational region has not been divided into spatial units for which deforestation baselines will be developed, a baseline must be developed for the Reference Region.

The Reference Region must encompass the Project Area, the Leakage Belt and any other geographic area that is relevant to determine the baseline of the Project Area.

A geographic area with agents, drivers and overall deforestation patterns observed during the minimum 10-year period preceding the start date was determined, representing a credible proxy for possible future deforestation patterns in the project area.

The RR was defined in accordance with the Methodology, following two criteria:

1. For projects below 100,000 ha, the Reference Region should be 20-40 times the size of the Project Area.
2. The conditions determining the likelihood of deforestation within the Project Area being similar or expected to become similar to those found within the Reference Region, depending on: the landscape configuration and ecological conditions (elevation, slope, vegetation, and rainfall), socio-economic and cultural conditions, and agents and drivers of deforestation (agent groups, infrastructure or other drivers). The latter condition was the most important for adjusting the RR for it to represent the land-use dynamics more accurately. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the principal means of human and product transportation in the region. As such, from the areas directly surrounding the project, the RR was expanded to meet the nearest main waterways and roads.

In addition, according to the Methodology, three main criteria are relevant to demonstrate that the conditions determining the likelihood of deforestation within the Project Area are similar or expected to become like those found within the Reference Region:

- **Agents and drivers of deforestation:** Timber logging (both legal and illegal) and cattle ranching are important economic activities within the Reference Region. As detailed in Section 1.13 and to be presented in Section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats throughout the Amazon region. Thus, the analysis of the Reference Region definition includes these factors.
- **Socio-economic and cultural conditions:** The Methodology implies that “the legal status of the land (private, forest concession, conservation concession, etc.) in the baseline case within the project area must exist elsewhere in the reference region. If the legal status of the project area is a unique case, demonstrate that legal status is not biasing the baseline of the project area”. This is complied with the areas surrounding the properties that are not public or part of any protected area, such as the Project Area. These conditions also comply with Land Use and Land Tenure items once the conditions of the Project Area are found elsewhere in the Reference Region. The Project Area is governed by the same policies,

legislation and regulations that apply elsewhere in the Reference Region. These policies are detailed in Section 1.14. Data presented of the private areas is available at Brazil's Environmental Rural Registration[55], National Protected Areas[56]. It is important to note that neither Indigenous Lands[57] nor Protected Areas were found nearby the Project Area.

- **Landscape configuration and ecological conditions:** To define the Reference Region, the watersheds located around the Project Area were used as units. For each of these watersheds, the average values of elevation, slope and precipitation were determined, as well as the percentages of the different types of vegetation. Based on these values, it was possible to visualize areas that presented similar values to the Project Area's parameters. The area units were then used to achieve an extent of approximately 20 times the size of the Project Area as the Reference Region.

From the definition of this area, which has 778,490 hectares (29.87 times the Project Area) and is distributed over the following municipalities Novo Aripuanã, Terra Preta and Borba. The criteria related to the type of vegetation, elevation, slope and precipitation were tested to verify the similarity in relation to the Project Area and the rest of the Reference Region. For all four variables, the values met the criteria, which indicates an adequacy of the Reference Region.

[55] Available at <https://www.car.gov.br/publico/municipios/downloads>
[56] Available at <https://metadados.snirh.gov.br/geonetwork/srv/api/records/9407d38f-84d2-48ea-97dd-ee152c493043>
[57] Available at <https://www.gov.br/funai/pt-br/atuacao/terras-indigenas/geoprocessamento-e-mapas>

**Figure 3. Reference Region Location**

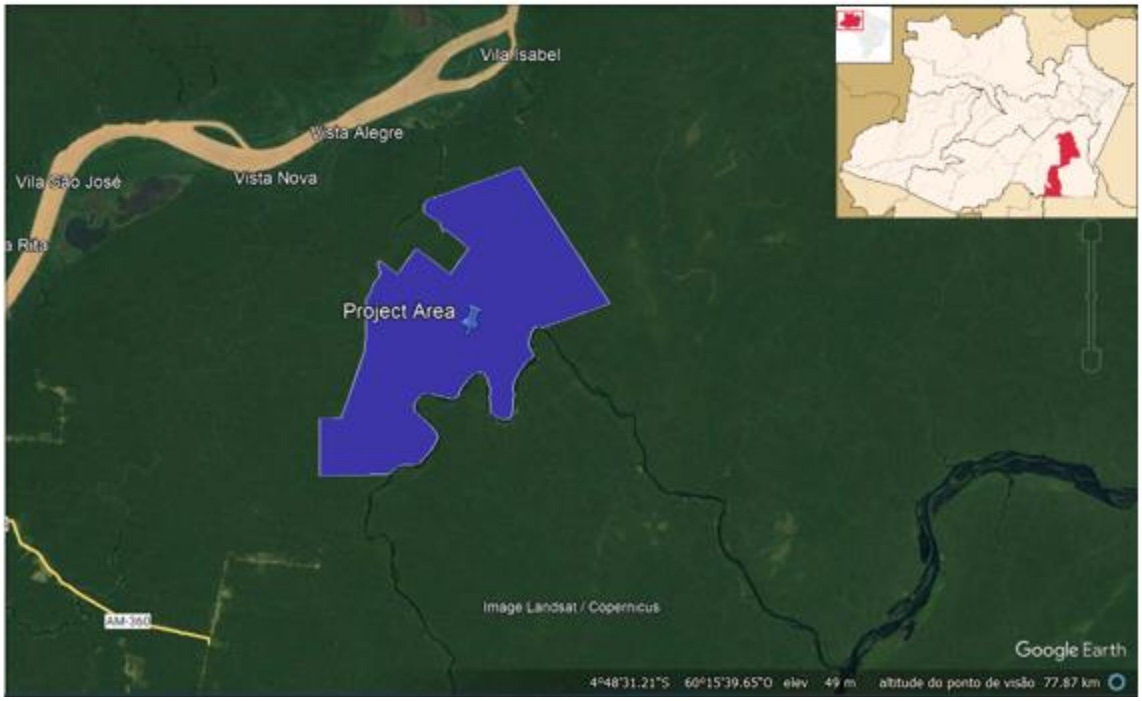

- Project Area

The Project Area comprises the Instance 1.

Instance 1 is composed by Seringal Sepoti, which have a total area of 26,062 ha. According to the VM0015 methodology, the Project Area "shall include only land qualifying as 'forest' for a minimum of 10 years prior to the project start date": the date when activities are initiated to protect against the risk of future deforestation. Thus, some adjustments and discounts are made to comply with the Methodology.

To define the Project Area, areas deforested up to the Project Start Date, vegetation areas classified as pioneer formation (including peats and wetlands) and areas containing water bodies were excluded from the properties' area. As a result, the Project Area was defined as 22,753.60 ha. Further characteristics of the Project Area until the Project Start Date are described in Section 1.13.

**Figure 4. Project Area of Sepoti REDD Project**




- Leakage Belt

  The Leakage Belt is defined by the Methodology as “the land area or land areas surrounding or adjacent to the project area in which baseline activities could be displaced due to the project activities implemented in the project area”, in other words, an area where emissions may occur due to the change in behavior of external agents in response to conservation actions carried out within the Project Area. These areas also include previously deforested areas given the region's economic patterns, but the focus is mainly on areas with potential for forest conversion for other uses.

  In order to define the Leakage Belt area, the Opportunity Cost analysis (Option I) was performed. Therefore, the economic viability of livestock production was spatialized in the project's Reference Region. Cattle is one of the main drivers of deforestation in the region, since in addition to being very profitable, it is strongly associated with land grabbing, one of the greatest threats in the region. The analysis consisted of the difference between the selling price of the cattle (per ton) and the average production cost (per ton) plus the cost of transportation to take the product to the nearest consumer center.

  The methodology for calculating road transportation costs regarding livestock in the region considered the sum of the distance that would be travelled in a straight line, between the pasture areas and the already open accesses (local highways and roads), with the distance travelled until the nearest commercial centers.

For monetary costs, the freight table of Ordinance No. 034/2017 (SEFAZ, 2017) for minimum prices for the provision of transportation services. Ordinance details the value of freight for transporting live cargo, in which the scenario of a D. Deck 45/48 trailer transporting a load of 14,000 kg was considered.

The average costs per animal considering an extensive breeding system are approximately R$906.00 (CARRERO et al., 2015). The average price per arroba varies between R$80 and R$92 (CARRERO et al., 2015). In the analysis, the minimum value of R$80 was used. For an average of 13 arrobas per animal, the revenue would be around R$ 1040.00.

All values were corrected by the Broad National Consumer Price Index (IPCA) considering the Project Start Date.

Thus, the calculation of the potential profitability was carried out for each territorial unit in the Reference Region, which can be summarized using the following formula:

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

Where:

**PPx**$_l$: Potential profitability of product Px at location l (pixel or polygon); R$/t

**S$x**: Product Px sale price; R$/t

**PCx**$_i$: Average in situ production cost per tonne of product Px; R$/t

**TDv**: Transportation distance travelled; km

**TCv**: Average transportation cost per tonne of product Px; R$/t/km

**V**: 1, 2, 3…V, surface type on which transportation occurs; dimensionless

From this data, it is possible to conclude that the entire Reference Region is in an economically viable area for livestock production, where the sum of revenues minus total costs is positive.

From the aforementioned considerations, it is possible to conclude that the areas with the highest profitability value would be more attractive for the activity. Thus, the areas with the highest profitability rating and adjacent to the Project Area, within a radius of 10 km, would be where deforestation is most likely to occur due to the Project Activity. In more distant areas, the increase in deforestation, as it is already in course, is probably associated to their proximity to rivers and roads.

Finally, by overlapping the Project Area buffer with the areas with the highest profitability potential, an area of 25,113 ha was defined as the Leakage Belt. The Figure below illustrates its location. In summary, the Leakage Belt was composed by areas within a 3km radius from the Project Area boundaries, which present higher economic viability for cattle ranching.

**Figure 5. Leakage belt Location**


- Forest

The Brazilian Forest Service's definition of forests is lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE)[58], updated by the SIVAM project[59]. Brazil endorses the definition of forest adopted by FAO: "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 %, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use".

[58] Available at <https://snif.florestal.gov.br/pt-br/conhecendo-sobre-florestas/168-tipologias-florestais?modal=1&tipo=tableau>
[59] As of 1996, through a contract signed between the Implementation Commission of the Airspace Control System - Ciscea, its Amazon's Surveillance System Project - SIVAM, and IBGE, updated the information that make up the Legal Amazon, attending, at the same time, the Systematization of Information on Natural Resources project. Information available at <https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf>; SIVAM Project: <https://www.camara.leg.br/noticias/55929-o-que-e-o-sivam/>

In order to define the Project Area, as previously described in this Section, only areas that comply with the definition of forest were considered. From this, the Project Area was submitted to an analysis using MapBiomas mapping and classification. MapBiomas applies a hierarchical system with a combination of LULC classes in accordance with national definition[60]. Thus, this assessment guarantees that the Project Area meets a definition of forest that has international recognition.

In addition to this, as per the VM0015 Methodology, “the Minimum Mapping Unit (MMU) size of the LULC maps created using RS imagery shall not be more than one hectare irrespective of forest definition”. Thus, the 30m pixel resolution through LANDSAT images used for mapping have the minimum mapping unit defined at 30x30m (0.09ha), easily fitting into the Methodology requirements. Details on data and image processing can be verified at Section 3.4.

Temporal Boundaries

- Starting date and end date of the historical reference period

  The adopted historical reference period was from 2011 to 2021.

- Starting date of the project crediting period of the AUD project activity

  The project has a crediting period of 30 years, from 25-April-2022 to 24-April-2052, which may be renewed up to 100 years.

- Starting date and end date of the first fixed baseline period

  The first baseline period is from 22-October-2022 to 21-October-2028.

Carbon Pools

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

**Figure 6. Carbon pools included or excluded within the boundary of the proposed AUD Project Activity**

| Carbon pools | Included / Excluded | Justification / Explanation of choice |
|---|---|---|
| Above-ground | Tree: Included | Carbon stock change in this pool is always significant |
| | Non-Tree: Excluded | Excluded in carbon stocks estimates |
| Below-ground | Included | Stock change in this pool is significant |

[60] A cross-reference of the MapBiomas LCLU classes with classes from other classification systems such as FAO, IBGE and National Inventory is available at Annex III of MapBiomas general handbook. Available at <https://mapbiomas-br-site.s3.amazonaws.com/Metodologia/Amazon _ Appendix _ ATBD_Collection_6.docx.pdf>

| | | |
|---|---|---|
| Dead wood | Exluded | Excluded for simplification. In the baseline scenario, dead wood is not removed and/or used before the deforestation, as it is often in the process of decomposition in the forest, being left to burn in the baseline case. Therefore, not accounting for this carbon pool is conservative, as it does not consider GHG emissions from deforestation and burning in the baseline. |
| Harvested wood products | Excluded | Stock change in this pool is not considered in baseline and project scenarios. |
| Litter | Excluded | Excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the AUD project activity. This exclusion is conservative. |
| Soil organic carbon | Excluded | Recommended when forests are converted to cropland. Not to be measured in conversions to pasture grasses and perennial crop according to VCS Methodology Requirements, 4.2. |

In accordance with the Methodology, approximately 1/10 of the carbon stock in the below-ground pool of the initial "forest" class will be released in a ten-year interval. This is further discussed at Section 4.1 – Baseline Emissions.

Furthermore, the Methodology considers the two sources of GHG emissions listed in the Table below. Their inclusion or exclusion within the boundary of the proposed AUD Project Activity, as well as the respective justification/explanation, were also discussed:

**Figure 7. Sources of GHG included or excluded within the boundary of the proposed AUD Project Activity**

| Source | | Gas | Included / Excluded | Justification / Explanation of choice |
|---|---|---|---|---|
| Baseline scenario | Biomass burning | $CO_2$ | Excluded | Excluded as recommended by the applied methodology. Counted as carbon stock change. |
| | | $CH_4$ | Included | Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology. |
| | | $N_2O$ | Included | Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology. |
| | | Other | Excluded | No other GHG gases were considered in this project activity. |
| | | $CO_2$ | Excluded | Not a significant source |

| | | | | |
|---|---|---|---|---|
| | Livestock emissions | $CH_4$ | Excluded | Excluded for simplification. This is conservative. |
| | | $N_2O$ | Excluded | Excluded for simplification. This is conservative. |
| | | Other | Excluded | No other GHG gases were considered in this project activity. |
| Project scenario | Biomass burning | $CO_2$ | Excluded | No biomass burning increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant. |
| | | $CH_4$ | Included | Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology. |
| | | $N_2O$ | Included | Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology. |
| | | Other | Excluded | No other GHG gases were considered in this project activity. |
| | Livestock emissions | $CO_2$ | Excluded | Not a significant source |
| | | $CH_4$ | Included | Included as non-CO2 emissions from livestock in the leakage management area |
| | | $N_2O$ | Included | Included as non-CO2 emissions from livestock in the leakage management area |
| | | Other | Excluded | No other GHG gases were considered in this project activity. |

## 3.4 Baseline Scenario

In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the Reference Region, Project Area and Leakage Belt, as described below. Therefore, the project falls into the AFOLU-REDD category, specifically: Avoided Unplanned Deforestation (AUD). The revenue from the present REDD project is not only essential to maintain this area as standing forest, as described under the Additionality of the Project (Section 3.5), but also to carry out the present Project's Leakage Management Activities.

Degradation was not considered in the present REDD Project, in accordance with Methodology requirements, which define "forest" and "non-forest" as the minimum land-use and land-cover classes.

ANALYSIS OF AGENTS, DRIVERS, AND UNDERLYING CAUSES OF DEFORESTATION

As specified in the Methodology, it is necessary to understand "who" the deforesting agent is and what drives land-use decisions ("drivers" and "underlying causes"). This analysis is important for two main reasons: (i) Estimating the quantity and location of future deforestation; and (ii) Designing effective measures to address deforestation, including leakage prevention measures[61].

- Database organization and pre-processing

  The forest dynamics data, deforestation vectors and other base information from the region under analysis, which were used to build the Project Baseline, were organized in a spatialized database, in the File Geodatabase format of ArcGIS 10.8. The data come from different sources and have different cartographic scales (Table below). The files are stored in vector and matrix (raster) format.

  At first, several layers were pre-selected, which may be related to the greater chance of deforestation in the Reference Region and Project Area. For example, rivers and roads are usually vectors of deforestation because they are the access routes to forest areas, where deforestation agents can encroach the territory to extract timber and other deforestation byproducts.

**Table 6. Spatialized data for the determination of the deforestation dynamics in the Reference Region and baseline structure**

| Data | Scale/Resolution | Year | Source |
|---|---|---|---|
| Watershed database | 1:1.000.000 | 2012 | ANA |
| Water bodies database | 1:100.000 | 2020 | ANA |
| Municipalities database | 1:250.000 | 2019 | IBGE |
| Rivers database | 1:1.000.000 | 2013 | ANA |
| FUNAI Indigenous Lands database | 1:500.000 | 2020 | FUNAI |
| CNUC Protected Areas database | Varia de 1:5.000 a 1:100.000 | 2019 | MMA |
| Federated Units Database | 1:250.000 | 2019 | IBGE |
| Rainfall database | 1 km | 2020 | Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315. |
| Forest Class database | 1:250.000 | 2019 | IBGE |

[61] VM0015: STEP 3: Analysis of agents, drivers and underlying causes of deforestation and their likely future development, page 37. Available at: <https://verra.org/wp-content/uploads/2018/03/VM0015-Methodology-for-Avoided-Unplanned-Deforestation-v1.1.pdf>.

| | | | |
|---|---|---|---|
| Road transport infrastructure database | 1:250.000 | 2019 | IBGE |
| Road transport infrastructure database | | 2012 | Imazon |
| Cities Points database | 1:250.000 | 2019 | IBGE |
| Settlement Projects database | | 2020 | INCRA |
| Elevation digital model | 30m | | SRTM |

The following information is provided for the identified agent of deforestation:

***a)*** **Cattle ranching**

*Cattle farming in the Amazon is primarily due to low land prices combined with adequate rainfall levels[62]. The Amazon region attends to national and regional demand. Analysis of supply and demand show that livestock farming could expand even more to attend to the majority of global demand. This scenario is extremely worrying in relation to Amazon deforestation levels.*

*Livestock farmers do not pay for the public lands which they acquire legally or illegally, and furthermore they harvest timber without paying the government and, in this way, they accumulate capital freely to reinvest into their operations. Thus, land speculation and cattle farming contribute to the advancement of deforestation in more isolated regions[63].*

*In Amazonas State, livestock represents 28% of the land use, equivalent to 1,141,768 ha. Until 2018, there was 80,959 agricultural establishments in the State[64]. In the project area's municipality, Novo Aripuanã, there are from 501 to 1000 establishments, and in Borba, municipality included in the reference region, from 1001 to 3000[65].*

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62 BRANDÃO, Fernanda. **Tendências para o consumo de carne bovina no Brasil**. 2013. 102 f. Thesis (Doctor grade) - Curso de Agronegócio, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013.

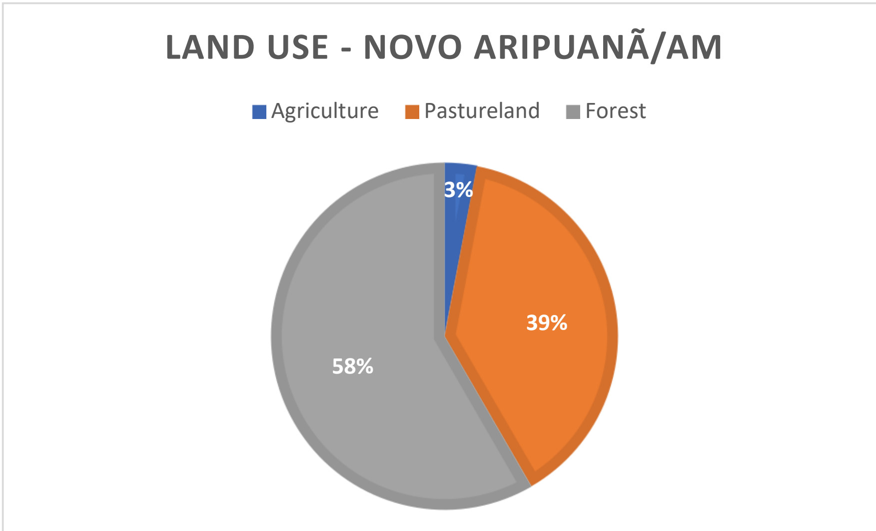
63 RAZERA, Allan. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005.

64 Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/estabelecimentos.html?localidade=13>Last visited on 29/12/2020

65 Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/pdf/am.pdf> Last visited on 29/12/2020

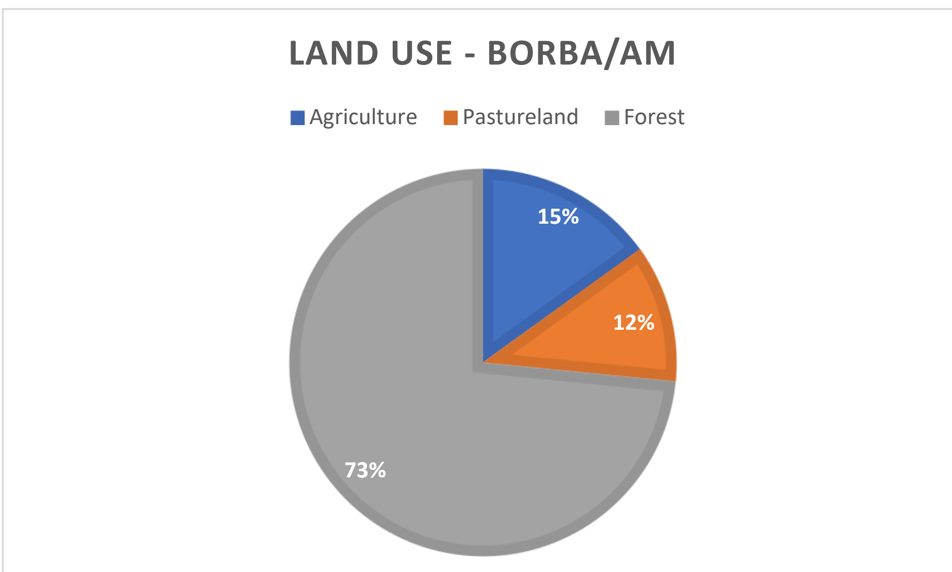
*In the case of Borba and Novo Aripuanã municipalities, it is possible to observe, from the graphs below[66], that pastureland represents a large part of the land use:*

*Figure 8. Land use of Novo Aripuanã (2017)*




*It can be observed that, second to forest, pastureland is the main land use in the municipality of Novo Aripuanã.*

*Figure 9. Land use of Borba (2017)*




[66]Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

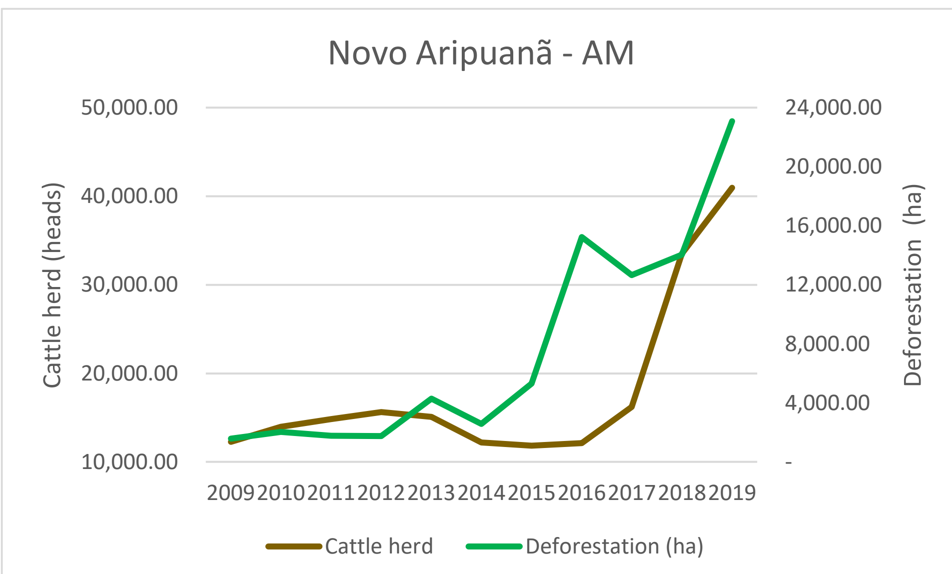
*In Borba, however, there is a lower difference between pastureland and agriculture use, with agriculture having approximately 1,200 hectares more than pasture. Nevertheless, as the municipality of Borba represents 20,38% of the Reference Region, and Novo Aripuanã 79,62%, it was assumed that pasture represents the largest land use and agent of deforestation in the region, together with timber harvesting, also considering the context of the southern region of Amazonas, being one of the main producers of cattle meat in Brazil. This data may be reassessed when new information from Brazil's agricultural census is available.*

*Novo Aripuanã's herd has been increasing in the last 10 years. According to IBGE's data, from 2014 to 2018, the number of cattle increased by 21,323 animals, and the trend is to keep rising.*

*Graphs below relates deforestation numbers with cattle herd in the region. According to PRODES satellite data, it can be noticed that, in Novo Aripuanã, the increase in deforestation areas can be directly related to the increase in livestock activity.*

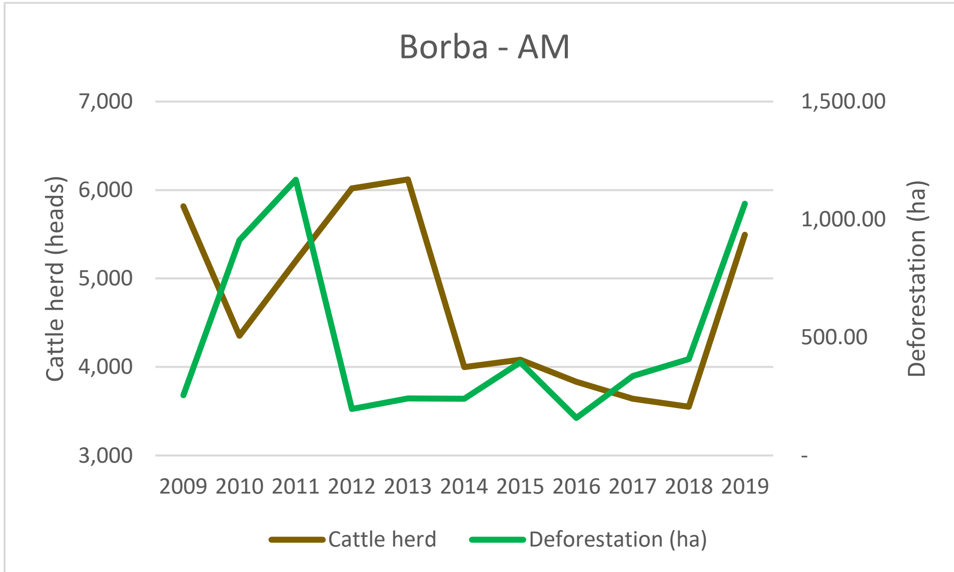
*The increase in the number of animals between 2016 and 2019 was accompanied by an increase in the number of hectares deforested in the same period. In Borba, although the relation is not so direct, mainly because the municipality has a significantly smaller cattle herd, it is possible to notice that the two parameters are related, with a tendency to increase and decrease in close periods, as can be seen between 2010 and 2014. The peak of deforestation in 2011 was followed by a peak in the number of animals in 2012, for example. There is also a tendency to increase deforestation starting in 2016.*

*Figure 10. Comparison of cattle herd and deforestation in Novo Aripuanã*[67]




[67] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> and < http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates> Last visited on 02/02/2021

*Figure 11. Comparison of cattle herd and deforestation in Borba*[68]




The increase in livestock activity can be related to migrants that invested in buying animals in other regions, and credit lines available to buy cattle. As Borba and Novo Aripuanã are frontier municipalities, and close to Apuí, reference in livestock in the region, cattle ranching is preferred due to ease in selling to near states, with cheaper logistics and guarantee of disease-free meat

### *b)* Timber Harvesting

As previously mentioned in section 1 (socio-economic conditions) above, timber logging (both legal and illegal) is an important economic activity within the reference region. Economic data sources between 2008 and 2018 show that timber is the largest contributor to the value of annual production when compared to all extractivism products in the project area and reference region municipalities.

In Novo Aripuanã, it can be noticed that between 2008 and 2013, the Brazil Nut production had the highest production value, that has been reducing while timber value has been increasing, reaching 4,000 reais.

Figure 12. Extraction production Value (R$) in Novo Aripuanã[69]

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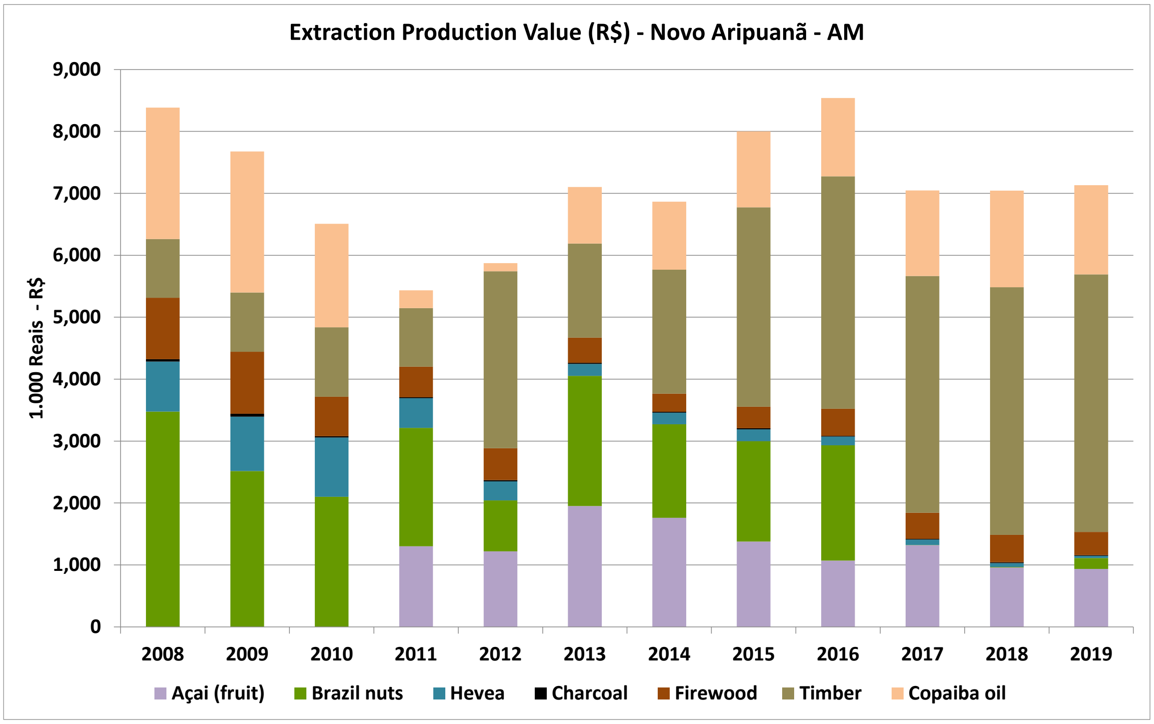
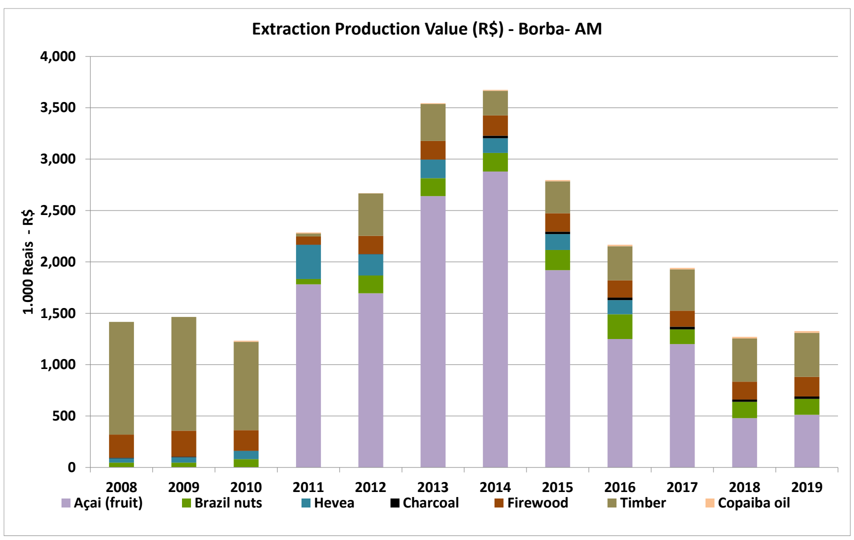
[68] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> and <http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates> Last visited on 02/02/2021

[69] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021




In Borba, açaí value is the highest, when compared to other products of the region. Timber represented the biggest value from 2008 to 2010, and it is the second from 2011 to 2018.

*Figure 13. Extraction production value (R$) in Borba*[70]




When assessing quantity produced, the timber production in both municipalities is also dominant, when compared to the other products:

[70] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

Figure 14. Produced wood quantity - Novo Aripuanã

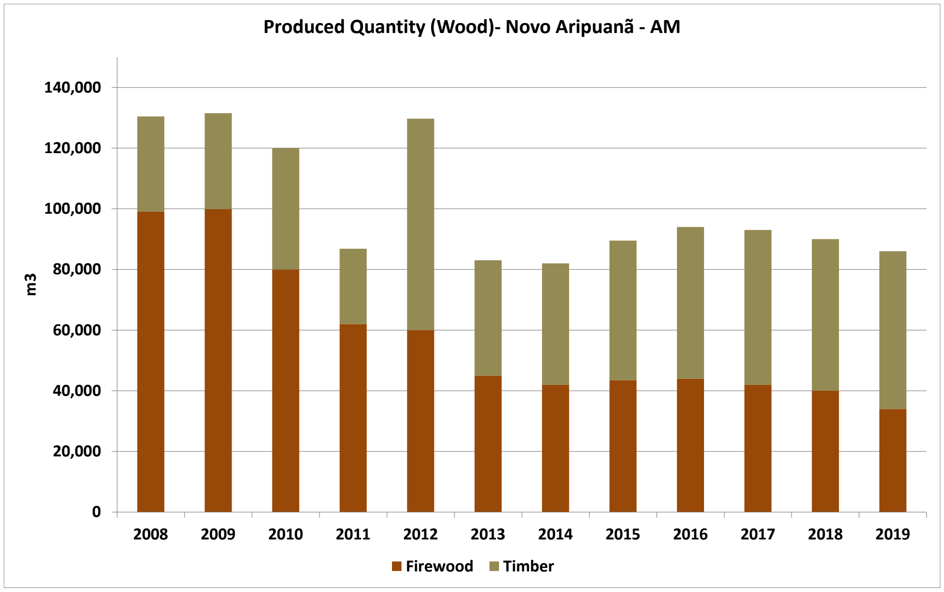



Figure 15. Produced quantity - Novo Aripuanã

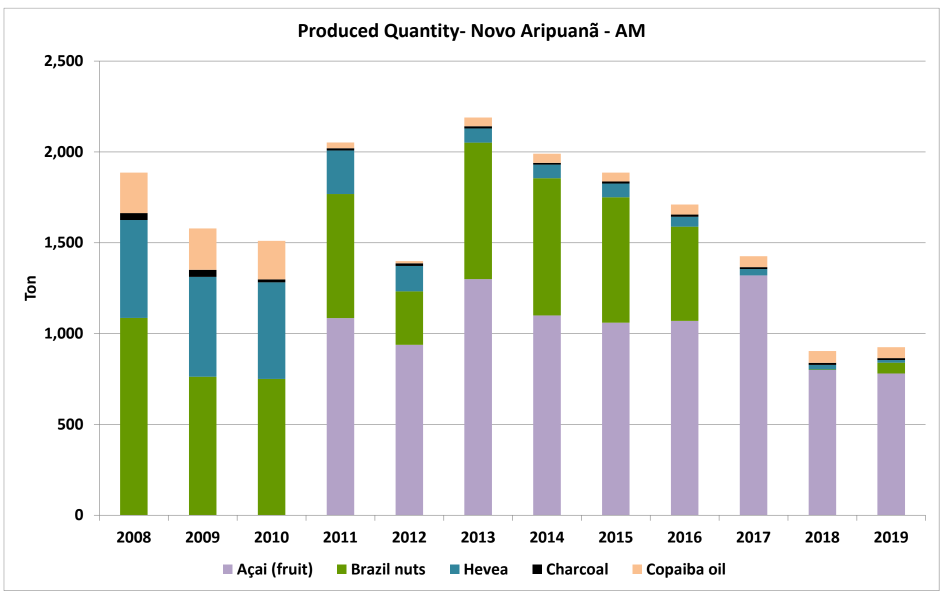



Figure 16. Produced wood quantity - Borba [71]

[71] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

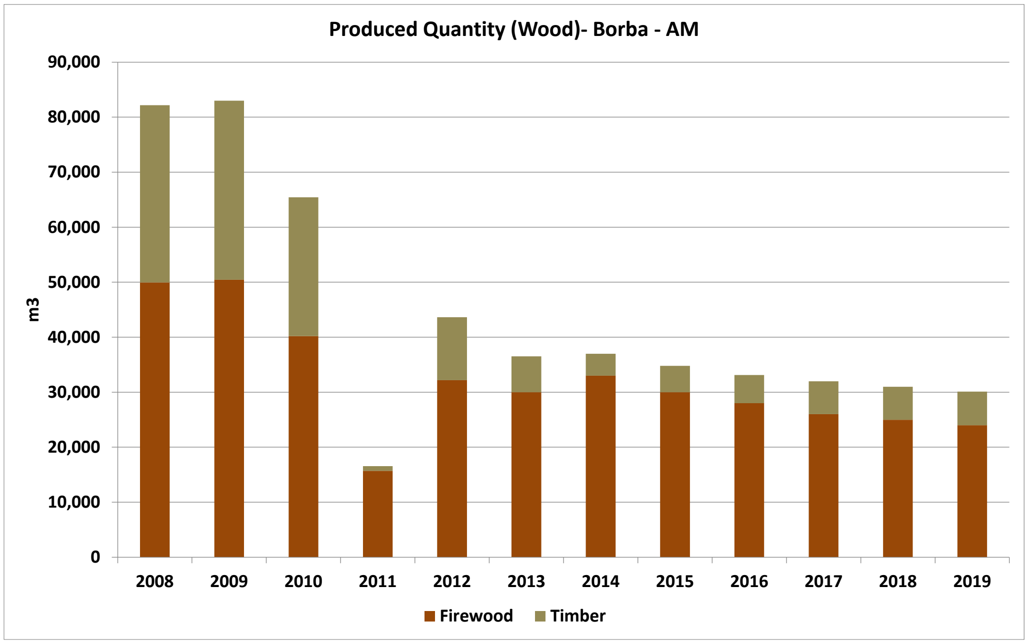
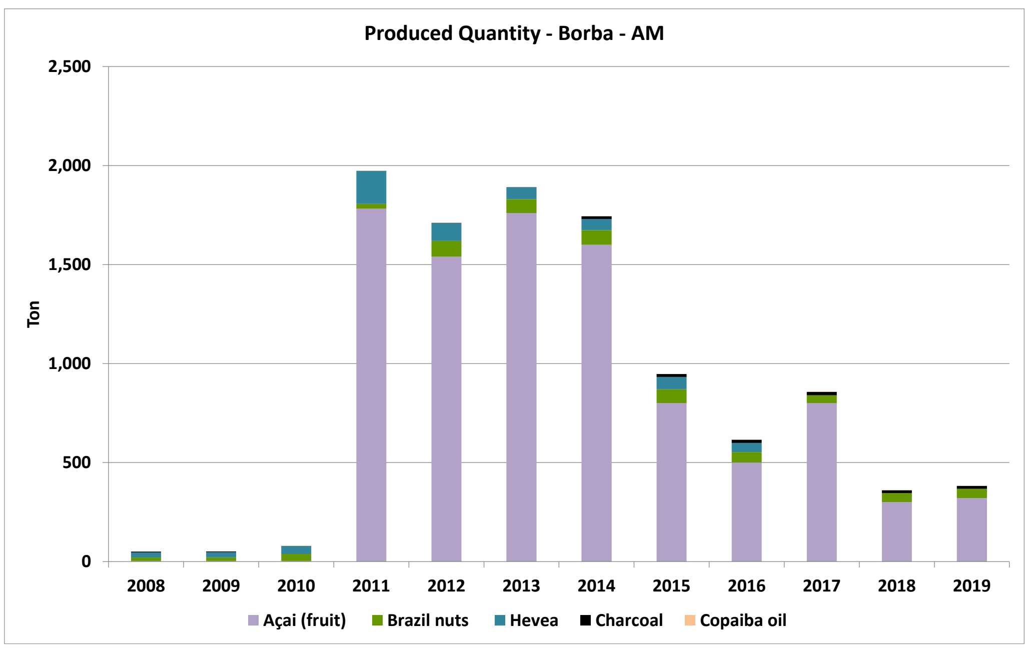



Figure 17. Produced quantity - Borba




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

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

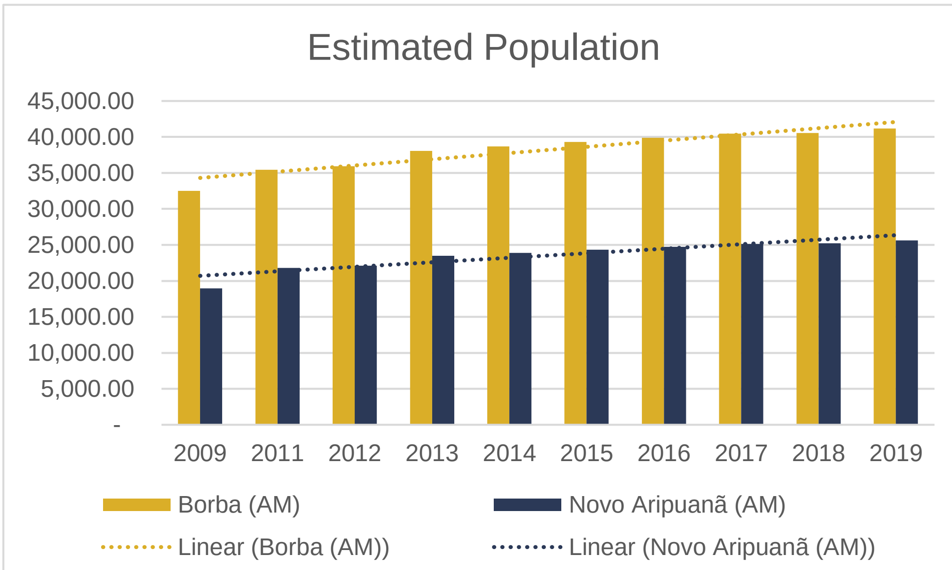
*a)* **Driver variables explaining the quantity (hectares) of deforestation:**

**1) Population growth**

Population is a variable that significantly predicts future deforestation quantity. Local residents are expected to carry out unplanned deforestation, which involves economic activities.

Population growth data shows that reference and project area are in an increasing tendency, with growth rate of 2.39% per year in Borba and 3.07% in Novo Aripuanã[72].

Figure 18. Population growth




The region has a low population density, as large landowners prevail in both municipalities. In Borba, it is 0.79 hab/km² and in Novo Aripuanã, 0.52 hab/km².

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

The increasing rate identified in the population data is an important variable affecting the amount of deforestation in the reference region.

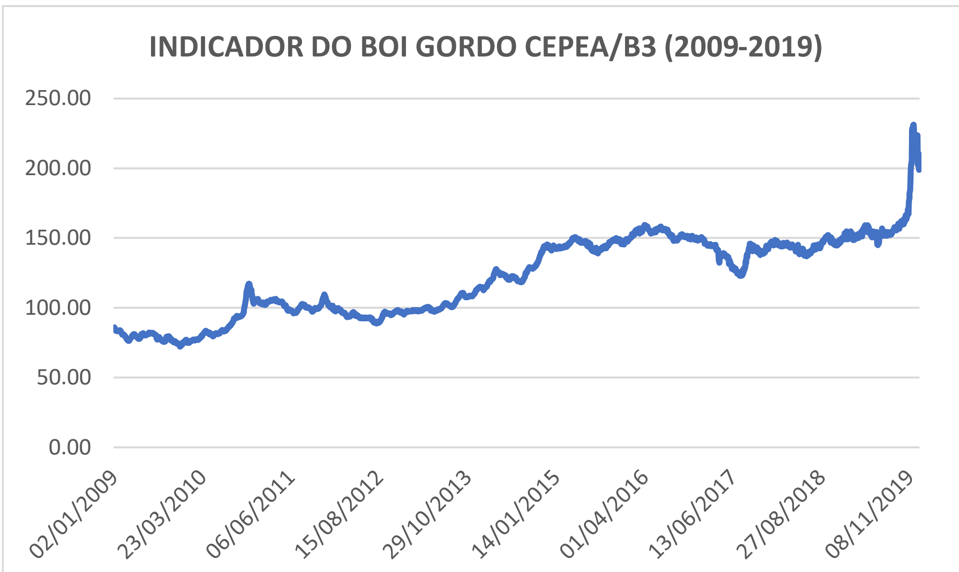
**2) Prices of timber logs and livestock per arroba:**

[72] Available in < https://sidra.ibge.gov.br/tabela/6579> Last visited on 06/04/2021

As detailed in previous sections and in the description of deforestation agents above, timber and cattle prices have much higher value than other products exploited in the region.

Research developed to determine leakage belt accounted approximately R$1040,00 per animal in the region, on an average of R$80,00 per arroba. Considering data of 2019, that indicated 33,523 animals in Novo Aripuanã and 5,494 in Borba, the amount of money produced by the activity in the region would surpass 5 million reais per year.

The graph below shows the variation in the price of live cattle as a commodity on the Brazilian stock exchange, between 2009 and 2019[73]. It is possible to note the increase in prices, which demonstrates the valorisation of meat as an investment product in the market.




Timber and firewood production in the region represented the higher value when compared to other PFNM produced in the municipalities. Prices vary between 4,000 and 12,000 reais per m³, as detailed previously in this PDD.

[73] Avaliable in <https://www.cepea.esalq.usp.br/br/indicador/boi-gordo.aspx>

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[74]. Thus, this disparity promotes the purchase of new forested areas, deforestation, and further creation of new pasturelands.

*b)* **Driver variables explaining the location of deforestation:**

The main drivers of deforestation related to the location of impact in the Project region are:

1) **Distance from deforested areas**

The presence of “non-forest” is a driver variable predicting quantity and location of future deforestation.  Forested areas are influenced by their proximity to areas that have already been deforested. The distance from previously deforested areas is one of the major causes of forest degradation in the Amazon biome and their spatio-temporal dynamics are highly influenced by annual deforestation patterns. In addition, forest fragmentation results from deforestation and disturbance, with subsequent edge effects extending deep into remaining forest areas[75],[76]. This driver was also analysed for the deforestation projection model, as mentioned throughout the present VCS PD.

2) **Roads, highways, access roads and navigable rivers**

Access roads are means of communication, which influence the spatial distribution of the land-use. They have an influence on fragmentation, population densities, agriculture and pastureland. The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and,

[74] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. **Economia Verde: Desafios e Oportunidades,** Campinas, v. 8, p.143-155, jun. 2011. Available at: <https://silo.tips/download/o-desmatamento-da-floresta-amazonica-causas-e-soluoes>. Last visited on: 29/12/2020.

[75] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757 Available at <https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

[76] IMAZON. Carbon emissions from deforestation and forest fragmentation in the Brazilian Amazon. 2011. Available at: http://imazon.org.br/publicacoes/carbon-emissions-from-deforestation-and-forest-fragmentation-in-the-brazilian-amazon/?lang=en .

consequently, the intensity of deforestation[77],[78],[79]. It is broadly recognized that deforestation is accelerated in regions that have denser road networks[80].

Waterways remain the overwhelmingly predominant means of transport and access to forest products. The Reference Region is located in one of Brazil's richest areas in terms of waterways, which historically determined the locations of settlements in relation to extraction of non-timber forest products (NTFPs) and timber. Waterways remain the overwhelmingly predominant means of transport and access to forest products. Furthermore, the small sawmills to which timber is taken for processing are located on riverbanks. For these reasons, the great majority of the regional population is located in small settlements on the banks of the rivers.

The Reference Region holds a dense network of primary, secondary, and tertiary roads. The lands located near these roads are more likely to undergo deforestation, generating a progressive fishbone effect. This deforestation pattern may even increase exponentially in some cases, given that a single road may originate several other offshoot roads in the future, and so on.

The Project Activity results in the increase in intensity of surveillance activities during the crediting period, in such a way that the main means of access to the Project Area will be continuously monitored and controlled, as a mitigation action.

3) Presence of protected areas, indigenous lands and settlements

There are several settlements around the Rerence Region.

The analysis of the contribution of settlements to deforestation in the Amazon was carried out from the 2016 reference[81], due to the lack of in-depth literature updated until 2021.

Agrarian reform settlements have emerged as one of the main focuses of deforestation in the Amazon between 2007 and 2014. The analysis indicates that deforestation seems to be closely linked to some of the main categories of existing settlement projects in the Amazon, as these classifications group together modalities

[77] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757. Available at <https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

[78] GENELETTI, D. Biodiversity Impact Assessment of roads: an approach based on ecosystem rarity. Environmental Impact Assessment Review, v.23, n.3, p.343-365, 2003 Available at <https://www.sciencedirect.com/science/article/abs/pii/S0195925502000999>

[79] Fearnside, P.M. e P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the Potential Impact of Linking the Arc of Deforestation to Central Amazonia. Environmental Management 38:705-716. Available at <https://www.researchgate.net/publication/6803490_BR-319_Brazil's_Manaus-Porto_Velho_Highway_and_the_Potential_Impact_of_Linking_the_Arc_of_Deforestation_to_Central_Amazonia>

[80] Available at <https://imazongeo.org.br/>

[81] Available at < https://ipam.org.br/wp-content/uploads/2016/02/Desmatamento-nos-Assentamentos-da-Amaz%C3%B4nia.pdf>

with specific objectives, established to promote, either agricultural-based, or forest-based and extractive land uses[82].

Historically, a large part of deforestation since 1997 has occurred in PAs (*Projetos de Assentamento* – Settlement Projects). The contribution of settlements to total deforestation in the Amazon has increased progressively, from an average of 18% between 2003 and 2005, to an average of 30% between 2010 and 2014.

This pattern indicates that the processes that affect the dynamics of forest clearing outside the settlements have repercussions within them, and that the strategies to encourage the reduction of deforestation in these settlements cannot be treated as isolated cases, distant from the local context of the territory in which they are inserted. It should be considered, however, that punitive strategies must be treated cautiously and in a surgical and educational manner within them, taking into account the impact that these sanctions may have on the food security of the real beneficiaries of agrarian reform. Thus, the importance of this carbon project and the socio-environmental actions to be applied as a way of mitigating deforestation is highlighted. The strategy is to detach the need for illegal deforestation as alternative income is generated in these communities, creating other economically productive strategies.

In conclusion, in 2014, as well as in the previous three years, few settlements were responsible for a large part of deforestation in this land category, with deforestation in these settlements occurring mainly through large continuous blocks. These two results indicate that deforestation in Amazonian settlements is localized and possibly results from a process of land reconcentration. Thus, the deforestation that occurs within the settlements is not carried out solely by land reform clients. The analysis show that it is common to find consolidated farms consolidated in the settlements. Entrepreneurs, traders and other segments of local society, not clients of the agrarian reform, have acquired lots within the settlements, following a strategy that begins with the commercialization of the remaining wood in the forests of the lots, followed by the deforestation of the same, and the establishment of pasture to cattle ranching.

- **Identification of underlying causes of deforestation**

Underlying causes of deforestation include the political scenario related to the environment in the baseline period. The political instability would probably reflect in the

[82] Settlements can be divided into two groups: I - those created through land acquisition by Incra, in the traditional way, called Settlement Projects (Projeto de Assentamento - PA), that include the environmentally differentiated ones and the Decentralized Sustainable Settlement Project (Projeto Descentralizado de Assentamento Sustentável - PDAS); II - those implemented by government institutions and recognized by Incra for access to some public policies of the National Agrarian Reform Program (Programa Nacional de Reforma Agrária - PNRA). More information available at < https://www.gov.br/incra/pt-br/assuntos/reforma-agraria/assentamentos#:~:text=Os%20assentamentos%20podem%20ser%20divididos,de%20Assentamento%20Sustent%C3%A1vel%20(PDAS)%3B>

increase of deforestation. There are no applicable mitigation actions for these causes, as they are political and determined through elections every 4 years. However, it is expected that the local actions developed by the project activity will help to reduce the impacts of these facts.

Due to being located in a region of large cattle ranchers, miners and settlements, the reference region has a considerable social conflict issue, primarily land conflict. Land is occasionally illegally occupied by squatters and illegal loggers[83],[84],[85]. Thus, the main underlying causes of deforestation within the reference region are associated with land conflicts (tenure issues), and the lack of public policies promoting sustainable alternatives to combat deforestation and degradation activities.

The continued lack of resolution of land tenure issues contributes to reducing legal production options and continues to promote the expansion of deforestation associated with cattle farming and land speculation in southern Amazonas. According to studies conducted in the region by Idesam, there is a pressing need for restructuring at a local level, which is lacking investment in infrastructure, equipment, and human resources to attend to strong land-tenure demand. The low presence of Governance and lack of land-tenure documentation, with thousands of rural producers owning non-documented properties, promotes a scenario of forest destruction for exploration of natural resources and creation of pastureland, driving the tendency for the frontier to grow[86].

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

2012's political scenario, with the flexibilization of the forest code legislation and amnesty to deforesters, the interruption of the creation of protected areas, including the unprecedented reduction of several of these protected areas in the Amazon, among other actions, proved to be the beginning of a series of setbacks, which have continued over the past 5 years.

From 2016 onwards, the impeachment on Brazil's president Dilma Rousseff wide opened the dismantling policy of the environmental agenda created by the new government

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[83] Available at <https://g1.globo.com/natureza/noticia/2019/09/04/invasoes-grilagem-e-queimadas-ameacam-areas-protegidas-na-amazonia.ghtml>

[84] Available at <https://acervo.socioambiental.org/sites/default/files/documents/prov0227_0.pdf>

[85] Available at https://www.bbc.com/portuguese/brasil-56211156

[86] INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Reduções de Emissões do Desmatamento e Degradação Florestal (REDD+): Estudo de Oportunidades para a Região Sul do Amazonas. Manaus: Idesam, 2011. 45 p. (Relatórios Técnicos nº1). 141 Available in <https://idesam.org/publicacao/REDD_Estudo_de_Oportunidades_Sul_Amazonas.pdf>

(Michel Temer, May 12, 2016 to December 31, 2018) to gain the support of the ruralist bench, constituted by a coalition of parliamentarians of the Brazilian National Congress with common interests, such as the advance of the livestock and agribusiness barrier in Brazil – and, consequently, the deforestation and the environmental policies that prevent it from occur. The Brazilian National Congress has approximately 500 parliamentarians, which means that obtaining support from the ruralist caucus (which has around 350 parliamentarians) guarantees a strategic advantage for the approval of provisional measures and decrees.

The 2017's federal government is marked by a series of acts against the environmental area, and such as Cutting budget and freezing investments in Brazilian science. The main ministries linked to Higher Education Institutions (Ministry of Education and Ministry of Science and Technology) suffered billionaire budget cuts, endangering scientific research and environmental monitoring bodies, as the largest network of biodiversity research in Brazil, the PPBio. Besides the budget cut, the Ministry of Science and Technology suffered another attack when it was merged with the Ministry of Communications, devaluing science by uniting two ministries with opposing goals and threatening the future of the country's scientific research. After the measure, which froze investments in education for the next 20 years, the National Council for Scientific and Technological Development (CNPq), the responsible body for financing most undergraduate and graduate research projects in the country, had a budget in 2017 lower than the equivalent of 2004. The scrapping of Brazilian scientific research bodies directly affects the monitoring and production of knowledge about the dynamics of deforestation and the influence of agribusiness in it.

In the Bolsonaro's pre-election period in 2018, the country was already discussing the threat of political bargaining to climate mitigation and the forest conservation in general. In exchange of political support, the government offered landholders to increase deforestation, and the signature of provisionary acts and decrees lowering environmental licensing requirements, suspending the ratification of indigenous lands, reducing the size of protected areas and facilitating land grabbers to obtain the deeds of illegally deforested areas[87].

In the beginning of 2019, the fusion of Environment and Agriculture Ministries was a clear attempt to obtain more rights for the expansion of agriculture and livestock. The decision was canceled a few days later, after pressure from environmentalists and others in the sector; however, major changes occurred in the ministerial office, limiting the reach and autonomy of the Environmental Ministry, with the absence of resources to combat deforestation[88].

[87] Available in < https://epoca.oglobo.globo.com/ciencia-e-meio-ambiente/blog-do-planeta/noticia/2017/09/o-desmanche-ambiental-do-governo-temer.html>

[88] Available in <https://www.socioambiental.org/pt-br/blog/blog-do-isa/a-anatomia-do-desmonte-das-politicas-socioambientais>

In addition, the transference of policies and instruments of water resources, including the National Water Agency (ANA) to the Ministry of Regional Development[89] and the Brazilian Forest Service and the Rural Environmental Registry (main instrument for controlling the regularization of large and small properties in forest regions) to the Ministry of Agriculture, Livestock and Supply[90] demonstrated the dismantling of the Environment Ministry. Furthermore, the officialization of indigenous lands, in addition to other land tenure issues, such as the agrarian reform and land regularization in the legal Amazon and traditional territories have also been transferred to the Ministry of Agriculture, Livestock and Supply[91].

As a consequence, the deforestation in the Amazon Rainforest was widely reported in 2019, as it was the third largest in history, with an increase of 29.5% in comparison to 2018. In total, 9,762 $km^2$ were deforested during that year[92]. In August, during the peak of fire warnings in the forest, fact that caused climate effects in São Paulo, 2,790 km away from the Amazon[93], the government tried to deviate attention from the fires, claiming they were fake news[94]. The number of fires in Brazilian forests increased 70% in 2019, the highest rate in 7 years. According to National Spatial Research Institute (INPE), the most affected biome was the Amazon, with 51.9%[95].

Also, during August, Germany and Norway announced the suspension of transfers to Amazon Programs after affirming that the Brazilian Government was not playing its part in fighting deforestation. The contribution to protecting the rainforest amounted to more than 133 million Brazilian reais, destined to the Amazon Fund[96].

Even though fire alerts increased in the period between 2019 and 2020, the Brazilian Government reduced the budget for forest fire prevention and control personnel. A reduction of 58% reached the brigade teams, with budget ranging from 23.78 million reais in 2019 to 9.99 million in 2020[97].

In June 2020, investment funds that manage approximately 4 trillion US dollars in assets asked Brazilian government to suspend the deforestation in the Amazon Rainforest. In

[89] Available in <https://oeco.org.br/reportagens/ana-muda-de-pasta-e-atribuicao-mas-incertezas-continuam/>
[90] Available in <https://oglobo.globo.com/brasil/bolsonaro-transfere-concessao-de-florestas-publicas-para-ministerio-da-agricultura-24427684>
[91] Available in <https://politica.estadao.com.br/noticias/geral,ministerio-da-agricultura-sera-responsavel-por-reforma-agraria-terras-indigenas-e-quilombos,70002663895>
[92] Available in <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294>
[93] Available in <https://www.economist.com/the-americas/2019/08/22/forest-fires-in-the-amazon-blacken-the-sun-in-sao-paulo>
[94] Available in <https://www.theguardian.com/environment/2019/sep/09/amazon-fires-brazil-rainforest>
[95] Available in <https://noticias.uol.com.br/meio-ambiente/ultimas-noticias/redacao/2019/08/19/numero-de-queimadas-cresce-70-e-e-o-maior-desde-2013-amazonia-lidera.htm>
[96] Available in <https://brasil.elpais.com/brasil/2019/08/15/politica/1565898219_277747.html>
[97] Available in <https://g1.globo.com/natureza/noticia/2020/09/12/em-um-ano-governo-bolsonaro-corta-verba-para-brigadistas-em-58.ghtml>

an open letter, they warned of the systematic, reputational, operation and regulatory risks of clients and projects in Brazil, in addition to the survival of the forest[98].

Government agencies such as INPE and IBAMA, responsible for deforestation monitoring have suffered funding cutoffs, dismissals and had their functions and increasing deforestation data publicly questioned and denied by the government[99].

The quantity of national parks protected areas and indigenous lands in the country was already questioned by Bolsonaro, that intended to extinguish those by decree[100], an unconstitutional action, after announcing the intention to review the protected areas' law (SNUC) and the existing units[101]. In addition, the Minister of the Environment speaks publicly, in a video released during investigations, of his intention to take advantage of the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and justice processes[102].

There are also several threats to the national environmental license process, which has existed since 1981, including from the Minister of the Economy, who wants to loosen the process to favor mining companies, even with the several recent cases of environmental crimes of breaches of poorly executed and maintained mining dams from companies in the country[103].

Specialists affirm that, with the current pace of dismantling of the inspection structure and environmental legislation demonstrated since the first 6 months of the current government, the forest destruction can reach an irreversible limit in 4 to 8 years. Recent scientific research shows that if an area of 40% of the original forest gets deforested, the rest cannot sustain the functioning of the tropical rainforest, and in this scenario, part of the forest may not be able to sustain itself. The Amazon has so far lost approximately 20% of its original coverage[104]

The development of REDD projects and a new culture of sustainable development and production, in addition to the profit from carbon credit sales, to encourage the maintenance of standing forest, goes against the non-environmental policy currently adopted by the country. Despite the National Commission for REDD+ being since 2015 established by decree, which is responsible for coordinating and monitoring the

[98] Available in <https://noticias.uol.com.br/ultimas-noticias/rfi/2020/06/23/fundos-de-investimentos-estrangeiros-cobram-de-bolsonaro-fim-do-desmatamento-da-amazonia.htm?cmpid=copiaecola>

[99] Available in <https://g1.globo.com/natureza/noticia/2019/08/02/cronologia-reacao-do-governo-ao-uso-de-dados-sobre-desmatamento-leva-a-exoneracao-de-diretor-do-inpe.ghtml>

[100] Available at <http://www.ihu.unisinos.br/78-noticias/589958-em-live-bolsonaro-reclama-que-nao-consegue-extinguir-parques-por-decreto>

[101] Available at <https://oeco.org.br/noticias/ricardo-salles-quer-rever-todas-as-unidades-de-conservacao-federais-do-pais-e-mudar-snuc/#:~:text=A%20lei%20do%20SNUC%20determina,extinguir%20uma%20unidade%20de%20conserva%C3%A7%C3%A3o>

[102] Available at <https://g1.globo.com/politica/noticia/2020/05/22/ministro-do-meio-ambiente-defende-passar-a-boiada-e-mudar-regramento-e-simplificar-normas.ghtml>

[103] Available at <https://brasil.elpais.com/brasil/2019/01/27/opinion/1548547908_087976.html>

[104] Available at <https://www.bbc.com/portuguese/brasil-48805675>

implementation of the National REDD+ Strategy in Brazil, it is noted that the main effort comes from landowners and project developers, since there is no guideline or effective planning from the government to amplify the development of new projects.

Although the Project is not able to change political and agricultural issues in Brazil, its position as a conservation agent will be used to try to reduce the inequalities that act as drivers of deforestation and expand forest monitoring actions, actions possible through the investment of proceeds from the sale of credits. More mitigation actions are detailed in the Monitoring Plan.

Another important underlying agent of deforestation is the poverty and wealth inequality, also influenced by the political situation. According to the statistics of the municipalities that make up the project area and reference region, the population with formal employment receives low wages, and the percentage of the people with formal work is very low, as shown in section 1.13 - Socioeconomic Conditions.

This key underlying cause has a major impact on deforestation decisions, as the main agents (cattle ranchers, operationally supported by loggers and land-grabbers) can easily recruit cheap manpower, consisting of workers seeking to sustain their families by means of this profitable activity, despite it being illegal, due to the inconsistency of law enforcement.

Over the coming years, it is not expected that the poverty issue will be rapidly solved, as it is historically deeply rooted. Given this context, poverty can be assumed to be a constant underlying cause during the project lifetime.

Although the Project Activity cannot solve the poverty issue, it aims to provide new jobs for local agents, who will be able to generate alternative revenue to support their families by means of legal and sustainable initiatives.

ANALYSIS OF CHAIN OF EVENTS LEADING TO DEFORESTATION

Therefore, the analysis of chain events leading to deforestation within the Reference Region was based on the facts presented above, analysing the relations between main deforestation agents, drivers, and underlying causes that caused and most likely will lead to deforestation.

Most of the deforestation occurring in the Amazon region is related to the implementation of infrastructure projects, population increase and agricultural and cattle ranching activities. Additionally, several other subjacent causes related to political, economic and social issues lead to an increased pressure over the region, mainly in the last few years.

The lack of enforcement of policies and laws also affects land tenure and property rights. This aspect stimulates the action of land grabbers and squatters. Ineffective legal land registration and documentation is also a barrier to official registration of timber production from natural forests. In this scenario, a great portion of harvested wood logs can be regarded as illegal and official registration is not technically feasible.

Those two land-use changes (timber harvesting and cattle ranching) are the main deforestation agents in the region, being possible to relate the deforestation curve to the increase in livestock and wood production, all of which are continuously growing. The profit from both products is also considerably higher than the production of other common products. The socioeconomic conditions of the population and the fact that the municipalities are predominantly dominated by large properties landowners (with political and historical contributions that made the region an important livestock producer), and the demographic growth implied by the need for new infrastructure projects, which stimulates the arrival of new habitants coming from other regions of the country attracted by the favourable conditions of production in low-cost forested areas, increase the pressure on the forest in the Project Area.

The recent history of polemics and anti-environmentalism actions of the Brazilian government, in addition to not tackling the direct causes, minimizing monitoring and restrictions in critical environmental areas, and no investments in sustainable management and farming methods end up influencing and even motivating deforestation, illegal occupation and non-compliance with environmental laws. The lack of strong environmental policies causes Brazilian laws to have gaps that are taken in advantage of by landowners, intensified by weakened controlling mechanisms that have been dismantled by the Government, making the conservation of the extensive Brazilian biomes even more difficult.

All the above factors combine to result in uncontrolled land invasions and deforestation, followed by cattle ranching activities, a scenario which is substantiated by illegal trespassing events, and the fact that daily patrolling of the area is required by one or two employees, in order to refrain the constant deforestation pressure.

**CONCLUSION**

The conduction of the Step 3 and available evidence allows the analysis of the most likely future deforestation trend within the Reference Region and Project Area in a conclusive way. The hypothesized relationships between agent groups, driver variables, underlying causes and historical levels of deforestation can be verified at hand of statistical tests, literature studies, or other verifiable sources of information, such as documented information provided by local experts, communities, deforestation agents and other groups with deep knowledge of the Reference Region and Project Area. The increasing deforestation rate, added to the region's cattle ranching advancement, population increase, lack of effective governmental control and environmental planning are clear evidence that the overall trend in future baseline deforestation rates will be increasing, and this demonstrates the need for conservation measures that encourage a change in the business and production model in the region.

## 3.5 Additionality

The VCS Tool for the Demonstration and Assessment of Additionality in VCS Agricultural, Forestry and Other Land Use (AFOLU) Project Activities - VT0001 version 3.0[105] must be applied for all project activities instances.

On the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v. 3.0.

Instances may or may not include Sustainable Forest Management Plan, as described on the Grouped Project Eligibility Criteria in Section 1.4.

In case the project activity does not involve Sustainable Forest Management Plan:

- The instance shall have financial, technical and scale consistent with the described in this PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied.

In case the project activity includes a Sustainable Forest Management Plan:

- A new additionality and AFOLU non-permanence risk analyses shall be provided. In this case, the investment comparison analysis (Option II) or the benchmark analysis (Option III) of the Tool shall be used.

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

a) AFOLU activities 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;
b) The applied baseline methodology provides a stepwise approach to justify determination of the most plausible baseline scenario, in accordance to VCS AFOLU Requirements.

Other instances shall perform the additionality analysis at the time of their inclusion in the monitoring report.

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

**Sub-step 1a. Identify credible land use scenarios to the proposed VCS AFOLU project activity**
Credible alternative land use scenarios to the present AFOLU project activity are:

**Instance 1**

I. **The continuation of the current (pre-project) land use scenario**:

105 Available in <https://verra.org/wp-content/uploads/2017/11/VT0001v3.0.pdf>

As there is no activity being held on Instance 1, the pre-project land use is the maintenance of the area as it is, without any activities and conservation measures, but still being accountable for the costs of taxes required to maintain the land tenure. Although no economic activities are carried out in the pre-project scenario, the area is exposed to invasions and illegal deforestation, precedents to cattle raising, a common practice in the region, for example, as detailed in section 3.4.

**II. Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project:**

The application of the project activity could be carried out on the land within the project boundary, nevertheless performed without being registered as the VCS REDD project. This scenario would include avoiding deforestation through security and monitoring installation. Additionally, complementary activities to improve the monitoring of deforestation caused by the agents (identified in section 3.4 above) would have to be carried out, such as: increased surveillance, monitoring and control by satellite images, REDD+ technical studies, social and environmental activities, among others. These investments are usually not made by the Brazilian Government, nor are part of sustainable forest management plans, as they are financially unattractive and not necessary to legally perform the timber harvest. Therefore, the economic feasibility of this scenario would be reduced without additional revenues from the sale of VCUs.

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

**Scenario I** - The pre-project activity consists of no activities to be developed within the area, which is in compliance with the Brazilian environmental laws.

**Scenario II** - The conservation of the forest, monitoring and surveillance are in compliance with the Brazilian environmental laws.

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

The baseline scenario is the continuation of the pre project activity. The area holds no activity in the baseline scenario. There are no economic activities implemented in the area or other land use activities.

Therefore, the difficulty in monitoring the area makes it exposed to encroachment and illegal deforestation, and activities such as cattle raising and wood extraction, without any control of the activities carried out within the area.

**STEP 2. Investment Analysis**

**Sub-step 2a. Determine appropriate analysis method**

Instance 1 and generates no financial or economic benefits other than VCS related income, then it was applied the Simple Cost Analysis (Option I).

**Sub-step 2b. Simple Cost Analysis**

The simple cost analysis was determined as the appropriate analysis method once the Project does not generate any financial or economic benefits other than VCUs related income. There is no for-profit sale of any products, as the NTFPs has not yet been implemented and as there is no timber production in the area as well.

In addition to the baseline yearly expenses of the landowner, the project activity will require investments in monitoring, security, socio-environmental activities and conservation of the area. These activities, without carrying out the carbon project, do not generate any income for the owner.

According to the additionality tool applied: If it is concluded that the proposed VCS AFOLU project produces no financial benefits other than VCS related income then proceed to Step 4 (Common Practice Analysis).

STEP 4. Common practice analysis

The practice of conservation of privately-owned forest areas in the Mato Grosso State is extremely rare. Conservation activities in larger areas are usually made in public areas, such as Conservation Units, Federal and State protected areas.

Although most of Brazil's agricultural output is deforestation-free, it is observed that a fraction of properties in the Amazon are responsible for 62% of all potentially illegal deforestation and that roughly 20% of soy exports and at least 17% of beef exports from both biomes to the EU may be contaminated with illegal deforestation[106]. As previously detailed, Mato Grosso is the main producer of cattle and agriculture in the country, and this sector represents most of the State and Brazil's GDP.

In addition to REDD projects, other forms of conservation of private areas are promoted in the country:

- **Private Reserve of Natural Heritage (RPPN)[107]:** it is a category of conservation unit created voluntarily by the landowner. When the area is categorized as RPPN, the owner is committed to nature conservation, without land expropriation. The benefits of the private reserve are preference in the analysis of applications to acquire rural credit, tax benefits and the possibility of cooperation with private and public entities in the protection and management of the land, but no revenue is generated as it is on REDD+ projects due to the sale of verified carbon units. In Mato Grosso State, there are 15 registered RPPNs, none in the Reference Region municipalities. RPPN management tends to be much more affordable than REDD+ projects due to its costless implementation.
- **Payment for Environmental Services (PES)[108]:** PES is a transaction of voluntary nature, through which a buyer of environmental services grants the provider of these services with financial resources or other form of payment, under the agreed conditions, in

[106] Available at <https://www.gov.br/icmbio/pt-br/servicos/crie-sua-reserva/perguntas-e-respostas-sobre-rppn>.
[107] Available at <https://www.icmbio.gov.br/portal/images/stories/comunicacao/downloads/perguntaserespostasrppn.pdf>
[108] Available at <http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/L14119.htm>

compliance with the relevant legal and regulatory provisions, so the provider can maintain, restore, or improve the environmental conditions of ecosystems. Regulation regarding this type of service in Brazil is at its early stages, as it has recently been approved, on January 13, 2021, when Law n° 14.119 was sanctioned. The law establishes the National Policy on Payment for Environmental Services and amends other laws to adapt to the new policy. However, the financial incentive is usually determined by the State, and it is commonly applied in taxes discounts, not representing an income to invest in other activities or in the maintenance of the area.

It is possible to note that, for the reasons, the project does not characterize as a common practice due to the presented barriers, such as lack of investment and opportunity cost of other land uses. During the attempt to identify similar projects, the essential distinctions between REDD+ projects compared in terms of area, challenges, monitoring costs, among other aspects, greatly diverge from the alternative initiatives identified.

The significant difference between the present REDD+ project and similar conservation practices on the region, regarding financial and opportunity obstacles, makes it possible to conclude that the project is unable to support itself and its conservation activities without the revenues from the verified carbon units, as investment and capital costs for REDD+ projects are very high, which differ from other similar practices (RPPN and PES).

Besides, due to the context of the region, and the fact that the project is located in a reference area for both logging and cattle ranching of the State offer risks to the conservation of the Project Area.

Therefore, the present Instance depends on the revenue from the VCUs to support itself and hence, it is additional.

## 3.6 Methodology Deviations

Not applicable as no methodology deviations were performed.

# 4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

## 4.1 Baseline Emissions

Analysis of historical land-use and land-cover change

- Collection of appropriate data sources

GIS MAPPING, REMOTE SENSING TECHNIQUES

To carry out the assessment of land use and land cover (LU/LC) for the baseline period (2011-2021), remote sensing satellite analysis was carried out, which is described below.

The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. The historical reference period for the present project during the assessment of the baseline period comprised analysis of images from 2011 - 2021. In accordance with the methodology, the analysis shall be made using the data obtained from monitoring LU/LC changes in the reference region during the historical reference period.

To map the dynamics of land use in the reference region, images from 2011 to 2021 produced by MapBiomas (collection 5.0) were used, made available in raster format on the program's website (http: //mapbioma .org/) and supervised classifications using Google Earth Engine for the period of April 2021. This classifier is the same one used in MapBiomas, allowing a closer approximation of the methodology.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[109] promoted by the Climate Observatory. The MapBiomas creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomas series and direct collection by visual interpretation of Landsat images to classify as a single map per class. This classification then goes through the stages of the spatial filter, applying neighbourhood rules and temporal filters, in particular changes in coverage and use that are impossible or not allowed, to reduce spatial and temporal inconsistencies.

For the supervised classification of April 2021, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomas methodology. To obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 5% cloud cover limit were collected within the Reference Region and an average of these images was generated. Training samples were generated for each land use class (forest, water, and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. Then the spatial filter with the Majority Filter tool from ArcGIS was applied using an 8-pixel neighborhood. This filter is used in MapBiomas to avoid unwanted modifications on the edges of pixel groups (blobs).

[109] SEEG website. Available at: http://seeg.eco.br/en/ Last visited on 19/04/2021

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

Following the VM00015 Methodology requirements, the LU/LC maps have been conducted using satellite images. There are 2 surveys available in Brazil for deforestation and forest mapping: INPE (PRODES) and Mapbiomas. However, none of them separates by forest classes.

Land-use change analyses have been conducted through MapBiomas images, which is a new platform that produces maps through a pixel-by-pixel classification from Landsat satellite images. The entire process is done with extensive machine learning algorithms through the Google Earth Engine system that offers more detailed, precise and available information. MapBiomas presents a higher temporal frequency than the official data from Prodes, and thus it is recommended as image reference for regions with high cloud cover throughout the whole year.

Thus, definition of classes of land-use and land-cover was performed through MapBiomas' classification, which identifies forest, non-forest vegetation, anthropic uses (categorized as deforestation) and hydrography (lakes and rivers). For this map, the accuracy assessment has been conducted, which meets the methodology requirements.

Furthermore, the official map for all vegetation types of the country, which was elaborated by IBGE (Brazilian Institute of Geography and Statistics), was used to check the vegetation types present within the RR, PA and LK. The vegetation type map was created by IBGE considering several aspects that are able to differentiate one type of vegetation to the other, such as species composition, elevation and climate variation, soil type, among others. The accuracy assessment of this mapping would be unfeasible, since the IBGE map was generated considering characteristics such as soil type, elevation, species composition, etc. For the correct accuracy of this information, a field survey would be necessary, which is costly and complicated to be carried out in the timeline of a carbon project.

**Table 7. Vegetation types found in the project boundaries**

| IDct | Name - Initial | Trend in carbon stock[1] | Presence in | Activity in the baseline case | | | Name - Final | Trend in carbon stock | Presence in | Activity in the project case | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LG | FW | CP | | | | LG | FW | CP |
| I1/F1 | Forest | constant | RR, PA, LK | yes | no | no | Forest | constant | RR, PA, LK | yes | no | no |
| I1/F2 | Forest | constant | RR, PA, LK | yes | no | no | Non Forest | constant | RR, PA, LK | yes | no | no |
| I2/F2 | Non Forest | constant | RR, LK | no | no | no | Non Forest | constant | RR, PA, LK | no | no | no |

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

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

**Table 8. List of land use and land cover change categories**

| Class identifier | | Trend in carbon stock[1] | Presence in[2] | Baseline activity[3] | | | Description (including criteria for unambiguous boundary definition) |
|---|---|---|---|---|---|---|---|
| IDcl | Name | | | LG | FW | CP | |
| 1 | Forest | constant | RR, PA, LK | yes | no | no | According to official classification of the types of vegetation of Brazil (SIVAM), no stratification in different forest classes was conducted. In addition, carbon density is not expected to undergo significant changes due to degradation in the baseline case. According to the significance test, carbon stock change due to logging activities in the baseline case is considered insignificant and therefore, trend in carbon stock could be deemed as constant. |
| 2 | No forest | constant | RR, PA, LK | no | no | no | Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification. |
| 3 | Hydrography | constant | RR, PA, LK | no | no | no | Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA. |

An analysis in the Amazon region[110] between 2007-2020 shows that there is no trend in degradation, although it affects an area larger than deforestation. It was concluded that degradation can serve as a warning that the region will soon be the target of deforestation practices. As the degradation has low local recurrence over the years, i.e., on average the same area is classified as degraded only once during the analyzed period, it is very unusual that the same area will suffer another degradation, since the valuable woods have already been harvested. Thus, it is very likely that carbon stocks after degradation might increase. Therefore, it is conservatively assumed that the trend in carbon stocks in the baseline case is constant.

The main forest type present in RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[111]:

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

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

[110] Available at https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/DQ-Degradacao-Florestal-Amazonia.pdf
[111] Available at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf

It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map comparing 2011 with 2021. It is important to note that while the latter shows only deforestation from 2011–2021, the Tables below display deforestation across the whole crediting period.

As shown in tables below, degradation was not considered in any of the LU/LC classes.

**Table 9. Land use change matrix in the reference region between 2010 and 2020**

| | | Initial LU/LC class | |
|---|---|---|---|
| | IDcl | Forest | No forest |
| Final Class | Forest | I1/F1 | 0 |
| | No forest | I1/F2 | I2/F2 |

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| | PA | Initial LU/LC class | |
|---|---|---|---|
| | IDcl | Forest | Non Forest in the PA |
| Final Class | Forest | 26,062 | 0.00 |
| | Non Forest in the PA | 2,521.68 | 0.00 |

| | LB | Initial LU/LC class | |
|---|---|---|---|
| | IDcl | Forest | Non Forest in the LK |
| Final Class | Forest | 25,113 | 0.00 |
| | Non Forest in the LK | 4,456 | 4,456 |

The Table below also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

**Table 10. List of land use and land cover change categories**

| Class identifier | | Trend in carbon stock[1] | Presence in[2] | Baseline activity[3] | | | Description (including criteria for unambiguous boundary definition) |
|---|---|---|---|---|---|---|---|
| IDcl | Name | | | LG | FW | CP | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Forest | constant | RR, PA, LK | yes | no | no | According to official classification of the types of vegetation of Brazil (SIVAM), no stratification in different forest classes was conducted. In addition, carbon density is not expected to undergo significant changes due to degradation in the baseline case. According to the significance test, carbon stock change due to logging activities in the baseline case is considered insignificant and therefore, trend in carbon stock could be deemed as constant. |
| 2 | No forest | constant | RR, PA, LK | no | no | no | Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification. |
| 3 | Hydrography | constant | RR, PA, LK | no | no | no | Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA. |

The annual deforestation dynamics in the Reference Region during the historical reference period can be seen in the figure and tables below.

- <u>Map accuracy assessment</u>

  To meet the particularities of the region, an independent evaluation was carried out for the reference region from the years 2011 to 2021.

  To assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated by calculating the user's and producer's percentage of correct answers, errors of omission and commission. For that, 200 sample points were randomly drawn on the reference region, 50 in each class (forest, hydrography and deforestation), and the degree of correctness classification was verified. As a reference, high resolution Landsat images were used, where it was possible to visually determine the land use of the sample points drawn.

  For the supervised classification in April 2021, 300 random points were drawn over the RR, 100 in each of the classes (forest, hydrography and deforestation). It is noteworthy that for this year only deforestation classification information was considered.

  The table below shows the accuracy analysis carried out for each year and each land use class.

**Table 11. Summary of confusion matrices from the evaluation of MapBiomas from 2011 to 2021**

| | Producer accuracy | | | | User accuracy | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Forest | Hydrography | Pioneer vegetation | Deforestation | Forest | Hydrography | Pioneer vegetation | Deforestation |
| 2011 | 86.51% | 96.35% | 97.96% | 88.51% | 97.50% | 87.50% | 80.00% | 96.25% |
| 2012 | 89.87% | 98.61% | 95.59% | 86.36% | 98.75% | 88.75% | 81.25% | 95.00% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2013 | 81.87% | 97.26% | 90.14% | 91.57% | 97.50% | 88.75% | 80.00% | 95.00% |
| 2014 | 81.11% | 98.57% | 92.86% | 89.41% | 97.50% | 86.25% | 81.25% | 95.00% |
| 2015 | 87.89% | 100.00% | 95.52% | 85.39% | 100.00% | 93.75% | 80.00% | 95.00% |
| 2016 | 86.56% | 95.77% | 92.86% | 86.52% | 96.25% | 85.00% | 81.25% | 96.25% |
| 2017 | 88.67% | 97.33% | 94.25% | 87.80% | 97.50% | 91.25% | 86.25% | 90.00% |
| 2018 | 87.81% | 98.68% | 98.48% | 86.21% | 98.75% | 93.75% | 81.25% | 93.75% |
| 2019 | 88.66% | 97.47% | 98.51% | 85.06% | 97.50% | 96.25% | 82.50% | 92.50% |
| 2020 | 85.11% | 100.00% | 95.95% | 93.75% | 100.00% | 90.00% | 88.75% | 93.75% |
| 2021 | 88.87% | 98.65% | 95.59% | 86.05% | 98.75% | 91.25% | 81.25% | 92.50% |

<u>PROJECTION OF FUTURE DEFORESTATION</u>

As the Methodology stipulates, the aim of this step is to locate in space and time the baseline deforestation in the project area, reference region and leakage belt.

- <u>Selection of Baseline Approach</u>

  The Historical Average (Approach A from the applied methodology) was chosen as Baseline Approach, since deforestation rates measured in different historical sub-periods in the reference region reveal a low increasing trend and therefore, in order to be conservative, a constant historical average deforestation rate trend was utilized to project future deforestation.

  The analysis of presented evidence related to deforestation agents and drivers, in addition to underlying causes, allows to conclude that the deforestation rate trend is likely to continue in the future.

- <u>Quantitative projection of future deforestation</u>

  For the deforestation baseline, the average deforestation rate during the 2011-2021 period (0.85%/year).

- <u>Projection of the annual areas of baseline deforestation in the reference region, leakage belt and project area:</u>

  Based on the selection of baseline approach, using the historical average approach, tables below show the results of the projection in reference region, leakage belt and project area.

**Table 12. Annual areas of baseline deforestation in the reference region**

| Project year t | Stratum i in the reference region (ha) | Total (ha) | |
|---|---|---|---|
| | ABSLRR | annual $ABSLRR_t$ | cumulative ABSLRR |
| 2022 | 2,426.99 | 2,426.99 | 2,426.99 |
| 2023 | 2,426.99 | 2,426.99 | 4,853.97 |
| 2024 | 2,426.99 | 2,426.99 | 7,280.96 |
| 2025 | 2,426.99 | 2,426.99 | 9,707.94 |
| 2026 | 2,426.99 | 2,426.99 | 12,134.93 |
| 2027 | 2,426.99 | 2,426.99 | 14,561.91 |
| 2028 | 2,184.29 | 2,184.29 | 16,746.20 |
| 2029 | 2,184.29 | 2,184.29 | 18,930.49 |
| 2030 | 2,184.29 | 2,184.29 | 21,114.77 |
| 2031 | 2,184.29 | 2,184.29 | 23,299.06 |
| 2032 | 2,184.29 | 2,184.29 | 25,483.35 |
| 2033 | 2,184.29 | 2,184.29 | 27,667.63 |
| 2034 | 1,965.86 | 1,965.86 | 29,633.49 |
| 2035 | 1,965.86 | 1,965.86 | 31,599.35 |
| 2036 | 1,965.86 | 1,965.86 | 33,565.21 |
| 2037 | 1,965.86 | 1,965.86 | 35,531.06 |
| 2038 | 1,965.86 | 1,965.86 | 37,496.92 |
| 2039 | 1,965.86 | 1,965.86 | 39,462.78 |
| 2040 | 1,769.27 | 1,769.27 | 41,232.05 |
| 2041 | 1,769.27 | 1,769.27 | 43,001.33 |
| 2042 | 1,769.27 | 1,769.27 | 44,770.60 |
| 2043 | 1,769.27 | 1,769.27 | 46,539.87 |
| 2044 | 1,769.27 | 1,769.27 | 48,309.14 |
| 2045 | 1,769.27 | 1,769.27 | 50,078.41 |
| 2046 | 1,592.35 | 1,592.35 | 51,670.76 |
| 2047 | 1,592.35 | 1,592.35 | 53,263.10 |
| 2048 | 1,592.35 | 1,592.35 | 54,855.45 |
| 2049 | 1,592.35 | 1,592.35 | 56,447.79 |
| 2050 | 1,592.35 | 1,592.35 | 58,040.14 |
| 2051 | 1,592.35 | 1,592.35 | 59,632.48 |

**Table 13. Annual areas of baseline deforestation in the project area**

| Project year t | Stratum i in the project area (ha) | Total (ha) | |
|---|---|---|---|
| | ABSLPA | annual $ABSLPA_t$ | cumulative ABSLPA |
| 2022 | 81.25 | 81.25 | 81.25 |
| 2023 | 81.25 | 81.25 | 162.50 |
| 2024 | 81.25 | 81.25 | 243.75 |
| 2025 | 81.25 | 81.25 | 325.00 |
| 2026 | 81.25 | 81.25 | 406.25 |
| 2027 | 81.25 | 81.25 | 487.50 |
| 2028 | 73.12 | 73.12 | 560.62 |
| 2029 | 73.12 | 73.12 | 633.75 |
| 2030 | 73.12 | 73.12 | 706.87 |
| 2031 | 73.12 | 73.12 | 780.00 |
| 2032 | 73.12 | 73.12 | 853.12 |
| 2033 | 73.12 | 73.12 | 926.25 |
| 2034 | 65.81 | 65.81 | 992.06 |
| 2035 | 65.81 | 65.81 | 1,057.87 |
| 2036 | 65.81 | 65.81 | 1,123.68 |
| 2037 | 65.81 | 65.81 | 1,189.50 |
| 2038 | 65.81 | 65.81 | 1,255.31 |
| 2039 | 65.81 | 65.81 | 1,321.12 |
| 2040 | 59.23 | 59.23 | 1,380.35 |
| 2041 | 59.23 | 59.23 | 1,439.58 |
| 2042 | 59.23 | 59.23 | 1,498.81 |
| 2043 | 59.23 | 59.23 | 1,558.04 |
| 2044 | 59.23 | 59.23 | 1,617.28 |
| 2045 | 59.23 | 59.23 | 1,676.51 |
| 2046 | 53.31 | 53.31 | 1,729.81 |
| 2047 | 53.31 | 53.31 | 1,783.12 |
| 2048 | 53.31 | 53.31 | 1,836.43 |
| 2049 | 53.31 | 53.31 | 1,889.74 |
| 2050 | 53.31 | 53.31 | 1,943.05 |
| 2051 | 53.31 | 53.31 | 1,996.35 |

**Table 14. Annual areas of baseline deforestation in the leakage belt**

| Project year t | Stratum i in the leakage belt (ha) | Total (ha) | |
|---|---|---|---|
| | ABSLLK | annual $ABSLLK_t$ | cumulative ABSLLK |
| 2022 | 78.29 | 78.29 | 78.29 |
| 2023 | 78.29 | 78.29 | 156.58 |
| 2024 | 78.29 | 78.29 | 234.87 |
| 2025 | 78.29 | 78.29 | 313.16 |
| 2026 | 78.29 | 78.29 | 391.46 |
| 2027 | 78.29 | 78.29 | 469.75 |
| 2028 | 70.46 | 70.46 | 540.21 |
| 2029 | 70.46 | 70.46 | 610.67 |
| 2030 | 70.46 | 70.46 | 681.13 |
| 2031 | 70.46 | 70.46 | 751.60 |
| 2032 | 70.46 | 70.46 | 822.06 |
| 2033 | 70.46 | 70.46 | 892.52 |
| 2034 | 63.42 | 63.42 | 955.94 |
| 2035 | 63.42 | 63.42 | 1,019.35 |
| 2036 | 63.42 | 63.42 | 1,082.77 |
| 2037 | 63.42 | 63.42 | 1,146.18 |
| 2038 | 63.42 | 63.42 | 1,209.60 |
| 2039 | 63.42 | 63.42 | 1,273.01 |
| 2040 | 57.07 | 57.07 | 1,330.09 |
| 2041 | 57.07 | 57.07 | 1,387.16 |
| 2042 | 57.07 | 57.07 | 1,444.24 |
| 2043 | 57.07 | 57.07 | 1,501.31 |
| 2044 | 57.07 | 57.07 | 1,558.39 |
| 2045 | 57.07 | 57.07 | 1,615.46 |
| 2046 | 51.37 | 51.37 | 1,666.83 |
| 2047 | 51.37 | 51.37 | 1,718.19 |
| 2048 | 51.37 | 51.37 | 1,769.56 |
| 2049 | 51.37 | 51.37 | 1,820.93 |
| 2050 | 51.37 | 51.37 | 1,872.29 |
| 2051 | 51.37 | 51.37 | 1,923.66 |

**Projection of the location of future deforestation**

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

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

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

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

(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2008 to 2017) through the Business-as-usual scenario.

**Assigning weightings to change agents**

The predictive variables considered to have the potential to influence the risk of deforestation in the region are the proximity to roads, proximity to cities, slope, altitude, presence of settlements, presence of strictly protected and sustainable use protection areas, presence of indigenous lands, proximity to rivers and the proximity to large rivers.

Regarding the proximity factor of roads, in addition to the official roads of the IBGE database, the most recent Imazon mappings were used, which contains the new roads that are being opened in the region, roads visibly opened by satellite images and information obtained in field (Figure below).

Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created using Dinamica EGO Software[112], which modeling techniques are used for calibrating, running and validating space-time models.

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

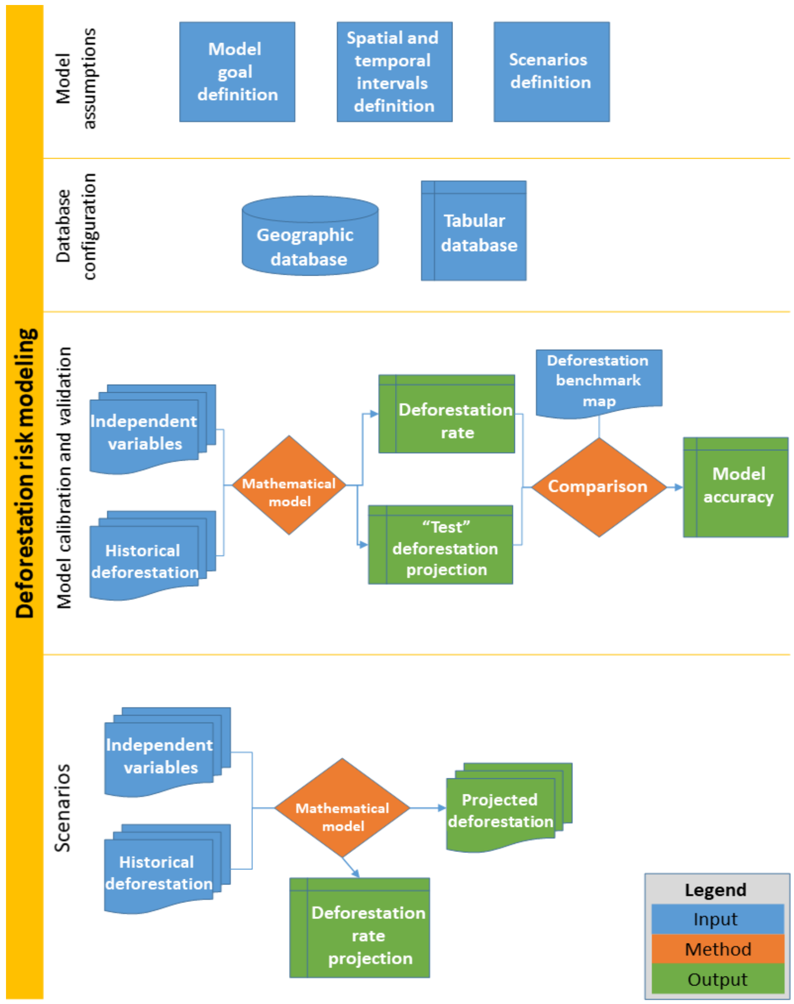
In addition, Dinamica EGO holds multiple transitions that can be calibrated employing the Weights of Evidence. This method calculates the influence of spatial determinants on the changes, producing as a result an integrated transition potential map, also known as the transition probability map.

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

[112] Dinamica Ego Software. Available at: <https://csr.ufmg.br/dinamica/>. Last visited on august 5th, 2021.

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

**Figure 19. Modelling steps focusing on the creation of the deforestation risk map and the projection of future deforestation**




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

**Table 15. List of variables, maps and factor maps**

| Factor Map | | Source | Variable represented | | Meaning of categories or pixel value | | Other maps or variables used to create the Factor Map | | Algorithm or equation used | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | File Name | | Unit | Description | Range | Meaning | ID | File Name | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | d_estradas_edited_v2.tif | IBGE/Imazon | Meter | Distance from paved and unpaved roads | 0-15,017.7 | Lower values mean more proximity | | Merge_IBGE_Imazon_edited_v2 | Euclidean Distance (ArcGis 10.6) | Quantitative variable |
| 2 | UCs.tif | MMA | | Sustainable Use Protected Areas | | | | | | Categoric variable |
| 3 | Tis.tif | FUNAI | | Indigenous lands | | | | | | Categoric variable |
| 4 | Assentamentos.tif | INCRA | | Rural Settlements | | | | | | Categoric variable |
| 5 | d_rios_g.tif | ANA | Meter | Distance from water bodies | 0 – 33,354 | Lower values mean more proximity | | RiosGrandes_ANA | Euclidean Distance (ArcGis10.6) | Quantitative variable |
| 6 | d_rios_mbiomas.tif | MapBiomas | Meter | Distance from water bodies | 0-17,197.6 | Lower values mean more proximity | | Rios_MapBiomas | Euclidean Distance (ArcGis10.6) | Quantitative variable |
| 7 | d_rios.tif | ANA | Meter | Distance from rivers | 0-11,370.4 | Lower values mean more proximity | | Rios_ANA | Euclidean Distance (ArcGis10.6) | Quantitative variable |
| 8 | d_urbana.tif | IBGE | Meter | Distance from urban centers | 10,441.6-101,033 | Lower values mean more proximity | | AreasUrbanas_IBGE | Euclidean Distance (ArcGis10.6) | Quantitative variable |
| 9 | dem.tif | SRTM | Meter | Average altitude variation | 0-139 | Lower values mean lower altitude | | | | Quantitative variable |
| 10 | slope_perc.tif | SRTM | Degrees | Average slope variation | 0-97.1825 | Lower values mean lower slope | | | Slope (ArcGis 10.6) | Quantitative variable |

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

Based on the weights of the evidence, the transition probability of each forest pixel to become other types of anthropic use is calculated. This probability is calculated based on the sum of all the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps[113].

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

**Table 16. Variation of the weights of evidence according to deforestation distance ranges**

| Distance to deforestation | | Weight of evidence |
|---|---|---|
| 0 | 100 | 0.723 |
| 100 | 200 | -0.162 |
| 200 | 300 | -0.563 |
| 300 | 400 | -1.192 |
| 400 | 500 | -1.966 |
| 500 | 600 | -3.737 |
| 600 | 1800 | -4.313 |

**Table 17. Variation of the weights of evidence according to the distance from roads**

| Distance to roads | | Weight of evidence |
|---|---|---|
| 0 | 1000 | 0.273 |
| 1000 | 3000 | -0.056 |
| 3000 | 4000 | -1.756 |

[113] Soares-Filho, B., Nepstad, D., Curran, L. et al. Modelling conservation in the Amazon basin. Nature 440, 520–523 (2006). <https://doi.org/10.1038/nature04389>.

| | | |
|---|---|---|
| 4000 | 5000 | -0.896 |

**Table 18. Variation of the weights of evidence according to the distance from rivers**

| Distance from rivers | | Weight of evidence |
|---|---|---|
| 0 | 2000 | -0.269 |
| 2000 | 4000 | 0.966 |
| 4000 | 6000 | 0.285 |

**Table 19.Variation of the weights of evidence according to slope**

| Slope | | Weight of evidence |
|---|---|---|
| 0 | 2 | -0.127 |
| 2 | 34 | 0.025 |

**Table 20. Variation of the weights of evidence according to altitude**

| Altitude | | Weight of evidence |
|---|---|---|
| 0 | 291 | -1.242 |
| 291 | 292 | -0.388 |
| 292 | 295 | 0.345 |
| 295 | 296 | 0.700 |
| 296 | 297 | 0.247 |
| 297 | 298 | -0.514 |
| 298 | 299 | -0.882 |

| Altitude | | Weight of evidence |
|---|---|---|
| 307 | 309 | -0.350 |
| 309 | 310 | -1.022 |
| 310 | 311 | -0.304 |
| 311 | 324 | -0.123 |
| 324 | 353 | 0.057 |
| 353 | 354 | 0.632 |
| 354 | 356 | 0.354 |

| Altitude | | Weight of evidence |
|---|---|---|
| 299 | 300 | 0.259 |
| 300 | 301 | -0.571 |
| 301 | 302 | 0.085 |
| 302 | 303 | 0.657 |
| 303 | 304 | -1.282 |
| 304 | 305 | -0.367 |
| 305 | 306 | 0.157 |
| 306 | 307 | -0.116 |

| Altitude | | Weight of evidence |
|---|---|---|
| 356 | 384 | 0.160 |
| 384 | 385 | -0.127 |
| 385 | 386 | -0.640 |
| 386 | 425 | -0.453 |
| 425 | 426 | 1.042 |
| 426 | 427 | 1.639 |
| 427 | 430 | 2.584 |
| 430 | 434 | 6.383 |

**Table 21. Variation of the weights of evidence according to distance from urban areas**

| Distance from urban areas | | Weight of evidence |
|---|---|---|
| 0 | 20000 | -0.487 |
| 20000 | 40000 | 0.173 |

**Table 22. Variation of the weights of evidence according to the distance from settlements**

| Distance from settlements | | Weight of evidence |
|---|---|---|
| 0 | 2000 | 1.548 |
| 2000 | 3000 | 1.222 |
| 3000 | 4000 | -0.917 |
| 4000 | 6000 | -0.971 |
| 6000 | 7000 | 0.650 |

| | | |
|---|---|---|
| 7000 | 8000 | 0.141 |
| 8000 | 9000 | -1.011 |
| 9000 | 11000 | -0.334 |
| 11000 | 12000 | -0.033 |
| 12000 | 13000 | 0.198 |
| 13000 | 14000 | -0.053 |
| 14000 | 15000 | 0.634 |
| 15000 | 16000 | 0.906 |
| 16000 | 17000 | -0.332 |
| 17000 | 18000 | -0.840 |
| 18000 | 19000 | 0.230 |
| 19000 | 24000 | 0.048 |
| 24000 | 25000 | -0.562 |
| 25000 | 26000 | 0.986 |
| 26000 | 28000 | -0.158 |

- <u>**Selection of most accurate deforestation risk map**</u>

As previously noted, the historical average approach was chosen to project the quantity of future deforestation, given the tendency to increase over time. In addition, to validate which are the best models to allocate where the deforestation happens, the calibration and confirmation methodology was applied, dividing the deforestation period in two.

For that, simulations of the deforestation projection were made, taking three dates as reference: 2011, 2015 and 2021. The period of 2011-2015 was used to generate the correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the models. After that a projection from 2016 to 2021 was made, developing a reference region scenario for this date. Therefore, the deforestation map for the period of 2016 to 2021 and two 2021 scenarios, real and projected, were developed. These scenarios were compared regarding the degree of similarity considering the exponential decay. The higher the similarity, the better the prediction of the model. This index ranges from 0 (no overlapping) to 1 (completely overlapped), and the closer to 1, the more similar is the simulated scenario in relation to the real. Two values are calculated for the indices, the comparison of the simulated map in relation to the real deforestation map and, the opposite, the real map in relation to the simulated map. Thus, to define the most accurate map, the average of these two values was used.

The first tested model was the one with all the predictor variables of deforestation (m00); next, the models were tested by removing each factor separately and measuring the degree of correctness of the model (m01 to m06). Therefore, the most important variables were those in which their absence caused a greater drop in the degree of similarity between the real and projected deforestation maps.

Next, the inverse combinations were made, that is, the models were analyzed only with the deforestation proximity variable (dynamic variable) and the static variables with the greatest impact on the degree of similarity, adding one by one in order of impact (m07 to m11). Through this procedure it is possible to guarantee that all the best models could be assessed. Only the dynamic variable “Proximity to Deforestation” was used in all models, as there is evidence that proximity to deforested areas is one of the most important variables to predict deforestation.

The best model was m09, with an average similarity of 0.217. This model applies three variables: distance from settlements, distance from urban areas and distance from rivers. Thus, it was selected to project the future deforestation.

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

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

In accordance with analysis achieved through the procedure described above, the quantity of baseline LU/LC-change was projected throughout the 1$^{st}$ baseline period, in the reference region, project area and leakage belt in each stratum. This is in accordance with step 5 of the methodology “Definition of the land-use and land-cover change component of the baseline”.

**Calculation of baseline activity data per forest class**

The following is in accordance with step 5.1 Calculation of baseline activity data per forest class”, in which is stipulated that the previously created maps of annual baseline deforestation and LU/LC map can be combined, producing a map showing deforestation per class in the baseline case.

The LU/LC-change within the project crediting period, caused by baseline deforestation consisted of initial forest classes being converted to the final LU/LC class of ‘non-forest’.

**Table 23. Annual areas deforested per forest class icl within the reference region in the baseline case (baseline activity data per forest class)**

| Area deforested per forest class *icl* within the reference region | | |
|---|---|---|
| *IDicl* | 1 | annual ABSLRRt (ha) |
| Name | **Forest** | |
| Project year *t* | ha | |
| 2022 | 715,761.60 | 715,761.60 |
| 2023 | 713,523.19 | 713,523.19 |
| 2024 | 711,284.79 | 711,284.79 |
| 2025 | 709,046.38 | 709,046.38 |
| 2026 | 706,807.98 | 706,807.98 |
| 2027 | 704,569.57 | 704,569.57 |
| 2028 | 702,555.01 | 702,555.01 |
| 2029 | 700,540.45 | 700,540.45 |
| 2030 | 698,525.88 | 698,525.88 |
| 2031 | 696,511.32 | 696,511.32 |
| 2032 | 694,496.75 | 694,496.75 |
| 2033 | 692,482.19 | 692,482.19 |
| 2034 | 690,669.08 | 690,669.08 |
| 2035 | 688,855.97 | 688,855.97 |
| 2036 | 687,042.87 | 687,042.87 |
| 2037 | 685,229.76 | 685,229.76 |
| 2038 | 683,416.65 | 683,416.65 |
| 2039 | 681,603.54 | 681,603.54 |
| 2040 | 679,971.75 | 679,971.75 |
| 2041 | 678,339.95 | 678,339.95 |
| 2042 | 676,708.15 | 676,708.15 |
| 2043 | 675,076.36 | 675,076.36 |
| 2044 | 673,444.56 | 673,444.56 |
| 2045 | 671,812.76 | 671,812.76 |
| 2046 | 670,344.15 | 670,344.15 |
| 2047 | 668,875.53 | 668,875.53 |
| 2048 | 667,406.91 | 667,406.91 |
| 2049 | 665,938.30 | 665,938.30 |
| 2050 | 664,469.68 | 664,469.68 |

| | | |
|---|---|---|
| 2051 | 663,001.06 | 663,001.06 |

**Table 24. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)**

| | Area (ha) forest class | Total forest area (ha) |
|---|---|---|
| *IDicl* | 1 | |
| Name | Forest | |
| Project year *t* | ha | |
| 2022 | 25,980.75 | 25,980.75 |
| 2023 | 25,899.50 | 25,899.50 |
| 2024 | 25,818.25 | 25,818.25 |
| 2025 | 25,737.00 | 25,737.00 |
| 2026 | 25,655.75 | 25,655.75 |
| 2027 | 25,574.50 | 25,574.50 |
| 2028 | 25,501.38 | 25,501.38 |
| 2029 | 25,428.25 | 25,428.25 |
| 2030 | 25,355.13 | 25,355.13 |
| 2031 | 25,282.00 | 25,282.00 |
| 2032 | 25,208.88 | 25,208.88 |
| 2033 | 25,135.75 | 25,135.75 |
| 2034 | 25,069.94 | 25,069.94 |
| 2035 | 25,004.13 | 25,004.13 |
| 2036 | 24,938.32 | 24,938.32 |
| 2037 | 24,872.50 | 24,872.50 |
| 2038 | 24,806.69 | 24,806.69 |
| 2039 | 24,740.88 | 24,740.88 |
| 2040 | 24,681.65 | 24,681.65 |
| 2041 | 24,622.42 | 24,622.42 |
| 2042 | 24,563.19 | 24,563.19 |
| 2043 | 24,503.96 | 24,503.96 |
| 2044 | 24,444.72 | 24,444.72 |
| 2045 | 24,385.49 | 24,385.49 |
| 2046 | 24,332.19 | 24,332.19 |
| 2047 | 24,278.88 | 24,278.88 |
| 2048 | 24,225.57 | 24,225.57 |
| 2049 | 25,980.75 | 25,980.75 |
| 2050 | 25,899.50 | 25,899.50 |
| 2051 | 25,818.25 | 25,818.25 |

**Table 25. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)**

| | Area (ha) forest class | Total forest area (ha) |
|---|---|---|
| *IDicl* | 1 | |
| Name | Forest | |
| Project year *t* | ha | |
| 2022 | 25,034.71 | 25,034.71 |
| 2023 | 24,956.42 | 24,956.42 |
| 2024 | 24,878.13 | 24,878.13 |
| 2025 | 24,799.84 | 24,799.84 |
| 2026 | 24,721.54 | 24,721.54 |
| 2027 | 24,643.25 | 24,643.25 |
| 2028 | 24,572.79 | 24,572.79 |
| 2029 | 24,502.33 | 24,502.33 |
| 2030 | 24,431.87 | 24,431.87 |
| 2031 | 24,361.40 | 24,361.40 |
| 2032 | 24,290.94 | 24,290.94 |
| 2033 | 24,220.48 | 24,220.48 |
| 2034 | 24,157.06 | 24,157.06 |
| 2035 | 24,093.65 | 24,093.65 |
| 2036 | 24,030.23 | 24,030.23 |
| 2037 | 23,966.82 | 23,966.82 |
| 2038 | 23,903.40 | 23,903.40 |
| 2039 | 23,839.99 | 23,839.99 |
| 2040 | 23,782.91 | 23,782.91 |
| 2041 | 23,725.84 | 23,725.84 |
| 2042 | 23,668.76 | 23,668.76 |
| 2043 | 23,611.69 | 23,611.69 |
| 2044 | 23,554.61 | 23,554.61 |
| 2045 | 23,497.54 | 23,497.54 |
| 2046 | 23,446.17 | 23,446.17 |
| 2047 | 23,394.81 | 23,394.81 |
| 2048 | 23,343.44 | 23,343.44 |
| 2049 | 23,292.07 | 23,292.07 |
| 2050 | 23,240.71 | 23,240.71 |
| 2051 | 23,189.34 | 23,189.34 |

**Table 26. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)**

| | Area (ha) forest class | Total forest area (ha) |
|---|---|---|
| *IDicl* | 1 | |
| Name | Forest | |
| Project year *t* | ha | |
| 2022 | 17,919.61 | 17,919.61 |
| 2023 | 17,738.22 | 17,738.22 |
| 2024 | 17,556.83 | 17,556.83 |
| 2025 | 17,375.44 | 17,375.44 |
| 2026 | 17,194.05 | 17,194.05 |
| 2027 | 17,012.67 | 17,012.67 |
| 2028 | 16,849.42 | 16,849.42 |
| 2029 | 16,686.16 | 16,686.16 |
| 2030 | 16,522.91 | 16,522.91 |
| 2031 | 16,359.66 | 16,359.66 |
| 2032 | 16,196.41 | 16,196.41 |
| 2033 | 16,033.16 | 16,033.16 |
| 2034 | 15,886.24 | 15,886.24 |
| 2035 | 15,739.31 | 15,739.31 |
| 2036 | 15,592.39 | 15,592.39 |
| 2037 | 15,445.46 | 15,445.46 |
| 2038 | 15,298.54 | 15,298.54 |
| 2039 | 15,151.61 | 15,151.61 |
| 2040 | 15,019.38 | 15,019.38 |
| 2041 | 14,887.15 | 14,887.15 |
| 2042 | 14,754.91 | 14,754.91 |
| 2043 | 14,622.68 | 14,622.68 |
| 2044 | 14,490.45 | 14,490.45 |
| 2045 | 14,358.22 | 14,358.22 |
| 2046 | 14,239.21 | 14,239.21 |
| 2047 | 14,120.20 | 14,120.20 |
| 2048 | 14,001.19 | 14,001.19 |
| 2049 | 13,882.18 | 13,882.18 |
| 2050 | 13,763.17 | 13,763.17 |
| 2051 | 13,644.16 | 13,644.16 |

Calculation of baseline activity data per post-deforestation forest class

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

According to the methodology VM00145, the Historical LU/LC-change (Method 1) was used to calculate the LU/LC class that will replace the forest cover in the baseline scenario. The table below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region.

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

**Table 27. Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data per zone)**

| Zone | | Name | | Total area of each zone | |
|---|---|---|---|---|---|
| | | Non-forest | | | |
| | | $ID_{fcl}$ | 1 | | |
| | | Area | % of zone | Area | % of zone |
| *IDz* | Name | ha | % | ha | % |
| 1 | Reference region | 99,237.59 | 19% | 99,237.59 | 19% |
| Total area of each class *fcl* | | 99,237.59 | 19% | 99,237.59 | 19% |

**Table 28. Annual areas deforested in each zone within the project area in the baseline case (baseline activity data per zone)**

| Area established after deforestation per zone within the reference region | | Total baseline deforestation in the reference region | |
|---|---|---|---|
| *$ID_{fcl}$* | 1 | *$ABSLRR_t$* | *ABSLRR* |
| Name | No forest | annual | cumulative |
| Project year | ha | ha | ha |
| 2022 | 2,238.40 | 2,238.40 | 2,238.40 |
| 2023 | 2,238.40 | 2,238.40 | 4,476.81 |
| 2024 | 2,238.40 | 2,238.40 | 6,715.21 |
| 2025 | 2,238.40 | 2,238.40 | 8,953.62 |
| 2026 | 2,238.40 | 2,238.40 | 11,192.02 |
| 2027 | 2,238.40 | 2,238.40 | 13,430.43 |
| 2028 | 2,014.56 | 2,014.56 | 15,444.99 |
| 2029 | 2,014.56 | 2,014.56 | 17,459.55 |

| | | | |
|---|---|---|---|
| 2030 | 2,014.56 | 2,014.56 | 19,474.12 |
| 2031 | 2,014.56 | 2,014.56 | 21,488.68 |
| 2032 | 2,014.56 | 2,014.56 | 23,503.25 |
| 2033 | 2,014.56 | 2,014.56 | 25,517.81 |
| 2034 | 1,813.11 | 1,813.11 | 27,330.92 |
| 2035 | 1,813.11 | 1,813.11 | 29,144.03 |
| 2036 | 1,813.11 | 1,813.11 | 30,957.13 |
| 2037 | 1,813.11 | 1,813.11 | 32,770.24 |
| 2038 | 1,813.11 | 1,813.11 | 34,583.35 |
| 2039 | 1,813.11 | 1,813.11 | 36,396.46 |
| 2040 | 1,631.80 | 1,631.80 | 38,028.25 |
| 2041 | 1,631.80 | 1,631.80 | 39,660.05 |
| 2042 | 1,631.80 | 1,631.80 | 41,291.85 |
| 2043 | 1,631.80 | 1,631.80 | 42,923.64 |
| 2044 | 1,631.80 | 1,631.80 | 44,555.44 |
| 2045 | 1,631.80 | 1,631.80 | 46,187.24 |
| 2046 | 1,468.62 | 1,468.62 | 47,655.85 |
| 2047 | 1,468.62 | 1,468.62 | 49,124.47 |
| 2048 | 1,468.62 | 1,468.62 | 50,593.09 |
| 2049 | 1,468.62 | 1,468.62 | 52,061.70 |
| 2050 | 1,468.62 | 1,468.62 | 53,530.32 |
| 2051 | 1,468.62 | 1,468.62 | 54,998.94 |

**Table 29. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)**

| Leakage Belt | | | |
|---|---|---|---|
| Area established after deforestation per zone within the leakage belt | | Total baseline deforestation in the leakage belt | |
| *$ID_{fcl}$* | 1 | *$ABSLLK_t$* | *ABSLLK* |
| Name | Non forest | annual | cumulative |
| Project year | ha | ha | ha |
| 2022 | 78.29 | 78.29 | 78.29 |
| 2023 | 78.29 | 78.29 | 156.58 |
| 2024 | 78.29 | 78.29 | 234.87 |
| 2025 | 78.29 | 78.29 | 313.16 |
| 2026 | 78.29 | 78.29 | 391.46 |
| 2027 | 78.29 | 78.29 | 469.75 |
| 2028 | 70.46 | 70.46 | 540.21 |
| 2029 | 70.46 | 70.46 | 610.67 |

| | | | |
|---|---|---|---|
| 2030 | 70.46 | 70.46 | 681.13 |
| 2031 | 70.46 | 70.46 | 751.60 |
| 2032 | 70.46 | 70.46 | 822.06 |
| 2033 | 70.46 | 70.46 | 892.52 |
| 2034 | 63.42 | 63.42 | 955.94 |
| 2035 | 63.42 | 63.42 | 1,019.35 |
| 2036 | 63.42 | 63.42 | 1,082.77 |
| 2037 | 63.42 | 63.42 | 1,146.18 |
| 2038 | 63.42 | 63.42 | 1,209.60 |
| 2039 | 63.42 | 63.42 | 1,273.01 |
| 2040 | 57.07 | 57.07 | 1,330.09 |
| 2041 | 57.07 | 57.07 | 1,387.16 |
| 2042 | 57.07 | 57.07 | 1,444.24 |
| 2043 | 57.07 | 57.07 | 1,501.31 |
| 2044 | 57.07 | 57.07 | 1,558.39 |
| 2045 | 57.07 | 57.07 | 1,615.46 |
| 2046 | 51.37 | 51.37 | 1,666.83 |
| 2047 | 51.37 | 51.37 | 1,718.19 |
| 2048 | 51.37 | 51.37 | 1,769.56 |
| 2049 | 51.37 | 51.37 | 1,820.93 |
| 2050 | 51.37 | 51.37 | 1,872.29 |
| 2051 | 51.37 | 51.37 | 1,923.66 |

Calculation of Baseline Emissions

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

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

Where,

| | |
|---|---|
| Cabicl | Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class icl; tCO2e $ha^{-1}$ |
| ab | Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl; Mg $ha^{-1}$ |
| CF | Default value of carbon fraction in biomass |
| 44/12 | Ratio converting C to CO2e |

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

Where,

| | |
|---|---|
| Cbbicl | Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class icl; $tCO2e\ ha^{-1}$ |
| bb | Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl; $Mg\ ha^{-1}$ |
| CF | Default value of carbon fraction in biomass |
| 44/12 | Ratio converting C to CO2e |

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

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

Where,

| | |
|---|---|
| ΔCBSLPAt | Total baseline carbon stock changes in the project area at year t; tCO2e |
| ΔCabBSLPAicl,t | Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e |
| ΔCbbBSLPAicl,t | Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO2e |

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

Where,

| | |
|---|---|
| ΔCabBSLPAicl,t | Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e |
| ABSLPAicl,t | Area of initial forest class icl deforested at time t within the project area in the baseline case; ha |
| ΔCabicl | Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class icl; $tCO2e\ ha^{-1}$ |

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

Where,

| | |
|---|---|
| ΔCbbBSLPAicl,t | Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO2e |
| ABSLPAicl,t | Area of initial forest class icl deforested at time t within the project area in the baseline case; ha |

ΔCbbicl Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category icl; $tCO2e\ ha^{-1}$

**Estimation of the average carbon stocks of each LU/LC class**

According to the applied methodology, average carbon stocks must be estimated for the forest classes existing within the project area. This information must be collected from existing carbon stock data for these classes from local published studies and existing forest and carbon inventories, according to the following criteria:

- The data is less than 10 years old;
- The data are derived from multiple measurement plots;
- All species above a minimum diameter are included in the inventories;
- The minimum diameter for trees included is 30 cm or less at breast height (DBH);
- Data is sampled from good coverage of the classes over which they will be extrapolated.

Project carbon stocks were calculated on the basis of biomass values from the study from Iguchi, 2015[114].The data will be updated and may be stratified if new and more updated references for each phytophysiognomy are published. It is also important to note that revenues from carbon credits will be an important factor in encouraging specific studies in the project area, which would produce direct data on the region's carbon dynamics.

The methodology of the study summarized below:

The estimation of the average carbon stocks for Dense Lowland Tropical Rainforest was based on Higuchi (2015)[115], which fulfil the criteria mentioned above.

The classification of the Brazilian vegetation is still constantly updated and studied, being evaluated and subdivided according to biological, geological or biodiversity characteristics. Pires & Prance (1985)[116] classified the forest formation of the Amazon biome into two major groups, Forest on *terra firme* (dense forest) and *Várzeas and igapós* forests, and their respective subdivisions. The authors classify that *terra firme* forests dominate the largest percentage of area in the Amazon. Most of it consist of lowland undulating terrain, rarely above 200 m, and most below 100 m.

[114] LUNARDELLI, Caroline. Influência de fatores ambientais e antrópico na estimativa de biomassa arbórea acima do solo no sul da Amazônia. UFMT, 2016. Available at https://ppbio.inpa.gov.br/sites/default/files/Lunardelli_C_Dissertacao_2016.pdf

[115] HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015. Available at: <https://acervodigital.ufpr.br/bitstream/handle/1884/41822/R%20-%20T%20-%20FRANCISCO%20GASPARETTO%20HIGUCHI.pdf?sequence=1&isAllowed=y> Last visited on: August 2021.

[116] Pires & Prance (J.M.Pires, & Prance, G.T.. (1985). The vegetation types of the Brazilian Amazon. Available at <https://www.researchgate.net/publication/259688522_The_vegetation_types_of_the_Brazilian_Amazon> Last visited on 21/March/2021.

The IBGE "Technical Manual for Brazilian Vegetation" (1992)[117] divides forestry formation into two types: Ombrophilous and Seasonal, being Ombrophilous, open and dense, predominant in the Brazilian Amazon.

As both classifications are based on characteristics of cover, soil, climate and location of the biome, the table below lists the respective definitions, comparing them:

**Table 30.** Comparison of forest classifications by Pires & Prance and IBGE

| | Pires & Prance (1985) | Technical Manual of the Brazilian vegetation (2012) |
|---|---|---|
| Forest on *Terra firme* (dense forest) | Dense forest<br>Dense forest is the formation with the greatest biomass, with a clear litter and occurs where environmental conditions are optimal and there are no limiting factors such as scarcity or excess of water. | Dense Ombrophylous rainforest (tropical rain forest)<br>The ombrothermal characteristic of the Dense Ombrophilous Forest is linked to tropical climatic factors of high temperatures and high rainfall, well distributed throughout the year, with practically no biologically dry period. It can be of uniform or emergent canopy.<br><br>It is subdivided into five formations ordered according to topographic hierarchy, which reflect different physiognomies:<br>**Alluvial, low land, submontane, montane and high montane formations.** |
| | Open forest without palms<br>Since there is a greater penetration of light, because of its lower trees, there is a tendency for shrub and liana species to develop well, and the forest floor is much more densely covered by vegetation. In this forest, even though it is much lower, occasional scattered individuals of very large trees occur. The lower biomass can be caused by a lower water table, by the impermeability of the soil, by poor drainage or by conditions which do not permit good root penetration, or by the occurrence of relatively long dry seasons and a lower relative humidity. These | Open Ombrophylous forest<br>This type of vegetation was considered for years as a type of transition between the Amazon rainforest and the extra-Amazonian areas. It presents four floristic factions that alter the ecological physiognomy of the dense rainforest, giving it a clear appearance, hence the name adopted, in addition to the climatic gradients with more than 60 dry days per year. It is divided into:<br>Lowland – predominance of palm trees<br>Submontane – predominance of palm trees, vines, sororoca and bamboo<br>Montane – predominance of palms and vines, the latter much more common. |

[117] Manual Técnico da Vegetação Brasileira – IBGE, 1992. Available at <https://biblioteca.ibge.gov.br/visualizacao/monografias/GEBIS%20-%20RJ/ManuaisdeGeociencias/Manual%20Tecnico%20da%20Vegetacao%20Brasileira%20n.1.pdf> Last visited on 21/March/2021.

| | | |
|---|---|---|
| | forests are not notably seasonally deciduous, and they are also not affected by fire.<br><br><u>Open forest with palms</u><br>Similar to the preceding, with trees of about the same height in the same density and of a similar floristic composition. It occurs more frequently than the forest without palms.<br><br><u>Liana forest:</u><br>Generally has an abundance of lianas. Generally not continuous. Usually intermeshed with dense forests wthout lianas forming a complex mosaic.<br><br><u>Dry forest:</u><br>Formation of transition forest that is occasionally found in the southeastern part of Amazonia on the border between Amazonia and Central Brazil. In this region, the climate is much more seasonal and dryer with lower relative humidity, with the result that in the dry season, the trees lose some of their leaves. Dry forest occurs in small clusters that do not occupy large areas.<br><br><u>Montane forests:</u><br>Forest formations which are differentiated by their altitude and rocky soil types. It occurs only at the extremities of Amazonia. | <u>Alluvial</u> – on ancient terraces located along the river; riverside formation that always occupies alluvial lands located in the fluvia of coastal mountains or plateaus. |
| <u>Inundated forests (*várzeas* and *igapós*)</u><br>Várzeas and igapós are regional terms applied both to types of soil and vegetation, noting the excess of humidity or swampy conditions, i.e., any ground that is not terra firme. *Igapó* is located in black and clearwater areas, while *Várzea* to muddy water inundation. Várzeas are formed by sedimentar | | Classification of forests by location - alluvial. While Pires and Prance unified the marshy characteristic in a classification, the manual divides them according to the context of the other formations, with respective information on species, cover, etc. Thus, the term alluvial represents, as a whole, riverside formation or riparian forest that occurs along water |

| | |
|---|---|
| ground that during its formation were influenced by fluctuation in sea levels. | courses, occupying the old terraces of quaternary plains. It can occur in dense, open and mixed rain forest within the classifications above. |

Thus, it can be concluded that the general definition of Dense Ombrophylous rainforest is similar to the definition of *terra firme* forests, as described by Higuchi (2015).

Therefore, the Higuchi's study of volume and biomass dynamics of the Amazonian rainforest was adopted to define the carbon stock of the category of dense tropical rainforest (lowland) located in PA, RR and LK. It is important to highlight that this vegetation type is characterized as Dense Ombrophylous Forest.

This choice was motivated by the focus of the study, which covered upland forests and the same phytophysiognomy, despite focusing on the State of Amazonas, the study covered a large number of sample plots and low uncertainty, with a confidence interval of 95%.

The data will be updated and may be stratified if new and more updated references for each phytophysiognomy are published. It is also important to note that revenues from carbon credits will be an important factor in encouraging specific studies in the project area, which would produce direct data on the region's carbon dynamics.

The methodology of Higuchi (2015) is summarized below.

The research was conducted in 11 locations distributed in 12 different municipalities in the State of Amazonas. All plots were allocated in areas of mature upland forests. None of the sampled areas has shown any clear sign of human disturbance in the past 50 years.

Regarding the sampling method, permanent plots were used, in addition to the standard EMBRAPA method.

EMBRAPA Method: 18 square plots of 1 ha (100 m x 100 m) each were installed and measured, randomly distributed over an area of 4 km² (2,000 m x 2,000 m). Each plot of 1 ha was subdivided into 100 units of 100 m², dimensioned in 10 m x 10 m. In each plot, the DBHs of all trees with a diameter greater than or equal to 10 cm were identified and measured. Dead trees and palm trees were not sampled in this location. Trees with DBH between 5 and 10 cm were sampled in ten subsamples randomly distributed in the 1 ha plot.

Permanent plots method: rectangular units with 2,500 m² were installed (¼ ha), dimensioned in 20 m x 125 m, according to the work of Higuchi et al. (1982), Higuchi, 1986-87 and Oliveira et al. (2014). Each sample unit had two sub-plots of 100 m² (10 mx 10 m) at the ends, one at the beginning of the left side and another at the end of the right side of the central path, for the measurement of natural regeneration (RN) (trees with DBH greater than or equal to 5 cm and less than 10 cm). The access path of each plot was arranged in the center of it, dividing it into two sides of 10 m each.

The sampling process adopted was mixed, where the sampling point of the first parcel was randomly drawn and the following parcels were systematically allocated from the first sampling unit.

The estimates of biomass were calculated using the equations adjusted by Silva (2007), in Manaus. The transformation to dry biomass considered the values of water and carbon in the wood determined by Silva (2007). A correction factor (fc) was applied for the use of these equations in different locations according to the dominant height of the sampled site. The equations used were:

$$BStot = 2{,}7179 \times DAP^{1{,}8774} \times 0{,}584 \times fc \text{, onde } R^2 = 0{,}94 \text{ e } Syx\% = 3{,}91.$$

$$AGB = 2{,}2737 \times DAP^{1{,}9156} \times 0{,}584 \times fc \text{, onde } R^2 = 0{,}85 \text{ e } Syx\% = 4{,}20.$$

$$BGB = 0{,}0469 \times DAP^{2{,}4754} \times 0{,}533 \times fc \text{, onde } R^2 = 0{,}95 \text{ e } Syx\% = 5{,}12.$$

$$fc = \frac{Hdom_i}{Hdom_{ZF2}}$$

Considering a minimum DBH of 5 cm and the arithmetic mean of the estimated averages for each site, the aboveground dry biomass (AGB) of *terra firme* forests in the state of Amazonas is 327.4 t.ha-1 (± 24.2 at 95% CI). This value was used for phytophysiognomies of Dense Ombrophilous Forest (Dense Tropical Rainforest).

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

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

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

**Table 31. Biomass to CO2 conversion factors[118]**

| Conversion Factors*** | |
|---|---|
| Biomass to Carbon | 0.5 |
| C to $CO_2$ | 3.6667 |

**Table 32. Biomass values used for the "forest" classes within the reference region.**

| REFERENCE REGION | | | |
|---|---|---|---|
| Forest class | Aboveground* | Belowground** | TOTAL |

[118] IPCC, 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

| | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cab_icl (tCO2/ha) | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cbb_icl (tCO2/ha) | Total biomass (Mg ha-1) | Biomass to Carbon (tC/ha) | Ctot_icl ($tCO_2$/ha) |
|---|---|---|---|---|---|---|---|---|---|
| Dense Lowland Tropical Rainforest | 327.40 | 163.70 | 600.23 | 78.58 | 39.29 | 144.06 | 405.98 | 202.99 | 744.29 |

**Table 33. Biomass values used for the "forest" classes within the project area.**

| PROJECT AREA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Forest class | Aboveground* | | | Belowground** | | | TOTAL | | |
| | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cab_icl (tCO2/ha) | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cbb_icl (tCO2/ha) | Total biomass (Mg ha-1) | Biomass to Carbon (tC/ha) | Ctot_icl ($tCO_2$/ha) |
| Dense Lowland Tropical Rainforest | 327.40 | 163.70 | 600.23 | 78.58 | 39.29 | 144.06 | 405.98 | 202.99 | 744.29 |

**Table 34. Biomass values used for the "forest" classes within the leakage belt.**

| LEAKAGE BELT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Forest class | Aboveground* | | | Belowground** | | | TOTAL | | |
| | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cab_icl (tCO2/ha) | Biomass ( Mg ha-1) | Biomass to Carbon (tC/ha) | Cbb_icl (tCO2/ha) | Total biomass (Mg ha-1) | Biomass to Carbon (tC/ha) | Ctot_icl ($tCO_2$/ha) |
| Dense Lowland Tropical Rainforest | 327.40 | 163.70 | 600.23 | 78.58 | 39.29 | 144.06 | 405.98 | 202.99 | 744.29 |

### Average carbon stocks of post-deforestation classes

Fearnside (1996)[119] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO2e/ha. It is important to note that no sampling was applied to calculate this data.

[119] FEARNSIDE, Philip M. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. Forest Ecology And Management, Manaus, v. 80, p.21-34, 1996 Available at < https://www.jstor.org/stable/3591054>

**Table 35. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region**

| Post deforestation class *fcl* | |
|---|---|
| Name | Non forest |
| $ID_{fcl}$ | 1 |
| Average carbon stock per hectare ±90% CI | |
| $Ctot_{fcl}$ | |
| $tCO_2e/ha$ | |
| 46.93 | |

Following a literature review, the use of Fearnside (1996) value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory120, the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used.

<u>Uncertainty assessment</u>

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

Iguchi, for the Dense Lowland Tropical Rainforest vegetation type, was conducted at a 95% confidence interval and present an uncertainty level less than 10% of the average carbon stock value.

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

[120] Available at <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/estimativas-anuais-de-emissoes-gee>

**Table 36. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt**

| Initial forest class *icl* | | | | | | |
|---|---|---|---|---|---|---|
| Boundaries | Average carbon stock 90% CI | | | | | |
| | Name | Forest | | | | |
| | $ID_{icl}$ | 1 | | | | |
| | $Cab_{icl}$ | | $Cbb_{icl}$ | | $Ctot_{icl}$ | |
| | C stock | ±90% CI | C stock | ±90% CI | C stock | ±90% CI |
| | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha |
| Project Area | 600.23 | 37.23 | 144.06 | 8.94 | 744.29 | 46.17 |
| Leakage Belt | 600.23 | 37.23 | 144.06 | 8.94 | 744.29 | 46.17 |

**Table 37. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties**

| | Initial forest class *icl* | | | | | | |
|---|---|---|---|---|---|---|---|
| | Boundaries | Average carbon stock 90% CI | | | | | |
| | | Name | Forest | | | | |
| | | $ID_{icl}$ | 1 | | | | |
| | | $Cab_{icl}$ | | $Cbb_{icl}$ | | $Ctot_{icl}$ | |
| | | C stock | C stock change | C stock | C stock change | C stock | C stock change |
| | | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha |
| Initial forest class | **Project Area** | 600.23 | 600.23 | 144.06 | 144.06 | 744.29 | 744.29 |
| Final forest class | | 600.23 | 600.23 | 144.06 | 144.06 | 744.29 | 744.29 |
| Initial forest class | **Leakage Belt** | 600.23 | 600.23 | 144.06 | 144.06 | 744.29 | 744.29 |
| Final forest class | | 600.23 | 600.23 | 144.06 | 144.06 | 744.29 | 744.29 |

<u>Carbon stock change factors</u>

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

a) Above-ground biomass:

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

b) Below-ground biomass:

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

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

**Table 38. Carbon stock change factors for initial forest classes (icl) in the reference region (Method 1)**

| Forest | | | |
|---|---|---|---|
| Year after deforestation | | $\Delta Cab_{icl,t}$ | $\Delta Cbb_{icl,t}$ |
| | | $tCO_2$/ha | $tCO_2$/ha |
| 1 | t* | -284.90 | -6.84 |
| 2 | t*+1 | 0 | -6.84 |
| 3 | t*+2 | 0 | -6.84 |
| 4 | t*+3 | 0 | -6.84 |
| 5 | t*+4 | 0 | -6.84 |
| 6 | t*+5 | 0 | -6.84 |
| 7 | t*+6 | 0 | -6.84 |
| 8 | t*+7 | 0 | -6.84 |
| 9 | t*+8 | 0 | -6.84 |
| 10 | t*+9 | 0 | -6.84 |
| 11 | t*+10 | 0 | 0 |
| 12 | t*+11 | 0 | 0 |
| 13 | t*+12 | 0 | 0 |
| 14 | t*+13 | 0 | 0 |
| 15 | t*+14 | 0 | 0 |
| 16 | t*+15 | 0 | 0 |
| 17 | t*+16 | 0 | 0 |
| 18 | t*+17 | 0 | 0 |

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

**Table 39. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method1)**

| Forest | | | |
|---|---|---|---|
| Year after deforestation | | $\Delta Cab_{icl,t}$ | $\Delta Cbb_{icl,t}$ |
| | | $tCO_2/ha$ | $tCO_2/ha$ |
| 1 | t* | -284.90 | -6.84 |
| 2 | t*+1 | 0 | -6.84 |
| 3 | t*+2 | 0 | -6.84 |
| 4 | t*+3 | 0 | -6.84 |
| 5 | t*+4 | 0 | -6.84 |
| 6 | t*+5 | 0 | -6.84 |
| 7 | t*+6 | 0 | -6.84 |
| 8 | t*+7 | 0 | -6.84 |
| 9 | t*+8 | 0 | -6.84 |
| 10 | t*+9 | 0 | -6.84 |
| 11 | t*+10 | 0 | 0 |
| 12 | t*+11 | 0 | 0 |
| 13 | t*+12 | 0 | 0 |
| 14 | t*+13 | 0 | 0 |
| 15 | t*+14 | 0 | 0 |
| 16 | t*+15 | 0 | 0 |
| 17 | t*+16 | 0 | 0 |
| 18 | t*+17 | 0 | 0 |
| 19 | t*+18 | 0 | 0 |
| 20 | t*+19 | 0 | 0 |
| 21-T | t*+20... | 0 | 0 |

**Table 40. Carbon stock change factors for initial forest classes (icl) in the Leakage Belt (Method 1)**

| Forest | | | |
|---|---|---|---|
| Year after deforestation | | $\Delta Cab_{icl,t}$ | $\Delta Cbb_{icl,t}$ |
| | | $tCO_2/ha$ | $tCO_2/ha$ |
| 1 | t* | -284.90 | -6.84 |
| 2 | t*+1 | 0 | -6.84 |
| 3 | t*+2 | 0 | -6.84 |
| 4 | t*+3 | 0 | -6.84 |
| 5 | t*+4 | 0 | -6.84 |
| 6 | t*+5 | 0 | -6.84 |

| | | | |
|---|---|---|---|
| 7 | t*+6 | 0 | -6.84 |
| 8 | t*+7 | 0 | -6.84 |
| 9 | t*+8 | 0 | -6.84 |
| 10 | t*+9 | 0 | -6.84 |
| 11 | t*+10 | 0 | 0 |
| 12 | t*+11 | 0 | 0 |
| 13 | t*+12 | 0 | 0 |
| 14 | t*+13 | 0 | 0 |
| 15 | t*+14 | 0 | 0 |
| 16 | t*+15 | 0 | 0 |
| 17 | t*+16 | 0 | 0 |
| 18 | t*+17 | 0 | 0 |
| 19 | t*+18 | 0 | 0 |
| 20 | t*+19 | 0 | 0 |
| 21-T | t*+20… | 0 | 0 |

**Table 41. Carbon stock change factors for final classes fcl or zones z (Method 1)**

| Year after deforestation | | $\Delta Ctot_{fcl,t}$ ($tCO_2e$/ha) |
|---|---|---|
| 1 | t* | 0.00 |
| 2 | t*+1 | 5.21 |
| 3 | t*+2 | 5.21 |
| 4 | t*+3 | 5.21 |
| 5 | t*+4 | 5.21 |
| 6 | t*+5 | 5.21 |
| 7 | t*+6 | 5.21 |
| 8 | t*+7 | 5.21 |
| 9 | t*+8 | 5.21 |
| 10 | t*+9 | 5.21 |
| 11 | t*+10 | 0 |
| 12 | t*+11 | 0 |
| 13 | t*+12 | 0 |
| 14 | t*+13 | 0 |
| 15 | t*+14 | 0 |
| 16 | t*+15 | 0 |
| 17 | t*+16 | 0 |
| 18 | t*+17 | 0 |
| 19 | t*+18 | 0 |
| 20 | t*+19 | 0 |
| 21-T | t*+20… | 0 |

**Calculation of baseline carbon stock changes**

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

**Table 42. Baseline carbon stock change in the Reference Region**

| Carbon stock change in the above-ground biomass per initial forest class *icl* | | Total carbon stock change in the above-ground biomass of initial forest class in the reference region | | Carbon stock change in the below-ground biomass per initial forest class *icl* | | Total carbon stock change in the below-ground biomass of initial forest class in the reference region | | Carbon stock changes in above-ground biomass per post-deforestation zone z | | Total carbon stock change of post deforestation zones in the reference region | | Total net carbon stock change in the reference region | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ID_{cl}$ | 1 | $\Delta CabBSLRR_{icl,t}$ | $\Delta CabBSLRR_{icl}$ | $ID_{cl}$ | 1 | $\Delta CbbBSLRR_{icl,t}$ | $\Delta CbbBSLRR_{icl}$ | $ID_{iz}$ | 1 | $\Delta CBSLRR_{z,t}$ | $\Delta CBSLRR_{z}$ | $\Delta CBSLRR_{t}$ | $\Delta CBSLRR$ |
| Name | Forest | annual | cumulative | Name | Forest | annual | cumulative | Name | Non-forest | annual | cumulative | annual | cumulative |
| Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 1,150,676 | 1,150,676 | 1,150,676 | 2022 | 27,616 | 27,616 | 27,616 | 2022 | 0 | 0 | 0 | 1,178,292 | 1,178,292 |
| 2023 | 1,150,676 | 1,150,676 | 2,301,351 | 2023 | 55,232 | 55,232 | 82,849 | 2023 | 21,062 | 21,062 | 21,062 | 1,184,846 | 2,363,138 |
| 2024 | 1,150,676 | 1,150,676 | 3,452,027 | 2024 | 82,849 | 82,849 | 165,697 | 2024 | 42,124 | 42,124 | 63,186 | 1,191,400 | 3,554,538 |
| 2025 | 1,150,676 | 1,150,676 | 4,602,702 | 2025 | 110,465 | 110,465 | 276,162 | 2025 | 63,186 | 63,186 | 126,372 | 1,197,955 | 4,752,493 |
| 2026 | 1,150,676 | 1,150,676 | 5,753,378 | 2026 | 138,081 | 138,081 | 414,243 | 2026 | 84,248 | 84,248 | 210,620 | 1,204,509 | 5,957,001 |
| 2027 | 1,150,676 | 1,150,676 | 6,904,054 | 2027 | 165,697 | 165,697 | 579,941 | 2027 | 105,310 | 105,310 | 315,930 | 1,211,063 | 7,168,064 |
| 2028 | 1,035,608 | 1,035,608 | 7,939,662 | 2028 | 190,552 | 190,552 | 770,492 | 2028 | 126,372 | 126,372 | 442,302 | 1,099,788 | 8,267,852 |
| 2029 | 1,035,608 | 1,035,608 | 8,975,270 | 2029 | 215,406 | 215,406 | 985,899 | 2029 | 145,328 | 145,328 | 587,629 | 1,105,687 | 9,373,539 |
| 2030 | 1,035,608 | 1,035,608 | 10,010,878 | 2030 | 240,261 | 240,261 | 1,226,160 | 2030 | 164,284 | 164,284 | 751,913 | 1,111,586 | 10,485,125 |
| 2031 | 1,035,608 | 1,035,608 | 11,046,486 | 2031 | 265,116 | 265,116 | 1,491,276 | 2031 | 183,239 | 183,239 | 935,152 | 1,117,484 | 11,602,609 |
| 2032 | 1,035,608 | 1,035,608 | 12,082,094 | 2032 | 262,354 | 262,354 | 1,753,630 | 2032 | 202,195 | 202,195 | 1,137,347 | 1,095,767 | 12,698,376 |
| 2033 | 1,035,608 | 1,035,608 | 13,117,702 | 2033 | 259,592 | 259,592 | 2,013,222 | 2033 | 200,089 | 200,089 | 1,337,436 | 1,095,112 | 13,793,488 |
| 2034 | 932,047 | 932,047 | 14,049,749 | 2034 | 254,345 | 254,345 | 2,267,567 | 2034 | 197,983 | 197,983 | 1,535,419 | 988,410 | 14,781,898 |
| 2035 | 932,047 | 932,047 | 14,981,797 | 2035 | 249,098 | 249,098 | 2,516,666 | 2035 | 193,981 | 193,981 | 1,729,400 | 987,165 | 15,769,062 |
| 2036 | 932,047 | 932,047 | 15,913,844 | 2036 | 243,851 | 243,851 | 2,760,517 | 2036 | 189,979 | 189,979 | 1,919,379 | 985,919 | 16,754,982 |
| 2037 | 932,047 | 932,047 | 16,845,891 | 2037 | 238,604 | 238,604 | 2,999,121 | 2037 | 185,977 | 185,977 | 2,105,356 | 984,674 | 17,739,656 |
| 2038 | 932,047 | 932,047 | 17,777,938 | 2038 | 236,119 | 236,119 | 3,235,240 | 2038 | 181,976 | 181,976 | 2,287,332 | 986,190 | 18,725,846 |
| 2039 | 932,047 | 932,047 | 18,709,985 | 2039 | 233,633 | 233,633 | 3,468,873 | 2039 | 180,080 | 180,080 | 2,467,412 | 985,600 | 19,711,446 |
| 2040 | 838,843 | 838,843 | 19,548,828 | 2040 | 228,911 | 228,911 | 3,697,784 | 2040 | 178,184 | 178,184 | 2,645,596 | 889,569 | 20,601,015 |
| 2041 | 838,843 | 838,843 | 20,387,671 | 2041 | 224,188 | 224,188 | 3,921,972 | 2041 | 174,583 | 174,583 | 2,820,179 | 888,448 | 21,489,463 |
| 2042 | 838,843 | 838,843 | 21,226,513 | 2042 | 219,466 | 219,466 | 4,141,438 | 2042 | 170,981 | 170,981 | 2,991,160 | 887,327 | 22,376,791 |
| 2043 | 838,843 | 838,843 | 22,065,356 | 2043 | 214,744 | 214,744 | 4,356,182 | 2043 | 167,380 | 167,380 | 3,158,540 | 886,207 | 23,262,997 |
| 2044 | 838,843 | 838,843 | 22,904,198 | 2044 | 212,507 | 212,507 | 4,568,688 | 2044 | 163,778 | 163,778 | 3,322,318 | 887,571 | 24,150,569 |
| 2045 | 838,843 | 838,843 | 23,743,041 | 2045 | 210,270 | 210,270 | 4,778,958 | 2045 | 162,072 | 162,072 | 3,484,390 | 887,040 | 25,037,609 |
| 2046 | 754,958 | 754,958 | 24,497,999 | 2046 | 206,020 | 206,020 | 4,984,978 | 2046 | 160,366 | 160,366 | 3,644,756 | 800,612 | 25,838,221 |
| 2047 | 754,958 | 754,958 | 25,252,957 | 2047 | 201,770 | 201,770 | 5,186,748 | 2047 | 157,125 | 157,125 | 3,801,880 | 799,603 | 26,637,824 |
| 2048 | 754,958 | 754,958 | 26,007,915 | 2048 | 197,519 | 197,519 | 5,384,267 | 2048 | 153,883 | 153,883 | 3,955,764 | 798,595 | 27,436,419 |
| 2049 | 754,958 | 754,958 | 26,762,874 | 2049 | 193,269 | 193,269 | 5,577,536 | 2049 | 150,642 | 150,642 | 4,106,405 | 797,586 | 28,234,005 |
| 2050 | 754,958 | 754,958 | 27,517,832 | 2050 | 191,256 | 191,256 | 5,768,793 | 2050 | 147,400 | 147,400 | 4,253,805 | 798,814 | 29,032,819 |
| 2051 | 754,958 | 754,958 | 28,272,790 | 2051 | 189,243 | 189,243 | 5,958,035 | 2051 | 145,865 | 145,865 | 4,399,670 | 798,336 | 29,831,155 |

**Table 43. Baseline carbon stock change in the Project Area**

| Carbon stock change in the above-ground biomass per initial forest class *icl* | | Total carbon stock change in the above-ground biomass of initial forest class in the project area | | Carbon stock change in the below-ground biomass per initial forest class *icl* | | Total carbon stock change in the below-ground biomass of initial forest class in the project area | | Carbon stock changes in above-ground biomass per post-deforestation zone z | | Total carbon stock change of post deforestation zones in the project area | | Total net carbon stock change in the project area | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ID_{cl}$ | 1 | $\Delta CabBSLPA_{icl,t}$ | $\Delta CabBSLPA_{icl}$ | $ID_{cl}$ | 1 | $\Delta CbbBSLPA_{icl,t}$ | $\Delta CbbBSLPA_{icl}$ | $ID_{iz}$ | 1 | $\Delta CBSLPA_{z,t}$ | $\Delta CBSLPA_{z}$ | $\Delta CBSLPA_{t}$ | $\Delta CBSLPA$ |
| Name | Forest | annual | cumulative | Name | Forest | annual | cumulative | Name | Non-forest | annual | cumulative | annual | cumulative |
| Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 60,115 | 60,115 | 60,115 | 2022 | 1,443 | 1,443 | 1,443 | 2022 | 0 | 0 | 0 | 61,557 | 61,557 |
| 2023 | 60,115 | 60,115 | 120,229 | 2023 | 2,886 | 2,886 | 4,328 | 2023 | 1,100 | 1,100 | 1,100 | 61,900 | 123,457 |
| 2024 | 60,115 | 60,115 | 180,344 | 2024 | 4,328 | 4,328 | 8,657 | 2024 | 2,201 | 2,201 | 3,301 | 62,242 | 185,699 |
| 2025 | 60,115 | 60,115 | 240,459 | 2025 | 5,771 | 5,771 | 14,428 | 2025 | 3,301 | 3,301 | 6,602 | 62,585 | 248,284 |
| 2026 | 60,115 | 60,115 | 300,573 | 2026 | 7,214 | 7,214 | 21,641 | 2026 | 4,401 | 4,401 | 11,003 | 62,927 | 311,211 |
| 2027 | 60,115 | 60,115 | 360,688 | 2027 | 8,657 | 8,657 | 30,298 | 2027 | 5,502 | 5,502 | 16,505 | 63,269 | 374,481 |
| 2028 | 54,103 | 54,103 | 414,791 | 2028 | 9,955 | 9,955 | 40,253 | 2028 | 6,602 | 6,602 | 23,107 | 57,456 | 431,937 |
| 2029 | 54,103 | 54,103 | 468,894 | 2029 | 11,253 | 11,253 | 51,506 | 2029 | 7,592 | 7,592 | 30,699 | 57,764 | 489,701 |
| 2030 | 54,103 | 54,103 | 522,998 | 2030 | 12,552 | 12,552 | 64,058 | 2030 | 8,583 | 8,583 | 39,282 | 58,072 | 547,774 |
| 2031 | 54,103 | 54,103 | 577,101 | 2031 | 13,850 | 13,850 | 77,909 | 2031 | 9,573 | 9,573 | 48,855 | 58,381 | 606,154 |
| 2032 | 54,103 | 54,103 | 631,204 | 2032 | 13,706 | 13,706 | 91,615 | 2032 | 10,563 | 10,563 | 59,418 | 57,246 | 663,400 |
| 2033 | 54,103 | 54,103 | 685,307 | 2033 | 13,562 | 13,562 | 105,177 | 2033 | 10,453 | 10,453 | 69,872 | 57,212 | 720,612 |
| 2034 | 48,693 | 48,693 | 734,000 | 2034 | 13,288 | 13,288 | 118,464 | 2034 | 10,343 | 10,343 | 80,215 | 51,637 | 772,250 |
| 2035 | 48,693 | 48,693 | 782,693 | 2035 | 13,014 | 13,014 | 131,478 | 2035 | 10,134 | 10,134 | 90,349 | 51,572 | 823,822 |
| 2036 | 48,693 | 48,693 | 831,386 | 2036 | 12,739 | 12,739 | 144,217 | 2036 | 9,925 | 9,925 | 100,274 | 51,507 | 875,329 |
| 2037 | 48,693 | 48,693 | 880,079 | 2037 | 12,465 | 12,465 | 156,683 | 2037 | 9,716 | 9,716 | 109,990 | 51,442 | 926,771 |
| 2038 | 48,693 | 48,693 | 928,771 | 2038 | 12,336 | 12,336 | 169,018 | 2038 | 9,507 | 9,507 | 119,497 | 51,521 | 978,293 |
| 2039 | 48,693 | 48,693 | 977,464 | 2039 | 12,206 | 12,206 | 181,224 | 2039 | 9,408 | 9,408 | 128,905 | 51,491 | 1,029,784 |
| 2040 | 43,824 | 43,824 | 1,021,288 | 2040 | 11,959 | 11,959 | 193,183 | 2040 | 9,309 | 9,309 | 138,214 | 46,474 | 1,076,257 |
| 2041 | 43,824 | 43,824 | 1,065,111 | 2041 | 11,712 | 11,712 | 204,895 | 2041 | 9,121 | 9,121 | 147,334 | 46,415 | 1,122,672 |
| 2042 | 43,824 | 43,824 | 1,108,935 | 2042 | 11,466 | 11,466 | 216,361 | 2042 | 8,933 | 8,933 | 156,267 | 46,357 | 1,169,029 |
| 2043 | 43,824 | 43,824 | 1,152,759 | 2043 | 11,219 | 11,219 | 227,580 | 2043 | 8,744 | 8,744 | 165,011 | 46,298 | 1,215,327 |
| 2044 | 43,824 | 43,824 | 1,196,582 | 2044 | 11,102 | 11,102 | 238,682 | 2044 | 8,556 | 8,556 | 173,568 | 46,369 | 1,261,696 |
| 2045 | 43,824 | 43,824 | 1,240,406 | 2045 | 10,985 | 10,985 | 249,667 | 2045 | 8,467 | 8,467 | 182,035 | 46,342 | 1,308,038 |
| 2046 | 39,441 | 39,441 | 1,279,847 | 2046 | 10,763 | 10,763 | 260,430 | 2046 | 8,378 | 8,378 | 190,413 | 41,826 | 1,349,864 |
| 2047 | 39,441 | 39,441 | 1,319,288 | 2047 | 10,541 | 10,541 | 270,971 | 2047 | 8,209 | 8,209 | 198,621 | 41,774 | 1,391,638 |
| 2048 | 39,441 | 39,441 | 1,358,730 | 2048 | 10,319 | 10,319 | 281,290 | 2048 | 8,039 | 8,039 | 206,661 | 41,721 | 1,433,359 |
| 2049 | 39,441 | 39,441 | 1,398,171 | 2049 | 10,097 | 10,097 | 291,387 | 2049 | 7,870 | 7,870 | 214,531 | 41,668 | 1,475,027 |
| 2050 | 39,441 | 39,441 | 1,437,612 | 2050 | 9,992 | 9,992 | 301,379 | 2050 | 7,701 | 7,701 | 222,231 | 41,732 | 1,516,759 |
| 2051 | 39,441 | 39,441 | 1,477,053 | 2051 | 9,887 | 9,887 | 311,265 | 2051 | 7,620 | 7,620 | 229,852 | 41,707 | 1,558,467 |

**Table 44. Baseline carbon stock change in the Leakage Belt**

| Carbon stock change in the above-ground biomass per initial forest class *icl* | | Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt | | Carbon stock change in the below-ground biomass per initial forest class *icl* | | Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt | | Carbon stock changes in above-ground biomass per post-deforestation zone z | | Total carbon stock change of post deforestation zones in the leakage belt | | Total net carbon stock change in the leakage belt | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ID_{cl}$ | 1 | $\Delta CabBSLLK_{icl,t}$ | $\Delta CabBSLLK_{icl}$ | $ID_{cl}$ | 1 | $\Delta CbbBSLLK_{icl,t}$ | $\Delta CbbBSLLK_{icl}$ | $ID_{lz}$ | 1 | $\Delta CtotBSLLK_{z,t}$ | $\Delta CtotBSLLK_{z}$ | $\Delta CtotBSLLK_{t}$ | $\Delta CtotBSLLK$ |
| Name | Forest | annual | cumulative | Name | Forest | annual | cumulative | Name | Non-forest | annual | cumulative | annual | cumulative |
| Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | Project year | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 51,678 | 51,678 | 51,678 | 2022 | 1,240 | 1,240 | 1,240 | 2022 | 0 | 0 | 0 | 52,918 | 52,918 |
| 2023 | 51,678 | 51,678 | 103,356 | 2023 | 2,481 | 2,481 | 3,721 | 2023 | 946 | 946 | 946 | 53,212 | 106,130 |
| 2024 | 51,678 | 51,678 | 155,033 | 2024 | 3,721 | 3,721 | 7,442 | 2024 | 1,892 | 1,892 | 2,838 | 53,507 | 159,637 |
| 2025 | 51,678 | 51,678 | 206,711 | 2025 | 4,961 | 4,961 | 12,403 | 2025 | 2,838 | 2,838 | 5,675 | 53,801 | 213,438 |
| 2026 | 51,678 | 51,678 | 258,389 | 2026 | 6,201 | 6,201 | 18,604 | 2026 | 3,784 | 3,784 | 9,459 | 54,095 | 267,534 |
| 2027 | 51,678 | 51,678 | 310,067 | 2027 | 7,442 | 7,442 | 26,046 | 2027 | 4,730 | 4,730 | 14,189 | 54,390 | 321,923 |
| 2028 | 46,510 | 46,510 | 356,577 | 2028 | 8,558 | 8,558 | 34,603 | 2028 | 5,675 | 5,675 | 19,864 | 49,392 | 371,316 |
| 2029 | 46,510 | 46,510 | 403,087 | 2029 | 9,674 | 9,674 | 44,278 | 2029 | 6,527 | 6,527 | 26,391 | 49,657 | 420,973 |
| 2030 | 46,510 | 46,510 | 449,597 | 2030 | 10,790 | 10,790 | 55,068 | 2030 | 7,378 | 7,378 | 33,769 | 49,922 | 470,895 |
| 2031 | 46,510 | 46,510 | 496,107 | 2031 | 11,907 | 11,907 | 66,974 | 2031 | 8,229 | 8,229 | 41,998 | 50,187 | 521,082 |
| 2032 | 46,510 | 46,510 | 542,616 | 2032 | 11,783 | 11,783 | 78,757 | 2032 | 9,081 | 9,081 | 51,079 | 49,212 | 570,294 |
| 2033 | 46,510 | 46,510 | 589,126 | 2033 | 11,659 | 11,659 | 90,415 | 2033 | 8,986 | 8,986 | 60,065 | 49,182 | 619,477 |
| 2034 | 41,859 | 41,859 | 630,985 | 2034 | 11,423 | 11,423 | 101,838 | 2034 | 8,892 | 8,892 | 68,957 | 44,390 | 663,867 |
| 2035 | 41,859 | 41,859 | 672,844 | 2035 | 11,187 | 11,187 | 113,025 | 2035 | 8,712 | 8,712 | 77,669 | 44,334 | 708,201 |
| 2036 | 41,859 | 41,859 | 714,703 | 2036 | 10,952 | 10,952 | 123,977 | 2036 | 8,532 | 8,532 | 86,201 | 44,278 | 752,480 |
| 2037 | 41,859 | 41,859 | 756,562 | 2037 | 10,716 | 10,716 | 134,693 | 2037 | 8,352 | 8,352 | 94,553 | 44,222 | 796,702 |
| 2038 | 41,859 | 41,859 | 798,421 | 2038 | 10,604 | 10,604 | 145,297 | 2038 | 8,173 | 8,173 | 102,726 | 44,291 | 840,993 |
| 2039 | 41,859 | 41,859 | 840,280 | 2039 | 10,493 | 10,493 | 155,790 | 2039 | 8,088 | 8,088 | 110,813 | 44,264 | 885,257 |
| 2040 | 37,673 | 37,673 | 877,953 | 2040 | 10,281 | 10,281 | 166,070 | 2040 | 8,002 | 8,002 | 118,816 | 39,951 | 925,208 |
| 2041 | 37,673 | 37,673 | 915,627 | 2041 | 10,068 | 10,068 | 176,139 | 2041 | 7,841 | 7,841 | 126,656 | 39,901 | 965,109 |
| 2042 | 37,673 | 37,673 | 953,300 | 2042 | 9,856 | 9,856 | 185,995 | 2042 | 7,679 | 7,679 | 134,335 | 39,851 | 1,004,960 |
| 2043 | 37,673 | 37,673 | 990,973 | 2043 | 9,644 | 9,644 | 195,640 | 2043 | 7,517 | 7,517 | 141,853 | 39,800 | 1,044,760 |
| 2044 | 37,673 | 37,673 | 1,028,646 | 2044 | 9,544 | 9,544 | 205,183 | 2044 | 7,355 | 7,355 | 149,208 | 39,862 | 1,084,621 |
| 2045 | 37,673 | 37,673 | 1,066,319 | 2045 | 9,443 | 9,443 | 214,627 | 2045 | 7,279 | 7,279 | 156,487 | 39,838 | 1,124,459 |
| 2046 | 33,906 | 33,906 | 1,100,225 | 2046 | 9,253 | 9,253 | 223,879 | 2046 | 7,202 | 7,202 | 163,689 | 35,956 | 1,160,415 |
| 2047 | 33,906 | 33,906 | 1,134,130 | 2047 | 9,062 | 9,062 | 232,941 | 2047 | 7,057 | 7,057 | 170,745 | 35,911 | 1,196,326 |
| 2048 | 33,906 | 33,906 | 1,168,036 | 2048 | 8,871 | 8,871 | 241,812 | 2048 | 6,911 | 6,911 | 177,656 | 35,866 | 1,232,191 |
| 2049 | 33,906 | 33,906 | 1,201,942 | 2049 | 8,680 | 8,680 | 250,492 | 2049 | 6,765 | 6,765 | 184,422 | 35,820 | 1,268,012 |
| 2050 | 33,906 | 33,906 | 1,235,848 | 2050 | 8,589 | 8,589 | 259,081 | 2050 | 6,620 | 6,620 | 191,042 | 35,875 | 1,303,887 |
| 2051 | 33,906 | 33,906 | 1,269,754 | 2051 | 8,499 | 8,499 | 267,580 | 2051 | 6,551 | 6,551 | 197,593 | 35,854 | 1,339,741 |

Baseline non-CO2 emissions from forest fires

As described in baseline scenario, slash-and-burn deforestation to clear the area is carried out for cattle ranching, which is the main cause of deforestation within the project area.

Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. It is worth mentioning that the effect of fire on CO2 emissions is counted in the estimation of carbon stock changes; therefore, CO2 emissions from biomass burning were ignored to avoid double counting. However, non-CO2 emissions (CH4 and N2O) from forest fires (EBBBSLPAt) were quantified and included as baseline emissions, as follows.

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

Where,

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

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

Where,

| | |
|---|---|
| $EBBCO_{2icl,t}$ | Per hectare $CO_2$ emission from biomass burning in slash and burn in forest class icl at year t; $tCO_2e/ha$ |
| NCR | Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless |
| $ER_{N2O}$ | Emission ratio for $N_2O$ (IPCC default value = 0.007) |
| $GWP_{N2O}$ | Global Warming Potential for $N_2O$ (IPCC default value)[121] |

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

Where,

| | |
|---|---|
| $EBBCO_{2icl,t}$ | Per hectare $CO_2$ emission from biomass burning in slash and burn in forest class icl at year t; $tCO_2e/ha$ |
| $ER_{CH4}$ | Emission ratio for $CH_4$ (IPCC default value = 0.012) |

[121] According to the VCS Standard, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fifth Assessment Report (GWP for N2O = 265).

| | |
|---|---|
| $GWP_{CH4}$ | Global Warming Potential for $CH_4$ (IPCC default value) [122] |

$$EBBCO_{2icl,t} = Fburnt_{icl} * \sum_{p=1}^{P} (C_{picl,t} * Pburnt_{p,icl} * CE_{p,icl})$$

Where,

| | |
|---|---|
| $EBBCO_{2icl,t}$ | Per hectare $CO_2$ emission from biomass burning in the forest class icl at year t; $tCO_2e/ha$ |
| $Fburnt_{icl}$ | Proportion of forest area burned during the historical reference period in the forest class icl; % |
| $C_{picl,t}$ | Average carbon stock per hectare in the carbon pool p burnt in the forest class icl at year t; $tCO_2e/ha$ |
| $Pburnt_{p,icl}$ | Average proportion of mass burnt in the carbon pool p in the forest class icl; % |
| $CE_{p,icl}$ | Average combustion efficiency of the carbon pool p in the forest class icl; dimensionless (IPCC default of 0.5) |
| p | Carbon pool that could burn, above-ground biomass |

The proportion of forest burned during the historical reference period used is the value of "Biomass combustion factors by phytophysiognomies group in the Amazon biome" for Seasonal semideciduous forest available at the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change[123]. The Fburnt estimated was 46.40%.

The Pburnt estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 $m^3/ha$ was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%.

However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation.

The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.

It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be

[122] According to the VCS Standard, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fifth Assessment Report (GWP for $CH_4$ = 28).
[123] Available at Volume 3, Table A2.4, page 305 <http://www.ccst.inpe.br/publicacao/terceira-comunicacao-nacional-do-brasil-a-convencao-quadro-das-nacoes-unidas-sobre-mudanca-do-clima-portugues/>

a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.

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

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

Where,

$EBBBSLPA_t$ Total actual non-$CO_2$ emissions from forest fire at year t in the project area in the baseline scenario; $tCO_2e/ha$

$ABSLPA_{icl,t}$ Annual area of deforestation of initial forest classes icl in the project area at year t; ha

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

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

**Table 45. Parameters used to calculate non-CO2 emissions from forest fires**

| Initial Forest Class | | Parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $Fburnt_{icl}$ | Cab | $Pburnt_{ab,icl}$ | $CE_{ab,icl}$ | ECO2-ab | EBBCO2-tot | $EBBN2O_{icl}$ | $EBBCH4_{icl}$ | $EBBtot_{icl}$ |
| IDcl | Name | % | tCO2e/ha | % | % | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha | tCO2e/ha |
| 1 | Forest | 46.4% | 284.90 | 78% | 50% | 51.56 | 51.56 | 0.46 | 5.62 | 6.09 |

**Table 46. Baseline non-CO2 emissions from forest fires in the project area**

| Project year *t* | Emissions of non-$CO_2$ gasses from baseline forest fires | | Total baseline non-$CO_2$ emissions from forest fires in the project area | |
|---|---|---|---|---|
| | $ID_{cl}$ = 1<br>Forest | | annual | cumulative |
| | $ABSLPA_{icl,t}$ | $EBBBSLtot_{icl}$ | $EBBBSLPA_t$ | EBBBSLPA |
| | ha | $tCO_2e$/ha | $tCO_2e$ | $tCO_2e$ |
| 2022 | 211.00 | 6.09 | 1,283.98 | 1,283.98 |
| 2023 | 211.00 | 6.09 | 1,283.98 | 2,567.96 |
| 2024 | 211.00 | 6.09 | 1,283.98 | 3,851.94 |
| 2025 | 211.00 | 6.09 | 1,283.98 | 5,135.93 |
| 2026 | 211.00 | 6.09 | 1,283.98 | 6,419.91 |
| 2027 | 211.00 | 6.09 | 1,283.98 | 7,703.89 |
| 2028 | 189.90 | 6.09 | 1,155.58 | 8,859.47 |
| 2029 | 189.90 | 6.09 | 1,155.58 | 10,015.05 |
| 2030 | 189.90 | 6.09 | 1,155.58 | 11,170.64 |
| 2031 | 189.90 | 6.09 | 1,155.58 | 12,326.22 |
| 2032 | 189.90 | 6.09 | 1,155.58 | 13,481.80 |
| 2033 | 189.90 | 6.09 | 1,155.58 | 14,637.39 |
| 2034 | 170.91 | 6.09 | 1,040.02 | 15,677.41 |
| 2035 | 170.91 | 6.09 | 1,040.02 | 16,717.44 |
| 2036 | 170.91 | 6.09 | 1,040.02 | 17,757.46 |
| 2037 | 170.91 | 6.09 | 1,040.02 | 18,797.49 |
| 2038 | 170.91 | 6.09 | 1,040.02 | 19,837.51 |
| 2039 | 170.91 | 6.09 | 1,040.02 | 20,877.54 |
| 2040 | 153.82 | 6.09 | 936.02 | 21,813.56 |
| 2041 | 153.82 | 6.09 | 936.02 | 22,749.58 |
| 2042 | 153.82 | 6.09 | 936.02 | 23,685.60 |
| 2043 | 153.82 | 6.09 | 936.02 | 24,621.63 |
| 2044 | 153.82 | 6.09 | 936.02 | 25,557.65 |
| 2045 | 153.82 | 6.09 | 936.02 | 26,493.67 |
| 2046 | 138.44 | 6.09 | 842.42 | 27,336.09 |
| 2047 | 138.44 | 6.09 | 842.42 | 28,178.51 |
| 2048 | 138.44 | 6.09 | 842.42 | 29,020.93 |
| 2049 | 138.44 | 6.09 | 842.42 | 29,863.35 |
| 2050 | 138.44 | 6.09 | 842.42 | 30,705.77 |
| 2051 | 138.44 | 6.09 | 842.42 | 31,548.19 |

## 4.2 Project Emissions

The present activity instance does not include planned deforestation and planned logging activities within the project area. In case future instances include Sustainable Forest Management Plan, the respective parameters and calculation must be included in this section.

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

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

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

Where,

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

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

Where,

| | |
|---|---|
| $\Delta CPSPA_t$ | Sum of ex ante estimated actual carbon stock changes in the project area at year t; $tCO_2e$ |
| $\Delta CPAdPA_t$ | Total decrease in carbon stock due to all planned activities at year t in the project area; $tCO_2e$ |
| $\Delta CUDdPA_t$ | Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; $tCO_2e$ |
| $\Delta CPAiPA_t$ | Total increase in carbon stock due to all planned activities at year t in the project area; $tCO_2e$ |

Due to the importance of project activities, which is expected to generate improvements in the local economy and employment generation, the Effectiveness Index (EI) was conservatively assumed as 92.07%. This percentage was calculated based on verified reports of other VM0015 REDD projects located in Brazil.

It was then applied to the ex-ante estimate of net carbon stock change in the project area under the project scenario, shown in Table below:

**Table 47. Ex ante estimated net carbon stock change in the project area under the project scenario**

| Project year *t* | Total carbon stock decrease due to planned activities | | Total carbon stock increase due to planned activities | | Total carbon stock decrease due to unavoided unplanned deforestation | | Total carbon stock change in the project case | |
|---|---|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative |
| | $\Delta CPAdPA_t$ | $\Delta CPAdPA$ | $\Delta CPAiPA_t$ | $\Delta CPAiPA$ | $\Delta CUDdPA_t$ | $\Delta CUDdPA$ | $\Delta CPSPA_t$ | $\Delta CPSPA$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 0.00 | 0.00 | 0.00 | 0.00 | 3,367.88 | 3,367.88 | 3,367.88 | 3,367.88 |
| 2023 | 0.00 | 0.00 | 0.00 | 0.00 | 3,386.61 | 6,754.49 | 3,386.61 | 6,754.49 |
| 2024 | 0.00 | 0.00 | 0.00 | 0.00 | 3,405.35 | 10,159.84 | 3,405.35 | 10,159.84 |
| 2025 | 0.00 | 0.00 | 0.00 | 0.00 | 3,424.08 | 13,583.92 | 3,424.08 | 13,583.92 |
| 2026 | 0.00 | 0.00 | 0.00 | 0.00 | 3,442.82 | 17,026.74 | 3,442.82 | 17,026.74 |
| 2027 | 0.00 | 0.00 | 0.00 | 0.00 | 3,461.55 | 20,488.29 | 3,461.55 | 20,488.29 |
| 2028 | 0.00 | 0.00 | 0.00 | 0.00 | 3,143.49 | 23,631.78 | 3,143.49 | 23,631.78 |
| 2029 | 0.00 | 0.00 | 0.00 | 0.00 | 3,160.36 | 26,792.14 | 3,160.36 | 26,792.14 |
| 2030 | 0.00 | 0.00 | 0.00 | 0.00 | 3,177.22 | 29,969.35 | 3,177.22 | 29,969.35 |
| 2031 | 0.00 | 0.00 | 0.00 | 0.00 | 3,194.08 | 33,163.43 | 3,194.08 | 33,163.43 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 3,132.00 | 36,295.43 | 3,132.00 | 36,295.43 |
| 2033 | 0.00 | 0.00 | 0.00 | 0.00 | 3,130.13 | 39,425.56 | 3,130.13 | 39,425.56 |
| 2034 | 0.00 | 0.00 | 0.00 | 0.00 | 2,825.15 | 42,250.71 | 2,825.15 | 42,250.71 |
| 2035 | 0.00 | 0.00 | 0.00 | 0.00 | 2,821.59 | 45,072.29 | 2,821.59 | 45,072.29 |
| 2036 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.03 | 47,890.32 | 2,818.03 | 47,890.32 |
| 2037 | 0.00 | 0.00 | 0.00 | 0.00 | 2,814.47 | 50,704.79 | 2,814.47 | 50,704.79 |
| 2038 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.80 | 53,523.59 | 2,818.80 | 53,523.59 |
| 2039 | 0.00 | 0.00 | 0.00 | 0.00 | 2,817.12 | 56,340.71 | 2,817.12 | 56,340.71 |
| 2040 | 0.00 | 0.00 | 0.00 | 0.00 | 2,542.63 | 58,883.34 | 2,542.63 | 58,883.34 |
| 2041 | 0.00 | 0.00 | 0.00 | 0.00 | 2,539.43 | 61,422.76 | 2,539.43 | 61,422.76 |
| 2042 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.22 | 63,958.99 | 2,536.22 | 63,958.99 |
| 2043 | 0.00 | 0.00 | 0.00 | 0.00 | 2,533.02 | 66,492.01 | 2,533.02 | 66,492.01 |
| 2044 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.92 | 69,028.93 | 2,536.92 | 69,028.93 |
| 2045 | 0.00 | 0.00 | 0.00 | 0.00 | 2,535.40 | 71,564.34 | 2,535.40 | 71,564.34 |
| 2046 | 0.00 | 0.00 | 0.00 | 0.00 | 2,288.37 | 73,852.70 | 2,288.37 | 73,852.70 |
| 2047 | 0.00 | 0.00 | 0.00 | 0.00 | 2,285.49 | 76,138.19 | 2,285.49 | 76,138.19 |
| 2048 | 0.00 | 0.00 | 0.00 | 0.00 | 2,282.60 | 78,420.79 | 2,282.60 | 78,420.79 |
| 2049 | 0.00 | 0.00 | 0.00 | 0.00 | 2,279.72 | 80,700.51 | 2,279.72 | 80,700.51 |
| 2050 | 0.00 | 0.00 | 0.00 | 0.00 | 2,283.23 | 82,983.74 | 2,283.23 | 82,983.74 |
| 2051 | 0.00 | 0.00 | 0.00 | 0.00 | 2,281.86 | 85,265.60 | 2,281.86 | 85,265.60 |

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

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

Where,

| | |
|---|---|
| $EBBPSPA_t$ | Total *ex ante* actual non-$CO_2$ emissions from forest fire due to unavoided unplanned deforestationat at year t in the project area; $tCO_2e$/ha |
| $EBBBSPA_t$ | Total non-$CO_2$ emissions from forest fire at year t in the project area; $tCO_2e$ |
| EI | *Ex ante* estimated Effectiveness Index; % |
| t | 1, 2, 3 … t, a year of the proposed project crediting period; dimensionless |

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

**Table 48. Total ex ante estimated actual emissions of non-$CO_2$ gases due to forest fires in the project area**

| Project year *t* | Total ex ante estimated actual non-$CO_2$ emissions from forest fires in the Project area | |
|---|---|---|
| | $EBBPSPA_t$ | EBBPSPA |
| | annual | cumulative |
| | $tCO_2e$ | $tCO_2e$ |
| 2022 | 70.25 | 70.25 |
| 2023 | 70.25 | 140.50 |
| 2024 | 70.25 | 210.74 |
| 2025 | 70.25 | 280.99 |
| 2026 | 70.25 | 351.24 |
| 2027 | 70.25 | 421.49 |
| 2028 | 63.22 | 484.71 |
| 2029 | 63.22 | 547.94 |
| 2030 | 63.22 | 611.16 |
| 2031 | 63.22 | 674.38 |
| 2032 | 63.22 | 737.61 |
| 2033 | 63.22 | 800.83 |
| 2034 | 56.90 | 857.73 |
| 2035 | 56.90 | 914.63 |
| 2036 | 56.90 | 971.53 |
| 2037 | 56.90 | 1,028.43 |
| 2038 | 56.90 | 1,085.33 |
| 2039 | 56.90 | 1,142.24 |
| 2040 | 51.21 | 1,193.45 |
| 2041 | 51.21 | 1,244.66 |
| 2042 | 51.21 | 1,295.87 |
| 2043 | 51.21 | 1,347.08 |
| 2044 | 51.21 | 1,398.29 |
| 2045 | 51.21 | 1,449.50 |
| 2046 | 46.09 | 1,495.59 |
| 2047 | 46.09 | 1,541.68 |
| 2048 | 46.09 | 1,587.77 |
| 2049 | 46.09 | 1,633.86 |
| 2050 | 46.09 | 1,679.95 |
| 2051 | 46.09 | 1,726.04 |

Total *ex ante* estimations for the project area

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

**Table 49. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area**

| Project year *t* | Total *ex ante* carbon stock decrease due to planned activities | | Total *ex ante* carbon stock increase due to planned activities | | Total *ex ante* carbon stock decrease due to unavoided unplanned deforestation | | Total *ex ante* carbon stock change | | Total *ex ante* estimated actual non-$CO_2$ emissions from forest fires in the project area | |
|---|---|---|---|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative |
| | $\Delta CPAdPA_t$ | ΔCPAdPA | $\Delta CPAiPA_t$ | ΔCPAiPA | $\Delta CUDdPA_t$ | ΔCUDdPA | $\Delta CPSPA_t$ | ΔCPSPA | $EBBPSPA_t$ | EBBPSPA |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 0.00 | 0.00 | 0.00 | 0.00 | 3,367.88 | 3,367.88 | 3,367.88 | 3,367.88 | 70.25 | 70.25 |
| 2023 | 0.00 | 0.00 | 0.00 | 0.00 | 3,386.61 | 6,754.49 | 3,386.61 | 6,754.49 | 70.25 | 140.50 |
| 2024 | 0.00 | 0.00 | 0.00 | 0.00 | 3,405.35 | 10,159.84 | 3,405.35 | 10,159.84 | 70.25 | 210.74 |
| 2025 | 0.00 | 0.00 | 0.00 | 0.00 | 3,424.08 | 13,583.92 | 3,424.08 | 13,583.92 | 70.25 | 280.99 |
| 2026 | 0.00 | 0.00 | 0.00 | 0.00 | 3,442.82 | 17,026.74 | 3,442.82 | 17,026.74 | 70.25 | 351.24 |
| 2027 | 0.00 | 0.00 | 0.00 | 0.00 | 3,461.55 | 20,488.29 | 3,461.55 | 20,488.29 | 70.25 | 421.49 |
| 2028 | 0.00 | 0.00 | 0.00 | 0.00 | 3,143.49 | 23,631.78 | 3,143.49 | 23,631.78 | 63.22 | 484.71 |
| 2029 | 0.00 | 0.00 | 0.00 | 0.00 | 3,160.36 | 26,792.14 | 3,160.36 | 26,792.14 | 63.22 | 547.94 |
| 2030 | 0.00 | 0.00 | 0.00 | 0.00 | 3,177.22 | 29,969.35 | 3,177.22 | 29,969.35 | 63.22 | 611.16 |
| 2031 | 0.00 | 0.00 | 0.00 | 0.00 | 3,194.08 | 33,163.43 | 3,194.08 | 33,163.43 | 63.22 | 674.38 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 3,132.00 | 36,295.43 | 3,132.00 | 36,295.43 | 63.22 | 737.61 |
| 2033 | 0.00 | 0.00 | 0.00 | 0.00 | 3,130.13 | 39,425.56 | 3,130.13 | 39,425.56 | 63.22 | 800.83 |
| 2034 | 0.00 | 0.00 | 0.00 | 0.00 | 2,825.15 | 42,250.71 | 2,825.15 | 42,250.71 | 56.90 | 857.73 |
| 2035 | 0.00 | 0.00 | 0.00 | 0.00 | 2,821.59 | 45,072.29 | 2,821.59 | 45,072.29 | 56.90 | 914.63 |
| 2036 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.03 | 47,890.32 | 2,818.03 | 47,890.32 | 56.90 | 971.53 |
| 2037 | 0.00 | 0.00 | 0.00 | 0.00 | 2,814.47 | 50,704.79 | 2,814.47 | 50,704.79 | 56.90 | 1,028.43 |
| 2038 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.80 | 53,523.59 | 2,818.80 | 53,523.59 | 56.90 | 1,085.33 |
| 2039 | 0.00 | 0.00 | 0.00 | 0.00 | 2,817.12 | 56,340.71 | 2,817.12 | 56,340.71 | 56.90 | 1,142.24 |
| 2040 | 0.00 | 0.00 | 0.00 | 0.00 | 2,542.63 | 58,883.34 | 2,542.63 | 58,883.34 | 51.21 | 1,193.45 |
| 2041 | 0.00 | 0.00 | 0.00 | 0.00 | 2,539.43 | 61,422.76 | 2,539.43 | 61,422.76 | 51.21 | 1,244.66 |
| 2042 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.22 | 63,958.99 | 2,536.22 | 63,958.99 | 51.21 | 1,295.87 |
| 2043 | 0.00 | 0.00 | 0.00 | 0.00 | 2,533.02 | 66,492.01 | 2,533.02 | 66,492.01 | 51.21 | 1,347.08 |
| 2044 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.92 | 69,028.93 | 2,536.92 | 69,028.93 | 51.21 | 1,398.29 |
| 2045 | 0.00 | 0.00 | 0.00 | 0.00 | 2,535.40 | 71,564.34 | 2,535.40 | 71,564.34 | 51.21 | 1,449.50 |
| 2046 | 0.00 | 0.00 | 0.00 | 0.00 | 2,288.37 | 73,852.70 | 2,288.37 | 73,852.70 | 46.09 | 1,495.59 |
| 2047 | 0.00 | 0.00 | 0.00 | 0.00 | 2,285.49 | 76,138.19 | 2,285.49 | 76,138.19 | 46.09 | 1,541.68 |
| 2048 | 0.00 | 0.00 | 0.00 | 0.00 | 2,282.60 | 78,420.79 | 2,282.60 | 78,420.79 | 46.09 | 1,587.77 |
| 2049 | 0.00 | 0.00 | 0.00 | 0.00 | 2,279.72 | 80,700.51 | 2,279.72 | 80,700.51 | 46.09 | 1,633.86 |
| 2050 | 0.00 | 0.00 | 0.00 | 0.00 | 2,283.23 | 82,983.74 | 2,283.23 | 82,983.74 | 46.09 | 1,679.95 |
| 2051 | 0.00 | 0.00 | 0.00 | 0.00 | 2,281.86 | 85,265.60 | 2,281.86 | 85,265.60 | 46.09 | 1,726.04 |

## 4.3 Leakage

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

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

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

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

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

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

$$\Delta CLPMLKt = \Delta CBSLLKt - \Delta CPSLKt$$

Where,

| | |
|---|---|
| ΔCLPMLKt | Carbon stock decrease due to leakage prevention measures at year t; $tCO_2e$ |
| ΔCBSLLKt | Annual carbon stock changes in leakage management areas in the baseline case at year t; $tCO_2e$ |
| ΔCPSLKt | Annual carbon stock change in leakage management areas in the project case; $tCO_2e$ |

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

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

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

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

**Table 50. Ex ante estimated net carbon stock change in leakage management areas**

| Project year *t* | Total carbon stock decrease due to planned activities | | Total carbon stock increase due to planned activities | | Total carbon stock decrease due to unavoided unplanned deforestation | | Total carbon stock change in the project case | |
|---|---|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative |
| | $\Delta CPAdPA_t$ | $\Delta CPAdPA$ | $\Delta CPAiPA_t$ | $\Delta CPAiPA$ | $\Delta CUDdPA_t$ | $\Delta CUDdPA$ | $\Delta CPSPA_t$ | $\Delta CPSPA$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 0.00 | 0.00 | 0.00 | 0.00 | 3,367.88 | 3,367.88 | 3,367.88 | 3,367.88 |
| 2023 | 0.00 | 0.00 | 0.00 | 0.00 | 3,386.61 | 6,754.49 | 3,386.61 | 6,754.49 |
| 2024 | 0.00 | 0.00 | 0.00 | 0.00 | 3,405.35 | 10,159.84 | 3,405.35 | 10,159.84 |
| 2025 | 0.00 | 0.00 | 0.00 | 0.00 | 3,424.08 | 13,583.92 | 3,424.08 | 13,583.92 |
| 2026 | 0.00 | 0.00 | 0.00 | 0.00 | 3,442.82 | 17,026.74 | 3,442.82 | 17,026.74 |
| 2027 | 0.00 | 0.00 | 0.00 | 0.00 | 3,461.55 | 20,488.29 | 3,461.55 | 20,488.29 |
| 2028 | 0.00 | 0.00 | 0.00 | 0.00 | 3,143.49 | 23,631.78 | 3,143.49 | 23,631.78 |
| 2029 | 0.00 | 0.00 | 0.00 | 0.00 | 3,160.36 | 26,792.14 | 3,160.36 | 26,792.14 |
| 2030 | 0.00 | 0.00 | 0.00 | 0.00 | 3,177.22 | 29,969.35 | 3,177.22 | 29,969.35 |
| 2031 | 0.00 | 0.00 | 0.00 | 0.00 | 3,194.08 | 33,163.43 | 3,194.08 | 33,163.43 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 3,132.00 | 36,295.43 | 3,132.00 | 36,295.43 |
| 2033 | 0.00 | 0.00 | 0.00 | 0.00 | 3,130.13 | 39,425.56 | 3,130.13 | 39,425.56 |
| 2034 | 0.00 | 0.00 | 0.00 | 0.00 | 2,825.15 | 42,250.71 | 2,825.15 | 42,250.71 |
| 2035 | 0.00 | 0.00 | 0.00 | 0.00 | 2,821.59 | 45,072.29 | 2,821.59 | 45,072.29 |
| 2036 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.03 | 47,890.32 | 2,818.03 | 47,890.32 |
| 2037 | 0.00 | 0.00 | 0.00 | 0.00 | 2,814.47 | 50,704.79 | 2,814.47 | 50,704.79 |
| 2038 | 0.00 | 0.00 | 0.00 | 0.00 | 2,818.80 | 53,523.59 | 2,818.80 | 53,523.59 |
| 2039 | 0.00 | 0.00 | 0.00 | 0.00 | 2,817.12 | 56,340.71 | 2,817.12 | 56,340.71 |
| 2040 | 0.00 | 0.00 | 0.00 | 0.00 | 2,542.63 | 58,883.34 | 2,542.63 | 58,883.34 |
| 2041 | 0.00 | 0.00 | 0.00 | 0.00 | 2,539.43 | 61,422.76 | 2,539.43 | 61,422.76 |
| 2042 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.22 | 63,958.99 | 2,536.22 | 63,958.99 |
| 2043 | 0.00 | 0.00 | 0.00 | 0.00 | 2,533.02 | 66,492.01 | 2,533.02 | 66,492.01 |
| 2044 | 0.00 | 0.00 | 0.00 | 0.00 | 2,536.92 | 69,028.93 | 2,536.92 | 69,028.93 |
| 2045 | 0.00 | 0.00 | 0.00 | 0.00 | 2,535.40 | 71,564.34 | 2,535.40 | 71,564.34 |
| 2046 | 0.00 | 0.00 | 0.00 | 0.00 | 2,288.37 | 73,852.70 | 2,288.37 | 73,852.70 |
| 2047 | 0.00 | 0.00 | 0.00 | 0.00 | 2,285.49 | 76,138.19 | 2,285.49 | 76,138.19 |
| 2048 | 0.00 | 0.00 | 0.00 | 0.00 | 2,282.60 | 78,420.79 | 2,282.60 | 78,420.79 |
| 2049 | 0.00 | 0.00 | 0.00 | 0.00 | 2,279.72 | 80,700.51 | 2,279.72 | 80,700.51 |
| 2050 | 0.00 | 0.00 | 0.00 | 0.00 | 2,283.23 | 82,983.74 | 2,283.23 | 82,983.74 |
| 2051 | 0.00 | 0.00 | 0.00 | 0.00 | 2,281.86 | 85,265.60 | 2,281.86 | 85,265.60 |

In addition, it is important to note that consumption of fossil fuels is considered insignificant in avoided unplanned deforestation project activities and shall not be considered.

**Table 51. Ex ante estimated total emissions above the baseline from leakage prevention activities**

| Project year | Carbon stock decrease due to leakage prevention measures | | Total *ex ante* GHG emissions from increased grazing activities | | Total *ex ante* increase in GHG emissions due to leakage prevention measures | |
|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative |
| | $\Delta CLPMLK_t$ | $\Delta CLPMLK$ | $EgLK_t$ | $EgLK$ | $ELPMLK_t$ | $ELPMLK$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2023 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2024 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2025 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2026 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2027 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2028 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2029 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2030 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2031 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2033 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2034 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2035 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2036 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2037 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2038 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2039 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2040 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2041 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2042 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2043 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2044 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2045 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2046 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2047 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2048 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2049 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2050 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2051 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. The ex-ante activity displacement leakage is calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This is done by multiplying the estimated baseline carbon stock changes for the project area by a "Displacement Leakage Factor" (DLF) representing the percent of deforestation expected to be displaced outside the project boundary.

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

$$\Delta CADLKt = \Delta CBSLPAt * DLF$$

Where,

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

As per the methodology, where leakage prevention activities are implemented, the factor shall be equal to the proportion of the baseline agents estimated to be given the opportunity to participate in leakage prevention activities and project activities.

For this project, the default activity-shifting leakage deduction of 15 percent to the gross GHG emission reductions and/or removals was considered, as per VCS Standard.

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

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

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

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

The actual calculated values for ex ante estimated leakage due to activity displacement, annually and cumulatively, are shown in the table below.

**Table 52. Ex ante estimated leakage due to activity displacement**

| Project year | Total ex ante estimated decrease in carbon stocks due to displaced deforestation | | Total ex ante estimated increase in GHG emissions due to displaced forest fires | |
|---|---|---|---|---|
| | annual | cumulative | annual | cumulative |
| | $\Delta CADLK_t$ | $\Delta CADLK$ | $EADLK_t$ | $EADLK$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 9,233.61 | 9,233.61 | 192.60 | 192.60 |
| 2023 | 9,284.97 | 18,518.58 | 192.60 | 385.19 |
| 2024 | 9,336.33 | 27,854.92 | 192.60 | 577.79 |
| 2025 | 9,387.70 | 37,242.62 | 192.60 | 770.39 |
| 2026 | 9,439.06 | 46,681.67 | 192.60 | 962.99 |
| 2027 | 9,490.42 | 56,172.09 | 192.60 | 1,155.58 |
| 2028 | 8,618.42 | 64,790.52 | 173.34 | 1,328.92 |
| 2029 | 8,664.65 | 73,455.16 | 173.34 | 1,502.26 |
| 2030 | 8,710.87 | 82,166.03 | 173.34 | 1,675.60 |
| 2031 | 8,757.10 | 90,923.13 | 173.34 | 1,848.93 |
| 2032 | 8,586.91 | 99,510.04 | 173.34 | 2,022.27 |
| 2033 | 8,581.77 | 108,091.82 | 173.34 | 2,195.61 |
| 2034 | 7,745.61 | 115,837.43 | 156.00 | 2,351.61 |
| 2035 | 7,735.85 | 123,573.29 | 156.00 | 2,507.62 |
| 2036 | 7,726.10 | 131,299.38 | 156.00 | 2,663.62 |
| 2037 | 7,716.34 | 139,015.72 | 156.00 | 2,819.62 |
| 2038 | 7,728.22 | 146,743.94 | 156.00 | 2,975.63 |
| 2039 | 7,723.60 | 154,467.53 | 156.00 | 3,131.63 |
| 2040 | 6,971.05 | 161,438.59 | 140.40 | 3,272.03 |
| 2041 | 6,962.27 | 168,400.86 | 140.40 | 3,412.44 |
| 2042 | 6,953.49 | 175,354.34 | 140.40 | 3,552.84 |
| 2043 | 6,944.70 | 182,299.05 | 140.40 | 3,693.24 |
| 2044 | 6,955.40 | 189,254.44 | 140.40 | 3,833.65 |
| 2045 | 6,951.24 | 196,205.68 | 140.40 | 3,974.05 |
| 2046 | 6,273.95 | 202,479.63 | 126.36 | 4,100.41 |
| 2047 | 6,266.04 | 208,745.67 | 126.36 | 4,226.78 |
| 2048 | 6,258.14 | 215,003.81 | 126.36 | 4,353.14 |
| 2049 | 6,250.23 | 221,254.04 | 126.36 | 4,479.50 |
| 2050 | 6,259.86 | 227,513.90 | 126.36 | 4,605.87 |
| 2051 | 6,256.11 | 233,770.01 | 126.36 | 4,732.23 |

*Ex ante* estimation of total leakage

The result of all sources of leakage is calculated as follows:

$$\Delta CLKt = \Delta CADLKt + \Delta CLPMLKt$$

Where,

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

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

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

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

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

$$ELK_t = EgLK_t + EADLK_t$$

Where,

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

$EgLK_t$ Emissions from grazing animals in leakage management areas at year t; $tCO_2e$

$EADLK_t$ Total *ex ante* increase in GHG emissions due to displaced forest fires at year t; $tCO_2e$

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

**Table 53. Ex ante estimated total leakage**

| Project year | Total ex ante GHG emissions from increased grazing activities | | Total ex ante increase in GHG emissions due to displaced forest fires | | Total ex ante decrease in carbon stocks due to displaced deforestation | | Carbon stock decrease due to leakage prevention measures | | Total net carbon stock change due to leakage | | Total net increase in emissions due to leakage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative |
| | $EgLK_t$ | $EgLK$ | $EADLK_t$ | $EADLK$ | $\Delta CADLK_t$ | $\Delta CADLK$ | $\Delta CLPMLK_t$ | $\Delta CLPMLK$ | $\Delta CLK_t$ | $\Delta CLK$ | $ELK_t$ | $ELK$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 0.00 | 0.00 | 192.60 | 192.60 | 9,233.61 | 9,233.61 | 0.00 | 0.00 | 9,233.61 | 9,233.61 | 192.60 | 192.60 |
| 2023 | 0.00 | 0.00 | 192.60 | 385.19 | 9,284.97 | 18,518.58 | 0.00 | 0.00 | 9,284.97 | 18,518.58 | 192.60 | 385.19 |
| 2024 | 0.00 | 0.00 | 192.60 | 577.79 | 9,336.33 | 27,854.92 | 0.00 | 0.00 | 9,336.33 | 27,854.92 | 192.60 | 577.79 |
| 2025 | 0.00 | 0.00 | 192.60 | 770.39 | 9,387.70 | 37,242.62 | 0.00 | 0.00 | 9,387.70 | 37,242.62 | 192.60 | 770.39 |
| 2026 | 0.00 | 0.00 | 192.60 | 962.99 | 9,439.06 | 46,681.67 | 0.00 | 0.00 | 9,439.06 | 46,681.67 | 192.60 | 962.99 |
| 2027 | 0.00 | 0.00 | 192.60 | 1,155.58 | 9,490.42 | 56,172.09 | 0.00 | 0.00 | 9,490.42 | 56,172.09 | 192.60 | 1,155.58 |
| 2028 | 0.00 | 0.00 | 173.34 | 1,328.92 | 8,618.42 | 64,790.52 | 0.00 | 0.00 | 8,618.42 | 64,790.52 | 173.34 | 1,328.92 |
| 2029 | 0.00 | 0.00 | 173.34 | 1,502.26 | 8,664.65 | 73,455.16 | 0.00 | 0.00 | 8,664.65 | 73,455.16 | 173.34 | 1,502.26 |
| 2030 | 0.00 | 0.00 | 173.34 | 1,675.60 | 8,710.87 | 82,166.03 | 0.00 | 0.00 | 8,710.87 | 82,166.03 | 173.34 | 1,675.60 |
| 2031 | 0.00 | 0.00 | 173.34 | 1,848.93 | 8,757.10 | 90,923.13 | 0.00 | 0.00 | 8,757.10 | 90,923.13 | 173.34 | 1,848.93 |
| 2032 | 0.00 | 0.00 | 173.34 | 2,022.27 | 8,586.91 | 99,510.04 | 0.00 | 0.00 | 8,586.91 | 99,510.04 | 173.34 | 2,022.27 |
| 2033 | 0.00 | 0.00 | 173.34 | 2,195.61 | 8,581.77 | 108,091.82 | 0.00 | 0.00 | 8,581.77 | 108,091.82 | 173.34 | 2,195.61 |
| 2034 | 0.00 | 0.00 | 156.00 | 2,351.61 | 7,745.61 | 115,837.43 | 0.00 | 0.00 | 7,745.61 | 115,837.43 | 156.00 | 2,351.61 |
| 2035 | 0.00 | 0.00 | 156.00 | 2,507.62 | 7,735.85 | 123,573.29 | 0.00 | 0.00 | 7,735.85 | 123,573.29 | 156.00 | 2,507.62 |
| 2036 | 0.00 | 0.00 | 156.00 | 2,663.62 | 7,726.10 | 131,299.38 | 0.00 | 0.00 | 7,726.10 | 131,299.38 | 156.00 | 2,663.62 |
| 2037 | 0.00 | 0.00 | 156.00 | 2,819.62 | 7,716.34 | 139,015.72 | 0.00 | 0.00 | 7,716.34 | 139,015.72 | 156.00 | 2,819.62 |
| 2038 | 0.00 | 0.00 | 156.00 | 2,975.63 | 7,728.22 | 146,743.94 | 0.00 | 0.00 | 7,728.22 | 146,743.94 | 156.00 | 2,975.63 |
| 2039 | 0.00 | 0.00 | 156.00 | 3,131.63 | 7,723.60 | 154,467.53 | 0.00 | 0.00 | 7,723.60 | 154,467.53 | 156.00 | 3,131.63 |
| 2040 | 0.00 | 0.00 | 140.40 | 3,272.03 | 6,971.05 | 161,438.59 | 0.00 | 0.00 | 6,971.05 | 161,438.59 | 140.40 | 3,272.03 |
| 2041 | 0.00 | 0.00 | 140.40 | 3,412.44 | 6,962.27 | 168,400.86 | 0.00 | 0.00 | 6,962.27 | 168,400.86 | 140.40 | 3,412.44 |
| 2042 | 0.00 | 0.00 | 140.40 | 3,552.84 | 6,953.49 | 175,354.34 | 0.00 | 0.00 | 6,953.49 | 175,354.34 | 140.40 | 3,552.84 |
| 2043 | 0.00 | 0.00 | 140.40 | 3,693.24 | 6,944.70 | 182,299.05 | 0.00 | 0.00 | 6,944.70 | 182,299.05 | 140.40 | 3,693.24 |
| 2044 | 0.00 | 0.00 | 140.40 | 3,833.65 | 6,955.40 | 189,254.44 | 0.00 | 0.00 | 6,955.40 | 189,254.44 | 140.40 | 3,833.65 |
| 2045 | 0.00 | 0.00 | 140.40 | 3,974.05 | 6,951.24 | 196,205.68 | 0.00 | 0.00 | 6,951.24 | 196,205.68 | 140.40 | 3,974.05 |
| 2046 | 0.00 | 0.00 | 126.36 | 4,100.41 | 6,273.95 | 202,479.63 | 0.00 | 0.00 | 6,273.95 | 202,479.63 | 126.36 | 4,100.41 |
| 2047 | 0.00 | 0.00 | 126.36 | 4,226.78 | 6,266.04 | 208,745.67 | 0.00 | 0.00 | 6,266.04 | 208,745.67 | 126.36 | 4,226.78 |
| 2048 | 0.00 | 0.00 | 126.36 | 4,353.14 | 6,258.14 | 215,003.81 | 0.00 | 0.00 | 6,258.14 | 215,003.81 | 126.36 | 4,353.14 |
| 2049 | 0.00 | 0.00 | 126.36 | 4,479.50 | 6,250.23 | 221,254.04 | 0.00 | 0.00 | 6,250.23 | 221,254.04 | 126.36 | 4,479.50 |
| 2050 | 0.00 | 0.00 | 126.36 | 4,605.87 | 6,259.86 | 227,513.90 | 0.00 | 0.00 | 6,259.86 | 227,513.90 | 126.36 | 4,605.87 |
| 2051 | 0.00 | 0.00 | 126.36 | 4,732.23 | 6,256.11 | 233,770.01 | 0.00 | 0.00 | 6,256.11 | 233,770.01 | 126.36 | 4,732.23 |

## 4.4 Net GHG Emission Reductions and Removals

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

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

Where:

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

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

$$VCUt = \Delta REDDt - VBCt$$

$$VBCt = (\Delta CBSLPAt - \Delta CPSPAt) * RFt$$

Where:

| | |
|---|---|
| VCUt | Number of Verified Carbon Units that can be traded at time t; t $CO_2e$ |
| ΔREDDt | Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; $tCO_2e$ |
| VBCt | Number of Buffer Credits deposited in the VCS Buffer at time t; t $CO_2e$ |

| | |
|---|---|
| ΔCBSLPAt | Sum of baseline carbon stock changes in the project area at year t; tCO2e |
| ΔCPSPAt | Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e ha-1 |
| Ft | Risk factor used to calculate VCS buffer credits; % |
| t | 1, 2, 3 … T, a year of the proposed project crediting period; dimensionless. |

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value of RFt for the first project instance activity was 15%.

The net GHG emission reductions and removals by the project activity of Sepoti REDD Project are summarized in the table below.

**Table 54. Summary of net GHG Emission Reductions and Removals**

| Year | Estimated baseline emissions or removals ($tCO_2e$) | Estimated project emissions or removals ($tCO_2e$) | Estimated leakage emissions ($tCO_2e$) | *Ex ante* buffer credits ($tCO_2e$) | Estimated net GHG emission reductions or removals ($tCO_2e$) |
|---|---|---|---|---|---|
| 2022 | 39,863 | 1,993 | 1,993 | 5,681 | 30,196 |
| 2023 | 40,143 | 1,993 | 2,007 | 5,723 | 30,420 |
| 2024 | 40,424 | 2,007 | 2,021 | 5,763 | 30,633 |
| 2025 | 40,705 | 2,021 | 2,035 | 5,803 | 30,846 |
| 2026 | 40,986 | 2,035 | 2,049 | 5,843 | 31,058 |
| 2027 | 41,267 | 2,049 | 2,063 | 5,883 | 31,271 |
| 2028 | 37,561 | 2,063 | 1,878 | 5,325 | 28,295 |
| 2029 | 37,814 | 1,878 | 1,891 | 5,391 | 28,654 |
| 2030 | 38,067 | 1,891 | 1,903 | 5,427 | 28,846 |
| 2031 | 38,319 | 1,903 | 1,916 | 5,463 | 29,037 |
| 2032 | 38,291 | 1,916 | 1,915 | 5,457 | 29,004 |
| 2033 | 38,263 | 1,915 | 1,913 | 5,453 | 28,982 |
| 2034 | 34,647 | 1,913 | 1,732 | 4,911 | 26,091 |
| 2035 | 34,594 | 1,732 | 1,730 | 4,930 | 26,202 |
| 2036 | 34,541 | 1,730 | 1,727 | 4,922 | 26,162 |
| 2037 | 34,487 | 1,727 | 1,724 | 4,914 | 26,122 |
| 2038 | 34,462 | 1,724 | 1,723 | 4,911 | 26,104 |
| 2039 | 34,437 | 1,723 | 1,722 | 4,908 | 26,084 |
| 2040 | 31,183 | 1,722 | 1,559 | 4,420 | 23,482 |
| 2041 | 31,135 | 1,559 | 1,557 | 4,437 | 23,582 |
| 2042 | 31,087 | 1,557 | 1,554 | 4,430 | 23,546 |
| 2043 | 31,039 | 1,554 | 1,552 | 4,423 | 23,510 |
| 2044 | 31,016 | 1,552 | 1,551 | 4,420 | 23,493 |
| 2045 | 30,993 | 1,551 | 1,550 | 4,417 | 23,476 |
| 2046 | 28,064 | 1,550 | 1,403 | 3,978 | 21,133 |
| 2047 | 28,021 | 1,403 | 1,401 | 3,993 | 21,224 |
| 2048 | 27,978 | 1,401 | 1,399 | 3,987 | 21,191 |
| 2049 | 27,935 | 1,399 | 1,397 | 3,981 | 21,158 |
| 2050 | 27,914 | 1,397 | 1,396 | 3,978 | 21,144 |
| 2051 | 27,894 | 1,396 | 1,395 | 3,975 | 21,129 |
| Total | 1,033,130 | 52,255 | 51,657 | 147,147 | 782,072 |

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

Table 55. Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and verified carbon units (VCUt)

| Project year | Baseline carbon stock changes | | Baseline GHG emissions from biomass burning | | Ex ante project carbon stock changes | | Ex ante project GHG emissions from biomass burning | | Ex ante leakage carbon stock changes | | Ex ante leakage GHG emissions | | Ex ante net anthropogenic GHG emission reductions | | Ex ante VCUs tradable | | Ex ante buffer credits | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative | annual | cumulative |
| | $\Delta CBSLPA_t$ | $\Delta CBSLPA$ | $EBBBSLPA_t$ | $EBBBSLPA$ | $\Delta CPSPA_t$ | $\Delta CPSPA$ | $EBBPSPA_t$ | $EBBPSPA$ | $\Delta CLK_t$ | $\Delta CLK$ | $ELK_t$ | $ELK$ | $\Delta REDD_t$ | $\Delta REDD$ | $VCU_t$ | $VCU$ | $VBC_t$ | $VBC$ |
| | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ | $tCO_2e$ |
| 2022 | 39,863 | 39,863 | 1,284 | 1,284 | 3,368 | 3,368 | 70 | 70 | 9,234 | 9,234 | 1,993 | 1,993 | 49,977 | 49,977 | 30,196 | 30,196 | 5,681 | 5,681 |
| 2023 | 40,143 | 80,006 | 1,284 | 2,568 | 3,387 | 6,754 | 70 | 140 | 9,285 | 18,519 | 2,007 | 4,000 | 50,249 | 100,226 | 30,420 | 60,615 | 5,723 | 11,404 |
| 2024 | 40,424 | 120,430 | 1,284 | 3,852 | 3,405 | 10,160 | 70 | 211 | 9,336 | 27,855 | 2,021 | 6,022 | 50,522 | 150,748 | 30,633 | 91,248 | 5,763 | 17,167 |
| 2025 | 40,705 | 161,135 | 1,284 | 5,136 | 3,424 | 13,584 | 70 | 281 | 9,388 | 37,243 | 2,035 | 8,057 | 50,794 | 201,542 | 30,846 | 122,094 | 5,803 | 22,970 |
| 2026 | 40,986 | 202,121 | 1,284 | 6,420 | 3,443 | 17,027 | 70 | 351 | 9,439 | 46,682 | 2,049 | 10,106 | 51,066 | 252,608 | 31,058 | 153,152 | 5,843 | 28,813 |
| 2027 | 41,267 | 243,388 | 1,284 | 7,704 | 3,462 | 20,488 | 70 | 421 | 9,490 | 56,172 | 2,063 | 12,169 | 51,339 | 303,947 | 31,271 | 184,423 | 5,883 | 34,696 |
| 2028 | 37,561 | 280,949 | 1,156 | 8,859 | 3,143 | 23,632 | 63 | 485 | 8,618 | 64,791 | 1,878 | 14,047 | 46,613 | 350,560 | 28,295 | 212,718 | 5,325 | 40,021 |
| 2029 | 37,814 | 318,763 | 1,156 | 10,015 | 3,160 | 26,792 | 63 | 548 | 8,665 | 73,455 | 1,891 | 15,938 | 46,858 | 397,419 | 28,654 | 241,372 | 5,391 | 45,412 |
| 2030 | 38,067 | 356,830 | 1,156 | 11,171 | 3,177 | 29,969 | 63 | 611 | 8,711 | 82,166 | 1,903 | 17,842 | 47,103 | 444,522 | 28,846 | 270,218 | 5,427 | 50,839 |
| 2031 | 38,319 | 395,149 | 1,156 | 12,326 | 3,194 | 33,163 | 63 | 674 | 8,757 | 90,923 | 1,916 | 19,757 | 47,349 | 491,871 | 29,037 | 299,255 | 5,463 | 56,302 |
| 2032 | 38,291 | 433,440 | 1,156 | 13,482 | 3,132 | 36,295 | 63 | 738 | 8,587 | 99,510 | 1,915 | 21,672 | 46,446 | 538,317 | 29,004 | 328,258 | 5,457 | 61,759 |
| 2033 | 38,263 | 471,703 | 1,156 | 14,637 | 3,130 | 39,426 | 63 | 801 | 8,582 | 108,092 | 1,913 | 23,585 | 46,419 | 584,736 | 28,982 | 357,241 | 5,453 | 67,212 |
| 2034 | 34,647 | 506,350 | 1,040 | 15,677 | 2,825 | 42,251 | 57 | 858 | 7,746 | 115,837 | 1,732 | 25,318 | 41,894 | 626,629 | 26,091 | 383,331 | 4,911 | 72,123 |
| 2035 | 34,594 | 540,944 | 1,040 | 16,717 | 2,822 | 45,072 | 57 | 915 | 7,736 | 123,573 | 1,730 | 27,047 | 41,842 | 668,472 | 26,202 | 409,533 | 4,930 | 77,053 |
| 2036 | 34,541 | 575,485 | 1,040 | 17,757 | 2,818 | 47,890 | 57 | 972 | 7,726 | 131,299 | 1,727 | 28,774 | 41,790 | 710,262 | 26,162 | 435,695 | 4,922 | 81,975 |
| 2037 | 34,487 | 609,972 | 1,040 | 18,797 | 2,814 | 50,705 | 57 | 1,028 | 7,716 | 139,016 | 1,724 | 30,499 | 41,739 | 752,000 | 26,122 | 461,817 | 4,914 | 86,889 |
| 2038 | 34,462 | 644,434 | 1,040 | 19,838 | 2,819 | 53,524 | 57 | 1,085 | 7,728 | 146,744 | 1,723 | 32,222 | 41,802 | 793,802 | 26,104 | 487,921 | 4,911 | 91,800 |
| 2039 | 34,437 | 678,871 | 1,040 | 20,878 | 2,817 | 56,341 | 57 | 1,142 | 7,724 | 154,468 | 1,722 | 33,944 | 41,777 | 835,579 | 26,084 | 514,005 | 4,908 | 96,708 |
| 2040 | 31,183 | 710,054 | 936 | 21,814 | 2,543 | 58,883 | 51 | 1,193 | 6,971 | 161,439 | 1,559 | 35,503 | 37,704 | 873,283 | 23,482 | 537,487 | 4,420 | 101,128 |
| 2041 | 31,135 | 741,189 | 936 | 22,750 | 2,539 | 61,423 | 51 | 1,245 | 6,962 | 168,401 | 1,557 | 37,059 | 37,658 | 910,941 | 23,582 | 561,069 | 4,437 | 105,565 |
| 2042 | 31,087 | 772,276 | 936 | 23,686 | 2,536 | 63,959 | 51 | 1,296 | 6,953 | 175,354 | 1,554 | 38,614 | 37,611 | 948,553 | 23,546 | 584,615 | 4,430 | 109,995 |
| 2043 | 31,039 | 803,315 | 936 | 24,622 | 2,533 | 66,492 | 51 | 1,347 | 6,945 | 182,299 | 1,552 | 40,166 | 37,565 | 986,117 | 23,510 | 608,124 | 4,423 | 114,418 |
| 2044 | 31,016 | 834,331 | 936 | 25,558 | 2,537 | 69,029 | 51 | 1,398 | 6,955 | 189,254 | 1,551 | 41,717 | 37,621 | 1,023,739 | 23,493 | 631,618 | 4,420 | 118,838 |
| 2045 | 30,993 | 865,324 | 936 | 26,494 | 2,535 | 71,564 | 51 | 1,450 | 6,951 | 196,206 | 1,550 | 43,266 | 37,599 | 1,061,338 | 23,476 | 655,093 | 4,417 | 123,255 |
| 2046 | 28,064 | 893,388 | 842 | 27,336 | 2,288 | 73,853 | 46 | 1,496 | 6,274 | 202,480 | 1,403 | 44,669 | 33,934 | 1,095,272 | 21,133 | 676,226 | 3,978 | 127,233 |
| 2047 | 28,021 | 921,409 | 842 | 28,179 | 2,285 | 76,138 | 46 | 1,542 | 6,266 | 208,746 | 1,401 | 46,070 | 33,892 | 1,129,164 | 21,224 | 697,450 | 3,993 | 131,226 |
| 2048 | 27,978 | 949,387 | 842 | 29,021 | 2,283 | 78,421 | 46 | 1,588 | 6,258 | 215,004 | 1,399 | 47,469 | 33,850 | 1,163,014 | 21,191 | 718,641 | 3,987 | 135,213 |
| 2049 | 27,935 | 977,322 | 842 | 29,863 | 2,280 | 80,701 | 46 | 1,634 | 6,250 | 221,254 | 1,397 | 48,866 | 33,808 | 1,196,822 | 21,158 | 739,799 | 3,981 | 139,194 |
| 2050 | 27,914 | 1,005,236 | 842 | 30,706 | 2,283 | 82,984 | 46 | 1,680 | 6,260 | 227,514 | 1,396 | 50,262 | 33,859 | 1,230,682 | 21,144 | 760,943 | 3,978 | 143,172 |
| 2051 | 27,894 | 1,033,130 | 842 | 31,548 | 2,282 | 85,266 | 46 | 1,726 | 6,256 | 233,770 | 1,395 | 51,657 | 33,839 | 1,264,521 | 21,129 | 782,072 | 3,975 | 147,147 |

# 5 MONITORING

## 5.1 Data and Parameters Available at Validation

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

| Data / Parameter | $Ctot_{fcl}$ |
|---|---|
| Data unit | $tCO_2e/ha$ |
| Description | Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in $tCO_2e/ha$ |
| Source of data | Long-term average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region were taken from the following study: FEARNSIDE, Philip M. Amazonian |

| | |
|---|---|
| | deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996. |
| Value applied | 46.93 |
| Justification of choice of data or description of measurement methods and procedures applied | Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas.<br>Following a literature review, the use of Fearnside value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory from 2019, the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used. |
| Purpose of Data | This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the reference region. |
| Comments | If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period. |

| Data / Parameter | DLF |
|---|---|
| Data unit | % |
| Description | Displacement Leakage Factor |
| Source of data | DLF was adopted as an average of displaced leakage in the Monitoring Reports of VM0015 projects developed in Brazil. An assessment of 15 verified projects located in Brazil was conducted, comparing leakage due to displaced deforestation on baseline and project scenarios. |
| Value applied | 0.71% |
| Justification of choice of data or description of measurement methods and procedures applied | The DLF was estimated as 0.71%, based on other REDD project activities and taking into account the project situation. |

| | |
|---|---|
| Purpose of Data | This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity. |
| Comments | *Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease.<br>This parameter will be updated at each renewal of fixed baseline period. |

| | |
|---|---|
| Data / Parameter | $\Delta CBSLLK_t$ |
| Data unit | $tCO_2e$ |
| Description | Annual carbon stock changes in leakage management areas in the baseline case at year t |
| Source of data | - Planned interventions proposed by the project proponent.<br>- Remote sensing and GIS. |
| Value applied | 0 |
| Justification of choice of data or description of measurement methods and procedures applied | Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted.<br>The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area. |
| Purpose of Data | This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented. |
| Comments | *Ex post* monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions.<br>This parameter will be updated at each renewal of fixed baseline period. |

| | |
|---|---|
| Data / Parameter | $EBBBSLPA_t$ |

| | |
|---|---|
| Data unit | $tCO_2e$ |
| Description | Sum of (or total) baseline non-CO2 emissions from forest fire at year t in the project area |
| Source of data | Remote sensing data and GIS, supervisor reports. |
| Value applied | 208.80 (Annual average actual non-$CO_2$ emissions due to biomass burning within the project area during the crediting period) |
| Justification of choice of data or description of measurement methods and procedures applied | Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt.<br>Non-$CO_2$ emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. In order to estimate non-$CO_2$ emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case.<br>Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t). |
| Purpose of data | This parameter is used to calculate non-$CO_2$ emissions due to forest fires within the project area in the baseline scenario, providing an ex-ante estimation. |
| Comments | Ex post monitoring of forest fires and non-$CO_2$ emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant). |

| | |
|---|---|
| Data / Parameter | $Fburnt_{icl}$ |
| Data unit | % |

| | |
|---|---|
| Description | Proportion of forest area burned during the historical reference period in the forest class. |
| Source of data | Measured or estimated from literature.<br><br>*Fburnt data source:*<br>VThird National Communication from Brazil to the United Nations Framework Convention on Climate Change - Volume 3, Table A2.4, page 305<br><br><http://www.ccst.inpe.br/publicacao/terceira-comunicacao-nacional-do-brasil-a-convencao-quadro-das-nacoes-unidas-sobre-mudanca-do-clima-portugues/> |
| Value applied | 46.40 |
| Justification of choice of data or description of measurement methods and procedures applied | Value of "Biomass combustion factors by phytophysiognomies group in the Amazon biome" for Seasonal semideciduous forest available at the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change. |
| Purpose of data | This parameter is the average percentage of the area within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming, and is used to calculate baseline and project non-$CO_2$ emissions from forest fire at year t in the project area (parameter EBBBSLPAt). |
| Comments | Monitoring is done only once at project start. |

| | |
|---|---|
| Data / Parameter | $Pburnt_{p,icl}$ |
| Data unit | % |
| Description | Average proportion of mass burnt in the carbon pool in the forest class |
| Source of data | Measured or estimated from literature.<br><br>*Pburnt data source:*<br>Anderson LO, Aragão LE, Gloor M, et al. **Disentangling the contribution of multiple land covers to fire-mediated carbon emissions in Amazonia during the 2010 drought.** Global Biogeochem Cycles. 2015; 29 (10):1739-1753. Doi: 10.1002/2014GB005008. Available at <https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014GB005008>. |

| | |
|---|---|
| Value applied | 78 |
| Justification of choice of data or description of measurement methods and procedures applied | Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 $m^3$/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%.<br>However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation.<br>The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.<br>It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process. |
| Purpose of data | This parameter is the average of biomass that has commercial value, and could be removed prior to clear cutting and burning, and is used to calculate baseline and project non-$CO_2$ emissions from forest fire at year t in the project area (parameter EBBBSLPAt). |
| Comments | Monitoring is done only once at project start. |

| | |
|---|---|
| Data / Parameter | EI |
| Data unit | % |
| Description | *Ex ante* estimated effectiveness index |
| Source of data | Estimate from project proponent based on verified reports of similar VM0015 REDD projects in Brazil up to date. Available in VERRA database. |
| Value applied | 92.07% |
| Justification of choice of data or description of | Based on the comparison between *ex post* and *ex ante* deforestation of similar REDD projects developed in Brazil, available in verified reports in VERRA database up to date. |

| | |
|---|---|
| measurement methods and procedures applied | |
| Purpose of Data | This parameter is used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation. |
| Comments | *Ex post* monitoring of the project area will be done to determine deforestation rate and the project emissions.<br>This parameter will be updated at each renewal of fixed baseline period. |

## 5.2 Data and Parameters Monitored

| Data / Parameter | $ab_{icl}$ |
|---|---|
| Data unit | Mg/ha |
| Description | Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha. |
| Source of data | Average values for the above-ground biomass were taken from the following study:<br>HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015. |
| Description of measurement methods and procedures to be applied | The following sources will be monitored:<br>- Biomass stock surveys<br>- Periodic reports from area supervisor<br>- Local Forest Inventories |
| Frequency of monitoring/recording | At each monitoring report. |
| Value applied | (table below) |

| Above-ground biomass $ab_{icl}$ (Mg/ha) | | | |
|---|---|---|---|
| Forest class | Reference Region | Project Area | Leakage Belt |

| | |
|---|---|
| | Forest class \| 327.40 \| 327.40 \| 327.40 |
| Monitoring equipment | No monitoring equipment is used to determine this parameter. |
| QA/QC procedures to be applied | Data shall be in accordance to VM0015 v1.1 requirements |
| Purpose of data | This parameter is used to calculate baseline emissions, project emissions and leakage emissions in both baseline and project scenarios. |
| Calculation method | Following a literature search the above-ground biomass values of these studies were used as they were determined to accurately represent the values of vegetation within the project reference region. |
| Comments | The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first. |

| | |
|---|---|
| Data / Parameter | $bb_{icl}$ |
| Data unit | Mg/ha |
| Description | Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha. |
| Source of data | Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha. |
| Description of measurement methods and procedures to be applied | The following sources will be monitored:<br>- Biomass stock surveys<br>- Periodic reports from area supervisor<br>- Local Forest Inventories |
| Frequency of monitoring/recording | At each monitoring report. |
| Value applied | (see table below) |
| Monitoring equipment | No monitoring equipment is used to determine this parameter. |

Value applied:

| Below-ground biomass $bb_{icl}$ (Mg/ha) | | | |
|---|---|---|---|
| Forest class | Reference Region | Project Area | Leakage Belt |
| Forest class | 78.58 | 78.58 | 78.58 |

| | |
|---|---|
| QA/QC procedures to be applied | Data shall be in accordance to VM0015 v1.1 requirements |
| Purpose of data | This parameter is used to calculate baseline, project and leakage emissions in the baseline and project scenarios. |
| Calculation method | Calculation according to the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha. |
| Comments | The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first. |
| Data / Parameter | ACPAt |
| Data unit | Ha |
| Description | Annual area within the Project Area affected by catastrophic events at year t. |
| Source of data | - Remote sensing data and GIS,<br>- Forest management team and other field data. |
| Description of measurement methods and procedures to be applied | In addition to field data from the management team, he following sources will also be monitored:<br>- INMET[124]<br>- INPE[125] |
| Frequency of monitoring/recording | At each time a catastrophic event occurs. |
| Value applied | The value will be calculated ex-post at each time a catastrophic event occurs, when significant. |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS:<br>- INMET<br>- INPE<br>- Field data from the management team |

[124] INMET. Instituto Nacional de Meteorologia. Available at: <https://portal.inmet.gov.br/>.
[125] INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://www.inpe.br/>.

| | |
|---|---|
| Purpose of data | This parameter is used to calculate project emissions in the project scenario. Provides an ex post estimation of the area affected by catastrophic events within the project area. |
| Calculation method | Remote sensing and GIS |
| Comments | Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant. |

| | |
|---|---|
| Data / Parameter | $ABSLLK_t$ |
| Data unit | Ha |
| Description | Annual area of deforestation within the leakage belt at year t. |
| Source of data | Remote sensing and GIS. |
| Description of measurement methods and procedures to be applied | Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. |
| Frequency of monitoring/recording | Annually |
| Value applied | 64.13 (estimated annual average) |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt. |
| Calculation method | Analysis of satellite images and maps. |
| Comments | Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage. |

| | |
|---|---|
| Data / Parameter | ABSLPAt |
| Data unit | Ha |
| Description | Annual area of deforestation in the project area at year t |
| Source of data | Remote sensing and GIS |
| Description of measurement methods and procedures to be applied | Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area. |
| Frequency of monitoring/recording | Annually |
| Value applied | 67.13 (estimated annual average) |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the ex ante and ex post values of the deforested area per forest class within the project area. |
| Calculation method | Analysis of satellite images and maps. |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $ABSLRR_t$ |
| Data unit | Ha |
| Description | Annual area of deforestation in the reference region at year t |
| Source of data | Remote sensing and GIS |
| Description of measurement methods and procedures to be applied | Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the reference region. |
| Frequency of monitoring/recording | Annually |
| Value applied | 2,614 (estimated annual average) |

| | |
|---|---|
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the reference region. |
| Calculation method | Analysis of satellite images and maps. |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $\Delta CADLK_t$ |
| Data unit | $tCO_2e$ |
| Description | Total decrease in carbon stocks due to displaced deforestation at year t |
| Source of data | Remote sensing and GIS. |
| Description of measurement methods and procedures to be applied | Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. |
| Frequency of monitoring/recording | Annually |
| Value applied | 5,862.33 (Annual average projected decrease in carbon stocks due to displaced deforestation in the leakage belt during the crediting period) |
| Monitoring equipment | Remote sensing and GIS. |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt. |

| | |
|---|---|
| Calculation method | Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area. |
| Comments | Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage. |

| | |
|---|---|
| Data / Parameter | ΔCPAdPAt |
| Data unit | tCO2e |
| Description | Total decrease in carbon stock due to all planned activities at year t in the project area |
| Source of data | Documents, remote sensing and GIS. |
| Description of measurement methods and procedures to be applied | The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant. |
| Frequency of monitoring/recording | Annually |
| Value applied | 0.00 (Annual average decrease in carbon stocks due to all planned activities within the project area during the crediting period) |
| Monitoring equipment | Remote sensing and GIS<br>SFMP reports, including the post-harvesting annual report. |
| QA/QC procedures to be applied | - Best practices in remote sensing.<br>- Internal procedures required by the SFMP and forest certification |
| Purpose of data | This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to planned activities in the project area. |
| Calculation method | This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities. |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $\Delta CPSLK_t$ |
| Data unit | $tCO_2e$ |
| Description | Total annual carbon stock change in leakage management areas in the project case at year t |
| Source of data | - Activities report related to leakage prevention measures<br>- Field assessment<br>- Remote sensing and GIS |
| Description of measurement methods and procedures to be applied | The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant. |
| Frequency of monitoring/recording | Annually |
| Value applied | 0 |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area. |
| Calculation method | Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area. |
| Comments | The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area. |

| | |
|---|---|
| Data / Parameter | $\Delta CUDdPA_t$ |
| Data unit | $tCO_2e$ |
| Description | Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area |
| Source of data | - Remote sensing and GIS<br>- Field reports. |

| | |
|---|---|
| Description of measurement methods and procedures to be applied | Forest cover change due to unplanned deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area. |
| Frequency of monitoring/recording | Annually |
| Value applied | 2,842.19 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the crediting period) |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing. |
| Purpose of data | This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project area. |
| Calculation method | Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area. |
| Comments | N/A |

| Data / Parameter | $EADLK_t$ |
|---|---|
| Data unit | $tCO_2e$ |
| Description | Total *ex post* increase in GHG emissions due to displaced forest fires at year t. |
| Source of data | Remote sensing data and GIS. |
| Description of measurement methods and procedures to be applied | Forest fires in the leakage belt area may be considered activity displacement leakage. GHG emissions due displaced forest fires will be subjected to monitoring, when significant. |
| Frequency of monitoring/recording | Annually |
| Value applied | 157.74 |
| Monitoring equipment | Remote sensing and GIS |

| | |
|---|---|
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. |
| Purpose of data | This parameter will be used to calculate leakage emissions in the baseline and project scenario. Provides the *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt. |
| Calculation method | GHG emissions from deforestation are estimated by multiplying the detected area of forest loss in the leakage belt times the average forest carbon stock per unit area. |
| Comments | Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage. |

| | |
|---|---|
| Data / Parameter | $EBBPSPA_t$ |
| Data unit | $tCO_2e$ |
| Description | Sum of (or total) of actual non-$CO_2$ emissions from forest fire at year t in the project area |
| Source of data | - Remote sensing data and GIS,<br>- Forest management team and field data. |
| Description of measurement methods and procedures to be applied | If forest fires occur, these non-$CO_2$ emissions will be subject to monitoring and accounting, when significant.<br>In addition to remote sensing data and GIS, which can identify the area affected by forest fire, the forest management team could also confirm the obtained data.<br>No forest fire will be used by the project owner for conducting planned deforestation or timber harvesting activities. However, it is expected that some unplanned deforestation within the project area will occur during the crediting period, which conversion of forest to non-forest may involve fire.<br>The effect of fire on carbon emissions is counted in the estimation of carbon stock changes in the parameter $\Delta CUDdPA_t$; therefore $CO_2$ emissions from forest fires were ignored to avoid double counting. However, non-$CO_2$ emissions ($CH_4$ and $N_2O$) from forest fires must be counted in the project scenario, when they are significant. |

| | |
|---|---|
| | In order to be conservative, it will be assumed that all unplanned deforestation within the project area will involve fire. Therefore, non-$CO_2$ emissions from forest fires will be quantified and deducted from emission reductions. |
| Frequency of monitoring/recording | Annually |
| Value applied | 57.53 (annual average actual non-$CO_2$ emissions due to biomass burning within the project area during the crediting period) |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. |
| Purpose of data | This parameter will be used to calculate *non-$CO_2$* emissions due to forest fires within the project area in the project scenario, providing an estimate of the *ex post* value for each vegetation type. |
| Calculation method | If forest fires occur, *non-$CO_2$* emissions from biomass burning will calculated according to requirements of methodology VM0015 v1.1. Therefore, this parameter will be calculated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the project scenario times the total GHG emission from biomass burning in initial forest classes ($EBBtot_{icl,t}$), when significant. |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $EBBtot_{icl,t}$ |
| Data unit | tCO2e/ha |
| Description | Total GHG emission from biomass burning in forest class icl at year t |
| Source of data | Calculated according to methodology VM0015 v1.1. |
| Description of measurement methods and procedures to be applied | This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-$CO_2$ emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project |

| | |
|---|---|
| | case. These average percentage values are assumed to remain the same in the future, according to the applied methodology |
| Frequency of monitoring/recording | Annually |
| Value applied | 6.09 |
| Monitoring equipment | Remote sensing and GIS |
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. |
| Purpose of data | This parameter is used to calculate the baseline, project and leakage non-$CO_2$ emissions from biomass burning occurred in the baseline and project scenarios |
| Calculation method | This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. |
| Comments | GWP for $CH_4$ and N2O were obtained according to the most recent version of the VCS Standard. |

| Data / Parameter | $EgLK_t$ |
|---|---|
| Data unit | $tCO_2e$ |
| Description | Emissions from grazing animals in leakage management areas at year t. |
| Source of data | - Activities report related to leakage prevention measures<br>- Field assessment<br>- Remote sensing data and GIS. |
| Description of measurement methods and procedures to be applied | GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant. |
| Frequency of monitoring/recording | Annually |
| Value applied | 0 (annual average for the crediting period) |
| Monitoring equipment | Remote sensing and GIS<br>Field assessment data |
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. |

| | |
|---|---|
| Purpose of data | This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value. |
| Calculation method | Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of $CH_4$ and $N_2O$ emissions from grazing animals. |
| Comments | The community living within the leakage management area practices grazing activities. Therefore, this shall be monitored during the crediting period.<br>GWP for $CH_4$ and N2O were obtained according to the most recent version of the VCS Standard. |

| | |
|---|---|
| Data / Parameter | $RF_t$ |
| Data unit | % |
| Description | Risk factor used to calculate VCS buffer credits |
| Source of data | - VCS Non-Permanence Risk Report – Sepoti REDD Project;<br>- Remote sensing data and GIS;<br>- SFMP data;<br>- Literature data. |
| Description of measurement methods and procedures to be applied | All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors. |
| Frequency of monitoring/recording | Annually |
| Value applied | 15 |
| Monitoring equipment | Remote sensing and GIS. |
| QA/QC procedures to be applied | Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event. |
| Purpose of data | This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account. |
| Calculation method | This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors |

| | |
|---|---|
| | described in the VCS Non-Permanence Risk Report will be assessed. |
| Comments | N/A |

## 5.3 Monitoring Plan

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

**Organizational structure**

According to the contract stipulated between Future Carbon and the landowner, the landowner is responsible for the costing and implementation and/or maintenance of the project's forest management and activities to reduce deforestation and degradation, surveillance, fire prevention, illegal extraction of wood, prevention of invasions, among others, implementation and maintenance of social and environmental activities to reduce leakage, decrease the risks of non-permanence of carbon and improve the results of SOCIALCARBON, or other Standard for the assessment of social and environmental co-benefits.

In addition, it is responsible for keeping all documentation required by the project in order, as well as project maintenance expenses; Execute, monitor and maintain in full operation the structure that authorizes and serves as the basis for the development of the Project, ensuring the reduction of deforestation and degradation, the implementation and maintenance of social and environmental activities (or designating and hiring third parties responsible for the activities).

The owner is responsible for establishing prospects in each Social Carbon report, as well as complying with at least 50% of the proposed actions, under penalty of losing the Social Carbon standard.

Future Carbon is responsible for the development of the project documents, assessment of the mapping files for application of the methodology, and internal auditing.

- **Revision of the baseline**

The current baseline is valid for 6 years. The baseline will be reassessed every 6 years, and it will be validated at the same time as the subsequent verification.

**Technical description of the monitoring task**

The baseline scenario will be monitored through the assessment of agents and drivers variables and satellite images to project expected deforestation. Information on agents, drivers and underlying causes of deforestation in the reference region will be collected at the end of each fixed baseline period, as these are essential for improving future deforestation projections and the design of the project activity. In addition, in the same frequency, the projected annual areas of baseline deforestation for the reference region will be revisited and eventually adjusted for the subsequent fixed baseline period.

The location of the projected baseline deforestation will be reassessed using the adjusted projections for annual areas of baseline deforestation and spatial data. All areas credited for avoided deforestation in past fixed baseline periods will be excluded from the revisited baseline projections as these areas cannot be credited again.

Baseline monitoring task will be done in accordance with the applied methodology, VM0015, version 1.1 or the most recent.

**Data to be collected**

Data will be collected to comply with the parameters used in the VM0015 v1.1, listed in Appendix 5, or the most recent.

**Overview of data collection procedures**

Data will be collected according to measurement methods and procedures described in section 5.1 and 5.2 above. All *ex ante* and *ex post* parameters will be reassessed at the moment of revision of the baseline.

**Quality control and quality assurance procedures**

QA/QC will be done according to best practices in remote sensing and as stated by VM0015 methodology.

**Data archiving**

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by the instance owner. Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the first monitoring period, as well as further monitoring reports in case it participates in the development of subsequent monitoring periods in the future.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VVBs at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

**Organization and responsibilities of the parties involved in all the above**

Future Carbon is responsible for the development of the Project Design Document and the first Monitoring Report. Therefore, it is responsible for the organization and calculation of items related to the methodology.

The instance owner is responsible for the development of the project activity, monitoring of the required parameters in section 5.2 above, and for the development of subsequent monitoring reports. In addition, it is also responsible for forest surveillance and generation of socioenvironmental activities to local communities.

Future Carbon and/or a related partner is responsible for all GIS related information.

- **Monitoring of actual carbon stock changes and GHG emissions within the project area**
    - **Monitoring of project implementation**

The instance owner is responsible for the implementation of the project activity. The monitoring of the sustainable management plan is carried out by the municipal and state secretariats.

Information from the sustainable forest management plan and post-exploratory reports will be used to update parameters related to planned deforestation and will be verified during the validation and verification of the carbon project.

**Updating Forest Carbon Stocks Estimates**

If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction, provided that these data are in accordance to the requirements established by the applied methodology VM0015. New data on carbon stocks will only be used if they are validated by an accredited VVB.

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

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

Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the subsequent baseline reports and monitoring periods.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VCS verifiers at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

Monitored data will be kept for two years after the end of the crediting period or the last issuance of carbon credits for this project activity, whichever occurs later. For this purpose, the authority for the registration, monitoring, measurement and reporting will be Future Carbon Ltda. Monitored parameters are described in Section 5.2 and will be monitored with the frequency described further below.

**Quality Assurance/Quality Control**

To ensure consistency and quality of results, spatial analysts carrying out the image processing, interpretation, and change detection procedures will strictly adhere to the steps detailed in the Methodology.

All of this reliable data, which will be collected and documented, will be used as a technical support tool for decision-making in order to improve project outcomes, and to adapt the project according to the current needs and realities. Project activities implemented within the project area must be consistent with the management plan of the PD.

The implementation of the project activity will be monitored by continuous monitoring activities using remote sensing techniques. Additionally, field studies will also be used. The land-use monitoring will be carried out with remote sensing methods, using images generated by Mapbiomas, INPE (PRODES)[126] and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

The management structure will also rely on the local community to help monitor the area. All the monitored parameters will be checked with the frequency detailed in the Section 5.2 above, as requested in the VCS Methodology VM0015, version 1.1.

With the carbon credits income, in order to complement the monitoring of the project area and its surroundings, the project proponent intends to improve the remote sensing methods and data used, which meet the accuracy assessment requirements laid out in the methodology.

**Procedures for handling internal auditing and non-conformities**

The procedures for handling internal auditing and non-conformities are going to be established by both project developer and project proponent. All the necessary taskforce and procedures will be in place to meet the highest levels of control.

A project information quality management system will be implemented, the main purpose of which is to minimize the risk of error, obtaining reliable data on which to base the monitoring results, and thus, minimizing non-conformities. It includes the training of general staff in the different roles to play within the framework of the Sepoti REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of Future Carbon.

[126] Available at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>

If non-conformities exist during the internal or external auditing processes, the data should be reviewed, and the non-conformities addressed.

- **Monitoring of land-use and land-cover change within the project area**

Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

The project boundary, as set out in the PD, will serve as the initial "forest cover benchmark map" against which changes in forest cover will be assessed over the interval of the monitoring period.

The entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event.

The increase or decrease in carbon stocks due to planned activities in the project area will also be monitored through documents and periodic assessment of classified satellite imagery covering the project area. In case of planned deforestation, emissions are estimated by multiplying the area of forest loss by the average forest carbon stock per unit area.

The results of monitoring shall be reported by creating *ex post* tables of activity data per stratum; per initial forest class *icl*; and per post-deforestation zone *z*, for the reference region, project area and leakage belt.

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

Other applied methodologies for monitoring of deforestation are listed below:

**Monitoring bases**

The instance owner is responsible for the implementation of monitoring bases, if necessary, to guarantee the standing forest and carbon stock.

**Satellite images and remote sensing monitoring**

The land use and land use cover change will be analyzed through remote sensing methods, using data from INPE (PRODES – deforestation; Queimadas – fire monitoring; TerraClass – qualification of Amazon deforestation), satellite images (LANDSAT, Sentinel, CBRES).

All reliable data collected and documented will be used as a technical support tool for decision making in order to improve project outcomes, and to adapt the project according to the current needs and reality. These decisions will be made during periodic meetings to review the Action Plan – that will be developed as part of the SocialCarbon Methodology. On these occasions, the design of the Monitoring Plan will be analyzed according to its efficiency in generating reliable feedback and all the necessary information. If any changes in the Monitoring Plan or management actions are identified, a corrective action will be designed and implemented.

Security procedures

The instance owner is responsible for the security procedures and reporting illegal activity to responsible authorities.

These actions are planned to avoid unplanned deforestation and carbon stock changes in the area. Related parameters shall be monitored and reassessed at every verification and revalidation point.

SOCIALCARBON Report will also monitor the relationship between the company and the communities, and its evolution on mitigating unplanned deforestation caused by these agents.

- Monitoring of carbon stock changes and non-CO2 emissions from fires

In addition to the mentioned above, the instance owner is responsible for training monitoring, management, safety and health personnel. This may include periodic fire brigade training, including first aid, fire procedures, training of new monitoring personnel and those responsible for management during harvests.

If forest fires occur, these non-CO2 emissions will be subject to monitoring and accounting, when significant.

- Monitoring of impacts of natural disturbances and other catastrophic events

The monitoring of natural impacts and other catastrophic events is responsibility of the instance owner. The company must notify Future Carbon so that it can include the related impacts in the carbon project reports, updating the related parameters, including the buffer report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

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

- **Monitoring of Leakage**

Monitoring of the leakage belt and leakage management area will be carried out as in the project area and reference region.

The most recent VCS guidelines on this subject matter shall be applied. Furthermore, as the leakage belt was determined using Option 1 (Opportunity cost analysis), the boundary of the leakage belt will have to be reassessed at the end of each fixed baseline period using the same methodological approaches used in the previous period. The calculation procedure for estimating leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

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

The carbon stock decrease or increase in GHG emissions due to leakage prevention measures, which will probably take place inside the leakage management area, will be monitored through documents and field assessment. In areas undergoing carbon stock enhancement, the project conservatively assumes stable stocks and no biomass monitoring is conducted.

**- Carbon stock decrease and increases in GHG emissions due to activity displacement leakage**

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

- **Organizational structure, responsibilities and competencies**

Monitoring will be done by the project proponent and outsourced to a third party having sufficient capacities to perform the monitoring tasks. To ensure the operation of the monitoring activities, the operational and managerial structure will be established according to the table below.

For all aspects of project monitoring, the project proponent will ensure that data collection, processing, analysis, management and archiving are conducted in accordance with the monitoring plan. The authority for the registration, monitoring, measurement and reporting will be Future Carbon.

**Table 56. Type of Monitoring and Party Responsible**

| Variables to be monitored | Responsible | Frequency |
|---|---|---|
| Reassessment of the baseline | Future Carbon and external institutions qualified for the GIS analysis and monitoring | Every 6 years |

| | | |
|---|---|---|
| Monitoring Deforestation and Project Emissions | Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring | Prior to each verification |
| Monitoring of non-$CO_2$ emissions from forest fires | Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring | Prior to each verification |
| Monitoring Leakage emissions | Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring | Prior to each verification |
| Monitoring of Natural Disturbance and catastrophic events | Instance owner and Future Carbon | When a natural event occurs |
| Updating Forest Carbon Stocks Estimates | Future Carbon | At least, every 10 years, only if necessary. |