INTEGRATED PROJECT FOR REFORESTATION AND AGROFORESTRY ON DEGRADED LANDS IN NICARAGUA

Project title	Integrated Project for Reforestation and Agroforestry on Degraded Lands in Nicaragua
Project ID	2365
Monitoring period	02-March-2021 to 31-August-2024
Original date of issue	26-December-2024
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Version	10
VCS Standard Version	V4.0
Prepared by	Form International B.V.

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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The proposed ARR VCS project by MLR Forestal de Nicaragua plans to reforest and rehabilitate a total area of 4,031.3 hectares until 2032 in Nicaragua, of which 1,974.6 hectares are to be commercial plantations and the remaining 2,056.7 hectares Protection area.

For the (previous) monitoring period 2016-2021, a total of 2,315.7 hectares were validated, of which 676.9 hectares were covered with pure teak stands, 182.1 ha were cacao agroforestry systems, and 1,456.7 hectares were dedicated to Protection area. As monitoring starts 2 years after planting, the monitoring during this period included only 247.7 hectares of pure teak, which resulted in 15,912 VCUs eligible for issuance.

For the actual monitoring period - 02 March 2021 – 31-August-2024, several changes are being presented, related to the impact of 2 hurricanes (Eta y Lota) at the end of 2019 and to the voluntary transfer of some land (39 ha of previous project area) to an indigenous community. Hence the distribution of planted areas between 2016 and 2024 does present differences in comparison to the PDD. Areas planted between 2016 - 2019 suffered losses due to hurricane damage; in 2020 no teak was planted since all attention went to recovering timber felled by the hurricanes. Table 1 presents the annual distribution of areas planted and protected and to be planted.

Table 1. Overview of annual area interventions and projected interventions

	Teak	Teak & Cacao	Protection area	Total ha
2016	41.9	0.0	0.0	41.9
2017	65.1	16.8	0.0	81.8
2018	0.0	65.9	0.0	65.9
2019	260.7	100.8	0.0	361.5
2020	18.7	196.4	1466.7	1681.9
2021	0.0	0.0	0.0	0.0
2022	26.0	0.0	0.0	26.0
2023	17.8	0.0	0.0	17.8
2024	9.6	0.0	0.0	9.6
2025	190.0	0.0	95.0	285.0
2026	190.0	0.0	95.0	285.0
2027	190.0	0.0	95.0	285.0
2028	190.0	0.0	95.0	285.0
2029	190.0	0.0	95.0	285.0
2030	190.0	0.0	95.0	285.0
2031	15.0	0.0	10.0	25.0
2032	0.0	0.0	10.0	10.0
Total	1594.7	379.9	2056.7	4031.3

Therefore, for the current monitoring period (2021-2024) the calculated GHG emission removal is based on a total of **439.7 ha of pure teak, 379.9 ha of teak in cacao and 1,466.7 ha of protection area**, for a total project area of ***2,286.3* ha,** which has resulted in a total sequestration of 65,154.0 tCO_2e compared to the carbon stock of the previous monitoring period.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation/ verification	01- July -2016 - 01- March -2021	VCS	RINA	4 years
Monitoring/verification	02 March 2021 - 31 -August -2024	VCS	Carbon Check	4 years

1.3 Sectoral Scope and Project Type

Sectoral scope	Agriculture, Forestry and Other Land Uses- AFOLU
AFOLU project category[1]	Group project
Project activity type	Afforestation, Reforestation, Revegetation (ARR) type

1.4 Project Proponent

Organization name	MLR Forestal de Nicaragua S. A.
Contact person	*Tom Lough*
Title	*CEO*
Address	Kilómetro 6.5 carretera a Masaya, Edificio Cobirsa, 5º piso, Managua, Nicaragua.
Telephone	+505 22985300
Email	info@mlr.com.ni

1.5 Other Entities Involved in the Project

Organization name	Form International B. V.

[1] *See Appendix 1 of the* VCS Standard

Role in the project	Project developer
Contact person	E. Schinkel
Title	Senior Forestry Consultant
Address	Eijerdijk 87, 8051 MS, Hattem, The Netherlands
Telephone	+31 (0) 38 444 89 90
Email	e.schinkel@forminternational.nl

1.6 Project Start Date

Project start date	01- July-2016
Justification	The last monitoring report was submitted on 31-May-2021 (Joint MR) and successfully verified on 02-May-2022 (RINA), which falls within the 5 years requirement for ex-ante projects.

1.7 Project Crediting Period

Crediting period	☐ *Seven years, twice renewable* ☐ *Ten years, fixed* X *Other,* forty years which is within VCS crediting period requirement.
Start and end date of first or fixed crediting period	01- July -2016 to 30- June -2056 (40 years)

1.8 Project Location

The project location and geographic boundaries of the teak plantations, teak and cacao plantations and protection areas are shown in Figure 1. The project sites are located in the district of Siuna and Bonanza in Northeast Nicaragua, and the sites are therefore called Siuna and Bonanza, respectively. Bonanza is located at approximately 14°01′N 84°35′W and Siuna at approximately 13°44′N 84°46′W.For the exact coordinates of the project locations consult the KML file attached. The land cover, geographic boundaries and geodetic coordinates of the district are depicted in more detail in Figure 2, also showing infrastructure and some of the roads.

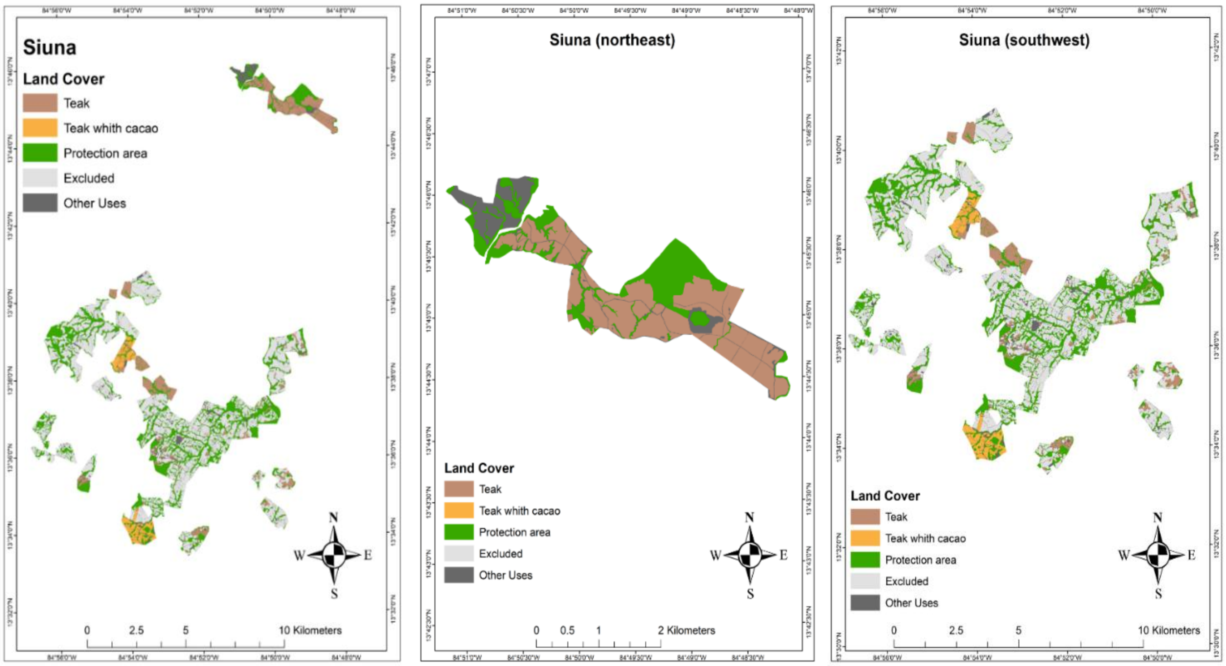


Figure 1. Siuna project areas in Siuna municipality. Left: overview map; middle: Siuna southwest; right: Siuna northeast

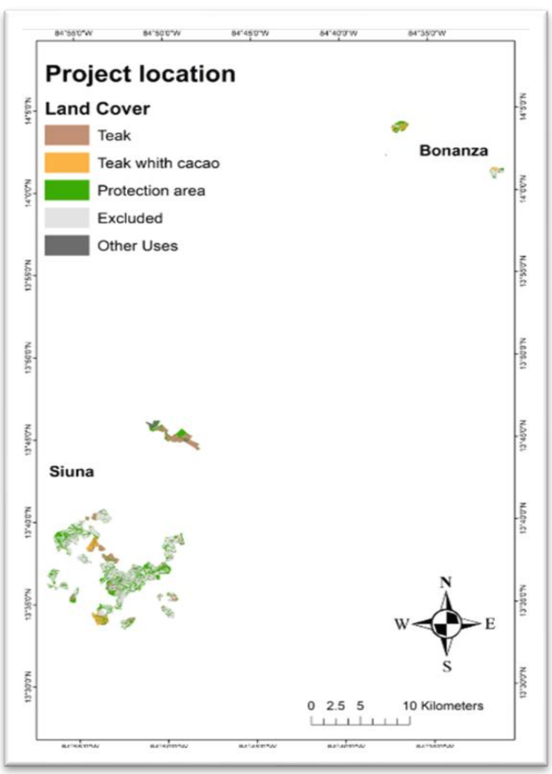


Figure 2. Location of project sites in the districts of Siuna and Bonanza with indication of land cover, geographic boundaries and geodetic coordinates

1.9 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	AR-ACM0003	AR ACM0003: Afforestation and reforestation of lands except wetlands	2.0
Tool	AR-TOOL02 (CDM)	Tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities	01
Tool	AR-TOOL14 (CDM)	Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities	4.2
Tool	AR-TOOL15 (CDM)	Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity	2.0
Tool	AR-TOOL16 (CDM)	Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities	01.1.0
Tool	N/A	Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities	01

1.10 Double Counting and Participation under Other GHG Programs

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

1.10.2 Registration in Other GHG Programs

Was the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ No

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐Yes ☒No.

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐Yes ☒No

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☒Yes ☐No

The project (positively affects) supply chain emission for teak wood, produced by MLR Forestal de Nicaragua. The proponent published the corresponding statement: *https://mlr.com.ni/mlr-forestal-y-importancia-de-la-certificacion-verified-carbon-standard-vcs/*

1.12 Sustainable Development Contributions

During the monitoring period, MLR Forestal promoted formal employment with gender equality, creating over 500 direct jobs in a poor region and offering salaries above the legal minimum for the agricultural sector[2]. It implemented a social investment plan supporting education, sports, health, and emergencies for families, and collaborated with local universities on agroforestry and social research. Environmental actions included forest restoration through enrichment planting, together with contribution to studies on studies on species registry on the area. Sustainable livelihoods were fostered through agroforestry practices for cacao production, backed by FSC and Rainforest Alliance certifications for forest and cacao plantations.

[2] The legal minimum salary for the agricultural sector in 2021 was C$4,414.91 per month, C$4,723.95 in 2022, C$5,196.34 in 2023 and C$5,721.17 in 2024. MLR complies with the legal salary requirements for all their employees, as seen in the contracts' salaries. In addition, there were other contributions that generate a living wage such as payment of daily food three times a day, lodging, transportation to and from communities as well as within the plantations, as well as economic support for specialized medicine for the worker and his family nucleus.

Table 2: Sustainable Development Contributions

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	1.1	1.1.1 Proportion of population below the international poverty line	Implemented activities to decrease	No further changes this monitoring period	The project has created 538 long term jobs in a poor rural region of Nicaragua, with salaries over the minimum wage legally defined for the agricultural sector.
2)	8.3	8.3.1. Proportion of informal employment in total employment, by sector and sex	Implemented activities to decrease	No further changes this monitoring period	Provided 538 secure and formal jobs to the local labour force. Thereof, 115 are performed by women, representing 21,9% without differentiation in wages or conditions based on gender. 100% of the workforce is under an indefinite-term contract.
3)	12.6	12.6.1. Number of companies publishing sustainability reports	Implemented activities to increase	No further changes this monitoring period	As a result of the company's FSC, Rainforest Alliance and VCS certification, it annually presents public reports to the interested parties on its management in technical, economic and sustainability terms.

4)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By replanting and conserving an additional 53.4 hectares of degraded lands, the project has sequestered 65,154.0 Tonnes of carbon from the atmosphere during the current monitoring period	By replanting and conserving 2,286.3 hectares of degraded lands, the project sequestered 82,834.1 Tonnes of carbon from the atmosphere.
5)	15.1	15.1.1. Forest area as a proportion of total land area	Implemented activities to increase	By replanting and conserving an additional 53.4 hectares of degraded lands, the project has increased the proportion of forest area to the total land area	By replanting and conserving a total of 2,286.3 hectares of degraded lands, the project has increased the proportion of forest area to the total land area
6)	15.1	15.1.2. Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	Implemented activities to increase	Contributed to ensuring conservation, restoration and sustainable use of 1,466.7 hectares terrestrial tropical moist deciduous forest its services through their activities.	Contributed to ensuring conservation, restoration and sustainable use of 1,466.7 hectares terrestrial tropical moist deciduous forest its services through their activities.

1.13 Commercially Sensitive Information

All information shared can be made publicly available

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

The stakeholder map has not changed since the project validation and the verification.

2.1.2 Stakeholder Consultation and Ongoing Communication

Ongoing consultation	-Meetings with community leaders for joint elaboration of annual social work plan, this for Unión La Bu, Bethel 2, Empalme La Bu and San Miguel 1 and the neighbouring communities on Waylawas, Mutiwas y Tadazna. - Annual community assemblies: A total of 5 assemblies per year were held in 2022, 2023 and 2024 around the second half of April, with an average of 350 participants. This included the communities Unión La Bu, Bethel 2, Empalme La Bu and San Miguel 1 and one joint assembly with the neighbouring landowners on Bonanza (Waylawas, Mutiwas y Tadazna). There was no assembly in 2021 due to Covid 19 restrictions. In these the results of the operation, issues related to certifications, grievance mechanisms, monitoring results were presented, and contributions were requested. - Monthly visits from a social specialist to the communities to review complaints, and do activities related with the corporate social responsibility program. - Annual meeting with community leader to update demographic census - Systems of complaints and suggestions by mailboxes located in each community, a telephone line, email, WhatsApp and a physical office for community service are put in place.

Date(s) of stakeholder consultation	The stakeholder consultation process was conducted between December 2020 and February 2021, including virtual meetings and a physical meeting with community organizations on 18-December-2020.
Communication of monitored results	Prior to the assemblies, a public summary of forest monitoring and public summary of the forest management plan is shared in the communities through the leader. Both documents collect all the annual results and are presented in different ways to the interested parties and contributions are requested to ensure continuous improvement.
Consultation records	This was reviewed in the previous verification
Stakeholder input	The Community Engagement Plan is updated annually, incorporating the results from the follow-up assemblies with the communities.

2.1.3 Free, Prior, and Informed Consent

This was reviewed on the previous verification (05-2021).

2.1.4 Grievance Redress Procedure

No conflicts arose between MLR Forestal and any local stakeholders. Most of the received grievances from community relate to problems of fences that need to be built or were deteriorated over time. Grievances by employees were mainly about house rules and site conditions in the working camps. All received grievances were resolved according to the approved grievance procedure, the Community Complaint Mechanism. There is a database with complaints provided by stakeholders since 2020 where complaints can be tracked from their receipt to their resolution and follow-up. As the database demonstrates, all complaints were properly handled by MLR Forestal within the expected time.

Grievances received	Resolution and outcome
2021	
From communities: **2 grievances** Worker's misbehaviour with community members	HR took up the case, reviewed the facts and got in direct communication with the workers involved. Talks on better driving behaviour was given.
From communities: **1 grievance** About an unpaved trail in a farmer's property	Operations and Forestry teams revied the case, had multiple visits, which result in the farmer accepting a non- founded grievance.
From communities: **1 grievance**	Management team took up the case; agreement reached with the parties.

About a dead animal on the project trail	
From workers: **3 grievances** Health and security conditions	Health and Safety Officer took corrective measures. Restock of PPE and aid kits.
From workers: **17 grievances** Long working hours, mistreatment, poor camp conditions, food and transport hours	HR and field supervisor reviewed the case, talk with the parties and the corresponding measures/ warnings were done. Talks to remind supervisor on better practices and explanation on contract conditions were given. 100% of complaints were closed.
From workers: **3 grievances** Sexual harassment among workers	HR team had meetings with workers, one worker was fired, and other prevention measures were taken for women safety. 100% Complaints closed.
From workers: **1 grievance** Worker misbehaviour	HR and field teams reviewed the case. A warning was given to the worker as well as talks reminding camp rules. Case closed.
From workers: **12 grievances** About payments and salaries	HR took up the cases, had meetings with workers and corresponding measures were taken for more transparency and information on payments. 100% of complaints were closed.
2022	
From communities: **13 grievances** fences in poor condition and damage to internal gates.	Forestry and field supervisors visited the places, and the proper repair was carried out. 100% of complaints were closed.
From communities: **2 grievances** Worker's misbehaviour with community members	HR took up the case, reviewed the facts and got in direct communication with the workers involved. 100% of complaints were closed.
From communities: **1 grievance** Blocked trail access	Security team review the facts and authorized access to community members.
From workers: **16 grievances** About problems with	HR took up the case, reviewed the facts and got in direct communication with the workers. Measures like stricter guidelines for cooks, talks for better driving and some basic

transportation, food, payment system and accommodation.	utilities for the camps were taken. 100% of complaints were closed.
2023	
From communities: **7 grievances** Mostly about fences in poor condition and damage to internal gates.	Visit to the places and the proper repairs were carried out by MLR, as appropriate. 100% of complaints were closed.
From workers: **5 grievances** About (bad) food, low salaries and long working hours.	HR team took up the case. Talks about contract conditions were given, measures for better food quality and quantity. 100% of complaints were closed.
From workers: **12 grievances** Worker's misbehaviour inside camps and with community members	The security team and HR team took up the case. Corresponding warning to misbehaved workers. In one identity supplantation case, worker was fired. 100% of complaints were closed.
From workers: **2 grievances** Sexual harassment between workers	The committee to evaluate and address grievances took up the case. The one who committed the acts was warned and measures were taken to keep women workers in the camps in a safer space.
2024	
From communities: **8 grievances** fences in poor condition and damage to internal gates	Forestry and field supervisors visited the places, and the proper repair was carried out, most of the times by MLR. 100% of complaints were closed.
From communities: **1 grievance** Worker's misbehaviour inside with community members	HR team took up the case. Corresponding warning to misbehaved workers. 100% of complaints were closed.
From workers **6 grievances** Mistreatment to workers and bad food	HR and forest teams took the cases. There were conversations to remind field supervisors and cooks on better practices, as well as provision of better food.

2.1.5 Public Comments

N.A as comments received as part of stakeholder consultation or outside of the public comment period were reviewed in the previous verification.

In the commenting period, no comments or suggestions were received through the grievance mechanism. No specific questions or suggestions regarding the project design or implementation were raised during the annual assemblies and as such, they were not included in the assembly minutes. The attendees signed the minutes, confirming that any matters discussed during the assemblies were adequately addressed.

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

The management team is formed by staff with significant experience in their respective professional fields, which is mainly distributed over the following key staff:

- CEO: T. Lough
- General Manager: Eng. C. Domke
- Head ESMS department: MSc. L. Lopez
- Head legal department: Dra. Adela Rodríguez
- Social expert: Lic. Mabel Lazo Quino
- Environmental expert: Biol. Roger Mayorga Martinez

A specialized staff was involved in the monitoring of the plantations and protection areas. The staff was prepared through a protocol, including qualification requirements and responsibilities, in the description of the positions for monitoring, measuring and cartography. Monitoring and measurement are supervised by the head of monitoring, measurement and cartography.

2.2.2 Risk assessment

	Risk identified	Mitigation or preventative measure(s) taken
Natural and human-induced risks to stakeholders' wellbeing	- Changes in the quality of surface and underground water due to the use of pesticides - Injuries and damage to employees during planting and maintenance - Health risks at work (workers) - Risk of exposure to pesticides	Addressed in the Social Management Program; Environmental Management Plan; General Management Plan and the monitoring Plan, quantifying water quality parameters.

Risks to stakeholder participation	No risk identified	No risk has been specifically identified as the project counts with community engagement plan, social investment plan, local employment plan and a community grievance mechanism.
Working conditions	Injuries and damages to employees during planting and maintenance	Addressed in the Social and environmental management plan, the Annual Operational Plan and the General management plan. MLR maintains an occupational health and safety program, has a public prosecutor and delivers protective equipment. There is evidence of training for the prevention of accidents and diseases and MLR performs annually a cholinesterase test to all workers who apply chemicals. In the reports, there has not been any fatality and affected workers have been compensated.
	Risk of pesticide exposure, both for employees and communities	Addressed in the Social and environmental management plan, the Annual Operational Plan and the General management plan. MLR maintains an occupational health and safety program, has a public prosecutor and delivers protective equipment. There is evidence of training for the prevention of accidents and diseases and MLR performs annually a cholinesterase test to all workers who apply chemicals. In the reports of recent years there is no case above the critical parameter threshold.
Safety of women and girls	*No risk identified*	No specific risk has been identified. The project counts with community engagement plan, social investment plan, local employment plan and a community grievance mechanism that does not differentiate between gender.
Safety of minority and marginalized groups, including children	No risk identified	There is low risk of pesticide exposure for communities, including native. Although low, the risk is addressed in the Social and environmental management plan, the Annual Operational Plan and the General management plan.
Pollutants (air, noise, discharges to	Changes in the quality of surface and groundwater due to the use of pesticides	Since MLR has three certification schemes, it uses restrictive lists of chemicals. Rainforest Alliance and FSC present an annual list of banned chemicals that are

water, generation of waste, and release of hazardous materials and chemical pesticides and fertilizers)		avoided. A record of chemical applications is kept, showing gradual decrease in doses. Also, risk is addressed in environmental management plan and the annual monitoring plan. Quality parameters in water, as mandate by law, were monitored and resulted in in the optimal range.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

	Risks identified[3]	Mitigation or preventative measure(s) taken
Discrimination	No risk identified	Project works under the ILO convention (ILO 111) that have been ratified by Nicaragua as a Member State and mostly incorporated into national labour legislation through the Labour Code. If complaints on this matter are raised through the grievance mechanism, the Attention and response team addressed it.
Sexual harassment	Low risk[4]	Low risk, particularly affecting field workers who stay overnight on field camps. MLR set in place an internal procedure on sexual harassments for the prevention, assessment and resolution of such cases, together with the conformation of a *committee to address and evaluate cases of child labour, forced labour, discrimination and violence and harassment at work*. Also, a guideline for reporting sexual harassment, measures in the General Human Resources Policy, including that

[3] The identified risks and commensurate mitigation or preventative measure(s) for forced labor, child labor, and human trafficking, must be inclusive of staff and contracted workers employed by third parties.

[4] The project does not operate under ILO Convention 190, as Nicaragua has not ratified it. Since this convention is not a mandatory requirement under FSC certification, it has not been explicitly incorporated into the project's policies. However, the principles of ILO 190 are indirectly supported through FSC's broader requirements, which include respecting workers' rights and dignity, preventing discrimination and abuse, and ensuring a safe and healthy working environment. Specifically, FSC Criteria 2.1 and 2.3 require fair treatment of workers and protection from discrimination—areas that overlap with the concerns addressed by ILO 190. In addition, the project has taken specific steps to address gender-based violence and harassment in the workplace through dedicated policies and action plans.

		all new employees must be instructed on the subject of evaluating and addressing sexual harassment. The internal risk monitoring is annually reviewed on the matter.
Gender equity in labor and work	No risk identified	Project works under the ILO convention (No. 100) that have been ratified by Nicaragua as a Member State and mostly incorporated into national labour legislation through the Labour Code.
Forced labor	No risk identified	Project works under the ILO convention (No. 29 and 105) that have been ratified by Nicaragua as a Member State and mostly incorporated into national labour legislation through the Labour Code.
Child labor	No risk identified	Project works under the ILO convention (No. 183 and 182) that have been ratified by Nicaragua as a Member State and mostly incorporated into national labour legislation through the Labour Code.
Human trafficking	No risk identified	Project works under the ILO convention (No. 29 and 105) that have been ratified by Nicaragua as a Member State and mostly incorporated into national labour legislation through the Labour Code.

2.3.2 Human Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	The company integrates a gender and generational, diversity, and human rights vision. This is seen in the Social and Environmental management plan, Social engagement plan, Agreements signed with close communities, Procedure for Land Acquisition and the Stakeholder Participation Plan.

2.3.3 Indigenous Peoples and Cultural Heritage

Risks identified	Mitigation(s) or preventative measure taken
No risk identified	There is a social expert permanent on the project area who visits nearby communities regularly. He hasn't pointed out any inappropriate situations or comments. The project has a multiannual engagement plan

	jointly elaborated with the community leaders of Mayangna Sauni Arungka Matumbak. Accordingly, engagement and social programs are updated based on annual population census.

2.3.4 Property Rights

Risks identified	Mitigation or preventative measure(s) taken
Terrain acquisition by MLR on communal land	Addressed in the Procedure for Land Acquisition and the Stakeholder Participation Plan.The voluntary land transfer of finca Miranda, carried following FPIC protocols, show good practices in term of respecting property, customary and IP rights.

2.3.5 Benefit Sharing

No benefit sharing considered in the project.

2.4 Ecosystem Health

Risk identified		Mitigation or preventative measure(s) taken during the monitoring period
Impacts on biodiversity and ecosystems	- Changes in the quality of surface and underground water due to the use of pesticides - Changes in floral composition	Addressed in the environmental management plan; Protection area restoration plan, the Annual Operational Plan and monitoring plan. The water quality parameters on water bodies and residual water have been on range during the monitoring period. Other measures include only planting of native species in the protection area.
Soil degradation and soil erosion	Changes in cover may lead to soil degradation and erosion	Addressed in the environmental management plan, General management plan, Protection area & Biodiversity management plan.

Water consumption and stress	Water stress due to overconsumption for project activities	Addressed in the environmental management plan; the Annual Operational Plan and monitoring plan. The indicator is the total volume extracted vs the volume granted by the authority, and reports (per well) go to the National Water Authority.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	Project activities had taken place on severely degraded areas that according to the SEIA are not critical habitats for the threatened species present in the project area (3 species). Although monitoring was intensive, none of these species could be associated with habitats within plantations and/or MLR protection areas
Areas needed for habitat connectivity	The protection area covers riparian forests that according to the SEIA can be considered crucial for habitat connectivity. Following the restoration activities on those areas, the areas are on track to be positively impacted by the project activities. According to biodiversity monitoring, the biodiversity index has remained stable over time (2020-2023), which is expected to increase along the restoration efforts.

	Risks identified	Mitigation or preventative measure(s) taken
Habitats for rare, threatened, and endangered species	No risk identified	According to the SEIA, there are not critical habitats for rare, threatened or endangered species. The Biodiversity monitoring Plan includes explicit monitoring of one of the endangered species (*Ateles geoffroyi*- EN)
Areas for habitat connectivity	No risk identified	According to the SEIA, no specific risks are associated to the riparian forest, as all the riparian forest patches (already degraded) will be subject to a restoration plan.

2.4.2 Introduction of species

Species introduced	Classification	Justification for use	Adverse effects and mitigation

Tectona grandis	Non-native, introduced	Teak was first introduced in Central America in 1926 at the Summit Botanical Garden in Panama, after which it has been planted in nearly all tropical American countries including Nicaragua. Experience with the silviculture of teak plantations started in the 19th century and this longstanding practice has resulted in sound management guidelines and good yield prognoses. The project counts the corresponding environmental authorization for teak planting.	Most areas surrounding the plantation are in agricultural use for which teak poses no threat. No teak will be planted in the river buffer zones. No chemical treatments are required for pest control, because of the low susceptibility of teak to diseases. Therefore, no ecological damage is caused to the environment.

Existing invasive species	Mitigation measures to prevent the spread or continued existence of invasive species
N/A	

	Risks identified	Mitigation or preventative measure(s) taken
Invasive species	No risk identified	No invasive species identified in the project area, according to the biodiversity baseline and SEIA

2.4.3 Ecosystem conversion

	Risks identified	Mitigation or preventative measure(s) taken
Ecosystem conversion	Land use change due to plantation establishment (removal of some existing vegetation)	The Forest Management Plan and the Procedure for Land Acquisition defines project activities only on degraded area, with an approved land management plan.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

2016-2018 planting period: previous monitoring period

Due to the impact of two hurricanes in 2020 and the company's focus on the timely recovery of wood from stands damaged during these hurricanes of the 247.7 hectares of pure teak planted during 2016-2018 that were reported originally in the PDD, currently only 141.0 remain. For 82.7 hectares, it was decided to add cacao to the teak. These areas shifted from the Teak stratum to the Teak in Cacao stratum.

This has resulted in an overestimation of the amount of GHG removals for the teak areas and thus the number of credits issued during the previous verification. These credits will be subtracted from the carbon stock available in the present period.

Table 3. Overview of the intended and realized project area (in hectares) per year in the period 2016-2018

Teak	2016	2017	2018	Total
PDD	93.6	85.0	69.1	**247.7**
Actual	41.9	65.1	0.0	**107.0**
Difference	-51.7	-19.9	-69.1	**-140.7**
Teak in Cacao				
PDD	0.0	0.0	0.0	**0.0**
Actual	0.0	16.8	65.9	**82.7**
Difference	0.0	16.8	65.9	**82.7**
Protection				
PDD	0.0	0.0	0.0	**0.0**
Actual	0.0	0.0	0.0	**0.0**
Difference	0.0	0.0	0.0	**0.0**

2019-2020 planting period: previous monitoring period

For 2019 - 2020 the PDD stated the establishment of an additional 429.2 ha of pure teak and 182.1 ha of teak/cacao in agroforestry stands. However, MLR managed only to establish 279,4 ha of pure teak and 266.2 ha of cacao (table 4 below). The deviation with respect to the PDD was due to the company's focus on the repair of hurricane damage on teak plantations and a shift to additional cacao. Since the missing area was not included in the previous verification, this deviation does not affect any issued credits.

Some differences also exist with the expected protection area. The PDD stated that, starting in 2020, a total of 1,456.7 ha were to be established as protection area - areas where pasture land, tacotales or degraded (remnant) forest cover would be allowed to naturally regenerate and set aside for protection. However, the transfer of the Miranda-farm to a neighbouring native community (in May 2023), meant a reduction of 18.9 ha previously considered as protection area. On the other hand, 28.9ha that were planned to be included for teak planting were not deemed suitable and entered the protection area. This resulted on a positive deviation of +10.0 ha for protection area, now consisting of 1,466.7 ha.

2021-2024: current monitoring period

In 2021, no new areas were established. In 2022, 2023 and 2024 (up to 31-August-2024) respectively 26.0, 17.8 and 9.6 ha of new teak plantation were established. There were no addition of cacao stands or protection area.

Table 4. Comparison of projected- (PDD[5]) and actual hectares intervened in 2016-2024

Teak	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
PDD	93.6	85	69.1	264	165.2	127.7	251.3	222.4	100.0	**1378.3**
Actual	41.9	65.1	0.0	260.7	18.7	0.0	26.0	17.8	9.6	**439.7**
Difference	-51.7	-19.9	-69.1	-3.3	-146.5	-127.7	-225.3	-204.6	-90.4	**-938.6**
Teak Cacao										
PDD	0.0	0.0	0.0	101.2	80.9	0.0	0.0	0.0	0.0	**182.1**
Actual	0.0	16.8	65.9	100.8	196.4	0.0	0.0	0.0	0.0	**379.9**
Difference	0.0	16.8	65.9	-0.4	115.5	0.0	0.0	0.0	0.0	**197.8**
Protection										
PDD	0	0	0	0	1456.7	0	0	0	0	**1456.7**
Actual	0	0	0	0	1466.7	0	0	0	0	**1466.7**
Difference	0	0	0	0	10.0	0	0	0	0	**10.0**

Note: The areas referred to as "protected areas" are not newly introduced project instances but rather designated zones within the originally validated project area that are undergoing active forest restoration. All activities remain within the same project area as defined in the PDD. These areas were pasturelands and tacotales (shrublands with scattered trees) and degraded remnant forest before project initiation and have been subject to assisted natural regeneration interventions, including enrichment planting. This has been explicitly documented in Section 1.11.3 of the PDD.

The project does not include a REDD+ component, as carbon credits are derived exclusively from sequestration through restoration rather than avoided deforestation or degradation. If these areas had been natural forests undergoing mere protection without active interventions, a REDD+ classification might have been warranted. However, this is not the case here, as these areas were degraded lands actively being restored. Thus, it is in full alignment with the ARR methodology under which the project was validated.

Nicaragua has a national ENDE-REDD+ Program[6]. ARR projects are not automatically subject to Jurisdictional and Nested REDD+ Requirements unless the host country mandates nesting for all land-

[5] As presented in Table 22 of the PDD (section 4.4), however, the figures in that table are rounded off to whole figures. The digits are derived from the ER sheet used for the PDD calculations.

[6] Estrategia ENDE -REDD+ 2018 -2040 https://faolex.fao.org/docs/pdf/nic222577.pdf

based carbon projects, which Nicaragua's REDD+ strategy does not require. The country's strategy focuses on deforestation and degradation, aiming to reduce emissions, without explicitly mandating ARR projects to be nested within the national REDD+ framework. This, together with the fact that the protected areas do not function as REDD+ components, there is no requirement for alignment with the Jurisdictional and Nested REDD+ framework.

3.2 Deviations

3.2.1 Methodology Deviations

In the teak-cacao agroforestry systems, a different method was used for sampling teak trees than described in the PDD. Instead of using Permanent Sampling plots, an individual tree sampling system methodology was used. This was done because the teak is planted in lines between the cacao, with a sizeable distance (8-16 meters per row) between the teak rows. If random sampling plots would've been placed, these plots would be highly variable, as a larger or smaller part of a teak line would be measured, causing a lower representativity of the sampling plots.

For this alternative sampling method, a systematic system was used for the selection of sample trees. The row furthest west was used as the start and from this row the 10th living tree counted would be the first tree of the sample. From here on, every 33rd living tree from the previous was sampled, following the rows in a systematic zigzag pattern (Fig. 3). As with this methodology every 33rd living tree is measured, it results in a sampling of 3% of all trees. Therefore, the sampling density is not reduced by this method deviation and thus the conservativeness of the quantification of GHG emission removals is not negatively impacted.

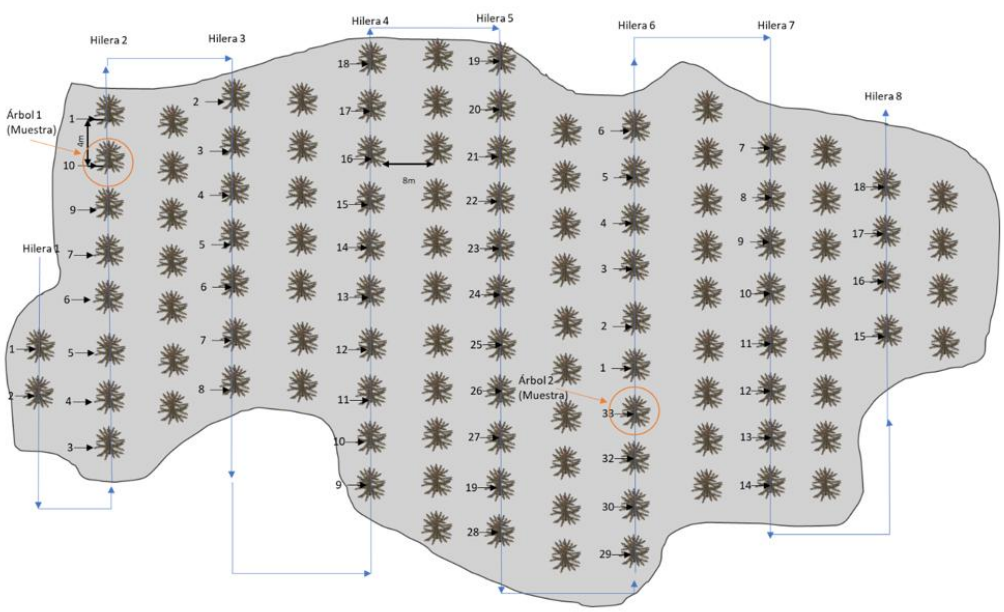


Figure 3. Individual tree sampling system where, starting at tree no. 10, every 33rd tree is sampled systematically.

3.2.2 Project Description Deviations

This monitoring period presents the following deviations from the PDD: Differences in area, differences in planting density for pure teak and for teak& cacao, lower rotation time for teak, redefinition of protection area baseline, clarification about ANR practices, resulting differences in the LTA calculations, and deviations in monitoring implementation.

Area revision

According to the PDD, by 2024 a total of 3,017.1 ha were planned to be under management. However, by August 2024 the actual total project area amounts to 2,286.3 ha (see Tables 4 and 5).

The deviation has been the result of the following, with a detailed description of differences per year in Table 4:

1. Hurricane damage (end of 2019), where stands had to be cut for replanting and most effort in 2020 went to recovering the timber of damaged trees instead of planting new areas. This event also caused a shift from pure teak to teak and cacao. This event resulted in reduction in plantation area.
2. Some planting area was found unsuited for teak and thus shifted to protection area (28.9ha). This meant reduction in planting area but addition to protection area.
3. the voluntary transfer of land (39.0 ha from the Miranda-farm) to an indigenous community in May 2023. In this farm, the project area was expected to be mostly for protection (18.9 ha); it was transferred before any intervention was done (Figure 4). This transfer meant a reduction in planting area but considering the shift of area unsuited for teak to protection area (28.9, previous bullet), the difference in protection area planned vs realized was only +10.0ha (Table 4).

It is to note that the carbon credits expected from Miranda-farm were not included in the previous verification period and therefore there is no need to return credits.

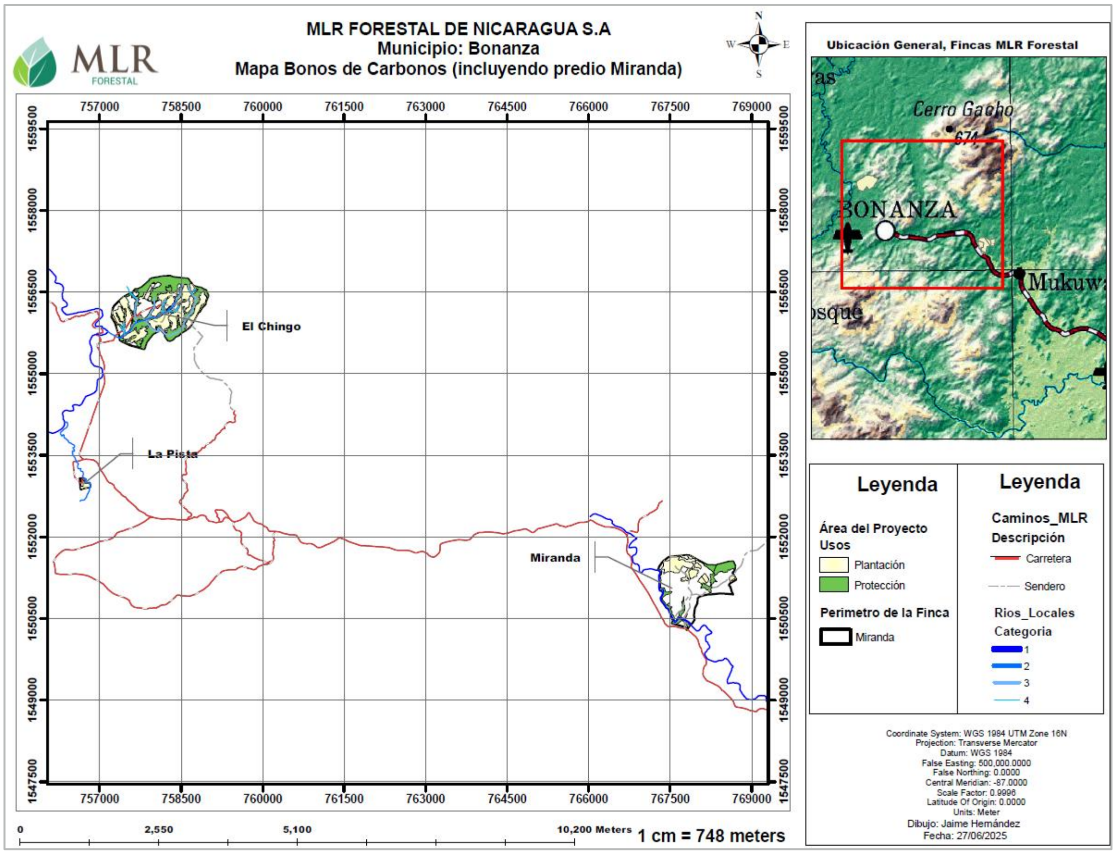


Figure 4. Zoomed-in view of previously planned project area in the Municipality of Bonanza featuring the Miranda Farm (bottom right). The whole area of Miranda is now excluded from the project area after its voluntary transfer in May 2023.

Table 5. An overview of the intended and realized project area in the period 2016-2024

Reforestation type	Intended area Bonanza 2016-2024 (ha)	Intended area Siuna 2016-2024 (ha)	Intended total area 2016-2024 (ha)	Realized area Bonanza 2016-2024 (ha)	Realized area Siuna 2016-2024 (ha)	Realized total area 2016-2024(ha)
Teak plantation (I)	0.0	1,378.4	**1,378.4**	0.0	439.7	**439.7**
Teak + cacao plantation (II)	80.9	101.2	**182.1**	60.7	319.2	**379.9**
Protection (III)	88.9	1,367.8	**1,456.7**	66.2	1,400.5	**1,466.7**
Total	169.7	2,847.4	**3,017.1**	126.9	2159.4	**2,286.3**

Planting density pure teak

For pure teak, 3 tree density regimes have been implemented, instead of 1 as described in the PDD;

1. 625 trees/ha. This was the original starting density.
2. 500 trees/ha. This will be the standard starting density moving forward
3. 312 trees/ha. This was for areas meant for cacao between the teak.

The planting density was lowered from 625 trees/ha. to 500 trees/ha. since the teak results to grow faster than expected. This way early inter-tree light competition is being reduced, optimizing growth. The other starting density, 312 trees/ha is the result of a system where the teak was meant to be planted in conjunction with cacao. However, the soil was not deemed suitable for cacao after planting the teak trees. As such, this stratum remained with 312 teak trees/ha but no cacao.

Of the 439.7 hectares of pure teak planted between 2016-2024, 106.9 hectares were planted according to the pure teak management regime as explained in the PDD (Regime 1, Table 6). On 58.2 hectares the teak was planted with an initial density of 500 trees per hectare (Regime 2. On 274.6 hectares, the teak was planted with an initial density of 312 trees per hectare (Regime 3), which will follow the schedule of Regime 1 from year 9 and beyond. All of these regimes will follow Regime 2 during the 2nd rotation. This is accounted for in the LTA calculations.

Table 6. The 3 different density regimes implemented in the pure teak stands

	Regime 1	Regime 2	Regime 3
Activity	# of trees after activity	# of trees after activity	# of trees after activity
Teak planting	625	500	312
Thinning year 4	450	400	312
Thinning year 8	300	300	300
Thinning year 12	250	200	250
Thinning year 16	180	200	180

Planting density teak-cacao agroforestry

Three regimes have been established within teak in cacao. These regimes are:

1. Teak in single rows in old cacao.
2. Teak in single rows in new cacao.
3. Teak in double rows in new cacao.

Teak and cacao are not necessarily planted in the same year. There is teak which has been planted in cacao older than 01-July-2016, so pre-project. As such, the carbon from the old cacao is not being considered for the project. Most teak has been planted in cacao (to be) established during the project period. For the latter, the baseline carbon stock has been estimated and discounted, and the carbon in the cacao is monitored and added to the project. Finally, in one stand, teak has been planted in double rows, instead of single rows. This caused the initial density of the teak to be twice as high as in the other regimes. However, in this case of double teak rows, the area between the rows of teak was discounted from the cacao area. For all regimes, an individual LTA has been calculated.

For both regimes (1 and 2) with a single row of teak in between the cacao, the teak starts at 156 trees per hectare and is reduced to 100 trees per hectare by year 3. These 2 regimes contain most of the teak in cacao (mixed) area, with 130.5 ha. in old cacao and 183.5 ha. in new cacao.

The 3rd regime has double rows of teak between the cacao, starting at 312 trees per hectare, being reduced to 200 trees by year 3 and to 100 by year 6. In total, this regime covers 65.9 ha. Since no cacao was planted between the double rows of teak, the teak area was discounted and results in a lower cacao area, with 58.4 ha.

Lowered rotation time for teak

As mentioned above, the teak growth exceeds expectations. As such, additional to the lowered starting density, the rotation time has also been shortened from 20 years to 18 years, to make use of the fast increment of juvenile teak when starting a new rotation. To account for this, an extra rotation round has been added to the project, for a total of three rotations of 54 years instead of two rotations and 40 years. With this, the 40-year period stays monitored. The LTA has also been adjusted accordingly.

Adjusted LTA outcomes

Due to the following adjustments (as indicated above) the LTA has been recalculated:

- The rotation length is reduced from 20 to 18 years, and the LTA is now calculated over a total of three rotations and 54 years, instead of two rotations and 40 years, as described above under “lowered rotation time for teak”;
- The inclusion of multiple initial plant densities (625, 500 and 312 trees/ha) compared to the single plant density described in the PD (625 trees/ha), having an impact on initial tree growth. Furthermore, the adjustment of the plant density also impacts on the thinning regimes, as described above under “planting density pure teak” and “planting density teak-cacao agroforestry”. The following table provides the changes:

Trees/ha after activity	PD	Adjustments		
Initial planting	625	625	500	312
Thinning year 4	450	450	400	312
Thinning year 8	300	300	300	300
Thinning year 12	250	250	200	250
Thinning year 16	180	180	200	180

- The relative distribution of the various regimes and systems is different from what was described in the PD, as described in "area revision" above. As a consequence, the overall project LTA is changed. The annual figures from the PD and how it is adjusted to current situation are presented in the next table.

	PD			Adjusted to current situation						
	Pure teak (625)	Teak & cacao		Teak (625)	Teak (500)	Teak (312)	Teak & cacao			
	Siuna	Siuna	Bonanza	Siuna			Siuna			Bonanza
		Old cacao	Old cacao				Old cacao (156)	New cacao (156)	New cacao (312)	Old cacao (156)
2016	93.6	0.0	0.0	41.9	0.0	0.0	0.0	0.0	0.0	0.0
2017	85.0	0.0	0.0	65.1	0.0	0.0	0.0	16.8	0.0	0.0
2018	69.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.9	0.0
2019	264.0	101.2	0.0	0.0	0.0	260.7	69.8	31.0	0.0	0.0
2020	165.2	0.0	80.9	0.0	4.8	13.9	0.0	135.7	0.0	60.7
2021	127.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	251.3	0.0	0.0	0.0	26.0	0.0	0.0	0.0	0.0	0.0
2023	222.4	0.0	0.0	0.0	17.8	0.0	0.0	0.0	0.0	0.0
2024	100.0	0.0	0.0	0.0	9.6	0.0	0.0	0.0	0.0	0.0
2025	160.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2026	163.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2027	214.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2028	144.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2029	163.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2030	163.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	0.0	0.0
2031	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0
2032	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	**2385.4**	**101.2**	**80.9**	**106.9**	**1213.2**	**274.6**	**69.8**	**183.5**	**65.9**	**60.7**
Total	**2385.4**	**182.1**		**1594.7**			**379.9**			
Grand total	**2567.5**			**1974.6**						

- The growth projections that are currently applied by the project proponent are different compared to the growth projections used in the PD. The current growth model is developed in the past years based on the growth figures of the entire management area of the project proponent (mostly teak stands not included in the project area) and therefore assumed to be a better fit for the expected growth of teak in the project area (same area, same management, similar genetics), as the previous growth projections were not based on own teak stands. C_{TREE} in t CO_2e/ha applied in the PD and in the current calculations are presented in the table below, with a distinction between the various regimes.

Age	PD			Adjustment					
	PT*	AF OC	AF NC	PT 625	PT 500	PT 312	AF 312	AF 156 NC	AF 156 OC
0	1.5	0.8	0.8	-	-	-	-	-	-
1	11.5	5.7	5.7	13.3	10.6	6.6	6.6	3.3	3.3
2	59.1	32.6	32.6	53.1	33.6	20.3	26.5	13.3	13.3
3	88.3	48.7	48.7	118.4	75.2	45.5	37.9	18.9	18.9
4	104.9	57.9	57.9	181.4	115.5	70.0	58.1	29.0	29.0
5	131.2	43.7	43.7	173.0	153.4	93.1	76.9	38.5	37.3
6	157.5	52.5	52.5	212.5	188.9	114.8	43.8	47.2	46.3
7	183.7	49.0	49.0	249.3	221.6	135.2	55.4	55.4	54.9
8	210.0	56.0	56.0	283.8	252.3	154.5	63.1	63.1	63.1
9	205.7	70.5	70.5	316.2	210.8	172.8	70.3	70.3	70.3
10	234.7	67.1	67.1	346.8	231.2	190.3	77.1	77.1	77.1
11	263.8	75.4	75.4	375.7	250.5	207.1	83.5	83.5	83.5
12	292.8	83.7	83.7	403.2	268.8	223.1	89.6	89.6	89.6
13	280.6	103.9	103.9	429.5	286.3	238.6	95.4	95.4	95.4
14	310.4	114.9	114.9	252.5	202.0	252.5	101.0	101.0	101.0
15	340.1	126.0	126.0	265.9	212.7	265.9	106.3	106.3	106.3
16	369.9	137.0	137.0	278.7	222.9	278.7	111.5	111.5	111.5
17	290.5	145.2	145.2	209.5	232.8	209.5	116.4	116.4	116.4
18	319.7	159.8	159.8	218.0	242.3	218.0	121.1	121.1	121.1
19	344.3	172.1	172.1						
20	367.3	183.7	183.7						

* PT = Pure Teak, AF = Teak and Cacao Agroforestry, OC = Old cacao, NC = New cacao, 625 / 500 / 312 = initial stocking (trees/ha)

The 2024 monitoring data provided some insight into the growth performance compared to the new growth projections. However, the monitoring data for each strata are still too limited to derive at system and regime specific growth and yield curves based on realisations. The LTA calculation therefore remains largely based on the ex-ante annual growth projections for the various systems and regimes. In future, the growth curves can be adjusted based on multiple years monitoring data.

Nevertheless, to already include some of the actual figures, the outcomes of the 2024 measurements were included in the respective years. A few comments are to be made here:

- Some values are lower than the projection, while others are in line or even higher than the projections. This relates to either diameter, stand density or carbon biomass. This is not uncommon in forestry due to a combination of the following factors: 1) fluctuations in growth between calendar years (including performance in past years), 2) variation in growth amongst sites, 3) slight variations in realisation of silvicultural measures - either the intensity or the age in which it is applied, 4) natural growth variation amongst individual trees (variation of genetics applied). This is also why data from multiple calendar years and multiple sites are needed to derive at a project specific expected growth curves.

- The inclusion of the measurement outcomes (realised growth figures) does have a very limited impact on the LTA calculations, as the amount data is still limited: on average for each system two years of realisedgrowth figures is applied, whereas the LTA is calculated over 54 years.

The changes in LTA between the previous (2021) and current (2024) verification are as provided below.

LTA in t CO_2e/ha	2021	2024
Pure teak (per ha)		
- Siuna, 625 trees/ha	231.8	205.3
- Siuna, 500 trees/ha	229.1	200.8
- Siuna, 312 trees/ha		195.3
Agroforestry teak and cacao (per ha)		
- Siuna, old teak 156 trees/ha	127.6	111.9
- Siuna, new teak 156 trees/ha	127.6	113.6
- Siuna, new teak double row 312 trees/ha		120.6
- Bonanza, old teak 156 trees/ha	124.8	108.8
- Bonanza, new teak 156 trees/ha	124.8	110.6
- Bonanze, double row 312 trees/ha		117.6
Overall	**437,119.2**	**293,356.2**

Redefinition of the baseline for protection area

During the measurement of the protection area, issues were discovered with the accuracy of the baseline distribution. To remedy this, remote sensing has been used to create a new baseline map and sampling plan on basis of 2019 satellite images. For this, the following protocol has been used:

The stratification of the conservation area has been done based on remote sensing. To create the classification, the following steps were undertaken:

I) Downloading the data

1. First, using Google Earth Engine, the Sentinel-2 L2A data is downloaded. Immediately, two vegetation indexes (NDVI and NDVIre) are created and added to the raster stack. The raster stack then contains 14 bands, 12 Sentinel-2 bands and 2 vegetation indexes.
2. Once the data is downloaded the data is loaded into SAGA and the Tasselled Cap Transformation is done to transform the spectral information into spectral indicators. Three indicators are created, Brightness (A measurement value for the ground); Greenness (A measured value for the vegetation); And wetness (A measured value for interactions of soil and canopy moisture).These three layers are then added to the raster stack, making the total stack contain 17 bands, 12 Sentinel-2 bands, 2 vegetation indexes and 3 Tasselled Cap bands.

3. Thirdly, a dataset containing canopy height information is downloaded. This data contains, at a 30-m spatial resolution, information on the canopy height obtained through the NASA GEDI, a space born lidar instrument onboard the International Space Station since April 2019. This layer is also added to the raster stack, making the final raster stack containing 18 bands, 12 Sentinel-2 bands, 2 vegetation indexes, 3 Tasselled Cap bands and 1 canopy height layer.

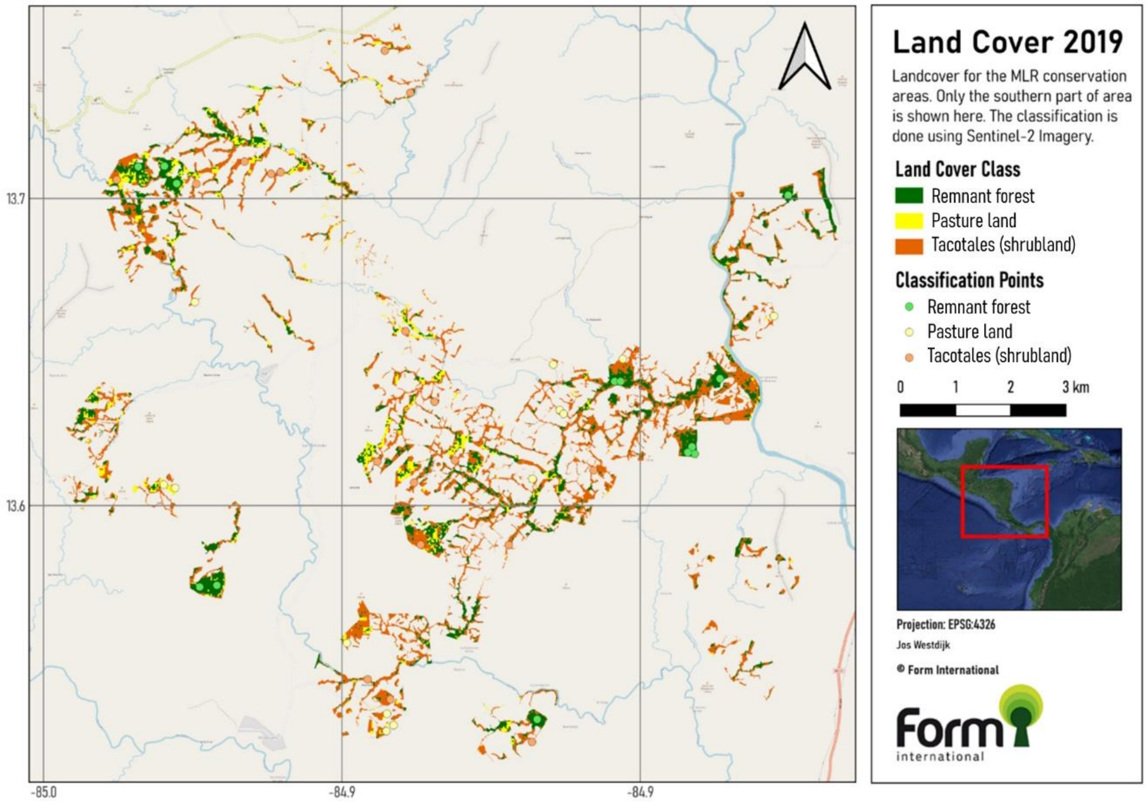
II) Selecting the training points for the Random Forest Classification

1. Once you have your full dataset over which you want to do a classification it is time to create the training points for the three classes (remnant forest, tacotales (shrubland) and pasture land). To select the training points a combination of evaluating Google Satellite (Through Google Earth) high resolution imagery, the raster stack projected as an RGB-Image, a K-Means unsupervised classification (Obtained using SAGA) and expert judgement has been used. For each class 20 training points were selected.

III) Classifying the image

1. To create the classification the raster stack containing the 17 different layers and the training points dataset are imported into SAGA after which the Random Forest machine learning algorithm is applied to classify the image.
2. The result from this image is then reimported into QGIS which can be used to visualize it.
3. The classification is validated using points which were not used to create the classification.

The model used for classification had an average prediction probability of 91.7%, showing good internal consistency but not directly indicating accuracy. After adding 20 points per class (174 pixels in total), the accuracy assessment shows an overall accuracy of 91.38%. This result confirms the model's reliability. The methodology followed is sound, and the classification is suitable for use. Results are shown in Table 7 .



Sample plot determination for the protection area

To comply with the VCS Carbon Standard, 0.5% of the surface area of each category will be measured. Each sample plot will be 500 m². The number of required sample plots is calculated based on this criterion:

Category	# plots
Pasture land	47
Tacotales	34
Remnant forest	62

Plot layout for the protection area

The sampling plots are circular with a radius of 12.62 meters ($\sqrt{(500m2/\pi)}$)

To ensure that each plot falls entirely within its category and to limit edge effects, a buffer of 18 meters is taken from the edges of each category. This buffer consists of the 12.62-meter radius and an additional 5.38 meters.

Within this buffered area, points are randomly generated for each category, maintaining a distance of 36 meters between each plot to avoid overlap and double-counting of trees. This spacing provides a 10.76-meter buffer between each plot.

The number of potential sample plots per category is calculated as follows:

Category	# potential sample plots
Remant forest	1417
Tacotales	126
Pasture land	519

From these potential plots, the required number of sample plots is randomly selected. Each selected point serves as the centroid of a sampling plot.

A circle with a radius of 12.62 meters is generated around each centroid. An intersection check with the conservation area is performed to ensure that these plots fall within the correct category boundaries.

Consequently, some areas previously considered as pasture land and tacotales shifted to remnant forest. This resulted in a more accurate and more conservative estimation of carbon growth. Baseline carbon stocks remained unchanged as these were estimated independent of the baseline area distribution. The new baseline is more conservative in nature, as the total area of remnant forest increased, compared to the pasture land and tacotales, increasing the total baseline carbon stock.

Table 7. Baseline distribution in the protection area

Baseline distribution	According PDD	New baseline	New (ha)
% pasture land	52.5%	41.2%	604.1
% tacotales	20.8%	14.5%	213.3
% remnant forest	26.7%	44.3%	649.3

Assisted Natural Regeneration clarification

The PDD states that the management of pure teak stands, and agroforestry stands includes Assisted Natural Regeneration (ANR). However, this was stated incorrectly and was a drafting error as this did not belong to the initial management strategy for these project activity types. ANR is only implemented in the management of the protection areas.

Small holder certification

The PDD states that “MLR is supporting small holder certification” (p16/32 PDD). However, small holder cacao producers are currently organized in two local cooperatives that apply for small holder certification. Therefore, support from MLR was not needed and is currently limited to providing technical assistance to small holder producers.

Chemical treatments

The management practices for teak and cacao, together with an optimal genetic selection result in a low susceptibility of the MLR-plantations to plagues and diseases. Therefor the use of chemical treatments is not being foreseen. All certification schemes to which the MLR-plantations have been submitted have specific regulations for the subject. Only weed control is partially being done with herbicides on an extensive basis, with low volumes and directed towards the objective of zero-fumigations in the near future.

Applicability of the baseline scenario, methodology and additionality

Despite the methodology deviations, the applicability of the methodology, additionality and the appropriateness of the baseline scenario remains, as explained as follows:

Appropriateness of the baseline scenario

Despite adjustments in baseline distribution to reflect increased forest cover and modifications to rotation times and planting density of teak trees, the project remains fully compliant with VCS- CDM methodology. The revised baseline accurately represents the business-as-usual scenario by incorporating precise remote sensing data, ensuring accurate land use accounting. While a larger portion of the project area is now forested, the overall landscape remains highly fragmented and degraded, consistent with the baseline scenario outlined in the PDD. The description of each of the baseline strata also remains the same as outlined in the PDD

Additionality

The project continues to demonstrate additionality as detailed in the barrier analysis of the PDD. Significant economic, institutional, and ecological barriers still prevent alternative land use scenarios such as extensive cattle grazing, subsistence mining, or conventional reforestation without VCS certification. Although conventional reforestation without VCS certification may seem slightly more feasible due to reduced reforestation areas and shorter rotation times, the required investment remains substantial. Additionally, the region's challenges in attracting capital investment, as described in the PDD, persist. Other barriers, including institutional constraints, informality, and distance to ports, remain robust, thereby maintaining the project's additionality.

Applicability of the methodology

The project continues to adhere to the VCS methodological framework, with revisions enhancing the accuracy and reliability of carbon sequestration estimates through best practice remote sensing techniques. Adjustments in rotation length and planting density have been incorporated into the ex-ante emission calculations and long-term average (LTA) calculations, ensuring alignment with methodological requirements. These changes primarily involve parametric adjustments rather than alterations to the project design, thereby maintaining the project's methodological integrity.

Monitoring in protection area

In the protection area, only the tacotales and pasture land were measured due to time constraint and the cost-ineffectiveness of currently measuring the remnant forest (time consuming with low carbon gain). As such, carbon from the remnant forest will not be claimed in this monitoring period.

Monitoring in agroforestry teak and cacao area

The old cacao agroforestry stands with teak in the distanced Bonanza were not measured due to time constraints and the cost-ineffectiveness of currently measuring these stands, as visually it was concluded that the growth is still limited.

3.3 Grouped Projects

N. A. as no new instances have been added to the project during the monitoring period.

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes ☒ No

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	ρ
Data unit	t d.m. m^{-3}
Description	The wood density for indigenous tree species
Source of data	The average wood density is determined per species based on relevant literature (ICRAF 2020; Marena, 2017)
Value applied:	Value varies per species. See for more details Appendix 1: ER-sheet
Justification of choice of data or description of measurement methods and procedures applied	Sample plots in the protection areas have been laid out and the tree species are identified where possible. For land preparation the tree species are also inventoried. Based on literature the wood density is determined to estimate tree biomass as accurately as possible.
Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions

Comments	

Data / Parameter	CF_{TREE}
Data unit	t C (t d.m.)$^{-1}$
Description	Carbon fraction in dry matter for indigenous trees
Source of data	(IPCC, 2006)
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC
Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	BDR_{SF}
Data unit	-
Description	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 project activity is located.
Source of data	Methodological tool (AR-TOOL14) "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)"
Value applied:	0.1
Justification of choice of data or description of measurement methods and procedures applied	Default value from methodological tool

Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	b_{FOREST}
Data unit	t d.m. ha^{-1}
Description	Default above-ground biomass content in forest in the region/country where the project activity is located
Source of data	(IPCC, 2003)
Value applied:	161
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC
Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	RS_{IND}
Data unit	-
Description	Root-shoot ratio for indigenous forest
Source of data	IPCC, 2006.
Value applied:	1.22
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC
Purpose of Data	• Calculation of project emissions

	• Calculation of baseline emissions
Comments	

Data / Parameter	CF_S
Data unit	t C (t d.m.)$^{-1}$
Description	Carbon fraction of shrub biomass
Source of data	Methodological tool (AR-TOOL14) "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	Default value from methodological tool
Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	R_S
Data unit	-
Description	Root-shoot ratio for shrubs
Source of data	Methodological tool (AR-TOOL14) "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)"
Value applied:	0.4
Justification of choice of data or description of measurement methods and procedures applied	Default value from methodological tool

Purpose of Data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	D_{TEAK}
Data unit	T d.m. m^{-3}
Description	Teak wood density
Source of data	IPCC, 2003.
Value applied:	0.55
Justification of choice of data or description of measurement methods and procedures applied	Default value for teak from IPCC
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	BEF_{TEAK}
Data unit	-
Description	This is BEF and R in one. Converts trunk biomass to total above and belowground tree biomass.
Source of data	Kraenzel, et. al, 2003.
Value applied:	1.53
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication

Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	CF_{TEAK}
Data unit	-
Description	Carbon fraction of teak biomass
Source of data	Kraenzel, et.al, 2003.
Value applied:	0.495
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$V_{TREE,l,teak}$
Data unit	m^3
Description	Equation to calculate total volume of the trunk from DBH and height
Source of data	Fallas Zúñiga, 2017.
Value applied:	-0.0068*DBH + 0.001*DBH^2
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication that is also used in verification of the inventory of PP by an independent party
Purpose of Data	Calculation of project emissions

Comments	

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 the project area
Source of data	Methodological tool (AR-TOOL16) "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)"
Value applied:	47 t C ha-1 for Ultisols 65 t C ha-1 for Alfisols
Justification of choice of data or description of measurement methods and procedures applied	Ultisols are a Low Activity Clay soil type. Alfisols are a High Activity Clay soil type. The climate region is a tropical moist region (FAO, 2012)
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$f_{LU,i}$
Data unit	-
Description	Relative stock change factor for baseline land-use in the relevant strata of the project area.
Source of data	Methodological tool (AR-TOOL16) "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)"
Value applied:	1.0

Justification of choice of data or description of measurement methods and procedures applied	The project area is characterized as (abandoned) pasture land
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$f_{MG,i}$
Data unit	-
Description	Relative stock change factor for baseline management regime in the relevant strata of the project area
Source of data	Methodological tool (AR-TOOL16) "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)"
Value applied:	0.7
Justification of choice of data or description of measurement methods and procedures applied	Value applied for degraded lands following the methodology.
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$f_{IN,i}$
Data unit	-
Description	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in the relevant strata of the project area

Source of data	Methodological tool (AR-TOOL16) "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)".
Value applied:	1.0
Justification of choice of data or description of measurement methods and procedures applied	No input of fertilizers in the baseline.
Purpose of Data	Calculation of project emissions
Comments	

4.2 Data and Parameters Monitored

Data / Parameter	A_{PLOT}
Data unit	Ha
Description	Total area of sample plots
Source of data	PP field monitoring
Description of measurement methods and procedures applied	See chapter 4.4 of the PDD for elaboration.
Frequency of monitoring/recording	Annual for pure teak and teak in cacao agroforestry stands At least before every monitoring event for the protection areas.
Value applied:	Aim is to sample 2% of the stratum area for teak and teak in cacao, and 0.5% for protection areas. For this monitoring period 8.6 ha, which is 2.1% was monitored in sample plots in the teak plantations. This was measured across 172 PSPs. For teak in cacao, in the single rows every 33rd tree was measured for 3.0% of the total area. In total 3.0% of the trees were measured. The teak in old cacao in Bonanza was not measured due to time constraints and as such is not considered in this monitoring period. For the cacao, mixed with teak, a total

	of 5.5 ha was measured, which is 3.5% of the total area. This was measured across 109 PSPs. In the protection area, only the tacotales and pasture land were measured due to time constraint and the cost-ineffectiveness of currently measuring the remnant forest (time consuming with low carbon gain). As such, carbon from the remant forest will not be claimed in this monitoring period. In total 4.05ha were measured, for 0.5% of the total area. In total, 81 PSPs were measured.
Monitoring equipment	GPS, measuring tape.
QA/QC procedures applied	Internal control by PP's Quality Control teams External verification on PP's inventory by independent auditor
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Calculation method	Plot size x number of plots
Comments	

Data / Parameter	H
Data unit	M
Description	Total tree height
Source of data	Measured by project proponent
Description of measurement methods and procedures applied	Is measured in permanent sample plots, see chapter 4.4 of the PDD for elaboration.
Frequency of monitoring/recording	Annual for pure teak and teak in cacao At least before every monitoring event for the protection areas.
Value applied:	Value varies depending on tree species and age.
Monitoring equipment	Manual hypsometer

QA/QC procedures applied	Internal control by PP's Quality Control teams External verification on PP's inventory by independent auditor
Purpose of data	Calculation of baseline emissions Calculation of project emissions
Calculation method	Not applicable
Comments	

Data / Parameter	DBH
Data unit	cm
Description	Diameter of the tree at 1.3m height
Source of data	Measured by project proponent
Description of measurement methods and procedures applied	Is measured in permanent sample plots, see chapter 4.4 of the PDD for elaboration.
Frequency of monitoring/recording	Annual for pure teak and teak in cacao At least before every monitoring event for the protection areas. Up to 10 axes per tree are recorded in the protection area, one for each individual stem of the tree which meets the criteria. Each axis is treated as an individual tree in the carbon calculations.
Value applied:	Value varies depending on tree species and age.
Monitoring equipment	Diameter tape
QA/QC procedures applied	Internal control by PP's Quality Control teams External verification on PP's inventory by independent auditor
Purpose of data	Calculation of baseline emissions Calculation of project emissions

Calculation method	Not applicable
Comments	

4.3 Monitoring Plan

Individual tree growth is monitored in all different reforestation types: in the commercial plantations with pure teak and the cacao agroforestry systems and in the protection area. The measurements are taken in Permanent Sample Plots (PSPs), which were established systematically in the different stands, and through the individual tree sampling system (ITSS). Every year after planting, additional plots are created in the newly planted areas. The number of plots will therefore increase accordingly each year.

Updating of strata

For each verification event an assessment is made of the need to update or change the existing strata. Reasons for changing strata are if unexpected disturbances or management activities have occurred that have altered otherwise homogeneous strata. The need or possibility to merge strata is also assessed.

Teak plantation

The forest inventory in the teak plantations is carried out once a year to determine the diameter, height and volumetric growth of the plantation. Monitoring of the teak plantation starts at the age of 2 years. In earlier years the plantation is too young and too variable to obtain reliable estimates of standing tree volumes.

Sampling is done through circular permanent sample plots, which are distributed along the teak forest plantations every 200 meters with an area of 500 square meters each. This results in a 2% sampling density. The MLR cartography team establishes the PSP distribution per reforestation type. The established field coordinates serve as the centre of each plot, considering the following criteria:

1) The plots are circular plots of 500 square meters
2) The centre of the plot is marked with a stake.
3) The radius of the plot is 12.62 meters
4) Considering the radius of the plot, its 4 cardinal points are marked with a stake.
5) The tip of the stakes is painted red or marked with coloured forest tape.
6) When determining the plot, 4 quadrants will be identified to carry out the measurement in an orderly manner.
7) Quadrant 1 is located between the Northeast reference, quadrant 2 between the Southeast reference, quadrant 3 between the Southwest reference and the quadrant 4 between the Northwest reference (see Fig. 5)

8) The individual trees are marked with sequential numbers.

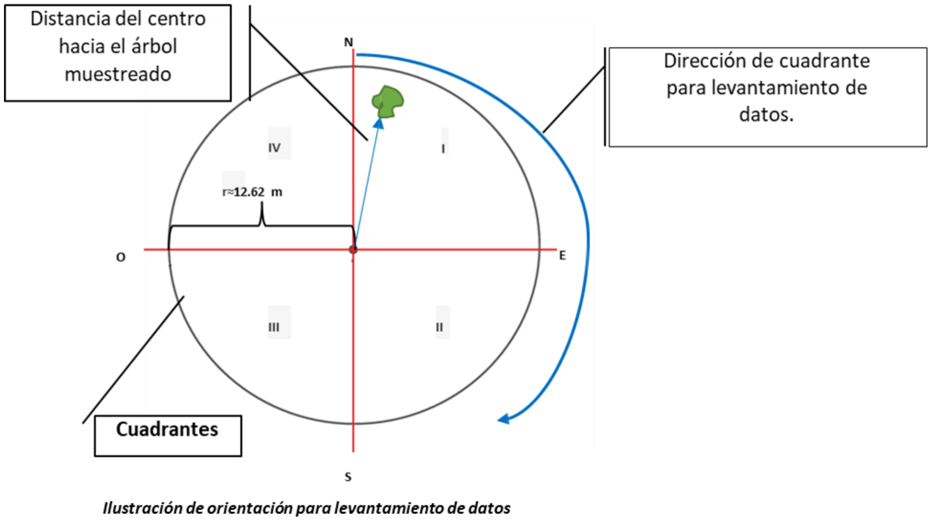


Figure 5. Permanent Sampling Plot design with display of orientation of data collection.

The expected confidence levels with the indicated sampling density are below 10%. The methodology applied for the determination of plots is described in the Procedure manual for inventory and installation of PSPs. Internal audit procedures exist to ensure precision.

For the collection of data, the following is taken into consideration:

1) The measurement starts in the first quadrant of the plot from the north, passing clockwise through each quadrant.
2) The distance from the centre of the plot to the corresponding trees is measured.
3) The diameter at breast height (DBH, 130 cm) of trees with a diameter greater than 10cm (DBH ≥ 10cm) will be measured.
4) Certain rules for measuring DBH apply, see Fig. 6.
5) The total height (Ht) of all trees that meet the DBH criteria will be measured. Generally, the hypsometer instrument is used but there where the vegetation does not allow estimation of the crown or placing the tape to measure the distance to the tree, a subjective assessment of the height is carried out.

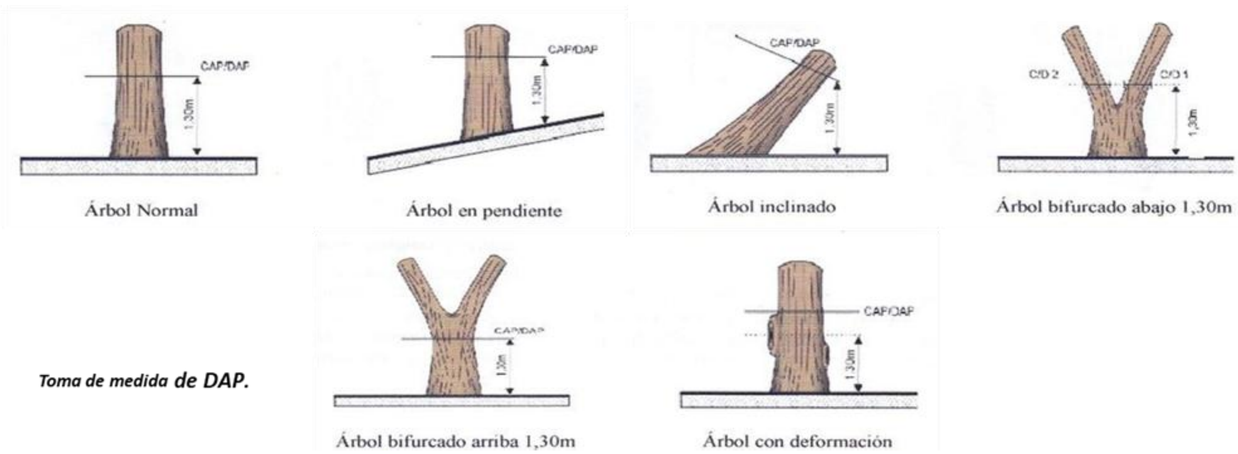


Figure 6. DBH measuring criteria

In each plot, the slope is determined. For this, the elevation of the land (m.a.s.l.) in two different points of the plot is determined, using GPS. One point is located in the highest part of the plot and another in the lowest part. Subsequently, the planimetry distance between both points (m) is measured and these data are noted for later analysis of the slope percentage. The following formula is used:

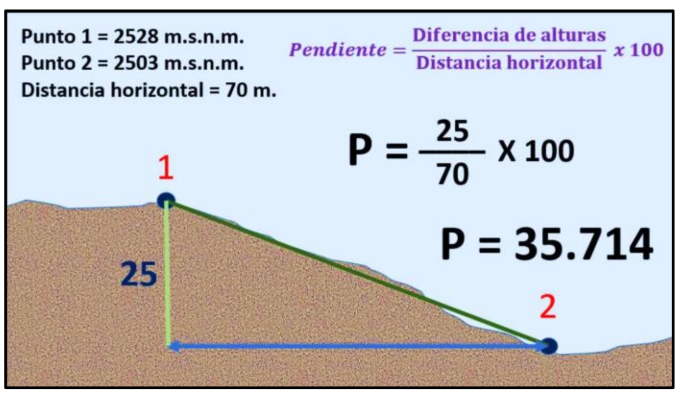


Figure 7. Formula for slope (%) determination

<u>Teak and cacao agroforestry system</u>

For teak and cacao in the mixture of teak and cacao a minimum of 2% sampling density is applied just like in pure teak stands. The sampling methodology is different, however.

- *Cacao:* The cacao shrubs are measured through rectangular PSPs of 500 m² (20x25m) with an orientation from east to west. Since the cacao has been planted in parallel lines, it was decided to use the rectangular plots instead of circular plots (see chapter 3.3.2.). The crown diameter of each cacao shrub in the plot is measured and recorded to determine the shrub cover on a hectare basis afterwards.

- *Teak in cacao*: As described in chapter 3.2.1, the teak is sampled through the 33rd tree methodology. Since the teak has been planted in lines with a spacings of 4x8m up to 4x16m, the use of sample plots is not suitable for this system. In the applied methodology, the 10th living tree in the 1st line with teak in each stand is measured and from there upon every 33rd living tree following the teak lines in a zigzag pattern until covering the whole stand. This results in over 3% sampling of the standing trees and an exact determination of the number of trees in each stand. Of each tree, DBH and height is determined according to the methodology used for pure teak stands.

As teak is at times added to cacao that predates the project start, in these cases the cacao is excluded from the calculations and as such not monitored.

Protection areas

For protection areas circular sample plots are being used. The plots are established in the three different baseline strata: pasture land, tacotales (brushwood) and remnant forest (though degraded). The designation of sample plot is based on remote sensing of the baseline of the protection areas. The distinction between the three strata is important in view of the considerable difference in carbon stock baseline between the different strata. The minimum sampling density is 0.5% for each of the baseline strata.

The sampling plots are circular with a radius of 12.62 meters ($\sqrt{(500m2/\pi)}$) To ensure that each plot falls entirely within its stratum and to limit edge effects, a buffer of 18 meters is taken from the edges of each category. This buffer consists of the 12.62-meter radius and an additional 5.38 meters.

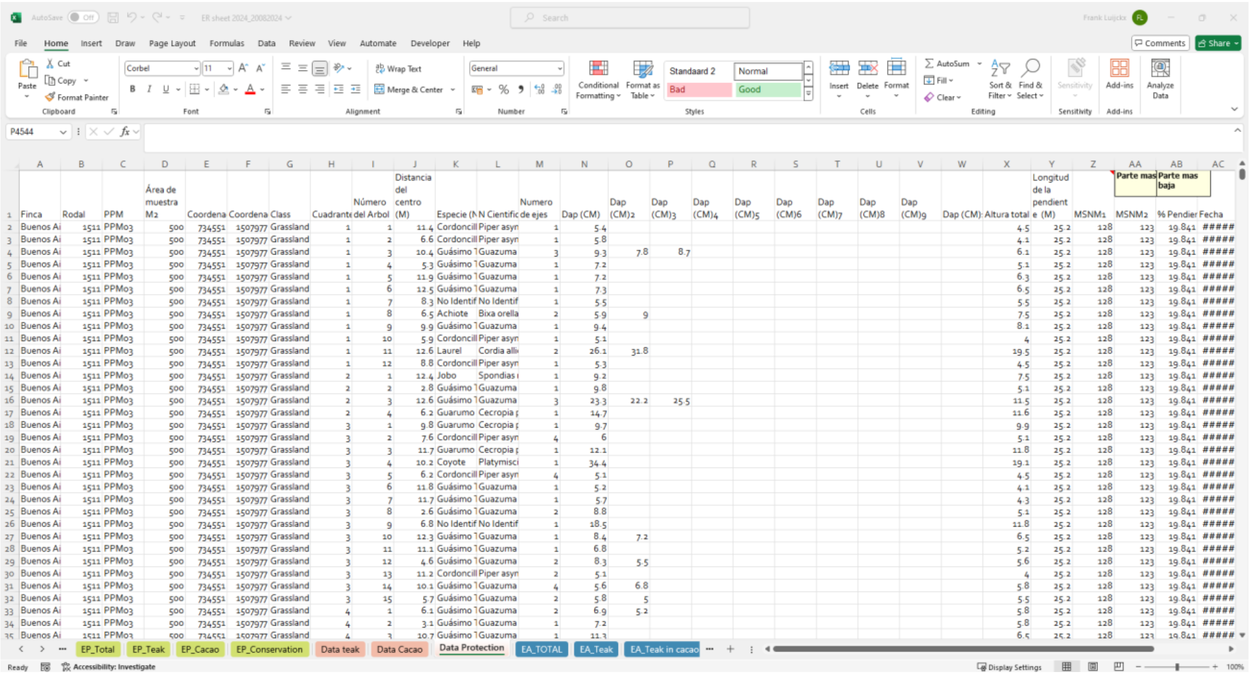
Within this buffered area, points are randomly generated for each category, maintaining a distance of 36 meters between each plot to avoid overlap and double counting of trees. This spacing provides a 10.76-meter buffer between each plot.

From these potential plots, the sample plots are randomly selected. Each selected point serves as the centroid of a sampling plot.

Of all trees with a DBH ≥5 cm the DBH and height are measured following the regular monitoring protocol. Where identification is possible, the species is recorded as well. All trees are marked with a coloured tape and number for future measurements. These measurements include trees and shrubs, so the measurement is for total woody biomass. This is a deviation from the PDD, where all trees with a DBH ≥10 cm were described to be measured, and shrub cover to be estimated visually. This method provides more accuracy as for the shrub cover there is no dependence on visual estimations.

For each axis of each tree, the DBH is measured. The biomass of each axis is calculated separately and summed into a tree biomass.

All collected data is entered in a data entry template in Excel (Fig. 8), including the following parameters: date, farm, stand number, plot number, planting frame, row number, tree number, DBH per axis, total height.



	Finca	Rodal	PPM	Área de muestra M2	Coordena	Coordena	Class	Cuadrante	Número del Arbol	Distancia del centro (M)	Especie (N	N Cientific	Numero de ejes	Dap (CM)	Dap (CM)2	Dap (CM)3	Dap (CM)4	Dap (CM)5	Dap (CM)6	Dap (CM)7	Dap (CM)8	Dap (CM)9	Dap (CM):	Altura total	Longitud de la pendiente (M)	MSNM1	MSNM2	% Pendier	Fecha
2	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	1	11.4	Cordoncill	Piper asyn	1	5.4										4.5	25.2	128	123	19.841	#####
3	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	2	6.6	Cordoncill	Piper asyn	1	5.8										4.1	25.2	128	123	19.841	#####
4	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	3	10.4	Guásimo T	Guazuma	3	9.3	7.8	8.7								6.1	25.2	128	123	19.841	#####
5	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	4	5.3	Guásimo T	Guazuma	1	7.2										5.1	25.2	128	123	19.841	#####
6	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	5	11.9	Guásimo T	Guazuma	1	7.2										6.3	25.2	128	123	19.841	#####
7	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	6	12.5	Guásimo T	Guazuma	1	7.3										6.5	25.2	128	123	19.841	#####
8	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	7	8.3	No Identif	No Identif	1	5.5										5.5	25.2	128	123	19.841	#####
9	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	8	6.5	Achiote	Bixa orella	2	5.9	9									7.5	25.2	128	123	19.841	#####
10	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	9	9.9	Guásimo T	Guazuma	1	9.4										8.1	25.2	128	123	19.841	#####
11	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	10	5.9	Cordoncill	Piper asyn	1	5.1										4	25.2	128	123	19.841	#####
12	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	11	12.6	Laurel	Cordia alli	2	26.1	31.8									19.5	25.2	128	123	19.841	#####
13	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	1	12	8.8	Cordoncill	Piper asyn	1	5.3										4.5	25.2	128	123	19.841	#####
14	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	2	1	12.4	Jobo	Spondias	1	9.2										7.5	25.2	128	123	19.841	#####
15	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	2	2	2.8	Guásimo T	Guazuma	1	9.8										5.1	25.2	128	123	19.841	#####
16	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	2	3	12.6	Guásimo T	Guazuma	3	23.3	22.2	25.5								11.5	25.2	128	123	19.841	#####
17	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	2	4	6.2	Guarumo	Cecropia p	1	14.7										11.6	25.2	128	123	19.841	#####
18	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	1	9.8	Guarumo	Cecropia p	1	9.7										9.9	25.2	128	123	19.841	#####
19	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	2	7.6	Cordoncill	Piper asyn	4	6										5.1	25.2	128	123	19.841	#####
20	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	3	11.7	Guarumo	Cecropia p	1	12.1										11.8	25.2	128	123	19.841	#####
21	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	4	10.2	Coyote	Platymisci	1	34.4										19.1	25.2	128	123	19.841	#####
22	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	5	6.2	Cordoncill	Piper asyn	4	5.1										4.5	25.2	128	123	19.841	#####
23	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	6	11.8	Guásimo T	Guazuma	1	5.2										4.1	25.2	128	123	19.841	#####
24	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	7	11.7	Guásimo T	Guazuma	1	5.7										4.3	25.2	128	123	19.841	#####
25	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	8	2.6	Guásimo T	Guazuma	2	8.8										5.1	25.2	128	123	19.841	#####
26	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	9	6.8	No Identif	No Identif	1	18.5										11.8	25.2	128	123	19.841	#####
27	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	10	12.3	Guásimo T	Guazuma	1	8.4	7.2									6.5	25.2	128	123	19.841	#####
28	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	11	11.1	Guásimo T	Guazuma	1	6.8										5.2	25.2	128	123	19.841	#####
29	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	12	4.6	Guásimo T	Guazuma	2	8.3	5.5									5.6	25.2	128	123	19.841	#####
30	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	13	11.2	Cordoncill	Piper asyn	2	5.1										4	25.2	128	123	19.841	#####
31	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	14	10.1	Guásimo T	Guazuma	4	5.6	6.8									5.8	25.2	128	123	19.841	#####
32	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	3	15	5.7	Guásimo T	Guazuma	2	5.8	5									5.5	25.2	128	123	19.841	#####
33	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	4	1	6.1	Guásimo T	Guazuma	2	6.9	5.2									5.8	25.2	128	123	19.841	#####
34	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	4	2	3.1	Guásimo T	Guazuma	1	7.2										5.8	25.2	128	123	19.841	#####
35	Buenos Ai	1511	PPM03	500	734551	1507977	Grassland	4	3	10.7	Guásimo T	Guazuma	1	11.3										6.5	25.2	128	123	19.841	#####

Figure 8. Data entry template in Excel used for inserting collected monitoring data.

<u>Organizational structure, responsibilities and competencies</u>

A specialized staff is involved in the monitoring of the plantations and protection areas. The staff is prepared through a protocol, including qualification requirements and responsibilities, in the description of the positions for monitoring, measuring and cartography. Monitoring and measurement is supervised by the Head of Monitoring, Measurement and Cartography. The actual monitoring is managed by the monitoring supervisor, and is carried out by 3 groups:

- Group 1: This is made up of 3 people who will be dedicated to identifying the plots in the field, they must mark the plots and list the existing trees.
- Group 2: This is made up of 2 teams of 2 persons who will oversee collecting the field data, in the plots that were previously identified.
- Group 3: This is made up of the internal audit group that includes 2 people.

The team receives annual training from the head of Monitoring, Measurement and Cartography. The procedure document used for training is the PSP Inventory and Installation Procedures Manual and contains all technical directives for the proper establishment and monitoring of PSPs. Tools used are a measure tape (no calibration applicable) and a Suunto clinometer (does not require calibration).

<u>Methods for recording, storing and aggregating data on parameters</u>

Annually, PSPs are assessed using a specific monitoring procedure. The basic shape of a PSP in general is a circular plot of 500m². Per plot the GPS location is recorded and used in the datafiles to allow for permanent identification of the plot. Based on the default plot size and soil inclination of the specific plot, the final plot size is calculated per plot. As mentioned earlier, the data are stored in an Excel database for further analysis. The measurements to be taken in the PSPs are specified in the monitoring protocol, and include information on plot location, measurement data, tree sizes and, for protection areas, shrub cover.

Internal audits, quality assurance and quality control procedures

To increase the accuracy of the monitoring data quality assurance and quality control, Qa/Qc procedures are established following IPCC good practice guidance for LULUCF. These are elaborated in the monitoring protocol. MLR has 3 certifications (FSC, Rainforest Alliance and VCS) and an evaluable scheme (IFC). For this purpose, an integrated management system was built whose evaluation is done through internal audits of processes. The audit is supported by a written procedure, which includes the audit program, checklist, audit report, registration of non-conformities and the continuous improvement plan. Additionally, an independent verification is carried out by an external auditor on the inventory outcomes.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The baseline emission quantification was performed in 2019 during the previous verification period. The calculations and associated uncertainty are thus not updated during this verification period. The quantification implemented during the previous verification is described in this section.

To estimate the carbon stock and change in carbon stock in tree and shrub biomass within the project boundaries at a given point in time, the CDM methodology AR-TOOL14 “TOOL14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (version 04.2) has been applied.

In the baseline vegetation, 4 clearly distinct carbon stock strata have been identified with the use of drone imagery and vegetation sampling:

Stratum 1: Pasture land;
Stratum 2: Tacotales (abandoned pastureland);
Stratum 3: Remnant Forest;
Stratum 4: Cacao plantations with remnant indigenous trees.

As mentioned earlier, during the measurement of the protection area, issues were discovered with the accuracy of the baseline distribution (see Table 6 in 3.2.2). To remedy this, remote sensing has been used to create a new baseline map. Parts of what had been considered pasture land and tacotales have been shifted to remnant forest. This allows for a more accurate and conservative estimation of carbon growth. Baseline carbon stocks are unchanged as these were independent of the baseline area distribution.

As there has been a significant shift towards remnant forest, the overall baseline carbon stock has increased, making this a conservative shift in the baseline distribution.

Following the methodology, carbon stock changes in dead wood, litter and soil organic carbon are not considered to determine baseline GHG removals by sink.

Table 8 below shows the carbon pools, the mode of biomass calculation and the determined carbon stock levels of these baseline carbon stock strata that were determined at the start of the project activities. For stratum 1, pasture land, shrub biomass is neglected as there are hardly any shrubs present in the area, which implies that for stratum 1 $\Delta C_{BSL,t}$= $\Delta C_{TREE\_BSL,t}$. For the other strata, shrub biomass is included.

Table 8. The identified baseline strata and their included carbon pools.

Stratum	Carbon pool	Relevant biomass pool	t CO_2e ha^{-1}	Mode of biomass calculation
Stratum 1 (pasture land)	$C_{TREE\_BSL\_1}$	Remnant protected trees	0.6	MLR inventory
	$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	15.1	MLR inventory
Stratum 2 (tacotales)	$C_{TREE\_BSL\_1}$	Remnant protected trees	2.5	MLR inventory
	$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	37.9	MLR inventory
	$C_{SHRUB\_BSL\_1}$	Shrubs that are removed as part of land preparation	34.5	Remote sensing analysis (drone imagery)
Stratum 3 (remnant forest)	$C_{TREE\_BSL\_3}$	Trees in mixed degraded forest	325.5	Sample plots
	$C_{SHRUB\_BSL\_2}$	Shrubs in mixed degraded forest	11.7	Sample plots
	$C_{TREE\_BSL\_1}$	Remnant trees	1.2	MLR inventory

Stratum 4 (cacao with remnant trees)	$C_{SHRUB\_BSL\_3}$	Shrubs (cacao)	33.8	Remote sensing analysis (drone imagery)

The initial carbon stock of the trees and shrubs under the baseline scenario was estimated using the following tools:

- AR-TOOL14, Chapter 8. Estimating carbon stock in trees at a point in time
- AR-TOOL14, Chapter 11. Estimating carbon stock in shrubs at a point of time

Protected remnant trees and trees that are felled as part of land preparation ($C_{TREE\_BSL\_1}$ + $C_{TREE\_BSL\_2}$)

To provide a solid estimation of the carbon stocks in this pool at the start of the project activity, the number of preserved trees and trees felled for land preparation were inventoried for a significant area of both pasture land and tacotales (24.3 ha in total). It is assumed that this area is representative for the whole project area. Based on the dimensions and tree species, the above-ground biomass (AGB) and carbon stock per tree were estimated as described in the PDD, using allometric equations obtained from literature (Chave, et.al, 2005; Saatchi, et.al, 2011). Different equations were used depending on the available information from the field, such as tree species and total tree height.

With the carbon stock per individual tree, the carbon stock in trees per hectare was calculated which resulted in 0.6 $tCO_2e\ ha^{-1}$ sequestered in the preserved remnant trees ($C_{TREE\_BSL\_1}$) in stratum 1 (pasture land), 2.5 $tCO_2e\ ha^{-1}$ in stratum 2 (Tacotales) and 1.2 t $CO_2e\ ha^{-1}$ in stratum 4 (Cacao plantations with remnant trees). In the trees that have been felled as part of land preparation ($C_{TREE\_BSL\_2}$), 15.1 t $CO_2e\ ha^{-1}$ was estimated to be present in stratum 1 (pasture land) and 37.9 $tCO_2e\ ha^{-1}$ in stratum 2 (Tacotales).

The (change in) carbon stock in the remnant indigenous trees in strata 1, 2 and 4 is accounted as zero since these trees are protected and excluded from further estimation of project net GHG removals by sink.

Shrubs that are removed as part of land preparation ($C_{SHRUB\_BSL\_1}$)

The estimation of the carbon stock in shrubs at the start of the project activity was done on basis of shrub crown cover. As the biomass in shrubs is smaller than the biomass in trees, a simplified method of measurement was used for estimating shrub crown cover, using remote sensing analysis (drone imagery). Based on the images, the shrub crown cover was estimated, as described in the PDD. Following the AR-TOOL14, a figure of 34.5 t $CO_2e\ ha^{-1}$ sequestered in this carbon pool in stratum 2 (Tacotales) was calculated.

Trees in mixed degraded (remnant) forest ($C_{TREE\_BSL\_3}$)

To determine the carbon stocks of the mixed degraded forest at the start of the project activity in stratum 3 (remnant forest), 35 sample plots of 500 m^2 were laid out in this stratum. Tree height, DBH (for all trees ≥ 10cm), tree species, slope and shrub cover were among the parameters recorded. Over sixty different tree species were identified. Based on the dimensions and tree species, the above-ground biomass (AGB) and carbon stock per tree was estimated as described in the PDD (Grijalva Pineda, 2005) using allometric equations obtained from literature (Chave, et.al, 2005; Saatchi, et.al, 2011). The total carbon stock per hectare was derived from these figures. A figure of 266.3 t CO_2e ha^{-1} sequestered in trees was calculated for the mixed degraded forest, but with the calculated uncertainty of 30% a discount of 75% was applied. This resulted in a final figure of 325.5 t CO_2e ha^{-1} for trees in mixed degraded forests ($C_{TREE\_BSL\_3}$). As in this stratum no further clearing of (invasive) trees in done, further changes (accumulation) in carbon stock compared to the baseline are because of the project intervention. Therefore, this is determined in regular forest monitoring which is elaborated in section 5.3.2 below.

Shrubs in mixed degraded (remnant) forest ($C_{SHRUB\_BSL\_2}$)

To determine the carbon stock in shrubs in the mixed degraded forest at the start of the project activity, no use of drone imagery could be made for the obvious reasons of visibility. Instead, the same 35 sample plots established for tree sampling in mixed degraded forest were used. In these sample plots, the percentage of shrub cover was determined by the fraction of covered capacity (FCC%) which is the portion of the land occupied by the horizontal projection of the bush canopies. In each plot quadrant a visual observation was made, estimating a figure of the diameter of the crown of the shrubs to determine the projected coverage on the ground in square meters, including only shrubs with woody characteristics. The sum of the square meters of coverage found, divided by the total area of the plot, allowed to determine the percentage of shrub cover. Using this parameter, the total shrub biomass and carbon stock per hectare was calculated according to the methods described in the Project Description Document chapter 4.1.3. This resulted in an average shrub cover of 30% in all plots, relating to 11.71 t CO_2e ha^{-1} sequestered in shrubs in mixed degraded forests ($C_{SHRUB\_BSL\_2}$).

Cacao shrubs ($C_{SHRUB\_BSL\_3}$)

The carbon stock in cacao shrubs is calculated using the same approach as applied for calculation of carbon stock in shrubs that are removed as part of land preparation ($C_{SHRUB\_BSL\_1}$). Crown cover of these shrubs was also estimated using remote sensing analysis (drone imagery), based on which the percentage of shrub crown cover in cacao could be estimated. This resulted in a figure of 33.8 t CO_2e ha^{-1} sequestered in this carbon pool in stratum 4 (Cacao plantations with remnant trees).

All calculations and associated uncertainty can be found in the ER sheet.

5.2 Project Emissions

5.2.1 Stratification

MLR Forestal applies different ARR techniques to achieve GHG emission removals. The selected carbon pools as mentioned in the PDD (above-ground biomass, below-ground biomass, soil organic carbon and leakage) are included in all project activities. However, different calculations for carbon storage apply since there is difference in the management of certain areas. There are three identified types of reforestation: teak plantation (I), agroforestry teak with cacao (II) and protection area (III).

The project is first stratified per reforestation typology. Consequently, the pools are stratified for planting year, region (only to calculate the SOC) and planting densities. For the protection areas, the carbon pools are stratified according to the baseline vegetation strata, as the biomass distribution in these strata is not homogenous and stratification will improve the precision of the biomass estimation. The protection area is subsequently subdivided by year of inclusion. The following strata are applied (see also further explanation in section 3.2.2):

- Teak plantation (I), with a subdivision per initial density (density at planting) and planting years:
    - 625 trees per ha, in Siuna, planting years 2016 and 2017;
    - 500 trees per ha, in Siuna, planting years 2020 and 2022;
    - 312 trees per ha, in Siuna, planting years 2019 and 2020;
- Agroforestry teak with cacao (II), with a subdivision per design and initial situation:
    - Teak in old cacao in Siuna, with a single row of teak in between the cacao, 156 teak trees per ha, planting year 2019;
    - Teak in old cacao in Bonanza, with a single row of teak in between the cacao, 156 teak trees per ha, planting year 2020;
    - Teak in new cacao in Siuna, with a single row of teak in between the cacao, 156 teak trees per ha, planting years 2017, 2019 and 2020;
    - Teak in new cacao in Siuna, with a double row of teak in between the cacao, 312 teak trees per ha, planting year 2018;
- Protection area (III), with a subdivision according to the baseline vegetation strata and location:
    - Pasture land in Siuna, that were put under management starting from the year 2020;
    - Pasture land in Bonanza, that were put under management starting from the year 2020;
    - Tacotales (shrubland) in Siuna, that were put under management starting from the year 2020;

- o Tacotales (shrubland) in Bonanza, that were put under management starting from the year 2020;
- o Remnant forest in Siuna, that were put under management starting from the year 2020;
- o Remnant forest in Bonanza, that were put under management starting from the year 2020.

Where estimation of carbon stock in trees at a given point of time in year *t* is carried out by applying different methods in different strata, the value of the total carbon stock is set equal to the sum of carbon stocks in all the strata in which the project area was divided.

5.2.2 Actual net GHG removals by sinks

As described above, the project consists of three different reforestation types. The long-term average was calculated following the VCS requirement 3.2.21 for those types where harvesting is applied. As described in the PDD, harvesting is applied in the teak plantation (I) and teak/cacao (II), but not in the protection areas.

Since AFOLU requires all emissions such as leakage and all carbon pools to be included, the project is first stratified per project activity and then per plant year, region and planting density. For each project activity the methodology AR-ACM0003 version 02.0 is followed. The estimated net GHG emission removals (t CO_2e) per year are calculated as:

$$\Delta C_{AR-VCS,t} = \Delta C_{AR-VCS,t\_TEAK} + (\Delta C_{AR-VCS,t\_TEAKINCACAO} + \Delta C_{AR-VCS,t\_CACAO}) + \Delta C_{AR-VCS,t\_PROTECTION}$$

The carbon stocks of the trees and shrubs different reforestation types are estimated using the following tools:

- AR-TOOL14, Chapter 8. Estimating carbon stock in trees at a point in time
- AR-TOOL14, Chapter 11. Estimating carbon stock in shrubs at a point of time

Shrubs in the protection area were calculated following the first tool. Instead of estimating the crown cover, all woody biomass with a DBH higher than 5cm was measured in the sampling plots. Everything above 10cm is considered a tree, and between 5cm and 10cm as shrub. These values are pooled together as woody biomass. This way of estimating shrub biomass is, though more time consuming, expected to be more accurate.

In the following sections, the actual net carbon emissions and removals per hectare are explained per carbon pool and project activity. The attached ER-sheet is understood to be an integral part of this chapter, as the calculations are large and numerous, and the calculated reductions are better understood with the ER-sheet by hand.

Long-term average

In the teak and teak in cacao plantations, rotational harvesting is done and thus an initial long-term average (LTA) calculation was carried out over two rotation periods during the validation in 2021. However, as a result of the implementation of different tree density regimes in these strata, as described in section 3.2, the LTA is calculated again. The intended rotation period of 20 years has been altered as well, to 18 years and thus the LTA is calculated over three rotations for a total of 54 years. A detailed overview of deviations in the LTA calculations can be found in section 3.2.2.

All teak plantation and teak in cacao strata can only generate VCUs until the LTA is reached. The long-term average is calculated following VCS requirement 3.2.25:

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

Parameter	Unit	Description
LA	t CO_2e	The long-term average GHG benefit
PEt	t CO_2e	The GHG emission reductions and removals generated in the project scenario calculated over all relevant carbon pools
BEt	t CO_2e	The GHG emission reductions and removals projected for the baseline scenario
n	Years	Total number of years in the established time period (54 years)

A detailed overview of the corresponding calculations of the long-term average can be found in the LTA_Calculation in the attached ex-post ER excel sheet.

The LTA calculation accounts for the removal of vegetation which was present pre-project by subtracting it in the first year on the PE. This means that in the *PE*, the baseline carbon stock has already been deducted. Since the baseline carbon stock (i.e., the "without-project" scenario) does not increase over time, as confirmed in the PDD, the baseline emissions (BE) values are set to zero.

LTAs have been adjusted during this monitoring period due to and on basis of adjustments in the stand densities of teak in the different regimes with pure teak and teak in cacao. The ex-post LTA has been updated from the ex-ante LTA using the latest monitoring data. The Ctree, DBH, and tree counts for the measured years have been incorporated into the LTA sheets within the Ex-post ER Excel. To ensure consistency, the DBH values for years before the monitoring period were adjusted where necessary to smooth the carbon sequestration curve. Similarly, tree densities before and after the monitoring period were adjusted to account for differences in present densities, also to ensure a smoother curve. The CSHRUB_Proj has been modified based on the measured carbon stock in both the new cacao areas and the cacao planted in double rows.

In the new cacao, the teak planted in 2019 is underperforming compared to the 2017 and 2020 cohorts, resulting in an inverted growth pattern across strata. However, this is not a concern for LTA carbon calculations because early growth rates can vary naturally and typically stabilize as the trees mature. Any initial underperformance is expected to balance out over the long term.

A sequence of measurements of the growth of teak under the different regimes will be necessary to calculate the effect of different densities on growth and subsequently on the LTAs.

Table 9: The ex-post LTA calculation for the total area with rotational forestry (Teak & Teak-in-cacao). All scenarios are to date GHG emission reductions and removals at year t

		Baseline scenario teak: to date GHG emission reductions and removals at year t	Baseline scenario Teak-in-cacao: to date GHG emission reductions and removals at year t	Baseline scenario: to date GHG emission reductions and removals at year t	Teak: to date GHG emission reductions and removals at year t	Teak-in-Cacao: to date GHG emission reductions and removals at year t	Project scenario: to date GHG emission reductions and removals at year t	Annual change in GHG benefit	Expected total GHG benefit to date	Total credits available each year
Calendar year	Year	tCO2e	tCO2e	tCO2e	tCO2e	tCO2e	tCO2e	tCO2e	tCO2e	VCUs
t	t	BE1	BE2	BE	PE1	PE2	PE	PEt − PEt-1	PE t − BE t	
2016	1	-	-	-	-642.7	-	-642.7	-	-642.7	-
2017	2	-	-	-	142.0	142.9	284.9	927.6	284.9	284.9
2018	3	-	-	-	5,764.2	610.7	6,374.8	6,089.9	6,374.8	6,089.9
2019	4	-	-	-	7,212.3	3,459.0	10,671.3	4,296.5	10,671.3	4,296.5
2020	5	-	-	-	16,767.8	6,297.3	23,065.1	12,393.7	23,065.1	12,393.7
2021	6	-	-	-	27,678.5	7,795.2	35,473.7	12,408.6	35,473.7	12,408.6
2022	7	-	-	-	29,535.4	16,774.2	46,309.6	10,835.9	46,309.6	10,835.9
2023	8	-	-	-	30,204.7	16,138.8	46,343.6	34.0	46,343.6	34.0
2024	9	-	-	-	59,192.3	17,674.9	76,867.1	30,523.6	76,867.1	30,523.6
2025	10	-	-	-	65,857.5	27,427.6	93,285.2	16,418.0	93,285.2	16,418.0
2026	11	-	-	-	74,066.9	30,185.3	104,252.1	10,967.0	104,252.1	10,967.0
2027	12	-	-	-	97,384.5	36,244.3	133,628.8	29,376.6	133,628.8	29,376.6
2028	13	-	-	-	102,708.5	39,341.7	142,050.1	8,421.3	142,050.1	8,421.3
2029	14	-	-	-	134,272.7	42,867.5	177,140.1	35,090.0	177,140.1	35,090.0
2030	15	-	-	-	174,173.8	46,267.2	220,441.1	43,301.0	220,441.1	43,301.0
2031	16	-	-	-	223,533.9	49,554.3	273,088.3	52,647.2	273,088.3	52,647.2

2032	17	-	-	-	277,889.6	52,740.0	330,629.6	57,541.3	330,629.6	20,268.0
2033	18	-	-	-	304,453.9	55,834.0	360,287.8	29,658.3	360,287.8	-
2034	19	-	-	-	339,457.7	58,844.6	398,302.3	38,014.5	398,302.3	-
2035	20	-	-	-	330,538.4	59,725.9	390,264.3	-8,038.0	390,264.3	-
2036	21	-	-	-	354,508.3	54,837.9	409,346.2	19,081.8	409,346.2	-
2037	22	-	-	-	322,128.5	46,004.3	368,132.7	-41,213.4	368,132.7	-
2038	23	-	-	-	325,148.6	25,630.1	350,778.7	-17,354.1	350,778.7	-
2039	24	-	-	-	345,644.0	30,426.3	376,070.3	25,291.7	376,070.3	-
2040	25	-	-	-	359,395.2	33,949.9	393,345.1	17,274.8	393,345.1	-
2041	26	-	-	-	362,755.4	35,062.0	397,817.4	4,472.3	397,817.4	-
2042	27	-	-	-	370,220.1	38,465.1	408,685.2	10,867.8	408,685.2	-
2043	28	-	-	-	330,916.3	41,638.3	372,554.6	-36,130.6	372,554.6	-
2044	29	-	-	-	316,122.2	44,605.7	360,727.9	-11,826.6	360,727.9	-
2045	30	-	-	-	289,685.6	47,391.5	337,077.1	-23,650.9	337,077.1	-
2046	31	-	-	-	285,032.7	50,017.2	335,049.9	-2,027.2	335,049.9	-
2047	32	-	-	-	276,346.1	52,501.2	328,847.2	-6,202.7	328,847.2	-
2048	33	-	-	-	267,145.0	54,859.2	322,004.1	-6,843.1	322,004.1	-
2049	34	-	-	-	313,872.3	57,104.5	370,976.7	48,972.6	370,976.7	-
2050	35	-	-	-	333,627.3	59,248.3	392,875.7	21,898.9	392,875.7	-
2051	36	-	-	-	358,931.8	61,300.5	420,232.3	27,356.7	420,232.3	-
2052	37	-	-	-	370,034.0	63,269.3	433,303.4	13,071.0	433,303.4	-
2053	38	-	-	-	375,721.2	63,108.9	438,830.1	5,526.7	438,830.1	-
2054	39	-	-	-	396,773.3	57,179.0	453,952.3	15,122.2	453,952.3	-
2055	40	-	-	-	354,007.9	47,350.1	401,358.0	-52,594.3	401,358.0	-
2056	41	-	-	-	352,608.6	26,163.3	378,771.9	-22,586.1	378,771.9	-
2057	42	-	-	-	369,743.9	30,426.3	400,170.2	21,398.4	400,170.2	-
2058	43	-	-	-	380,186.9	33,949.9	414,136.9	13,966.6	414,136.9	-
2059	44	-	-	-	380,239.0	35,062.0	415,301.0	1,164.1	415,301.0	-
2060	45	-	-	-	384,467.6	38,465.1	422,932.7	7,631.7	422,932.7	-
2061	46	-	-	-	341,977.0	41,638.3	383,615.3	-39,317.4	383,615.3	-
2062	47	-	-	-	324,022.7	44,605.7	368,628.4	-14,986.9	368,628.4	-
2063	48	-	-	-	294,952.6	47,391.5	342,344.1	-26,284.4	342,344.1	-
2064	49	-	-	-	288,192.9	50,017.2	338,210.1	-4,134.0	338,210.1	-
2065	50	-	-	-	277,926.2	52,501.2	330,427.3	-7,782.8	330,427.3	-
2066	51	-	-	-	267,671.7	54,859.2	322,530.8	-7,896.5	322,530.8	-
2067	52	-	-	-	313,872.3	57,104.5	370,976.7	48,445.9	370,976.7	-
2068	53	-	-	-	333,627.3	59,248.3	392,875.7	21,898.9	392,875.7	-
2069	54	-	-	-	358,931.8	61,300.5	420,232.3	27,356.7	420,232.3	-

	Sum								15,841,235.5	293,356.2
	LTA								293,356.2	

5.2.2.1 Reforestation type I: teak plantation

Methodology

Due to the shift of areas between the strata and the increase in measuring plots, the carbon calculations could not fully follow AR-TOOL14, as we were unable to directly calculate the increase in carbon stock per sampling plot. Instead, we determined the current difference between the carbon stock change compared to the baseline for each of the sub-strata.

From this, the previous and already verified carbon stock was subtracted for the increase between the verification periods. Please refer to the ER-sheet excel for the in-depth calculations.

Change in carbon stock

The change in tree biomass is calculated per substratum, by calculating the biomass of each plant year. The change in tree biomass is estimated using the following equation:

$$\Delta C_{\text{p\_TEAK\_PROJ}} = \Delta C_{p\_TEAK\_PROJ,t2\text{-BSL}} - \Delta C_{p\_TEAK\ PROJ,t1\text{-BSL}}$$

$\Delta C_{p\_TEAK\ PROJ,t1\text{-BSL}}$ is the carbon stock change compared to the baseline in trees as estimated at time t1, which is the time of monitoring for the previous verification event, 2021. In 2021, the carbon stock in the teak stratum was 17,400 t CO_2e, thus for this stratum $C_{TREE\_PROJ,t1}$ = 17,400 t CO_2e.

The remnant trees are protected in the project area were therefore not felled; these trees are conservatively assumed to reach a steady state in year zero and are therefore not monitored for ex post calculation. Conservatively, these trees are also not added as a constant to the total C_{TREE} of this relative stratum. Therefore, only the biomass present in the trees and shrubs that were felled as part of land preparation is included in the baseline.

$\Delta C_{p\_TEAK\_PROJ,t2\text{-BSL}}$ is the increment of the planted teak trees and SOC compared to the baseline. The total tree carbon stock is estimated based on field measurements in Permanent Sample Plots as elaborated in the monitoring plan. The SOC is estimated based on the CDM Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities.

Baseline

All commercial plantations, including this reforestation type (teak plantation), are established in two different baseline strata, for 71.6% in stratum 1 (pasture land) and for 28.4% in stratum 2 (tacotales).

Therefore, a corresponding weighted average of the carbon stocks in $C_{TREE\_BSL\_2}$ and $C_{SHRUB\_BSL\_1}$ in stratum 1 and 2 has been calculated, as visible in table 22. Thus, in $C_{TREE\_BSL\_2}$, trees felled as part of land preparation, on average 21.6 t CO_2e ha^{-1} was sequestered. In $C_{SHRUB\_BSL\_1}$, shrubs felled as part of land preparation, on average 9.8 t CO_2e ha^{-1} was sequestered. This totals to 31.4 t CO_2e ha^{-1} sequestered in the cleared trees and shrubs for land preparation, which is deducted from the increment from the planted teak trees. As the different baseline carbon pools consist of multiple baseline strata (pasture land and tacotales), a weighted average of the carbon stock in each baseline carbon pool is calculated, as presented in Table 10.

Table 10. Weighted average carbon stock per baseline carbon pool

Baseline carbon stock pool	Baseline stratum	t CO_2e ha^{-1}	Fraction of baseline carbon pool covered by the different baseline strata	Weighted average baseline carbon stock (t CO_2e ha^{-1})
$C_{TREE\_BSL\_2}$ (trees felled as part of land preparation)	Pasture land	15.1	71.6%	21.6
	Tacotales	37.9	28.4%	
$C_{SHRUB\_BSL\_1}$ (shrubs felled as part of land preparation)	Pasture land	0.0	71.6%	9.8
	Tacotales	34.5	28.4%	
			Total	31.4

<u>Teak tree biomass</u>

According to Appendix 1 in the methodological tool the amount of tree biomass ($B_{TREE,l,teak}$) of an individual tree l is estimated using the following equation:

$$B_{TREE,l,teak} = V_{TREE,l,teak} \times D_{TEAK} \times BEF_{TEAK}$$ (Eq. 5 AR-TOOL14 –Appendix 1)

Total tree volume of individual trees is estimated using the total tree volume equation from Fallas for clones (Fallas Zúñiga, 2017). A specific gravity of 0.55 t m^{-3} is used (IPCC, 2006). The BEF-value, which is based on peer reviewed scientific literature (Kraenzel, 2003), includes roots, and therefore the proportion of the total biomass that accounts for trunk biomass (65.28%) provides for a BEF-value of 1.53 that includes R_{TEAK}.

The total tree biomass in a sample plot is calculated by adding the biomass of all individual trees measured in each sample plot. The total teak tree biomass ($B_{TREE,teak}$) equals the total tree biomass in the sample plot, since other tree species in the plot (if any) are not taken into consideration. Following the methodological tool section 8.1.2., the tree biomass per hectare ($b_{TREE,\mathrm{p,i}}$) in the sample plots is calculated by dividing the tree biomass in the plot by the plot area. The mean tree biomass for each teak stratum and the associated variance are estimated following methodological tool equation 16 and 17. Subsequently, the mean tree biomass per hectare in all tree biomass estimation strata (bTREE) is calculated, along with its associated uncertainty.

For the combined substrata, the result is an average of 49.9 t d.m. ha-1 in the measured teak strata, with an associated uncertainty of 4.1%. As this uncertainty is below the threshold of 10% specified in the methodological tool, no uncertainty discount is applied. This allows to calculate the total carbon stock increase compared to the baseline in the commercial teak plantations following equations 12 and 13 of the methodological tool, amounting to 29,597 t CO_2e in total. A full breakdown of the carbon stock per teak stratum can be found in **Table 11**. Here, CF_{TREE} is the default value of 0.47 for carbon fraction of tree biomass as specified in the methodological tool.

Because teak was initially planted at low densities in 2022, the current carbon stock has not surpassed the baseline levels. As a result, the change in carbon is negative, leading to a reduction in the total carbon stock.

Table 11: Variation in carbon per substratum in teak

Plant year	Plant system	ha	Teak carbon/ha	Baseline carbon	Δ Carbon
2016	625	41.9	218.5	31.4	7,831.4
2017	625	65.1	187.4	31.4	11,411.6
2019	312	260.7	57.3	31.4	10,367.5
2020	500	4.8	51.1	31.4	149.2
2022	500	26.0	1.2	31.4	-639.8
2020	312	13.9	54.6	31.4	476.9
Total					29,596.6

Change in Soil Organic Carbon ($\Delta \boldsymbol{SOC}$)

ΔSOC is only relevant for baseline strata 1, 2 and 4 since these are degraded areas. Where remnant forest patches exist ΔSOC is conservatively neglected. The whole project area, except the remnant forest patches, has been used as pasture, and consisted of either pasture land (baseline stratum 1) or recently abandoned pasture land (tacotales, baseline stratum 2) at the project start.

The change in Soil Organic Carbon was estimated using the “Tool for estimation of change in soil organic carbon stock due to the implementation of A/R CDM project activities” (version 01.1.0). The implementation of this tool is elaborated in the PDD. The result of this tool is a fixed estimate of the change in soil organic carbon stock per year per hectare over a period of twenty years.

The rate of change in SOC found for the Siuna and Bonanza areas were found to be 2.8 and 2.6 t CO_2e ha^{-1} yr^{-1} respectively. The results are summarized in Table 15. $\Delta SOC_{AL,t}$ represents the fixed amount of annual carbon storage. The calculation can be found in Annex 1. Multiplying the number of years and hectares with the $\Delta SOC_{AL,t}$ results in the amount soil organic carbon change within the teak strata, amounting to 4270.3 t CO_2e in total.

Table 12. Change in SOC in teak plantations

Project activity	Area	Plant year	Years	ΔSOC_AL	Area (ha)	ΔSOC
I. Teak	Siuna	2016	8	2.8	41.9	928.4
I. Teak	Siuna	2017	7	2.8	65.1	1,262.3
I. Teak	Siuna	2019	5	2.8	260.7	3,613.4
I. Teak	Siuna	2020	4	2.8	18.7	207.8
I. Teak	Siuna	2022	2	2.8	26.0	144.1
					Total	6,156.0

Sum of changes in the selected carbon pools

VCUs are only generated until the LTA is reached. The total change in the selected carbon pools in the teak plantation strata is the change in tree biomass and soil organic carbon:

Table 13. Carbon figures per substratum for teak

Plant year	Plant system	Ha	Teak carbon/ ha	SOC carbon/h a	Total carbon per ha	Baseline carbon	Δ carbon	Total Δ Carbon
2016	625	41.9	218.5	22.2	240.6	31.4	209.2	8,759.8
2017	625	65.1	187.4	19.4	206.8	31.4	175.4	11,411.6
2019	312	260.7	57.3	13.9	71.2	31.4	39.8	10,367.5
2020	500	4.8	51.1	11.1	62.2	31.4	30.8	149.2
2022	500	26.0	1.2	5.5	6.8	31.4	-24.6	-639.8
2020	312	13.9	54.6	11.1	65.7	31.4	34.3	476.9
Total								30,525.0

This gives a current total carbon increase compared to the baseline of 30,525.0 t CO_2e. The previous verification round had a carbon increase of 17,399.6 t CO_2e. compared to the baseline. Therefore, the increase in carbon stock in the teak is 30,525.0 – 17,399.6 = 13,125.5 (see Table 14).

Table 14. Carbon increase in teak compared to the previous verification round.

Reforestation type	Current carbon stock	Previous carbon stock	Δ Carbon
Teak	30,525.0	17,399.6	**13,125.5**

5.2.2.2 Reforestation type II: teak in cacao plantation

Methodology

This stratum follows a similar methodology as the pure teak stratum, with the extra addition of cacao measurements in the new and double row sub-strata.

Due to the shift of areas between the strata and the expansion of measuring plots, the carbon calculations could not fully follow AR-TOOL14, as we were unable to directly calculate the increase in carbon stock per sampling plot. Instead, we determined the current difference between the carbon stock change compared to the baseline for each of the sub-strata.

From this, the previous and already verified carbon stock was subtracted for the increase between the verification periods. Please refer to the ER-sheet excel for the in-depth calculations.

Due to time constraints and the remote location of the Bonanza municipality, the 60.7 ha teak in cacao in this area has not been measured and will be exempted from this verification round. Any carbon increase in this area will not be claimed in this verification round.

Additionally, the cacao planted in 2023 was too small to verify crown cover and as such is not yet considered in this verification round.

Change in carbon stock

The change in tree biomass is calculated per substratum, by calculating the biomass of each plant year. The change in tree biomass is estimated using the following equation:

$$\Delta C_{\mathrm{p\_TEAK\_PROJ}} = \Delta C_{p\_TEAK\_PROJ,t2\text{-BSL}} - \Delta C_{p\_TEAK\ PROJ,t1\text{-BSL}}$$

$\Delta C_{p\_TEAK\ PROJ,t1\text{-BSL}}$ is the carbon stock change compared to the baseline in trees as estimated at time t1, which is the time of monitoring for the previous verification event, 2021. In 2021, the carbon stock in the Teak in Cacao stratum was not verified. Thus for this stratum $C_{TREE\_PROJ,t1}$ = 0 t CO_2e.

The remnant trees are protected in the project area were therefore not felled; these trees are conservatively assumed to reach a steady state in year zero and are therefore not monitored for ex post calculation. Conservatively, these trees are also not added as a constant to the total C_{TREE} of this relative stratum. Therefore, only the biomass present in the trees and shrubs that were felled as part of land preparation is included in the baseline.

$\Delta C_{p\_TEAK\_PROJ,t2\text{-BSL}}$ is the increment of the planted teak trees, newly planted cacao in the new cacao and double row substrata and SOC compared to the baseline. The total tree carbon stock is estimated based on field measurements in which the 33rd or 66th tree is measured as elaborated in the monitoring plan. The cacao carbon stock is calculated via crown cover estimations in Permanent Sampling Plots, as described in the monitoring plan and in the PDD. The SOC is estimated based on the CDM Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities.

Baseline

All commercial plantations, including this reforestation type (teak in cacao plantation), are established in two different baseline strata: for 71.6% in stratum 1 (pasture land) and for 28.4% in stratum 2 (tacotales). Therefore, a corresponding weighted average of the carbon stocks in $C_{TREE\_BSL\_2}$ and $C_{SHRUB\_BSL\_1}$ in stratum 1 and 2 has been calculated, as visible in **table 15**. Thus, in $C_{TREE\_BSL\_2}$, trees felled as part of land preparation, on average 21.6 t CO_2e ha^{-1} was sequestered. In $C_{SHRUB\_BSL\_1}$, shrubs felled as part of land preparation, on average 9.8 t CO_2e ha^{-1} was sequestered. This totals to 31.4 t CO_2e ha^{-1} sequestered in the cleared trees and shrubs for land preparation, which is deducted from the increment from the planted teak trees. This was only deducted for the new cacao and double row substrata, as in the old cacao, no shrubs or trees were removed during the project preparation.

Table 15. Weighted Average Carbon Stock Calculation for Baseline Carbon Pools Across Different Strata (Pasture land and Tacotales)

Baseline carbon stock pool	Baseline stratum	t CO_2e ha^{-1}	Fraction of baseline carbon pool covered by the different baseline strata	Weighted average baseline carbon stock (t CO_2e ha^{-1})
$C_{TREE\_BSL\_2}$ (trees felled as part of land preparation)	Pasture land	15.1	71.6%	21.6
	Tacotales	37.9	28.4%	
$C_{SHRUB\_BSL\_1}$ (shrubs felled as part of land preparation)	Pasture land	0.0	71.6%	9.8
	Tacotales	34.5	28.4%	
			Total	31.4

<u>Teak tree biomass</u>

According to Appendix 1 in the methodological tool the amount of tree biomass ($B_{TREE,l,teak}$) of an individual tree l is estimated using the following equation:

$$B_{TREE,l,teak} = V_{TREE,l,teak} \times D_{TEAK} \times BEF_{TEAK}$$ (Eq. 5 AR-TOOL14 –Appendix 1)

Total tree volume of individual trees is estimated using the total tree volume equation from Fallas for clones. A specific gravity of 0.55 t m^{-3} is used (IPCC, 2006). The BEF-value, which is based on peer reviewed scientific literature, includes roots, and therefore the proportion of the total biomass that accounts for trunk biomass (65.28%) provides for a BEF-value of 1.53 that includes R_{TEAK}.

The total tree biomass per stratum is calculated via the measurements of all individual trees measured. The total teak tree biomass ($B_{TREE,teak}$) equals the total tree biomass in the substrata, since other tree species in the plot (if any) are not taken into consideration. Following the methodological tool section 8.1.2., the tree biomass per hectare ($b_{TREE,\mathrm{p,i}}$) in the sample plots is calculated by dividing the tree biomass in each substratum by the plot area, which is the total area divided by 33. The mean tree biomass for each teak stratum and the associated variance are estimated following methodological tool equation 16 and 17. Subsequently, the mean tree biomass per hectare in all tree biomass estimation strata (bTREE) is calculated, along with its associated uncertainty.

For the combined substrata, the result is an average of 49.9 t d.m. ha-1 in the measured teak strata, with an associated uncertainty of 3.5%. As this uncertainty is below the threshold of 10% specified in the methodological tool, no uncertainty discount is applied. This allows us to calculate the total carbon stock increase compared to the baseline in the commercial teak in cacao plantations following equations 12 and 13 of the methodological tool, amounting to 1,068.4 t CO_2e in total. A full breakdown of the carbon stock per stratum can be found in **table 16**. Here, CF_{TREE} is the default value of 0.47 for carbon fraction of tree biomass as specified in the methodological tool.

Because teak was initially planted at low densities, the current carbon stock in 2020 and 2019 has not surpassed the baseline shrub clearance levels. As a result, the change in carbon is negative, leading to a reduction in the total carbon stock.

Table 16: Variation in carbon per substratum in teak

Plant year	Plant system	Ha	C_tree/ha	Baseline carbon	Δ Carbon
2020	New	135.7	21.0	31.4	-1,412.8
2019	Old	69.8	9.4	0	655.5
2019	New	31.0	13.7	31.4	-550.1
2018	Double Row	65.9	63.5	31.4	2,113.0
2017	New	16.8	47.1	31.4	262.9
Total					1,068.4

<u>Change in Cacao (ΔCacao)</u>

The cacao biomass is calculated via Permanent Sampling Plots, in which the crown cover of the cacao is measured. This is done via calculating the diameter of the crown of each cacao shrub in the plot. This is converted to m^2, from which the total crown cover in each Permanent Sampling Plot is calculated, by summing all the m^2 and dividing this by 500 (sample plot size). This crown cover percentage is set to a maximum of 100%, as this can never be higher than 100%. The cacao biomass is then calculated following the same methodology as how the baseline shrub biomass was calculated for the project. By using the IPCC value of 161.0 ton/m^3 of aboveground biomass content in forests, and the 0.1 Ratio shrub biomass and default above-ground biomass in forest of AR-TOOL14, which assumes a shrub crown cover of 100%, we calculate the cacao biomass as 161.0*0.1*%crown cover. For each substratum (planting year * planting system), the mean cacao biomass and associated uncertainty was calculated.

For the combined substrata, the result is an average of 7.94 t d.m. ha-1 in the measured cacao strata, with an associated uncertainty of 6.1%. As this uncertainty is below the threshold of 10% specified in the methodological tool, no uncertainty discount is applied. This allows to calculate the total carbon stock increase compared to the baseline in the cacao following equations 12 and 13 of the methodological tool, amounting to 3,078.3 t CO_2e in total. A full breakdown of the carbon stock per stratum can be found in table 17.

Table 17. Variation in Carbon per substratum in cacao

Plant year	Plant system	Ha	Cacao carbon/ha	Δ Carbon
2022	New	108.0	2.5	273.8
2020	New	1.1	0.8	0.9
2016	New	31.0	38.0	1,180.6
2017	Double Row	58.4	20.3	1,185.7
2017	New	15.1	29.0	437.4
Total				3,078.3

Change in Soil Organic Carbon ($\Delta \boldsymbol{SOC}$)

ΔSOC is only relevant for baseline strata 1, 2 and 4 since these are degraded areas. Where remnant forest patches exist ΔSOC is conservatively neglected. The whole project area for teak in cacao has been used as pasture, and consisted of either pasture land (baseline stratum 1), recently abandoned pastureland (tacotales, baseline stratum 2) or old cacao (baseline stratum 4) at the project start.

The change in SOC was estimated using the "Tool for estimation of change in soil organic carbon stock due to the implementation of A/R CDM project activities" (version 01.1.0). The implementation of this tool is elaborated in the PDD. The result of this tool is a fixed estimate of the change in soil organic carbon stock per year per hectare over a period of twenty years.

The rate of change in SOC found for the Siuna and Bonanza areas were found to be 2.8 and 2.6 t CO2e ha-1 yr-1 respectively. The results are summarized in Table 21. $\Delta SOCAL,t$ represents the fixed amount of annual carbon storage. The calculation can be found in Annex 1. Multiplying the number of years and hectares with the $\Delta SOC_{AL,t}$ results in the amount soil organic carbon change within the cacao strata, amounting to 4,270.3 t CO2e in total.

Table 18. Change in SOC in cacao plantations

Plant year	Plant system	Municipality	Years	ΔSOC_AL	ΔSOC/ha	Area	ΔSOC
2020	New	Siuna	4	2.8	11.1	135.7	1,504.8
2019	Old	Siuna	5	2.8	13.9	69.8	967.2
2019	New	Siuna	5	2.8	13.9	31.0	430.2
2018	Double Row	Siuna	6	2.8	16.6	65.9	1,095.7
2017	New	Siuna	7	2.8	19.4	16.8	325.5
Total Δ SOC							4,323.4

Sum of changes in the selected carbon pools

VCUs are only generated until the long-term average is reached. The total change in the selected carbon pools in the teak plantation strata is the change in tree biomass and soil organic carbon:

Table 19. Carbon figures per substratum for teak

Location	Start Year	Cacao plant year	Cacao plant system	Teak ha	Cacao ha	Teak carbon /ha	SOC carbon /ha	Cacao carbon stock/ ha	Baseline carbon deduction	Δ carbon	Total Δ Carbon	Comment
Siuna	2020	2023	New	28.2	28.2	21.0	11.1	-	31.4	0.7	19.1	
Bonanza	2020	2015	Old	25.3	25.3	-	-	-	-	-	-	*Not measured*
Bonanza	2020	2011	Old	8.5	8.5	-	-	-	-	-	-	*Not measured*
Bonanza	2020	2013	Old	25.7	25.7	-	-	-	-	-	-	*Not measured*
Bonanza	2020	2012	Old	1.2	1.2	-	-	-	-	-	-	*Not measured*
Siuna	2019	2014	Old	50.8	50.8	9.4	13.9	-	-	23.3	1,180.5	
Siuna	2019	2015	Old	19.0	19.0	9.4	13.9	-	-	23.3	442.2	
Siuna	2019	2016	New	31.0	31.0	13.7	13.9	38.0	31.4	34.2	1,060.7	
Siuna	2017	2020	New	1.1	1.1	47.1	19.4	0.8	31.4	35.9	40.7	
Siuna	2017	2022	New	0.5	0.5	47.1	19.4	2.5	31.4	37.6	20.2	
Siuna	2017	2017	New	15.1	15.1	47.1	19.4	29.0	31.4	64.0	967.1	
Siuna	2018	2017	Double Row	65.9	58.4	63.5	16.6	18.0	31.4	66.7	4,394.4	
Siuna	2020	2022	New	107.5	107.5	21.0	11.1	2.5	31.4	3.2	345.3	
Total											**8,470.1**	

Note that the total area of cacao is lower than that of teak in this stratum. This is partially because the **old cacao in Bonanza is not considered for this monitoring period** and partially because 28.2 ha of cacao has only been planted until 2023 and is still too small to be measured and partially because between the rows of teak in the double row substratum, no cacao was planted. This is accounted for in the total carbon stock change compared to the baseline calculation.

This gives a current total carbon increase compared to the baseline of 8,470.1 tCO_2e. The previous verification round had a carbon increase of 280.5 tCO_2e. compared to the baseline. Therefore, the increase in carbon stock in the teak is 8,470.1 – 280.5 = 8,189.6 (Table 20)

Table 20. Carbon increase in teak compared to the previous verification round.

Reforestation type	Current carbon stock	Previous carbon stock	Δ Carbon
Teak in cacao	8,470.1	280.5	8,189.6

5.2.2.3 Reforestation type III: Protection area

As elaborated in the PDD, $GHG_{E,t}$=0, which means that $\Delta C_{ACTUAL,t}$=$\Delta C_{P,t}$. Since litter and dead wood are conservatively excluded, $\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta SOC_{AL,t}$.

Change in carbon stock in indigenous tree and shrub biomass

The protection areas are composed of remnant forest patches (baseline carbon stock stratum 3), tacotales (baseline carbon stock stratum 2) and pasture land (baseline carbon stock stratum 1). These areas are protected and managed according to the management plan for protection areas and are expected to gradually develop to natural forest areas. Notable in the protection areas is that the area is not cleared for land preparation. The increase in carbon stock through the project activity is added to the carbon stock in trees and shrubs in the baseline.

The change in tree and shrub biomass is estimated by estimating the tree and shrub biomass in each baseline stratum. ΔSOC is only relevant for baseline strata 1, 2 and 4 since these are degraded areas. Where remnant forest patches exist ΔSOC is conservatively neglected.

The methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (AR-TOOL14 v. 04.2) chapters 6.2, 8.11 and 11 are used to determine tree and shrub carbon stock changes.

The changes in biomass are estimated using the following equations:

$$\Delta C_{tree} = \frac{44}{12} * CF_{TREE} * \Delta B_{TREE} \qquad \text{(Eq. 3 AR-TOOL14)}$$

$$\Delta C_{TREE\_PA\_PROJ} = C_{TREE\_PA\_PROJ,t2} - C_{TREE\_BSL\_3}$$

$$\Delta C_{SHRUB} = C_{SHRUB,t2} - C_{SHRUB,t1} \qquad \text{(Eq. 24 AR-TOOL14)}$$

$$\Delta C_{SHRUB\_PA\_PROJ} = C_{SHRUB\_PA\_PROJ,t2} - C_{SHRUB\_BSL\_2}$$

Baseline

For each stratum, the baseline carbon is calculated and transformed into the biomass (Table 21). These values are subsequently used for the carbon calculations per stratum.

Table 21. Carbon and biomass estimations per stratum

Baseline stratum	A_i	c_TREE, t1ha	b_TREE, t1	c_SHRUB,t
Tacotales	212,7	40,4	23,4	34,5
Pasture land	604,1	15,8	9,1	0,0
Remnant forest	649,7	325,5	188,9	11,7

Indigenous tree & shrub biomass

Due to time and cost efficiency reasons, the remnant forest was not monitored in this verification round. As such, no carbon increase here will be claimed in this verification round.

To determine the carbon stock in trees and in the pasture land and tacotales in the protection area, 81 sample plots were laid out in these substrata, 47 in pasture land and 34 in tacotales. Tree height (H), tree diameter at breast height (DBH) and, if determinable, tree species are recorded, among other parameters. Local species names were largely identified to their scientific names by the field team already. Remaining individuals that were not identified to their scientific name yet were identified during the data analysis. Over eighty different tree species were identified. Both shrubs and trees were measured, with individuals with a DBH larger than 10cm being assigned as trees, and individuals with a DBH between 5cm and 10cm being assigned as shrubs.

According to equation 4 in Appendix 1 in the methodological tool AR-TOOL14, the total biomass per tree (above and below ground) was estimated in tonnes based on the dimensions, tree species and their wood specific gravity and by adding the root-to-shoot ratio to the AGB of each tree. An allometric equation obtained from literature was used. Subsequently, the biomass of each individual tree was summed per sample plot, regardless of species, thereby implementing AR-TOOL14 eq. A-2 immediately without specifying the biomass of specific species per plot (AR-TOOL14 eq. A-3) as this step does not add any value nor affect the conservativeness of the calculations in a negative way.

Following eq. e-8, the mean change in tree biomass per hectare in the tree biomass estimation strata (Δb_{TREE}) and its associated uncertainty were estimated, amounting to 44.4 t d.m. ha^{-1} with an uncertainty of 13.1%. According to the methodology Appendix 2, $C_{TREE\_PA\_PROJ,t2}$ must be made conservative by applying an uncertainty discount of 25%. This is adopted as the most conservative way to deal with variance in the mixed degraded forests. This amounted to a discount of 1.65 t d.m. ha^{-1}, which was subsequently applied to both the pasture land and tacotales substrata.

Table 22. Undiscounted and discounted biomass and carbon stock per hectare for the protection area.

Class	Year	b_TREE/ha	C_tree/ha	b_Tree/ha Discounted	C_tree/ha Discounted
Pasture land	2020	39.09	67.4	37.4	64.5
Tacotales	2020	59.60	102.7	58.0	99.9

The carbon stock increase compared to the baseline in trees and shrubs in the is 34,783.5 t CO_2 ha^{-1}. A full breakdown of the carbon stock per baseline land cover stratum can be found in **table 23**. Again, as the remnant forest substratum was not measured for this verification round, it is not taken into account.

Table 23. Change in tree biomass in the different protection area baseline land cover strata.

Protection baseline	Ha	Baseline carbon	Biomass carbon	Total Δ Carbon

Pasture land	604.1	15.8	64.5	2,9456.0
Tacotales	213.3	74.9	99.9	5,327.5
Total				34,783.5

Change in Soil Organic Carbon (ΔSOC)

ΔSOC is only relevant for the pasture land and tacotal substrata since these are degraded areas. For the remnant forest substratum, ΔSOC is conservatively neglected. Therefore, only in the 817.4 hectares of protection area with a baseline land cover of pasture land and tacotales, a change in SOC is accounted for. The change in SOC for the protection area strata is determined analogously with the change in SOC for the pure teak plantations, with a rate of change in SOC found for the Siuna and Bonanza areas of 2.77 and 2.59 t CO_2e ha-1 yr-1 respectively. The results are summarized in **Table 24.** $\Delta SOCAL,t$ represents the fixed amount of annual carbon storage. The calculation can be found in the guiding ER sheet. Multiplying the number of years and hectares with the $\Delta SOCAL,t$ results in the amount soil organic carbon change within the protection areas, amounting to 9,055.4 t CO_2e in total.

Table 24. Change in Soil Organic Carbon in the protection areas

Project activity	Area	Plant year	Substratum	Years	ΔSOC_AL	Area (ha)	ΔSOC
III. Protection	Siuna	2020	Pasture land	4	2.8	595.9	6,608.0
III. Protection	Bonanza	2020	Pasture land	4	2.6	8.2	84.4
III. Protection	Siuna	2020	Tacotales	4	2.8	210.4	2,333.1
III. Protection	Bonanza	2020	Tacotales	4	2.6	2.9	30.0
						Total	9,055.4

Sum of changes in the selected carbon pools

As there is no harvesting or thinning involved in the protection area, there is no LTA. As such, the carbon stock increase compared to the baseline is the total amount of carbon to be verified. This is calculated as shown in Table 25.

Table 25. Carbon stock in protection area

Protection baseline	Start Year	Location	Ha	Biomass carbon	SOC carbon/ ha	Total carbon per ha	Baseline carbon	Δ carbon	Total Δ Carbon	Comment
Remnant Forest	2020	Siuna	594.2							*Not measured*
Remnant Forest	2020	Bonanza	55.1							*Not measured*

Pasture land	2020	Siuna	595.9	64.5	11.1	75.6	15.8	59.8	35,666.1	
Pasture land	2020	Bonanza	8.2	64.5	10.3	74.9	15.8	59.1	482.3	
Tacotales	2020	Siuna	210.4	99.9	11.1	111.0	74.9	36.1	7,588.3	
Tacotales	2020	Bonanza	2.9	99.9	10.3	110.2	74.9	35.3	102.3	
Total									43,838.9	

This gives a current total carbon increase compared to the baseline of 43,838.9 t CO_2e. In the previous verification round, the protection area was not verified and as such had a carbon increase of 0.0 t CO_2e. compared to the baseline. Therefore, the increase in carbon stock in the teak is 43,838.9 – 0.0 = 43,838.9.

Table 26. Carbon increase in the protection area compared to the previous verification round.

Reforestation type	Current carbon stock	Previous carbon stock	Δ Carbon
Protection area	43,838.9	0	43,838.9

5.2.2.4 Overview of GHG removals per stratum

The abovementioned three strata cover all the emission reductions of the project. In total this gives a current carbon stock increase compared to the baseline of 82,834.1 tCO_2e. In the previous verification round 17,680.1 tCO_2e was verified, leaving 65,154.0 tCO_2e as the increase in carbon stock between the previous verification round and the current one.

Table 27. Carbon increase in teak compared to the previous verification round.

Reforestation type	Current carbon stock	Previous carbon stock	Δ Carbon
I. Teak	30,525.0	17,399.6	13,125.5
II. Teak with cacao	8,470.1	280.5	8,189.6
III. Protection	43,838.9	-	43,838.9
Total	82,834.1	17,680.1	65,154.0

As the LTA has not yet been reached, as shown in Table 28 below, the entire increase in carbon stock is eligible for VCU issuance.

Table 28. The current carbon stock increase with a LTA cap for the strata with harvesting.

Reforestation type	GHG benefit to date	Long term average cap	Current VCUs eligible	VCUs granted previously	VCUs eligible
Teak+ teak with cacao (Rotation)	38,995.2	293,356.2	38,995.2	17,680.1	21,315.1
Protection	43,838.9		43,838.9	-	43,838.9
Total	82,834.1		82,834.1	17,680.1	65,154.0

5.3 Leakage Emissions

Under the applicability of methodology AR ACM0003 the only relevant type of leakage is due to displacement of agricultural activities. During the design phase of the project, it was found that all former landowners and property users of the project area have moved to already or historically deforested zones. Because of these conditions and following the methodological tool "Estimation of the increase in GHG emission attributable to displacement of pre project agricultural activities in A/R CDM project activity", leakage is insignificant.

5.4 GHG Emission Reductions and Carbon Dioxide Removals

State the non-permanence risk rating (%)	23%	
Has the non-permanence risk report been attached as either an appendix or a separate document?	☒Yes	☐No
For ARR and IFM projects with harvesting, state, in tCO_2e, the Long-term Average (LTA).	293,356.2 for the teak and teak in cacao strata combined. The protection area has no LTA as there is no harvesting.	
Has the LTA been updated based on monitored data, if applicable?	☒Yes	☐No
State, in tCO_2e, the expected total GHG benefit to date.	82,834.1	
If a loss occurred (including a loss event or reversal), state the amount of tCO_2e lost:	No lost ocurred	

For commercial purposes, the carbon reductions for this monitoring period were calculated using an annual vintage approach. This method is conservative, assuming a linear increase in carbon stock, even though the actual increase is expected to be exponential. To determine the carbon removals for each vintage year, the total carbon removals for each substratum were first calculated. These removals were then divided among the vintage years based on the number of months each substratum was sequestering carbon during this verification period, relative to the total duration of carbon sequestration for the substratum during the same period.

The breakdown of the carbon removal per vintage period is presented in Table 29, with the total requested VCU for this monitoring period in Table 30. Further explanation of the differences in expected VCU per vintage year is provided in Table 31.

Table 29. Summary of carbon removals per vintage period (values are rounded down to whole figures).

Vintage period	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage emissions (tCO_2e)	Buffer pool allocation (tCO_2e)	Reductions VCUs (tCO_2e)	Removals VCUs (tCO_2e)	Total VCU issuance (tCO_2e)	Status

01/Jul/2016 - 01/Mar/2021	*0*	- 17,680	*0*	1,768	*0*	15,912	15,912	Already issued
02/Mar/2021- 31/Dec/2021	*0*	- 15,665	*0*	4,156	0	11,509	11,509	*To be issued in this round*
01/Jan/2022- 31/Dec/2022	*0*	- 18,651	*0*	4,948	0	13,703	13,703	*To be issued in this round*
01/Jan/2023- 31/Dec/2023	*0*	- 18,503	*0*	4,908	0	13,595	13,595	*To be issued in this round*
01/Jan/2024- 31/Aug/2024	*0*	- 12,335	*0*	3,272	0	9,063	9,063	*To be issued in this round*
Total	***0***	**-82,834**	***0***	**19,052**	**0**	**63,782**	**63,782**	

Table 30. Total requested VCU for issuance for this verification round

Current carbon stock increase compared to baseline	82,834.1
Non-permanence buffer risk	23%
Buffer credits	19,051.8
Buffer credits already withheld	1,768.0
Buffer credits to be withheld this verification round	17,283.8
VCU's already issued	15,912.0
ΔC AR_VCS available	**47,870.3**

Table 31. Explanation of the differences between expected and actual emission reductions.

Vintage period	Ex-ante estimated reductions	Achieved reductions	Percent difference	Explanation of the difference
01/Jul/2016- 01/Mar/2021	-	17,680.1	-	These removals have been verified last verification round, **only over teak and the SOC for teak in cacao**. With the new verification round, each year has its separate vintage, as such, these removals cannot be compared with the ex-ante estimated removals.
02/Mar/2021- 31/Dec/2021	34,974.3	- 15,665.2	-55%	Part of these credits are in the first vintage. If these are summed the difference is smaller, which can be partially explained by the current exclusion of teak in cacao in Bonanza and the remnant forest substratum in the protection area.
01/Jan/2022- 31/Dec/2022	35,612.1	- 18,650.6	-48%	This difference can be explained by the exclusion of teak in cacao in Bonanza and

				the remnant forest substratum in the protection area.
01/Jan/2023-31/Dec/2023	35,682.4	- 18,502.9	-48%	As above
01/Jan/2024-31/Aug/2024	31,861.6	- 12,335.3	-61%	As above. Additionally, the ex-ante calculations calculate the emission removals per full calendar year, while the actually achieved emission removals only span until the end of august. Moreover, the teak and teak in cacao were mainly measured in October 2023, lowering the total amount of actual emission reductions even further, compared to the ex-ante calculations.
Total	152,384.4	82,834.1	-46%	As already mentioned above, a large part of the difference can be explained by the exclusion of the teak in cacao in Bonanza, the exclusion of the remnant forest in the protection area and the early measurement of most of the teak, for both the teak and teak in cacao strata. If this large gap is not mediated or significantly lowered next verification round, the ex-ante calculations will be adjusted.

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