Verified Carbon Standard

REFORESTATION OF LAND FOR MULTIPLE USES

Lacan
Ativos Reais

DOCUMENT PREPARED BY LACAN AND PLANTAR CARBON

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The grouped project “Reforestation of land for multiple uses” is a voluntary action to promote sustainable tree planting on non-forested lands in the Central-West region of Brazil, specifically in the states of Mato Grosso (MT), Mato Grosso do Sul (MS) and Goiás (GO). Its objective is to generate net removals of greenhouse gases through the conversion of traditional land uses in the region – e.g. non-forested/agricultural areas – into reforestation actions, based on the engagement of investors and independent rural producers. Also, the project proposes the restoration of non-forested lands with the purpose of enhancing carbon stocks of native vegetation, including protected areas such as Permanent Preservation Areas, Legal Reserves, and other lands, as applicable to each case (see section 1.11 for further details). This grouped project will apply the reforestation methodology already approved under the CDM, *AR-ACM0003 – Afforestation and reforestation of lands except wetlands*, version 02.0.

The Central-West region is the second largest of Brazil in territorial extension occupying almost 19% of the national territory and is characterized by extensive areas dedicated to agriculture and pasture, and low population density. Project Activity Instances (PAIs) implemented within the limits established to this grouped project will be subject to a similar baseline scenario, considering that the reforestation activities proposed will only be implemented in non-forested areas, with a history of anthropic intervention, especially due to agriculture/feedstock activities. The Central-West region is also characterized by late development and settlement making this region the second least populated in the country. With just over 16 million inhabitants, the area accounts for only approximately 8% of the Brazilian population. Its population is mainly located in urban areas[1]. Despite the territorial extension, the characteristics of the settlements and distribution of the population make the boundary of this grouped project a region of large stretches of land, occupied by extensive farms of agricultural/grazing activities, with similar socio-economical features and no significant distinctions between stakeholders’ characteristics.

Almost half of the entire areas of the states that form the project’s boundaries are used for cultivating agricultural crops and/or cattle grazing, while only 1% of the areas are being used for reforestation, making farming the predominant land use (see Section 3.5 below). At the same time, preservation areas have been overlooked and the productive frontier often surpassed their limits opening areas to implement productive activities regardless of the laws. Thus, this grouped project proposes a change in the traditional land use in this region, known as the main agricultural frontier in the country, rendering reforestation practices as a sustainable alternative.

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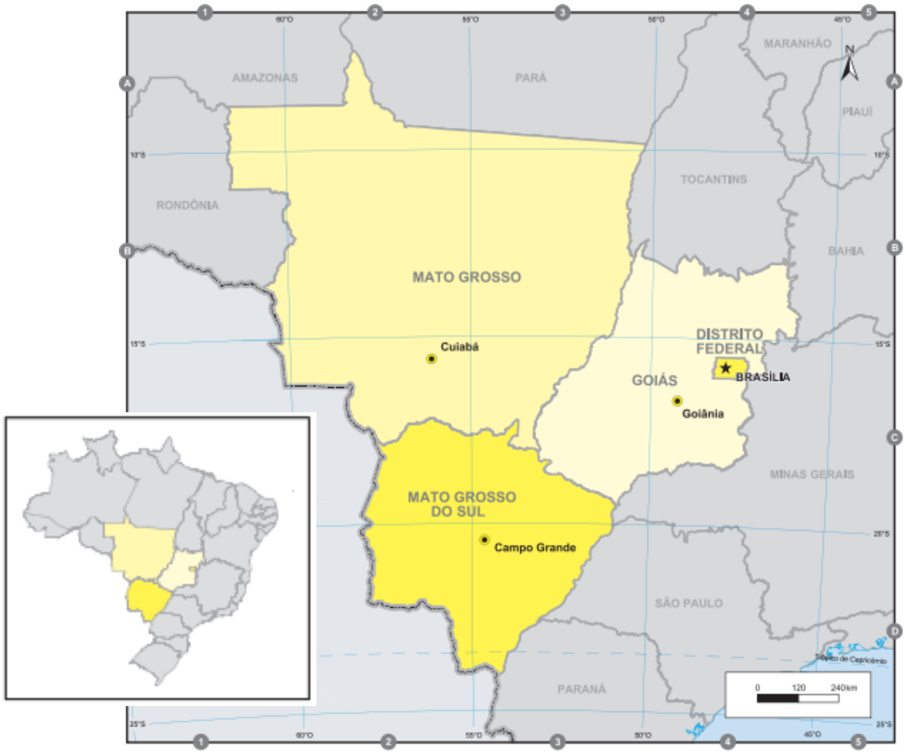
[1] See https://brasilescola.uol.com.br/brasil/regiao-centro-oeste.htm.

Figure 1: Map of geographic area for the Grouped Project showing the location of Mato Grosso, Mato Grosso do Sul and Goiás states, and its respective capital cities.



Source: adapted from IBGE (Brazilian Institute of Geography and Statistics)

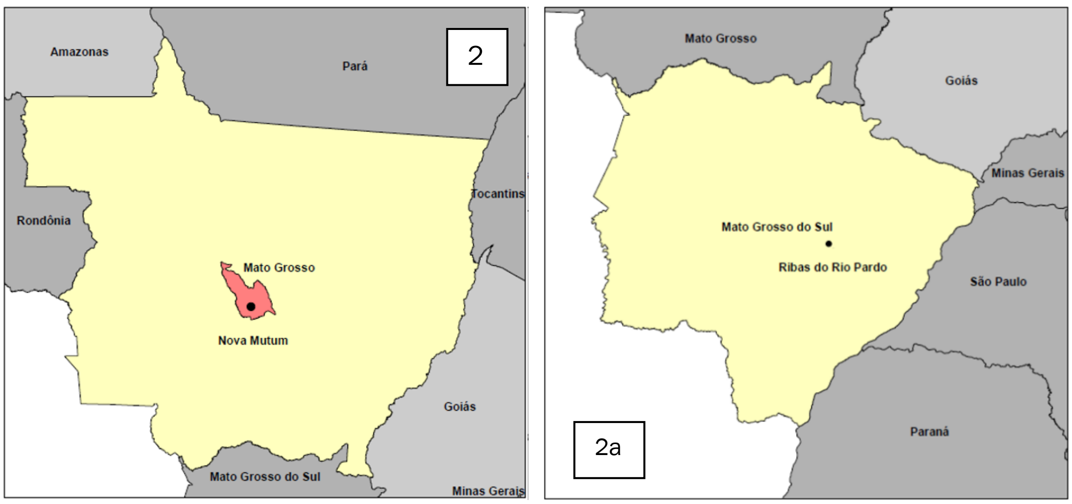
The <u>**first PAI**</u> refers to productive areas within Autometal Farm in Nova Mutum municipality, in the state of Mato Grosso, and aims to reforest **4,273.65 ha** of land previously used for cattle raising through the implementation of *Eucalyptus spp.* plantations, as timber species for commercial reforestation. The first plantings started on 15/01/2020 and are expected to remove approximately 475,913.11 tCO_2e.

In addition to reforestation for production purposes, other instances may also include reforestation with native species in areas that have been used for livestock and/or agriculture. This modality of reforestation project contributes to the restoration of the native vegetation through human induced actions, including management, enrichment, and planting of native species specific to the local phytophysiognomy.

The <u>**second PAI**</u> comprises **26 ha** of permanent preservation areas (APPs) within Boa Aguada I, Boa Aguada IV and Santo André farms, in the municipality of Ribas do Rio Pardo, Mato Grosso do Sul. These areas will be subject to reforestation activities using native species, to be selected from a list of available seedlings from local suppliers. The first interventions are scheduled for late 2023 and this component is expected to remove approximately 3,565.47 tCO_2e.

The overall purpose of this grouped project initiative is to develop an attractive reforestation system, stimulating the integration of reforestation activities for the purposes of production and restoration, which simultaneously provides environmental and social benefits to the region.

Figure 2: map of the project areas for commercial planting of eucalyptus (PAI 1 in Nova Mutum municipality, MT) and; Figure 2a: project areas for restoration (PAI 2 in Ribas do Rio Pardo municipality, MS). Source: Lacan.



Lacan Investimentos e Participações Ltda, hereinafter referred to as **LACAN**, will be the sole responsible for coordinating the implementation and maintenance of the reforestation activities. The forestry activities will be conducted by LACAN's own staff or outsourced staff, whereas LACAN will be responsible for the administration of the reforestation practices that will generate additional carbon stocks in the partners' rural properties, i.e. in each PAI. The PAIs will be implemented in areas from partners/ investors/ leasers (hereinafter, **Partners**). LACAN will enter into formal partnership agreements with Partners, ensuring it will have control of all records and information related to the implementation of the activities. Partners will be offered a share in the carbon credits, depending on the partnership modality agreed.

Besides the generation of additional carbon stocks, resulting in net GHG removals, this grouped project will contribute to the production of timber for various supply chains, e.g. for energy purposes, sawmills, pulp and paper etc. However, in this grouped project, any climate benefits associated with the reduction of emissions from the use of sustainable wood instead of fossil or non-renewable energy products or sources are not claimed.

In addition, the grouped project provides various environmental and social benefits, contributing to the sustainable development of the region, through measures such as those listed below. It is expected that the initiative can serve as a reference for the country:

- proactive engagement with neighboring communities;

- development of local commerce and service providers in the region;
- generation of income and direct and indirect jobs in rural areas;
- training and technical guidance;
- valorization of local culture and avoiding rural-urban migration;
- increase in forest stocks, indirectly helping to relieve pressure on native forests;
- protection and conservation of carbon stocks in remnant native forests;
- encouraging the restoration of conservation areas;
- increasing awareness of environmental preservation and conservation;
- shelter for wildlife.

This grouped project will also encourage forest certification practices for the areas of the PAIs, which have even more stringent criteria than Brazilian legislation.

1.2 Sectoral Scope and Project Type

This grouped project corresponds to sectoral scope 14 *AFOLU-Agriculture, Forestry and Other Land Use*, as an *Afforestation, Reforestation and Revegetation* (ARR). It aims to reforest non forested lands, which are expected to remain non forested in the absence of the project, either increasing vegetative cover through planting of commercial species, i.e. eucalyptus, and/or the human-assisted natural regeneration of woody vegetation, i.e. regional native species.

1.3 Project Eligibility

Following VCS provisions for AFOLU Afforestation, Reforestation and Revegetation (ARR), LACAN must evidence that the lands where the project activities will be carried out were not cleared of native ecosystems ten years prior to the implementation of each PAI. The eligibility demonstration shall consider vegetation on the land to be below the forest threshold values applicable by Brazil[2]:

- Areas larger than 1 ha;
- Expected tree height above 5 meters;
- Canopy cover greater than 30%.

It is expected that the young natural vegetation, existing in the areas at the beginning of the project, do not exceed the forest threshold values applicable by the Host Country.

All areas will be identified through georeferencing. Maps of land use, satellite images and/or documentation of the property may be used to facilitate the designation of the project areas, as well as to verify that they are in accordance with the criteria established. The PAIs will have their

[2] As per Brazilian Designated National Authority definition of forest. See https://cdm.unfccc.int/DNA/index.html.

limits defined using georeferencing methods. The geographical coordinates of the project boundaries will be collected, and from these the polygons of each project will be constructed in shape and/or KML files.

The project sites were first assessed through satellite images and maps to check broad suitability with eligibility requirements, and the GPS coordinates of the boundary (geographical boundary) were established. Then further analysis was made and photos from drones were taken to establish land use conditions.

PAI 1

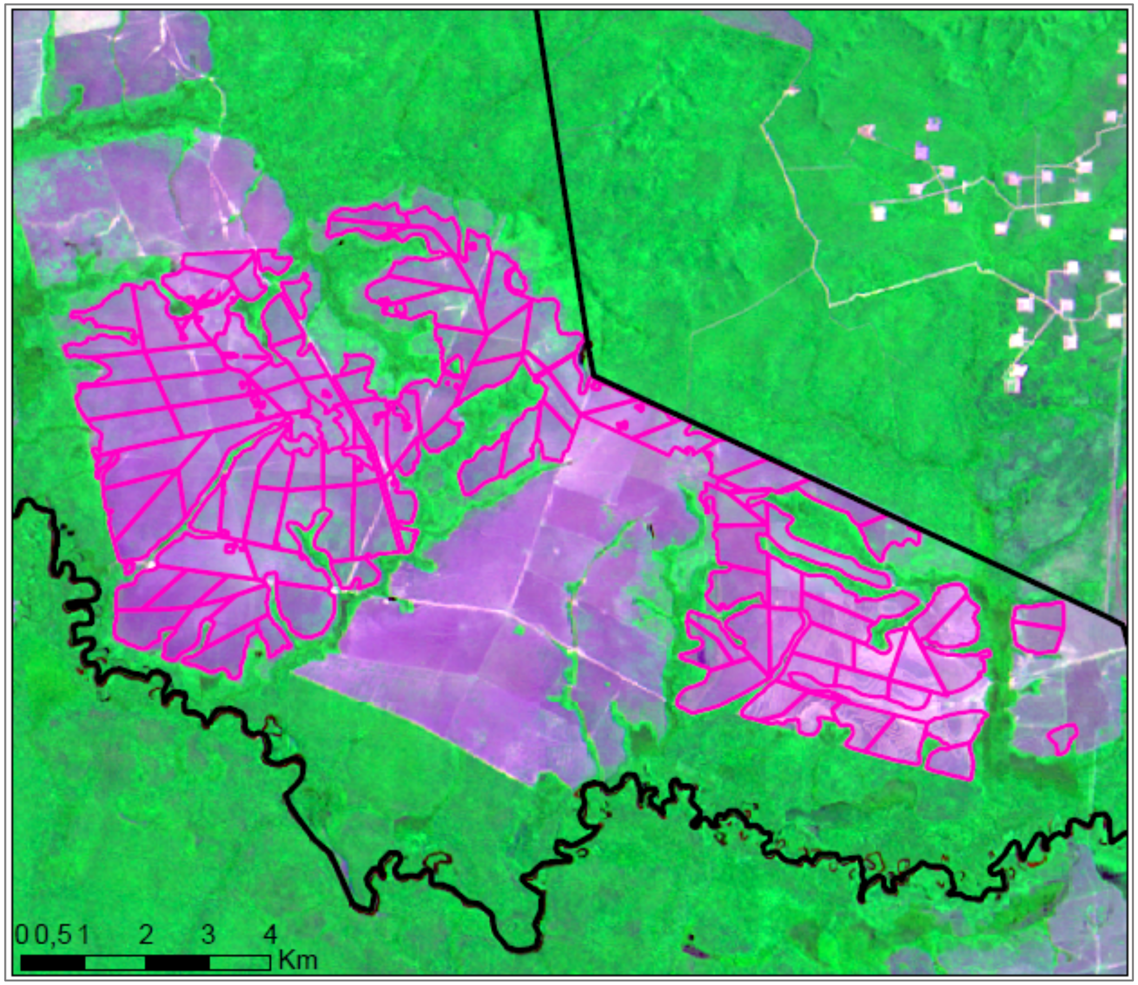
Autometal farm, Nova Mutum, Mato Grosso, Brazil

Total area eligible for the project: 4,273.65 ha

Commercial reforestation: *Eucalyptus.spp*

The figures below show the project area for commercial reforestation in 2009 and 2019, evidencing that the proposed instance areas in Autometal farm were non-forested land in both periods of time. The analysis applied the methodology proposed by MATTOS, 1990 Visual analysis of vegetation cover in Landsat-TM satellite images ("*Análise visual da cobertura vegetal, em imagens do satélite Landsat-TM*", in Portuguese) to classify images obtained by Satellite Landsat-TM (Thematic Mapper (TM) sensor of 30m resolution). The classification proposed was carried out by the authors from interpretation of photos, correlation of information, field visits, and data analysis. The eligibility analysis for the project area was conducted by first assessing the project sites through satellite images and maps to check broad suitability with eligibility requirements. Then, the GPS coordinates of the boundary (geographical boundary) were established.

Figure 3: satellite image INPE, 2009 to show non-forested land in the project's area 10 year prior to project implementation in Autometal farm in **2009.** Source: Lacan.



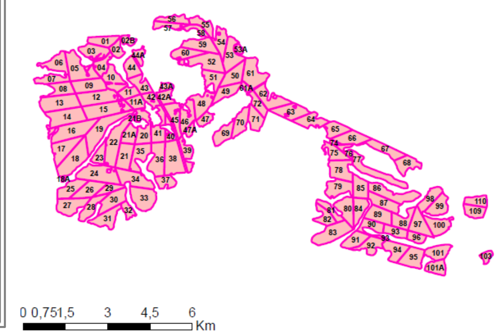
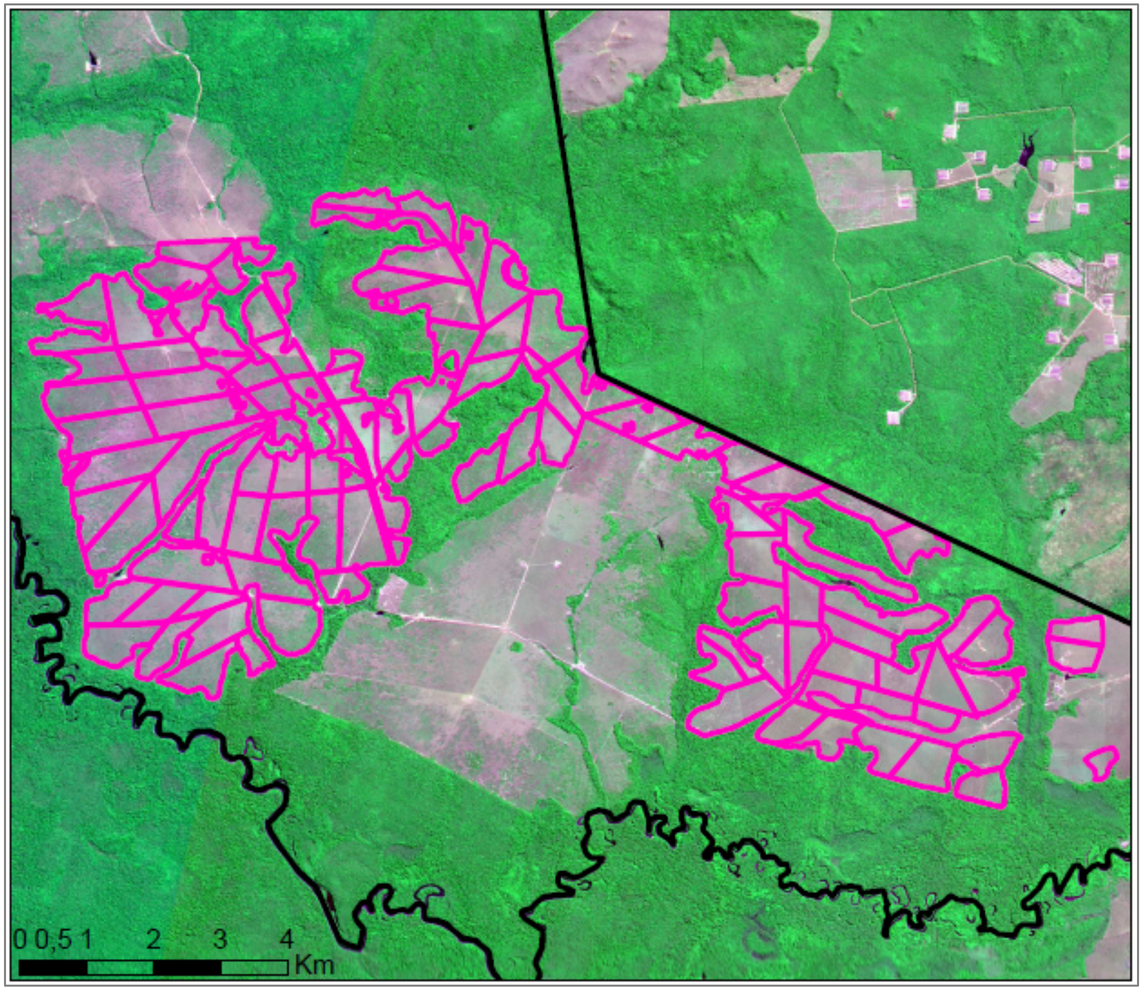


Figure 4: Detailed image from satellite CBERS 4, July/**2019** (source: INPE, 2019) to show non-forested land in the project's area prior to project implementation in Autometal farm. Source: Lacan.



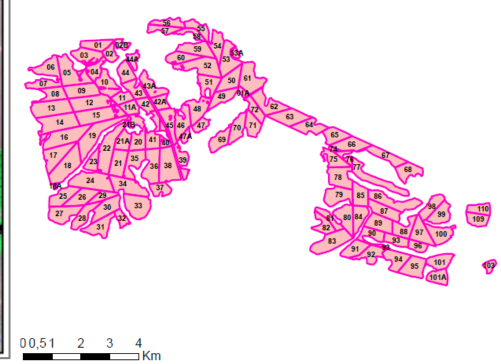


Figure 5: Satellite image from the project's areas in Autometal farm in 2019, prior to project implementation. Source: Lacan.

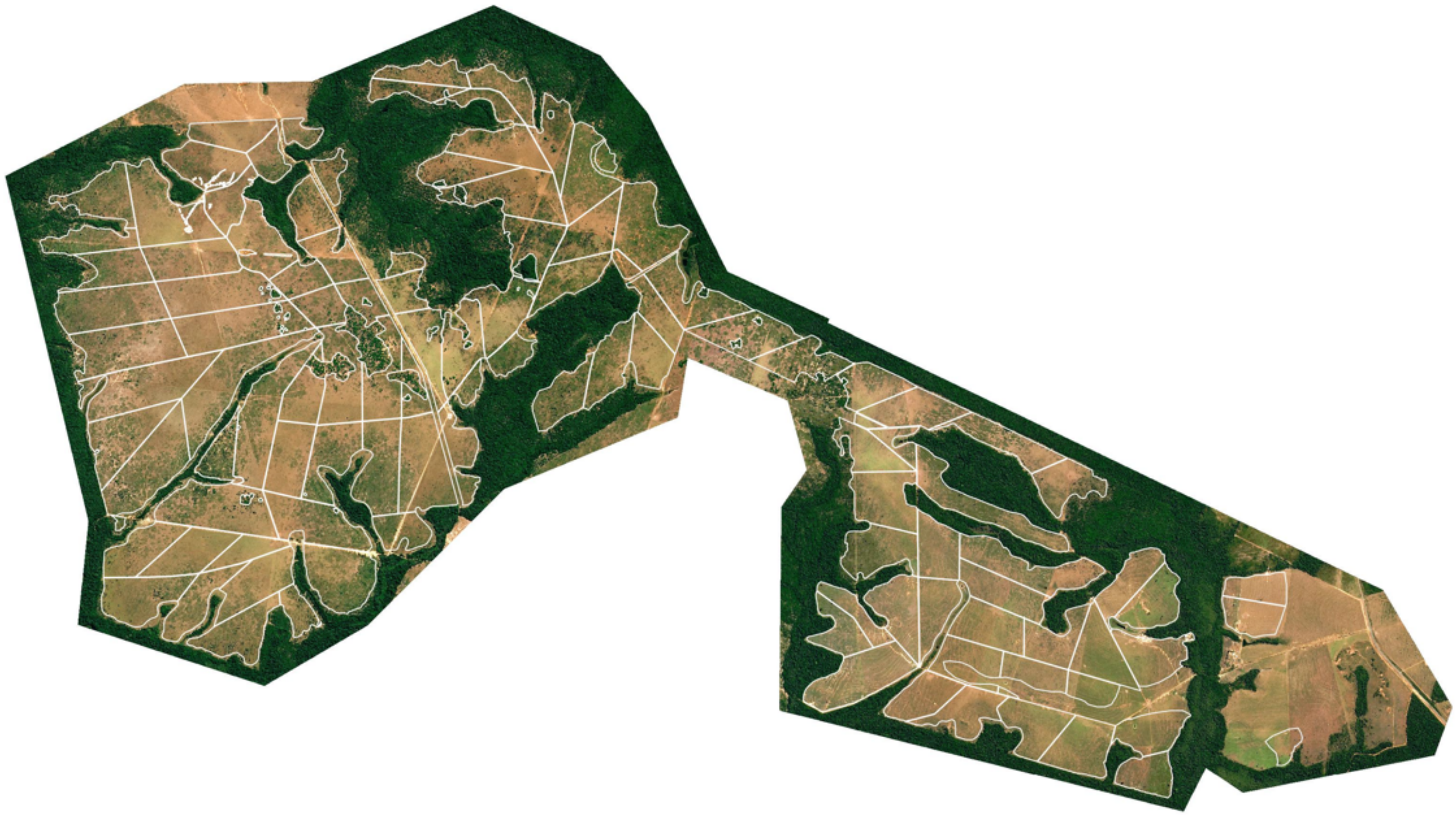


Figure 6: overall situation of the land prior to project implementation. Autometal farm, MT, in 2020. Source: Lacan.

PAI 2

Boa Aguada I, Boa Aguada IV and Santo André farms, Ribas do Rio Pardo municipality, Mato Grosso do Sul, Brazil.

Total area eligible for the project: 3 polygons, 26 hectares.

Restoration: multiple native tree species from Cerrado phytophysiognomy.

Description of images:

a) Satellite: Kompsat 2[3] PSM mode 1 m resolution, scale 1:5.000, true-color and false-color for comparison;

b) Orthorectified image, UTM/Sirgas 2000, GEOTIF 3 or 4 bands.

→ True-color enables for visual interpretation of the vegetation/ land use in the area with high quality.

The classification proposed was carried out by interpretation of photos, correlation of information, field visits, and data analysis. The eligibility analysis for the project area was conducted by first assessing the project sites through satellite images and maps to check broad suitability with eligibility requirements. Then, the GPS coordinates of the boundary (geographical

[3] See https://eos.com/find-satellite/kompsat-2/.

boundary) were established. The figures below show the project area for restoration reforestation in 2012 and 2022, evidencing that the proposed instance areas were non-forested land in both periods of time.

Figure 7: overall satellite Kompsat 2 (Sept/**2012**) and CBERS 4A (Apr/**2022**) images showing land use in (a) Boa Aguada I, (b) Boa Aguada IV and (c) Santo André farms prior to project implementation (the project's areas are coloured in green). Source: Lacan.

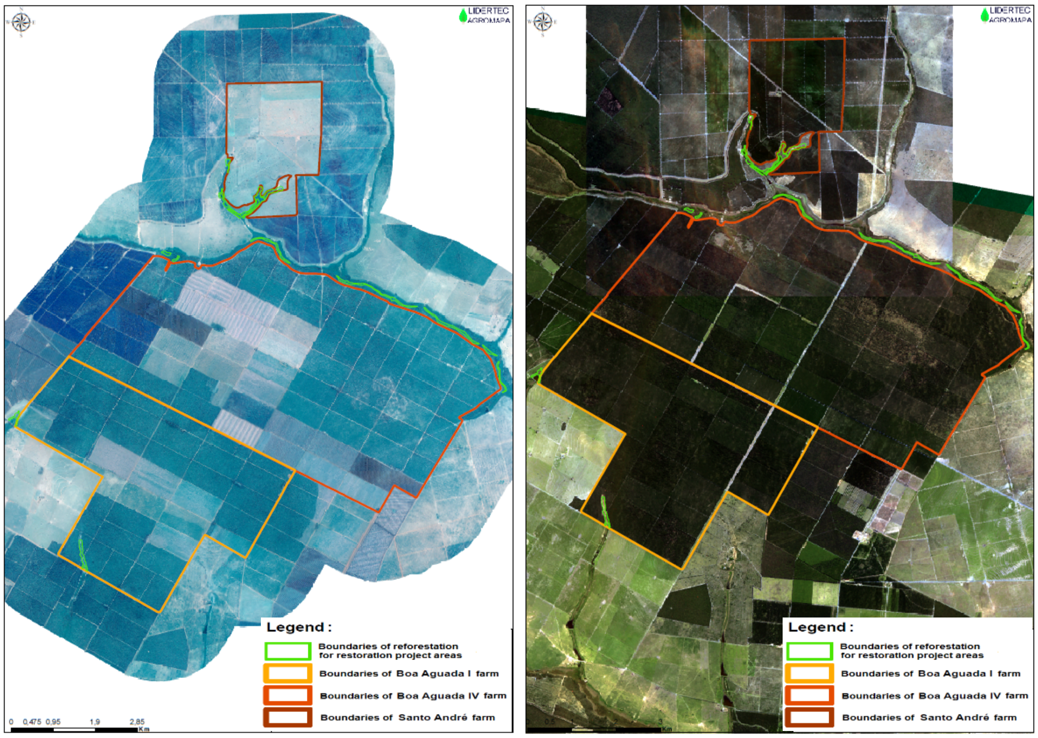


Figure 8: satellite Kompsat 2 (Sept/**2012**) image showing the project's areas in detail (yellow boxes) in (a) Boa Aguada I farm. Source: Lacan.

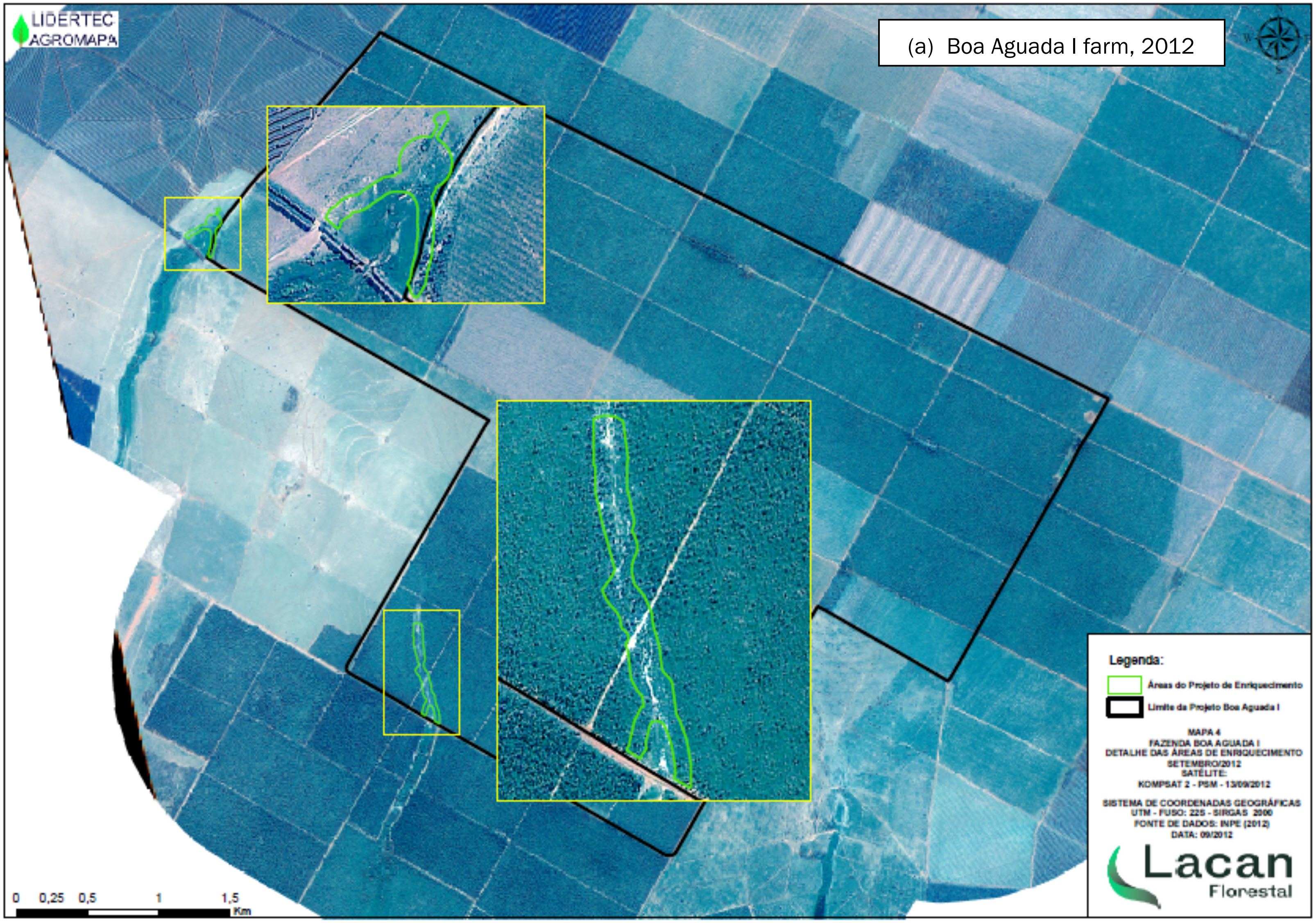


Figure 9: satellite Kompsat 2 (Sept/**2012**) image showing the project's areas in detail (yellow boxes) in (b) Boa Aguada IV farm. Source: Lacan.

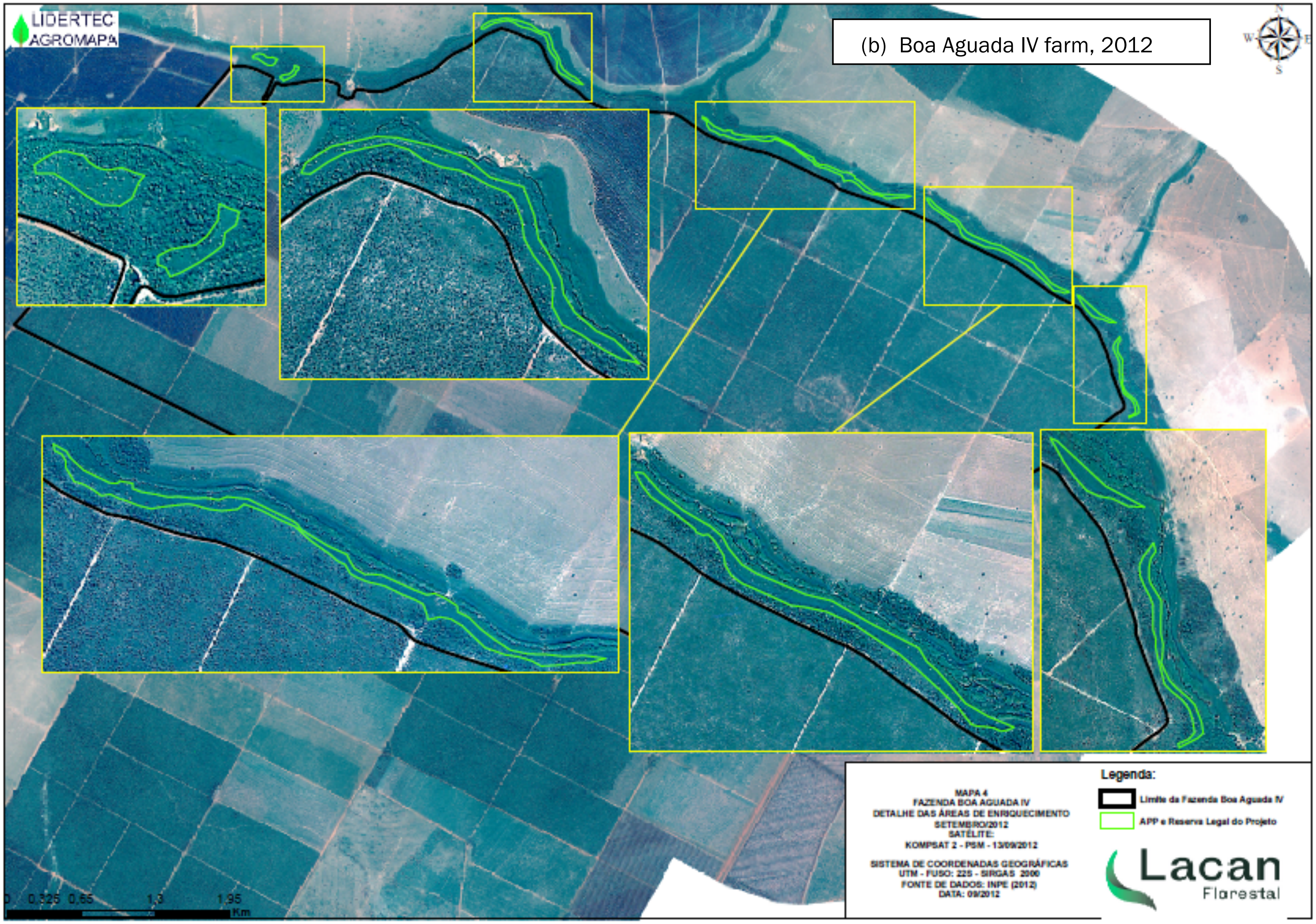


Figure 10: satellite Kompsat 2 (Sept/**2012**) image showing the project's areas in detail (yellow boxes) in (c) Santo André farm. Source: Lacan.

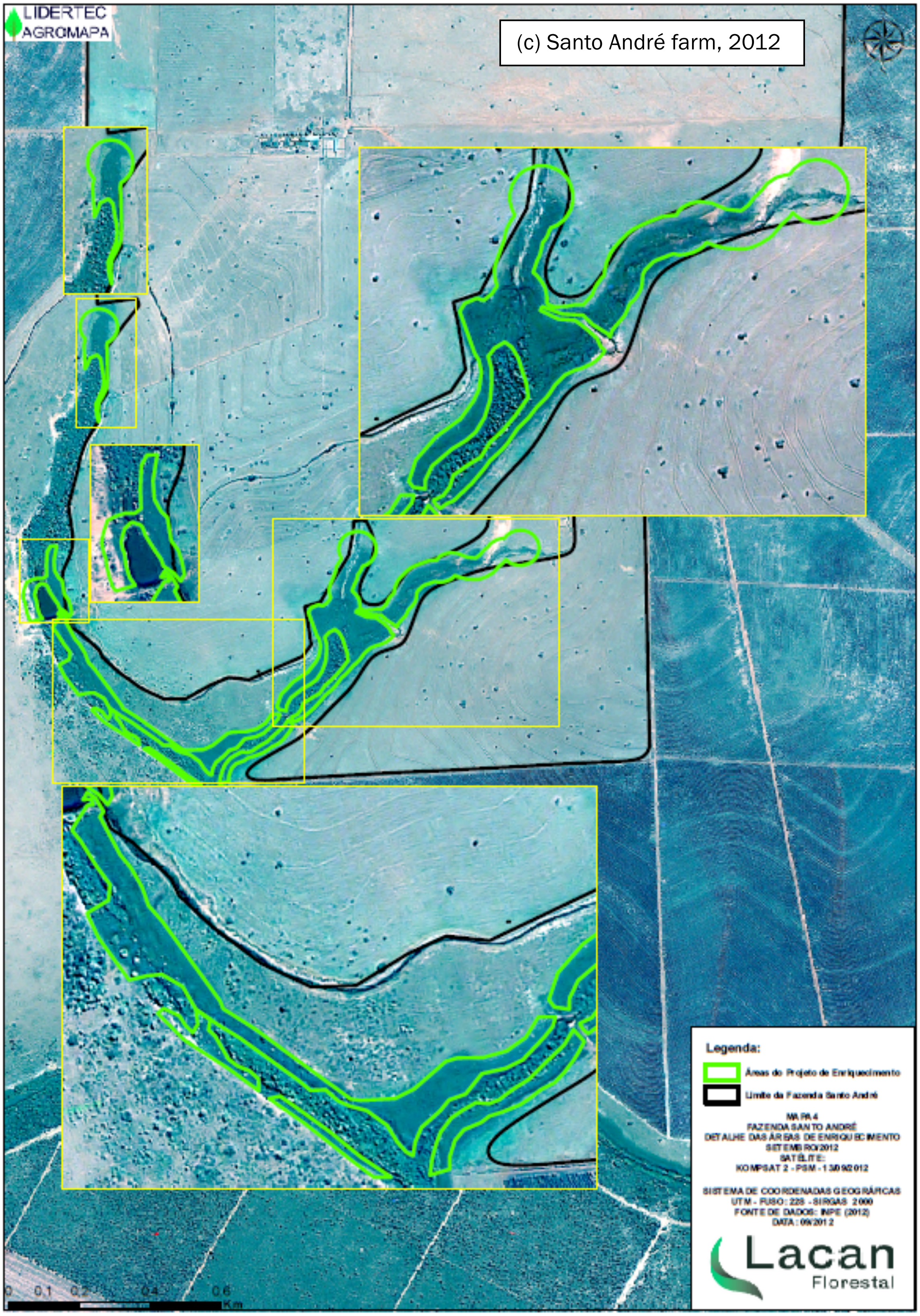


Figure 11: Detailed image from satellite CBERS 4, April/2022 (source: INPE, 2022) of the project's area prior to project implementation in (a) Boa Aguada I farm. Source: Lacan.

Figure 12: Detailed image from satellite CBERS 4, April/2022 (source: INPE, 2022) from the various fragments of the project's area prior to project implementation in (b) Boa Aguada IV farm. Source: Lacan.

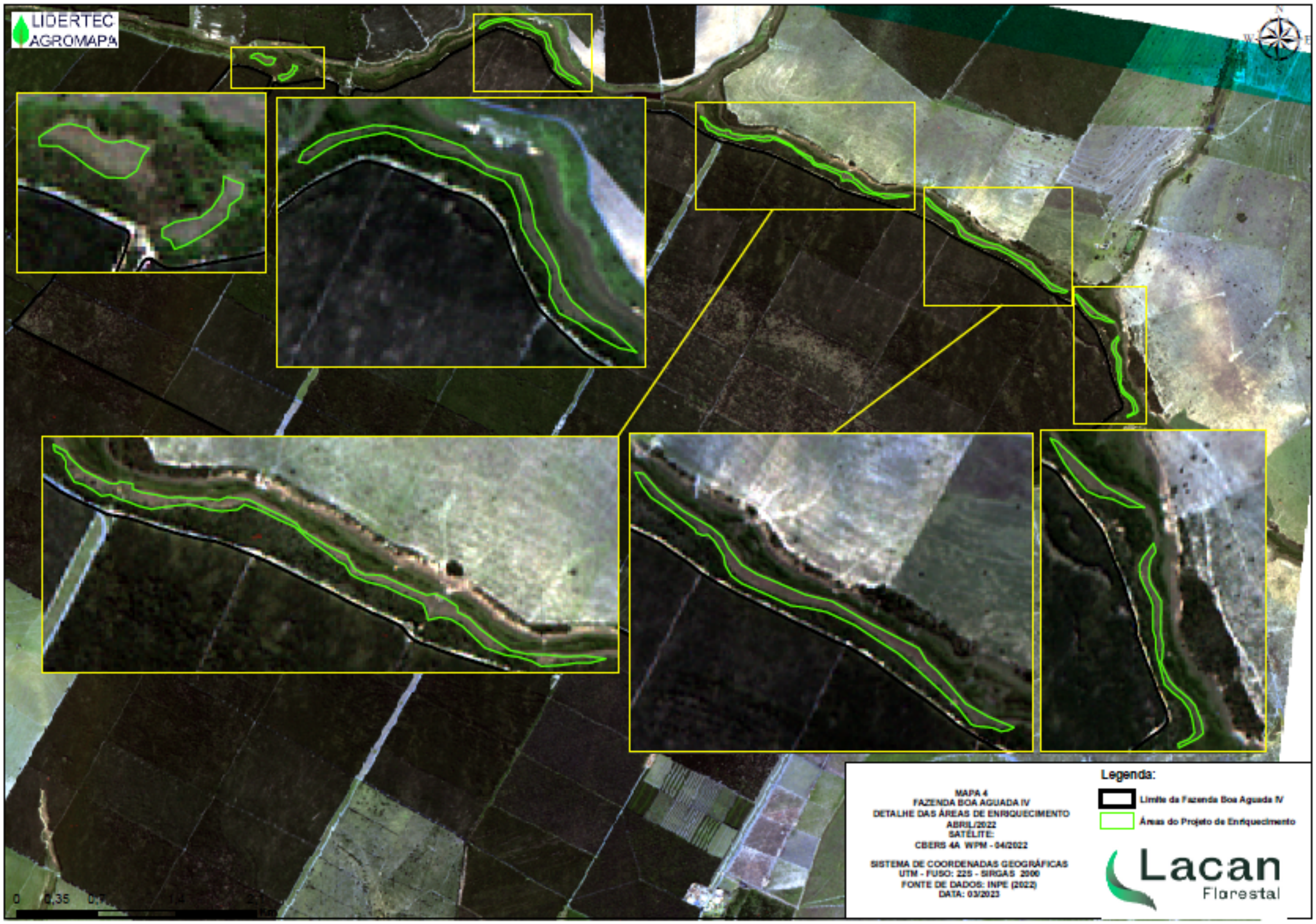
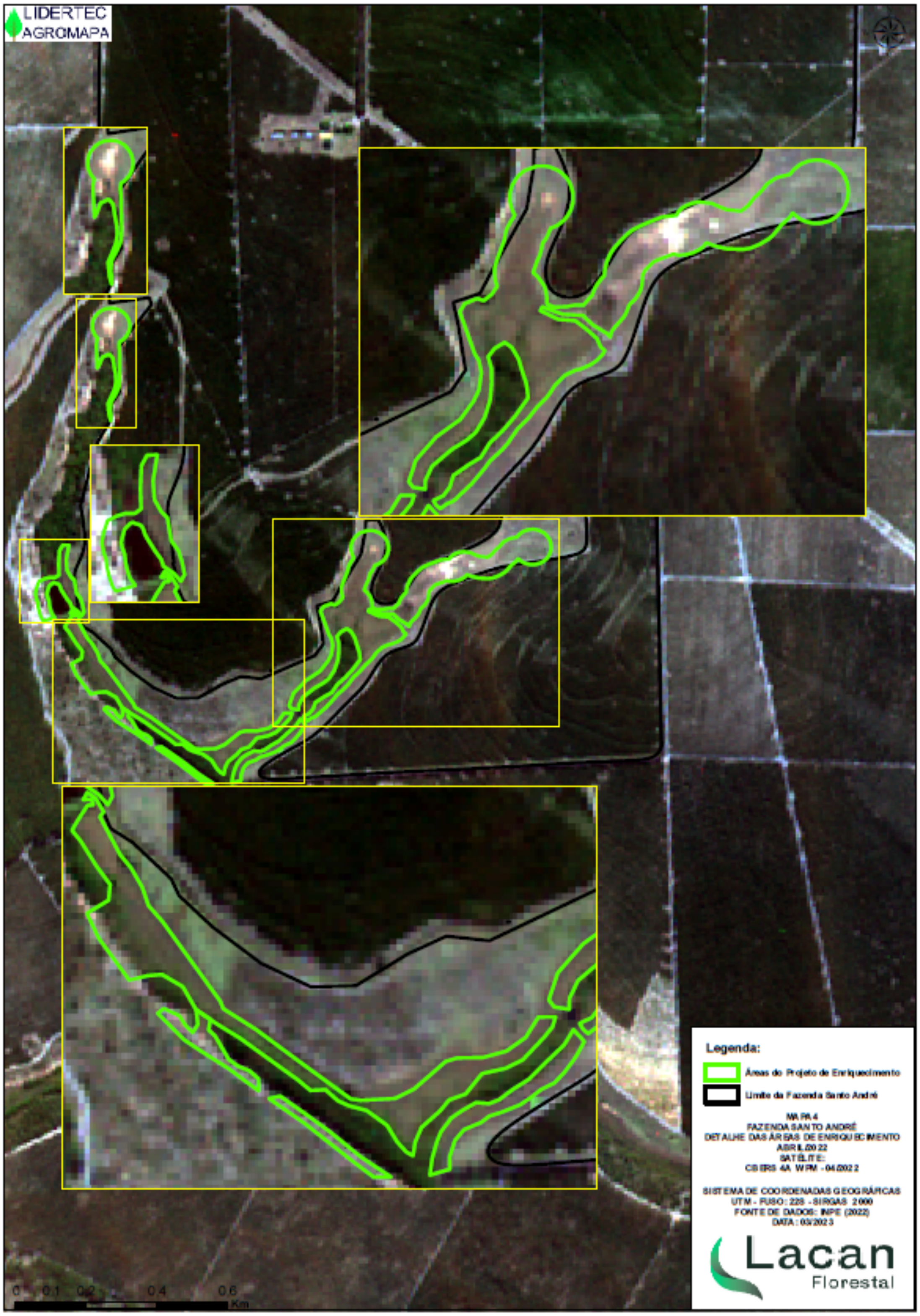


Figure 13: Detailed image from satellite CBERS 4, April/2022 (source: INPE, 2022) from the various fragments of the project's area prior to project implementation in (b) Boa Aguada IV farm. Source: Lacan.



Hence, the eligibility analysis of the PAIs areas is:

The project area shall not be cleared of native ecosystems within the 10-year period prior to the project start date: images capture the status of the land coverage in the property as already converted to productive area. As can be seen from the analysis and maps, the PAIs lands in 2009 did not contain native ecosystems nor forest as per Brazil's definition. This is also true for 2019.

The lands of PAIs 1 and 2, at the start of the project, consist of non-forested lands/pasturelands (as per the analysis). Data from field surveys in PAI 1 in 2019 show the presence of erosion, grooves, and exposed soil in some areas. The areas are not expected to reach or exceed the forest threshold values applicable to the host Party in the area as, considering the historic land use this farm is a consolidated productive area, and one can clearly conclude that the land is not part of forest area that is temporarily unstocked as a result of human intervention (e.g. harvesting) or natural causes, and the land is not expected to revert to forest.

As can be concluded from the analysis, the land under PAIs 1 and 2 meet criteria listed above for land eligibility and hence is eligible to be included under this grouped project.

1.4 Project Design

This VCS Project Description is designed as a grouped project.

Eligibility Criteria

The criteria for including a Project Activity Instance (PAI) into this grouped project are:

Eligibility criteria	Criteria assessment
Meet the applicability conditions set out in the methodology applied to the project.	Each PAI must ensure compliance with the methodology's applicability conditions, as per section 3.2.
Use the technologies or measures specified in the project description and apply the technologies or measures in the same manner as specified in the project description.	Each PAI must confirm the use and application of the specified technologies or measures presented in section 1.11, e.g. through the Management Plan for the area, informing on land regularization, location of preservation areas and any environmental certification (e.g. FSC).
Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	Each PAI must be subject to the baseline scenario determined in section 3.4 for the specified project activity and geographic area. The baseline scenario is determined for the Central-West region of Brazil, which is this grouped project's boundary, that is, where the PAIs will be implemented.

	The boundary of this project was defined as to represent similar land use and socio-economic characteristics.
Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area.	Each PAI must demonstrate additionality by applying the steps as per section 3.5 (under development).
The proposed PAI must be located within the limits of the states of Mato Grosso (MT), Mato Grosso do Sul (MS) or Goiás (GO), as per table 1 in section 1.12.	Project areas must be clearly demarcated and georeferenced.
Each PAI must prove the eligibility of the areas where the project will be implemented.	The proposed PAI must evidence eligibility of areas according to the provisions of section 1.3.
In the case of reforestation for restauration, land use cover at the start date of the project activity must be characterized as non-forested land, including sparse regeneration.	The proposed PAI must evidence eligibility of areas according to the provisions of section 1.3.

1.5 Project Proponent

Organization name	Lacan Investimentos e Participações Ltda
Contact person	Mr. Alexandre Bomfim and/or Mr. Guilherme Ferreira
Title	Project Proponent (PP)
Address	Av. Brigadeiro Faria Lima, 2179 – Conj 61 – Jardins – São Paulo/SP CEP: 01451-000 - Brazil
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1.6 Other Entities Involved in the Project

There are no other entities involved in this grouped project.

1.7 Ownership

LACAN is the Project Proponent, and the landowners are the Partners.

LACAN will demonstrate its legal right to control and operate the grouped project's activities through the formal partnership/lease agreements signed between LACAN and the partners.

1.8 Project Start Date

The grouped project "*Reforestation of land for multiple uses*" start date is 15/01/2020, which is the date of the first planting in Autometal Farm.

1.9 Project Crediting Period

The project crediting period is from 15/01/2020 to 14/01/2051, that is, 31 years. The grouped project may be renewed at most four times totalizing 100 years. Hence, this grouped project could continue until 14/01/2120.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Considered this is an ARR project with rotational activities that fits the harvesting activity definition, the long-term average (LTA) shall be applied, according to VCS Standard v4.4. Therefore, the project LTA was calculated as per the formula item 3.2.25 of the Standard.

The buffer discount of 17.75% has been added to the total estimated ERs, according to the "AFOLU Non-permanence Risk Tool".

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2020	104,682.49
2021	247,013.99
2022	389,345.50

2023	531,840.98
2024	674,336.45
2025	816,831.93
2026	331,232.49
2027	247,833.86
2028	390,329.34
2029	532,824.82
2030	675,320.29
2031	817,815.77
2032	332,216.33
2033	248,817.70
2034	391,313.18
2035	533,808.66
2036	676,304.13
2037	818,799.61
2038	333,200.17
2039	249,801.54
2040	392,297.02
2041	534,792.50
2042	677,287.97
2043	819,638.55
2044	333,894.19
2045	250,350.66
2046	392,701.23
2047	535,051.80
2048	677,402.37
2049	819,752.95

2050	334,008.59
2051	250,465.06
2052	392,815.63
2053	535,166.20
2054	677,516.77
2055	819,867.35
2056	334,122.99
2057	250,579.46
Total estimated ERs	**394,371.13**
Total number of crediting years	**38**
Average annual ERs	**10,378.19**

Note: This ex ante corresponds to the Long Term Average GHG benefit by eucalyptus forest + the maximum stock of carbon contribued by the native forest at project scenario, with buffer discount of 17.75%, and baseline discount.

1.11 Description of the Project Activity

The purpose of this grouped project is to implement reforestation for multiple uses, including restoration, in the Central-West region of Brazil (states of Goiás, Mato Grosso and Mato Grosso do Sul), where the areas have been traditionally dedicated to agricultural crops or pasture.

The proposed reforestation activities will achieve GHG removals through tree growth: carbon will be removed from the atmosphere through the growth of trees and stored in aboveground and belowground biomass of these living trees. According to the applied methodology AR-ACM0003, emissions attributable to the project activity due to implementation activities, including emissions related to burning of fossil fuels for transportation and machinery, and nitrogen emissions from the use of fertilizers, shall be considered insignificant and therefore accounted as zero in the calculation of net removals.

LACAN is fully responsible for the grouped project “Reforestation of land for multiple uses” and for developing it in partnership with rural landowners. The company will also be responsible for managing the reforestation practices of each PAI.

This grouped project is not located within areas covered by a jurisdictional REDD+ program. According to VERRA’s website, the only JNR project in Brazil is located in Acre, a state in

Northwestern Brazil (JNR *Project 2264 - Jurisdictional Subnational Program for Incentives for Environmental Services of Carbon of the State of ACRE, Brazil – ACRE ISA-Carbon Program)*[4].

REFORESTATION FOR PRODUCTION PURPOSES

The technologies and measures to be implemented in each step of the project activity for production reforestation are detailed below.

Planting species: planting will be carried out with clones of genus *Eucalyptus spp*., including species such as hybrid 'Urograndis' (*Eucalyptus urophyla* X *E. grandis*) and hybrid 'Urocam' (*Eucalyptus urophyla* X *Eucalyptus camaldulensis*).

Clearing the area: this consists of removing obstacles in the area to ensure good quality in subsequent operations. It includes the removal of undergrowth, controlling leaf-cutting ants and weeds, and the construction and maintenance of roads and firebreaks. It requires mechanization, carried out with a bulldozer, excavator, loader and agricultural tractors. LACAN does not and will not use fire as a clearing technique.

Soil preparation: this aims to make the area ready for planting. The planting lines will be demarcated through subsoiling, which may or may not include fertilization, depending on soil conditions. Activities can be mechanized, using tractors, or semi-mechanized. LACAN will adopt minimal cultivation, i.e. only turning the soil on the planting line, resulting in a very low impact on the level of soil cover.

The planting spacing will vary from approximately 3.4 X 2.0 (around 1470 trees/ha) to 3.4 X 2.7 (around 1090 trees/ha) and is defined to ensure the best use of each PAI land.

Planting and regrowth:

→ *Planting or implantation* means when new seedlings are planted. During implantation, seedling and planting will be done in a semi-mechanized or mechanized way. Watering ("*molhamento*") may be applied, which means 2.5 to 3l of water per seedling when planting. The seedlings will be clonal seedlings purchased in the market. To ensure a high survival rate and quality of planting, the seedlings will be acquired from reliable locations, with high phytosanitary and quality control and the species will be selected according to the final destination of the wood and its adaptability to the PAI's region. The survival rate is expected to be around 95%.

Replanting: consists of replacement of dead seedlings; it will be carried out by the end of the first month after planting. It usually means less than 1%.

Tillage and planting activities can be carried out at any time of the year to be determined by LACAN.

[4] Searched at https://registry.verra.org/app/search/JNR/All%20Projects.

→ *Regrowth*: after harvesting, the growth of sprouts is conducted in the stumps of the harvested trees; the main sprout is selected, and the others are eliminated.

Maintenance: the period from post-planting to the penultimate year. It involves combating leaf-cutting ants, controlling weed, pests and diseases in plantings, in addition to monitoring nutritional levels until the third year of planting. It aims to reduce the mortality of plantations and ensure productivity. It also encompasses the construction and maintenance of roads and fire breaks, as well as the forest fire prevention and control plan.

i) Ant control: it begins before planting and is planned annually. Ant control is performed in a localized and systematic way by means of ant killer. In addition, periodic monitoring of the forest is carried out to identify any infestation for early combat.

ii) Weed control: it begins before planting during the clearing the area stage and is carried out annually in the planting line using herbicides for the first three years, when normally the canopy closure occurs, and the operation is no longer necessary. In addition, periodic monitoring of the forest will be carried out to identify any infestation for early combat.

iii) Fertilization: four fertilization actions are planned at 0, 3, 6 and 12 months-of-age after planting, throughout each rotation, to enhance production. In addition, periodic monitoring of the forest will be carried out to identify some deficiency for early correction.

All operations comply with safety and quality standards required by applicable legislation of forest certification.

LACAN may conduct two rotations in each production cycle, where the average cutting age of plantations is six years and coppice is also six years (in both rotations the harvest occurs between 5.5 and 7.5 years-of-age,). In general, the company that buys the wood is responsible for the harvesting. However, it transports only the stems, leaving branches, leaves, and roots in the area to protect the soil from erosive processes and compaction and allowing the cycling of nutrients. LACAN does not remove the roots from the soil.

Figure 14: Autometal farm after implementation of the project activity, 2020.

Source: LACAN

REFORESTATION FOR RESTORATION PURPOSES

Historically, the pre-project activities established in the project's region frequently used as much of the property's areas as possible, which yield financial gains to the producer, despite applicable laws. In 2012, the new Brazilian Forestry Code was approved, which establishes guidelines for the protection and restoration of Permanent Preservation Areas (APPs) and Legal Reserve areas. According to the Code, the natural regeneration of the areas, for example, allows the owner to only limit the area to be protected, with no further substantive interventions. After the implementation of the Code, some producers started regulating their lands by moving their productive activities out of the preservation areas but did not take any human induced active measures for their restoration. The prevailing situation is that the former cultivation of pasture infested the area with exotic grass species (*Bracchiaria spp.*) that is characterized by a thick layer of grass and intertwined roots that covers the soil and obstruct it so that native seeds cannot reach the soil to absorb water, germinate, and flourish. Therefore, the restoration options allowed by the legislation do not guarantee celerity, or even effectiveness, in the process of establishing native forests.

There are still many challenges to be faced, among them, that of finding efficient and economically viable mechanisms for the control of exotic grasses, suppressing the use of agrochemicals and being able to favor a network of seeds so that there can be genetic variability in planting, as well as having seed availability all year round and effective public policies.

This proposed project activity aims to actively promote the restoration of native vegetation areas, including preservation areas, by different actions that will speed up the regeneration process and contribute to the diversity of forest species. It will consider different pre-project land use situations to assess and plan the project activities to be implemented for restoration, such as areas, either APPs or legal reserves, which are not yet established or that are in poor conditions, as well as productive areas. To accomplish the grouped project's purposes a range of human induced activities will be implemented in order to enable restoration, including (CASA DA FLORESTA, 2021):

(a) Planting: consisting in cleaning of area, tilling, planting, irrigation, and maintenance activities;

(b) Direct sowing: consisting in cleaning of area, tilling and sowing, especially in the wet season; and

(c) Assisted regeneration.

The main aspects to be considered when assessing a course of action for a given area are the cost for implementation and monitoring, and the access to nurseries that offers satisfactory seedlings.

The PAI 2 comprises APPs in poor condition, and the planned intervention for the areas may include the steps listed below, which characterizes as intervention (a) above:

Planning: Mapping, demarcation and protection of the area. Identification of local phytophysiognomy for selection appropriate seedlings and/or seeds.

Soil preparation and 1st fertilization;

Planting: where planting is performed, proper spacing will be observed in order to ensure adequate survival rates above 80/90%, e.g. spacing of approximately 3 meters X 2 meters (around 1,600 trees/ha). the native species will be defined depending on the availability of seedlings at the time of planting, i.e. the availability of seeds to produce the seedlings, dormancy stage of seeds, etc.

It is planned the sowing of some species of the *Leguminosae* family (e.g. *Crotalaria ochroleuca*, *Cajanus cajan*, other) and/or *Raphanus* genus (e.g. *Raphanus sativus L.*). The purpose is to accelerate soil cover, which hinders the recolonization of exotic grasses and favors the germination of new unplanted individuals.

Replanting: consists of replacement of dead seedlings.

Weeding: mostly carried out manually, especially in preservation areas.

2nd Fertilization: if necessary.

Monitoring: visual monitoring aiming the identification of any disturbance, e.g. insect infestations, diseases and/or other disturbing factors. The survival rate, development and new individuals will be monitored.

For the selection of eligible species, the identification of floristic composition in forest remnants of different stages of succession around the project areas was conducted. The following criteria were considered:

- Group/ecological function (filling or diversity):
    - Filling: fast growing species of quick crown formation; this component aims to create partial and gradual shading conditions, reducing grass dominance and favoring the growth of diversity individuals as well as the emergence of new species.
    - Diversity species are those that will contribute to genetic variability, supply of different types of fruits and diversity in vertical structure; genetic maintenance and perpetuity of the forest population.
- Succession group (Pioneer or secondary): Heliophyte species tolerant to full sunlight environment;
- Type of fruit (dry or fleshy).

The production of seedlings will be directed so that they are equally divided between filling and diversity species.

Figure 15: some of PAI 2's areas prior to the implementation of the project activity, 2023.

1.12 Project Location

The geographical area within which this grouped project will be implemented is defined as the borders of the states of Mato Grosso (MT), Mato Grosso do Sul (MS) and Goiás (GO), in the Central-West region of Brazil (refer to Figure 1 for a map of this grouped project's boundaries).

Table 1: Geographic information of the grouped project boundaries.

BRAZILIAN STATE	LATITUDE	LONGITUDE
Mato Grosso	12° 40' 45.142" S	56° 56' 22.816" W
Mato Grosso do Sul	20° 46' 20.028" S	54° 47' 06.551" W
Goiás	15° 49' 37.333" S	49° 50' 10.406" W

All areas will be identified through georeferencing. Maps of land use, satellite images and/or documentation of the property may be used to facilitate the designation of the project areas, as well as to verify that they are in accordance with the criteria established by the methodological tool.

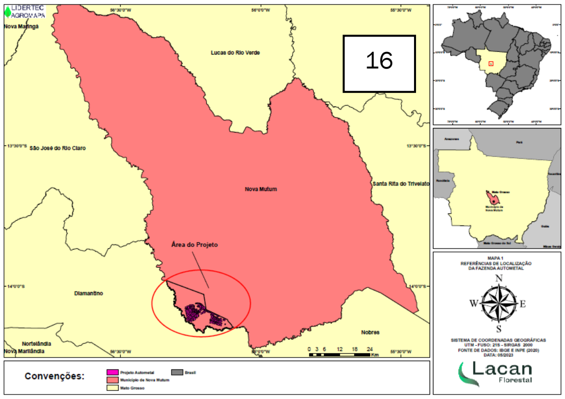
The geographical coordinates of the project boundaries will be collected, and from these the polygons of each project will be constructed in shape and/or KML files.

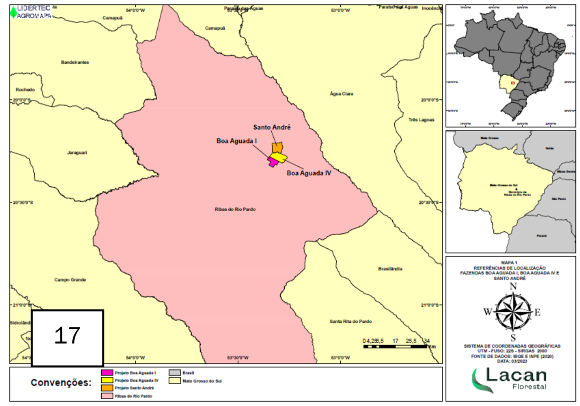
Table 2: Geographic information of the instances.

<table>
<tr><th>INSTANCE</th><th>LATITUDE</th><th>LONGITUDE</th></tr>
<tr><td>Autometal farm</td><td>14° 7'32.79"S</td><td>56° 9'44.03"O</td></tr>
<tr><td>Boa Aguada I farm</td><td rowspan="3">20°16'37.49"S</td><td rowspan="3">53°19'0.47"O</td></tr>
<tr><td>Boa Aguada IV farm</td></tr>
<tr><td>Santo André farm</td></tr>
</table>

Figure 16: location of Autometal farm, in Nova Mutum municipality, Mato Grosso[5]. Figure 17: Location of Boa Aguada I, Boa Aguada IV and Santo André farms, in Ribas do Rio Pardo municipality, Mato Grosso do Sul. Source: Lacan.

[5] Other areas within Autometal farm are also undergoing implementation of project activities aiming at carbon credits through the CDM/or substitute mechanism.





1.13 Conditions Prior to Project Initiation

<u>General physical conditions for the grouped project (Central-West region of Brazil)</u>

The Central-West region of Brazil comprises the states Goiás (GO), Mato Grosso (MT) and Mato Grosso do Sul (MS) and is characterized by extensive areas dedicated to agriculture and pasture, and low population. Thus, any PAI implemented within the limits of this grouped project will be subject to a similar baseline scenario, especially considering that the reforestation activities proposed by LACAN will be implemented in non-forested areas, with a history of anthropic intervention, particularly due to agriculture/feedstock activities (furthermore, all PAIs will undergo the eligibility assessment of the area, as prescribed in section 1.3 of this PD). LACAN does not consider areas within the Pantanal for this grouped project (refer to section 3.2).

Figure 18: example of implementation area, Autometal farm, MT (pre-project situation). Source: LACAN

Figure 19: example of implementation area, PAI 2, MS (pre-project situation). Source: LACAN

Ecosystems

The predominant biome in the Central-West region is the "cerrado", or Brazilian savanna, the second largest biome in Brazil, of which less than 20% of its original vegetation cover remain. Also, the world's biggest wetland is in this region, the "Pantanal" (mainly in West of Mato Grosso do Sul), as well as a strip of the Amazon Forest, in the North of Mato Grosso and a thin area of the Atlantic Forest, in the South of Goiás and Mato Grosso do Sul.

Figure 20: biomes of the Central-West region. Source: Adapted from www.novaescola.org.br

Physical geography

The Central-West region's physical geography is divided into three main areas:

The Brazilian Highlands ("*Planalto Central*"[6]) – occupies most part of the region. Present altitudes ranging from 600m to 1000m where crystalline rocks are predominant. in addition to the latosols. Its main vegetation is the "cerrado" and its tropical climate is characterized by the absence of the cold season.

Southern Brazilian Highlands ("*Planalto Meridional*"[7]) - its geological formation is from the Mesozoic era, presenting sedimentary rocks, sandstones, and basalts. Its climate is the subtropical humid.

The Pantanal floodplain[8] ("*Planície do Pantanal*") - the Paraguay river and its numerous affluents flood the region forming extensive flooded areas. Altitude does not surpass 200 meters above sea level and declivity is almost zero.

Figure 21: physical geography of the Central-West region[9].

[6] See https://www.infoescola.com/geografia/planalto-central/.

[7] See https://www.infoescola.com/geografia/planalto-meridional/.

[8] See https://brasilescola.uol.com.br/brasil/aspectos-naturais-centro-oeste.htm.

[9] See https://escolaeducacao.com.br/classificacao-do-relevo-brasileiro/.

Hydrology

In terms of water resources, this is a very rich region, as it is drained by many rivers, which form three major river basins: the Amazon, the Tocantins-Araguaia and the Rio de la Plata (specifically, the Paraná and Paraguay rivers sub-basins).

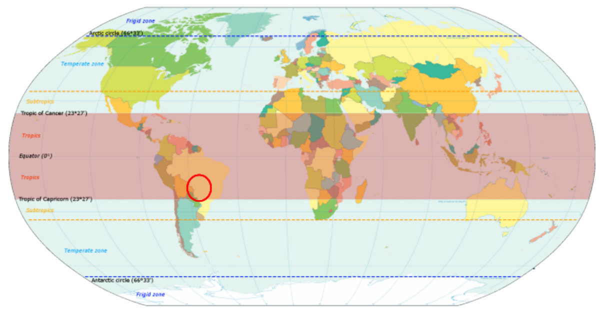
Figure 22: river basins of the Central-West region[10] (marked in blue).

[10] See source https://www.todamateria.com.br/bacia-platina/.

Climate

The predominant climate in the region is tropical savanna, presenting dry winters and wet hot summers, with temperatures ranging from 15°C in colder days and 40°C in the hottest ones[11].

MATO GROSSO/MT - Autometal farm



Mato Grosso (MT) is the third largest state in terms of territorial size in Brazil with 903,357.908 km². It is located in the Central-West region, one characterized by extensive areas dedicated to agribusiness, i.e. pasture and agriculture, and low population rate. According to the latest survey by IBGE (2010), Mato Grosso's demographic density rate is of 3.3 inhabitants per km². The State official website says, "Mato Grosso has 3,035,122 inhabitants, representing 1.59% of the Brazilian population. Nowadays, 41% of the state's residents were born in other parts of the country or abroad" [12]. Its capital is Cuiabá, which is located exactly halfway between the Atlantic and the Pacific oceans.

The natural aspects of the Central-West region of Brazil are greatly influenced by its location in the tropical zone, just above the Tropic of Capricorn.

Mato Grosso is the only state in Brazil to have three of the country's main biomes: the Amazon, with 480,215 km² (53.6%), the "Cerrado" occupying 354.823 km² (39.6%) and the smallest area is the "Pantanal", with 60,885 km² (6.8%). As shown in Figure 23, the first instance area is located entirely within the Cerrado biome, being in the central part of the state. The floristic richness of the "cerrado" is only second to that of humid tropical forests. The vegetation is composed of grasses, shrubs, and sparse trees. The trees have twisted stems and long roots, which allow the absorption of water even during the dry winter season.

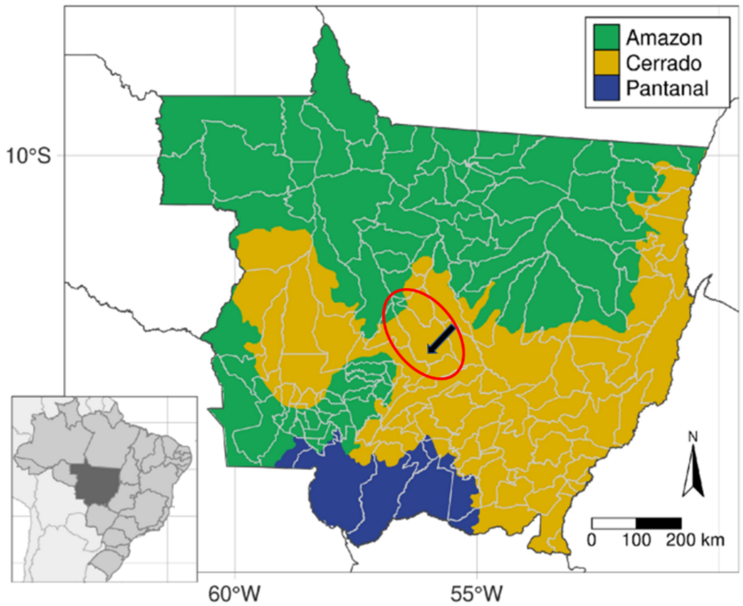
To date, more than 1,500 species of animals are known in the Cerrado environment, including vertebrates (mammals, birds, fish, reptiles, and amphibians) and invertebrates (insects, molluscs, etc.). About 161 of the world's 524 mammal species are in the Cerrado. It presents 837 species of birds, 150 species of amphibians and 120 species of reptiles.

The Cerrado is mainly characterized by the tropical climate, with a drought that lasts for approximately five months. In the driest month, the average amount of rain reaches 30 mm, and sometimes even zero.

[11] See https://www.embrapa.br/contando-ciencia/regiao-centro-oeste.

[12] See http://www.mt.gov.br/geografia.

Figure 23: biomes of Mato Grosso state, emphasis on Nova Mutum municipality and approximate location of the Autometal farm areas. Source: Adapted from Kuschnig *et al*[13].



Mato Grosso presents three of the most important hydrographic basins in Brazil: Amazon Basin, Rio de La Plata Basin ("Bacia Platina") and Tocantins Basin. The main sub-basins of the state are: Guaporé sub-basin, Aripuanã sub-basin, Juruena-Arinos sub-basin, Teles Pires sub-basin and Xingu sub-Basin. The rivers belonging to the Amazon Basin drain 2/3 of the Mato Grosso territory.

The predominant climate in the region is tropical savanna, presenting dry winters and wet hot summers, with temperatures ranging from 15°C in colder days and 40°C in the hottest ones. It presents high rainfall exceeding the annual average of 1,500mm.

NOVA MUTUM/MT – Autometal farm

Location: The municipality of Nova Mutum is in the Middle-North of Mato Grosso (see Figure 23); Mesoregion 127 – North of Mato Grosso ("Norte Mato-Grossense"); Microregion 523 – "Alto Teles Pires".

Geographical boundaries: North: Nova Maringá, Tapurah and Lucas do Rio Verde; East: Sorriso and Santa Rita do Trivelato; South: Nobres and Diamantino; West: São José do Rio Claro and Diamantino.

Altitudes: Between 450 meters and 550 meters.

[13] See https://www.nature.com/articles/s41598-021-00861-y.

Climate: Equatorial – Tropical hot and semi humid, with two well-defined seasons:

- o Drought: May/ September.
- o Rains: October/ April

Average annual temperature: 24ºC - with average maximum at 33ºC and minimum average of 21ºC.

Geological Formation: Unfolded Phanerozoic. Quaternary Basin of the Xingu and Mesozoic Basin of Parecis.

Annual Precipitation: The average annual rainfall is 2,200mm, ranging from 1,850mm to 2,400mm and the relative humidity of the air reaches 80% in the rainy season, and may fall to 35% in drought.

Water Resources: The municipality of Nova Mutum is located in the Amazon Basin. The main rivers are: Verde river, Arinos river, Ranchão river, Novo river, Beija-Flor river, Dos Patos river, Moderno river and Piuvão river.

Relief: The relief of Nova Mutum is characterized by being flat, with a slope not exceeding 3% and is part of the "Chapada dos Parecis".

Soil: The soil is predominantly latosol (80%) and quartz sands (20%).

Vegetation: The vegetation of the municipality consists of 70% "cerrado" and 30% forest.

Figure 24: Autometal farm after implementation of the project activity. Source: Lacan.

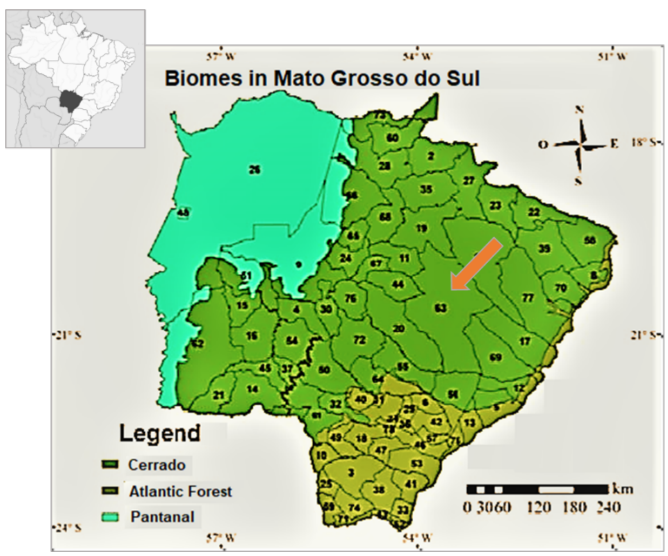
MATO GROSSO DO SUL/MS[14] – Boa Aguada I and IV, Santo André farms

Mato Grosso do Sul (MS) is located in the heart of South America. In Brazil, it borders the states of Mato Grosso, Goiás, São Paulo, Paraná and Minas Gerais. In addition, it is one of the main accesses to Mercosur, bordering Bolivia and Paraguay. It is interconnected by railroads, highways and waterways (Paraná and Paraguay rivers) with Argentina and Uruguay, being the main route of the routes, which connects the Atlantic coast to the Pacific coast.

In most of the state, the tropical climate predominates, with summer rains and dry winter, characterized by averages ranging between 26°C and 23°C. Rainfall is approximately 1,500mm per year.

The Cerrado biome covers most of the state. There is also the Pantanal, in which savannah vegetation and fields are combined, and an area of Atlantic Forest on the South/Southeast of the state.

Figure 25: biomes of Mato Grosso do Sul state, emphasis on Ribas do Rio Pardo municipality and approximate location of the Second Instance farms' areas. Source: adapted from Marcuzzo *et al*.[15]



The main rivers that cross the state are Paraná rivers (main tributaries: Sucuriú, Verde, Pardo and Ivinheima), to the East, and Paraguay (main tributary: Miranda), to the West. Long-term floods take place in the Pantanal every year.

[14] See http://www.ms.gov.br/institucional/.

[15] See https://www.researchgate.net/publication/322345215_Estudo_da_Sazonalidade_das_Chuvas_no_Estado_do_Mato_Grosso_do_Sul_e_Sua_Distribuicao_Espaco-Temporal_-_Study_of_Seasonal_and_Space-Time_Distribution_Rains_in_Mato_Grosso_do_Sul_State_-_Studio_della_st .

RIBAS DO RIO PARDO/MS[16] – Boa Aguada I and IV, Santo André farms

Ribas do Rio Pardo is 102 km from Campo Grande, capital of Mato Grosso do Sul, located on the banks of highway BR-262.

The municipality is under the influence of the tropical climate (AW), with the average temperatures of the coldest month ranging from 20°C and 18°C. Annual rainfall varies between 1,200 to 1,500mm. To the South, the predominant climate is humid to sub-humid, with moisture content values varying from 20 to 40% annually. Annual rainfall ranges from 1,500 to 1,750mm.

Ribas do Rio Pardo is inserted in the Cerrado zone.

Figure 26: One of PAI 2's areas prior to the implementation of the project activity. Source: Lacan.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

This grouped project complies with all laws and regulations of Brazil, as well as those of the entire area within its boundaries.

National level:

[16] See https://www.ribasdoriopardo.ms.gov.br/ribas/historia.

- the "Brazilian Forestry Code" Law 12 651, 25 May 2012[17]: creates the Rural Environmental Registry (CAR), the Environmental Regularization Program (PRA)
- the IBAMA[18] Normative Instruction n. 6/2013 and IBAMA Law 10.165/00: regarding IBAMA's Federal Technical Registration;
- the Ministry of the Environment Normative Instruction n.5/2009[19]: provides for the methodological procedures for restoration and recuperation of Permanent Preservation Areas (APP) and Legal Reserves.

State level:

- **Mato Grosso** state Decree n.262/2019, SEMADE (State Secretariat for the Environment and Economic Development), **Mato Grosso do Sul** Resolution n. 9/2015, and **Goiás** State Secretariat Decree n.9710/2020 (refer to section 2.3): exemption from the Environmental Impact Study – EIA for reforestation activities;
- Mato Grosso do Sul Resolution n.9/2015, SEMADE-MS: regarding planting license and harvest license;
- Mato Grosso do Sul state Law n. 3 628/2008: provides for Legal Reserve restoration within the state;
- Mato Grosso do Sul state Decree n. 13 977/2014: provides for the Rural Environmental Registry (CAR), and other state programs;
- Goiás state Normative Instruction n.18/2021, SEMADE-GO: establishes procedures for the definition of priority in the analysis of the Rural Environmental Registry;
- Mato Grosso state Complementary Law n.592/2017: provides for the Environmental Regularization Program (PRA), 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 state of Mato Grosso.

LACAN seeks to manage the grouped project's activities through an operational and environmental management plan, periodically verifying the strict compliance with legal requirements, and the updating of laws, treaties, agreements, conventions, etc., among other pertinent requirements.

1.15 Participation under Other GHG Programs

[17] See http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm.

[18] Brazilian Institute of the Environment and Renewable Natural Resources

[19] See http://www.ibama.gov.br/sophia/cnia/legislacao/MMA/IN0005-090909.PDF.

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

This grouped project was validated by RINA Services S.p.A. in 01/10/2021 as “PoA for reforestation of land for multiple uses” under the Clean Development Mechanism (CDM) and is seeking registration under that mechanism or its substitutes.

1.15.2 Projects Rejected by Other GHG Programs

N/A. This grouped project was never rejected by any other GHG Programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

N/A. This grouped project does not reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

N/A. This grouped project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates.

Supply Chain (Scope 3) Emissions

N/A. This project description is not being completed for the purpose of listing on the pipeline as under development. This is the under validation version.

1.17 Sustainable Development Contributions

The grouped project "Reforestation of lands for multiple uses" aims to generate net removals of greenhouse gases through the conversion of traditional land use in the region, mainly agriculture & livestock, to reforestation activities, based on the participation of investors and independent rural producers. As a result, the project will not only provide the generation of additional carbon stocks, but will also contribute to the production of wood for various supply chains, for example, energy purposes, sawmill, pulp, etc.

- *On mitigation of local environmental impacts provided by the project compared to the estimated local environmental impacts for the reference scenario.*

The implementation of the project will bring several environmental benefits, such as the recovery and maintenance of soil integrity, conservation of water resources and biodiversity. The farms where the company operates are located in heavily anthropized areas, mostly old pastures poorly maintained.

In addition, the presence of plantations will promote monitoring of fire occurrences, whether accidental or not, in planted and conservation areas, as well as in neighboring areas, in a region that has been suffering a lot from fires lately.

The project will also stimulate the adoption of forest certification practices, preferably by the Forest Stewardship Council (FSC), or its equivalent. It is known that the criteria and principles by which forest certifications are based, ensure a high level of scrutiny, and cover the main aspects related to sustainability.

- *On the commitment of the project with social and labor responsibilities, increase in the qualitative and quantitative level of jobs (direct and indirect) comparing the project scenario with the reference scenario.*

The project will meet all legal and regulatory requirements related to safety conditions at work, for own and outsourced employees. PP will promote training actions for occupational hygiene, safety and medicine, especially in relation to the use of personal safety equipment, which are delivered to all employees, not excluding third parties, in a registered manner.

The following are some examples of potential actions: training of operators for safe performance of the activity, establishment of Work Instructions and monitoring of compliance, safe control of tools and equipment, maintenance of traffic routes and access in safe conditions of use, among others. In addition, the contracting of regional goods and services will be prioritized.

- *On the direct and indirect effects on the quality of life of the communities, observing the socioeconomic benefits provided by the project in relation to the reference scenario.*

The reference scenario where the project will be implemented (i.e. states of Mato Grosso, Mato Grosso do Sul and Goiás) is characterized by an intense activity of extensive livestock and agriculture. The work opportunities generated by the project contribute to a better distribution of income in the region, consequently increasing the quality of life of several local families. This benefit is attributed to the prioritization given to hiring suppliers from cities and rural areas close to the project's operation areas.

- *On the level of technological innovation of the project in relation to the reference scenario.*

The project is based on sustainable reforestation practices and advanced planting and maintenance technology, with the purpose of being a reference in forest operations, more specifically in relation to the quality of its forests. The process of planting trees involves forestry techniques that minimize the impact on soil, optimize water use and improve the worker's quality of life. Products for pest control, herbicides, and fertilizers are used as recommended by best practices.

- *On the project's contribution to regional development.*

Increasing the availability of wood from sustainable sources is key for contributing to regional integration and articulation with other sectors. The implementation of new reforestation areas, with different forestry treatments, where there had previously been overused pasture, boosts the local economy, since it influences the socioeconomic activities of the communities where the projects are located.

The operation and maintenance of the project require the contribution of regional service providers, operating in the most diverse areas such as: seedling production, professionals related to the environment, health professionals, administrative area, mechanics, machine operators, technicians, suppliers of inputs, freight services, etc. Regional integration and articulation with other sectors are also due to the negotiation of wood, which can be made available to different enterprises in various sectors, i.e. pulp companies, power generation companies, furniture companies, among others.

1.18 Additional Information Relevant to the Project

Leakage Management

According to the methodology AR-ACM0003, version 02.0, and VCS' *Methodology Requirements* version 4.1, the CDM methodological tool "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*" in its latest version should be applied. This complies with VCS's provisions in section 3.7 of its document, where it stablishes that

Activity-shifting leakage occurs when the actual agent of deforestation and/or forest or wetland degradation moves to an area outside of the project boundary and continues its deforestation or degradation activities elsewhere.

The tool estimates the increase in emissions based on changes in carbon stocks in the affected carbon pools in the land receiving the displaced activities. Even if there is some animal in the project's areas before the implementation of the project's activities, it is more likely that the landowner directs the cattle to slaughterhouses, which is usual in this situation, or relocates the cattle to grazing farms, which are abundant in the region. However, LACAN will prepare and apply a questionnaire to all potential PAIs regarding the situation of the land to be leased, the existence of any agricultural activity/ cattle, and its possible displacement and destination.

Commercially Sensitive Information

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

Further Information

N/A. There is no other relevant information about the Project.

2 SAFEGUARDS

2.1 No Net Harm

The analysis related to the activities of this proposed project was conducted at the grouped project level mainly based on the clear status of the actual land use in the area (overwhelmingly dominated by agriculture/pastureland as demonstrated in Section 3.5 of this PD), and by the states' legislations, which do not require EIA for silviculture activities (see 2.3 below). Since the EIA is an analysis to anticipate the risks and possible environmental impacts to be prevented, corrected, mitigated and/or compensated, it is concluded that reforestation activities are considered of low risk of environmental impacts within the project context, especially because of the clear *positive* impacts when comparing with the prevailing land use.

Environmental impacts are consequences or changes in the environment caused by humans, which can be negative when the previous situation worsens, or positive when they promote the recovery of the affected areas. The environmental impacts resulting from silviculture practices in non-forested areas, when properly managed, are positive, especially when converting agricultural land into forest plantations.

According to OLIVEIRA, 2017,

> *"In agricultural crops, biodiversity is extremely restricted compared to areas with forest plantations. In agricultural cultivation, the survival of other plant species is inhibited by factors such as the use of herbicides, annual soil preparation (ploughing and harrowing) and the competition promoted by the cultivated plant. In forestry crops, these factors, when used, are restricted to the forest implantation phase, leaving various years without being applied."*

Reforestation enables maintaining soil fertility through litter and harvest residues in the soil between the crop rotations, as they are incorporated as organic matter.

In areas whose original vegetation cover has already been removed, which is the case of areas under this grouped project, reforestation begins to contribute to numerous environmental aspects, such as reducing erosion and maintaining soil structure. Forest fires are monitored in planted and conservation areas, a benefit that not only protects the project's areas, but also is extended to neighboring ones. In addition, the correct delimitation, restoration and conservation of legal reserve areas and permanent preservation on properties safeguards biodiversity[20].

LACAN seeks to manage the project activities through an operational and environmental management plan, aiming to prevent impacts and optimize operating costs. The verification of compliance with legal requirements is carried out periodically. Compliance and updating of laws, treaties, agreements, conventions, etc., among other pertinent requirements, are verified.

Within the scope of this grouped project, the PP will also encourage voluntary forest certification practices for the areas included as PAIs, despite not being a mandatory or legal requirement. Even though Brazilian environmental legislation already contemplates several criteria to ensure good environmental practices, LACAN also commits to the principles and criteria (P&C) of the FSC®[21] for Forest Management Certification and Chain of Custody, with socio-environmental responsibility towards communities and neighbours in all forestry management operations, as summarized below:

1. Compliance with FSC Laws and Principles®;
2. Responsibilities and rights of land ownership and use;
3. Rights of Indigenous Peoples;
4. Community Relations and Workers' Rights;
5. Benefits of Forests;

[20] See https://www.embrapa.br/codigo-florestal/area-de-reserva-legal-arl

[21] Or equivalent certification system if there is any relevant change in the future.

6. Environmental impact;
7. Management plan;
8. Monitoring and evaluation;
9. Maintenance of Forests of High Conservation Value;
10. Plantations[22].

The properties that comprise the project's areas PAI1 and PAI2 are already under the PP's FSC certification scope.

It is worth noting that both Brazilian legislation and FSC principles and criteria allow for the implementation of reforestation projects based on planted forests, either diverse or homogeneous, since several practices and references already indicate that possible impacts on water resources, when applicable, can be managed in accordance with the principles of sustainable development regarding environmental, social, and economic aspects (OLIVEIRA, 2017).

Thus, in the context explained above, the sustainable reforestation activities proposed by the grouped project constitute a nature-based solution. Since reforestation practices will be implemented on non-forested lands, including areas previously occupied by agriculture, environmental conditions are expected to improve. In any case, LACAN will encourage the use of state-of-the-art operational techniques, always targeting the conservation and maintenance of natural resources, considered to be its greatest assets, as per the following key activities:[23]

- contribution with the recovery and maintenance of soil integrity;
- control of invasive species;
- maintaining ecological corridors;
- monitoring of fire occurrences, benefiting not only its areas, but also neighboring areas;
- guaranteeing that all activities that require licensing will have their applications approved by the competent bodies;
- implementing FSC certification.

It is important to note that one of the principles (Principle 6) specifically covers environmental impacts. The operational procedures that are part of Lacan's Management System, which will also be adopted under this grouped project, and other documents related to forest management activities support the management plan to be contemplated for the PAIs' areas. These documents

[22] See https://br.fsc.org/pt-br/polticas-e-padres/princpios-e-critrios/os-10-princpios.

[23] Based on

https://07505549-16a6-42cf-8953-76bced28b1d0.filesusr.com/ugd/3c8577_6c0df0ce5fda482f819bac24d853d83a.pdf undergo periodic reviews considering changes in technical&scientific, socio-environmental, and economic scenarios. So, it is hoped that certification will maximize the potential of the project's contribution to the sustainable development of the region.

Other concern is with hydrological resources. The main measures to be carried out in the PAIs' areas for monitoring and preserving water resources are:

- Licensing for water collection to its forestry activities, according to legislation;
- Collect water only from sources permitted by environmental authorization issued by the environmental agency and/or as established by the relevant legislation.
- Record the amount of water captured in all forest management.
- The equipment used for water collection must be protected (containment basin) to avoid contamination of soil and water resources.
- Isolation of the water collection point and proper distribution of the different land uses.
- Monitoring of the Natural Regeneration of Native Species.

The sustainable management of water resources comprises actions aimed at ensuring water quality standards in the watershed. The actions to be developed in the PAIs' areas are listed below:

- Fencing the area adjacent to the water source (Preservation Area) to prevent animals, people, and vehicles from entering; taking all measures to favor its isolation to avoid the contamination of the land or even the water, e.g. fishing/hunting ban;
- Redistribution of roads, aiming at protecting the springs, since most of rural roads were not properly planned;
- Conservation of the entire basin and vegetable cover surrounding the springs;
- Construction of protective structures for the springs
- Control of erosion;
- Laboratory Analyses: analysis will be carried out sorted by areas with more ecological and social representativeness; conduct qualitative analysis preferably in areas that have some type of activity e.g. planting, maintenance and /or harvesting.

It can therefore be concluded that the reforestation activities proposed by the grouped project will result in positive impacts of similar size and intensity within its boundaries due to the similarity of the baseline conditions of the lands in which they will be implemented. That is, even though there are specificities in some areas of the region, the impacts themselves will be of the same nature. As for impacts on biodiversity and natural ecosystems outside the project´s boundary, reforestation activities have proven to add quality to biodiversity, water, soil, air, landscape (as seen above), especially in areas where historical use is agricultural/feedstock activities. Hence, the probable impacts occurring outside the project's limits will also be positive.

2.2 Local Stakeholder Consultation

Lacan's local stakeholder consultation was planned primarily for the vicinity of Autometal farm, having as reference a radius of 20 km from the project's planting sites. It was concluded that this radius is very wide, covering an area that does not suffer any influence from the activities proposed by the project, much less that any community or individual within this distance depends in any way on the project's areas. Hence, a new radius was traced, 3 km from the project limits, and following FSC guidance for similar analysis, and, likewise, no potential stakeholders within this area depend or rely in any way on the project's areas. Therefore, it was defined that the local stakeholders' consultation would be conducted following two tracks: a) communicating with institutional stakeholders at the local level and, b) in-person visits to the farm's neighbours.

As detailed in section 2.5 below, Mato Grosso is characterized by large uninhabited areas, covered either by native vegetation, pastureland, or crops. Autometal farm neighbours grange farms, one of Nova Mutum's main economic sources, and large native vegetation areas, even the Arinos river borders the property. Also, the Socio_Economical Monitoring Report (SIMETRIA, 2022), prepared for Lacan for its FSC certification process.

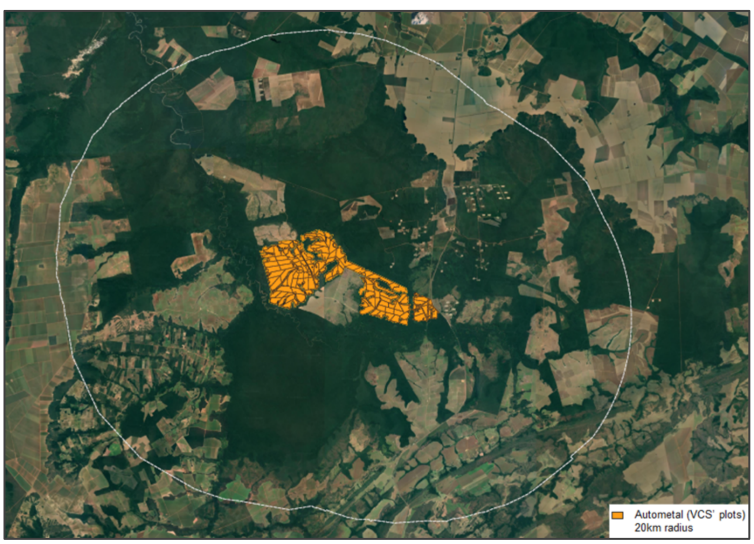


Figure 27: 20km radius applied to the project area. It is clear that Autometal farm is surrounded in great part by large areas of native vegetation, even communities are separated from the farm's boundaries by a river (Arinos river, to the left). This characteristic was determinant to the identification of the stakeholders, as well as to evidence that the community does not rely on the project's areas.

a) The local institutions were identified and selected for their role as representation of community's interests and their connection to the grouped project's proposals and possible contributions (see the list of invited institutions on the table below). All were contacted via email since 18/03/2023. A text with information on the proposed grouped project, its purpose and potential impacts was attached to the email. It also included the invitation for comments and suggestions and contact information.

Table 3: list of local institutions consulted during Local Stakeholder Consultation in MT.

Stakeholder	Department	Contact info
Nova Mutum Municipal Secretariat of Agriculture and Environment	General contact	sama@novamutum.mt.gov.br
	Social Assistance	assistenciasocial@novamutum.mt.gov.br
	Environmental Licensing	licenciamento.sama@novamutum.mt.gov.br
Coomuserv - *Cooperativa Mutuense de Trabalho* (Labor Coorperative from Nova Mutum)		gerencia@coomuserv.com.br
Bem Viver – *Educação Ambiental* (Environmental education, in Nova Mutum)		bemvivertga@gmail.com

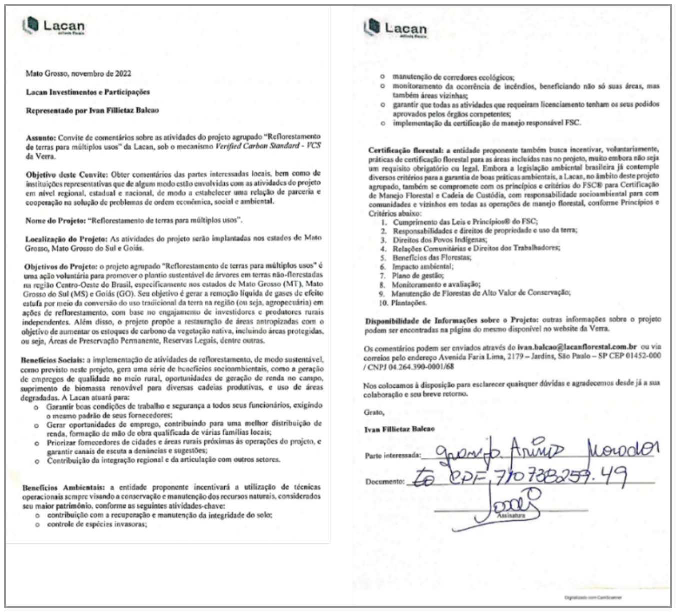
b) The in-person visits took place since November, 2022 when Lacan's team visited four neighbouring grange farms (as below). All neighbours received the explicative printed material with Lacan's available contact channels (email and physical address). Their signatories were taken in a participation list to register the visit. The contact channels are available as the mechanism for on-going communication with local stakeholders.

Table 4: list of neighbours visited by the PP's team during Local Stakeholder Consultation.

Stakeholders - Neighbours
Granja Arinos
Granja Faria[24]
Granja São Domingos
Granja São José

Figure 28: an example of the file sent via email and handed to stakeholders (signed by one of the neighbours' representative). Source: Lacan.

[24] See http://granjafaria.com.br/.



Lacan

Mato Grosso, novembro de 2022

Lacan Investimentos e Participações

Representado por Ivan Fillietaz Balcao

Assunto: Convite de comentários sobre as atividades do projeto agrupado "Reflorestamento de terras para múltiplos usos" da Lacan, sob o mecanismo *Verified Carbon Standard - VCS* da Verra.

Objetivo deste Convite: Obter comentários das partes interessadas locais, bem como de instituições representativas que de algum modo estão envolvidas com as atividades do projeto em nível regional, estadual e nacional, de modo a estabelecer uma relação de parceria e cooperação na solução de problemas de ordem econômica, social e ambiental.

Nome do Projeto: "Reflorestamento de terras para múltiplos usos".

Localização do Projeto: As atividades do projeto serão implantadas nos estados de Mato Grosso, Mato Grosso do Sul e Goiás.

Objetivos do Projeto: o projeto agrupado "Reflorestamento de terras para múltiplos usos" é uma ação voluntária para promover o plantio sustentável de árvores em terras não-florestadas na região Centro-Oeste do Brasil, especificamente nos estados de Mato Grosso (MT), Mato Grosso do Sul (MS) e Goiás (GO). Seu objetivo é gerar a remoção líquida de gases de efeito estufa por meio da conversão do uso tradicional da terra na região (ou seja, agropecuária) em ações de reflorestamento, com base no engajamento de investidores e produtores rurais independentes. Além disso, o projeto propõe a restauração de áreas antropizadas com o objetivo de aumentar os estoques de carbono da vegetação nativa, incluindo áreas protegidas, ou seja, Áreas de Preservação Permanente, Reservas Legais, dentre outras.

Benefícios Sociais: a implementação de atividades de reflorestamento, de modo sustentável, como previsto neste projeto, gera uma série de benefícios socioambientais, como a geração de empregos de qualidade no meio rural, oportunidades de geração de renda no campo, suprimento de biomassa renovável para diversas cadeias produtivas, e uso de áreas degradadas. A Lacan atuará para:

- Garantir boas condições de trabalho e segurança a todos seus funcionários, exigindo o mesmo padrão de seus fornecedores;
- Gerar oportunidades de emprego, contribuindo para uma melhor distribuição de renda, formação de mão de obra qualificada de várias famílias locais;
- Priorizar fornecedores de cidades e áreas rurais próximas às operações do projeto, e garantir canais de escuta a denúncias e sugestões;
- Contribuição da integração regional e da articulação com outros setores.

Benefícios Ambientais: a entidade proponente incentivará a utilização de técnicas operacionais sempre visando a conservação e manutenção dos recursos naturais, considerados seu maior patrimônio, conforme as seguintes atividades-chave:

- contribuição com a recuperação e manutenção da integridade do solo;
- controle de espécies invasoras;

Lacan

- manutenção de corredores ecológicos;
- monitoramento da ocorrência de incêndios, beneficiando não só suas áreas, mas também áreas vizinhas;
- garantir que todas as atividades que requeiram licenciamento tenham os seus pedidos aprovados pelos órgãos competentes;
- implementação da certificação de manejo responsável FSC.

Certificação florestal: a entidade proponente também busca incentivar, voluntariamente, práticas de certificação florestal para as áreas incluídas nas no projeto, muito embora não seja um requisito obrigatório ou legal. Embora a legislação ambiental brasileira já contemple diversos critérios para a garantia de boas práticas ambientais, a Lacan, no âmbito deste projeto agrupado, também se compromete com os princípios e critérios do FSC® para Certificação de Manejo Florestal e Cadeia de Custódia, com responsabilidade socioambiental para com comunidades e vizinhos em todas as operações de manejo florestal, conforme Princípios e Critérios abaixo:

1. Cumprimento das Leis e Princípios® do FSC;
2. Responsabilidades e direitos de propriedade e uso da terra;
3. Direitos dos Povos Indígenas;
4. Relações Comunitárias e Direitos dos Trabalhadores;
5. Benefícios das Florestas;
6. Impacto ambiental;
7. Plano de gestão;
8. Monitoramento e avaliação;
9. Manutenção de Florestas de Alto Valor de Conservação;
10. Plantações.

Disponibilidade de Informações sobre o Projeto: outras informações sobre o projeto podem ser encontradas na página do mesmo disponível no website da Verra.

Os comentários podem ser enviados através do **ivan.balcao@lacanflorestal.com.br** ou via correios pelo endereço Avenida Faria Lima, 2179 – Jardins, São Paulo – SP CEP 01452-000 / CNPJ 04.264.390-0001/68

Nos colocamos à disposição para esclarecer quaisquer dúvidas e agradecemos desde já a sua colaboração e seu breve retorno.

Grato,

Ivan Fillietaz Balcao

Parte interessada:

Documento:

Assinatura

Digitalizado com CamScanner

For PAI2, it was assessed that no local stakeholder relies on the areas and, due to the nature of the reforestation activity, that is, restoration purposes, and also to the small size of the areas, the local consultation was carried out exclusively by email. The local institutions were identified and selected for their role as representation of community's interests and their connection to the grouped project's proposals and possible contributions (see the list of invited institutions on the table below). All were contacted via email on from May, 2023 and the text sent was the same as shown in figure 28.

Table 3a: list of local institutions consulted during Local Stakeholder Consultation in MS.

Stakeholder	Contact info
SEMAC / IMASUL- Mato Grosso do Sul Institute for the Environment - Três Lagoas Region	aaraujo@imasul.ms.gov.br
UFMS - Mato Grosso do Sul Federal University	gab.cptl@ufms.br
AEMS - Faculdades Integradas de Três Lagoas (university)	aems@aems.edu.br
Tres Lagoas Municipal Secretariat for the Environment	semads@treslagoas.ms.gov.br
Sebrae - Brazilian Service of Support to Micro and Small Enterprises	josi.signori@ms.sebrae.com.br
SENAI –National Service for Industrial Apprenticeship	adevaldo@ms.senai.br

Commercial and Industrial Association of Tres Lagoas	mkt@acitreslagoas.com.br
Suzano S/A	lorraine.ls@suzano.com.br
DNIT - National Department of Transportation Infrastructure	miltonmarinho@uol.com.br
Municipal Secretariat of Social Assistance	juliana.bernandes@treslagoas.ms.gov.br
Candeias Association	adm.pvca@outlook.com

It is the PP's intention to post on its communication channels the link to the Verra VCS project page, as to communicate, according to VCS requirements, the project design and implementation, including the results of monitoring, and the process and progress of the VCS validation and verification phases. Risks, costs, and benefits the project may bring to local stakeholders are addressed in section 2.1 above.

2.3 Environmental Impact

State law in the states that make up the grouped project limits do not require an Environmental Impact Study – EIA for reforestation, since this is considered to have low environmental impact, as per Mato Grosso state Decree n.262/2019[25], Mato Grosso do Sul SEMADE (State Secretariat for the Environment and Economic Development) Resolution n. 9/2015[26], and Goiás State Secretariat Decree n.9710/2020[27].

It is important to note, however, that all PAIs included under this project will seek forest certification (example, FSC), which requires even more rigorous socio-environmental management criteria than the legislation. As already mentioned, the properties that comprise the project's areas PAI1 and PAI2 are already under the PP's FSC certification scope.

Considering that the lands in which the PAIs will be established will all be non-forested areas with a history of anthropic intervention, especially due to agriculture/grazing activities; that the reforestation activities proposed by the grouped project add quality to biodiversity, water, soil, air, landscape (already extensively presented in this PD), and that LACAN rigorously conducts its activities, observing all regulatory and safety provisions, it is rather unlikely that any potential negative environment and socio-economic impact would result from the project's activities. It can

[25] See https://www.iomat.mt.gov.br/portal/visualizacoes/pdf/15698/#/p:1/e:15698

[26] See https://www.imasul.ms.gov.br/wp-content/uploads/2019/11/Res-Semade-09-2015-compilada.pdf

[27] See https://legisla.casacivil.go.gov.br/api/v2/pesquisa/legislacoes/103356/pdf

therefore be concluded that the reforestation activities proposed by the project will result in environmental, social and the biodiversity benefits.

The grouped project's contributions to the sustainable development are described in sections 1.17 and 2.3 of this PD.

2.4 Public Comments

No comments were received yet for this grouped project up to the date of conclusion of this PD.

2.5 AFOLU-Specific Safeguards

Refer to section 2.2 above for local stakeholder identification process and a description of results.

The Central-West region is the second largest of Brazil in territorial extension occupying 18.86% of the national territory, but also has the second lowest population density among all Brazilian regions. It is characterized by late development and settlement with a population of 16.09 million inhabitants[28], that is, an average of 10 inhabitants per km^2, the area accounts for approximately only 8% of the Brazilian population. Its population is mainly located in urban areas[29].

> *In the Central-West Region, the population growth process is inseparable from the geography of modernized agriculture, which has given a new specificity to the reorganization of the population in the territory. Although responsible for a rural area characterized by low demographic densities, the demographic growth of numerous municipalities located in the area of advancing modernized agricultural production of soy and cotton is increasing at annual rates, especially in its urban areas. Consequently, a close association between agricultural and demographic dynamics is confirmed in this region, with a strong impact on the growth of urban centers in that region.*
>
> *(Source: https://biblioteca.ibge.gov.br/visualizacao/livros/liv64529_apres_intr.pdf)*

Figure 29: common landscape in the project boundary (in this case, MS). Source: LACAN

[28] See https://www.educamaisbrasil.com.br/enem/geografia/regiao-centrooeste

[29] See https://brasilescola.uol.com.br/brasil/regiao-centro-oeste.htm

Therefore, one can conclude that despite the territorial extension, the characteristics of the settlements and distribution of the population make this grouped project region one of large stretches of land with no inhabited areas, occupied by extensive farms of agricultural/livestock activities, with similar socio-economical features and no significant distinctions between stakeholders' characteristics.

Furthermore, the four properties that comprise the project's areas PAI1 and PAI2 are under the PP's FSC certification scope and, therefore, are subject to periodic socioeconomical monitoring[30]. In this sense, potential impacts, either positive or negative, can be tracked and properly addressed, as the case may be.

No risks to local stakeholders nor to their resources due to the project's implementation were identified; no risks to local stakeholder's property rights were identified. All properties are under contractual arrangements and duly signed agreements with the landowners.

Also, the PP has an operational procedure in place to regulate communication actions and through it ensure ongoing communication with local stakeholders, including any grievances.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The methodology applied by this grouped project is *AR-ACM0003 - Afforestation and reforestation of lands except wetlands, version 02.0*[31].

Methodological tools applied by this methodology[32]:

[30] Reports for these areas under FSC certification will be made available to the DOE during validation.

[31] See https://cdm.unfccc.int/methodologies/ARmethodologies/approved

[32] See https://cdm.unfccc.int/Reference/tools/index.html

1. *Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities, version 01.*
2. *Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity, version 04.0.0.*
3. *Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities, version 03.1* [33]
4. *Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activities, version 04.2*
5. *Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity, version 2.0*
6. *Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities, version 01.1.0*[34]

3.2 Applicability of Methodology

This methodology is applicable because the grouped project meets the following applicability conditions.

Table 5: methodology and applicable tools applicability conditions

Methodology and tools applied	Applicability conditions	Project compliance
AR-ACM003 methodology, version 02.0	a) The area of the project activity does not fall into the category of wetlands.	The project participant will verify the type of terrain on which the proposed project instances will be deployed using, for example, the Soil Map of Brazil – IBGE[35], in order to ensure that they are not established in wet areas, e.g. through information on the geographical location of the area and type of soil. Therefore, project activities will not fall into the category of wetlands.
AR-ACM003 methodology, version 02.0	b) Soil disturbances attributed to activities in the proposed project do not cover more than 10% of the project area that: i) Contain organic soils; ii) At the baseline are subject to land use management	In general, LACAN adopts minimal cultivation, i.e. only turning the soil on the planting line, resulting in low impact on the level of soil cover. i) Contain organic soils: LACAN will verify the type of land on which the proposed PAIs will be

[33] Not applicable to this grouped project, as per Section 3.3 and 4.4.1(a) below.

[34] Not applicable to this grouped project, as per Section 3.3 and 4.4.1(a) below.

[35] See ftp://geoftp.ibge.gov.br/informacoes_ambientais/pedologia/mapas/brasil/solos.pdf

AR-ACM003 methodology, version 02.0	conditions which receive inputs listed in Appendices 1 and 2 of the AR-ACM003 methodology, version 02.0.	deployed using, for example, the Soil Map of Brazil - IBGE, in order to ensure that they are not established in organic soils, e.g. by information of the geographical location of the area and type of soil. Therefore, project activities will not fall into the organic soil category. ii) At the baseline are subject to land use management conditions which receive inputs listed in Appendices 1 and 2 of the AR-ACM003 methodology, version 02.0: If the land use at baseline falls within one of the conditions listed in Appendices 1 and 2 of the AR-ACM003 methodology, LACAN will verify that tillage do not disturb more than 10% of the project area, e.g. evaluation of the proportion of tilled area (width x length of the tillage line x number of tilled lines or dug area x number of pits) in relation to the total area of the project.
"Combined tool to identify the baseline scenario and demonstrate the additionality of the CDM A/R project activities", version 01	c) Reforestation in the area within the proposed boundaries, conducted with or without registration as AFOLU VCS activity, should not lead to the violation of any applicable laws, even if these laws are not being enforced.	Reforestation in the area within the proposed limits do not violate any local or national laws.
	d) This tool is not applicable to small-scale AFOLU project activities.	All PAIs under this grouped project will be large-scale, considering the current criteria of the CDM and the Designated National Authority of Brazil.
Tool "*Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity, version 04.0.0.*"_	e) The tool is applicable to all occurrence of fire within the project boundary.	This PD takes into consideration the emissions occurring due to accidental fires.
	f) Non-CO_2 GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a	This applicability condition will be assessed during the monitoring of each PAI. LACAN will verify if the area affected by fire in a given year exceeds the limit of 5% of the project area. If the burnt area exceeds 5% of the project area, the area affected will be delimited according to parameter $A_{BURN,i,t}$ and the

	given year is ≥5% of the project area.	calculation of non-CO_2 GHG emissions will be done according to item 4.4.1(b).
Tool "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities, version 03.1*"		N/A. These tools have no internal applicability conditions.
Tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activities, version 04.2*"		
Tool "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity, version 2.0*"	This tool is not applicable if the displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or peat lands.	As mentioned above (a), no PAI under this grouped project will be implemented in areas containing wetlands, nor peatlands.
"*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities, version 01.1.0*"	This tool is applicable when the areas of land, the baseline scenario, and the project activity meet the following conditions: (e) The areas of land to which this tool is applied: (i) Do not fall into wetland category; or (ii) Do not contain organic soils as defined in 'Annex A: glossary' of the IPCC GPG LULUCF 2003; (iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2; (f) The A/R CDM project activity meets the following conditions: (iii) Litter remains on site and is not removed in the A/R CDM project activity; (iv) Soil disturbance attributable to the A/R CDM project activity, if any, is: • In accordance with appropriate soil conservation	<u>NOTE</u>: The carbon stock in this pool will be considered for restoration areas only. (e) (i) and (ii) Refer to item (a) above, applicability conditions of methodology AR-ACM003 methodology v.02.0. (f) (iii) Litter will not be removed from site, as per conventional reforestation practices applied by the PP; and (iv) • The PP applies minimum cultivation techniques in its reforestation project areas. • Soil disturbance will not be repeated in restoration areas and is limited to the implementation stage.

	practices, e.g. follows the land contours; • Limited to soil disturbance for site preparation before planting and such disturbance is not repeated in less than twenty years.	

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Above-ground biomass	CO_2	Yes	This is the largest carbon sink considered by the project
		CH_4	No	
		N_2O	No	
		Other	No	
	Below-ground biomass	CO_2	Yes	The carbon stock in this sink is expected to increase due to the implementation of the project
		CH_4	No	
		N_2O	No	
		Other	No	
	Dead wood Litter Soil organic carbon	CO_2	No	There will be no carbon accounting in these pools.
		CH_4	No	
		N_2O	No	
		Other	No	
Project	Above-ground biomass	CO_2	Yes	This is the largest carbon sink considered by the project
		CH_4	No	
		N_2O	No	
		Other	No	
	Below-ground biomass	CO_2	Yes	The carbon stock in this sink is expected to increase due to the implementation of the project
		CH_4	No	
		N_2O	No	
		Other	No	
	Dead wood	CO_2	Yes	

Source		Gas	Included?	Justification/Explanation
	Litter Soil organic carbon	CH_4	No	The carbon accounting in these pools will be considered only for restoration areas. For eucalyptus planting, conservatively, there will be no carbon accounting in these pools. However, it is expected that there will be an increase in carbon in these pools throughout the project.
		N_2O	No	
		Other	No	
Leakage	Above-ground biomass Below-ground biomass	CO_2	Yes	If leakage is applicable, these pools would represent the largest source of leakage emissions.
		CH_4	No	
		N_2O	No	
		Other	No	
	Dead wood Litter Soil organic carbon	CO_2	Yes	Carbon in these pools will not be accounted.
		CH_4	No	
		N_2O	No	
		Other	No	

Source		GHG	Included?	Justification/Explanation
Baseline	Burning of woody biomass	CO_2	No	CO_2 emissions due to the burning of biomass will be accounted for as a change in the carbon stock
		CH_4	Yes	Emissions from accidental fires will be monitored.
		N_2O	Yes	Emissions from accidental fires will be monitored.
Project activity	Burning of woody biomass	CO_2	No	Not applicable
		CH_4	Yes	Emissions from accidental fires will be monitored.
		N_2O	Yes	Emissions from accidental fires will be monitored.

The PAIs will have their limits defined using georeferencing methods. The geographical coordinates of the project boundaries will be collected, and from these the polygons of each project will be constructed in shape and/or KML files.

Figure 30: PAI 1 boundary in Autometal farm. (in pink). Source: Lacan.

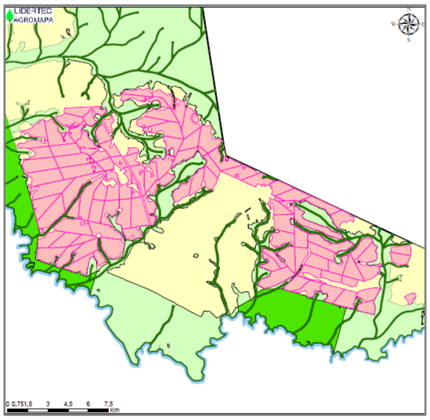
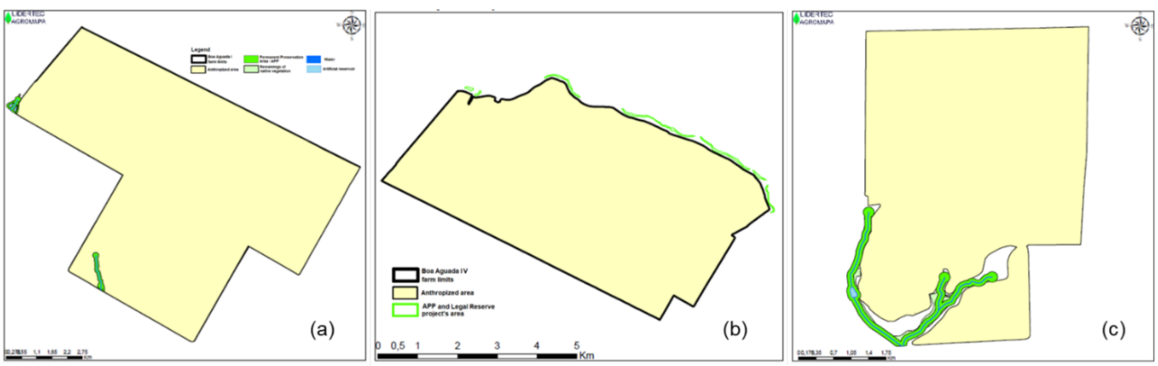


Figure 31: PAI 2 boundary in (a) Boa Aguada I, (b) Boa Aguada IV and (c) Santo André farms (in green). Source: Lacan.



3.4 Baseline Scenario

The identification of the baseline scenario for the areas at the limits of the project activity instances will follow the provisions of the methodology *AR-ACM0003* version 02.0 in its item "Identification of the baseline scenario and demonstration of additionality" which provides for the application of the "Combined tool to identify the baseline scenario and demonstrate the additionality of the CDM A/R project activities". The application of the tool is detailed in section 3.5 below.

The identified baseline scenario is <u>the continuation of land use practices that existed prior to the PAI</u>, i.e. non-forested areas.

Figure 32: status of the area prior to project implementation, Autometal farm, MT. Source: LACAN.

Figure 33: status of the area prior to project implementation, PAI 2, MS.

The baseline scenario for PAI 1 and PAI 2 is consistent with the baseline identified in section 3.5 below, as per the application of the tool "Combined tool to identify the baseline scenario and demonstrate additionality in ARR CDM project activities", i.e. *continuation of land use practices that existed prior to the PAI; non-forested areas*. This can be confirmed by the analysis of the project's areas carried out in section 1.3 above.

3.5 Additionality

In general, this grouped project seeks to show that reforestation activities are additional in relation to the predominant land use in the baseline applicable to the case (non-forested areas, especially agriculture and grazing). PAIs would not be implemented in the absence of this grouped project, especially due to the barriers mentioned below, above all the prevailing practices and the aversion to long-term risk inherent to reforestation activities.

The *AR-ACM0003* version 02.0 methodology requires the use of the "Combined tool to identify the baseline scenario and demonstrate the additionality of the CDM A/R project activities", version 01, to establish a baseline and demonstrate additionality. The tool is applied under the following conditions:

o Forestation of the land within the proposed project boundary performed with or without being registered as an AFOLU VCS project activity shall not lead to violation of any applicable law even if the law is not enforced.

This grouped project complies with all laws and regulations of the Host Country, as well as those of the entire area within the boundaries of the project.

o This tool is not applicable to small-scale afforestation and reforestation project activities.

The VCS adopts the CDM definition for small-scale[36] projects (as per *VCS Standard v4.1*). According to this definition, this grouped project will not develop PAIs that fall into that category, considering the current criteria in the CDM's scope and the complementary regulations determined by the Designated National Authority under the CDM in Brazil.

STEP 0. Preliminary screening based on the starting date of the AFOLU project activity

- The start date of this grouped project is 15/01/2020, which is the date of the first plantings in Autometal farm, in Mato Grosso.
- The carbon credits' incentives were seriously considered, as evidenced by:
    - Meetings/training with external consultants for the development of the project;
    - Signing the contract with external consultants;
    - Sending official notification of the PP's intention to seek registration through the CDM to the CDM Secretariat and the Brazilian DNA on 05/12/2019. This date represents the company's actual step towards the implementation of reforestation project activities aiming at additional GHG removals and other environmental benefits.

[36] See the definition of "SSC A/R CDM project activity" at https://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf

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

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

Realistic and credible land use scenarios have been identified that could occur in areas within the proposed grouped project boundaries, in the absence of reforestation project activities under the VCS. The following alternative land use scenarios have been identified:

- *Scenario 1*: Continuation of current land use.

Justification: as outlined below, the traditional land use within the boundaries of the grouped project is agricultural activities. In the absence of this grouped project, it is most likely that the pre-existing land use will remain, i.e. non-forested areas.

- *Scenario 2*: Reforestation of the land within the grouped project boundaries without being registered as an AFOLU VCS project.

Justification: Although plausible, it is very unlikely that the area within the limits of the grouped project will be reforested, considering not only the historical use, but also the various barriers listed in the next steps of this tool.

- *Scenario 3*: A continuation of the pre-existing land use before the project, considering the reforestation of at least part of the land at a rate resulting from i) legal requirements; and ii) the expansion of reforestation actions observed in the geographic area with socioeconomic and ecological contexts similar to those of the grouped project.

Justification: Although not very representative, it is a plausible scenario.

Outcome of Sub-step 1a: the plausible alternative scenarios for land use within the Grouped project boundaries therefore are:

- *Scenario 1*: Continuation of current land use.
- *Scenario 2*: Reforestation of the land within the grouped project boundaries without being registered as an AFOLU VCS project.
- *Scenario 3*: Planting in at least some of the land within the grouped project boundaries.

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

The plausible scenarios mentioned above follow the applicable laws and regulations in Brazil and in the areas that make up the limits of the grouped project.

There are no applicable mandatory laws and regulations that prohibit any of the identified alternative scenarios. According to the Brazilian Forestry Code, "*the extraction of firewood and other products from planted forests in areas not considered Permanent Preservation and Legal Reserve Areas is free*" (Forestry Code, Chapter VIII paragraph 2).

The Brazilian Forestry Code[37] also regulates and determines the establishment of Protected Areas, through legal reserves and permanent preservation areas. Nonetheless, this law explicitly allows the use of market instruments, such as the VCS, to serve as means of implementation of its objectives[38]. It has also been developed after 2001, hence not part of the baseline scenario[39]. Still, the practice of reforestation for the purpose of restoration of such areas faces various barriers and obstacles, and most importantly, there is no financial return for such efforts, as discussed below.

Outcome of Sub-step 1b: the scenarios listed below are plausible land use scenarios that are in accordance with Brazilian legislation and the states that are part of the Grouped project limits.

- *Scenario 1*: continuation of current land use.
- *Scenario 2*: Reforestation of the land within the grouped project boundaries without being registered as an AFOLU VCS project.
- *Scenario 3*: planting in at least part of the land within the limits of the Grouped project.

STEP 2. Barrier Analysis

As determined by the applicable methodology, this grouped project has adopted the following steps for analyzing barriers:

Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenarios.

[37] The Forestry Code regulates at a national level the protection of native vegetation, and activities related to the use of forests resources.

[38] Article 41, Paragraph 4 of Law 12651 of May 25, 2012 allows the use of Brazilian and international market mechanisms to achieve feasibility of actions to recover and preserve areas of native forest: *"§ 4º Activities of maintenance of Permanent Preservation Areas, or areas of Legal Reserve or restricted use, are eligible for any payments or incentives from environmental services, characterizing additionality for the purposes of Brazilian and international markets for the certified emission reductions of greenhouse gases."*

[39] Appendix 19 of the EB23, National and/or sectoral policies and baseline scenario for Afforestation and Reforestation project activities, as determined by the methodological tool applied in this methodology "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities", Version 01.

This grouped project faces the following barriers that could prevent its implementation. Scenario 1 is free of any of the barriers identified.

a) Barrier due to traditional local land use: the historical tradition of land use for agriculture and livestock grazing;

b) Barriers related to markets, transport and storage: market and operational difficulties inherent to forestry activities;

c) Investment barrier: liquidity, long term, the country's investment and financing culture and context.

Outcome of Sub-step 2a: the barriers that would prevent one or more land uses identified in Sub-step 1b are listed above.

Sub-step 2b. Elimination of land use scenarios that are prevented by the identified barriers.

a) Barrier due to traditional local land use

The predominant land use practices in the grouped project region will then be analyzed, i.e., the situation in the states of the Central-West region of Brazil: Mato Grosso, Mato Grosso do Sul and Goiás.

Brazil has the largest commercial cattle herd in the world, alongside around 180 million hectares of natural and cultivated pastures (LAPIG, 2020)[40], as well as approximately 65.3 million hectares (IBGE, 2020)[41] dedicated to grain production (250 million tons in 2020). These two areas combined (245 million hectares) represent about 30% of the country's territory (875.2 million hectares).

In 2018, 8.6 million hectares (IBGE, 2020) were reforested for economic purposes ("planted forests"), representing less than 0.9% of the country's territory. Thus, even at the national level, the area designated for agriculture is considerably larger than that for reforestation. Therefore, the prevailing productive practices of land use in Brazil are clearly focused on pastures and grain cultivation. This situation in the Central-West of the country is even clearer.

[40] PASTAGEM.org, 2020. Atlas Digital das Pastagens Brasileiras.

See https://www.lapig.iesa.ufg.br/lapig/index.php/produtos/atlas-digital-das-pastagens-brasileiras

[41] IBGE, 2020. Levantamento Sistemático da Produção Agrícola. See https://sidra.ibge.gov.br/tabela/1618

The states in the Central-West region of Brazil total 160 million hectares (IBGE, 2020). Agriculture and pastureland are the common practice in the region, being an intrinsic part of the regional culture, as outlined in Table 6 and Figure 35 below.

Table 6: area of states – by region, within the limits of the grouped project– in hectares, in 2018. Source: IBGE, 2020.

Grouped project BOUNDARIES (STATES)	AREA (ha)	AREA AGRO+PASTURE (ha)	TOTAL AREA %	FORESTRY AREA (ha)	TOTAL AREA %
Mato Grosso	90,320,244	30,875,000	34%	132,500	0.15%
Mato Grosso do Sul	35,714,553	19,537,100	55%	1,071,400	3%
Goiás	34,010,649	21,887,000	64%	131,500	0.39%
Total	160,045,446	72,299,100	45%	1,335,400	0.8%

Figure 34: Total area of the states of Mato Grosso, Mato Grosso do Sul and Goiás for the main land uses in 2018. Source: Produced originally based on IBGE, 2020.

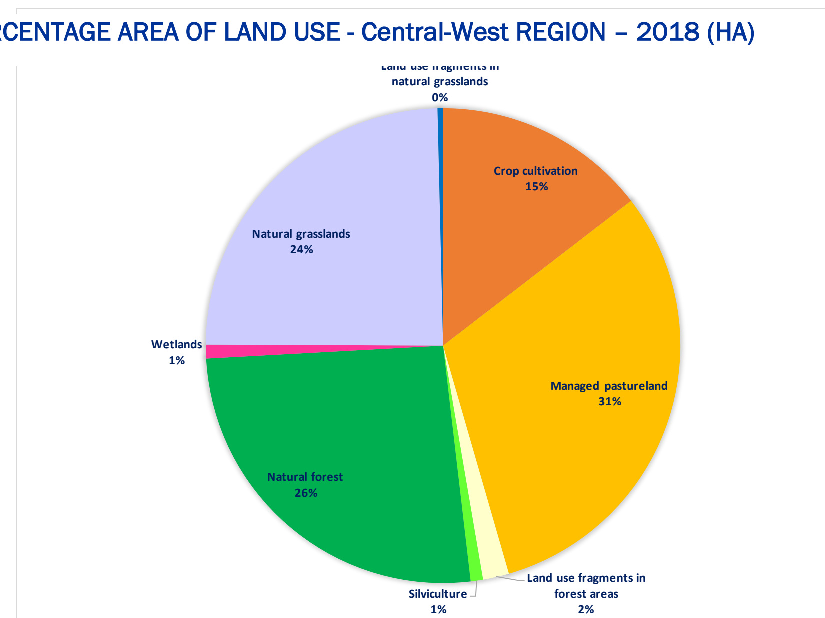
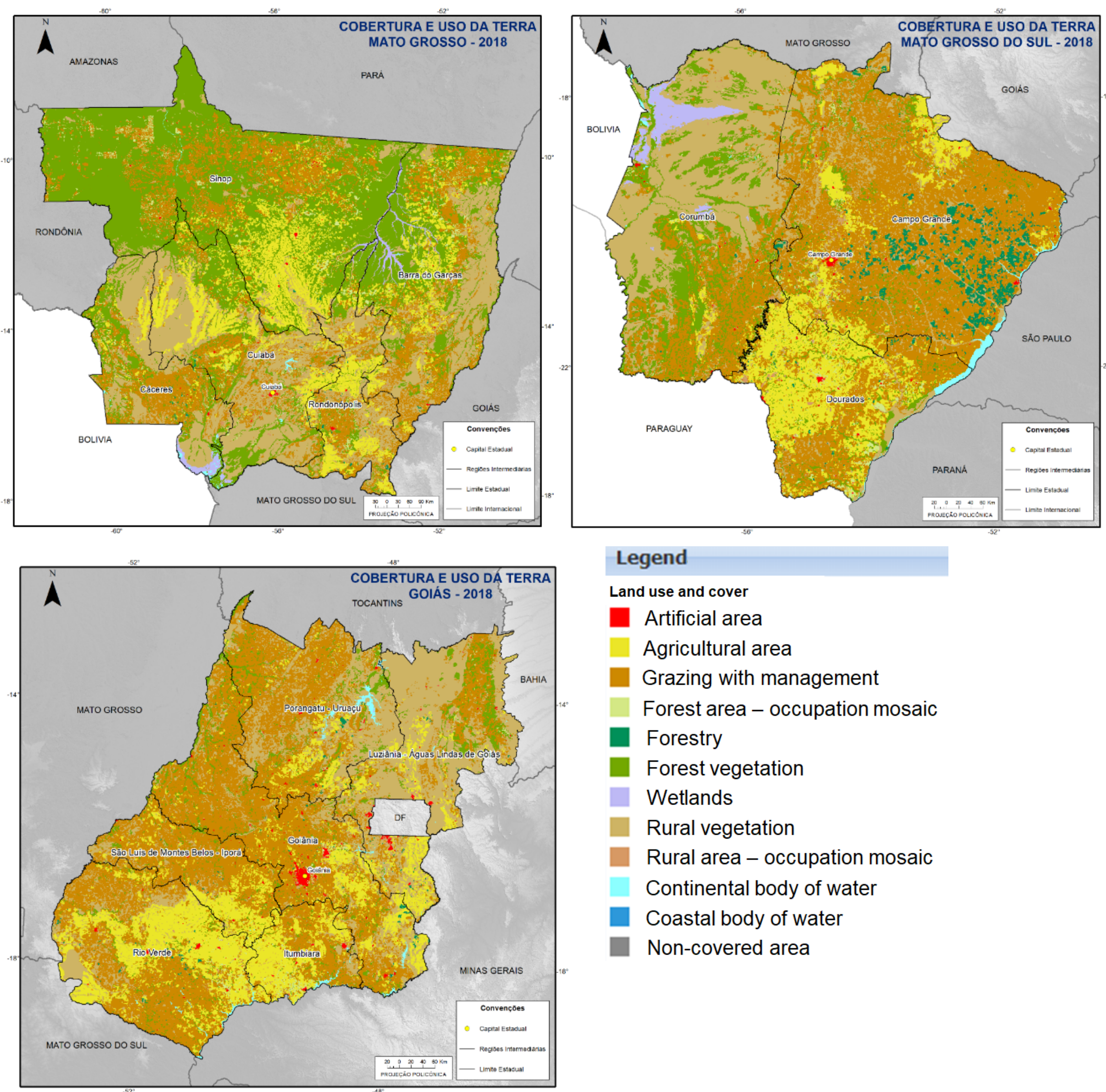


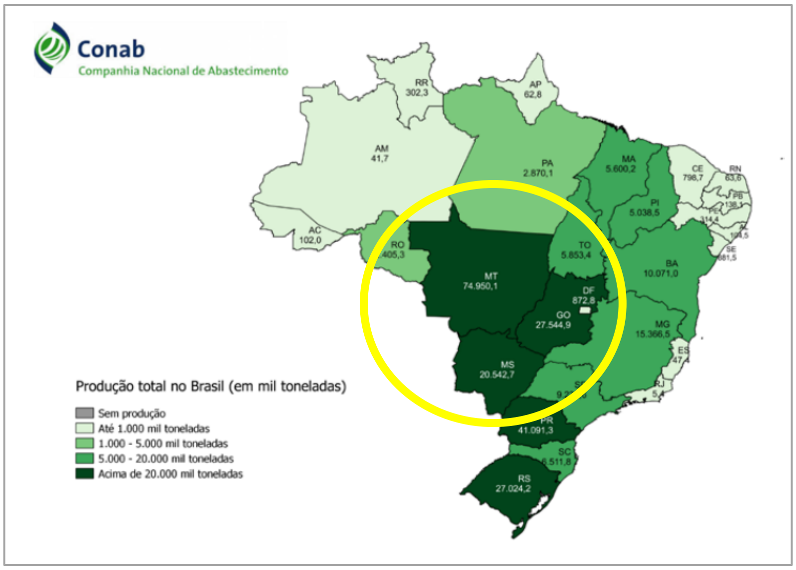
Figure 35: Land use map – states of the Central-West region: Mato Grosso, Mato Grosso do Sul and Goiás, 2018. Source: IBGE, 2020[42].

[42] See https://www.ibge.gov.br/apps/monitoramento_cobertura_uso_terra/v1/



In this context, the land use in the states where the grouped project is to be implemented is traditionally agricultural, with them being among the largest agricultural producers in the country (see map, states MT, MS and GO), based on cultures of much shorter production cycles than forest cycles.

Figure 36: Total production in Brazil (in thousand tons). Source: CONAB [National Food Supply Company], 2020.



The Central-West Region of Brazil currently represents the core of the expansion of the Brazilian agricultural frontier, standing out in the ranking of agriculture Gross Value of Production (GVP)[43]. In 2018, the states of Mato Grosso, Mato Grosso do Sul and Goiás were among the top four in the country in terms of livestock (ABN, 2018), with special emphasis on grain production – MT topping the national rankings in grain production and the total agriculture GVP in Brazil.

Much of the agriculture's predominance can be understood not only by the physical strength of the crops, but also by the tradition and custom of cultivating the land in short cycles. According to the National Supply Company (CONAB, 2020), "*thanks to the cultivation techniques implemented, from soil management, through to seed technology and applied with modern machines, in addition to qualified labour, the country has the distinction of being able to produce up to <u>three crops of grain</u>[44] in the same area.*" It is worth highlighting the fact that, in a single area, the grower can produce up to three harvests per year.

The investment in reforestation, in turn, requires careful assessment and prior planning, as the economic return of the enterprise occurs at greater intervals when compared to agriculture, which is even clearer in the next sections. For example, eucalyptus takes approximately <u>7 years from planting to first harvest</u>, that is, from the initial disbursement to the first year of revenue obtained from the sale of the product. The long return period and its implications in relation to risks, predictability and instabilities represent a radically different characteristic from the

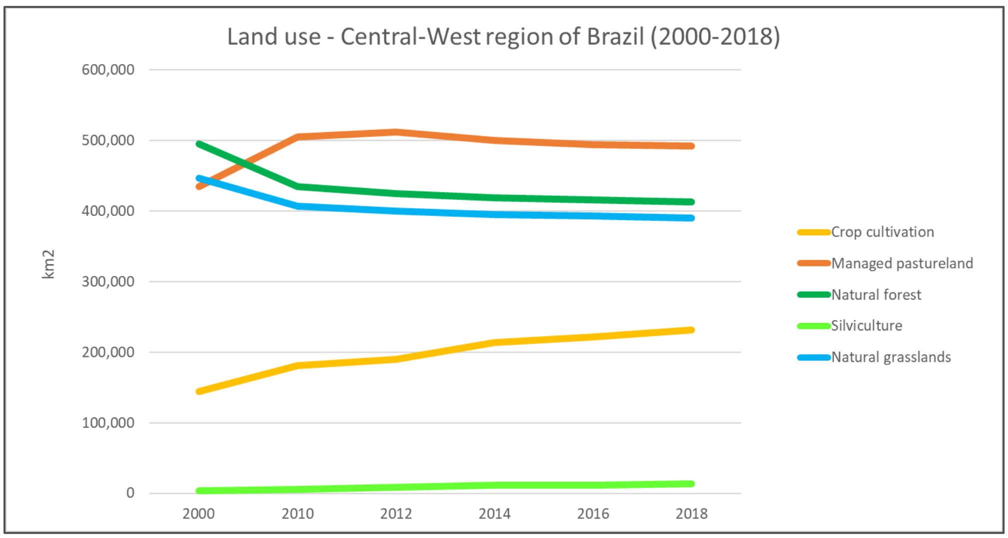
[43] The GVP of the Central-West region totaled R$231.4 billion in 2020 (MAPA, 2020)

[44] Emphasis added.

prevailing practice of agricultural crops in the region, in addition to the specificities of implantation, harvesting and marketing strategies, which can also be a deterrent[45].

In addition to the prevailing agricultural practices, it is worth noting that the reforestation for restoration purposes and the loss of carbon stocks through deforestation remains a pressing issue, making the need and, at the same time, the challenges to restore areas even stronger. Although the Cerrado biome (the prevailing biome in the project area) represents only 9.9% of the total deforestation alerts raised in the country in 2021, the total area deforested in the Cerrado represents almost 30.2% of the total deforestation in the country, which illustrates the overall challenge in the region (MAPBIOMAS, 2022).

Figure 37: dynamics of the main land-uses in the Central-West region, compared to silviculture, 2010–2018. Source: IBGE, 2020.



Thus, considering that land use in the grouped project region is clearly predominantly agriculture, and that reforestation areas represent less than 1% of the entire region (IBGE, 2020), the most likely land use scenario within the limits of the grouped project, without the program, would clearly be agriculture and livestock with deforested or partially deforested preservation areas.

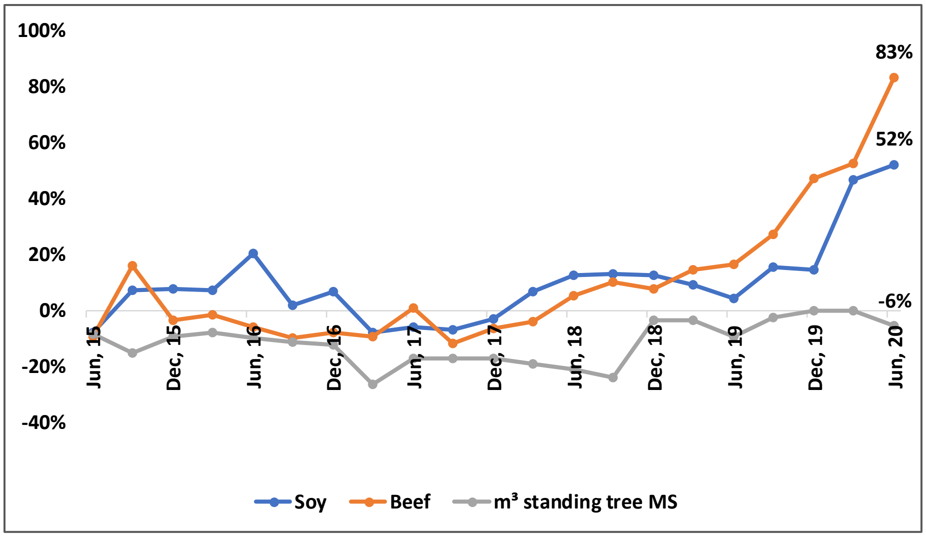
b) Barriers related to markets, transport and stock

The trade of forest products in Brazil faces various market difficulties, especially in relation to agriculture.

[45] See https://www.embrapa.br/florestas/transferencia-de-tecnologia/eucalipto/perguntas-e-respostas.

Regarding market dynamics, when compared to the values of the last years, the cubic metre of standing wood devalued by 6%, while soy and beef appreciated by 52% and 83% per tonne, respectively (see Figure 38[46]).

Figure 38: Percentage change in the trade price of soy, wood and cattle – June 2015 base. Source: Poyry[47] and Index Mundi[48]



When the main forest product markets are analyzed, the data also corroborates a less favorable situation. Even in scenarios of growth in sales volume, revenues are either stable or declining, revealing a devaluation of the product unit.

According to data from the Secretariat of Foreign Trade of Brazil (SECEX), there was a unit devaluation in various forestry products. For example, since 2010, the production of laminate flooring, paper and wood panels has remained virtually constant, while prices have depreciated by 7%, 6% and 3%, respectively. Since 2007, the same has been seen in other sectors: sawn wood (6%), plywood (26%) and charcoal (6%)[49].

It should also be noted that unlike agriculture, reforestation activities do not constitute the generation of commodities traded in future markets. Based on production estimates, future markets allow the sale of the expected harvest at a predetermined price, which substantially expands the set of opportunities to make a project more attractive and less risky. The table below indicates the commodities traded on the Brazilian stock exchange. Forest products are not

[46] Data available: Mato Grosso do Sul (source).

[47] Poyry: Radar, Year 13, Issue 2, Second quarter 2020.

[48] Index Mundi, 2020. See: https://www.indexmundi.com/commodities/?commodity=wood-pulp&months=120&currency=eur

[49] Even in the pulp sector, there was a 38% growth in production between 2019 and 2010, however the unit prices of short fibre and long fibre pulp depreciated by 10% and 28% respectively (IBÁ, 2020[49]).

included. According to the B3, the contracts made available are determined according to market demand.

Table 7: Main contracts traded on the B3. Source: B3[50]

Segmento	Contrato	Código de Negociação
Ações e Índice	Índice Bovespa Índice S&P500 Futuro de Ações	IND e WIN ISP e WSP B3SAO e outros
Taxa de Juros	Taxa DI Taxa Selic Cupom Cambial de DI Cupom de IPCA	DI1 DDI OC1 DAP IAP
Moedas	Dólar dos Estados Unidos Euro Libra Esterlina Iene Japonês Iuan Chinês Outras	DOL e WDO EUR GBR JAP CNY
Commodities	Boi Gordo Milho Café Soja Açúcar Etanol	BGI CCM ICF SFI ETN

When considering reforestation activities with native species with the purpose of restoration, there are no expected substantive revenues, only costs, in the absence of reliable payments for environmental services. The decision for restoring large deforested areas, converting them from productive areas to preservation areas, is still a tough one, since this would be an irreversible step. And, as there are no rules issued to regulate how the financial incentives for activities of restoration and improvement of ecosystems would take place, this decision is largely unfeasible in the medium and long run. Furthermore, even the enforcement of the obligations set out in the Forestry Code for areas covered by it, i.e. Legal Reserves and Permanent Preservation Areas is affected since there are not yet any instruments in place for payment of costs or remuneration able to serve as a means for implementation of restitution of forests.

As previously mentioned, the productive areas established in the project's region add significant share of the lands potentially fit for cultivation, providing the producer with economic gains. Demarcation of areas of native forest, as per the legislation, represent not only reduction of these cultivable areas, and consequently of possible gains, but also a cost which has to be paid exclusively by the producer.

Regarding logistics, another relevant aspect in relation to the conversion of agricultural areas into reforestation activities is the greater difficulty in converting reforestation areas to other crops at the end of the forestry project, if the independent producer desires this. This is because, in addition to harvesting the trees, it would be necessary to eliminate tree stumps to make new

[50] http://www.b3.com.br/pt_br/produtos-e-servicos/negociacao/renda-variavel/mercado-de-acoes/mercado-futuro.htm.

plantings feasible. This implies more difficulty and additional costs for the producer, aggravating the perception of inflexibility associated with forestry.

Market liquidity is also a relevant aspect. While revenue flows occur at least annually in agriculture, and in some cases, there is the possibility of up to three harvests in one year, in reforestation activities, liquidity occurs only from the seventh year.

Thus, the discrepancy in price developments, the absence of a structured spot market, access to future markets, the devaluation of the unit product and, especially, lower liquidity in relation to the agricultural crops prevalent in the grouped project region (according to the barrier (a)) constitute important barriers, which hinder the conversion of agricultural areas into independent reforestation projects.

c) Investment barriers: liquidity, long term, investment culture and financing in the country

As mentioned above, unlike the main agricultural crops, forest production requires long periods of investment maturity, depending on the eucalyptus cycle in Brazil, whose first harvest occurs only around the seventh year after planting, in a total investment cycle that usually ranges from 14 to 28 years. In other words, the producer has a high disbursement at the beginning of the period but must wait approximately 7 years for the first source of revenue to occur, assuming various risks related to the development of the forest and the dynamics of the market during the long periods between planting and harvest.

In addition, reforestation for restoration purposes is an activity that provides no economic return to the rural producer. Still, the simple process of delimiting an area to allow for natural regeneration generates costs for the landowner, without any expectation of financial return. Especially within the grouped project's boundary, where large areas were deforested to serve as productive areas (cattle and crops), even their share of preservation areas as per the Law, and those areas are often covered by exotic grass species, such as *Brachiaria spp*., and/or in poor conditions due to bad or excessive cultivation management and techniques, overused soil, cattle trampling, among others. Consequently, these areas are commonly hard to regenerate by themselves, due to poor soil conditions, erosion, entanglement of grasses' roots, depletion of natural seed banks needing some degree of intervention (EMBRAPA, 2016[51]).

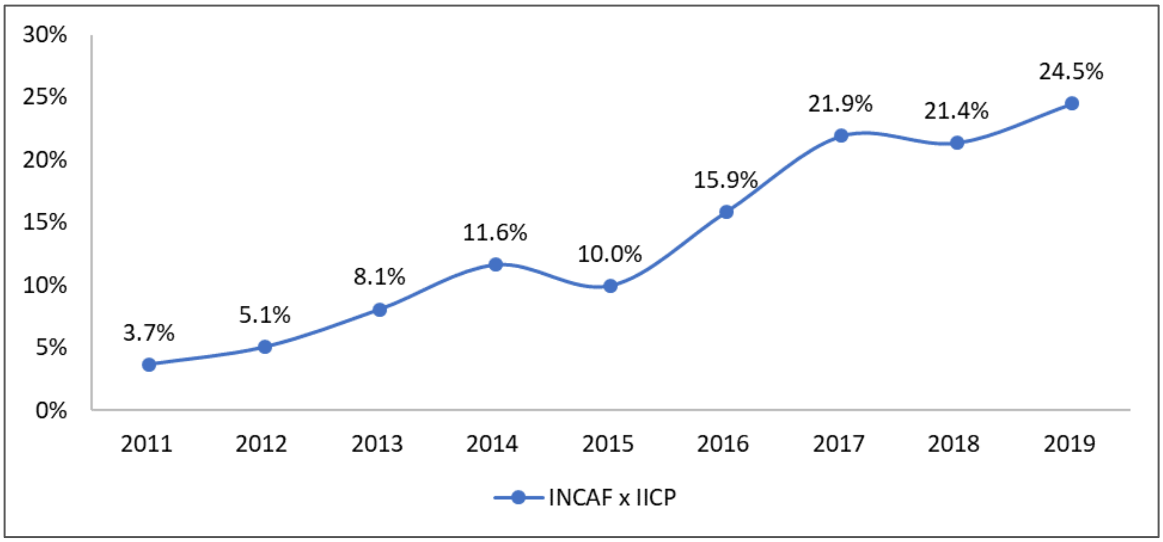
For most agricultural collections, especially in the grouped project region (including soy and cattle, which prevail in the Central-West), the cycles are at least annual and, therefore, the level of uncertainty over reforestation is substantially higher, and so are the perceptions of risks on the part of investors accustomed to other cultures, as demonstrated in the barriers above.

In addition to the risks linked to the long-term nature of this type of investment, the dynamics of increased activity costs have also not been favorable. In contrast to the history of falling or stabilizing prices of forest products mentioned in the point above (market barriers), the costs of

[51] Embrapa, 2016. See https://www.embrapa.br/busca-de-noticias/-/noticia/9618828/regeneracao-natural-nao-e-eficiente-em-areas-de-agricultura .

forest production in Brazil, with regard to the general market situation, have grown above inflation over the years (see Figure 39 for the last 10 years). In the same context, the costs of forestry activity represented by the INCAF (Forest Activity Costs Index) have historically grown above the cost of agricultural production, represented by the IICP (Production Cost Inflation Index). The accumulated variation between INCAF and IICP corresponds to 24%, i.e. the cost of forestry activity rose 24% above inflation presented by agricultural activity in the period between 2011 and 2019.

Figure 39: Accumulated variation between the Forest Activity Cost Index (INCAF) and the Production Cost Inflation Index (IICP). Source: Pöyry e Farsul (2020).



Besides the difficulty inherent in long-term reforestation, financing conditions also represent a significant challenge in relation to traditional agricultural practices. Historically, agribusiness in Brazil relies on rural insurance, credit insurance, and the future harvest is the collateral (IPEA, 2015)[52]. But since the middle of the last decade, the system has been moving towards agricultural insurance contracted alongside credit, giving financial guarantees against unsuccessful harvests. This does not apply to the activity proposed in this grouped project and the use of the forest itself as a guarantee for financing is not yet an option. Even when considering the main instrument for low carbon financing in the land use and forests sector in Brazil (Low Carbon Agriculture Program – ABC), 98% of the funds[53] in the last 10 years were destined for predominantly agricultural activities. Forests are also not accepted as a guarantee – only tangible items such as mortgages, future harvests, fiduciary property, surety, bonds, or reserve of means of payment are accepted.

[52] http://repositorio.ipea.gov.br/bitstream/11058/3407/1/td_2028.pdf

[53] Agroicone, 2020.

Other capital market instruments are also less accessible to independent producers. For example, issuing Agribusiness Receivables Certificates (CRAs) generally requires well-defined amortization and payment terms, which is easily manageable with annual agricultural crops. On the other hand, in the case of independent reforestation actions, it is difficult to accurately predict when the harvest will take place (revenue generation) according to the market conditions at the time.

Furthermore, the availability of resources in the capital market from large institutional investors for alternative investments, such as forest-based investments, is still very small, given the diverse peculiarities of the business. In Brazil, even among the main pension funds, which are generally more open to investments in long-term assets, participation is much lower. According to ABRAPP (Brazilian Association of Closed Supplementary Pension Entities), over the past 7 years investments by the main pension funds in Brazil in FIPs (Investment Funds in Participations, which include forestry along with several other sectors), fell from 2.6% of the total amount available to only 1.1%, corroborating the difficulty in accessing this type of capital (ABRAPP, 2020). All of this has occurred even in recent periods in which there has been a large availability of capital in the world, which also highlights the difficulty of attracting this type of long-term resource to Brazil (see also the next barrier).

Also, in terms of the long-term investment context, Brazil has lost its investment grade (poor credit rating)[54] for several reasons, especially due to its unstable economic and fiscal context. Over the past few years, Brazil has suffered from political and economic instability (even before the COVID-19 pandemic), which has made investments in forest production proportionately more risky and less attractive compared to the baseline, given the intrinsic relationship with long-term exposure and connection with the various barriers above. This political instability is strongly associated with expectations of economic volatility, directly interfering with investment decisions in Brazil and the ability to attract long-term resources. To cite a more recent period, in the past 7 years, various political events have played a crucial role in investment decisions and expectations. Included in this period are events such as the 2013 protests[55], the beginning of a presidential impeachment process in 2015[56], allegations of corruption against the president who succeeded the previous presidency, removed through impeachment, a decrease in the country's investment grade among others.

The variations in the net foreign direct investment flows portray this point well. FDI values in 2019 fell 32% compared to the 2011 flow, even before the pandemic[57].

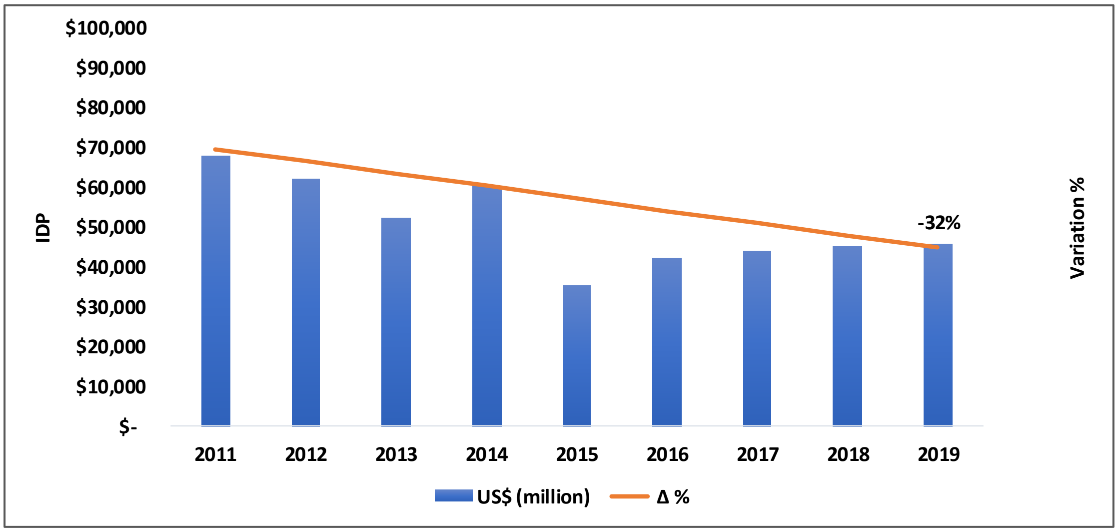
[54] http://g1.globo.com/economia/noticia/2015/09/standard-and-poors-tira-grau-de-investimento-do-brasil.html

[55] See: https://www.bbc.com/portuguese/brasil-44310600

[56] See: https://www2.camara.leg.br/atividade-legislativa/plenario/discursos/escrevendohistoria/destaque-de-materias/impeachment-da-presidente-dilma

[57] In 2020 specifically, the decline was even more dramatic. With regard to direct investments, Brazil fell by 41% compared to the same period in 2019 (the lowest value in 11 years) according to the Central Bank of Brazil.

Figure 40: Historical series of Net Direct Investments in Brazil. Source: Central Bank of Brazil



Based on the VCS, the measures proposed under this grouped project – reforestation practices in partnership with local owners – are more attractive as they generate additional economic incentive, including in the period that may precede the first harvest of the wood (before 7 years) since carbon stocks made possible by the project can be established and verified after 2, 3 or 4 years of forest maturation.

<u>Outcome of Sub-step 2b:</u> The land use scenario that is not impeded by the analyzed barriers is *Scenario 1: continuation of current land use*.

Sub-step 2c. Determination of the baseline scenario (if permitted by the Barriers Analysis)

The decision tree proposed by the methodological tool is applied to determine the baseline scenario:

a) Is the reforestation not registered as an AFOLU VCS project included in the list of land uses that are not impeded by barriers?

No. At the end of Sub-step 2b, only one scenario remains that is not subject to any of the impediments presented by the list of barriers analyzed, and this is *Scenario 1: continuation of current land use*.

Table 8: summary of the conclusions of the analysis of the identified barriers.

Alternative scenarios			Summary of analysis
Scenario 1 *continuation of current land use*	*Scenario 2* *Reforestation of the land within the grouped project boundaries without being registered as an AFOLU VCS project*	*Scenario 3* *planting in at least part of the land within the limits of the Grouped project*	
a) Barrier due to local land use tradition *Historical tradition of land use with agriculture and livestock activities*			
No	Yes	Yes	Farming is widely disseminated in the region within the limits of the Grouped project, inherent to the culture and tradition of land use in the region. Without any perspective of incentive (Scenario 2), it is very unlikely that producers will migrate from their traditional crops to a totally new and specialized activity, such as reforestation. In the same way, the specificities of reforestation, without specialized technical support, would discourage producers from taking risks in the long run, even if partially, in this enterprise (Scenario 3). The current situation of land use in the grouped project region corroborates the context: reforestation represents only 0.8% of the area. Scenario 1 is, therefore, the scenario that faces no barriers to its continuity.
b) Barriers related to markets, transport and stock *Market and operational difficulties inherent to forestry activity*			
No	Yes	Yes	The absence of a structured spot market and of access to future markets, especially the lower liquidity in relation to agricultural crops prevalent in the grouped project region, constitute relevant barriers that hinder the conversion of agricultural areas into independent reforestation actions (Scenarios 2 and 3) . Scenario 1 is, therefore, the most likely scenario.
c) Investment barrier *Less liquidity, increased production costs and competition with agribusiness for financing sources*			

No	Yes	Yes	Forestry production requires long periods of investment maturity (a minimum of approximately 7 years), unlike the main agricultural crops (harvests at least annually), characterized by being an investment with less liquidity and greater risk. In addition to the risks linked to the long-term nature of this type of investment, the limited resources available for forest production (whether via debt, capital markets, etc.), among other aspects, corroborate the difficulty in mobilizing resources and interest in forestry investment in relation to the tradition of land use in the region (Scenario 3). Scenario 1 is, therefore, the most likely scenario. Also, in periods of economic instability, investors tend to focus their investments on projects that have greater liquidity and greater profitability to minimize their risks (Scenario 3). Due to the characteristics inherent to reforestation projects, these tend to be neglected when there is the possibility of agriculture (Scenario 1).

b) Does the list contain only one land use scenario?

Scenario 1, continuation of current land use, is not impeded by any of the barriers analyzed.

Thus, the conclusion is that the most plausible baseline scenario for this grouped project region is the continuation of current land use. Therefore, the baseline scenario for this grouped project is Scenario 1.

STEP 3. Investment analysis

This step is used only if the Barriers Analysis is not conclusive and is therefore not applicable to this PD.

STEP 4. Analysis of common practice

According to the combined tool, the previous steps shall be complemented with an analysis of the extent to which forestation activity has already diffused in the geographical area of the proposed AFOLU VCS project activity.

The geographic region considered for the comparison between the proposed reforestation activity by this grouped project and other similar activities was the Central-West region of Brazil.

Currently, there are four AFOLU VCS projects registered in this region of Brazil[58]. Two of them are very small in size (Projects 1663 and 2079) and the other are proposed for native vegetation only (Projects 665 and 738). Hence, none of them are comparable to the activities of this proposed grouped project.

As already presented in Step 2, Analysis of Barriers, the states of the Central-West region are notable for their remarkable performance in the agricultural sector, being even mentioned as “the country's breadbasket”. There are forest plantations in the states, but the proportion of area covered by reforestation compared to agricultural areas for the total number of states is almost insignificant. Even in Mato Grosso do Sul, which has a greater amount of reforested area, this area represents only 3% of the state’s total. Mato Grosso and Goiás do not reach 1% each (IBGE, 2020/IBA, 2019). Clearly, reforestation as proposed by this grouped project is not the baseline and is therefore additional.

Although, the previous assessment demonstrates that project activity is not the common practice in the region, an additional common practice check has been performed as per the combined tool. There are other companies in the grouped project’s region that have also established reforestation activities. However, as presented below, such activities are mostly related to verticalized operations from large multinational companies from the agribusinesses industry, to use biomass as sources of heat for drying grains, energy for cold storage of food and steam generation in production processes, i.e. an input for their agricultural production processes. These companies are listed below and all of them are located in the grouped project’s area, i.e. the Center-West region of Brazil (States of Mato Grosso/MT, Goias/GO and Mato Grosso do Sul/MS):

Cargil[59]: founded 155 years ago, Cargill is a private, multinational company headquartered in the state of Minnesota, USA, whose activity is food production and processing. It is currently the second largest privately held company in the world and employs more than 160,000 people in 67 countries.

BRF[60]: BRF is a Brazilian multinational food company, the result of the merger between Sadia and Perdigão, two of the main food companies in Brazil. It is the world's largest producer and exporter of processed meats, mostly based on poultry, and the second largest food industry in the country. It has more than 85 years of history and a team of 95,000 employees in 130 countries.

[58] See https://registry.verra.org/app/search/VCS/Registered.

[59] See https://www.cargill.com.br/en/cargill-at-a-glance

[60] See https://www.brf-global.com/en/about/brf/about-us/

Bunge[61]: founded a trading company in Amsterdam in 1818, Bunge is an agribusiness and food multinational grain trading company that produces food, operates in port and logistics services and produces sugar and bioenergy. According to a survey by Brand Finance, in 2012 Bunge was among the 20 most valuable brands in Latin America: the only agribusiness and bioenergy company to be included in this ranking, and the second-ranked company in the food sector.

ADM[62]**:** is a conglomerate founded in the USA in 1818, operating more than 270 factories worldwide, with 40,000 employees, where cereal grains and oilseed plants are transformed into numerous products used in food, beverages, industries and animal fodder.

Amaggi[63]**:** Amaggi is a Brazilian company in the areas of agriculture (production of soybeans, corn and cotton), logistics and operations (port, road and river operations), commodities and energy (generation and commercialization of electric energy). Operates in 7 countries with 6,000 employees. It was ranked the fifth largest exporter of soybean and soy products in Brazil in 2020.

The forestation activities carried out by these companies are not similar to the one proposed by this grouped project, and did not face barriers likewise, especially because of the staggering difference between the companies' scale and purposes. The target of the reforestation activities carried out by these large companies is not the forestry activity itself, but rather the provision of an input to their production of grains and animal protein under their agribusinesses. The difference in the scale of the companies, when compared to LACAN, and the purpose of their plantations substantially affects the approach, conditions and resources that can be made available and accessed for the establishment of the forest areas and constitute essential distinctions between the proposed forestation activity and the ones found in the region. So, forestation activities in the region cannot be considered similar due to essential distinctions between them and the proposed grouped project: the proposed ARR grouped project is not the baseline scenario and, hence, is additional.

3.6 Methodology Deviations

Not applicable. This grouped project proposes no deviation to the applied methodology.

[61] See https://www.bunge.com/who-we-are/our-history

[62] See https://www.adm.com/our-company/adm-facts

[63] See https://www.amaggi.com.br/en/about-the-company/our-performance/

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

4.1.1 Baseline net GHG removals by sinks

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$ Equation 1[64]

Where:

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks, *t*; t CO_2-e

$\Delta C_{TREE\_BSL,t}$ = Change in carbon stock in baseline tree biomass within the project boundary in year *t*; as estimated by the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*"; t CO_2-e

$\Delta C_{SHRUB\_BSL,t}$ = Change in carbon stock in baseline shrub biomass within the project boundary in year *t*; as estimated by the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*"; t CO_2-e

$\Delta C_{DW\_BSL,t}$ = Change in carbon stock in baseline dead wood biomass within the project boundary in year *t*; as estimated by the tool "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*"; t CO_2-e

$\Delta C_{LI\_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary in year *t*; as estimated by the tool "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*"; t CO_2-e

[64] For Equation 1 the numbering adopted in the *AR-ACM0003* methodology was maintained.

4.1.1.1 Carbon stock in trees in the baseline (Pre-project trees)

The determination of carbon stock in pre-existing trees in each instance is calculated according to item 5.11 of version 04.2 of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*", following items below.

The carbon stock in pre-existing trees may be considered as <u>zero</u> if:

(a) *"The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;*

(b) *The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;*

(c) *The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity."*

(d) there are no pre-existing trees in the baseline.

The previous land use was determined as non-forested lands, especially agriculture and pasture. Although there may be some trees in the areas, their density will not characterize forest formation according to Brazil's definition of forest. Preferably, the pre-project trees in the project boundary will not be harvested and other forestry and planting activities will be carried out as to avoid competition with existing trees. However, whenever pre-project trees occur in the project boundary, the instance implementer could:

i) Georeference the pre-project trees, at the time of inclusion of the instance, to monitor their survival during the crediting period of the project (if the isolated trees are not georeferenced, conservatively, instance implementer shall apply the baseline discount of these trees); and/or

ii) Harvest the pre-project trees and apply the baseline discount, as below.

In case the PP opts to apply the discount in a given instance, the carbon stock in the biomass of trees in the baseline within the project boundary could be estimated by **stratified random sampling (Option 1)**, **census (Option 2)** or estimation by **proportionate crown cover (Option 3).** According to the density of pre-project trees the project implementer could opt for one of the possible options of measurements:

- <u>**Option 1** - stratified random sampling</u>: most suitable for areas with higher density of trees. It is estimated by measurement of sample plots using **stratified random sampling**, as described in section 8 (8.1.1) of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*", version 04.2;

- **Option 2** – census: most suitable for areas with lower density of trees. It is calculated through the census of the area.
- **Option 3** – proportionate crown cover: only applicable for "estimation of the pre-project carbon stock in tree biomass in the baseline where the mean pre-project tree crown cover is **less than 20 per cent** of the threshold tree crown cover reported by the host Party under paragraph 8 of the annex to decision 5/CMP.1", as per item 8.3 of "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*", version 04.2.

Option 1 (measurement of sample plots; stratified random sampling):

$$C_{TREE\_BL} = \frac{44}{12}\, x\, CF_{TREE\_BL} x B_{TREE\_BL}$$ Equation 12[65]

$$B_{TREE\_BL} = A\ x\ b_{TREE\_BL}$$ Equation 13

$$b_{TREE\_BL} = \sum_{i=1}^{M} w_i\ x\ b_{TREE\_BL,i}$$ Equation 14

$$u_{C\_BL} = \frac{t_{VAL}\ x\ \sqrt{\sum_{i=1}^{M} w_i^2\ x\ \frac{s_i^2}{n_i}}}{b_{TREE\_BL}}$$ Equation 15

$$b_{TREE\_BL,i} = \sum_{p=1}^{ni} b_{TREE\_BL,p,i}$$ Equation 16

$$s_i^2 = \frac{n_i\ x\ \sum_{p=1}^{ni} b_{TREE\_BL,p,i}^2 - \left(\sum_{p=1}^{ni} b_{TREE\_BL,p,i}\right)^2}{n_i\ x\ (n_i - 1)}$$ Equation 17

Where

C_{TREE_BL}	=	Carbon stock in trees in the tree biomass estimation strata in the baseline; t CO_2e

[65] For Equations 12 to 17, the numbering adopted in the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

CF_{TREE_BL}	=	Carbon fraction of tree biomass; t C (t d.m.)$^{-1}$. A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.
B_{TREE_BL}	=	Tree biomass in the tree biomass estimation strata in the baseline; t d.m
A	=	Sum of areas of the tree biomass estimation strata; ha
b_{TREE_BL}	=	Mean tree biomass per hectare in the tree biomass estimation strata in the baseline; t d.m. ha^{-1}
w_i	=	Ratio of the area of stratum *i* to the sum of areas of tree biomass estimation strata (i.e./); dimensionless
$b_{TREE\_BL,i}$	=	Mean tree biomass per hectare in stratum *i*; t d.m. ha^{-1}
u_{C_BL}	=	Uncertainty in C_{TREE_BL}
t_{VAL}	=	Two-sided Student's t-value for a confidence level of 90 per cent and degrees of freedom equal to n – M, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata
s_i^2	=	Variance of tree biomass per hectare across all sample plots in stratum *i*; (t d.m. ha^{-1})^2
n_i	=	Number of sample plots in stratum *i*.
$b_{TREE\_BL,p,i}$	=	Biomass of tree in the baseline per hectare in plot p of stratum *i*; t d.m. ha^{-1}

In this context, the **biomass of the trees per hectare** will be calculated as detailed in the Appendix 1 of the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2*.

$$b_{TREE\_BL,p,i} = \frac{B_{TREE\_BL,p,i}}{A_{PLOT,i}} \times (1 + R_i)$$

Equation 1[66]

[66] For Equations 1 to 4, the numbering adopted in the Appendix 1 methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

$$B_{TREE\_BL,p,i} = \sum_{j} B_{TREE\_BL,j,p,i}$$ Equation 2

$$B_{TREE\_BL,j,p,i} = \sum_{l} B_{TREE\_BL,l,j,p,i}$$ Equation 3

$$B_{TREE\_BL,l,j,p,i} = f_{BL,j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots)$$ Equation 4

Where:

$b_{TREE\_BL,p,i}$	=	Tree biomass per hectare in sample plot *p* of stratum in the baseline *i*; t d.m. ha^{-1}
$B_{TREE\_BL,p,i}$	=	Tree biomass in sample plot *p* of stratum *i* in the baseline; t d.m
$A_{PLOT,i}$	=	Size of sample plot in stratum *i* in the baseline; ha
R_i	=	Root-shoot ratio for stratum *i*; dimensionless
$B_{TREE\_BL,j,p,i}$	=	Biomass of trees of biome *j* in sample plot *p* of stratum *i* in the baseline; t d.m
$B_{TREE\_BL,l,j,p,i}$	=	Biomass of tree *l* of biome *j* in sample plot *p* of stratum *i* in the baseline; t d.m.
$f_{BL,j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots)$	=	Above-ground biomass of the tree returned by the allometric equation for biome *j* relating the measurements of tree *l* to the above-ground biomass of the tree; t d.m.

The value R_i is estimated as $R_i = \frac{e^{(-1.085+0.9256\times\ln b)}}{b}$, where b is the aboveground tree biomass per hectare (tons of dry matter ha^{-1}), as presented in Appendix 1 of the methodological tool *"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities", version 04.2*.

Option 2 (census):

$$C_{TREE\_BL} = \frac{44}{12}\, x CF_{TREE\_BL} x B_{TREE\_BL}$$ Equation 12[67]

Where

C_{TREE_BL}	=	Carbon stock in trees in the baseline; t CO_2e
CF_{TREE_BL}	=	Carbon fraction of tree biomass; t C (t d.m.)$^{-1}$. A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.
B_{TREE_BL}	=	Tree biomass in the baseline; t d.m. ha^{-1}

In the context of census, the **biomass of trees** will be calculated as detailed in the Appendix 1 of the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2*.

$$B_{TREE\_BL} = \sum_{i} B_{TREE\_BL,i}$$ Equation 2[68]

$$B_{TREE\_BL,i} = f_{BL,i}(x_{1,l}, x_{2,l}, x_{3,l}, \dots) \times (1 + R_i)$$ Equation 4

Where

$B_{TREE\_BL,i}$	=	Biomass of tree of biome (native) or species (exotic) *i* in the baseline; t d.m.
$f_{BL,i}(x_{1,l}, x_{2,l}, x_{3,l}, \dots)$	=	Above-ground biomass of the tree returned by the allometric equation for biome (native) or species (exotic) *i* relating the measurements of tree l to the above-ground biomass of the tree; t d.m.

[67] For Equation 12 the numbering adopted in the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

[68] For Equations 2 and 4, the numbering adopted in the Appendix 1 methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

R_i = Root-shoot ratio for stratum *i*; dimensionless;

The value R_i is estimated as $R_i = \frac{e^{(-1.085+0.9256 \times \ln b)}}{b}$, where b is the aboveground biomass of trees per hectare (tons of dry matter ha^{-1}), as presented in the *methodological* tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" Version 04.2*.

Option 3 (proportionate crown cover):

$$C_{TREE\_BSL} = \sum_{i=1}^{M} C_{TREE\_BSL,i}$$ Equation 20[69]

$$C_{TREE\_BSL,i} = \frac{44}{12} \times CF_{TREE} \times b_{FOREST} \times (1 + R_{TREE}) \times CC_{TREE\_BSL,i} \times A_i$$ Equation 21

Where:

C_{TREE_BSL}	=	Carbon stock in pre-project tree biomass; t CO_2e
$C_{TREE\_BSL,i}$	=	Carbon stock in pre-project tree biomass in stratum *i*; t CO_2e
CF_{TREE}	=	Carbon fraction of tree biomass; t C $(t.d.m.)^{-1}$
b_{FOREST}	=	Mean above-ground biomass in forest in the region or country where the ARR project is located; t d.m. ha^{-1}; Values from Table 3A.1.4 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values.
R_{TREE}	=	Root-shoot ratio for trees in the baseline; dimensionless. A default value of 0.25 is used unless transparent and verifiable information can be przaovided to justify a different value.

[69] For Equations 20 and 21, the numbering adopted in item 8.3 of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

$CC_{TREE\_BSL,i}$	=	Crown cover of trees in baseline stratum *i*, at the start of the ARR project activity, expressed as a fraction (e.g. 10 per cent crown cover implies $CC_{TREE\_BSL,i}$ = 0.10); dimensionless;
A_i	=	Area of baseline stratum *i*, delineated on the basis of tree crown cover at the start of the ARR project activity; ha

4.1.1.2 Changes in carbon stocks in trees and shrubs in the baseline

Changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero, according to item 5.12 of the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2, for those lands for which the PP can demonstrate that one or more of the following indicators apply:

a. *"Observed reduction in topsoil depth (e.g. as shown by root exposure, presence of pedestals, exposed sub-soil horizons);*

b. *Presence of gully, sheet or rill erosion; or landslides, or other forms of mass movement erosion;*

c. *Presence of plant species locally known to be indicators of infertile land;*

d. *Land comprises of bare sand dunes, or other bare lands;*

e. *Land contains contaminated soils, mine spoils, or highly alkaline or saline soils;*

f. *Land is subjected to periodic cycles (e.g. slash-and-burn, or clearing-regrowing cycles) so that the biomass oscillates between a minimum and a maximum value in the baseline;*

g. *Conditions (a), (b) and (c) under paragraph 11 apply."*

If the presence of shrubs is observed in the baseline condition and these shrubs are harvested, the carbon stock in the biomass of shrubs in the baseline within the project boundary will be estimated by proportionate crown cover, as described section 11 of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2.

Those areas where the shrub crown cover is less than 5 per cent are treated as a single stratum and the shrub biomass in this stratum is estimated as zero. For those areas where the shrub crown cover is more than 5 per cent, the carbon stock in biomass of shrubs in the baseline within the project boundary will be estimated as follows:

$$C_{SHRUB,t} = \frac{44}{12} \times CF_S \times (1 + R_S) \times \sum_i A_{SHRUB,i} \times b_{SHRUB,i}$$ Equation 26[70]

$$b_{SHRUB,i} = BDR_{SF} \times b_{FOREST} \times CC_{SHRUB,i}$$ Equation 27

Where:

$C_{SHRUB,t}$	=	Carbon stock in shrubs within the project boundary at a given point of time in year *t*; t CO_2-e.
CF_S	=	Carbon fraction of shrub biomass; t C (t.d.m.)$^{-1}$. A default value of 0.47 t C (t.d.m.)$^{-1}$ is used.
R_S	=	Root-shoot ratio for shrubs; dimensionless. The default value of 0.40 is used.
$A_{SHRUB,i}$	=	Area of shrub biomass estimation stratum *i*; ha
$b_{SHRUB,i}$	=	Shrub biomass per hectare in shrub biomass estimation stratum *i*; t d.m. ha^{-1}
BDR_{SF}	=	Ratio of shrub biomass per hectare in land having a shrub crown cover of 1.0 (i.e. 100 per cent) and the default above-ground biomass content per hectare in forest in the region/country where the A/R CDM project activity is located; dimensionless. A default value of 0.10 should be used unless transparent and verifiable information can be provided to justify a different value.
b_{FOREST}	=	Mean above-ground biomass in forest in the region or country where the A/R CDM project is located; t d.m. ha^{-1}. Values from Table 3A.1.4 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values.

[70] For Equations 26 and 27, the numbering adopted in the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2* was maintained.

$CC_{SHRUB,i}$	=	Crown cover of shrubs in shrub biomass estimation stratum *i* at the time of estimation, expressed as a fraction.

4.2 Project Emissions

Actual net GHG removals by sinks

Actual net GHG removals by sinks are calculated according to the applied methodology and the most recent version of the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" methodological tool.

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$ Equation 2[71]

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks in year *t*; t CO_2e
$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools in year *t*; t CO_2e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity in year *t*, as estimated by the tool "*Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*"; t CO_2e

Change in carbon stocks in the project, occurring in selected carbon pools in year *t*.

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$ Equation 3[72]

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in selected carbon pools in year *t*; t CO_2e

[71] For Equation 2, the numbering adopted in the *AR-ACM0003* methodology was maintained.

[72] For Equation 3, the numbering adopted in the *AR-ACM0003* methodology was maintained.

$\Delta C_{TREE\ PROJ,t}$ = Change in carbon stock in tree biomass in the project in year *t*, as estimated by the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" tool; t CO_2e

$\Delta C_{SHRUB\ PROJ,t}$ = Change in carbon stock in shrub biomass in the project in year *t*, as estimated by the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*"; t CO_2e

$\Delta C_{DW\ PROJ,t}$ = Change in carbon stock in dead wood in the project in year t, as estimated by the "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*" tool; t CO_2e

$\Delta C_{LI\ PROJ,t}$ = Change in carbon stock in litter in the project in year t, as estimated by the *"Estimation of carbon stocks and change in carbon stocks in Litter and litter in A/R CDM project activities"* tool; t CO_2e

$\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in project, in year t, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", as estimated in the same tool; t CO_2e

Trees (ΔC_{TREE})

Average tree carbon stocks in the stratum, used to estimate tree biomass and associated uncertainties, are calculated as follows (all time-dependent quantities refer to the measurement time):

$$\Delta C_{TREE\_PROJ,t} = C_{TREE}$$

Therefore,

$$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE} \qquad \text{Equation 12[73]}$$

$$B_{TREE} = A \times b_{TREE} \qquad \text{Equation 13}$$

[73] For Equations 12 to 15, we have kept the numbering adopted in the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"* methodological tool, version 04.2.

$$b_{TREE} = \sum_{i=1}^{M} Wi \times b_{TREE,i}$$ Equation 14

$$u_C = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^{M} w_i^2 \times \frac{s_i^2}{n_i}}}{b_{TREE}}$$ Equation 15

Where:

C_{TREE} = Carbon stock in trees in the tree biomass estimation strata; t CO_2e

CF_{TREE} = Carbon fraction in tree biomass; t C (t d.m.)$^{-1}$

A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.

B_{TREE} = Tree biomass in the tree biomass estimation strata; t d.m

A = Sum of areas of the tree biomass estimation strata; ha

b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; td.m.ha^{-1}

Wi = Ratio of the area of stratum *i* to the sum of areas of tree biomass estimation strata (i.e., $w_i = A_i/A$); dimensionless

$b_{TREE,i}$ = Mean tree biomass per hectare in stratum *i*; td.m.ha^{-1}

u_C = Uncertainty in C_{TREE}

t_{VAL} = Two-sided Student's t-value for a confidence level of 90 per cent and degrees of freedom equal to n – M, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata

s_i^2 = Variance of tree biomass per hectare across all sample plots in stratum *i*; (t d.m. ha^{-1})

n_i = Number of sample plots in stratum *i*.

If the estimate from Equation (15) is higher than 10 per cent, its conservativeness can be increased by applying the uncertainty discount provided in Table 1 of Appendix 2 of the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*", version 04.2.

$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}} \times (1 + R_i)$$ Equation 1[74]

$$B_{TREE,p,i} = \sum_j B_{TREE,j,p,i}$$ Equation 2

Where:

$b_{TREE,p,i}$	=	Biomass of trees per hectare in sample plot *p* of stratum *i*; t d.m. ha^{-1}
$B_{TREE,p,i}$	=	Biomass of trees in sample plot *p* of stratum *i*; t d.m.
$A_{PLOT,i}$	=	Size of sample plot in stratum *i*; ha
$B_{TREE,j,p,i}$	=	Biomass of trees of species *j* in sample plot *p* of stratum *i*; t d.m.
R_i	=	Root-shoot ratio for stratum *i*; dimensionless

Value R_i is estimated as $R_i = \frac{e^{(-1.085+0.9256 \times \ln b)}}{b}$, where b is the above-ground tree biomass per hectare (tonnes of dry matter ha^{-1}), as presented in the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities* methodological tool, version 04.2.

$$B_{TREE,j,p,i} = f_j(x_{1,j}, x_{2,j}, x_{3,j}, \ldots)$$ Equation 4

Where:

$B_{TREE,j,p,i}$	=	Biomass of tree *j* in sample plot *p* of stratum *i*; t d.m.

[74] For Equations 1, 2 and 4, we have kept the numbering adopted in Appendix 1 of the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"* methodological tool, version 04.2.

$f_i(x_{1,j}, x_{2,j}, x_{3,j}, \dots)$ = Above-ground biomass of the tree returned by the allometric equation for stratum *i* which represents a ratio between measurement of the tree diameter (DBH) and tree height and aboveground tree biomass; t d.m.

The allometric equation will be used for parameter $B_{TREE,p,i}$, both ex ant and ex post.

The equations chosen are presented in section 5.1 under parameter $f_j(x_{1,l}, x_{2,l}, x_{3,l}, \dots)$ and meet condition 6(c) of the tool "*Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities*", version 01.0.0.

Shrubs (ΔC_{SHRUB})

For the purpose of ex-ante estimation of carbon stock and change in carbon stock in the project scenario, change in carbon stock of shrubs may be estimated as zero, as described by the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2, thus:

$$\Delta C_{SHRUB\_PROJ,t} = 0$$

Dead wood (ΔC_{DW})

According to the methodological tool "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*", version 3.1, two methods are offered for estimation of carbon stock in dead wood: a measurement-based method and a conservative default-factor based method. For each instance the project proponent will define which method will be used to estimate carbon in dead wood.

Measurement-based method

Biomass of dead wood of species *j* in sample plot *p* in stratum i at a given point of time in year *t* is calculated separately for the following two types of dead wood:

(a) Standing dead wood;

(b) Lying dead wood.

Estimation of standing dead tree biomass using BEF method

Under this method volume tables (or volume functions/curves) are used to convert tree dimensions to stem volume of trees. Stem volume of trees is converted to above-ground tree biomass using basic wood density and biomass expansion factors and the aboveground tree biomass is expanded to total tree biomass using root-shoot ratios. Thus, dead wood biomass in standing dead trees of species *j* in sample plot *p* is calculated as:

$$B_{DWS\_TREE,j,p,i,t} = D_j \times BEF_{2,j} \times (1 + R_j) \times \sum_{k=1}^{K} V_{TREE,j}\,(DBH_k, H_k) \times \alpha_k \qquad \text{Equation 1}$$

Where:

$B_{DWS\_TREE,j,p,i,t}$	=	Biomass of dead wood in dead trees of species j in sample plot p of stratum i at a point of time in year t; t d.m.
$V_{TREE,j}(DBH_k, H_k)$	=	Stem volume of the k^{th} dead tree of species *j* in plot *p* of stratum *i* as returned by the volume function for species *j* using the tree dimension(s) as entry data; m^3
DBH_k	=	Diameter of the k^{th} dead tree of species *j* in plot *p* of stratum *i* at a point of time in year *t*; metre or any other unit of length used by the volume function
H_k	=	Height of the k^{th} dead tree of species *j* in plot *p* of stratum *i* at a point of time in year *t*; metre or any other unit of length used by the volume function
α_k	=	Biomass reduction factor for the k^{th} dead tree, depending upon its category according to paragraph 14; dimensionless
D_j	=	Basic wood density of species *j*; t d.m. m^{-3}
$BEF_{2,j}$	=	Biomass expansion factor for conversion of stem biomass to above-ground tree biomass, for species *j*; dimensionless
R_j	=	Root-shoot ratio for tree species j; dimensionless
j	=	1, 2, 3, ... tree species in plot *p*
k	=	1, 2, 3, ... dead trees of species j in plot *p* in stratum *i*

p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

Estimation of standing dead tree biomass using allometric method

Under this method allometric equations are used to convert tree dimensions to aboveground biomass of trees and the above-ground tree biomass is expanded to total tree biomass using root-shoot ratios. Thus, dead wood biomass in standing dead trees of species j in sample plot p is calculated as:

$$B_{DWS\_TREE,j,p,i,t} = (1 + R_j) \times \sum_{k=1}^{K} f_j\,(DBH_{k,}H_k) \times \alpha_k \qquad \text{Equation 2}$$

Where:

$B_{DWS\_TREE,j,p,i,t}$	=	Biomass of dead wood in dead trees of species j in sample plot p of stratum i at a point of time in year t; t d.m.
$f_j(DBH_{k,}H_k)$	=	Above-ground biomass of the kth dead tree of species j in sample plot p of stratum i returned by the allometric function for species j using the tree dimension(s) as entry data; t d.m.
α_k	=	Biomass reduction factor for the k^{th} dead tree, depending upon its condition according to paragraph 14; dimensionless
R_j	=	Root-shoot ratio for tree species j; dimensionless
j	=	1, 2, 3, … tree species in plot *p*
k	=	1, 2, 3, … dead trees of species j in plot *p* in stratum *i*

p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

In both the BEF method and the allometric method, the carbon stock in dead wood biomass in standing dead trees of species j in sample plot p of stratum i is calculated as follows:

$$C_{DWS\_TREE,j,p,i,t} = \frac{44}{12} \times CF_{TREE} \times B_{DWS\_TREE,j,p,i,t} \qquad \text{Equation 3}$$

Where:

$C_{DWS\_TREE,j,p,i,t}$	=	Carbon stock in dead wood in standing dead trees of species *j* in sample plot *p* in stratum *i* at a given point of time in year t; t CO_2e
CF_{TREE}	=	Carbon fraction of tree biomass; dimensionless
$B_{DWS\_TREE,j,p,i,t}$	=	Biomass of dead wood in standing dead trees of species j in sample plot p of stratum i at a point of time in year t; t d.m.
j	=	1, 2, 3, … tree species in plot *p*
p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

Estimation of carbon stock in standing dead wood in tree stumps

Each dead tree stump in a sample plot is categorized into a decay class as:

(a) Sound;

(b) Intermediate; or

(c) Rotten, on the basis of a machete test[75].

A density reduction factor is assigned to each of the decay classes, which is to be multiplied by the basic wood density of the species of the stump to obtain its estimated wood density. The following default values[76] of the density reduction factors for the three decay classes are used, unless PPs have more specific data available with them: for the decay class: (a) Sound, the density reduction factor = 1.00; for the decay class; (b) Intermediate, the density reduction factor = 0.80; for the decay class; and (c) Rotten, the density reduction factor = 0.45.

For each dead tree stump of height less than 4 m the mid-height diameter is measured. For each dead tree stump of height 4 m and above, the diameter at breast height (DBH) is measured.

For stumps of height more than 4 m, the mid-height diameter of the stump is estimated[77] as:

$$D_{MID\_STUMP} = 0.57 \times DBH \times \left(\frac{H_{STUMP}}{H_{STUMP} - H_{DBH}}\right)^{0.80} \text{ for } H_{STUMP} > 4 \text{ m} \qquad \text{Equation 4}$$

Where:

D_{MID_STUMP}	=	Mid-height diameter of the dead tree stump; m
DBH	=	Diameter at breast height of the dead tree stump; m
H_{STUMP}	=	Height of the stump; m
H_{DBH}	=	Height above ground level at which DBH is measured; m

[75] The stump wood is struck with a machete - if the blade bounces off it is sound; if it enters slightly into the wood, is it intermediate; and if it causes the wood to fall apart, it is rotten. IPCC GPG LULUCF 2003, section 4.3.3.5.3 DEAD ORGANIC MATTER.

[76] Adapted from Harmon, M. E. and J. Sexton. (1996) Guidelines for Measurements of Woody Detritus in Forest Ecosystems. US LTER Publication No. 20. US LTER Network Office, University of Washington, Seattle, WA, USA.

[77] Adapted from Ormerod, D W, 1973. A simple bole model. Forestry Chronicle. 49:136-138.

Carbon stock in dead wood in dead tree stumps of species *j* in plot *p* is calculated as:

$$C_{DWS\_STUMP,j,p,i,t} = \frac{44}{12} \times CF_{TREE} \times D_j \times (1 + R_j) \times \frac{\pi}{4} \sum_k D_{MID\_STUMP,k}{}^2 \times H_k * \beta_k \quad \text{Equation 5}$$

Where:

$C_{DWS\_STUMP,j,p,i,t}$	=	Carbon stock in dead wood in dead tree stumps of species j in sample plot p in stratum i at a given point of time in year t; t CO_2e
CF_{TREE}	=	Carbon fraction of tree biomass; dimensionless
D_j	=	Basic wood density of species *j*; t d.m. m^{-3}
R_j	=	Root-shoot ratio for tree species j; dimensionless
$D_{MID\_STUMP,k}$	=	Mid-height diameter of the k^{th} dead tree stump of species *j* in plot p in stratum *i* at a given point of time in year *t*; m
H_k	=	Height of the k^{th} dead tree stump of species j in plot p in stratum i at a given point of time in year t; m
β_k	=	Density reduction factor (per paragraph 24) applicable to the kth dead tree stump of species j in plot p in stratum i at a given point of time in year t; dimensionless
j	=	1, 2, 3, … tree species in plot *p*
k	=	1, 2, 3, … dead trees of species *j* in plot *p* in stratum *i*
p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary

t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

Lying dead wood

Lying dead wood is estimated by using line transect method (Harmon and Sexton, 1996)[78]. Two transect lines, of total length of at least 100 m[79], approximately orthogonally bisecting each other at the centre of the plot are established and the diameter of each piece of lying dead wood (with diameter ≥10 cm) intersecting a transect line is measured.

Each piece of dead wood is assigned to one of three decay classes and each of the three decay classes are assigned a density reduction factor as explained in paragraphs 23 and 24.

Based on these measurements and categorization into decay classes, carbon stock in lying dead wood of species *j* in plot *p* is calculated as:

$$C_{DWL,j,p,i,t} = a_{PLOT} * \frac{44}{12} \times CF_{TREE} \times D_j * \frac{\pi^2}{8L} \times \sum_{n=1}^{N} D_{n^2} * \beta_n \qquad \text{Equation 6}$$

Where:

$C_{DWL,j,p,i,t}$	=	Carbon stock in lying dead wood of species *j* in sample plot *p* in stratum *i* at a given point of time in year t; t CO_2e
a_{PLOT}	=	Area of the sample plot p; ha
CF_{TREE}	=	Carbon fraction of tree biomass; dimensionless
L	=	Sum of the lengths of the transect lines approximately orthogonally bisecting each other at the centre of the plot p; m
D_n	=	Diameter of the n^{th} piece of lying dead wood intersecting a transect line; cm

[78] Harmon, M. E. and J. Sexton. (1996) Guidelines for Measurements of Woody Detritus in Forest Ecosystems. US LTER Publication No. 20. US LTER Network Office, University of Washington, Seattle, WA, USA.

[79] If the parcel area does not allow for the required length in two lines, then more than two lines are permissible. However, where lines are obliged to run in parallel they should be separated by at least 20 m.

β_n	=	Density reduction factor applicable to the n^{th} piece of lying dead wood intersecting a transect line; dimensionless
j	=	1, 2, 3, … tree species in plot *p*
p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

The carbon stock in dead wood in a stratum is then calculated as:

$$C_{DW,i,t} = \frac{A_i}{A_{PLOT,i}} \sum_p \sum_j (C_{DWS\_TREE,j,p,i,t} + C_{DWS\_STUMP,j,p,i,t} + C_{DWL,j,p,i,t})$$

Equation 7

Where:

$C_{DW,i,t}$	=	Carbon stock in dead wood in stratum i at a given point of time in year t; t CO_2e
A_i	=	Total area of stratum i; ha
$A_{PLOT,i}$	=	Total area of sample plots in stratum *i*; ha
$C_{DWS\_TREE,j,p,i,t}$	=	Carbon stock in dead wood in standing dead trees of species j in sample plot *p* in stratum *i* at a given point of time in year *t*; t CO_2e
$C_{DWS\_STUMP,j,p,i,t}$	=	Carbon stock in dead wood in dead tree stumps of species *j* in sample plot *p* in stratum *i* at a given point of time in year *t*; t CO_2e
$C_{DWL,j,p,i,t}$	=	Carbon stock in lying dead wood of species j in sample plot *p* in stratum *i* at a given point of time in year *t*; t CO_2e

j	=	1, 2, 3, … tree species in plot *p*
p	=	1, 2, 3, … sample plots in stratum *i*
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

Finally, the carbon stock in dead tree biomass within the project boundary at a given point of time in year *t* is calculated by summing up $C_{DW,i,t}$ over all the strata, that is:

$$C_{DW,t} = \sum_{i} C_{DW,i,t} \quad \text{Equation 8}$$

Where:

$C_{DW,t}$	=	Carbon stock in dead wood within the project boundary at a given point of time in year t; t CO_2e
$C_{DW,i,t}$	=	Carbon stock in dead wood in stratum *i* at a given point of time in year *t*; t CO_2e
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR project activity

Conservative default-factor based method

This method is used when the project proponent does not want to make measurements through sampling. The default-factor based method is applicable only if dead wood remains in situ and is not removed from the project boundary through any type of anthropogenic activities.

In the default-factor based method, the carbon stock in dead wood is estimated as:

$$C_{DW,i,t} = C_{TREE,i,t} \times DF_{DW}$$ Equation 9[80]

Where:

$C_{DW,i,t}$	=	Carbon stock in dead wood in stratum *i* at a given point of time in year *t*; t CO_2e
$C_{TREE,i,t}$	=	Carbon stock in trees biomass in stratum *i* at a point of time in year *t*, as calculated in tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
DF_{DW}	=	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; percent
i	=	1, 2, 3, ... biomass estimation strata within the project boundary
t	=	1, 2, 3, ... years elapsed since the start of the ARR project activity

The rate of change of deadwood biomass over a period of time is calculated assuming a linear change. Therefore, the rate of change in carbon stock in deadwood over a period of time is calculated as per section 6.3 of the tool:

$$dC_{DW,(t_1,t_2)} = \frac{C_{DW,t_2} - C_{DW,t_1}}{T}$$ Equation 10

Where:

$dC_{DW,(t_1,t_2)}$	=	Rate of change in carbon stock in dead wood within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2e yr^{-1}
C_{DW,t_2}	=	Carbon stock in dead wood within the project boundary at a point of time in year t_2; t CO_2e
C_{DW,t_1}	=	Carbon stock in dead wood within the project boundary at a point of time in year t_1; t CO_2e

[80] For Equations 9, 10 and 11, the numbering adopted in section 6 of the *"Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"* methodological tool, version 3.1 was maintained.

T	=	Time elapsed between two successive estimations ($T=t_2 - t_1$); yr

Change in carbon stock in dead wood within the project boundary in year t ($t_1 \leq t \leq t_2$) is given by:

$$\Delta C_{DW,t} = dC_{DW,(t_1 t_2)} \times 1 year \text{ for } t_1 \leq t \leq t_2 \quad \text{Equation 11}$$

where:

$\Delta C_{DW,t}$	=	Change in carbon stock in dead wood within the project boundary in year t; t CO_2e
$dC_{DW,(t_1 t_2)}$	=	Rate of change in carbon stock in dead wood within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2e yr^{-1}

Litter (ΔC_{Li})

Two methods are offered for estimation of carbon stock in litter: a measurement-based method and a conservative default-based approach.

Measurement-based method for estimation of carbon stock in litter

For estimating carbon stock in litter, four litter samples are collected from each sample plot, using a sampling frame which is placed in four randomly selected positions within the plot. The four samples are well mixed into one composite sample and its wet weight is taken. A sub-sample taken from the composite sample is weighed, oven dried, and weighed again to determine its dry weight. The dry-to-wet weight ratio of the sub-sample is calculated and used for estimating the dry weight of the composite litter sample.

Carbon stock in litter biomass in plot p is then calculated as:

$$C_{LI,p,i,t} = \frac{44}{12} \times CF_{LI} \times 2.5 * \frac{A_{p,i}}{a_{p,i}} \times B_{LI\_WET,p,i} \times DWR_{LI,p,i} \quad \text{Equation 12}$$

where:

$C_{LI,p,i,t}$	=	Carbon stock in litter in plot p in stratum i; t CO_2e
CF_{LI}	=	Carbon fraction of dry biomass in litter; dimensionless (IPCC default value8 of 0.37 is used)
$B_{LI\_WET,p,i}$	=	Wet weight of the composite litter sample collected from plot p of stratum i; kg
$DWR_{LI,p,i}$	=	Dry-to-wet weight ratio of the litter sub-sample collected from plot *p* in stratum *i*; dimensionless
$A_{p,i}$	=	Area of sample plot *p* of stratum *i*; ha
$a_{p,i}$	=	Area of sampling frame for plot *p* in stratum *i*; m^2
i	=	1, 2, 3, ... biomass estimation strata within the project boundary
p	=	1, 2, 3, ... sample plots in stratum *i*
t	=	1, 2, 3, ... years elapsed since the start of the ARR Project activity

Carbon stock in litter in stratum i is then calculated as:

$$C_{LI,i,t} = \frac{A_i}{A_{PLOT,i}} \sum_p C_{LI,p,i,t} \qquad \text{Equation 13}$$

where:

$C_{LI,i,t}$	=	Carbon stock in litter in stratum *i* at a given point of time in year *t*; t CO_2e
A_i	=	Area of stratum *i*; ha
$A_{PLOT,i}$	=	Area of sample plots in stratum *i*; ha
$C_{LI,p,i,t}$	=	Carbon stock in litter in plot p in stratum *i*; t CO_2e
i	=	1, 2, 3, ... biomass estimation strata within the project boundary
p	=	1, 2, 3, ... sample plots in stratum *i*

t	=	1, 2, 3, … years elapsed since the start of the ARR Project activity

Finally, the carbon stock in litter biomass within the project boundary at a given point of time in year t is calculated by summing $C_{LI,i,t}$ over all the strata, that is:

$$C_{LI,t} = \sum_{i} C_{LI,i,t}$$ Equation 14

where:

$C_{LI,t}$	=	Carbon stock in litter within the project boundary at a given point of time in year t; t CO_2e
$C_{LI,i,t}$	=	Carbon stock in litter in stratum *i* at a given point of time in year *t*; t CO_2e
$A_{PLOT,i}$	=	Area of sample plots in stratum *i*; ha
i	=	1, 2, 3, … biomass estimation strata within the project boundary
t	=	1, 2, 3, … years elapsed since the start of the ARR Project activity

Default-factor based method

The default-factor based method is applicable only if litter remains *in situ* and is not removed from the project boundary through any type of anthropogenic activities.

In the default-factor based method, the carbon stock in litter is estimated as:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI}$$ Equation 15[81]

Where:

$C_{LI,i,t}$	=	Carbon stock in litter in stratum *i* at a given point of time in year *t*; t CO_2e

[81] For Equations 15, 16 and 17, the numbering adopted in section 7 of the "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*" methodological tool, version 3.1 was maintained.

$C_{TREE,i,t}$	=	Carbon stock in trees biomass in stratum *i* at a point of time in year *t*, as calculated in tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
DF_{LI}	=	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; percent

The rate of change of litter biomass over a period of time is calculated assuming a linear change. Therefore, the rate of change in carbon stock in litter over a period of time is calculated as:

$$dC_{LI,(t_1,t_2)} = \frac{C_{LI,t_2} - C_{LI,t_1}}{T} \quad \text{Equation 16}$$

Where:

$dC_{LI,(t_1,t_2)}$	=	Rate of change in carbon stock in litter within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2e yr^{-1}
C_{LI,t_2}	=	Carbon stock in litter within the project boundary at a point of time in year t_2; t CO_2e
C_{LI,t_1}	=	Carbon stock in litter within the project boundary at a point of time in year t_1; t CO2e
T	=	Time elapsed between two successive estimations ($T=t_2 - t_1$); yr

Change in carbon stock in litter within the project boundary in year *t* ($t_1 \leq t \leq t_2$) is given by:

$$\Delta C_{LI,t} = dC_{LI,(t_1,t_2)} \times 1\, year \text{ for } t_1 \leq t \leq t_2 \quad \text{Equation 17[82]}$$

[82] For Equations 1 to 17, the numbering adopted in the "*Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities*" methodological tool, version 03.1 was maintained.

Where:

$\Delta C_{LI,t}$	=	Change in carbon stock in litter within the project boundary in year *t*; t CO_2e
$dC_{LI,(t_1,t_2)}$	=	Rate of change in carbon stock in litter within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2e yr^{-1}

Soil Organic Carbon (ΔC_{SOC})

Soil organic carbon will be calculated according to the methodological tool "*Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*", version 01.1.0. The tool guides the stratification of areas according to:

- Climatic region and soil types presented in table 3 of the tool;
- Pre-project management activities on cropland, provided in tables 4 and 5 of the tool;
- Pre-project pasture management activities, provided in table 6 of the tool.

An estimate of the carbon stock immediately before the start of the project ($SOC_{INITIAL,i}$) will be obtained for later comparison to the soil organic carbon stock in reference ecosystems ($SOC_{REF,i}$) to define the amount of carbon that could be assimilated in this reservoir over time.

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i}$$ Equation 1[83]

Where:

$SOC_{INITIAL,i}$	=	SOC stock at the beginning of the ARR project activity in stratum *i* of the areas of land; t C ha^{-1}
$SOC_{REF,i}$	=	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation ñ normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

[83] For Equations 1 to 8, the numbering adopted in the "*Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities"* methodological tool, version 01.1.0 was maintained .

$f_{LU,i}$	=	Relative stock change factor for baseline land-use in stratum *i* of the areas of land; dimensionless
$f_{MG,i}$	=	Relative stock change factor for baseline management regime in stratum *i* of the areas of land; dimensionless
$f_{IN,i}$	=	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum *i* of the areas of land; dimensionless.
i	=	1, 2, 3, ... strata of areas of land; dimensionless

The values of $SOC_{REF,i}$, $f_{LU,i}$, $f_{MG,i}$ and $f_{MG,i}$ will be taken from table 3-6 provided in the methodological tool "Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities".

For each stratum of the areas of land which is subjected to soil disturbance attributable to project activity and for which the total area disturbed, over and above the area disturbed in the baseline, is greater than 10% of the area of the stratum, the following carbon loss is accounted:

$$SOC_{LOSS,i} = SOC_{INITIAL,i} * 0.1 \quad \text{Equation 2}$$

For all other strata:

$$SOC_{LOSS,i} = 0 \quad \text{Equation 3}$$

Where:

$SOC_{INITIAL,i}$	=	SOC stock at the beginning of the ARR project activity in stratum *i* of the areas of land; t C ha^{-1}
$SOC_{LOSS,i}$	=	Loss of SOC caused by soil disturbance attributable the ARR project activity, in stratum *i* of the areas of land; t C ha^{-1}

0.1	=	The approximate proportion of SOC lost within the first five years from the year of site preparation
i	=	1, 2, 3, … strata of areas of land; dimensionless

Then, the rate of change in SOC stock in project scenario until the steady state is reached is estimated as follows:

$$dSOC_{t,i} = 0 \quad \text{for } t < t_{PREP,i}$$ Equation 4

$$dSOC_{t,i} = -\frac{SOC_{LOSS,i}}{1\ year} \quad \text{for } t = t_{PREP,i}$$ Equation 5

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years} \quad \text{for } t_{PREP,i} < t \leq t_{PREP,i} + 20$$ Equation 6

Where:

$dSOC_{t,i}$	=	The rate of change in SOC stock in stratum i of the areas of land in year *t*; t C ha^{-1} yr^{-1}
$t_{PREP,i}$	=	The year in which first soil disturbance takes place in stratum i of the areas of land
$SOC_{REF,i}$	=	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation ñ normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}
$SOC_{INITIAL,i}$	=	SOC stock at the beginning of the ARR project activity in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable the ARR project activity, in stratum *i* of the areas of land; t C ha^{-1}

i = 1, 2, 3, … strata of areas of land; dimensionless

t = 1, 2, 3, … years elapsed since the start of the ARR project activity

The change in SOC stock for all the strata of the areas of land, in year *t* is calculated as indicated in equation 8 of the tool:

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i A_i * dSOC_{t,i} * 1 year$$ Equation 8

Where:

$\Delta SOC_{AL,t}$ = Change in SOC stock in areas of land meeting the applicability conditions of this tool. in year *t*; t CO_2-e

Ai = The area of stratum *i* of the areas of land; ha

$dSOC_{t,i}$ = The rate of change in SOC stocks in stratum *i* of the areas of land; t C ha^{-1} yr^{-1}

I = 1, 2, 3, … strata of areas of land; dimensionless

Emission of non-CO_2 GHG resulting from burning of biomass

According to the applied methodology, the only GHG emissions computed by projects are those resulting from fires, whether accidental or not. The "*Estimation of non-CO_2 GHG emissions* *resulting from burning of biomass attributable to an A/R CDM project activity"*[84] methodological tool is used to calculate GHG emissions from fires.

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t}$$ Equation 1[85]

Where:

$GHG_{E,t}$	=	Emission of non-CO_2 GHG resulting from burning of biomass and forest fires within the project boundary in year *t*; t CO_2-e
$GHG_{SPF,t}$	=	Emission of non-CO_2 GHGs resulting from use of fire in site preparation in year *t*; t CO_2-e
$GHG_{FMF,t}$	=	Emission of non-CO_2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management, in year *t*; t CO_2-e
$GHG_{FF,t}$	=	Emission of non-CO_2 GHGs resulting from fire in year *t*; t CO_2-e

The three circumstances admitted by the tool in which there may be GHG emissions in the projects are:

- ✓ Emission of non-CO_2 GHGs resulting from use of fire in site preparation
- ✓ Emission of non-CO_2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management; and
- ✓ Emission of non-CO_2 GHGs resulting from forest fires.

In case of forest fires, the area affected will be monitored according to parameter $A_{BURN,i,t}$ described in section 5.2. The emissions of non-CO_2 resulting from forest fire will be calculated as per the tool "*Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*":

$$GHG_{FF,t} = GHG_{FF\_TREE,t} + GHG_{FF\_DOM,t}$$ Equation 6

Where:

[84] See https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf.

[85] For Equation 1, 6 and 7, the numbering adopted in the *"Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"* methodological tool, version 04.0.0. was maintained.

$GHG_{FF,t}$	=	Emission of non-CO_2 GHGs resulting from forest fire, in year *t*; tCO_2-e
$GHG_{FF\_TREE,t}$	=	Emission of non-CO_2 GHGs resulting from the loss of aboveground biomass of trees due to forest fire, in year *t*; tCO_2-e
$GHG_{FF\_DOM,t}$	=	Emission of non-CO_2 GHGs resulting from the loss of dead organic matter due to forest fire, in year *t*; tCO_2-e

As the pool *dead organic matter* will not be monitored in this project, the stock of dead organic matter is considered zero and emissions of non-CO_2 GHGs resulting from the loss of dead organic matter due to forest fire are not accounted.

$GHG_{FF\_DOM,t} = 0$

$$GHG_{FF\_TREE,t} = 0.001 * \sum_{i=1}^{M} A_{BURN,i,t} * b_{TREE,i,t_L} * COMF_i * \left(EF_{CH4,i} * GWP_{CH4} + EF_{N2O,i} * GWP_{N2O}\right)$$

Equation 7[86]

where:

$GHG_{FF\_TREE,t}$	=	Emission of non-CO_2 GHGs resulting from the loss of aboveground biomass of trees due to forest fire, in year *t*; tCO_2-e
$A_{BURN,i,t}$	=	Area burnt in stratum *i* in year *t*; ha
b_{TREE,i,t_L}	=	Mean aboveground tree biomass per hectare in stratum *i* in year *tL* which is the year in which last verification was carried out before occurrence of the fire; t d.m. ha^{-1} Where aboveground biomass of living trees is not burnt by fire, b_{TREE,i,t_L} may be set equal to zero
$COMF_i$	=	Combustion factor for stratum *i*; dimensionless
$EF_{CH4,i}$	=	Emission factor for CH_4 in stratum *i*; g CH_4 (kg dry matter burnt)$^{-1}$

[86] For Equation 7 the numbering adopted in the methodological tool *"Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity" version 04.0.0.* was maintained.

GWP_{CH4} = Global warming potential for CH_4; dimensionless

$EF_{N2O,i}$ = Emission factor for N_2O in stratum *i*; g N_2O (kg dry matter burnt)$^{-1}$

GWP_{N2O} = Global warming potential for N_2O; dimensionless

I = 1, 2, 3 … *M* strata

T = 1, 2, 3, . years elapsed since the start of the project activity

4.3 Leakage

According to the methodology, leakage from project activity refer to the displacement, to other areas, of agricultural activities that already existed in the project area before the project. For the calculation of leakage, the "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*" methodological tool will be used, in its latest version.

$$LK_t = LK_{AGRIC,t}$$ Equation 4[87]

where

LK_t = GHG emissions due to leakage in year *t*; t CO_2-e

$LK_{AGRIC,t}$ = Leakage due to displacement of agricultural activities in year *t*, as estimated in the tool "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*"; t CO_2-e

As set out in section 1.11, one of the eligibility criteria for instances is the assessment of the area proposed for the project in order to determine whether there has been/will be a shift from agricultural activity to a new area.

If the instance does not cause emissions due to leakage, according to provisions of the methodological tool "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*" version 02.0, then GHG emissions due to leakage can be considered as <u>zero</u>:

[87] For Equation 4 the numbering adopted in the *AR-ACM0003* methodology was maintained.

$LK_t = 0$

If the area meets the criteria for the calculation of leakage emissions due to activity displacement, the following equations should be applied:

$$LK_{AGRIC,t} = \frac{44}{12} \times (\Delta C_{BIOMASS,t} + \Delta SOC_{LUC,t})$$ Equation 1[88]

$$\Delta C_{BIOMASS,t} = [1{,}1 \times b_{TREE} \times (1 + R_{TREE}) + b_{SHRUB} \times (1 + R_S)] \times CF \times A_{DISP,t}$$ Equation 2

$$\Delta SOC_{LUC,t} = SOC_{REF} \times (f_{LUP} \times f_{MGP} \times f_{INP} - f_{LUD} \times f_{MGD} \times f_{IND}) \times A_{DISP,t}$$ Equation 3

Where:

$\Delta C_{BIOMASS,t}$ = Decrease in carbon stock in the carbon pools of the land receiving the activity displaced in year *t*; t d.m.

Note: the factor of 1.1 is used to account for the carbon stock in dead wood and litter pools as a fixed percentage of the carbon stock in living trees.

CF = Carbon fraction of woody biomass; dimensionless

A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.

$A_{DISP,t}$ = Area of land from which agricultural activity is being displaced in year *t*; ha

b_{TREE} = Mean above-ground tree biomass in land receiving the displaced activity; t d.m. ha^{-1}

R_{TREE} = Root-shoot ratio for trees in the land receiving the displaced activity; dimensionless

A default value of 0.25 is used unless transparent and verifiable information can be provided to justify a different value.

[88] For Equations 1, 2 and 3, we have kept the numbering adopted in the "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*" methodological tool.

b_{SHRUB}	=	Mean above-ground shrub biomass in land receiving the displaced activity; t d.m. ha^{-1} The value of this parameter is obtained by applying one of the applicable methods from the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" to the land receiving the displaced activity.
R_S	=	Root-shoot ratio for shrubs in the land receiving the displaced activity; dimensionless A default value of 0.40 is used unless transparent and verifiable information can be provided to justify a different value.
$\Delta SOC_{LUC,t}$	=	Change in soil organic carbon (SOC) stock due to land-use change in the land receiving the displaced activity in year *t*; tC ha^{-1}. The value of this parameter may be set to zero if: (a) The only displaced activity being received in the land is grazing activity; or (b) The value of the parameter as estimated from Equation (3) is less than zero (i.e. negative). Change in the organic carbon stock in the soil due to change in the land use of the site that will receive the relocated activity in the year *t*; t C ha^{-1}
SOC_{REF}	=	SOC stock corresponding to the reference condition in native lands by climate region and soil type applicable to the land receiving the displaced activity; t C ha^{-1}. The value of this parameter is taken from Table 3 of the "*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*"
$f_{LUP}, f_{MGP}, f_{INP}$	=	Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land before the displaced activity is received; dimensionless. The value of these parameters is taken from Tables 4, 5, and 6 of the "*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*"

$f_{LUD}, f_{MGD}, f_{IND}$	=	Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land after the displaced activity has been received; dimensionless. The value of these parameters is taken from Tables 4, 5, and 6 of the "*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*".
t	=	1, 2, 3,... years elapsed since the start of the ARR project activity.

4.4 Net GHG Emission Reductions and Removals

In order to determine the removals attributable to the project, the guidance provided by the *AR-ACM0003* methodology was considered. Net anthropogenic GHG removals by carbon pools are calculated through the equation:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Equation 5[89]

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks in year *t*; t CO_2e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks in year *t*; t CO_2e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks, in year *t*; t CO_2e
LK_t	=	GHG emissions due to leakage in year *t*; t CO_2e

[89] For Equation 5. the numbering adopted in the *AR-ACM0003* methodology was maintained.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2020	0	104,682.49	0	104,682.49
2021	0	247,013.99	0	247,013.99
2022	0	389,345.50	0	389,345.50
2023	0	531,840.98	0	531,840.98
2024	0	674,336.45	0	674,336.45
2025	0	816,831.93	0	816,831.93
2026	0	331,232.49	0	331,232.49
2027	0	247,833.86	0	247,833.86
2028	0	390,329.34	0	390,329.34
2029	0	532,824.82	0	532,824.82
2030	0	675,320.29	0	675,320.29
2031	0	817,815.77	0	817,815.77
2032	0	332,216.33	0	332,216.33
2033	0	248,817.70	0	248,817.70
2034	0	391,313.18	0	391,313.18
2035	0	533,808.66	0	533,808.66
2036	0	676,304.13	0	676,304.13
2037	0	818,799.61	0	818,799.61
2038	0	333,200.17	0	333,200.17
2039	0	249,801.54	0	249,801.54
2040	0	392,297.02	0	392,297.02
2041	0	534,792.50	0	534,792.50
2042	0	677,287.97	0	677,287.97
2043	0	819,638.55	0	819,638.55
2044	0	333,894.19	0	333,894.19
2045	0	250,350.66	0	250,350.66
2046	0	392,701.23	0	392,701.23
2047	0	535,051.80	0	535,051.80

2048	0	677,402.37	0	677,402.37
2049	0	819,752.95	0	819,752.95
2050	0	334,008.59	0	334,008.59
2051	0	250,465.06	0	250,465.06
2052	0	392,815.63	0	392,815.63
2053	0	535,166.20	0	535,166.20
2054	0	677,516.77	0	677,516.77
2055	0	819,867.35	0	819,867.35
2056	0	334,122.99	0	334,122.99
2057	0	250,579.46	0	250,579.46
Total				**394,371.13**

Note: This ex ante corresponds to the Long Term Average GHG benefit by eucalyptus forest + the maximum stock of carbon contribued by the native forest at project scenario, with buffer discount of 17.75%, and baseline discount.

To calculate the average of carbon stock of the project scenario, the Long-Term Average was considered to the instance where wood will be harvested, according to "VCS Standard" guidelines. The Long-Term average was calculated by observing the following:

- The total period covered by the project was defined based on a number of complete cutting cycles, which included the minimum period of 30 years stipulated by the VCS for AFOLU projects (For the first instances, a period of 38 years was considered);

- The expected total GHG benefit of the project for each year of the established time period was determined (section 4.4.1).

- The total GHG benefit of each year during the established time period was summed, and divided by the total number of years considered to the project scenario, as follows:

Equation item 3.2.25[90]

$$LA = \frac{\sum_{t=0}^{n} PE_t - BE_t}{n}$$

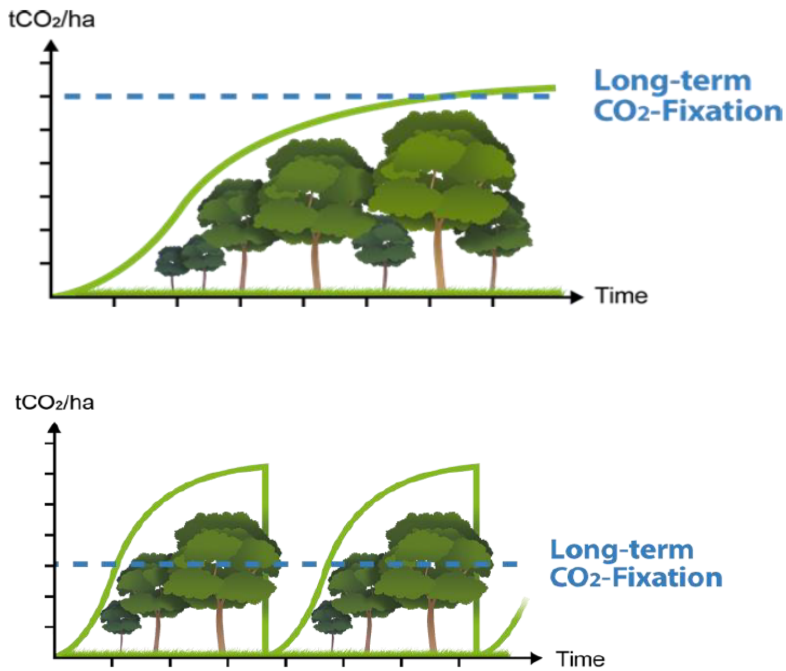
Where:

[90] VCS Standard, version 4.4.

LA	=	Long Term Average GHG benefit
PE_t	=	The total to-date GHG emission reductions and removals generated in the project scenario (tCO_2e). Project scenario emission reductions and removals shall also consider project emissions of CO_2, N_2O, CH_4 and leakage.
BE_t	=	The total to-date GHG emission reductions and removals projected for the baseline scenario (tCO_2e).
t	=	Year
n	=	Total number of years in the established time period

A project may seek GHG credits during each verification event until the long-term average GHG benefit is reached. Once the total number of GHG credits issued has reached this average, the project can no longer issue further GHG credits. The long-term average GHG benefit shall be calculated at each verification event, meaning the long-term average GHG benefit may change over time based on monitored data.
In the instance where there will be no harvest, the calculation of the long-term average was not considered. Thus, to calculate the total average of credits in the project scenario, the sum of credits defined by the long term average for forests harvested and the maximum stock of carbon contributed by the native forest (without using the long term average) was calculated. The figure below demonstrates, respectively, the operating dynamics when there is no application of the Long -Term average and when there is:

Figure 41: Long-term average operating logic. Source: Methodology for Afforestation/Reforestation (A/R) GHGs Emission Reduction and Sequestration – Gold Standard.



Buffer

A calculation was carried out regarding the non-permanence risk of the project, which should be used to determine the number of buffer credits that an AFOLU project shall deposit into the AFOLU pooled buffer account. This procedure was carried out following the guidelines of the "AFOLU Non-permanence risk tool", version 4.0, and the value obtained was deducted from the total value of estimated credits for the project scenario. The discounted amount was 17.75%.

4.4.1 Ex ante calculation

The following is two examples of how *ex ante* estimates will be generated for each instance. The first example refers to an (a) eucalyptus project and the second to a (b) restoration project. Values may change at each instance, and specific calculations will be provided during validation of instances.

a) EUCALYPTUS PROJECT:

For *Eucalyptus spp.* simulation, the area considered is the PAI 1's **4,273.65 hectares**, in which pre-project land use was non-forestry activities, that is, agriculture and pasture.

Actual net GHG removals by sinks

As presented in section 4.2, actual net removals are calculated from the equation:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net removals by sinks in year *t*; t CO_2-e
$\Delta C_{P,t}$	=	Change in the carbon stocks in the project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year *t*, as estimated in the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO_2-e

According to section 1.11, the PP does not use fire as a clearing technique in the first instance ($GHG_{SPF,t}$ and $GHG_{FMF,t}$). Thus, only the third option, forest fires $GHG_{FF,t}$, can occur, which are usually accidental and not part of the usual management practices.

Non-CO_2 GHG emissions within the project boundary will be monitored as per the description in Section 5.2. For the purposes of exemplifying actual net removals, it is considered that no accidental fires have taken place, and therefore:

$GHG_{E,t} = 0$

Thus, actual net removals from the project will be:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$\Delta C_{TREE\ PROJ,t}$	=	Change in carbon stock in tree biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{SHRUB\ PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{DW\ PROJ,t}$	=	Change in carbon stock in dead wood in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e
$\Delta C_{LI\ PROJ,t}$	=	Change in carbon stock in litter in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e
$\Delta SOC_{AL,t}$	=	Change in carbon stock in SOC in project, in year *t*, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", as estimated in the same tool; t CO_2-e

According to the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2, it is conservatively considered that there are no shrubs in the project area, so shrub carbon stocks will be considered as zero. The example also assumes that project activity will not compute dead wood biomass, litter biomass and soil organic carbon. In this case, the parameters related to these carbon pools also will be considered as zero. Thus,

$\Delta C_{SHRUB\ PROJ,t} = 0$

$\Delta C_{DW\_PROJ,t} = 0$

$\Delta C_{LI\_PROJ,t} = 0$

$\Delta SOC_{AL,t} = 0$

Therefore, actual net removals from the project are estimated based on the change in carbon stock in the biomass of trees. The first step is to estimate above-ground tree biomass in the first instance.

Trees (ΔC_{TREE})

The data used in the ex-ante section results from a simulation that was based on the inventory of a Eucalyptus area implemented in the "Cerrado" (Brazilian savanna) region, which is representative of the majority of the project's region. Plots of various ages were used and the mean of DBH and height by age was calculated in order to simulate a very heterogeneous forest. In Table below, the measurement data of a 0.04 ha sample plot that could contain about 66 trees were simulated. The biomass values in each of the tree's compartments were calculated using the equation described in section 5.1 of the ex-ante fixed parameter $f_i(x_{1,j}, x_{2,j}, x_{3,j}, \ldots)$.

Table 9. Example of calculation of tree biomass *j* in sample plot *p* of stratum *i*.

Tree	DBH (cm)	Ht (m)	Stem biomass (kg)	Branches biomass (kg)	Leaves biomass (kg)	Aboveground biomass (kg)
1	8.03	12.05	8.59	2.44	0.20	11.23
2	8.04	12.07	8.63	2.44	0.20	11.27
3	8.24	12.37	9.42	2.54	0.21	12.17
4	8.25	12.45	9.54	2.50	0.21	12.26
5	8.25	12.50	9.62	2.48	0.21	12.31
6	8.27	12.52	9.70	2.49	0.21	12.40
7	8.30	12.70	10.02	2.44	0.21	12.67
8	8.39	12.75	10.25	2.52	0.22	12.99
9	8.52	12.79	10.58	2.65	0.23	13.46
10	8.81	13.37	12.15	2.70	0.24	15.09
11	8.82	13.39	12.21	2.70	0.24	15.15
12	8.85	13.68	12.77	2.60	0.25	15.62
13	8.96	13.76	13.18	2.69	0.25	16.13
14	9.04	14.15	14.09	2.60	0.26	16.94
15	9.22	14.62	15.47	2.59	0.27	18.33
16	9.35	14.63	15.85	2.72	0.28	18.85
17	9.42	15.00	16.81	2.64	0.28	19.73
18	9.46	15.03	16.98	2.66	0.28	19.92
19	9.49	15.21	17.48	2.62	0.28	20.39
20	9.88	15.24	18.72	3.05	0.31	22.08
21	9.89	15.61	19.61	2.88	0.31	22.80
22	9.96	15.63	19.89	2.96	0.31	23.16

23	10.06	16.12	21.40	2.84	0.32	24.56
24	10.10	16.87	23.48	2.58	0.32	26.38
25	10.47	16.96	25.17	2.93	0.35	28.44
26	10.53	17.03	25.56	2.96	0.35	28.88
27	10.59	17.48	27.07	2.83	0.36	30.26
28	10.97	17.48	28.75	3.25	0.39	32.38
29	10.98	17.70	29.44	3.16	0.38	32.99
30	11.05	17.76	29.95	3.21	0.39	33.55
31	11.24	17.88	31.21	3.39	0.41	35.00
32	11.25	17.97	31.54	3.35	0.41	35.30
33	11.51	18.04	32.97	3.62	0.43	37.02
34	11.56	18.12	33.51	3.65	0.43	37.59
35	11.59	18.18	33.86	3.65	0.43	37.94
36	11.66	18.44	35.13	3.61	0.44	39.18
37	11.74	18.55	35.88	3.65	0.45	39.98
38	12.00	18.90	38.55	3.79	0.47	42.81
39	12.05	19.06	39.40	3.78	0.47	43.65
40	12.26	19.13	40.88	4.01	0.49	45.38
41	12.29	19.30	41.68	3.96	0.49	46.13
42	12.39	19.30	42.27	4.08	0.50	46.85
43	12.48	19.58	43.89	4.05	0.51	48.45
44	12.48	19.78	44.75	3.96	0.51	49.21
45	12.49	19.78	44.81	3.97	0.51	49.29
46	12.50	19.99	45.78	3.87	0.51	50.16
47	12.52	20.23	46.92	3.78	0.51	51.21
48	12.55	20.51	48.29	3.69	0.51	52.48
49	12.64	20.52	48.92	3.79	0.52	53.23
50	12.69	20.58	49.47	3.82	0.52	53.81
51	12.71	20.61	49.79	3.83	0.53	54.14
52	12.90	20.67	51.27	4.02	0.54	55.84
53	12.98	20.77	52.29	4.08	0.55	56.92
54	13.04	20.83	52.95	4.11	0.55	57.62
55	13.04	20.83	53.01	4.12	0.56	57.68
56	13.12	20.90	53.83	4.17	0.56	58.57
57	13.27	21.03	55.50	4.30	0.58	60.37
58	13.33	21.08	56.16	4.35	0.58	61.09
59	13.33	21.15	56.54	4.32	0.58	61.44
60	13.37	21.27	57.39	4.30	0.59	62.28
61	13.61	21.29	59.21	4.61	0.61	64.43
62	13.70	21.40	60.48	4.67	0.62	65.77
63	13.71	21.47	60.85	4.64	0.62	66.11
64	13.81	21.55	62.04	4.73	0.63	67.40
65	13.84	21.81	63.68	4.63	0.63	68.95

66	13.97	21.95	65.42	4.72	0.64	70.78

The total above-ground biomass of the plot was **2.476.47** ton of dry matter (sum of the above-ground biomass of all 66 trees). The next step to calculate the actual net removals is to calculate the biomass of the tree per hectare in the p portion of stratum i, according to the equations below:

$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}} \times (1 + R_i)$$

$$B_{TREE,p,i} = \sum_j B_{TREE,j,p,i}$$

Where:

$b_{TREE,p,i}$	=	Biomass of trees per hectare in sample plot *p* of stratum *i*; t d.m. ha^{-1}
$B_{TREE,p,i}$	=	Biomass of trees in sample plot *p* of stratum *i*; t d.m.
$A_{PLOT,i}$	=	Size of sample plot in stratum *i*; ha
$B_{TREE,j,p,i}$	=	Biomass of trees of species *j* in sample plot *p* of stratum *i*; t d.m.
R_i	=	Root-shoot ratio for stratum *i*; dimensionless[91]

In this simulation we are considering that the result of the plot will represent the sum of the sample plots of species j in plot p of stratum i. As the plot area is 0.04 ha, we have:

$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}}$ = **2,476.47** t d.m./0.04 ha = **61.912 t d.m. ha^{-1}**

Based on this value, the value R_j is estimated, as described in Section 4.2:

[91] In this case the factor R_i will **not** be calculated because the allometric equation used for pine already contemplates the carbon factor referring to the roots.

$R_i = \frac{e^{(-1.085+0.9256\times\ln b)}}{b}$, where b is the above ground tree biomass per hectare (tons of dry matter, ha^{-1}).

R_i = $e^{(-1.095 + 0.9256 \text{ x } \ln(61.91))}/61.91$ = **0,249**

Thus, the tree biomass per hectare in sample plot *p* of stratum *i* will be:

$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}} \times (1 + R_i)$ = 61.91 x (1 + 0.249) = **77.30 t d m ha^{-1}**

The tree biomass obtained in the strata is then converted into carbon stocks:

$$\Delta C_{TREE\_PROJ,t} = C_{TREE}$$

Then,

$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE}$ Equation 12[92]

$B_{TREE} = A \times b_{TREE}$ Equation 13

$b_{TREE} = \sum_{i=1}^{M} Wi \times b_{TREE,i}$ Equation 14

Where:

C_{TREE} = Carbon stock in trees in the tree biomass estimation strata; t CO_2e

[92] For Equations 12 to 15, we have kept the numbering adopted in the "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"* methodological tool, version 04.2.

CF_{TREE} = Carbon fraction in tree biomass; t C (t d.m.)$^{-1}$

A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.

B_{TREE} = Tree biomass in the tree biomass estimation strata; t d.m

A = Sum of areas of the tree biomass estimation strata; ha

b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; td.m.ha^{-1}

Wi = Ratio of the area of stratum *i* to the sum of areas of tree biomass estimation strata (i.e., $w_i = A_i/A$); dimensionless

$b_{TREE,i}$ = Mean tree biomass per hectare in stratum *i*; td.m.ha^{-1}

Since the simulation used one single stratum, the value of Wi will be 1. The average tree biomass in **Autometal I and II** will be:

$B_{TREE} = A \times b_{TREE}$ = 3,143.20 x 77.30 t d m ha^{-1} = **242,976.76** t. d. m.

From the fixed *ex ante* value of parameter CF_{TREE} of 0.47 (presented in section 5.1) we have:

$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE}$ = (44/12) x 0.47 x 242,976.76 t. d.m. = 418,729.95 tCO_2e

For **Autometal III** the average tree biomass will be:

$B_{TREE} = A \times b_{TREE}$ = 1,130.45 x 77.30 t d m ha^{-1} = **87,386.50** t d m

From the fixed *ex ante* value of parameter CF_{TREE} of 0.47 (presented in section 5.1) we have:

$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times B_{TREE}$ = (44/12) x 0.47 x 87,386.50 t. d.m. = 150,596.07 tCO_2e

Planting on Autometal Farms I and II started in 2020, while planting in Autometal farm III started in 2021. The ex ante calculation for the project's 38-year projection was carried out taking this into account, thus:

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2020	0	104,682.49	0	104,682.49
2021	0	247,013.99	0	247,013.99
2022	0	389,345.50	0	389,345.50
2023	0	531,677.00	0	531,677.00
2024	0	674,008.51	0	674,008.51
2025	0	816,340.01	0	816,340.01
2026	0	330,576.59	0	330,576.59
2027	0	247,013.99	0	247,013.99
2028	0	389,345.50	0	389,345.50
2029	0	531,677.00	0	531,677.00
2030	0	674,008.51	0	674,008.51
2031	0	816,340.01	0	816,340.01
2032	0	330,576.59	0	330,576.59
2033	0	247,013.99	0	247,013.99
2034	0	389,345.50	0	389,345.50
2035	0	531,677.00	0	531,677.00
2036	0	674,008.51	0	674,008.51
2037	0	816,340.01	0	816,340.01
2038	0	330,576.59	0	330,576.59
2039	0	247,013.99	0	247,013.99
2040	0	389,345.50	0	389,345.50
2041	0	531,677.00	0	531,677.00
2042	0	674,008.51	0	674,008.51
2043	0	816,340.01	0	816,340.01

2044	0	330,576.59	0	330,576.59
2045	0	247,013.99	0	247,013.99
2046	0	389,345.50	0	389,345.50
2047	0	531,677.00	0	531,677.00
2048	0	674,008.51	0	674,008.51
2049	0	816,340.01	0	816,340.01
2050	0	330,576.59	0	330,576.59
2051	0	247,013.99	0	247,013.99
2052	0	389,345.50	0	389,345.50
2053	0	531,677.00	0	531,677.00
2054	0	674,008.51	0	674,008.51
2055	0	816,340.01	0	816,340.01
2056	0	330,576.59	0	330,576.59
2057	0	247,013.99	0	247,013.99
Total				**481,196.48**

Note: Average carbon stock = 112.60 CO_2e/ha; Average annual carbon increment per hectare = 32.17 CO_2e/ha/year.

The ex post values will be calculated at the time of verification, through a forest inventory, which will be carried out following the procedures guided by the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" in its most recent version, as demonstrated in section 4.2 of this PD.

With the value of tree carbon stock in the first instance, the change in carbon stock in the project scenario will be:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + 0 + 0 + 0 + 0$$

$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t}$ = C_{TREE} = **481,196.48 tCO_2e**

Finally, actual net removals will be:

$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$ = 481,196.48 – 0 = **481,196.48 tCO_2e**

Baseline net GHG removals by sinks

According to section 5.4 of the methodology AR-ACM003 the baseline net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$

Where:

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{TREE\_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{SHRUB\_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{DW\_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e

$\Delta C_{LI\_BSL,t}$	=	Change in carbon stock in baseline litter biomass within the project boundary, in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e

Pre-existing trees (ΔC_{TREE_BSL})

Some of the pre-existing trees at the eucalyptus plantation areas were removed by the project proponent. This removal is legally allowed through legal authorizations that will be presented to VVB during validation. Removal of all pre-existing trees was considered conservatively as trees that remain in place will not be monitored.

For the calculation of $\Delta C_{TREE\_BSL,t}$ for the first instance, according to section 4.1.1.1, the crown cover analysis procedure (Option 3) was performed, as instructed by the methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities". Pre-existing trees removed from the baseline were identified using satellite imagery. Subsequently, the crown cover of these trees was accounted and transformed into an area using NDVI image analysis. Meeting the guidelines of AR-TOOL14, section 8.3, the change in tree carbon stock at baseline is estimated as follows:

$$C_{TREE\_BLS} = \sum_{t=1}^{M} C_{TREE_{BLS},i}$$

$$C_{TREE_{BLS,i}} = \frac{44}{12} * CF_{TREE} * b_{FOREST} * (1 + R_{TREE}) * CC_{TREE_{BLS},i} * A_i$$

Where:

C_{TREE_BLS}	=	Mean annual change in carbon stock in trees in the baseline; t CO_2e yr^{-1}
$C_{TREE_{BLS,i}}$	=	Mean annual change in carbon stock in trees in the baseline, in baseline stratum i; t CO_2e yr^{-1}
CF_{TREE}	=	Carbon fraction of tree biomass; t C $(t.d.m.)^{-1}$
b_{FOREST}	=	Mean above-ground biomass in forest in the region or country where the ARR project activity is located; t d.m. ha^{-1} yr^{-1}.

R_{TREE}	=	Root-shoot ratio for the trees in the baseline; dimensionless.
$CC_{TREE_{BLS},i}$	=	Crown cover of trees in the baseline, in baseline stratum i, at the start of the ARR project activity, expressed as a fraction; dimensionless.
A_i	=	Area of baseline stratum i, delineated on the basis of tree crown cover at the start of the ARR project activity; ha

The parameters applied are detailed below:

Table 10: Parameters applied for calculating baseline carbon stock on trees

Parameter	Value	Unit	Reference
CF_{TREE}	0.47	t C (t.d.m)$^{-1}$	Default value defined by the AR_TOOL14
b_{FOREST}	110.12	t.d.m ha^{-1}	Miranda et al. (2014).
R_{TREE}	0.25	dimensionless	Default value defined by the AR_TOOL14
CC_{Tree_BSL}	Table 11 (by stratum)	dimensionless	Measured for each stratum with NDVI analysis
Ai	Table 11 (by stratum)	ha	Measured.

Table 11: Stand area, crown cover area and carbon stock in the baseline per stand

Stand	Stand área (ha)	Crown cover per stand (ha)	ΔCTree_BSL (t CO_2e)
31	43.07	0.32	61.52
32	17.22	0.22	41.35
27	49.17	0.24	45.03
28	35.73	0.05	9.62
33	58.37	0.96	182.64
29	21.41	0.00	0.08
26	41.87	0.00	0.17
25	40.19	0.11	21.18
37	25.42	0.05	8.81
24	71.93	0.81	154.53
34	54.59	0.10	19.05
36	54.94	0.13	23.84
38	67.67	0.02	3.15
39	29.22	0.04	6.77
18	73.12	0.23	42.74
17	51.92	0.07	14.16
16	74.22	0.10	19.36
22	71.57	0.13	25.24

14	67.74	0.16	30.74
41	39.96	0.42	79.70
45	36.14	0.45	85.11
15	68.91	0.19	36.53
13	65.92	0.27	50.31
11	22.85	0.19	35.92
8	33.74	0.21	39.32
9	48.74	0.00	0.06
7	29.64	0.48	90.54
43A	9.87	0.25	47.78
5	68.53	0.22	42.13
4	26.63	0.00	0.00
48	45.47	1.22	231.98
44	30.54	0.33	62.53
3	42.54	0.01	1.52
1	30.82	0.00	0.11
2	20.18	0.10	19.17
19	73.38	0.11	20.61
23	24.57	1.15	219.04
30	46.43	0.03	5.58
35	43.75	0.15	28.92
12	60.84	0.05	8.71
11A	23.78	0.23	44.43
40	16.00	0.01	1.25
42	20.23	0.17	32.28
43	29.47	0.06	11.44
44A	15.20	0.32	59.97
58	16.93	0.12	22.94
57	19.99	0.66	124.83
55	26.59	0.17	31.69
56	24.54	0.23	43.15
60	32.29	0.45	86.04
49	34.52	0.47	89.74
51	35.77	2.38	452.38
54	34.26	0.85	160.70
50	41.07	0.71	134.47
59	44.34	0.29	54.75
52	61.91	0.90	170.76
42A	21.38	0.32	61.51
02B	12.12	0.06	10.97
47	18.14	0.26	49.82
46	41.05	0.46	87.69
21	44.00	0.00	0.00

21A	28.73	0.00	0.06
21B	1.57	0.01	1.73
20	47.64	0.22	42.13
61	59.59	0.56	106.03
47A	9.89	0.06	11.08
10	44.81	0.00	0.66
61A	6.82	0.02	3.57
6	40.73	0.89	169.39
53	48.66	0.16	29.87
53A	6.81	0.12	23.47
18A	1.81	0.04	7.63
95	46.23	0.01	2.68
94	41.18	0.02	4.27
92	36.30	0.00	0.91
101	35.18	0.00	0.53
93	26.32	0.00	0.00
100	41.66	0.03	5.33
97	44.07	0.00	0.00
88	34.45	0.01	1.25
89	43.22	0.00	0.00
109	28.50	0.00	0.02
81	21.65	0.02	4.50
90	31.72	0.00	0.00
80	43.34	0.02	3.89
110	24.45	0.00	0.00
99	38.25	0.11	19.96
87	41.13	0.02	2.87
98	34.29	0.07	13.59
79	45.76	0.49	92.29
86	57.96	0.14	26.06
78	49.76	0.08	15.56
77	56.40	0.23	43.38
76	13.28	0.00	0.00
75	32.01	0.22	42.13
91	35.08	0.00	0.34
84	34.26	0.00	0.00
82	28.65	0.08	14.25
85	36.56	0.03	5.54
101A	28.89	0.12	22.96
83	62.88	0.01	2.37
74	3.64	0.00	0.00
62	48.65	0.46	87.58
63	46.46	1.01	191.31

65	33.70	0.46	87.49
66	41.43	0.00	0.00
69	35.58	0.85	162.18
70	37.73	0.44	82.78
71	33.13	0.01	2.73
72	25.90	0.14	26.72
67	38.06	0.18	33.23
68	35.84	0.25	47.75
64	37.27	1.53	291.21
96	19.82	0.00	0.00
103	12.05	0.02	3.70
93	1.51	0.00	0.00
Total			**5,283.37**

As described in Section 4.1.1.2, for the first instance the project activity will not consider carbon removals from the pool shrubs, as the previous land use is determined as non-forested land, notably agriculture or pasture. So, condition "f" applies to the instance and the carbon stocks and change in carbon stocks in shrubs in the baseline could be accounted as zero. The pools dead wood and litter also were considered as zero. Therefore, these pools in the baseline may be considered as zero:

$\Delta C_{SHRUB\_BSL,t} = 0$

$\Delta C_{DW\_BSL,t} = 0$

$\Delta C_{LI\_BSL,t} = 0$

Therefore, it is conservatively considered that the carbon stock of all pre-existing trees is removed from the baseline, thus:

$\Delta C_{TREE\_BSL,t}$ = 5,283.37 t CO_2e

GHG emissions due to leakage

For the assessment of leakage, the PP created a questionnaire that was applied to identify if there was displacement of agricultural activities due to the project. If the displacement is identified and it is characterized by generating GHG emissions in another area outside the project boundaries, the equations in section 4.2 of this PD will be applied. This questionnaire will be presented to the VVB during validation.

For the first instance was not identified displacement of agricultural activities to any other area. Therefore, GHG emissions due to leakage in this estimate are considered as zero:

LK_t = 0

Net anthropogenic GHG removals by sinks

Net anthropogenic GHG removals by sinks are calculated using the equation:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
LK_t	=	GHG emissions due to leakage in year *t*; t CO_2-e

Considering the results presented in the ex ante simulation above:

$\Delta C_{AR-CDM,t}$ = 481,196.48 – 5,283.37 - 0 = **475,913.11 tCO_2e**

b) RESTORATION PROJECT:

For restoration planting simulation, the area considered is the PAI 2's **26 hectares**.

Actual net GHG removals by sinks

As presented in section 4.2, actual net removals are calculated from the equation:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net removals by sinks in year *t*; t CO_2-e

$\Delta C_{P,t}$	=	Change in the carbon stocks in the project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the ARR project activity, in year *t*, as estimated in the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO_2-e

Non-CO_2 GHG emissions within the project boundary will be monitored as per the description in Section 5.2. For the purposes of exemplifying actual net removals, it is considered that no accidental fires have taken place, and therefore:

$GHG_{E,t} = 0$

Thus, actual net removals from the project will be:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$\Delta C_{TREE\_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{SHRUB\_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e
$\Delta C_{DW\_PROJ,t}$	=	Change in carbon stock in dead wood in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e

$\Delta C_{LI\ PROJ,t}$ = Change in carbon stock in litter in project in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2-e

$\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in project, in year *t*, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", as estimated in the same tool; t CO_2-e

Trees (ΔC_{TREE})

To calculate the estimate of ΔC_{TREE} for restoration activities, the average annual carbon increment value for the Cerrado region, obtained from the Reference Report of the Brazilian Inventory of Anthropogenic GHG Emissions and Removals[93], was used. According to Section 8.2 of the tool *"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities",* carbon stock in tree biomass can be estimated by existing data related to growth and development of trees over time. The annual carbon increment value was then multiplied by the planting age and by the total area to be restored by the project in that instance. This value is multiplied by 44/12 to obtain the amount of CO_2e contributed per year to the restoration planting, during the project's crediting period. Thus,

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2023	0	163.97	0	163.97
2024	0	327.95	0	327.95
2025	0	491.92	0	491.92
2026	0	655.89	0	655.89
2027	0	819.87	0	819.87
2028	0	983.84	0	983.84
2029	0	1,147.81	0	1,147.81
2030	0	1,311.79	0	1,311.79
2031	0	1,475.76	0	1,475.76
2032	0	1,639.73	0	1,639.73

[93] MCTIC (2020): *Relatório de Referância da 4 Comunicação Nacional - Setor de LULUCF*

2033	0	1,803.71	0	1,803.71
2034	0	1,967.68	0	1,967.68
2035	0	2,131.65	0	2,131.65
2036	0	2,295.63	0	2,295.63
2037	0	2,459.60	0	2,459.60
2038	0	2,623.57	0	2,623.57
2039	0	2,787.55	0	2,787.55
2040	0	2,951.52	0	2,951.52
2041	0	3,115.49	0	3,115.49
2042	0	3,279.47	0	3,279.47
2043	0	3,298.53	0	3,298.53
2044	0	3,317.60	0	3,317.60
2045	0	3,336.67	0	3,336.67
2046	0	3,355.73	0	3,355.73
2047	0	3,374.80	0	3,374.80
2048	0	3,393.87	0	3,393.87
2049	0	3,412.93	0	3,412.93
2050	0	3,432.00	0	3,432.00
2051	0	3,451.07	0	3,451.07
2052	0	3,470.13	0	3,470.13
2053	0	3,489.20	0	3,489.20
2054	0	3,508.27	0	3,508.27
2055	0	3,527.33	0	3,527.33
2056	0	3,546.40	0	3,546.40
2057	0	3,565.47	0	3,565.47
Total				**3,565,47**

The ex post values will be calculated at the time of verification, through a forest inventory, which will be carried out following the procedures guided by the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” in its most recent version, as demonstrated in section 4.2 of this PD.

Shrubs (ΔC_{shrubs})

According to the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2, it is conservatively considered that there are no shrubs in the project area, so shrub carbon stocks for the ex ante calculation will be considered as zero.

$\Delta C_{SHRUB\_PROJ,t} = 0$

If shrubs are observed in the forest inventory at the time of verification, they can be measured for addition in the ex post calculation according to the methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2.

Dead Wood (ΔC_{DW})

In this instance, dead wood will not be removed from the project site through any anthropogenic activity. Thus, the calculation of this carbon pool can be performed using the conservative default-factor based method, according to the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities", Version 3.1, as cited and detailed in section 4.2 of this PD. Values will be obtained ex post. Thus, for the ex ante calculation of this PD, conservatively, this value will be considered zero. Thus,

$\Delta C_{DW} = 0$

Litter (ΔC_{Li})

In this instance there will be no removal of litter from the project site by any anthropogenic activity. Thus, the calculation of this carbon pool can be performed using the conservative default-factor based method, according to the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities", Version 3.1, as described in section 4.2 of this PD. Values will be obtained ex post. Thus, for the ex ante calculation of this PD, conservatively, this value will be considered as zero. Thus,

$\Delta C_{LI} = 0$

Soil Organic Carbon (ΔC_{SOC})

In the second instance the main types of soils are oxisoils of low clay activity and sandy soils occurring in "Tropical moist" climate region. The value used for $SOC_{REF,i}$ was taken from table 3 of the methodological tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". An average between the values of LAC soils and Sand soils was calculated:

Table 12: Default reference SOC stocks (SOC_{REF}) for mineral soils (tC ha^{-1} in 0-30 cm depth)

Climate region	HAC soils[(a)]	LAC soils[(b)]	Sandy soils[(c)]	Spodic soils[(d)]	Volcanic soils[(e)]
Boreal	68	NA	10	117	20
Cold temperate, dry	50	33	34	NA	20
Cold temperate, moist	95	85	71	115	130
Warm temperate, dry	38	24	19	NA	70
Warm temperate,	88	63	34	NA	80
Tropical, dry	38	35	31	NA	50
Tropical, moist	65	47	39	NA	70
Tropical, wet	44	60	66	NA	130
Tropical montane	88	63	34	NA	80

Source: AR tool 16

Thus:

$SOC_{REF,i}$ = 47 t C ha^{-1}

According to the tool, the parameter $SOC_{INITIAL}$ is estimated using factors that correct the reference values (SOC_{REF}) according to the land-use type, management activities and inputs applied. Thus, for ex ante estimations in pasture areas, table 6 of the tool was consulted.

Table 13: Relative stock change factors (f_{LU}, f_{MG}, and f_{IN}) for grassland management (net effect over a period of 20 years)

Factor type	Level	Climate regime	Factor value	Description
Land use (f_{LU})	All	All	1.00	All permanent grassland is assigned a land-use factor of 1
Management (f_{MG})	Non-degraded grassland	All	1.00	Non-degraded and sustainably managed grassland, but without significant management improvements
Management (f_{MG})	Moderately degraded grassland	Temperate/Bore al	0.95	Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs
		Tropical	0.97	
		Tropical Montane	0.96	
Management (f_{MG})	Severely degraded	All	0.70	Lands are identified as degraded lands using the "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities"
Input (f_{IN})	Low/Medium	All	1.00	All grassland without input of fertilizers is assigned an input factor of 1
	High	All	1.11	Grasslands with direct application of fertilizers - organic or inorganic

For ex ante estimations in pasture areas it was considered that the restoration activities will be implanted in conditions of moderately degraded to severely degraded grasslands (an average was calculated), and low/medium input of residues, thus:

$$f_{LU,i} = 1$$

$$f_{MG,i} = 0.835$$

$$f_{IN,i} = 1$$

Thus,

$$SOC_{INITIAL,i} = SOC_{REF,i} \times f_{LU,i} \times f_{MG,i} \times f_{IN,i}$$

$$SOC_{INITIAL,i} = 47 \text{ x } 0.835 \text{ x } 1$$

$$SOC_{INITIAL,i} = 39{,}24 \text{ t C ha}^{-1}$$

Soil disturbance attributable to project activity in the strata where SOC was accounted is less than 10% of the area of the stratum. Hence, the carbon loss is taken as zero. Thus,

$dSOC_{t,i}$ = $(SOC_{REF,i}$ - $(SOC_{INITIAL,i}$ – $SOC_{LOSS,i}))/20$ years; for $t_{PREP,i} < t \leq t_{PREP,i+20}$

$dSOC_{t,i}$ = (47 – (39,25– 0))/20

$dSOC_{t,i}$ = 0,39 t C ha^{-1}

The change in SOC stock for all the strata of the areas of land, in year t, is calculated as:

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i A_i * dSOC_{t,i} * 1 year$$

$\Delta SOC_{AL,t}$ = 44/12 x 26 x 0,39

$\Delta SOC_{AL,t}$ = 37.18 t CO_2e

Therefore, conservatively, the change in carbon stock in the project scenario will be:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t}$ + 0 + 0 + 0 + 33.68

$\Delta C_{P,t} =$ 3,565.47 + 37.18 **= 3,602.65**

Finally, actual net removals will be:

$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$ = 3,602.65 – 0 = **3,602.65 tCO_2e**

Baseline net GHG removals by sinks

According to section 5.4 of the methodology AR-ACM003 the baseline net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$

Where:

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{TREE\_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO_2-e
$\Delta C_{SHRUB\_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO_2-e
$\Delta C_{DW\_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO_2-e
$\Delta C_{LI\_BSL,t}$	=	Change in carbon stock in baseline litter biomass within the project boundary, in year *t*, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO_2-e

In this instance pré-existing trees were not observed. As described in Section 4, the project activity will not consider carbon removals from pools shrubs, dead wood and litter. Therefore these pools in the baseline may be considered as zero:

$\Delta C_{TREE\_BSL,t} = 0$

$\Delta C_{DW\_BSL,t} = 0$

$\Delta C_{LI\_BSL,t}$ = 0

$\Delta C_{SHRUB\_BSL,t}$ = 0

GHG emissions due to leakage

As stated in section 4.4, leakage for the second instance is considered to be zero as there are no displacement of agricultural activities to any other area. Therefore, GHG emissions due to leakage in this estimate are considered as zero:

LK_t = 0

Net anthropogenic GHG removals by sinks

Net anthropogenic GHG removals by sinks are calculated using the equation:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
LK_t	=	GHG emissions due to leakage in year *t*; t CO_2-e

Considering the results presented in the ex ante simulation above:

$\Delta C_{AR-CDM,t}$ = 3,602.65 - 0 - 0 = **3,602.65 tCO_2e**

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	CF_{TREE}
Data unit	t C (t d.m.)$^{-1}$
Description	Carbon fraction in tree biomass
Source of data	Default value of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	The default value from the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2 is used
Purpose of Data	Calculation of net baseline removals and Calculation of actual net removals
Comments	N/A

Data / Parameter	$COMF_i$
Data unit	Dimensionless
Description	Combustion factor for stratum *i*
Source of data	Default value of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0
Value applied	**Age Range** **Default Value** 3 - 5 years 0.46 6 -10 years 0.67 11 - 17 years 0.50 18 and above 0.32
Justification of choice of data or description of measurement methods and procedures applied	The default value of the methodological tool "Tropical Forest" of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0 is used

Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$EF_{CH4,i}$
Data unit	g kg^{-1} burnt dry matter
Description	CH_4 emission factor in stratum i
Source of data	Default value of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0
Value applied	6.8
Justification of choice of data or description of measurement methods and procedures applied	The default value for "Tropical Forest" of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0 is used
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	GWP_{CH4}
Data unit	Dimensionless
Description	Global warming potential for CH_4
Source of data	VCS Standard v.4.4 Table 2 (IPCC - *Fourth Assessment Report)*
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$EF_{N2O,i}$
Data unit	g kg^{-1} burnt dry matter
Description	Emission factor for N_2O in stratum *i*
Source of data	Default value of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0
Value applied	0.2
Justification of choice of data or description of measurement methods and procedures applied	The default value for "Tropical Forest" of the methodological tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" version 04.0.0 is used
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	GWP_{N2O}
Data unit	Dimensionless
Description	Global warming potential for N_2O
Source of data	VCS Standard v.4.4 Table 2 (IPCC - *Fourth Assessment Report)*
Value applied	265
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	DF_{LI}
Data unit	*Percent*
Description	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass;

Source of data	Table 6, of section 8 of the methodological tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities".
Value applied	*1%*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	DF_{DW}
Data unit	*Percent*
Description	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass;
Source of data	Table 5, of section 8 of the methodological tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities".
Value applied	*1%*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$SOC_{REF,i}$
Data unit	$t\ C\ ha^{-1}$
Description	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation, normally forest) by climate region and soil type applicable to stratum i of the areas of land;

Source of data	Tables 3-6 of the methodological tool "Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project activities".
Value applied	*47*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$f_{LU,i}$
Data unit	*Dimensionless*
Description	Relative stock change factor for baseline land-use in stratum i of the areas of land;
Source of data	Tables 3-6 of the methodological tool "Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project activities".
Value applied	*1*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$f_{MG,i}$
Data unit	*Dimensionless*
Description	Relative stock change factor for baseline land-use in stratum i of the areas of land;

Source of data	Tables 3-6 of the methodological tool "Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project activities".
Value applied	*0.835*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$f_{IN,i}$
Data unit	*Dimensionless*
Description	*Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum i of the areas of land;*
Source of data	Tables 3-6 of the methodological tool "Estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project activities".
Value applied	*1*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	$SOC_{LOSS,i}$
Data unit	*t C ha^{-1}*
Description	Loss of SOC caused by soil disturbance attributable the A/R CDM Project activity, in stratum i of the areas of land;
Source of data	"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities".

Value applied	*0*
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of actual net removals
Comments	The minimum cultivation will be carried out and therefore the turning in the soil will be less than 10%.

Data / Parameter	$f_j(x_{1,l}, x_{2,l}, x_{3,l}, \ldots)$
Data unit	t d.m.
Description	Above-ground biomass of the tree returned by the allometric equation tree biomass given by the allometric equation for stratum *i* which represents a ratio between measurement of the tree diameter (DBH) and tree height and aboveground tree biomass.
Source of data	Eucalyptus: Soares & Oliveira (2002)
Value applied	Eucalyptus: Total biomass = bole biomass + branch biomass + leaf biomass • Bole biomass = $e^{(-6.609865\ 1.661056.Ln\ (DBH)\ 1.851121.Ln\ (Ht))}$ x 1/0.5 • Branch biomass: = $e^{(-1,695267\ +\ 3,888792.Ln(DBH)\ -\ 2,492777.Ln(Ht))}$ x 1/0,5 • Leaf biomass: = $e^{(-6,649474\ +\ 2,273838.Ln(DAP)\ -\ 0,155153.Ln(Ht))}$ x 1/0,5
Justification of choice of data or description of measurement methods and procedures applied	For the eucalyptus forest allometric equations found in the literature will be used both, ex ante and ex post estimates unless new equations obtained from transparent and verifiable data are used. The sources for the equations used meet condition 6 (c) of the tool "*Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities*", version 01.0.0.
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	R_j

Data unit	*Dimensionless*
Description	Root-shoot ratio for stratum *i*
Source of data	Calculated according to the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2
Value applied	$R_j = \frac{e^{(-1.085+0.9256\times\ln b)}}{b}$ Where: b = above-ground biomass per hectare (t d.m. ha^{-1})
Justification of choice of data or description of measurement methods and procedures applied	Equation used in ex-ante and ex-post estimates. Standard calculation of the methodological tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" version 04.2
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	Carbon increment in native trees
Data unit	t C ha^{-1} ano^{-1}
Description	Carbon increment per year in Cerrado native forest
Source of data	Default value of the MCTI (2020): Relatório de Referência da 4ª Comunicação Nacional - LULUCF, table 29.
Value applied	*Primary forest: 0.20* *Secondary forest: 1.72*
Justification of choice of data or description of measurement methods and procedures applied	Annual carbon increment data, used according to item 8.2 of the methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 04.2.
Purpose of Data	Calculation of net baseline removals and Calculation of actual net removals

Comments	N/A

Data / Parameter	$BEF_{2,j}$
Data unit	Dimensionless
Description	Biomass expansion factor for conversion of stem biomass to aboveground biomass for tree species j
Source of data	Values from Table 3A.1.10 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values
Value applied	*Ex post in case this method is chosen.*
Justification of choice of data or description of measurement methods and procedures applied	The default value from the methodological tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities".
Purpose of Data	Calculation of actual net removals
Comments	N/A

Data / Parameter	D_J
Data unit	*t.d.m. m^{-3}*
Description	Basic wood density for species *j*
Source of data	*Values from Table 3A.1.9 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values*
Value applied	*Ex post in case this method is chosen.*
Justification of choice of data or description of measurement methods and procedures applied	The default value from the methodological tool *"Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities".*

Purpose of Data	Calculation of actual net removals
Comments	N/A

5.2 Data and Parameters Monitored

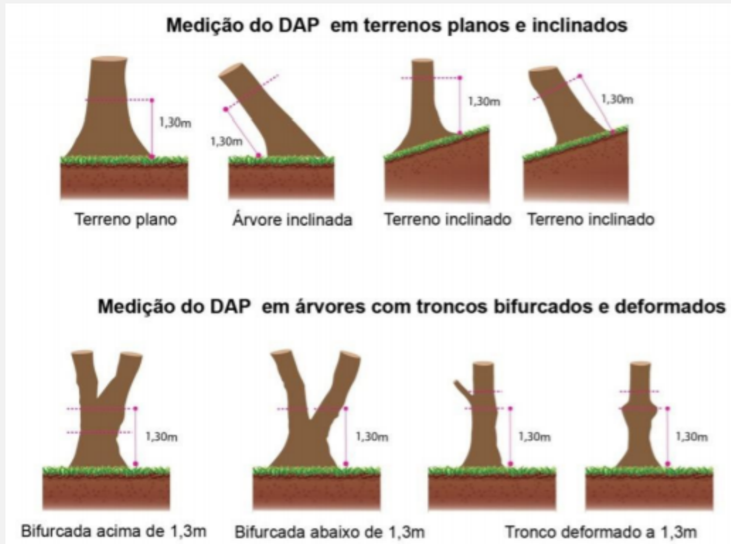
Data / Parameter	Ai
Data unit	Ha
Description	The area of stratum i of the areas of land
Source of data	GPS and/or GIS
Description of measurement methods and procedures to be applied	The project's planting areas will be delimited via GPS or GIS. Measurement in the field is made with GPS in APP areas and in the productive area. In the office, the field information is used for demarcation on the cartographic base. After planting a further flight is made to analyze whether the whole area made available has been planted and whether the full limit has been obeyed. Adjusting the cartographic base, ensuring precision and avoiding errors of areas.
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	GPS and/or GIS
QA/QC procedures to be applied	Refer to IPCC 2003 2.4.4.2 "Ground-based surveys". Field teams will be formed by PP's own team or outsourced. The team members will have appropriate qualification to perform the activity and correct use of the equipment and will act in accordance with the best practices for area measurement. GPS instruments used are free of error and as per the manufacturer's specifications.
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	n_i
Data unit	Dimensional
Description	Number of sample plots in stratum *i*
Source of data	Calculated
Description of measurement methods and procedures to be applied	The calculation method is described in the tool "*Calculation of the number of sample plots for measurements within A/R CDM project activities*" (version 02.1.0)
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	$A_{PLOT,i}$
Data unit	Ha
Description	Size of sample plot in stratum *i*
Source of data	Measured/calculated
Description of measurement methods and procedures to be applied	The plots will be located in the field with the aid of GPS. The plots will have a circular and or rectangular shape of approximately 0.04 ha. The plots will be allocated in the field in a systematic way, beginning randomly.
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	GPS and/or GIS

QA/QC procedures to be applied	Refer to IPCC 2003 2.4.4.2 "Ground-based surveys". Field teams will be formed by PP's own team or outsourced. The team members will have appropriate qualification to perform the activity and correct use of the equipment and will act in accordance with the best practices for area measurement. GPS instruments used are free of error and as per the manufacturer's specifications. Follow guidelines provided in the forestry inventory standard operational procedure. These SOPs were made available to the VVB during validation
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	DBH
Data unit	Cm
Description	Diameter at breast height
Source of data	Measurement
Description of measurement methods and procedures to be applied	The measurement of the circumference of the trees in the plot is made using a tape measure (thus measuring the circumference at breast height) and the circumference is converted into diameter at breast height according to the equation W below: $DAP = \frac{CAP}{\pi}$ Equation W Where: DAP = Diameter at breast height, cm CAP = Circumference at breast height, cm π = Pi, 3.1416 The measurement of the circumference at breast height is made at 1.30 m from the ground and must follow the forest inventory procedures according to the "Field Manual of the National Forestry Inventory of Brazil" published by the Ministry of the Environment (2020). The figure below is from the manual and

	illustrates how measurements should be taken on the stem in different situations. 
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	Tape measure
QA/QC procedures to be applied	Follow guidelines provided in the forestry inventory standard operational procedure. These SOPs were made available to the VVB during validation
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	**Ht**
Data unit	Metres
Description	Total height of tree
Source of data	Measured/estimate
Description of measurement methods	The height of the tree is measured with the aid of height measurement equipment (for example: hypsometer, clinometer, laser sensor) or estimated by hypsometric equations. At least 4

and procedures to be applied	trees will be measured per sample plot (in general, the acceptable error in hypsometric equations is achieved measuring approximately 10 trees). From the correlation between the DBH data and the height measured, the heights of the other trees in the plot will be estimated using a hypsometric equation. The choice for hypsometric equation will consider the correlation between diameter and height in order to guarantee the best quality and accuracy of the adjustments.
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	Height measurement equipment (for example: hypsometer, clinometer, laser sensor), if.
QA/QC procedures to be applied	Planted forests: Follow guidelines provided in the forestry inventory standard operational procedure. Restoration: Follow guidelines provided in the general procedure for the implementation of the instances. These SOPs were made available to the VVB during validation.
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	$a_{p,i}$
Data unit	m 2
Description	Area of litter sampling frame used in plot *p* in stratum *i*
Source of data	Measured/calculated
Description of measurement methods and procedures to be applied	Standard operating procedures (SOPs) prescribed under national forest inventory will be applied in case this method is chosen. In the absence of these, SOPs from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.

Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	GPS and/or GIS
QA/QC procedures to be applied	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

Data / Parameter	$B_{LI\_WET,p,i}$
Data unit	*Kg*
Description	Wet weight of the composite litter sample collected from plot p of stratum i; kg
Source of data	Measured
Description of measurement methods and procedures to be applied	Standard operating procedures (SOPs) prescribed under national forest inventory are applied in case this method is chosen. In the absence of these, SOPs from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied.
Frequency of monitoring/recording	Every verification period
Value applied	[to be completed by the instance at each check]
Monitoring equipment	GPS and/or GIS
QA/QC procedures to be applied	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these,

	QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied
Purpose of data	Calculation of actual net removals
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

Field data collection may be performed by a third-party company specialized in forest inventories. For the selection of the company, the PP will assess its technical capacity to carry out the work. The teams and data collected will be audited by the PP as specified in contract. Upon receipt of the data, the PP will check whether the data meets the parameters determined in the project. If so, the PP will be responsible for collecting, processing, and archiving the data for at least 2 years after the end of the project verification period using inventory system, databases or spreadsheets. Monitoring of the project activities will be planned and executed according to Section 6 of the tool "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*", version 4.2, and data will be archived and kept for at least 2 years after the end of the project verification period.

As per the table below, the PP may conduct the instances' verifications in different periods according to the purpose of the forest and/or planting species. This may be done by grouping instances' according to their age range, optimizing resources.

Table 14: proper period for monitoring carbon stocks of forests

Year	Age (months)	Eucalyptus	Restoration Planting
1	0 to 12 months	-	
2	12 to 24 months	-	
3	24 to 36 months	X	
4	36 to 48 months	X	
5	48 to 60 months	X	x
6	60 to 72 months	Harvesting	
7	72 to 84 months		
8	84 to 96 months		
9	96 to 108 months		
10	108 to 120 months		

11	120 to 132 months		
12	132 to 144 months		
13	144 to 156 months		
14	156 to 168 months		

Collection of all relevant data, as per the methodology requirements

Applicability conditions:

(a) Previous land use: the PP will use satellite images 10-year prior and immediately previous to the project implementation, to ensure that the proposed project area was not occupied by native ecosystems in this period,

(b) The area of the project activity does not fall into the category of wetlands: The PP will verify through shapes and/or maps that the proposed project is not located in wetlands.

(c) Soil disturbance attributed to the proposed project activity do not cover more than 10% of the project area that:

i. Contain organic soils: the PP will verify through shapes and/or maps that the proposed project is not located in areas where organic soils occur.

ii. At the baseline are subject to land use management conditions which receive inputs listed in Appendices 1 and 2 of the AR-ACM003 methodology, version 02.0: if the land use at baseline falls within one of the conditions listed in Appendices 1 and 2 of the AR-ACM003 methodology, the PP will check if tillage do not disturb more than 10% of the project area, e.g. evaluation of the proportion of tilled area (width x length of the tilled line x number of tilled lines or dug area x number of pits) in relation to the total area of the project. In general, the PP adopts minimal cultivation, that is, it only performs the revolving of the soil in the planting line, resulting in very low impact on the soil cover.

(d) Forestation of the land within the proposed project boundary performed with or without being registered as the AFOLU project activity shall not lead to violation of any applicable law even if the law is not enforced: the PP will present all the necessary documentation for the implementation of the project to the relevant agencies of the Host Country.

(e) Not applicable to small-scale AFOLU project activities: no area within this grouped project will be considered small-scale projects.

Project boundary: The geographical coordinates of the project boundary and all stratifications will be recorded using GPS, satellite images and/or land use maps. The PP will designate a GIS expert to coordinate this activity together with a team or hire a specialized company.

Existing vegetation: according to the standard for eligible areas, pre-project/existing vegetation are sparse and scattered. In case they occur, in case of native species, they will not be removed, and their survival will be monitored throughout the project lifetime. Moreover, they will not be accounted for the estimation of carbon stocks.

Leakage: according to the applied methodology, leakage refers to the displacement of agricultural activities. In order to identify and minimize potential leakage, the PP will prepare and apply a questionnaire to all potential instances regarding the situation of the land to be leased, the existence of any agricultural activity/ cattle and its possible displacement and destination.

All monitored will be kept and archived for at least two years after the end of the final crediting period.

The organizational structure, responsibilities, and competencies of the

Lacan has the overall responsibility for all operational and management arrangements for the implementation of this grouped project. The PP must form a team to deal with project's matters and check that all new instances meet the eligibility criteria (as per section 1.4) for their inclusion in this grouped project. The team may hire consultants to support them in this task, as they deem necessary. The organizational structure of the project is as described below.

Table 15: organizational structure responsible for the grouped project and its instances

Director		- Develop the idea of the Grouped project; - Develop a business plan for the Grouped project; - Approve the hiring of consultants, specialists, auditing companies, and others, whenever necessary; - Act as a focal point in communication with the Verra Registry and others; - Approve the inclusion of new instances.
Forestry manager		- Coordinate the development of the Grouped project documentation; - Coordinate the development of the documentation of a new instance; - Approve the results, documents and reports; - Evaluate the areas to be prospected; - Check the eligibility of each prospected area in accordance with the criteria established for inclusion of new instances.

Forestry surpervisor		- Coordinate the prospection of the areas; - Monitor the execution of instances' forestry activities; - Monitor the forestry activities schedule, as well as the quality of activities performed in the instances'; - Control of staff training.
Analyst		- Check the eligibility of each prospected area in accordance with the criteria established for the inclusion of new instances; - Check documents, spreadsheets and reports; - Technically evaluate the information obtained in the field; - Keep the instances database updated; - Control registration and archiving of data and documents, physical and digital; - Control the archive of audits and inspections; - Provide the inclusion of calibration frequency and data collection in internal operational procedures.
Instances' agents (outsourced)		- Implement and perform forestry activities (as listed in the section 1.11 above).

Some of the general competencies required from the grouped project's team members are as follows:

- Clear understanding of the goals and purpose of the grouped project;
- Know the eligibility criteria for inclusion of instances under the grouped project, that is, be able to access weather a proposed instance is eligible to be a part of the grouped project;
- Know the Monitoring Plan for the instances;
- Capacity to assess project related documents such as land documents, licenses and other to verify the qualification of the instance to be included under the grouped project;
- Capacity to analyze monitoring data and monitoring related documents;
- Capacity to interact with possible instance implementers and clearly communicate the grouped project's concept.

The PP should provide training and capacity-building activities for its staff, based on any identified needs, so as to ensure the continuous improvement of the grouped project management system. Records of staff development activities will be archived.

<u>Sampling Plan</u>

Strata identification in the proposed project activity follows the stratification guidelines mentioned in the *AR-ACM003* methodology, both for baseline net GHG removals by sinks, and for actual net GHG removals by sinks:

(a) For baseline net GHG removals by sinks, stratification of the project area is done according to the type of vegetation existing at the site;

(b) For actual net GHG removals by sinks, the *ex ante* stratification of the project area is based on the expected year of implementation. The implementation of the project will only involve planted forests.

The project will adopt a simple sampling procedure.

Number of sample plots:

Initially, sample plots will be systematically installed every 10 ha, with a random start, in order to ensure uniform coverage of the area. Subsequently, based on the standard deviation, a minimum number of sample plots will be calculated in order to guarantee that biomass estimation error is not higher than +/- 10 per cent with a confidence level of 90 per cent. The number of sample plots required for the project (n) will be defined by the following equation (as per the *Calculation of the number of sample plots for measurements within A/R CDM project activities* tool):

$$n = \frac{N * t_{VAL}{}^2 * \left(\sum_i w_i * s_i \right)^2}{N * E^2 + t_{VAL}{}^2 * \sum_i w_i * s_i{}^2}$$

Equation 1[94]

where:

n	=	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

[94] For Equations 1 and 4, the numbering adopted in the methodological tool "*Calculation of the number of sample plots for measurements within A/R CDM project activities" version 02.1.0* was maintained.

N	=	Total number of possible sample plots within the project boundary (i.e. sampling space or population); dimensionless
t_{VAL}	=	Two-sided Student's *t*-value, at infinite degrees of freedom with a 90 per cent confidence level; dimensionless
w_i	=	Relative weight of area of stratum *i* (that is, area of stratum *i* divided by project area); dimensionless
s_i	=	Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})
E	=	Acceptable margin of error in estimation of biomass stock within the project boundary; t d.m. (or t d.m. ha^{-1}), that is, in the units used for s_i
i	=	1,2,3,..... biomass stock estimation strata within the project boundary

The number of sample plots allocated to a stratum is calculated as

$$n_i = n * \frac{w_i * s_i}{\sum_i w_i * s_i} \qquad \text{Equation 4}$$

where:

n_i	=	number of sample plots allocated to stratum *i*; dimensionless
n	=	number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
w_i	=	Relative weight of the area of stratum *i* (i.e. the area of the stratum *i* divided by the project area); dimensionless
s_i	=	Estimated standard deviation of biomass stock in stratum *i*; t d.m. (or t d.m. ha^{-1})
i	=	*1, 2, 3,* . biomass stock estimation strata within the project boundary

Internal quality control (QC) and quality assurance (QA) procedures will be applied in order to guarantee the highest possible standardization and accuracy of field data.

Sampling Project

Type of sample plot	Permanent and/or temporary sample plots
Sample plot shape	Circular and/or rectangular
Sample plot size	Approximately 300 m^2, but could be substantially larger in thinning areas
Number of sample plots	To be calculated according to forest variability using accepted formulas
Sample plot location	Sample plots will be systematically distributed, with a random start. Sample plot coordinates, location, number, and other registration information will be stored.
Monitoring frequency	Sample plots will be monitored for each crediting period.
Assessment of carbon stock changes over time	Changes will be estimated using an allometric equation based on DHB and Ht.
Monitoring of GHG emissions due to the project activity	Monitoring of accidental fires according to AR-TOOL 08 (section 4.2 Emission of non-CO_2 GHG resulting from burning of biomass)

Procedures for QA/QC

The PP will address any QA/QC procedures through its internal procedures for forestry inventory (to be developed for the grouped project also based on commonly accepted principles and practices of forest inventory and forest management in the host country or an adaptation of SOPs available from published handbooks or scientific literature or from the “IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003”, as per the methodology *AR-ACM0003 version 02.0* provisions.

(i) Reliability regarding field measurements/ data collection

Field team members will have appropriate training to carry out field measurements and the monitoring activities required and will act in accordance with the best practices for data collection. All training, whether internal or external, generates a record, e.g. attendance list.

Each team member is fully aware of the importance of collecting the data as accurately as possible and the impact that this activity can have on the final calculation of GHG removals from the atmosphere by the project.

(ii) Methods used to collect field data

Standard operational procedures are in place in order to guarantee quality of data collection, measurements and procedures. SOPs for all activities under this grouped project will be made available to the VVB during validation.

All standard operational procedures are subject to change/ continuous improvement throughout the implementation of the grouped project, provided they comply with the requirements within this PD.

(iii) Data maintenance and archiving

To increase the accuracy of the monitoring data, quality assurance and quality control procedures are established following commonly accepted principles and practices of forest inventory and forest management in the host country i.e. NBR-Brazilian Technical Norm and FSC. These are elaborated in the SOP "*PGI 001-Document Control*", a SOP regarding document control that is in place and was made available to the DOE during validation.

Monitored data required for verification and issuance are kept and archived for at least two years after the end of the final crediting period or the last issuance of VCUs, whichever occurs later.

(iv) Continuous improvement

The data accumulated in previous years will guide the continuous improvements in operations. Continuous process of observation, verifications, checks, comparations and analyses, aiming at identifying needs for corrections, improvements of procedures and their execution at all levels are to be carried out.