INTEGRATED PROJECT FOR REFORESTATION AND AGROFORESTRY ON DEGRADED LANDS IN NICARAGUA

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The proposed ARR VCS project plans to reforest and rehabilitate a total area of 4,204 hectares until 2030 in Nicaragua. Since 2016, 677 hectares of pure teak (*Tectona grandis*) and, to a lesser extent, cocoa agroforestry systems (*Theobroma cacao*) have been realized (incl. 2020). This area was realized in the northeast of Nicaragua, in the Autonomous Region of the North Caribbean Coast (RACCN), specifically in the municipalities of Siuna and to a minor extent in Bonanza and within the limits of the buffer zone of the BOSAWAS Biosphere Reserve (RBB), approximately 315 km from the capital of the country Managua. The realized plantations form the first instances of this grouped project. The project foresees a gradual expansion of planted area starting with 100 to 200 hectares per year, adding new project areas to the project within the same area of the RACCN, Nicaragua. After a final harvest of the teak, the area is replanted – this rotation cycle is to continue endlessly.

The forestry initiative was born in 2008 Bonanza and was managed by Norteak Madera until 2015. Since middle 2015 MLR took the management control of the Project with a different vision, focused on an agro-forestry project combining teak and cacao crops.

The total current area of the properties of MLR is 5139.55 ha. Of this area, 2315.71 hectare is included in the actual VCS project (areas 2016-2020). The project plans to expand to a total VCS project area of 4,204 hectares (Ha) until 2030, of which 2,567 hectares are commercial plantations, mainly in the Municipality of Siuna, according to the availability of area, labor and other necessary elements, that allow the expansion of the Project in degraded areas. Furthermore, from 2020 onwards, the project manages assigned protection areas for gradual rehabilitation into natural lands, specifically in those areas that have suffered high levels of degradation. In the Municipality of Siuna 2146.01 hectares are part of the project, and 169.70 hectares in the Municipality of Bonanza.

The project is grouped project, with all group instances and related properties owned by MLR Forestal. MLR Forestal realizes central monitoring of the project through its corporate and management structure (see Section 2.1). MLR Forestal has centralized monitoring system in place through its Monitoring department [80], and also a centralized training programme training protocols to ensure consistency of monitoring and management across its operations [81].

The land areas reforested are established on former degraded pasture lands. These lands have suffered deforestation and soil degradation due to land-use change processes in the previous century, principally for the purposes of extensive traditional cattle grazing, subsistence agriculture in which the practices of slash-and burn agriculture prevailed, and to a smaller extent subsistence mining activities.

MLR's purpose is to restore these degraded lands with a commercial timber species and high-productive cacao cultures with fine aromas, in an agro-forestry system setting. MLR has been able to attract a variety of foreign investors in a remote and relatively abandoned region of the country. The company holds an FSC certificate for its forest management, a third-party certification scheme which certifies that the forest is sound and sustainably managed.

For the cacao plantations, these have been certified under the Rainforest Alliance Certificate program (previously UTZ), which covers and guarantees good agricultural practices and proper harvest management, social and living conditions and the environment.

To align the social and environmental performance of the Project with other applicable international standards, MLR has voluntarily assumed the incorporation of the 8 Environmental and Social Sustainability Standards of the International Finance Corporation (IFC, 2012).

The project has a net-positive carbon impact (sequestration) through the increase of carbon biomass through the growth of its timber and agroforestry plantations and avoidance of deforestation of remaining forest patches on its land areas. All riverbeds and frequented inundated areas are protected areas. Deforestation rates and threats in the region are high, both Bonanza and Siuna are considered deforestation hotspots at national level [1]. The vegetation cover of the North Atlantic Caribbean Coast Autonomous Region (RACCN) has shown a decrease of approximately 431,000 hectares in the period from 2001 to 2017 [2], the region responsible for 62% of the country loss of vegetation cover [3].

Furthermore, the site has a history of encroachment and soil degradation for mining purposes – the area is rich in both gold and silver.

The present project will sequester an annual average of 26 167 tons of CO_2e during the project period of 40 years.

1.2 Sectoral Scope and Project Type

The project is classified as a grouped project because new areas will be included in the future. The sectoral scope of this project is Agriculture, Forestry and Other Land Uses (AFOLU). Within this category, the project is of the Afforestation, Reforestation, Revegetation (ARR) type.

1.3 Project Eligibility

The project has a net-positive carbon impact (sequestration) through the increase of carbon biomass through the growth of its timber and agroforestry plantations and restoration of degraded forest land areas. The project activity is supported by a CDM methodology, and is therefore eligible as methodology for this VCS project. The project activity is not listed as excluded activity under the scope of the VCS program.

1.4 Project Design

The project is designed as a grouped project. The reason is that the project covers multiple locations in 2 municipalities (Siuna and Bonanza). Also, the project is foreseen to expand in the future. The specific project areas can be observed in the geodetic reference file.

For inclusion of future areas within the group project, the following set of eligibility criteria are developed:

Eligibility Criteria

New project areas to be included in the project must comply with the following eligibility criteria. The second column indicates the documental justification that needs to be provided.

Table 1 - Eligibility criteria

No.	Description	Justification
1	Shall be managed by MLR according to the same management, monitoring systems and sustainability principles.	Demonstration new group instance falls under management & monitoring systems of MLR, e.g. through land titles, updated management plans, managerial decisions.
2	Area is part of the geographic RACCN region	Demonstration in maps of ubication of land area taking as reference the official geographical structure of the Nicaraguan Institute of Territorial Studies (INETER)[1].
3	Project activity shall be on degraded lands.	Demonstration of equality of new group instance with identified baseline (Section 3.4), and in compliance with the VCS standard (section 3.2.4), showing deforestation has occurred at least 10 year before project start date.
4	Project activity shall not be on organic and/or drained soils or is wetland.	Demonstration that new group instance is void of organic and/or drained soils or wetland through soil studies.

[1] https://www.ineter.gob.ni/

5	Technologies or measures are part of those specified in the project description, including: - Shall apply one or more of the project activities and reforestation types defined in section 1.11; - Litter shall remain on site; - Concern reforestation activities (A/R category)	Demonstration that new group instance is managed under same management system with similar operational activities as rest of project (and is part of reforestation types (1.11), and litter thus remains on site).
6	Shall have the baseline scenario equivalent to that identified in section 3.4.	Compliance is shown of applicability of methodology AR-ACM0003 section 2.2 for the new group instance and fitness to baseline scenario as described under 3.4.
7	Compliance of additionality characteristics consistent with the initial instances of this project and geographic area	Demonstration that existing additionality analysis is valid for new group instance, or in case it differs, justification of additionality of group instance.
8	Compliance with legal, social, ecological and technical criteria.	Evidence that company's AL-PR01 Procedure for the acquisition of land has been applied ([4]).
9	PP shall have the right of use for each new project area.	Land tenure titles or land use rights in hands of PP.
10	Start date of additional group instance is after project start date (01/07/2016).	Evidence indicating plantation activities started on or after start date of project.

1.5 Project Proponent

Organization name	MLR Forestal de Nicaragua S.A.
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1.6 Other Entities Involved in the Project

Organization name	Form International B.V.
Role in the project	Project developer
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1.7 Ownership

MLR Forestal de Nicaragua (MLR, hereinafter) has legal land ownership titles for all project areas. These lands were mostly acquired from the former project owner, however, many others were later acquired directly by MLR from other owners in the area, especially in Siuna.

The properties are based in 2 districts, Siuna, which consists of 13 farms and 54 titles (4,869.97) and Bonanza (269.58 ha), consisting of 4 titles and 2 farms, totaling 5,139.55 hectares.

The following table provides an overview of the titles, farms, and the area part of the MLR Forestal's project till March 2021.

Table 2 - Property overview MLR

Title	Zone	Farm	Area (ha)	Included in project (actual monitoring period)	Excluded in actual MP
1	Bonanza	Miranda	56.61	20.54	36.07
2	Bonanza	Miranda	37.69	11.52	26.17
3	Bonanza	Miranda	19.54	6.94	12.60
4	Bonanza	El Chingo	153.31	129.32	23.99
5	Siuna	Buenos aires	86.72	24.13	62.59
6	Siuna	Waylawas	274.20	77.59	196.61
7	Siuna	Danlí	56.05	8.91	47.14
8	Siuna	Danlí	99.41	11.14	88.27
9	Siuna	Las Delicias	92.22	50.80	41.42
10	Siuna	Waspado	47.59	13.46	34.13
11	Siuna	Waspado	27.94	6.55	21.39
12	Siuna	Waspado	59.97	14.40	45.57
13	Siuna	Waspado	31.95	5.81	26.14
14	Siuna	Waspado	12.77	1.70	11.07
15	Siuna	Waspado	21.16	2.78	18.38
16	Siuna	Waspado	108.86	28.48	80.38
17	Siuna	Waspado	77.91	13.07	64.84
18	Siuna	Waspado	98.23	38.66	59.57
19	Siuna	Waspado	244.05	114.98	129.07
20	Siuna	Waspado	34.24	6.89	27.35
21	Siuna	Waspado	88.84	9.59	79.25
22	Siuna	Waspado	112.30	101.40	10.90
23	Siuna	Mutiwas	211.13	54.34	156.79
24	Siuna	Mutiwas	150.37	41.34	109.03
25	Siuna	Mutiwas	48.82	13.65	35.17
26	Siuna	Mutiwas	154.87	53.72	101.15
27	Siuna	Mutiwas	86.55	31.64	54.91
28	Siuna	Mutiwas	67.80	37.09	30.71
29	Siuna	Mutiwas	69.50	21.94	47.56
30	Siuna	Mutiwas	207.40	46.59	160.81
31	Siuna	Mutiwas	77.97	17.21	60.76
32	Siuna	Aló	126.96	38.15	88.81
32	Siuna	La Bu	154.50	141.45	13.05
33	Siuna	Aló	28.81	21.41	7.40
34	Siuna	Aló	8.24	1.69	6.55
35	Siuna	Aló	65.57	31.85	33.72
36	Siuna	Aló	36.66	8.16	28.50
37	Siuna	Aló	107.19	33.02	74.17
38	Siuna	Santa Fe	387.85	161.24	226.61
39	Siuna	Santa Fe	70.53	51.28	19.25

40	Siuna	Bethel	102.08	42.62	59.46
41	Siuna	Bethel	39.96	10.23	29.73
42	Siuna	Bethel	62.28	14.66	47.62
43	Siuna	San Miguel	120.67	62.80	57.87
44	Siuna	Tadazna	30.74	10.30	20.44
45	Siuna	Tadazna	109.53	23.08	86.45
46	Siuna	Tadazna	33.00	17.36	15.64
47	Siuna	Tadazna	4239.72	24.59	25.13
48	Siuna	Matis	211.53	196.08	15.45
49	Siuna	Matis	276.68	215.16	61.52
50	Siuna	Waspado	28.21	28.21	0.00
51	Siuna	Waspado	4.71	4.71	0.00
52	Siuna	Waspado	7.96	7.96	0.00
53	Siuna	Waspado	104.07	104.05	0.02
54	Siuna	San Miguel	1.71	0.00	1.71
55	Siuna	San Miguel	0.40	0.00	0.40
56	Siuna	Danli	48.06	48.06	0.00
57	Siuna	Waspado	3.53	0.00	3.53
58	Bonanza	La Pista	2.43	1.42	1.01
Total general			**5139.55**	**2315.71**	**2823.84**

In 2015, the company established a land acquisition protocol which contemplates criteria for the selection, negotiation and acquisition of new properties, including environmental, social, and land-use criteria and the respective procedures for acquisitions processes. There is a legal department in charge of verifying that the properties meet all legal requirements.

Currently, the ownership encompasses 58 land use titles, and covers 5,139.55 hectares[2]. The forest stands are fully owned by MLR, and since middle 2015 also under direct management of MLR. Of these 5139.55 hectares, 2315.71 hectares are falling under the actual VCS project (2016-2020), and 2823.84 are excluded.

As can be observed in Figure 1, not all lands owned by the project owner are part of the actual VCS project. This is due to areas with previously replanted areas, exclusion due to recent hurricane damage (and thus to be replanted in upcoming years) and areas not yet reforested (and with potential to be included in the VCS project in the future). The following table provides an overview of the concerned areas.

[2] The small area of La Pista (58) in the list is currently undergoing formalization process.

Land use	Total area (ha)	Included area (2016-2020 area) (ha)	Excluded area (ha)
Total	5139.55	2315.71	2823.84
Excluded			
Plantations pre-2016			1906.45
Plantations excluded due to hurricane damage 2016-2020*			176.87
Hurricane damage pre-2016			343.02
Other uses (incl. bare land)*			397.5

*potential for inclusion in the project in the future.

To reach the target of 4,204 hectares by 2030, MLR Forestal will acquire new land private areas in the vicinity of the actual project regions.

1.8 Project Start Date

01-07-2016

The project start date is the date on which activities that lead to the generation of GHG emission removals are implemented, specifically land preparation and planting. The execution of the on-the-ground planting activities started from July 2016 [5], as such the start date of the project was defined at 01-07-2016. The rainfall in 2016 started relatively late, as reported in this article [6]. This was also the reason why MLR Forestal started in July in the year 2016 with planting activities.

1.9 Project Crediting Period

Start date: 01 – 07 – 2016

End date: 31 – 06 – 2056

Total number of years: 40

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale

Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2016	0
2017	2 970
2018	5 688
2019	7 508
2020	46 471
2021	50 717
2022	48 107
2023	51 672
2024	55 107
2025	56 556
2026	58 499
2027	57 416
2028	63 279
2029	60 618
2030	55 866
2031	57 992
2032	52 156
2033	41 481
2034	39 377
2035	32 816
2036	29 911
2037	22 625

2038	17 953
2039	17 892
2040	9 377
2041	8 702
2042	8 424
2043	8 165
2044	7 882
2045	7 615
2046	7 361
2047	7 080
2048	6 810
2049	6 550
2050	6 381
2051	6 222
2052	6 070
2053	5 926
2054	5 788
2055	5 658
Total estimated Ers	1 046 688
Total number of crediting years	40
Average annual Ers	26 167

1.11 Description of the Project Activity

GHG emission removals are achieved by establishing (agro)forestry plantations and by restoring natural forest in protection areas. Three different reforestation (or rehabilitation) types are identified (see also the table below): teak plantation (I), plantations with a mixture of teak and cacao (II), and (III) protection areas in which the natural forest is restored.

The different reforestation types are elaborated on below. All these project activities are carried out and monitored according to the CDM consolidated methodology AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 02.0.

The company actual commercial plantation size is 859 hectares, of which 677 are pure teak stands, and 182.1 ha are teak mixed with cacao as baseline. The company projects expansion of its commercially planted areas to a total of 2,567 productive hectares and a total project area size of 4,204 ha, with reforesting on existing and new properties. The company has included carbon capture, promotion of fauna through established corridors, the promotion of formal employment opportunities, equal opportunities to women and the contribution to the fight against deforestation and forest degradation as part of its sustainability policies [7, 8, 9].

The company has put a social, environmental, health and security management system in place in 2019, to positively impact social and environmental areas, reduce risks and contribute to the regional economic development [7].

In the region where the project is located a jurisdictional REDD+ program is under development, but this is not implemented yet [10, 11].

Table 3 Project area characterization 2016 - 2020

Reforestation type	Bonanza area (ha)	Siuna area (ha)	Total area (ha)
Teak plantation (I)	0.0	677.0	677.0
Teak + cacao plantation (II)	80.9	101.2	182.1
Protection (III)	88.9	1367.8	1456.7
Total	169.7	2146.0	2315.7

Per farm and zone, the 2016-2020 plantations are as follows:

Zona	Finca	Area (ha)
Bonanza	El Chingo	59.32
	La Pista	1.42
	Miranda	20.14
Siuna	Aló	18.52
	Buenos aires	7.08

	Danli	43.67
	La Bu	101.18
	Las Delicias	15.67
	Matis	264.01
	Mutiwas	19.71
	San Miguel	28.45
	Santa Fe	18.03
	Tadazna	38.78
	Waspado	207
	Waylawas	16.06
Grand Total		859.04

Per planting year, this is as follows:

Zona	Year	Area (ha)
Bonanza	2020	80.88
Siuna	2020	165.24
	2019	365.19
	2018	69.10
	2017	85.01
	2016	93.62

Grand Total		859.04

Local communities and people are involved in all of the below-mentioned management activities, through the provision of labour, and also through the provision of services (e.g. catering, transport, etc.). Laborers from the communities receive trainings that develop skills in field and management operations. Additionally, smallholder farmers are supported with trainings on cacao best management practices, the use of best genetical material and MLR provides assistance to farmers on cacao certification. Furthermore, stakeholders are part of annual consultation rounds and made aware of the company project advances and plans, and the existence of community complaint system procedure.

At regional level, MLR supports 10,000 seedlings annually from its nursery to the municipality at no cost, for reforestation activities of riversides.

These activities are leading to an increase of sustainable agro-forestry practices in the villages within the municipalities MLR is active [8].

1.11.1 Teak plantation (I)

The main species used in the project's forest plantations is Teak (*Tectona grandis*). Teak is native to India, Myanmar, the Laos and Thailand, and is naturalized in Java, Indonesia, where it was introduced about 400 to 600 years ago [12, 13]. Teak was first introduced in Central America in 1926 at the Summit Botanical Garden in Panama [14], after which it has been planted in nearly all tropical American countries including Nicaragua [15].

Figure 1 - Teak plantation (source: MLR Forestal)

Teak grows best in warm, moderately moist tropical conditions with rainfall between 1400-2500mm, a 3 to 5-month dry season, and below 1000m above sea level [16, 17]. Teak is a deciduous hardwood tree that can reach heights over 50m in its place of origin, and in Central America it can reach heights over 30m [16]. In the past decades, teak has become one of the most important tropical hardwood plantation species [13]. Teak is highly valued for its physical and aesthetic wood properties, and the increasing demand for quality timber and declining supply from natural forests have led to an increase in the development of teak plantations [12, 18].

The environmental impact of sustainable teak production is low. It is planted on deep and level soils which are relatively insensitive to erosion, and the teak is not 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. Also, the spread of teak outside the plantation can easily be controlled, since dispersal distance of teak seeds is limited. Teak cannot invade areas with dense (high grass) vegetation without human interference because it is a high light demanding species. Most areas surrounding the plantation are in agricultural use for which teak poses no threat.

Experience with the silviculture of teak plantations started in the 19th century [19] and this longstanding practice has resulted in sound management guidelines and good yield prognoses. This provides a solid technical basis for plantation establishment. Teak plantations of MLR Forestal are managed as even-aged stands with a rotation cycle of 20 year and four intermediate thinnings [17]. This choice is based on economic and silvicultural considerations. Following VCS requirement 3.2.21, carbon removals due to harvesting are appropriately accounted for by claiming a maximum amount of sequestered carbon equal to the project's long-term average CO_2 sequestration.

During the 20 year cycle of teak, different silvicultural management activities are performed to obtain optimal growth and yields. After final harvest of the teak, the area is replanted with teak (cacao is not replanted) [17] – this cycle is to continue indefinitely . Activities per year are demonstrated in the table below.

Table 4 - Teak field management measures

Activity	Year	# of trees before activity	# of trees after activity
Terrain preparation	0		
Teak planting	0	0	625
Fertilization	0		
Teak replant	0	593	625
Manual pruning	1,2,3,4,5,6,7		
Mechanized pruning	2		
Thinning year 4	4	625	450
Thinning year 8	8	450	300
Thinning year 12	12	300	250

Thinning year 16	16	250	180
Final harvest	20	180	0
Teak replant (new rotation cycle)	21 (0 in new cycle)		
Manual weeding	yearly		
Chemical weeding	yearly		

1.11.2 Mixture teak with cacao (II)

The project involves the establishment and maintenance of agroforestry plantations on degraded and deforested lands. These plantations consist of a mixture of teak (Tectona grandis) and cacao (Theobroma cacao), where cacao beans are regularly harvested and an additional revenue stream is generated from the teak [20].

Figure 2 - Agroforestry plantations with a mixture of teak and cacao (source: MLR Forestal)

Cacao needs a specific amount of cover to provide the shade that cacao needs to have a balanced metabolism [1]. Because of the high levels of rainfall in the project area the teak does not drop leaves in the drier season, which makes teak highly suitable to function as permanent shade tree [20]. By using teak, with its high commercial wood value, the project can benefit from the entire process from management to commercialization of the agroforestry plantation [20]. The teak is established in rotations cycles of 20 years and the logs from thinnings and harvests are further commercialized.

Cacao (*Theobroma cacao*) is a small evergreen tree/plant native to the deep tropical regions of Mesoamerica as an understorey plant, and is now cultivated all across the lowland tropics. Cacao is usually found below 300m of altitude, but can also be found at 900m [21] best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. best with temperatures between 18 and 28.5 degrees Celsius, with a maximum temperature of 30-33.5 degrees Celsius. Optimal rainfall is between 1,500-2,000 mm per/year, however, the maximum is 3,000 mm/year, evenly distributed throughout the year. Cacao requires fertile, moisture-retentive but well-drained soil, with sun or partial shade.

Cacao can reach a height of about 4 to 8 m, and exceptionally of 20 m. The plant is part of the family Malvaceae. Cacao has a short bole of about 20-30 cm in diameter. The growth rate of cacao is medium, rarely growing more than 1.5 m tall after 2 years [22].

The management applied by MLR Forestal is defined in its Cacao Management Plan [20], and includes descriptions and directions from site preparation, establishment, maintenance up to disease control and harvest and post-harvest practices.

During the 20 year cycle of teak mixed with cacao, different silvicultural management activities are performed to obtain optimal growth and yields. After final harvest of the teak, the area is replanted with teak (cacao is not replanted) [17] - this cycle is to continue indefinitely. Activities per year are demonstrated in the table below.

Table 5 - Teak within cacao field management measures

Teak within cacao			
Activity	Year	# of trees before activity	# of trees after activity
Terrain preparation	0		
Teak planting	0	0	300
Fertilization	0		
Teak replant	0	275	300
Manual pruning	1,2,3,4,5,6,7		
Mechanized pruning	2		
Thinning year 4	4	300	300
Thinning year 8	8	300	150
Thinning year 12	12	150	150
Thinning year 16	16	150	150
Final harvest	20	150	150
Teak replant (new rotation cycle)	20 (0 in new cycle)		
Manual weeding	yearly		
Chemical weeding	yearly		

The environmental and social impact of cacao cultivation has been evaluated in the Cacao Management Plan, and identified and rated impact on water sources, soils, vegetation, fauna, ecological processes, landscape, social-cultural, social-political and demographic components. It is concluded that the cacao cultivation does not cause major environmental impacts during its planting, maintenance and harvest. No risks of erosion is present at establishment due to minimal soil disturbance and absence of irrigation systems. Furthermore, it is shown that there are numerous positive socio-environmental impacts, including flora and fauna conservation (native birds, micro-flora and fauna), landscape preservation, job creation and strengthening the agricultural cooperatives & organization [20].

A plantation design of a typical teak-cacao mixture is provided below.

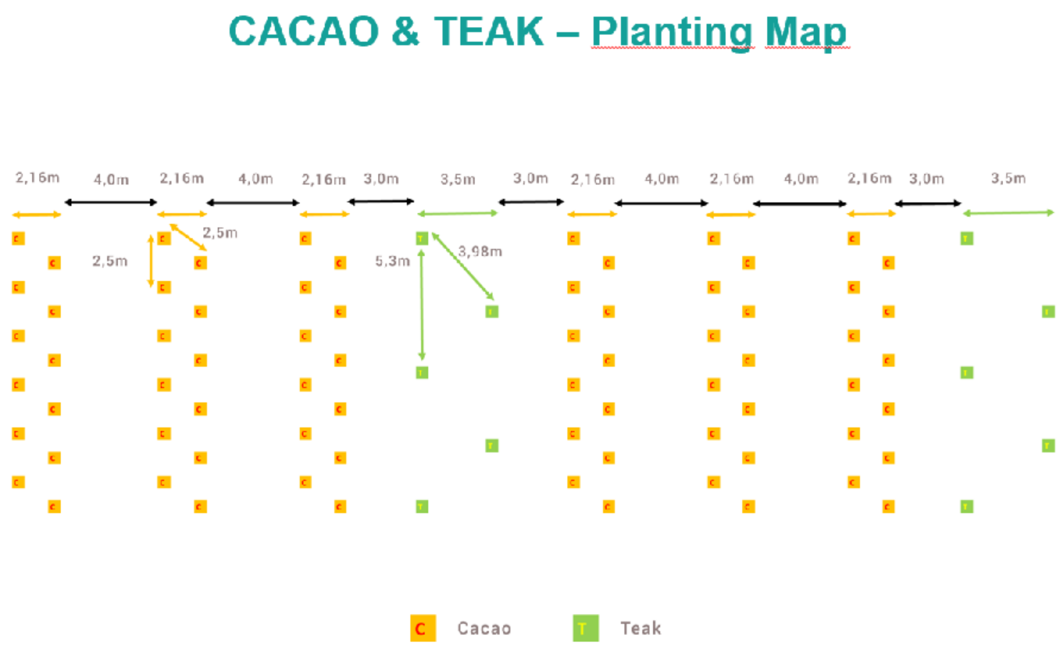


Figure 3 - Cacao & teak planting design

In 2020, MLR started piloting the use of Acacia (Acacia mangium) as a shade tree for cacao. This species was planted in 1 year old teak in the farm of Matiz. In 2021, the company is projecting planting cacao, which will then be growing under shade of the Acacia. After 4 years, the acacia will be removed, and some of it will be used for charcoal. This additional activity is only taking place in one farm, and as the planting and removal of the acacia is only done over a few years, within the project period, and carbon sequestered is also emitted to the atmosphere, the net carbon effect is 0, and was therefore not included in the sequestration and emission calculations.

1.11.3 Protection (III)

The fallow areas within the project area were not managed after the land management was taken over by MLR Forestal. An independent study [23] confirmed that the project area was severely degraded and deforested. It was however also concluded that reforestation by MLR can function as a sustainable system to facilitate (1) the recovery of forest cover, (2) the conservation and recovery of degraded soils, (3) the prevention of illegal extraction of wood from critical habitats of conservation, (4) the protection of water resources, and (5) the protection of flora and fauna. Therefore, in 2020 a process was started to actively manage these areas as protection area to restore the natural functioning of the areas, contemplated in MLR's Protection area & Biodiversity management plan [24].

In general, the protection areas set aside when they contain remnant forest or are located in areas that have no commercial value such as steep areas. But in land use planning it is sought to locate the different protection areas in such a way that they form biological corridors for flora and fauna [17]. Therefore, before the project implemented management activities the area consisted of a mixture of pasture land with some scattered trees remaining, abandoned pasture land with shrub regrowth and remnant trees ('tacotales') and remnant forest. Tacotales are abandoned pasture lands where shrub and tree regrowth have taken place in recent years. This land is known locally as 'tacotales', and is defined as 'young vegetation, dense shrubs and/or secondary regrowth' [25].

In 2020 an inventory was carried out based on a new-developed procedure for characterization of protection areas [26]. Incorporating this characterization, a process was started for updating the Protection area & Biodiversity Management Plan for these protection areas. The specific management activities depend on the baseline vegetation, while protection against illegal activities applies in all protection areas. In line with objectives set out in the management plan, enrichment planting has started in 2020 in 3 sites on 2 different properties (Matiz and Waspado) in fallow areas with high potential for landscape restoration [27], and takes place annually.

The plan further sets out activities to establish informative and educational signs boards at principle access points of each of the properties, as well as in the camps and at the protection sites. These sign boards also inform about the company directives applicable in such area, such as prohibition to enter the area (unless for educational, monitoring or enrichment activities), avoidance of noise creation, etc. Further, the plan contains specific directions on flora and fauna monitoring, the latter includes reptiles, amphibians and mammals. Recent monitoring reports show presence of 5 amphibian species, 29 reptile species, 15 mammal species and 185 bird species. In total 51 species of flora and fauna species are classified as vulnerable or protected by national or international conventions (e.g. CITES) [27]. An academic journal article on butterfly presence in MLR's properties, noted the existence of 72 butterfly species in the Siuna project region [28].

Figure 4 Patch of degraded remnant forest in the protection area (source: MLR Forestal)

1.12 Project Location

The project location and geographic boundaries of the teak plantations, teak and cacao plantations and protection areas are shown in Figure 5, Figure 6 (map of Siuna) and Figure 7 (map of Bonanza). The maps also show infrastructure and some of the roads. 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. The exact coordinates of the project locations are visible on the maps.

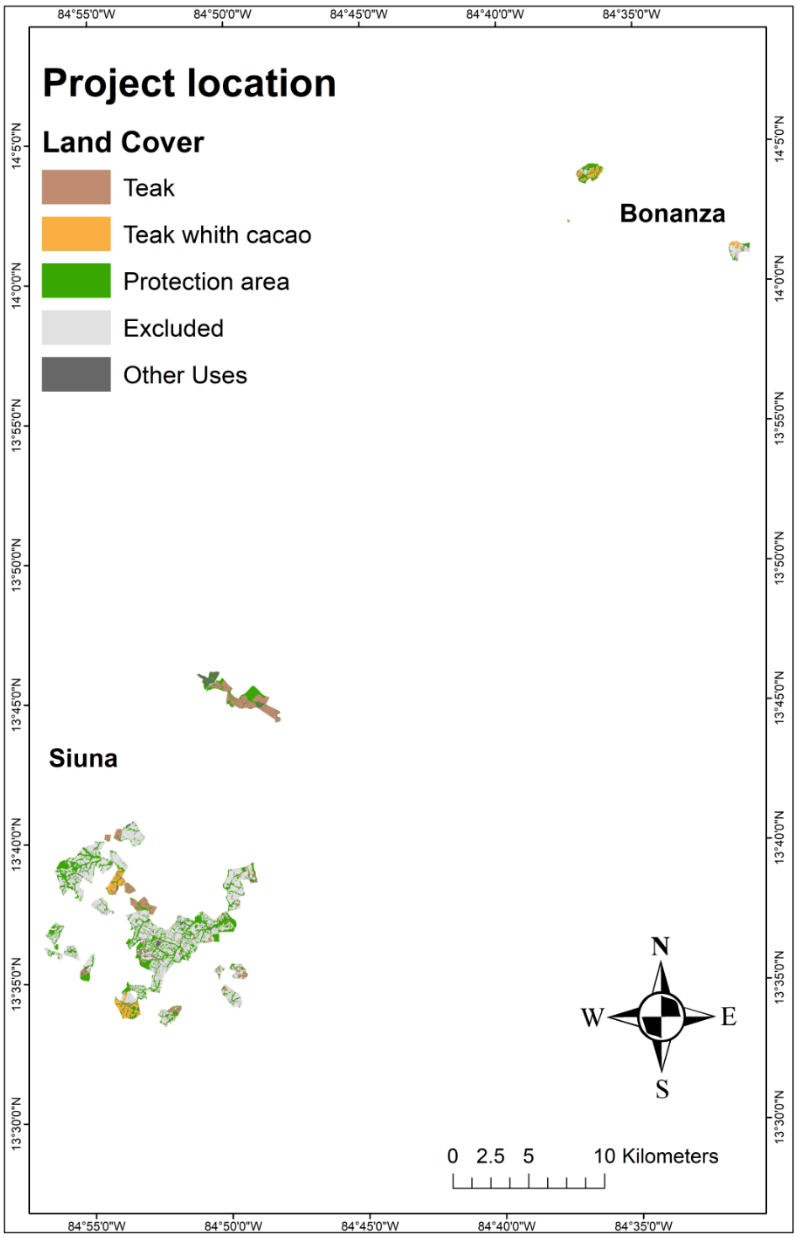


Figure 5 Location of project sites in the districts of Siuna and Bonanza with indication of land cover, geographic boundaries and geodetic coordinates

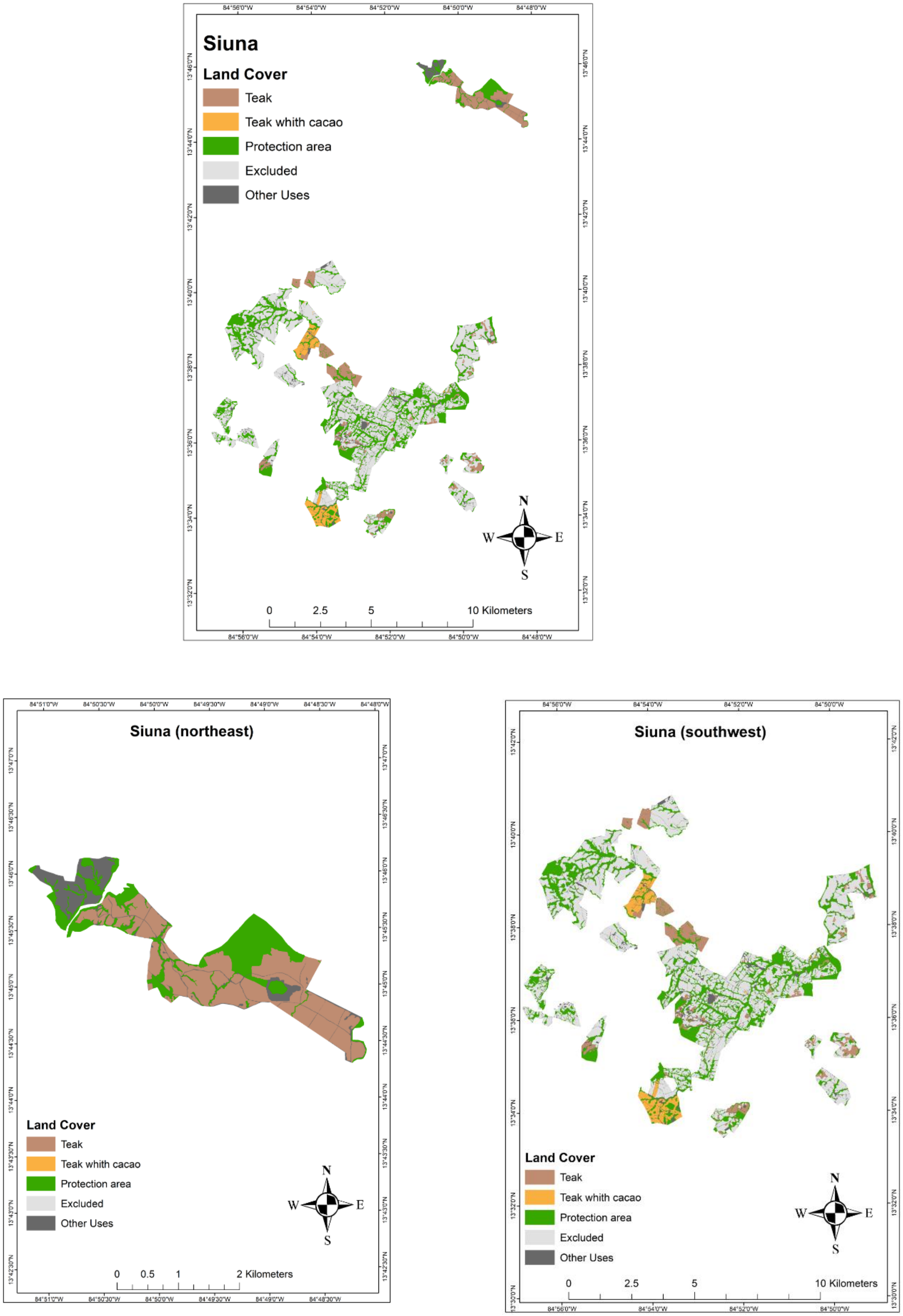


Figure 6 Siuna project areas in Siuna municipality. Above: overview map; below: Siuna southwest & Siuna northeast

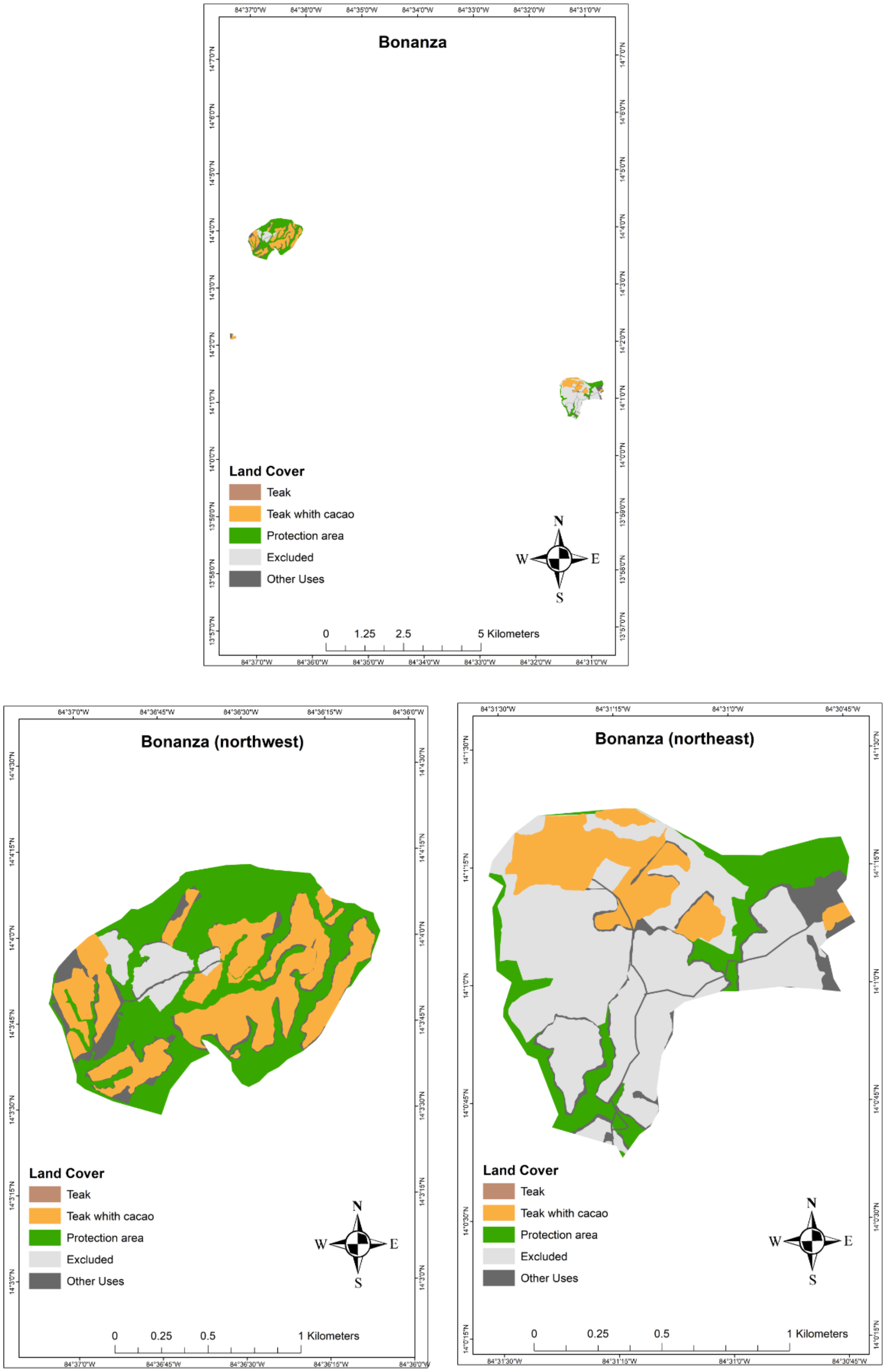


Figure 7 - Bonanza project areas in Bonanza municipality. Above: overview map; below: Bonanza northwest & Bonanza southeast

1.13 Conditions Prior to Project Initiation

The conditions prior to project initiation are described below. The project area was already degraded prior to the project start date, and the project was not implemented to first generate GHG emissions for their subsequent reduction or removal.

Climate

The project area is characterized by a humid tropical climate, with high levels of rainfall. Rainfall in the area varies between 2,000 and 3,000 mm, with a peak in September. The dry season occurs between the months of May to July. The average temperature in the region is around 28ºC, with generally April having the highest temperatures reaching 32ºC, and December having the lowest temperatures reaching to 23ºC [29, 2].

Topography

Most of the project area can be characterized as undulating to moderately undulating land with good drainage. In 85% of the lands the altitude ranges between 100m and 250m above sea level, and the remaining 15% of the project area represents higher land, with hills and low mountains [2].

Soils

The major soil type in the project area is that of the Ultisols, commonly known as red clay soils. Ultisols represent 100% and 81.1% of the territory of Bonanza and Siuna respectively. Ultisols are soils from humid temperate to tropical zones on old weathered surfaces. Ultisols are the more highly leached forest soils having less than 35% base saturation, contrary to the Alfisols, which is soil type of the remainder of the project area. Alfisols are mineral soils that are typically found under a hardwood forest cover. They have a clay-enriched subsoil and relatively high native fertility. Alfisols have undergone only moderate leaching, and have by definition at least 35% base saturation. [2, 30].

Hydrography

The project area is mainly located in the Prinzipolka watershed, with a small portion of the project area being located in the Rio Coco watershed. Several smaller rivers and streams run through or are close to the project area. Some of these streams serve as a source of water for the local population, although the surface waters are considered contaminated due to anthropogenic activities [2].

Vegetation

Nicaragua is characterized by having diverse life zones, with the subtropical humid forest and a portion of the tropical dry forest being the predominant ecosystems in the project area [2]. The project area is located within the limits of the buffer zone of the Reserva de Biosfera Bosawás (RBB), which is one of the most extensive nature reserves in Central America, covering 15% of the Nicaraguan territory [2].

At the beginning of the last century, primary forests prevailed in the project area, where traditionally the producer carried out a slash-and-burn system, to replace the forest and establish extensive livestock activities and small-scale subsistence agriculture [17]. As a result of decades of human induced land degradation, the natural vegetation of the project area is severely degraded. The Autonomous Region of the Caribbean Coast of the North Atlantic (RACCN) has faced a loss of tree cover of approximately 388 thousand hectares in the period from 2001 to 2016. This accounts for 35% of the loss of tree cover at the national level, of which the municipalities of Siuna (34%) and Bonanza (10%) are main contributors [31] as these municipalities are seen as hotspots of deforestation [32].

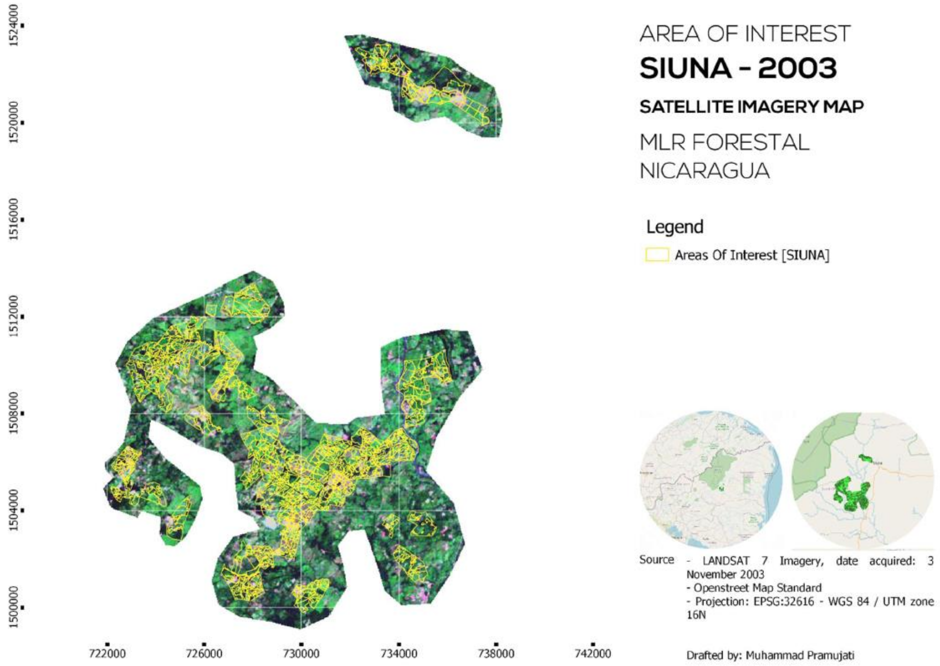
Most of the ranchers in the Mining Triangle graze their animals in deforested natural forests, doing an inadequate soil management. If the herd grows or if cattle are received in stock-farming, in a period of time, not greater than five years, they are forced to cut more trees to establish new grazing areas, leaving deforested lands with a high degree of deterioration and pastures with low productivity rates. This model of productive migration, known as the advance of the agricultural frontier, brings with it the latent threat to the areas of forests that still exist, particularly in Siuna, where the development of extensive cattle ranching is one of the main threats to the Biosphere Reserve [33].

Most of the area is currently characterized as pasture and farmland, while most of the natural forest has disappeared. Currently only remnants of disturbed riparian forests are observed and some scattered groups of mature trees representing secondary, transitional forests, with trees easily exceeding 20 - 30 m in height [2]. Without the proposed reforestation project, the area would remain degraded or degrade even further due to agricultural activities and logging of the last remaining trees.

Figure 8 - Aerial image of a "typical degraded land" where MLR plants. Observe exposed soils, scattered trees and grasslands of very low productivity.

Portions of the project area were already planted with cacao before project initiation (2016). These, often old and poorly managed cacao stands, have a low carbon stock on degraded soils and consequently a low productivity. Without the project carbon stock would remain low and soils would further degrade.

An analysis was made of the land use systems of the MLR properties in the Siuna and Bonanza municipalities [34]. This analysis shows that the area was already deforested long before the project started. Figure 9 and Figure 10 show the land use in 2003 and 2020, and the imagery and corresponding analysis demonstrates that the area was already deforested long before the project started.



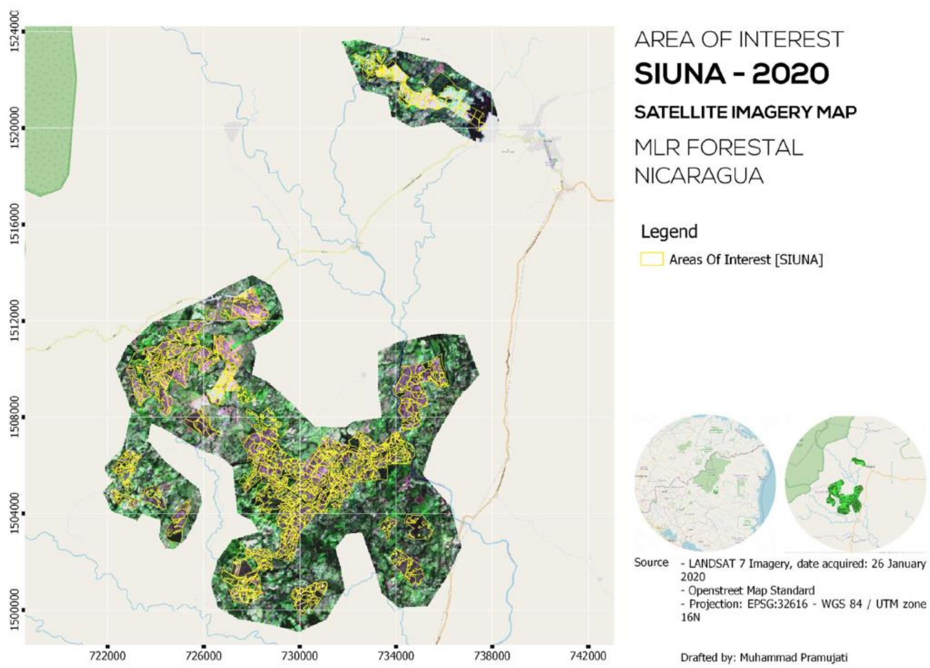


Figure 9 - Land use analysis for 2003 and 2020 (Siuna)

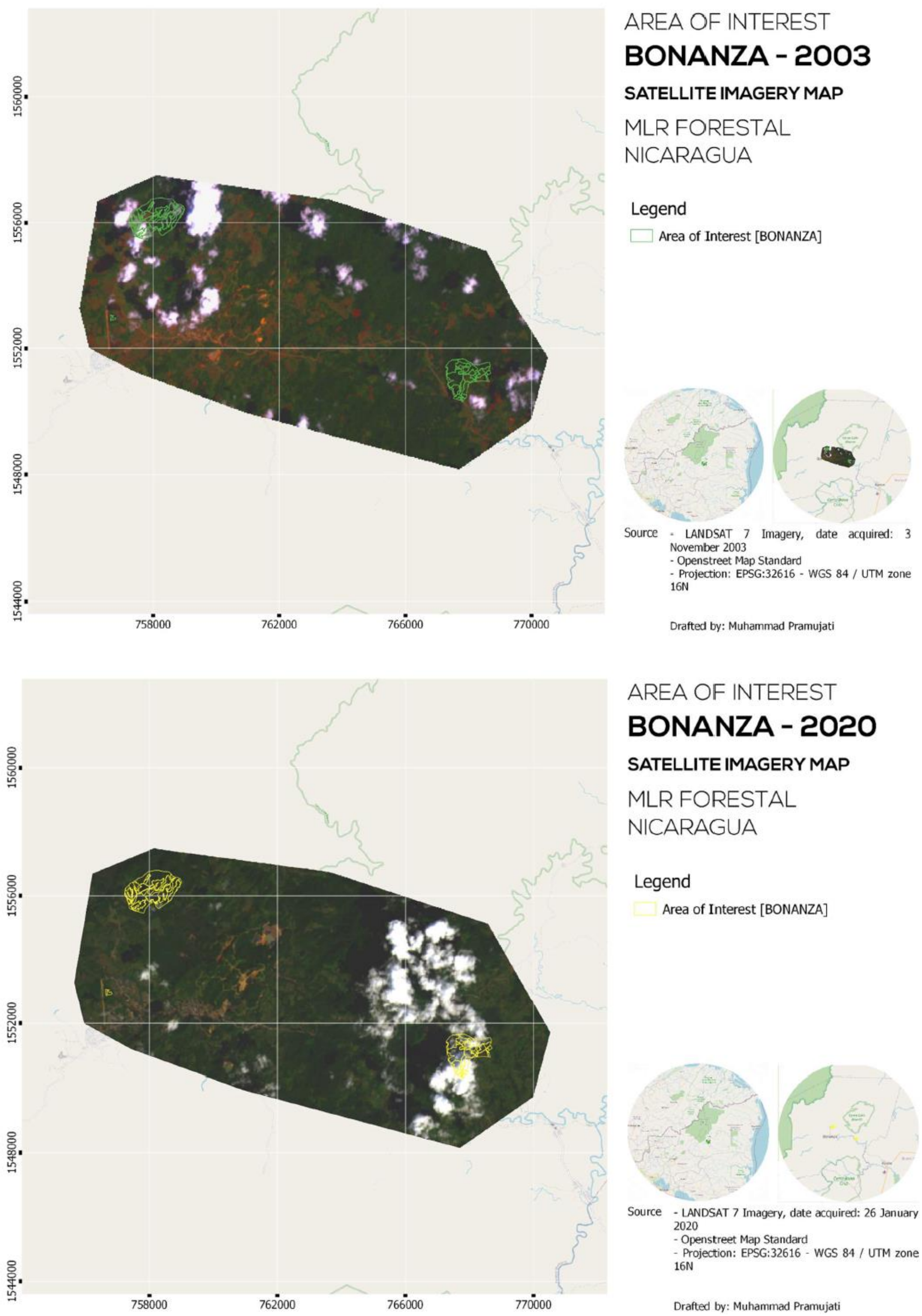


Figure 10 Land use analysis for 2003 and 2020 (Bonanza)

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

MLR Forestal de Nicaragua S.A. ('MLR Forestal', hereinafter) is a legally registered company in the country of Nicaragua, its constitution subscribed in the public registers for persons, real estate and commercial property[3]. MLR adheres to strict compliance with all laws, statutes and regulatory frameworks in Nicaragua, that apply to the company, including international conventions. Compliance with these laws and regulations is i.a. part of the annual FSC audits. Changes in legislation are registered and the company makes sure that legal compliance is maintained.

As forestry enterprise, MLR is subject to the Forestry Sector Laws, especially Act 462 [35] its regulations, Decree 73-2003 and other forestry sector regulations.

Pursuant to Law 462, the establishment, maintenance, thinning and exploitation of plantations do not require any permit, however they must be registered. Therefore, MLR Forestal is registered in National Forestry Institute (INAFOR) as a forestry company and all its plantations have a registration certificate in compliance with article 24 of Act 462.

It also has a Forestry Initiative approved by INAFOR in 2014, which will allow it to make use of some tax benefits established in the Law according to Article 38 of Act 462 and Article 283 of Act. 822 (Tax Harmonization Act).

Furthermore, the company obtained different permits issued by competent authorities to carry out its operation, among these: Environmental Authorizations for some operational activities, registry and authorization for the use of groundwater (water wells), the required Hygiene and Labour Security License which guarantees adequate worker conditions from the Ministry of Labour, and the Authorization of the Technical-Organizational Regulation No. 176-2018, issued by the same Ministry.

1.15 Participation under Other GHG Programs

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

The project has not been registered nor is seeking registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG program.

1.16 Other Forms of Credit

[3] Libro de Personas del Registro Público de la Propiedad Inmueble y Mercantil: Escritura N° 26 de Constitución de Sociedad Anónima y Estatutos, autorizado en Managua a las 9:00 am del 13 de diciembre de 2010 por el notario Álvaro Martín Peralta Gadea, inscrita con el No. 40, 927-B5, Pag. 76-95, Tomo: 1119-B5 de Libro Segundo de Sociedades y con No. 36934, pág. 26/27 tomo 185 del Libro de Personas

1.16.1 Emissions Trading Programs and Other Binding Limits

Not applicable.

1.16.2 Other Forms of Environmental Credit

Since the project involves reforestation, no other credits than the VCU are aspired by the project proponent. The project's FSC and Rainforest Alliance (previously UTZ) certification will not generate environmental credits.

1.17 Additional Information Relevant to the Project

Leakage Management

Under the applicability of methodology AR-ACM0003, the only relevant type of leakage is due to displacement of agricultural activities.

Leakage emissions attributable to the displacement of agricultural activities as a result of the implementation of an A/R CDM project activity is estimated as the decrease in carbon stocks in the affected carbon pools of the land receiving the displaced activity.

Under section 4.3 is shown that is very unlikely displacement has resulted in leakage emissions, as former land-owners have either moved to historically degraded areas, or had negative impact on forest cover in the neighboring sites during the 2003-2010 time interval.

Nonetheless, MLR is supporting farmer communities through its Environmental and Social Management System [2]. The company annually sets quantified goals on the engagement and technical support to farmer communities, and sees itself as an agent of change at regional and national level. It therefore aims at increasing sustainable land management activities in the region and incentivizing community leadership and (agro)forestry entrepreneurship. For example, farmer communities are supported with trainings on cacao best management practices, the use of best genetical material and MLR provides assistance to farmers on cacao certification. These activities are leading to an increase of sustainable agro-forestry practices in the villages within the municipalities MLR is active [8].

At regional level, MLR is supporting improvement of school infrastructure, and supporting The Environment commission ('Commission Ambiental', consisting of MARENA, INAFOR and Municipality) with seedlings for forestry and reforestation development. Every year, 10,000 seedlings are provided at no cost to the project for reforestation activities of riversides, principally developed in the subwatershed Ulí (from with the Siuna region is supplied with water),

At national level, MLR Forestal supports the national reforestation campaign promoted by the Nicaraguan national government. All these activities contribute to the preservation of remaining forest habitats, and increase of sustainable land-use practices (forestry and agroforestry) and reforestation, thereby reducing potential leakage.

Commercially Sensitive Information

This Project Description Document does not contain any commercially sensitive information. Only the Annex with calculation details is commercially sensitive information.

Sustainable Development

The Nicaraguan government has defined its commitment and goals of the SDG in the National Development Plan 2018-2021, aligned with the internationally defined 17 SDGs [36]. The plan defines 19 areas in which plans have been formulated, including social development, social productive development, environmental policies and protection of natural resources, promoting and facilitation of investments, climate change and financing.

Looking at the internationally adopted SDGs, MLR Forestal's project contributes to a variety of those, included:

Goal 1: No Poverty

MLR Forestal is creating a significant amount of long-term jobs, in a poor rural region of Nicaragua, thereby contributing to the reduction of poverty in the region.

Goal 8: Decent Work and Economic Growth

MLR Forestal has a focus on high-adding value to its products and is working in a labour intensive sector, providing secure and decent jobs to the local labour force. Furthermore, their business model is based on resource-efficient production, with high production volumes per hectare, and two different product classes coming from the land area (timber and cacao).

Goal 12: Responsible Consumption and Production

MLR Forestal has adopted sustainable production methods, as demonstrated by the FSC and Rainforest Alliance certification they own. Furthermore, they achieve sustainable management of land.

Goal 13: Climate Action

MLR Forestal's reforestation of degraded lands, contribute to the sequestration of GHG emissions, thereby contributing to the reduction of climate hazards. The trainings provided to their staff, and conveyed to stakeholders in meetings make population aware of importance of climate change mitigation and adaptation, and sounds environmental management practices.

Goal 15: Life on Land

MLR Forestal strongly contributes to ensuring conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, through their activities. The amount of protection areas within their properties, also reflects this.

Reporting on these specific goals / indicators to public authorities, is not a requirement.

Furthermore, it's important to stipulate that the company's activities are in line with the "Law on Conservation, Promotion and Sustainable Development of Forestry Sector, No 462", enacted in 2003 [37]. This Law considers the forestry sector as an axis of sustainable economic and social development of the country. It provides the legal framework and conservation, protection, restoration and increase and sustainable development based on forestry resources (including plantations) is a principal goal. In this sense, MLR Forestal's project can be seen as an exemplary project completely aligned to the national government's policy on sustainable development through development of commercial restauration projects.

The Law also provided a favorable framework for the establishment of commercial forest plantations, including a series of financial incentives that offset the long period of maturation of the reforestation. These financial incentives were later extended to be valid until 2023 (original Law planned validation till 2013), and MLR has been aligned for this government support, showing its compliance with national development programmes [38].

As indicated in section 1.14, MLR Forestal registered all of its plantations at the National Forestry Institute INAFOR, in compliance with Article 24 of Act 462, and as such is part of the national registry on plantations and related national monitoring / inventories.

Further Information

In November 2020, during the preparation of the project description, MLR's properties have been impacted by two hurricanes, Iota and Eta. While the first mainly impacted the project region with very heavy rainfalls, the second led to more environmental damage due to combination of soaked soils and hurricane winds, which led to unrooting and falling of trees in some teak stands and in certain parts of the protection areas. MLR Forestal inventoried the damage and revised its long-term operational planning [39]. Furthermore, 176.87 hectares of the earlier defined VCS project areas were severely affected and excluded from the actual project. The consequences are limited for the commercial teak and cocoa stands, and some heavily affected plots will be pre-maturely harvested and again be reforested. For other damaged teak stands, only the thinning schemes will be adjusted to obtain newly optimized densities. The number of hectares per land use type (mentioned in table 1), as well as other figures in the document take into account the updated land-use figure and planning.

2 SAFEGUARDS

2.1 No Net Harm

MLR Forestal defines itself as a responsible business enterprise, and has opted for a business management from a sustainable perspective, developing initiatives which generate value for its collaborators, the community and the environment. Based on these values, a social and environmental commitment is sustained, assumed with satisfaction and free consent by the investment group. The company implements actions focused on the development and modernization of the sector and the establishment of fine cacao and high-quality commercial teak, destined for the export market. Meanwhile, a major focus is on the promotion and improvement of the environmental quality, and the protection of the biodiversity in the areas of influence, without losing sight of the social environments. Along with the technical part, there is an awareness of the need to reconcile the growth of the enterprise with that of the communities or social environments, which is achieved through building long-term sustainable partnerships. This development process should allow to maintain strict control over the impacts generated by forestry and agroforestry operations in the surrounding society and the environment. To harmonize these processes, MLR has taken on the challenge of incorporating principles and international criteria that serve as a route or management model. These include the Performance Standards (PS) of the International Finance Corporation (IFC), the principles and criteria of the Forest Stewardship Council (FSC) for forest plantations, and Rainforest Alliance (previously UTZ) in the case of cacao plantations, without prejudice to the incorporation of new support standards such as ISO 9001, ISO 14001 and ISO 45001 standards. IFC's PS for Sustainability establishes minimum requirements and good practices to be implemented in order to evaluate and manage impacts and social and environmental risks of private sector investments throughout the investment. Additionally, they also establish a management framework that guides the holder of the investment to implement and manage your project in a sustainable manner, and in response to risks and impacts environmental and social issues that may arise.

MLR developed its own Environmental and Social Management System (ESMS) to manage the entire organizational structure, composed of all the company's employees and specific human resources, for both sites (Siuna and Bonanza).

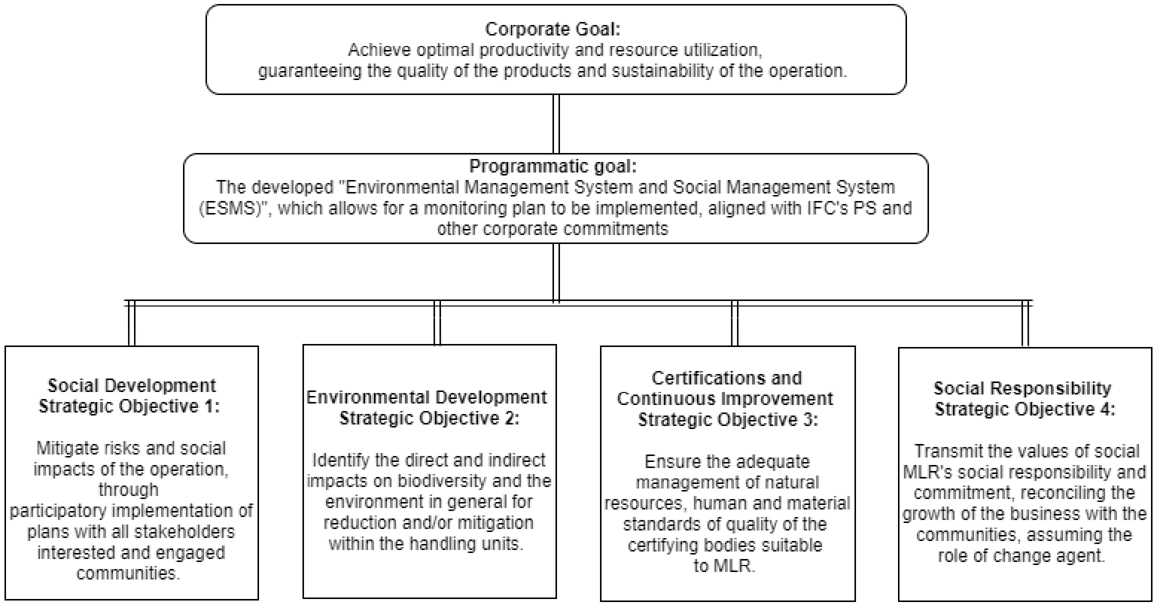


Figure 11 - ESMS diagram

As a basis for the ESMS, an extensive Social and Environmental Impact Assessment was realized in 2019 [2]. The scope of the environmental and social management plan (ESMS) is the same as the scope for the Social and Environmental Impact Assessment. The goal is to give guidelines to all parties involved during the companies' operations of its agroforestry establishment, maintenance and harvest, in fulfilment of environmental and social requirements.

The ESMS addresses the recommendations and mitigation measures proposed by prescribing appropriate technologies and systems in protocols to be used during the execution of the work and by monitoring the effects of the measures. The environmental and social management plan is composed of plans and protocols that describe the techniques and methods to be used and the way the work is monitored.

The following principal negative impacts were identified in the SEIA [2].

Negative impact	Impact area	Explanation	Mitigation instruments	Samples of measures
Environmental				
Road construction, log yards & camps	Water, soil, air, landscape, flora, fauna	Construction of roads, log yards and camps impact vegetation cover, soils and biodiversity.	Protection area & Biodiversity management plan [24]	Careful planning of roads & protection areas set asides

Terrain preparation	Water, soil, landscape, flora, fauna	Terrain preparation for plantations requires removal of grasses and shrubs, affecting indicated areas.	Social and environmental management plan [40]; General management plan [17]; Protection area & Biodiversity management plan [24]	Conservation of protected tree species; us of low-impact hand tools
Use of fertilizers and herbicides	Water, soil, air, flora, fauna	Use of fertilizers and herbicides may affect indicated areas	Social and environmental management plan [40]; General management plan [17]	Restrictions on types and amounts of pesticide use.
Transport	Water, soil, air, fauna	Use of light-weight vehicles for transport of staff impacts soils, air, and causes nuisance	Social and environmental management plan [40]; Annual Operational Plan Sustainable Development [41]	Monitoring on use of vehicles
Socio-economical				
Terrain acquisition	Mobility	Potential change in access ways and transport barriers	Procedure for Land Acquisition [4]; Stakeholder Participation Plan [42]	Social impact assessment
Field work within plantations	Health, security	Use of herbicides, through use of equipment	Social and environmental management plan [40]; Annual Operational	Use of protective gear; health and security trainings

			Plan Sustainable Development [41] General management plan [17]	
Transport	Health, security	Risk of accidents,	Social and environmental management plan [40] & Annual Operational Plan Sustainable Development [41]	Security trainings; HR policy

Land disputes are not considered an impact or risk, as all used terrains are private land areas.

Additional to the mentioned mitigation instruments, the effectiveness of management is checked annually through monitoring activities of a range of criteria. Monitoring is done based on the annual monitoring plan, which defines the fields of monitoring. Subjects covered during monitoring include:

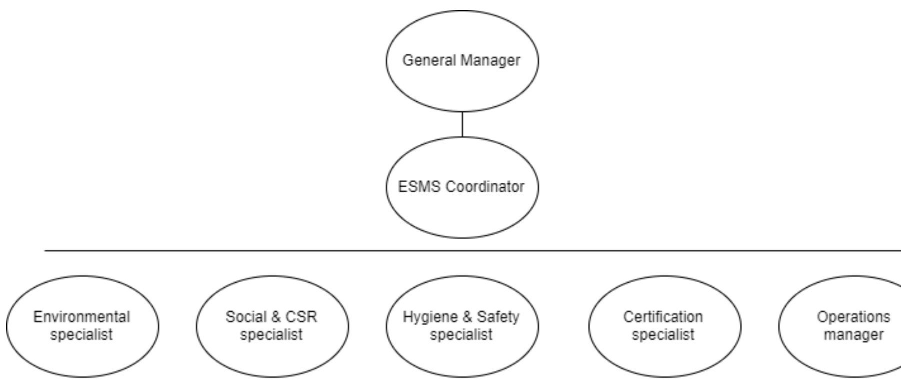
- Mapping and map analysis;
- Permanent Sample Plots Protection area;
- Timber plantation Permanent Sample Plots;
- Soil type (structure, texture, pH, etc);
- Soil erosion and sedimentation;
- Flora and fauna;
- Establishment, marking, thinning and pruning, quality;
- Plague and disease monitoring (teak & cacao);
- Social impact;
- Socio-economic data from communities
- Community leaders & early-risks in community
- Training and capacity building;
- Health and safety;
- Residual waters

Findings from monitoring activities are fed back into the management system through the adaptation of protocols and/or management plans.

The capacity and size of the company in this relatively abandoned region of the country brings responsibility in relation to communities in the region. MLR is fully aware of its role and capacity in this area, and sees itself as an agent of change. It has identified 5 social axes in which it focuses its social and community programme, namely:

1. Quality education
2. Socio-economic development
3. Environmental training
4. Emergency assistance
5. Sports
6. Recreation

The responsibility for implementing the ESMS lies with MLR Forestal and the ESMS coordinator regarding monitoring, training and document maintenance. The following corporate structure has been defined for this purpose:



The role General Manager is fulfilled by Mr. C. Domke, while the Mr. L. Lopez is MLR's ESMS Coordinator.

2.2 Local Stakeholder Consultation

From the onset of MLR's activities, the company's investment has been steered towards a financial return and activities that address both local and global problems, and contributing to socio-economic and environmental development.

MLR Forestal has been implementing different actions involving stakeholders within the framework of the developed Community Relationship Framework Plan (CRFP), which establishes strategic guidelines and activities required for the adequate approach of relationships with the population and stakeholders of the area where the Project operates. It contains specific guidelines for the systematization and documentation of these interactions.

Company policies & procedures

The company has a series of normative documents, which guarantee the participation of stakeholders in the process of consultation and informing on activities being carried out by the company. These documents are the following:

a. Stakeholder Participation Plan (GDS-PL-03): establishes inclusive and effective participation mechanisms under a systematic approach that allows the identification of stakeholders in the management process of the project, as well as their expectations according to the level of involvement of each one [42].

b. Procedure for Land Acquisition (AL-PR-01): identifies which social actors are consulted, to avoid displacement and to verify that there are no other social problems related to land tenure and land use. It seeks to harmonize the process of land acquisition for the gradual expansion of the project, and minimizing legal, technical, environmental and social risks of all stakeholders, taking as a premise the criteria established in the IFC Performance Standards.

c. Community Complaint Mechanism (AS-PR-02): this mechanism allows members of communities and institutions to give their opinion or complaint (grievance) in cases where stakeholders may feel activities harm them. This mechanism establishes refunds and monthly meetings with the communities.

d. Identification of Third Party Stakeholders: there is a complete list of community members, leaders, representatives of civil institutions, NGOs, universities, churches, local and national government authorities, suppliers, etc. with whom various contacts have been made to coordinate stakeholder consultations.

e. Environmental and Social Impact Evaluation: during the course of the project, several social interventions have been made to monitor the impact that the project could generate. The most recent evaluation (SEIA) was carried out in 2019, for which a prestigious consulting company in the Central American region was contracted, which realized impact measurements at an integral level, including neighboring communities.

Implementation

Local stakeholder consultations are continuous processes and part of above-mentioned company policies, as well as annual operation plans ('POAs'). For the Forest Management plan, a stakeholder process was realized in which stakeholders were consulted, including governmental agencies, and community leaders and members. Part of the annual auditing for its FSC and Rainforest Alliance (previously UTZ) certifications, as well as frequent audits by international banks, is compliance with stakeholder requirements and adherence to IFC Performance Standards.

MLR has an in-house social specialist who realizes visits, consultation, presentation of the company's processes, gathering of feedback and potential complaints, and the execution of MLR's social entrepreneurial and community development program. The frequency of engagement with the principal stakeholders (such as local communities) is determined in the Stakeholder Participation Plan.

In 2018, a Social and Environmental base line study was realized, and in 2019 an in-depth Social and Environmental Impact Assessment was realized [2]. These referential studies brought a series of results, outcomes, social and environmental risks, and actions suggested for creating positive impact at community and municipal level. These advices were subsequently translated into its Environmental and Social Management System.

For the present carbon certification project, a broad and in-depth stakeholder consultation process has taken place within the December 2020 – February 2021 period.

Based on the existing '*Identification of Third Party Stakeholders*' documentation, the management, with the support of the project developer (knowledgeable on stakeholder processes for carbon certification processes) selected 5 principle stakeholders for consultation, based on the following criteria:

- Level of exposure to potential risks/harms to the stakeholder by the project activity
- Level of impact of proposed activities
- Number of people represented by the stakeholder
- Relevance to the carbon certification process
- Ensuring social, economic and cultural diversity among stakeholder groups

The resulting lists of stakeholders is the following:

Stakeholder group	Stakeholder name	Stakeholder approach
Environmental organizations/NGOs	The Foundation for the Development of Private Nature Reserves in Nicaragua (Red de Reservas Silvestres Privadas, Red-RSP) Instituto Nacional Forestal Las Minas	Digital
Certification scheme owners	FSC Nicaragua	Digital
	Rainforest Alliance	Digital
Social/development-focused organizations/NGOs	UNIDO (United Nations Industrial Development Organization)	Digital
	Catholic Relief Services	Digital
Community organizations	Community leaders of neighbouring communities of the Siuna municipality: Unión La Bu, San Miguel #1 and Empalme La Bu.	Physical meeting (18/12/2020)

	Cooperativa COPESIUNA	Digital
Government	INAFOR MARENA (Ministerio de los Recursos Naturales) DIGAM (Dirección de Medio Ambiente de la Alcaldía Municipal de Siuna) SERENA Secretaría de los Recursos Naturales del Gobierno Regional Autónomo de la Costa Caribe Norte)	Digital

As part of the process of this project, public consultation was carried out in three ways.

The first was through the website of the scheme owner VERRA, where the consultation mechanism is published and this process was promoted through the website of the company mlr.com.ni, so all those interested or who may show interest in the subject were invited to access it. For this purpose, the internet address of the public consultation period was shared and it was also indicated that any party who considered themselves interested could write to the email info@mlr.com.ni. Furthermore, a Facebook post has been published with a reference to the website publication in which the public was invited to comment.

Secondly, stakeholder organizations with offices were directly approached via e-mail - to limit COVID-19 risks, MLR adopted this strategy for receiving their input and feedback.

Thirdly, at the community level, a consultation process was carried out with the leaders of at least three communities neighboring the project, with the objective of formally presenting the integrated reforestation and agroforestry project in degraded lands for carbon sequestration, and at the end of the presentation, a consultation was held with all participants.

Results of stakeholder consultation

The public consultation via the VERRA website did not result in any responses, and nor did the company receive input via the VCS Project feedback request via email.

The consultation at community level was carried out on 18 December 2020 and during the working session with the community leaders, in addition to presenting the project and providing the possibility to ask questions or raise concerns, they were informed of the impact generated by the plantations in terms of increased carbon biomass through the growth of their plantations and the avoidance of deforestation of forest patches that remain in the territories, also favoring biological connectivity, providing important environmental services, among others.

No questions or complaints were raised during the community consultation, as reflected in the Stakeholder consultation report [43].

Figure 12 - Community leaders neighboring the MLR project in Siuna who participated in the presentation and consultation process.

Figure 13 - Community leaders listen attentively to the presentation of MLR Forestal's plantation carbon sequestration project.

2.3 Environmental Impact

The Forest Management certification under the FSC Principles and Criteria demonstrates externally verified compliance with a range of environmental and social criteria, including that the project has not been realized on land which has undergone deforestation within the 10 year period prior to the project start date, as well as compliance with the law and adherence to sustainability standards.

In 2019, an in-depth social and environmental impact assessment (SEIA) was realized by TECDEA [2]. The assessment showed that the area, part of the bufferzone of the Bosawas Forest Reserve, was severely degraded and soils depleted due to extensive cattle herding activities. The study is in line with an earlier impact evaluation, which has shown that the reforestation activities have a positive influence on soil quality, water quality and biodiversity [44].

The SEIA did not foresee any environmental and social negative impacts by implementation of project activity following AFOLU requirement 3.1.5. The areas where moderate potential environmental negative impacts have been identified, such as soil erosion risks due to road construction and noise pollution due to machinery, are all being addressed in the company's ESMS [40].

The study further indicated that the project, which includes the reforestation and conservation and restoration of the buffer zones, leads to the elimination of illegal logging, forest conversion for agriculture and the abandonment of mining, fire and poaching. This brings a positive impact on the protection of flora and fauna and biodiversity on the long term, and create new habitats for wildlife. Further, the establishment of cacao and teak leads to reduction of soil erosion compaction and degradation [2], and a net positive effect on GHG emissions.

Prior to the formulation of the 2019 SEIA, a study was carried out to identify natural values that require special protection measures within the current area of influence of the plantations. The main conclusions of the study were that no High Conservation Value Areas exist in the area. It furthermore concluded that the teak plantations themselves are not a threat to wildlife, as the plantations are reusing land already highly degraded by extensive cattle raising. The plantations actually provide a cover for fauna to move and hide [17].

2.4 Public Comments

The public comment period started on the 7th of December 2020, and was finalized by the 6th of January 2021. All project documentation was made available on 'Verra Projects Open for Public Comment' page[4]. Similarly, MLR's corporate website was updated with a news item indicating the possibility for the public to comment on the project.

[4] https://verra.org/open-for-public-comment/

No public comments have been received during the public comment period.

2.5 AFOLU-Specific Safeguards

All activities realized by the company are realized on privately-owned land, and as such this project does not affect local stakeholder's property rights.

The identification of stakeholders was realized according to the procedure Stakeholder Participation Plan (GDS-PL-03) [42] and has been described above in section 2.2.

The project risks, such as those related to the construction of roads, controlled use of permitted herbicides and water use, are contemplated in the ESMS [40] and are operationally carried out under the Stakeholder Participation plan, and through the operational Strategic Sustainable development plan, which holds an overview of all environmental and social risk-mitigating efforts by the enterprise [45]. Important to note is that the Social base line study realized in 2018 principally identified positive impact due to the presence of the enterprise, such as increased labor requirement, increased forestry knowledge in the region and among institutes, provision of environmental services and contribution to development of the local community [46].

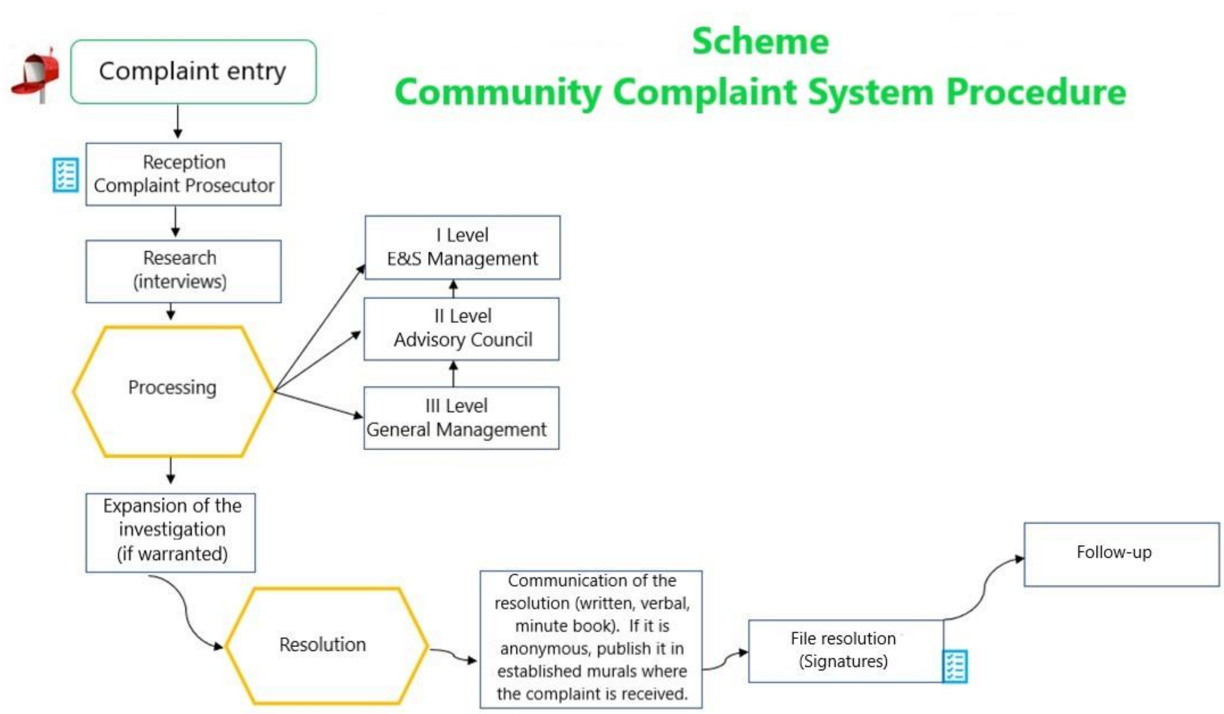


Figure 14 - MLR's Community grievance procedure

The ongoing communication and consultation with local stakeholders take place according to the earlier mentioned Stakeholder Participation Plan. Grievance by local communities are handled via the Community Complaint Mechanism (AS-PR-02): both organized and non-organized neighboring communities can commit grievances through different mediums. Figure 13 is a demonstration of the booklet used to inform community members about how they can express grievances. Figure 12 shows the company's procedure for handling of grievances.

Complaints provided by stakeholders were recorded since 2020, and first complaint received on 27/1/2020, and all complaints properly handled off by the company, as demonstrated in the register of complaints and suggestions of communities [47].

During the years 2016-2019 stakeholder consultations has been part of the company's annual external FSC audits, and in 2019, the realized SEIA. Generally, none or a limited number of comments from stakeholder were received, which were all properly handled off; a summary of these stakeholder consultations have been made in the report 'MLR – Stakeholder consulting evidence' [48], and further backed up by the respective FSC audit reports [49] and an example of report on the resolution of a community complaint [50].

Figure 15 - Booklet to inform community members on options to express grievances.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The CDM consolidated methodology AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 02.0 is applied.

In addition, the following tools are applied by the project:

- Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (Version 01)
- Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)
- Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity (Version 02.0)
- Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)
- Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities (Version 01)

3.2 Applicability of Methodology

This section provides evidence that AR-ACM0003 version 02.0 is applicable. According to the methodology's section 2.2 Applicability, the methodology is applicable if the following conditions are met:

a) The land subject to the project activity does not fall in wetland category;

There are no wetlands within the project boundary [2].

b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary:

(i) Land containing organic soils;

Amongst the encountered soil series (Ultisols and Alfisols), no organic soils are present within the project boundary [2].

(ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology.

The project area is characterized as degraded pasture land and, in areas closer to population centers, this is combined with subsistence farming [2].

The lands of Appendix 1 refer to cropland in which soil disturbance is restricted. Farming in the area is characterized as small-scale subsistence farming [2], which is characterized as cultivation with reduced tillage and limited use of inputs. Therefore, the project area does not classify as land listed in Appendix 1.

The lands of Appendix 2 refer to grassland in which soil disturbance is restricted. Grasslands in the project area are used for extensive livestock ranching activities and without the use of inputs [17]. Therefore, the project area does not classify as land listed in Appendix 2.

Furthermore, the tool *Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities* is applicable, as the forestation of the land [...] does not lead to violation of any applicable law [...] and the project does not concern a small - scale afforestation (<15 kton of CO2Eq annually), as shown in section 1.10.

As for the tool *Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*, no applicability conditions exist, and the tool can therefore be applied.

For the *Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity,* the tool is not applicable if displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or peat lands. As demonstrated above, the project does not take place in wetlands or peatlands, and therefore the tool is applicable.

As for the *Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*, the requirements for applicability are that areas do not fall into the wetlands category (compliance covered above), litter remains on site and is not removed in the A/R CDM project activity (true, litter is not removed on site through management practices); and soil disturbance [...] is in accordance with appropriate soil conservation practices and limited to soil disturbances for site preparation before planting and such disturbance is not repeated in less than twenty years. The latter conditions are also true, as soil disturbance only takes place once in twenty years with the site preparation before planting with the tree species [17].

Concerning the *Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities*, the applicability is limited to projects in the A/R category, which is the case for the current project, as the project concerns a reforestation project.

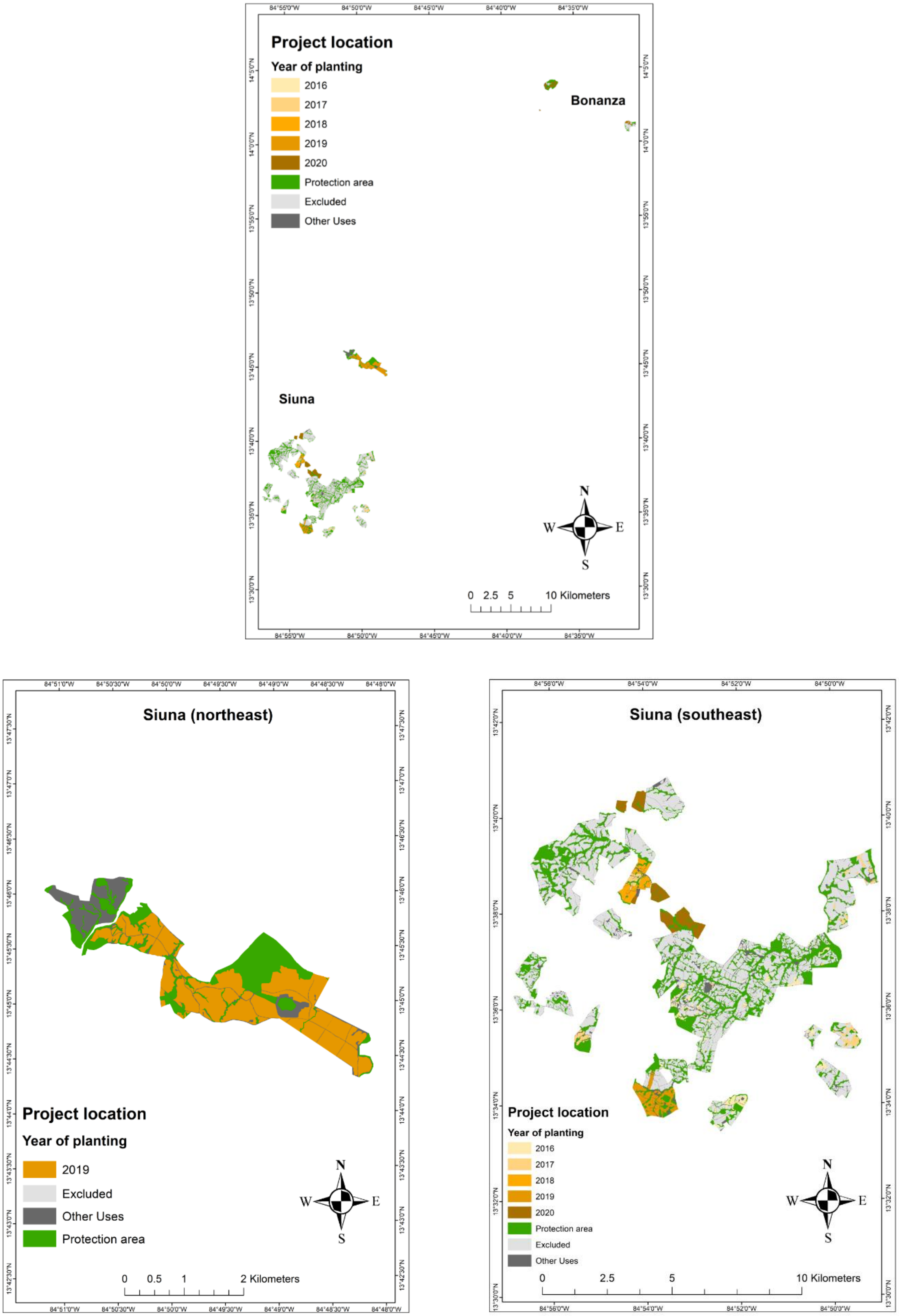
3.3 Project Boundary

The selected carbon pools and emission sources in the project methodology and the justification or explanation for the inclusion or exclusion of different pools are outlined in the following table.

Source		Gas	Included?	Justification/Explanation
Baseline	Above-ground biomass	CO_2	Yes	Major carbon pool in the baseline and project activity
	Below-ground biomass	CO_2	Yes	Major carbon pool in the baseline and project activity
	Soil Organic Carbon	CO_2	No	This is estimated as an annual increase over 20 years according to the applicable tool and therefore only included in the project and not in the baseline.
	Dead wood	CO_2	No	Because of the reforestation project activity, dead wood can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool is conservatively neglected.
	Litter	CO_2	No	Because of the reforestation project activity, litter can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool is conservatively neglected.
Project	Above-ground biomass	CO_2	Yes	Major carbon pool in the baseline and project activity
	Below-ground biomass	CO_2	Yes	Major carbon pool in the baseline and project activity
	Soil Organic Carbon	CO_2	Yes	A significant increase in this carbon pool is expected due to the project activity.
	Dead Wood	CO_2	No	This carbon pool is conservatively neglected.
	Litter	CO_2	No	This carbon pool is conservatively neglected.

Source		Gas	Included?	Justification/Explanation
Project	Burning of woody biomass	CO_2	No	Fire is not used as a management tool for land preparation.
		CH_4	No	Fire is not used as a management tool for land preparation.
		N_2O	No	Fire is not used as a management tool for land preparation. Increase of GHG emissions due to displacement of pre-project agricultural activities.
	Leakage	CO_2	Yes	Increase of GHG emissions might occur due to displacement of pre-project agricultural activities.
	Fossil fuel	CO_2	No	The use of fossil fuels is not included following chapter 5.5 of the methodology.

In the following figure, the project boundaries are indicated as well as land use.



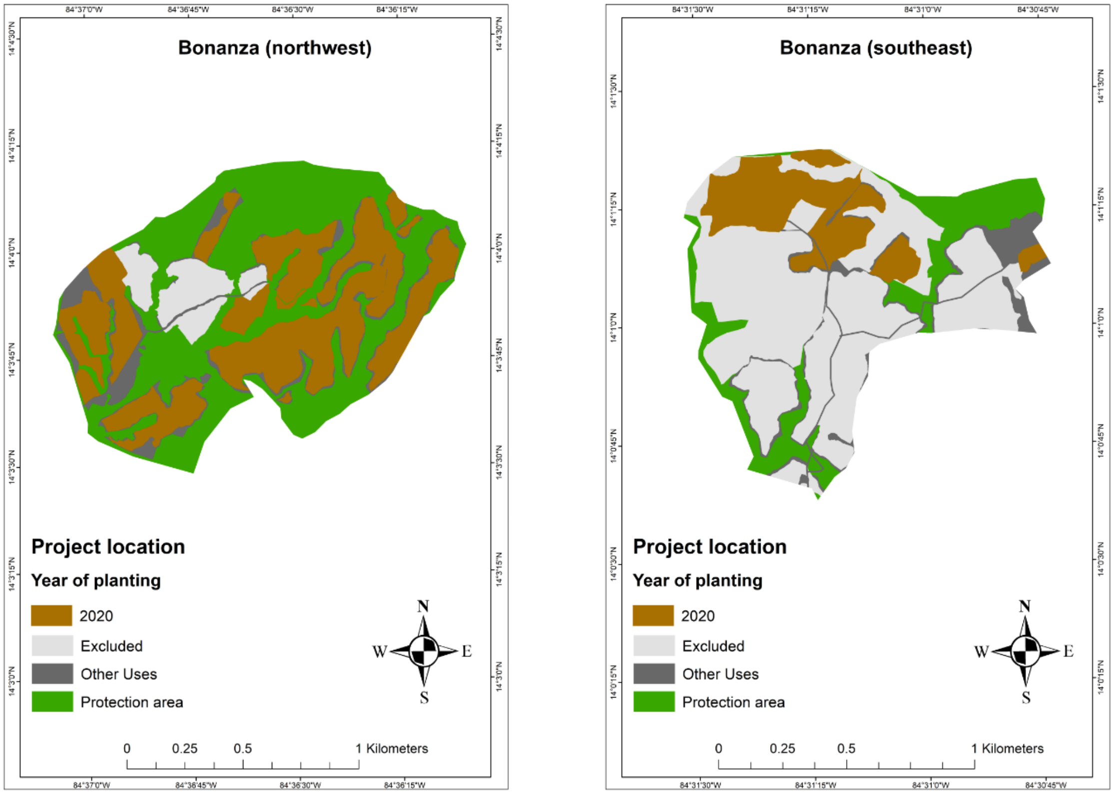


Figure 16 - Project location with indication of planting years, geographic boundaries and geodetic coordinates (see in section 1.12 for a map of the project location with indication of land cover).

3.4 Baseline Scenario

The carbon stocks and change of carbon stocks of the various strata under the baseline scenario have been estimated as described in this chapter.

Four strata forming a mosaic landscape have been identified under the baseline scenario. These four strata were present under the baseline scenario in different compositions prior to the development of production areas or restoration of protection areas in the project.

Analyses on the Geographic Registries from MLR show that of productive land areas, approximately 71.6% were before intervention classified as pasture lands, and 28.4% as tacotales [51]. Furthermore, 6% of the project area has been planted with cocoa in an earlier stage.

Figure 17 - Project boundaries of areas, with planting years

The definition for tacotales used in the MLR analysis includes remnant forest. Remnant forest patches were conserved by MLR, and are now included in the protection areas. As a consequence, the baseline area distribution of the protection areas is different from the analysis mentioned above.

The study on Land use change by Chavarría [23] provides a land use ratio of 26.66% forest and 73.33% agricultural land for Siuna (Landsat images of 2005). The protection areas are considered to be a representation of the total area as described by this study, since it does not make a distinction between productive and unproductive lands.

The remaining 73.33% is composed of pasture lands and tacotales, for which 71.6% is classified as pasture lands and 28.4% as tacotales following the MLR analysis [51]. This is considered to be conservative as the MLR analysis included remnant forest in the tacotales.

This leads to the following stratification of the baseline strata (Table 6).

Table 6 Stratification of baseline strata in the project area (till 2020)

Baseline	Bonanza area (ha)	Siuna area (ha)	Total area (ha)	Percentage
Pasture	46.7	1203.0	1249.7	54.0%
Tacotales	18.5	477.2	495.7	21.4%
Remnant forest	23.7	364.7	388.3	16.8%
Cacao	80.9	101.2	182.1	7.9%
Total	**169.7**	**2146.0**	**2315.8**	**100.0%**

A further description of the baseline strata is given:

Stratum 1: pasture land

The majority of MLR's property were classified as pasture land. This land was in the pre-project stage used for low-productive, extensive cattle grazing. This type of pasture land is characterized by unmanaged grasslands, which are degrading because of grazing activities [17]. The lands sometimes have scattered trees remaining, generally of species protected by law (e.g. Caoba (*Swietenia macrophylla*) and Cedro *(Cedrela Odorata)*). No shrubs or significant shrub cover were present in this baseline land use type.

Stratum 2: "tacotales" or abandoned pasture land

The second most common baseline is abandoned pasture land where shrub and tree regrowth have taken place in recent years [2]. This land is classified locally as 'tacotales', and is defined as 'young vegetation, dense shrubs and/or secondary regrowth' [25]. There is an often dense shrub cover, some remaining trees, and presence of pioneer trees species such as balsa (*Ochroma Pyramidale).*

Stratum 3: remnant forest

The remnant forest present in MLR's areas are relatively limited, as the properties have undergone deforestation and land-use changes many decades ago [17], The areas with left-over forests are mostly located near small rivers. Such forests are often denominated as 'gallery' or 'riparian forests', and these can be considered affected primary forests or secondary forest patches. Often, these forest patches have also undergone human intervention for (illegal) timber logging or some cattle grazing in the past. Despite their limited size, these remnant forests have an important role in conserving biodiversity in the region [17]. Some tree species present in such remnant forests are Caoba (*Swietenia macrophylla*), Laurel (*Cordia alliodora*) and Cedro (*Cedrela Odorata*), of which some are protected by law.

Stratum 4: cacao with remnant indigenous trees

Part of the project areas was planted with cacao before the start of the project. This baseline land-use category is covered with productive cacao shrubs (*Theobroma cacao*) [17]. In some areas there is presence of scattered remaining trees (protected by law) (e.g. Caoba, Cedro) [2].

3.5 Additionality

Following the CDM methodology AR-ACM0003, the "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" is used to demonstrate the additionality of the proposed VCS project.

The tool has two Applicability Conditions, which are met:

- The proposed project activities do not lead to the violation of any applicable law, see section 1.14.

- The proposed project is not a small-scale project according to the UNFCCC definitions [52]. The expected GHG sequestration is more than 8 kilotons per year and the project is not a low-income community project.

Following the tool's section II.6, a few steps must be applied to demonstrate additionality:

STEP 0. Preliminary screening based on the starting date of the A/R project activity

The project was born in 2008 as reforestation initiative of the former owner [2]. Management of the property was done by Norteak Madera until mid 2015 [53]. Since then, the investment group opted for the direct operation of the project, forming a technical group, in charge of carrying out the development and operation of the project according to the vision from the owners.

From the acquisition of the company, MLR Forestal's management has aimed for a sustainable reforestation project combining high quality timber production and sustainable cacao production with carbon crediting for revenue generation. PP has set up the commercial agroforestry project as an example for sustainable plantation establishment and management, and contributing to the Caribbean Coast Development Strategy of the Atlantic North Autonomic Region. MLR implements the project according to the highest technical, social and environmental benchmarks available, notably by certifying the plantation to international FSC standards and its Rainforest Alliance (previously UTZ) certification for cacao.

The registration and sale of carbon credits have always been an important part of the original plan of MLR's management, as set out in the document 'Initiative Forestal', section VIII 'ESTIMACIÓN DEL SECUESTRO DE CARBONO' [9], as well as in the document 'Initiativa Forestal' dated 2013 [44], and were considered an important economic pillar for the financial sustainability of the project. Furthermore, the CEO of the company Mr. S. Rios has been aware of the value of voluntary carbon certification, as demonstrated in the CDM certification of a hydroelectric plant in 2014[5], co-owned by MLR Forestal's CEO. Due to poor demand conditions of voluntary carbon markets [54], the cost involved in registration and sale of carbon credits would not be compensated by revenues. This would make a carbon project not additional and therefore this activity was initially not pursued by the management. With the recovering voluntary carbon market, registration and sale of CERs become additional again for MLR.

STEP 1. Identification of alternative land use scenarios to the proposed A/R CDM project activity

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

Land use scenario A: Continuation of the pre-project land use;

[5] https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1393557792.37/view

The vegetation cover of the North Atlantic Caribbean Coast Autonomous Region (RACCN) has shown a decrease of approximately 431,000 hectares in the period from 2001 to 2017 [2]. This region is responsible for 62% of the country loss of vegetation cover, and the municipalities of Rosita, Siuna and Bonanza, contributing to this forest loss with percentages of 38, 26 and 25 respectively [3]. According to a diagnostic presented by J. Guevara of Centro Humboldt, an environmental NGO, Nicaragua will be left without forest cover by 2028 with actual deforestation rates [55].

The Siuna and Bonanza project site is located within the buffer zone of the BOSAWAS biosphere reserve (RBB) [56]. The management plan in force for this reserve allows for cattle ranching activities in the this zone, but clear definitions and control mechanisms that ensure sustainability and do not result in deforestation loss, are absent [56].

In this scenario, the project area continues to be deforested and would even further degrade. Areas with grasslands and shrubs and remaining forest patches will gradually be lost due to the continuous pressure for land for extensive and low-productive animal husbandry; this scenario is the easiest and cheapest way of taking advantage of the area, not only for the existing population in nearby communities, but also for migrants from other regions of the country. The purchase of animals for dairy and meat production, and their low maintenance cost makes this a very likely scenario, as is occurring in large parts of the project region.

This process of deforestation and forest degradation is often referred to as the advance of the agricultural frontier, the geographical boundary between forest ecosystems and agricultural land-use [56].

The common practice driving the advance of the agricultural frontier are land clearing cycles through fire or removal of vegetation through application of herbicides or by hand, adding to the lack of measures to protect soil erosion that leads to a loss of organic matter and exhaustion of the soil structure. This leads to a substantial loss of soil fertility, often resulting in abandoned degraded lands, extensive grazing and erosion due to trampling and lack of vegetation.

Overall, it is likely that deforested lands and remaining forest patches would be cleared again to turn it in pasture for subsistence animal husbandry farming. Therefore, the same effects as for the current grasslands can be expected with further degradation and erosion.

<u>Land use scenario B:</u> The area is turned into a traditional cacao plantation;

Historically, cacao has been an important crop in the country. This agricultural activity is promoted by the national government through programs such as the program ProCacao. The ProCacao programme assisted farmers with the use of grafted seedlings and improve productivity through the transfer of knowledge and better agricultural practices.

The cacao production systems can be either established in systems with and without forest cover. In the Siuna region cacao production is often an element of a range of production of (subsistence) crops, such as beans, maize and grassland for cattle. The sustainability of such cacao systems in terms of soil degradation, nutrient loss, species and biodiversity loss and environmental services is highly variable; often, cacao farms are poorly managed and do not reach optimal production levels [57].

In the Caribbean North, ten Cacao cooperatives are active; one of those is located in the Siuna municipality, namely Cooperativa Campesina Copesiuna, of which 163 small producers are part. In 2018, the total area under production by the producers was 700 'manzanas', equal to 490 hectares [58]. At national level, 11,100 hectares of cacao are planted, of which 7,200 are productive [59].

This scenario generally expands in mosaics of land areas if the price of cacao is sufficiently high or when demand is considered stable/increasing. International price levels have been considerably lower compared to its peak in 2011 (approx. 36%) [60], but the Nicaraguan cacao is generally well-received on the international markets, and cacao is one of the few agric commodities that has found its way up in terms of volume and export value in the past years [61]. Overall, this scenario could be considered likely for (at least a part) of the project area. It must be noted that, in case sections of the land area would be used for cacao production, they would likely be abandoned because of reduced productivity of crops after approximately 15 years [62] [63].

<u>Land use scenario C:</u> Subsistence mining

The triangle Siuna-Rosita-Bonanza is an historic mining area. The first mining activities date back to 1890, but it was until the 1950's that economic mining activity took a boost [64]. The road connecting these cities, was constructed in 1953 by transnational mining cooperation for the purpose of transporting mining equipment, staff and the shipping of mining products. Eight million ounces of gold have been produced in the mining triangle (Siuna-Rosita-Bonanza) up to date [65].

The artisanal mining is an important activity by the local population in the region, and known as 'güiricería'. Principle metals that can be found in this region are gold and silver. This mining activity is characterized by hand-work, use of simple tools and machinery realized by individuals or small local mining cooperation's, and by the application of mercury for the extraction of gold [66]. This activity takes place in particular in water bodies, which currently fall within the protection areas of the project.

The mining activity can have a strong negative impact on the environment if not done correctly, due to large scale soil and water contamination (with mercury) with strong long-term effects on ecosystem and community health, as well as forest deforestation. The residual contaminated water streams often affect local population and animal husbandry, and is an historic source of social conflicts in the region [2]. Generally, used or abandoned mining sites are not apt for production of food crops, and remain contaminated and abandoned for decades.

<u>Land use scenario D:</u> Conventional commercial reforestation plantation without VCS certification.

The Forest Conservation, Promotion and Development Act No. 462 states that the state has "the responsibility to ensure the sustainable development of the forest sector" for the purpose of encouraging the development of the forest sector, promoting the elaboration of activities of adequate management of forest resources and achieving the reversal of the deforestation process suffered by the country.

In September 2003, this law was approved with the purpose of establishing legal regime for conservation and sustainable development of the sector. The act ensured financial incentives for enterprises that invest in reforestation or the establishment of plantation. These financial incentives initially lead to the attraction of foreign investors in forestry plantation.

Overall, the impact of the Act has been limited: only 12 enterprises registered its Forestry Initiative between 2009 and 2017, possibly due to the extensive documentation that needs to be supplied. The Act in general is focused on larger, legally established enterprises, and does not foresee in support to small-scale landholders. Overall, registered forestry plantation enterprises have less than 20,000 ha under management, including MLR Forestal [38].

Investments in forest plantation (without CER sales) are generally seen as unattractive due to the long period of investment required and subsequent return periods for most investors (approximately 15-25 years), even despite financial tax incentives provided by the government. Investors or banks are usually not willing to invest such a large amount of time before cash-flow becomes positive, demonstrated by a recent communication with a Nicaraguan commercial bank on possibilities for credit [67], as well as in Nicaraguan Forestry Sector Diagnose from the BID [68]. Usually, a good part of the timber (in particular pre-harvest thinnings) can be sold on domestic markets, but timber prices in the region are low, also caused by a high influx of illegal timber from illegal logging and deforestation, which is estimated at 55% in the BOSAWAS region [33].

Outcome of Sub-step 1a: *List of credible alternative land use scenarios that would have occurred on the land within the project boundary of the A/R CDM project activity.*

a) Land use scenario A: Continuation of the pre-project land use;
b) Land use scenario B: The area is turned into a traditional cacao plantation;
c) Land use scenario C: Subsistence mining
d) Land use scenario D: Conventional commercial reforestation plantation without VCS certification.

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

Land use scenario A: Continuation of the pre-project land use;

The BOSAWAS Management plan does not allow for unsustainable land-use practices in the buffer zone, and foresees only in cattle ranging in silvopastoral schemes, taking into account soil use capacity [56]. However, law enforcement and governance in the region is very weak, and unsustainable land-use practices and land-use conversion for monetary gain is the norm in the region, evidenced by the deforestation statistics and high level of degraded lands. Hence, existing legislation is currently not sufficiently enforced to prevent encroachment of the remaining forest patches.

This land-use scenario is characterized by low-productive and extensive cattle grazing, which will lead to further degradation of soils and remaining forests.

Land use scenario B: The area is turned into a traditional cacao plantation;

Planting of cacao is in line with the BOSAWAS Management plan and is actually promoted by the government by its ProCacao programme. It is not in conflict with the any Nicaraguan legislation.

Land use scenario C: Subsistence mining

Subsistence mining, with the use of eco-friendly technologies, is allowed in the Bosawás buffer zone according to the BOSAWAS Management plan. According to Decree 20-2017, such activities require an environmental authorization for the exploitation and/or processing of small mining with a production level of up to 15 tons/day. [69].
The use of mercury is common, which does not comply with the requirement of eco-friendly technologies. Subsistence mining, however, is wide-spread in the region, and authorities are not properly enforcing this legislation due to the socio economic implications [33], nor fully enforcing the Minamata convention on use and related human and environmental risks of mercury.

Land use scenario D: Conventional commercial reforestation plantation without VCS certification

Commercial plantation forestry is allowed within the BOSAWAS Management plan. Establishment of commercial plantations on degraded forest land is allowed and stimulated by the national and local governments. The Forest Conservation, Promotion and Development Act No. 462 actually provides incentives to do so. As such, this scenario is not in conflict with any Nicaraguan legislation.

Outcome substep 1b

All alternative land-use scenarios comply are plausible alternatives, either in compliance with laws or are generally present in the region due to the systemic lack of enforcement.

STEP 2. Barrier analysis

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

Land use scenario A: Continuation of the pre-project land use

This land use scenario is not constrained by any barriers and is therefore the prevailing land use practice.

Land use scenario B: The area is turned into a traditional cacao plantation;

Ecological barriers

The soils of the areas have been considerably exhausted due the deforestation and extensive cattle grazing [2]. Presence of cattle compact soils, which is the opposite soil condition of what cacao plants need to flourish [70]. Traditional cacao planting will therefore be of very limited productivity, unless considerable investment is done in improving soils and nutrient levels.

Poverty barrier

Nicaragua is a country with a high degree of poverty, particularly in rural areas. According to the 2009 Living Standards Measurement Survey (LSMS), 42.5% of the population lives in poverty, with 14.6% in a state of extreme poverty [71]. Average annual income has been calculated at US$ 1,890 in 2019 [72]. The population in the villages of the region generally depends on subsistence agriculture in small farms nearby their houses, which allows for survival and occasional side-selling, but not for making a step toward higher incomes.

The North Caribbean Coast Autonomous Region (RACCN), is populated by approximately 394,792 inhabitants (INIDE 2008), where 27% of the total population is located in urban areas, while 73% is located in rural areas. The Human Development Report (UNDP, 2019), the human development index for Nicaragua and the RACCN region is 0.66, which represents low human development conditions, including low income per capita [73].

Credit access barrier

It is recognized by the Nicaraguan Government in their reports that the fragility of the banking system is a problem to be solved in order to secure the economic development of the country [71]. Agrarian reform introduced new land titles of property, but these are rarely accepted as a guarantee by the commercial banks. No credit is available from credit institutions in this region, as also reflected in an email communication from a Nicaraguan bank [67]. Additionally, the poor geographical location of financial institution nationwide, lack of use of bank accounts (and as such, registered income history), hinder issuing of productive loans. As such, farmers can often not access credit based on their houses, land titles, or farming activities, which will make it nearly impossible for them to acquire larger farms such as those in the project, for developing and investing in a cacao plantation.

Social barrier

Although cacao is increasing in importance as productive crop, and promoted by national government initiatives, overall production area at national and regional level is still very low, with only 7,200 ha of productive cacao areas nationwide, and taking place at small scale [70].

Absent of knowledge among the rural population, due to limited knowledge and knowledge transfer (by e.g. government, education institutes, NGOs), is a barrier for this scenario.

Intensive training must be done to the local communities to get to well-managed, as cacao cultivation is not a common and historic crop grown by the local communities, and management differs considerable from annual cash crops (e.g. the longer investment period, maintenance efforts required).

Disease barrier

The Frosty pod disease (FPD), a fungal disease caused by Moniliophthora roreri, strongly affects cacao production and can cause near-total crop failure [74]. The disease manifests itself in the form of brown spreading lesions on the pod surface and ultimately the production of powdery spores. The disease has reached plantations in Nicaragua and is even more difficult to control than the better known witches' broom disease, as the spores are often the first sign of infection. The disease mostly springs up in poorly managed plantations – MLR's well-managed cacao plantations are not suffering from the disease. It is estimated that production without the fungi is between 5 and 25 qq (quintales) per hectare in Nicaragua, while those affected by FPD reach 3.5 qq/ha [75].

Investment barrier

The 3-5 year period which cacao plants require to become productive often provides too little financial incentives for subsistence farmers. To provide annual income, they prefer land-use activities that provide food crops and returns in the same year.

Land use scenario C: Subsistence mining

Human health barrier

The artisanal mining is usually done by the application of mercury (among 98% of miners) [66], which utilization has grave consequences for the miners, their families and especially their children, who are often playing in the same river where mercury is applied. Persons coming in contact with (water-contaminated) mercury, or relying on drinking water contaminated with mercury, suffer from impact of mercury on the nervous system, brains, lungs and kidneys. Worst cases suffer from muscle tremors, and deterioration of the motoric system [66]. Many families who were dedicated to subsistence mining in the past have left this activity for health reasons.

Ecological barrier

Similar to the effects on human health, the use of mercury leads to contaminated soils and water, affecting the aquatic and terrestrial flora and fauna and having a strong impact on the local biodiversity.

Over-exploitation barrier

Many of the mines in the Siuna-Rosita-Bonanza triangle have already ran through numerous phases of exploration, and much of the 'low hanging fruit' has already been exploited during past mining booms [76]. Mining sites are generally characterized by their spontaneous and temporal nature.

Due to over-exploitation, the mineral extracted by artisanal miners tends to have low grades, forcing artisanal miners to search for ore in deeper and riskier areas without obtaining the expected economic return, which makes this activity riskier and less profitable.

Labor security barrier

One of the largest barrier of gold mining is the high labor insecurity it implies. As finding small pieces of gold or silver is a strong matter of luck, days of heavy labor do not form any guarantee for an income, let alone a stable and reliable income [66]. Often, months pass in which income is not covering costs for subsistence miners. As such, many families prefer dedicating their labor time towards more secure forms of income (e.g. cattle raising) [2] that also provide more food security.

Land use scenario D: Conventional commercial reforestation plantation without VCS certification

Investment barrier

The project's region is a remote area of Nicaragua, where conflicts with respect to land-tenure, encroachment of areas due to illegal mining/deforestation does not stimulate foreign investment. Capital investment does not easily find its way in this region of the country, and is perceived as high risk (in an already risky country, as can be observed by the countries risk premium of 6,3% [77]). Also, banks demand high interest rates [78]. Investment for sustainable and commercial reforestation is therefore often tied to foreign investors, demanding high returns, extensive risk mitigation strategies and clear ecological and social co-benefits, including demonstrated positive contributions to climate change mitigation. These demands are difficult to bring together and efforts to mitigate risks and enhance co-benefits raise costs compared with conventional plantation development. This tension in the business model can be eased with the use of carbon finance. Without carbon finance, many of the additional goals that PP has set to ensure sustainability of the project, could not be achieved.

Institutional barrier

The insecure and often disputed land-tenure titles do not favor investment in commercial reforestation. There are overlapping jurisdictional systems, and capacity for execution, project formulation and strategic planning have been reported as weak [79]. The only option therefore is to realize this on private land. As in many developing countries, the judicial system is relatively weak, and corruption levels are considerable (Nicaragua ranking at place 161 of 180 at Transparency international's Corruption Perception Index for 2019), which is debilitating the appetite for private investment [80].

Informality barrier

A lot of illegal logging is taking place in the BOSAWAS buffer zone region, leading to informal timber market places with low prices [33]. This does not favor the establishment of a commercial reforestation plantation, as competition of informal markets is fierce.

Distance to ports barrier

The distance of the Siuna and Bonanza region to shipping ports is relatively high. Both the Atlantic and Pacific ports the truck transport time is above 10 hours, with bad road conditions and a river-pass by boat (Atlantic port) complicating transport [81] [82][6]. This transport time is relatively long for the Central-American region.

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

The following table shows the summary of barriers hindering land-use option scenarios.

Land use scenario	Barriers limiting scenario
A - Continuation of the pre-project land use	-
B - The area is turned into a traditional cacao plantation	Ecological barrier Poverty barrier Credit access barrier Social barrier Disease barrier Investment barrier
C - Subsistence mining	Human health barrier Ecological barrier Over-exploitation barrier Labor security barrier
D - Conventional commercial reforestation plantation without VCS certification	Investment barrier Institutional barrier Informality barrier Distance to port barrier

[6] Note the Google Map routes reference indicate time for car transport; truck transport takes approx. twice as long due heavy loads, road conditions and river passage.

Outcome of step 2b.

Considering the barriers present for land use scenario B, C and D, these will be excluded from further consideration.

Sub-step 2c. Determination of baseline scenario (if allowed by the barrier analysis)

Land-use scenario A is the only scenario left in sub-step 2b:

This land-use scenario is continuation of the pre-project land use, which is low-productive and extensive cattle grazing, which leads to further degradation of soils and remaining forests.

This is the baseline scenario.

STEP 4. Common practice analysis

In Nicaragua, commercial reforestation has large potential, but is still a relatively small sector that is not expanding. Its economic potential is not exploited. This is in particular true for the RACCN region where the project is located. No other commercial teak plantation project has been developed, besides MLR. Teak is considered among the eight ideal species for the establishment of industrial plantations in Nicaragua, with a potential area of more than 1.7 million hectares [83], yet this has not attracted investment in the RACCN region.

Reports indicate that 27,000 ha of commercial plantations were established between 2003 and 2018 in Nicaragua [84]. Of these enterprises, only MLR Forestal is located in the RACCN region. Of the 9 enterprises reported by a report on plantations in Nicaragua by Funides, 6 use teak species and MLR Forestal is the only enterprise in Siuna (RACCN) region, and the only enterprise that mixes it with cacao [38], two distinctive features of MLR. It is further mentioned that the reforestation sector passes through a strong reduction in investment and hectares established [84]. This shows that commercial reforestation projects are seen as not attractive economically, also in the Siuna project region. Without additional revenue streams from carbon credits, as strategically planned for, such projects generally do not come off the ground.

MLR's approach can further be called unique due to its product diversification, FSC and Rainforest Alliance (previously UTZ) certification.

Concluding from step 4: Common practice analysis of section it is proven that reforestation is not a common practice in the project zone, neither is the mix of cacao and teak as a large commercial project at national level. It is clear that the expected and most probable scenario is the continuity of pre-project activities (extensive cattle grazing on degraded lands, in and further degradation of forest areas).

As such, no long-term activities are observed to be similar to the proposed by the project, with the objective of reforestation. We can therefore establish that activities proposed by the A/R project for carbon sequestration proves to be additional.

3.6 Methodology Deviations

Not applicable.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The CDM methodology AR-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 to estimate the carbon stock and change in carbon stock in tree and shrub biomass within the project boundary at a given point in time. Four clearly distinct strata have been identified with the use of drone imagery and vegetation sampling. These baseline carbon stock strata are:

Stratum 1: Pasture land;

Stratum 2: Tacotales (abandoned pasture land);

Stratum 3: Remnant forest;

Stratum 4: Cacao with remnant indigenous trees.

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

The table below shows the carbon pools and the mode of biomass calculation of these baseline carbon stock strata. For stratum 1, shrub biomass is neglected as it is hardly present in the area, which implies that for stratum 1 $\Delta C_{SHRUB\_BSL,t} = 0$. The calculation methods for the determination of these carbon pools is elaborated in the next three sections.

Stratum	Carbon pool	Relevant biomass pool	Mode of biomass calculation
Stratum 1	$C_{TREE\_BSL\_1}$	Remnant protected trees	MLR inventory
	$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	MLR inventory
Stratum 2	$C_{TREE\_BSL\_1}$	Remnant protected trees	MLR inventory
	$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	MLR inventory
	$C_{SHRUB\_BSL\_1}$	Shrubs that are removed as part of land preparation	Remote sensing analysis (drone imagery)
Stratum 3	$C_{TREE\_BSL\_3}$	Trees in mixed degraded forest	Sample plots

	$C_{SHRUB\_BSL\_2}$	Shrubs in mixed degraded forest	Sample plots
Stratum 4	$C_{TREE\_BSL\_1}$	Remnant trees	MLR inventory
	$C_{SHRUB\_BSL\_3}$	Shrubs (cacao)	Remote sensing analysis (drone imagery)

Since the strata consisted of trees and/or shrubs, 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

The baseline net GHG removals are therefore determined as:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} \qquad \text{(Eq.1 AR-ACM0003)}$$

$$\Delta C_{TREE\_BSL,t} = C_{TREE\_BSL,t2} - C_{TREE\_BSL,t1} \qquad \text{(Eq.1 AR-TOOL14)}$$

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

Chapter 1.13 describes the historical vegetation, and historical deforestation and degradation practices in the region prior to the project interventions. In the area the agricultural frontier is advancing, and the land use dynamics are related to this with dominance of grass- and shrubland associated with mainly agricultural and livestock activities [2]. Therefore, it is assumed that the pressure on land would continue to exist until beyond the project duration without the project interventions. As a result, the average changes in carbon stocks in trees and shrubs of all strata under the baseline scenario are assumed to remain zero over time.

For this reason, in accordance with the methodological tool AR-TOOL14 the following applies:

“Changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero for those lands for which the project participants can demonstrate, through documentary evidence or through participatory rural appraisal (PRA), that the following indicator applies:

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

4.1.1 Baseline carbon stock stratum 1: pasture land

The only carbon pool C_{BSL} in this stratum is the carbon stock in remnant trees. Therefore, $C_{BSL} = C_{TREE\_BSL}$

With land preparation a portion of the remnant trees is conserved $\left(C_{TREE\_BSL\_1}\right)$, while another part of the trees is removed $\left(C_{TREE\_BSL\_2}\right)$. Therefore, the baseline carbon stock in trees is calculated as follows:

$$C_{TREE\_BSL} = C_{TREE\_BSL\_1} + C_{TREE\_BSL\_2}$$

To provide a solid estimation of the carbon stocks in this pool, the number of preserved trees and trees felled for land preparation were inventoried for a significant area of both pastureland and tacotales. It is assumed that this area is representative for the whole project area. Based on the dimensions and tree species, the above-ground biomass was estimated. As the trees are identified based on local knowledge of common names, the scientific name of the tree species was determined based on the identified common name [85]. The above-ground biomass (AGB) of the trees was estimated using allometric equations obtained from literature [86, 87]. Different equations were used depending on the available information from the field, such as tree species and total tree height.

Following the methodological tool total biomass in trees (b_{TREE}) is estimated as follows:

$$b_{TREE} = f(BA) \times (1 + R_j) \qquad \text{(Eq.7 Appendix 1 AR-TOOL14)}$$

where $f(BA)$ is the above-ground tree biomass per hectare, and R_j is the root-shoot ratio for tree species j. The root-shoot ratio is calculated as prescribed by the methodological tool, as follows:

$$R_j = \frac{e^{(-1.085+0.9256*\ln b)}}{b}$$

where b is the above-ground biomass of the tree.

The carbon stock in the individual trees (C_{TREE}) is estimated using the following equation:

$$C_{TREE} = \frac{44}{12} \times CF_{TREE} \times b_{TREE} \qquad \text{(Eq.12 AR-TOOL14)}$$

where CF_{TREE} is the default value of 0.47 for carbon fraction of tree biomass as specified in the methodological tool. With the carbon stock in the individual trees for the inventoried area, the carbon stock in trees per hectare can be calculated.

During the tree inventory, for every tree it was determined whether the tree will be preserved or removed with land preparation. Based on this classification, the carbon stock of preserved trees and removed trees was estimated following the methodology described above using the inventory data for pastureland. Table 7 summarizes the baseline carbon stocks in this stratum.

Table 7 Baseline carbon stocks for baseline stratum 1: pastureland with remnant trees

Carbon pool	Relevant biomass pool	t CO_2e ha^{-1}

$C_{TREE\_BSL\_1}$	Remnant protected trees	0.6
$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	15.1

Remnant Indigenous Trees are protected and excluded from further estimation of project net GHG removals by sinks. According to paragraph 5 of the methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" the (change in) carbon stock in trees in the baseline may be conservatively estimated as zero where the following conditions have been met:

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

In baseline stratum 1, indigenous trees are protected and excluded from further estimation of project net GHG removals by sinks. This procedure is part of the management plan and respected in the field. The scattered indigenous trees within the plantations do not undergo any physical management intervention (pruning, cutting shoots, pest control etc.). Activities are only carried out in the understory such as manual and chemical controls at the time that the pure plantation is intervened [17]. In ex post calculations the indigenous trees growth in the baseline are excluded and not claimed for carbon credits.

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

The scattered remnant indigenous trees within the plantations are monitored for health and growth on an annual basis [17]. Also, the pre-project trees are generally much bigger than the planted trees, which implies that the pre-project trees are not competing with the planted trees (Figure 18). There is no evidence through monitoring that the remaining indigenous trees in stratum 1 were affected by disturbances that would decrease carbon stock in trees. The remnant indigenous trees are protected and mapped. Losses of remnant indigenous trees must be reported to the authorities.

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

Each scattered indigenous tree is marked with a blue dot, georeferenced and identified on a map. There is a general inventory where the species and mensuration variable are described in each of the stands in the project area [17].

Figure 18 Remnant indigenous trees in the plantations (source: MLR Forestal)

4.1.2 Baseline carbon stock stratum 2: tacotales

The carbon pools C_{BSL} in this stratum are the carbon stock in trees and carbon stock in shrubs, as this stratum ('tacotales') is characterized as abandoned pastureland where shrub and tree regrowth have taken place in recent years. Therefore, $C_{BSL} = C_{TREE\_BSL} + C_{SHRUB\_BSL}$.

The carbon stock in trees in this stratum is estimated following the same approach as described for the carbon stock in trees in baseline stratum 1. Therefore, $C_{TREE\_BSL} = C_{TREE\_BSL\_1} + C_{TREE\_BSL\_2}$ also applies for this stratum. The only difference is that a higher tree density was found in tacotales, and consequently a higher carbon stock in trees (see Table 8).

Carbon stock in shrubs

The other carbon pool in this stratum is the carbon stock in shrubs that is removed with land preparation. Therefore, $C_{SHRUB\_BSL} = C_{SHRUB\_BSL\_1}$.

Following paragraph 11 of the methodological tool, carbon stock in shrubs at a point of time is estimated on the basis of shrub crown cover. Following the methodology a simplified method of measurement was used for estimating shrub crown cover, since the biomass in shrubs is smaller than the biomass in trees. Crown cover of shrubs (CC_{SHRUB}) was therefore estimated using remote sensing analysis (drone imagery), based on which shrub crown cover could be estimated [88].

Total shrub biomass per hectare (b_{SHRUB}) is estimated using the following equation:

$$b_{SHRUB} = BDR_{SF} \times b_{FOREST} \times CC_{SHRUB} \qquad \text{(Eq. 27 AR-TOOL14)}$$

where BDR_{SF} is the ratio between shrub biomass per hectare in land having a shrub crown cover of 1.0 and the default above-ground biomass content per hectare in forest. Following the methodology, a default value of 0.1 is used. b_{FOREST} is the default above-ground biomass content in forest in the region or country, and has a default value of 161 ton ha^{-1} [89]. CC_{SHRUB} is the crown cover of shrub in the stratum, which is estimated using remote sensing analysis.

The total carbon stock in shrubs per hectare (C_{SHRUB}) is estimated as follows:

$$C_{SHRUB} = \frac{44}{12} \times CF_S \times (1 + R_S) \times \sum A_{SHRUB} \times b_{SHRUB} \qquad \text{(Eq.26 AR-TOOL14)}$$

where CF_S is the carbon fraction in shrub biomass, with a default value of 0.47 as per the methodological tool. R_s is the root-shoot ratio for shrubs with a default value of 0.4 as per the methodological tool. A_{SHRUB} is the area of the stratum in hectares.

Table 8 summarizes the baseline carbon stocks in this stratum.

Table 8 Baseline carbon stocks for baseline stratum 2: tacotales

Carbon pool	Relevant biomass pool	t CO_2e ha^{-1}
$C_{TREE\_BSL\_1}$	Remnant protected trees	2.5
$C_{TREE\_BSL\_2}$	Trees that are felled as part of land preparation	37.9
$C_{SHRUB\_BSL\_1}$	Shrubs that are removed as part of land preparation	34.5

4.1.3 Baseline carbon stock stratum 3: remnant forest

The carbon pools C_{BSL} in this stratum are the carbon stock in trees and carbon stock in shrubs, as this stratum (Remnant forest) is characterized by trees and shrubs in a mixed degraded forest. Therefore, $C_{BSL} = C_{TREE\_BSL} + C_{SHRUB\_BSL}$.

Carbon stock in trees

The carbon stock in trees in the baseline of the mixed degraded forest is $C_{TREE\_BSL} = C_{TREE\_BSL\_3}$. To determine the carbon stocks of the mixed degraded forest at the start of the project activity, sample plots are laid out in this stratum. Tree height (H), tree diameter at breast height (DBH) and tree species are recorded, among other parameters. Over sixty different tree species were identified. The total biomass of the trees was estimated using the approach elaborated in chapter 4.1.1. With the obtained estimates of tree biomass in the sample plots, the total tree biomass per hectare ($b_{TREE\_BSL\_3}$) is derived so that:

$$b_{TREE\_BSL\_3} = \frac{B_{TREE\_BSL\_3}}{A_{PLOT}} \qquad \text{(Eq.1 Appendix 1 AR-TOOL14)}$$

where $B_{TREE\_BSL\_3}$ is total tree biomass in the plot, and A_{PLOT} is the plot size. The carbon stock in trees per hectare ($C_{TREE\_BSL\_3}$) is calculated as follows:

$$C_{TREE\_BSL\_3} = \frac{44}{12} \times CF_{TREE} \times b_{TREE\_BSL\_3} \qquad \text{(Eq. 12 AR-TOOL14)}$$

where CF_{TREE} is the carbon fraction in wood. The precision of the baseline carbon stock is estimated following equation of the CDM tool.

$$u_C = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^{M} w_i^2 \times \frac{s_i^2}{n_i}}}{b_{TREE}} \qquad \text{(Eq. 15 AR-TOOL14)}$$

If u_C is greater than 10%, $C_{TREE\_BSL\_3}$ is made conservative by applying uncertainty discount according to the procedure provided in Appendix 2 of the CDM tool. At the time of verification, the uncertainty is calculated again, and a confidence deduction will be applied according to this methodology in case the uncertainty is higher than allowed. This is adopted as the most conservative way to deal with variance in the mixed degraded forests.

Carbon stock in shrubs

The other carbon pool in this stratum is the carbon stock in shrubs. Therefore, $C_{SHRUB\_BSL} = C_{SHRUB\_BSL\_2}$.

For quantification of this carbon pool the same approach is used as for shrubs in baseline stratum 2 'tacotales'. The only difference is that shrub crown cover is estimated through ocular estimation in the sample plots in the protection areas.

Table 9 summarizes the baseline carbon stocks in this stratum.

Table 9 Baseline carbon stocks for baseline stratum 3: remnant forest

Carbon pool	Relevant biomass pool	t CO_2e ha^{-1}
$C_{TREE\_BSL\_3}$	Trees in remnant forest	325.5
$C_{SHRUB\_BSL\_2}$	Shrubs in remnant forest	11.7

4.1.4 Baseline carbon stock stratum 4: cacao

The carbon pools C_{BSL} in this stratum are the carbon stock in trees and carbon stock in cacao (shrubs), as this stratum is characterized as older cacao with remnant indigenous. Therefore, $C_{BSL} = C_{TREE\_BSL} + C_{SHRUB\_BSL}$.

Carbon stock in remnant trees

The carbon stock in remnant trees in the baseline of cacao areas is $C_{TREE\_BSL} = C_{TREE\_BSL\_1}$. To determine the carbon stock in remnant trees it is assumed that the older cacao plantations were established in areas with a baseline that is comparable with the baseline strata 1 'Pasture' and 2 'Tacotales'. Mapping data of the protected remnant trees suggest that remnant tree density in cacao areas is not higher than found for baseline strata 1 and 2. It is therefore considered conservative to use a weighted average of the remnant protected trees found in these strata as baseline carbon stock for this stratum.

Carbon stock in cacao

The carbon stock in cacao is calculated using the same approach as applied for calculation of carbon stock in shrubs in stratum 2 'tacotales'. Crown cover of shrubs (CC_{SHRUB}) was estimated using remote sensing analysis (drone imagery), based on which shrub crown cover in cacao could be estimated.

Table 10 summarizes the baseline carbon stocks in this stratum.

Table 10 Baseline carbon stocks for baseline stratum 4: cacao

Carbon pool	Relevant biomass pool	t CO_2e ha^{-1}
$C_{TREE\_BSL\_1}$	Remnant trees	1.2
$C_{SHRUB\_BSL\_3}$	Shrubs (cacao)	33.8

4.2 Project Emissions

4.2.1 Stratification

MLR Forestal applies different ARR techniques to achieve GHG emission removals. The selected carbon pools mentioned in section 3.3 are applied in all project activities. However, different ex ante calculations for carbon storage apply since there is difference in the management of certain areas. There are three identified types:

Table 11 Management of the different project activities

Project Activity	Baseline scenario	Clear felling	Thinning / pruning	Planting	Assisted Natural Regeneration (ANR)
Teak plantation (I)	1 & 2	YES	YES	YES	YES

Mixture teak with cacao (II)	1 & 2 & 4	YES	YES	YES	YES
Protection (III)	1 & 2 & 3	NO	NO	YES	YES

In the Teak plantation and Teak-cacao plantation clear felling, thinning and pruning are part of the management and therefore a long-term average is applied. Remnant indigenous trees will not be felled during harvesting operations. In the protection areas there will be no harvesting, no pruning and no commercial thinning.

As the project expands gradually for all the different reforestation types, the project is further stratified by planting year as shown in the table below.

Table 12 Stratification

Municipality	Year	Teak plantation (I)	Mixture teak with cacao (II)	Protection (III)
Bonanza	2016	0.0	0.0	0.0
	2017	0.0	0.0	0.0
	2018	0.0	0.0	0.0
	2019	0.0	0.0	0.0
	2020	0.0	80.9	88.9
Siuna	2016	93.6	0.0	0.0
	2017	85.0	0.0	0.0
	2018	69.1	0.0	0.0
	2019	264.0	101.2	0.0
	2020	165.2	0.0	1367.8
TOTAL		**677.0**	**182.1**	**1456.7**

4.2.2 Actual net GHG removals by sinks

As described above, the project consists of four different reforestation types. The long-term average shall be calculated following the VCS requirement 3.2.21 when harvesting is applied. As described in chapter 1.11, 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. For each project activity the methodology AR-ACM0003 version 02.0 is followed.

In the following sections, the actual net carbon emissions and removals per hectare are explained per carbon pool and project activity. Some of the emissions and removals of the selected carbon pools are calculated differently for different project activities and some are calculated in the same way for different project activities. How different and same calculation methods are applied is further elaborated in the following sections.

4.2.2.1 Reforestation type I: teak plantation

Actual net GHG removals by sinks $(\Delta C_{ACTUAL,t})$

The actual net GHG removals equal the carbon stock increase in the relevant carbon pools minus the GHG emissions within the project boundary.

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t} \qquad \text{(Eq. 2 AR-ACM0003)}$$

Parameter	Unit	Description
$\Delta C_{ACTUAL,t}$	t CO_2e	Actual net GHG removals by sinks, in year t
$\Delta C_{P,t}$	t CO_2e	Change in the carbon stocks in project, occurring in the selected carbon pools, in year t
$GHG_{E,t}$	t CO_2e	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R project activity, in year t

Increase in non-CO_2 emissions $(GHG_{E,t})$

Following the methodology and the “tool for non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (v04.0.0)” under $GHG_{E,t}$ only the non-CO_2 gases N_2O and NH_4 need to be quantified. However, MLR Forestal is not using fire as a management tool. Therefore:

$$GHG_{E,t} = 0$$

Sum of changes in selected carbon pools $(\Delta C_{P,t})$

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

(Eq. 3 AR-ACM0003)

The relevant carbons pools are:

- Above and belowground tree biomass
- Above and belowground shrub biomass
- Soil organic carbon

Litter and dead wood are conservatively excluded from the project scenario as GHG removal by sinks. Therefore, shrub biomass is only accounted for in the baseline scenario and conservatively assumed to be zero in the project scenario.

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

Estimating change in carbon stock in tree biomass $(\Delta C_{TREE\_PROJ,t})$

The change in tree biomass is calculated by estimating the biomass at the beginning and end of each verification period. The tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” is used to determine changes in tree carbon stock. Because shrub biomass is negligible in the teak plantations, this pool is conservatively excluded.

The change in tree biomass and the associated uncertainty are estimated using the following equations:

$$\Delta C_{TREE\_PROJ,t} = C_{TREE,t_2} - C_{TREE,t_1} \qquad \text{(Eq. 1 AR-TOOL14)}$$

$$u_{\Delta C} = \frac{\sqrt{\left(u_1 \times C_{TREE,t_1}\right)^2 + \left(u_2 \times C_{TREE,t_2}\right)^2}}{|\Delta C_{TREE}|} \qquad \text{(Eq. 2 AR-TOOL14)}$$

The tree biomass in the first year is the same as the baseline biomass in trees at the start of the project activity (C_{TREE_BSL}). As the project activity is implemented in areas with either baseline stratum 1 ‘pasture land’ or baseline stratum 2 ‘tacotales’, a weighted average of the carbon stocks in trees is used following the baseline area distribution as explained in chapter 3.4. The tree biomass cleared during land preparation will be deducted from the baseline carbon stock and the increment of the planted trees added.

Methods for determining C_{TREE_BSL} have been discussed in chapter 4.1. The change in carbon stock for remnant indigenous trees was conservatively estimated as zero following the methodological tool (see also chapter 4.1).

To determine the total above- and belowground biomass of planted trees, tree volume is calculated based on data collected in permanent sample plots in the PP's teak plantations.

Total tree volume of individual trees is estimated using the total tree volume equation from Fallas for clones [90], as in the project area only clonal material is planted. According to the methodological tool the amount of tree biomass $(B_{TREE,l,teak})$ of an individual tree l is estimated using the following equation:

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

The BEF-value, which is based on peer reviewed scientific literature [91], 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 the tree biomass per hectare $(b_{TREE,teak})$ in the sample plots is calculated by dividing the tree biomass in the plot by the plot area. The mean tree biomass and the associated variance for the teak strata are estimated following equation 16 and 17 of the methodological tool. This allows to calculate the mean carbon stock in the commercial teak plantations and the associated uncertainty following equations 12 – 15 of the methodological tool. At the time of verification, the uncertainty is calculated again, and a confidence deduction will be applied according to this methodology in case the uncertainty is higher than the threshold specified in the methodological tool.

Soil Organic Carbon (ΔSOC)

The CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" is used to determine ΔSOC. ΔSOC is only relevant for baseline strata 1 and 2, since these are degraded areas. Where 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 pastureland (baseline stratum 1) or recently abandoned pastureland (baseline stratum 2) at the project start.

The initial SOC stock at the start of the project is estimated as follows:

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i} \quad \text{(Eq. 1 AR-TOOL-16)}$$

Following the methodological tool, the entire project area is classified as a tropical moist region [92]. The soil types found [2] in the area are Ultisols (100% in the Bonanza area, 81,1% in the Siuna area) and Alfisols (18,9% in the Siuna area). According to the methodological tool Ultisols are classified as a Low Activity Clay (LAC), while (non-acidic) Alfisols are classified as a High Activity Clay (HAC). The SOC reference values $(SOC_{REF,i})$ were obtained from table 3 of the methodological tool.

The project area is characterized as (abandoned) pastureland, mainly as a result of the advance of the agricultural frontier [2, 33]. The corresponding land use factor $(f_{LU,i})$ was obtained from table 6 of the methodological tool. The land management factor $(f_{MG,i})$ depends on the extent of degradation of the land. Identification of land as degraded land is done using the 'Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities'. In accordance with this tool the area was classified as degraded, which was demonstrated through documentary evidence. It was reported that the areas in the region that are deforested as a result of the advancing agricultural frontier, are characterized by a high degree of land degradation and pastures with low productivity [33]. This type of landuse is an easy and cheap way of utilizing the area, with a lack of measures to protect the area from soil erosion that leads to a loss of organic matter and the soil structure exhaustion. Abandoning land care, grazing and erosion due to trampling continue to degrade soil.

The project area is mainly used for extensive cattle, which does not involve the use of fertilizers. The input factor $(f_{IN,i})$ is obtained from table 6 of the methodological tool accordingly.

Table 13 SOC parameters

Parameter	Ultisols (LAC)	Alfisols (HAC)
$SOC_{REF,i}$	47	65
$f_{LU,i}$	1.0	1.0
$f_{MG,i}$	0.7	0.7
$f_{IN,i}$	1.0	1.0
$SOC_{INITIAL,i}$	32.9	45.5

As the project activity does not involve soil disturbance such as ploughing and ripping [17], according to the methodological tool $SOC_{LOSS} = 0$. According to the methodological tool, the increase in SOC content in the project scenario takes place at a constant rate over a period of 20 years from the year of planting. Therefore, the annual rate of change in SOC stock in the project scenario until the steady-state SOC content is reached is estimated as follows:

$$dSOC_t = \frac{SOC_{REF} - (SOC_{INITIAL} - SOC_{LOSS})}{20\ years} \qquad \text{(Eq. 1 AR-TOOL-16)}$$

To estimate the rate of change in SOC for the project areas, a weighted average is applied for the Siuna area according to the soil type distribution percentages mentioned above. The rate of change in SOC found for the Bonanza and Siuna areas are 0.71 and 0.76 t C ha^{-1} yr^{-1} respectively. This corresponds with 2.77 and 2.59 t CO_2e ha^{-1} yr^{-1} respectively.

Long-term average (LTA)

In the teak plantation rotational harvesting will be done, and a long-term average calculation is carried out over two rotation periods. The long-term average should include at least one rotation period, which is 20 years for teak. The LTA is therefore calculated over 40 years. All teak plantation strata can only generate VCUs until the long-term average is reached. This long-term average is calculated following VCS requirement 3.2.21. Following this equation, the long-term average (LTA) is reached around year 11 after planting, and equals 231.8 tCO2eq. for Siuna, and 229.1 tCO2eq. for Bonanza areas (the slight difference is due to difference in soil types and related SOC). A detailed overview of the corresponding calculations is shown in Table 14 (Siuna) and Table 15 (Bonanza), and the calculations itself can be consulted in Annex I.

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

Parameter	Unit	Description
LA	t CO_2e	The long-term average GHG benefit
PE_t	t CO_2e	The GHG emission reductions and removals generated in the project scenario calculated over all relevant carbon pools
BE_t	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 (40 years)

VCUs teak

VCUs can now be calculated for teak. VCUs are only generated until the long-term average is reached.

$$\Delta C_{AR-VCS,t\_TEAK} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \quad \text{(Eq. 5 AR-ACM0003)}$$

Table 14: Long term average calculation teak – Siuna areas

	C_{TREE_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year
Year	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1
0	32.6	1.5	34.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	11.5	12.6	-21.5	2.8	0.0	-18.7	0.0	0.0	-18.7	-18.7	0.0	0.0
2	1.2	59.1	60.3	47.7	2.8	0.0	50.4	0.0	0.0	50.4	31.7	31.7	31.7
3	1.2	88.3	89.4	29.2	2.8	0.0	31.9	0.0	0.0	31.9	63.7	63.7	31.9
4	1.2	104.9	106.1	16.6	2.8	0.0	19.4	0.0	0.0	19.4	83.1	83.1	19.4
5	1.2	131.2	132.4	26.3	2.8	0.0	29.0	0.0	0.0	29.0	112.1	112.1	29.0
6	1.2	157.5	158.6	26.3	2.8	0.0	29.0	0.0	0.0	29.0	141.2	141.2	29.0
7	1.2	183.7	184.9	26.3	2.8	0.0	29.0	0.0	0.0	29.0	170.2	170.2	29.0
8	1.2	210.0	211.2	26.3	2.8	0.0	29.0	0.0	0.0	29.0	199.3	199.3	29.0
9	1.2	205.7	206.9	-4.3	2.8	0.0	-1.5	0.0	0.0	-1.5	197.8	197.8	-1.5
10	1.2	234.7	235.9	29.0	2.8	0.0	31.8	0.0	0.0	31.8	229.5	229.5	31.8
11	1.2	263.8	264.9	29.0	2.8	0.0	31.8	0.0	0.0	31.8	261.3	231.8	2.3
12	1.2	292.8	293.9	29.0	2.8	0.0	31.8	0.0	0.0	31.8	293.1	231.8	0.0
13	1.2	280.6	281.7	-12.2	2.8	0.0	-9.4	0.0	0.0	-9.4	283.7	231.8	0.0
14	1.2	310.4	311.5	29.8	2.8	0.0	32.6	0.0	0.0	32.6	316.2	231.8	0.0
15	1.2	340.1	341.3	29.8	2.8	0.0	32.6	0.0	0.0	32.6	348.8	231.8	0.0
16	1.2	369.9	371.1	29.8	2.8	0.0	32.6	0.0	0.0	32.6	381.3	231.8	0.0
17	1.2	290.5	291.7	-79.4	2.8	0.0	-76.6	0.0	0.0	-76.6	304.7	231.8	0.0
18	1.2	319.7	320.8	29.2	2.8	0.0	31.9	0.0	0.0	31.9	336.6	231.8	0.0
19	1.2	344.3	345.4	24.6	2.8	0.0	27.4	0.0	0.0	27.4	364.0	231.8	0.0
20	1.2	367.3	368.5	23.1	2.8	0.0	25.8	0.0	0.0	25.8	389.8	231.8	0.0
21	1.2	11.5	12.6	-355.9	0.0	0.0	-355.9	0.0	0.0	-355.9	34.0	231.8	0.0

22	1.2	59.1	60.3	47.7	0.0	0.0	47.7	0.0	0.0	47.7	81.6	231.8	0.0
23	1.2	88.3	89.4	29.2	0.0	0.0	29.2	0.0	0.0	29.2	110.8	231.8	0.0
24	1.2	104.9	106.1	16.6	0.0	0.0	16.6	0.0	0.0	16.6	127.4	231.8	0.0
25	1.2	131.2	132.4	26.3	0.0	0.0	26.3	0.0	0.0	26.3	153.7	231.8	0.0
26	1.2	157.5	158.6	26.3	0.0	0.0	26.3	0.0	0.0	26.3	180.0	231.8	0.0
27	1.2	183.7	184.9	26.3	0.0	0.0	26.3	0.0	0.0	26.3	206.3	231.8	0.0
28	1.2	210.0	211.2	26.3	0.0	0.0	26.3	0.0	0.0	26.3	232.5	231.8	0.0
29	1.2	205.7	206.9	-4.3	0.0	0.0	-4.3	0.0	0.0	-4.3	228.2	231.8	0.0
30	1.2	234.7	235.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	257.3	231.8	0.0
31	1.2	263.8	264.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	286.3	231.8	0.0
32	1.2	292.8	293.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	315.3	231.8	0.0
33	1.2	280.6	281.7	-12.2	0.0	0.0	-12.2	0.0	0.0	-12.2	303.1	231.8	0.0
34	1.2	310.4	311.5	29.8	0.0	0.0	29.8	0.0	0.0	29.8	332.9	231.8	0.0
35	1.2	340.1	341.3	29.8	0.0	0.0	29.8	0.0	0.0	29.8	362.7	231.8	0.0
36	1.2	369.9	371.1	29.8	0.0	0.0	29.8	0.0	0.0	29.8	392.4	231.8	0.0
37	1.2	290.5	291.7	-79.4	0.0	0.0	-79.4	0.0	0.0	-79.4	313.0	231.8	0.0
38	1.2	319.7	320.8	29.2	0.0	0.0	29.2	0.0	0.0	29.2	342.2	231.8	0.0
39	1.2	344.3	345.4	24.6	0.0	0.0	24.6	0.0	0.0	24.6	366.8	231.8	0.0
40	1.2	367.3	368.5	23.1	0.0	0.0	23.1	0.0	0.0	23.1	389.8	231.8	0.0

Table 15: Long term average calculation teak – Bonanza areas

	C_{TREE_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year
Year	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1

0	32.6	1.5	34.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	11.5	12.6	-21.5	2.6	0.0	-18.9	0.0	0.0	-18.9	-18.9	0.0	0.0
2	1.2	59.1	60.3	47.7	2.6	0.0	50.2	0.0	0.0	50.2	31.4	31.4	31.4
3	1.2	88.3	89.4	29.2	2.6	0.0	31.8	0.0	0.0	31.8	63.1	63.1	31.8
4	1.2	104.9	106.1	16.6	2.6	0.0	19.2	0.0	0.0	19.2	82.3	82.3	19.2
5	1.2	131.2	132.4	26.3	2.6	0.0	28.9	0.0	0.0	28.9	111.2	111.2	28.9
6	1.2	157.5	158.6	26.3	2.6	0.0	28.9	0.0	0.0	28.9	140.1	140.1	28.9
7	1.2	183.7	184.9	26.3	2.6	0.0	28.9	0.0	0.0	28.9	168.9	168.9	28.9
8	1.2	210.0	211.2	26.3	2.6	0.0	28.9	0.0	0.0	28.9	197.8	197.8	28.9
9	1.2	205.7	206.9	-4.3	2.6	0.0	-1.7	0.0	0.0	-1.7	196.1	196.1	-1.7
10	1.2	234.7	235.9	29.0	2.6	0.0	31.6	0.0	0.0	31.6	227.7	227.7	31.6
11	1.2	263.8	264.9	29.0	2.6	0.0	31.6	0.0	0.0	31.6	259.3	229.1	1.4
12	1.2	292.8	293.9	29.0	2.6	0.0	31.6	0.0	0.0	31.6	290.9	229.1	0.0
13	1.2	280.6	281.7	-12.2	2.6	0.0	-9.6	0.0	0.0	-9.6	281.2	229.1	0.0
14	1.2	310.4	311.5	29.8	2.6	0.0	32.4	0.0	0.0	32.4	313.6	229.1	0.0
15	1.2	340.1	341.3	29.8	2.6	0.0	32.4	0.0	0.0	32.4	346.0	229.1	0.0
16	1.2	369.9	371.1	29.8	2.6	0.0	32.4	0.0	0.0	32.4	378.4	229.1	0.0
17	1.2	290.5	291.7	-79.4	2.6	0.0	-76.8	0.0	0.0	-76.8	301.5	229.1	0.0
18	1.2	319.7	320.8	29.2	2.6	0.0	31.8	0.0	0.0	31.8	333.3	229.1	0.0
19	1.2	344.3	345.4	24.6	2.6	0.0	27.2	0.0	0.0	27.2	360.4	229.1	0.0
20	1.2	367.3	368.5	23.1	2.6	0.0	25.6	0.0	0.0	25.6	386.1	229.1	0.0
21	1.2	11.5	12.6	-355.9	0.0	0.0	-355.9	0.0	0.0	-355.9	30.2	229.1	0.0
22	1.2	59.1	60.3	47.7	0.0	0.0	47.7	0.0	0.0	47.7	77.9	229.1	0.0
23	1.2	88.3	89.4	29.2	0.0	0.0	29.2	0.0	0.0	29.2	107.1	229.1	0.0
24	1.2	104.9	106.1	16.6	0.0	0.0	16.6	0.0	0.0	16.6	123.7	229.1	0.0
25	1.2	131.2	132.4	26.3	0.0	0.0	26.3	0.0	0.0	26.3	150.0	229.1	0.0
26	1.2	157.5	158.6	26.3	0.0	0.0	26.3	0.0	0.0	26.3	176.2	229.1	0.0

27	1.2	183.7	184.9	26.3	0.0	0.0	26.3	0.0	0.0	26.3	202.5	229.1	0.0
28	1.2	210.0	211.2	26.3	0.0	0.0	26.3	0.0	0.0	26.3	228.8	229.1	0.0
29	1.2	205.7	206.9	-4.3	0.0	0.0	-4.3	0.0	0.0	-4.3	224.5	229.1	0.0
30	1.2	234.7	235.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	253.5	229.1	0.0
31	1.2	263.8	264.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	282.5	229.1	0.0
32	1.2	292.8	293.9	29.0	0.0	0.0	29.0	0.0	0.0	29.0	311.6	229.1	0.0
33	1.2	280.6	281.7	-12.2	0.0	0.0	-12.2	0.0	0.0	-12.2	299.3	229.1	0.0
34	1.2	310.4	311.5	29.8	0.0	0.0	29.8	0.0	0.0	29.8	329.1	229.1	0.0
35	1.2	340.1	341.3	29.8	0.0	0.0	29.8	0.0	0.0	29.8	358.9	229.1	0.0
36	1.2	369.9	371.1	29.8	0.0	0.0	29.8	0.0	0.0	29.8	388.7	229.1	0.0
37	1.2	290.5	291.7	-79.4	0.0	0.0	-79.4	0.0	0.0	-79.4	309.3	229.1	0.0
38	1.2	319.7	320.8	29.2	0.0	0.0	29.2	0.0	0.0	29.2	338.4	229.1	0.0
39	1.2	344.3	345.4	24.6	0.0	0.0	24.6	0.0	0.0	24.6	363.0	229.1	0.0
40	1.2	367.3	368.5	23.1	0.0	0.0	23.1	0.0	0.0	23.1	386.1	229.1	0.0

4.2.2.2 Reforestation type II: Mixture teak with cacao (II)

ΔC_{ACTUAL} for mixed plantations of teak and cacao is determined analogously with ΔC_{ACTUAL} for teak, and therefore only relevant differences will be discussed below. The only relevant difference from the calculations for the teak plantation is the change in carbon stock in shrubs ($\Delta C_{SHRUB\_PROJ,t}$), which is actually the change in carbon stock in cacao.

For the agroforestry plantations of teak with cacao, a distinction is made between teak established in older cacao plantations (baseline carbon stock stratum 4), and teak with cacao established in new areas (baseline carbon stock strata 1 and 2). In the new cacao areas the planting of cacao is part of the project activity, while this is not the case for teak established in old cacao.

Estimating change in carbon stock in cacao biomass ($\Delta C_{SHRUB\_PROJ,t}$)

The change in shrub biomass is calculated by estimating the biomass at the beginning and end of each verification period. The tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" is used to determine changes in shrub carbon stock.

For the older teak with cacao plantations the baseline carbon stock in cacao (shrubs) is not removed with tree planting, but is maintained and managed as cacao. Any positive carbon stock enhancement through e.g. improved management is conservatively excluded.

Following section 6.4 of the methodological it is demonstrated that there has been no decrease in carbon stock in cacao through demonstration of applicability of the following aspects at each verification:

(a) No harvest of cacao plants has occurred in the stratum since the previous verification;

(b) The stratum was not affected by any disturbance (e.g. pest, fire) that would decrease the carbon stock in cacao plants;

(c) Remote sensing data or inventory data demonstrate that tree crown cover in the stratum has not decreased since the previous verification.

Therefore, $C_{SHRUB} = C_{SHRUB\_BSL\_3}$

For new teak with cacao plantations the carbon stock in cacao ($C_{SHRUB\_BSL\_3}$) is zero at start of the project activity, but the baseline carbon stock in shrubs ($C_{SHRUB\_BSL\_1}$) is removed at the start of the project activity and the carbon stock of the planted cacao $\left(C_{SHRUB\_CACAO}\right)$ added.

Therefore: $C_{SHRUB} = C_{SHRUB\_CACAO} - C_{SHRUB\_BSL\_1}$

The biomass in cacao is estimated using the following equation:

$$b_{SHRUB,i} = BDR_{SF} \times b_{FOREST} \times CC_{SHRUB,i} \qquad \text{(Eq. 27 AR-TOOL 14)}$$

where BDR_{SF} is the ratio between shrub biomass per hectare in land having a shrub crown cover of 1.0 and the default above-ground biomass content per hectare in forest. Following the methodology, a default value of 0.1 is used. b_{FOREST} is the default above-ground biomass content in forest in the region or country, and has a default value of 161 ton ha^{-1} [89]. CC_{SHRUB} is the crown cover of shrub (i.e. cacao) in the stratum, which is estimated using field inventories [93].

The total carbon stock in cacao (C_{SHRUB}) is estimated as follows:

$$C_{SHRUB} = \frac{44}{12} \times CF_S \times (1 + R_S) \times \sum_i A_{SHRUB,i} \times b_{SHRUB,i} \qquad \text{(Eq. 26 AR-TOOL 14)}$$

where CF_S is the carbon fraction in cacao biomass, with a default value of 0.47 as per the methodological tool. R_s is the root-shoot ratio for shrubs with a default value of 0.4 as per the methodological tool. A_{SHRUB} is the area of the stratum in hectares.

Since management of the cacao plantations does not involve felling of cacao plants, after initial establishment the same procedure for demonstration of 'no decrease' will be followed as described above for the older cacao areas.

VCUs Mixture teak with cacao

VCUs can now be calculated for the mixture of teak and cacao. VCUs are only generated until the long-term average is reached.

$$\Delta C_{AR-VCS,t\_CACAO} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \qquad \text{(Eq. 5 AR-ACM0003)}$$

Following these equation, the long-term average (LTA) is reached around year 13 after planting for teak in old cacao, and equals 127.6 tCO2eq. for Siuna, and 124.8 tCO2eq. for Bonanza areas (the slight difference is due to difference in soil types and related SOC). For teak in new cacao equal 130.0 and 127.2 for Siuna and Bonanza respectively. A detailed overview of the corresponding calculations is shown in Table 16 till Table 19, and the calculations itself can be consulted in Annex I.

Table 16 - Long term average calculation teak cacao mixture (old cacao) – Siuna areas

	C_{TREE_BSL}	C_{SHRUB_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year
Year	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1
0	1.2	33.8	0.8	35.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	33.8	5.7	40.7	5.0	2.8	0.0	7.7	0.0	0.0	7.7	7.7	7.7	7.7
2	1.2	33.8	32.6	67.6	26.9	2.8	0.0	29.7	0.0	0.0	29.7	37.4	37.4	29.7
3	1.2	33.8	48.7	83.7	16.1	2.8	0.0	18.9	0.0	0.0	18.9	56.3	56.3	18.9
4	1.2	33.8	57.9	92.9	9.2	2.8	0.0	12.0	0.0	0.0	12.0	68.3	68.3	12.0
5	1.2	33.8	43.7	78.7	-14.2	2.8	0.0	-11.4	0.0	0.0	-11.4	56.8	56.8	-11.4
6	1.2	33.8	52.5	87.5	8.8	2.8	0.0	11.5	0.0	0.0	11.5	68.4	68.4	11.5
7	1.2	33.8	49.0	84.0	-3.5	2.8	0.0	-0.7	0.0	0.0	-0.7	67.6	67.6	-0.7
8	1.2	33.8	56.0	91.0	7.0	2.8	0.0	9.8	0.0	0.0	9.8	77.4	77.4	9.8
9	1.2	33.8	70.5	105.5	14.5	2.8	0.0	17.3	0.0	0.0	17.3	94.7	94.7	17.3
10	1.2	33.8	67.1	102.1	-3.5	2.8	0.0	-0.7	0.0	0.0	-0.7	94.0	94.0	-0.7
11	1.2	33.8	75.4	110.4	8.3	2.8	0.0	11.1	0.0	0.0	11.1	105.1	105.1	11.1
12	1.2	33.8	83.7	118.6	8.3	2.8	0.0	11.1	0.0	0.0	11.1	116.2	116.2	11.1
13	1.2	33.8	103.9	138.9	20.3	2.8	0.0	23.0	0.0	0.0	23.0	139.2	127.6	11.4
14	1.2	33.8	114.9	149.9	11.0	2.8	0.0	13.8	0.0	0.0	13.8	153.0	127.6	0.0
15	1.2	33.8	126.0	161.0	11.0	2.8	0.0	13.8	0.0	0.0	13.8	166.8	127.6	0.0
16	1.2	33.8	137.0	172.0	11.0	2.8	0.0	13.8	0.0	0.0	13.8	180.6	127.6	0.0
17	1.2	33.8	145.2	180.2	8.2	2.8	0.0	11.0	0.0	0.0	11.0	191.6	127.6	0.0
18	1.2	33.8	159.8	194.8	14.6	2.8	0.0	17.4	0.0	0.0	17.4	209.0	127.6	0.0
19	1.2	33.8	172.1	207.1	12.3	2.8	0.0	15.1	0.0	0.0	15.1	224.0	127.6	0.0

20	1.2	33.8	183.7	218.7	11.5	2.8	0.0	14.3	0.0	0.0	14.3	238.3	127.6	0.0
21	1.2	33.8	5.7	40.7	-177.9	0.0	0.0	-177.9	0.0	0.0	-177.9	60.4	127.6	0.0
22	1.2	33.8	32.6	67.6	26.9	0.0	0.0	26.9	0.0	0.0	26.9	87.3	127.6	0.0
23	1.2	33.8	48.7	83.7	16.1	0.0	0.0	16.1	0.0	0.0	16.1	103.4	127.6	0.0
24	1.2	33.8	57.9	92.9	9.2	0.0	0.0	9.2	0.0	0.0	9.2	112.6	127.6	0.0
25	1.2	33.8	43.7	78.7	-14.2	0.0	0.0	-14.2	0.0	0.0	-14.2	98.4	127.6	0.0
26	1.2	33.8	52.5	87.5	8.8	0.0	0.0	8.8	0.0	0.0	8.8	107.2	127.6	0.0
27	1.2	33.8	49.0	84.0	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	103.7	127.6	0.0
28	1.2	33.8	56.0	91.0	7.0	0.0	0.0	7.0	0.0	0.0	7.0	110.7	127.6	0.0
29	1.2	33.8	70.5	105.5	14.5	0.0	0.0	14.5	0.0	0.0	14.5	125.2	127.6	0.0
30	1.2	33.8	67.1	102.1	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	121.8	127.6	0.0
31	1.2	33.8	75.4	110.4	8.3	0.0	0.0	8.3	0.0	0.0	8.3	130.0	127.6	0.0
32	1.2	33.8	83.7	118.6	8.3	0.0	0.0	8.3	0.0	0.0	8.3	138.3	127.6	0.0
33	1.2	33.8	103.9	138.9	20.3	0.0	0.0	20.3	0.0	0.0	20.3	158.6	127.6	0.0
34	1.2	33.8	114.9	149.9	11.0	0.0	0.0	11.0	0.0	0.0	11.0	169.6	127.6	0.0
35	1.2	33.8	126.0	161.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	180.7	127.6	0.0
36	1.2	33.8	137.0	172.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	191.7	127.6	0.0
37	1.2	33.8	145.2	180.2	8.2	0.0	0.0	8.2	0.0	0.0	8.2	199.9	127.6	0.0
38	1.2	33.8	159.8	194.8	14.6	0.0	0.0	14.6	0.0	0.0	14.6	214.5	127.6	0.0
39	1.2	33.8	172.1	207.1	12.3	0.0	0.0	12.3	0.0	0.0	12.3	226.8	127.6	0.0
40	1.2	33.8	183.7	218.7	11.5	0.0	0.0	11.5	0.0	0.0	11.5	238.3	127.6	0.0

Table 17 - Long term average calculation teak cacao mixture (old cacao) – Bonanza areas

	C_{TREE_BSL}	C_{SHRUB_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year

Year	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1
0	1.2	33.8	0.8	35.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	33.8	5.7	40.7	5.0	2.6	0.0	7.5	0.0	0.0	7.5	7.5	7.5	7.5
2	1.2	33.8	32.6	67.6	26.9	2.6	0.0	29.5	0.0	0.0	29.5	37.0	37.0	29.5
3	1.2	33.8	48.7	83.7	16.1	2.6	0.0	18.7	0.0	0.0	18.7	55.7	55.7	18.7
4	1.2	33.8	57.9	92.9	9.2	2.6	0.0	11.8	0.0	0.0	11.8	67.5	67.5	11.8
5	1.2	33.8	43.7	78.7	-14.2	2.6	0.0	-11.6	0.0	0.0	-11.6	55.9	55.9	-11.6
6	1.2	33.8	52.5	87.5	8.8	2.6	0.0	11.3	0.0	0.0	11.3	67.2	67.2	11.3
7	1.2	33.8	49.0	84.0	-3.5	2.6	0.0	-0.9	0.0	0.0	-0.9	66.3	66.3	-0.9
8	1.2	33.8	56.0	91.0	7.0	2.6	0.0	9.6	0.0	0.0	9.6	75.9	75.9	9.6
9	1.2	33.8	70.5	105.5	14.5	2.6	0.0	17.1	0.0	0.0	17.1	93.0	93.0	17.1
10	1.2	33.8	67.1	102.1	-3.5	2.6	0.0	-0.9	0.0	0.0	-0.9	92.2	92.2	-0.9
11	1.2	33.8	75.4	110.4	8.3	2.6	0.0	10.9	0.0	0.0	10.9	103.0	103.0	10.9
12	1.2	33.8	83.7	118.6	8.3	2.6	0.0	10.9	0.0	0.0	10.9	113.9	113.9	10.9
13	1.2	33.8	103.9	138.9	20.3	2.6	0.0	22.8	0.0	0.0	22.8	136.8	124.8	10.9
14	1.2	33.8	114.9	149.9	11.0	2.6	0.0	13.6	0.0	0.0	13.6	150.4	124.8	0.0
15	1.2	33.8	126.0	161.0	11.0	2.6	0.0	13.6	0.0	0.0	13.6	164.0	124.8	0.0
16	1.2	33.8	137.0	172.0	11.0	2.6	0.0	13.6	0.0	0.0	13.6	177.6	124.8	0.0
17	1.2	33.8	145.2	180.2	8.2	2.6	0.0	10.8	0.0	0.0	10.8	188.4	124.8	0.0
18	1.2	33.8	159.8	194.8	14.6	2.6	0.0	17.2	0.0	0.0	17.2	205.6	124.8	0.0
19	1.2	33.8	172.1	207.1	12.3	2.6	0.0	14.9	0.0	0.0	14.9	220.5	124.8	0.0
20	1.2	33.8	183.7	218.7	11.5	2.6	0.0	14.1	0.0	0.0	14.1	234.6	124.8	0.0
21	1.2	33.8	5.7	40.7	-177.9	0.0	0.0	-177.9	0.0	0.0	-177.9	56.7	124.8	0.0
22	1.2	33.8	32.6	67.6	26.9	0.0	0.0	26.9	0.0	0.0	26.9	83.6	124.8	0.0
23	1.2	33.8	48.7	83.7	16.1	0.0	0.0	16.1	0.0	0.0	16.1	99.7	124.8	0.0
24	1.2	33.8	57.9	92.9	9.2	0.0	0.0	9.2	0.0	0.0	9.2	108.9	124.8	0.0

25	1.2	33.8	43.7	78.7	-14.2	0.0	0.0	-14.2	0.0	0.0	-14.2	94.7	124.8	0.0
26	1.2	33.8	52.5	87.5	8.8	0.0	0.0	8.8	0.0	0.0	8.8	103.4	124.8	0.0
27	1.2	33.8	49.0	84.0	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	99.9	124.8	0.0
28	1.2	33.8	56.0	91.0	7.0	0.0	0.0	7.0	0.0	0.0	7.0	106.9	124.8	0.0
29	1.2	33.8	70.5	105.5	14.5	0.0	0.0	14.5	0.0	0.0	14.5	121.5	124.8	0.0
30	1.2	33.8	67.1	102.1	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	118.0	124.8	0.0
31	1.2	33.8	75.4	110.4	8.3	0.0	0.0	8.3	0.0	0.0	8.3	126.3	124.8	0.0
32	1.2	33.8	83.7	118.6	8.3	0.0	0.0	8.3	0.0	0.0	8.3	134.6	124.8	0.0
33	1.2	33.8	103.9	138.9	20.3	0.0	0.0	20.3	0.0	0.0	20.3	154.9	124.8	0.0
34	1.2	33.8	114.9	149.9	11.0	0.0	0.0	11.0	0.0	0.0	11.0	165.9	124.8	0.0
35	1.2	33.8	126.0	161.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	176.9	124.8	0.0
36	1.2	33.8	137.0	172.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	187.9	124.8	0.0
37	1.2	33.8	145.2	180.2	8.2	0.0	0.0	8.2	0.0	0.0	8.2	196.2	124.8	0.0
38	1.2	33.8	159.8	194.8	14.6	0.0	0.0	14.6	0.0	0.0	14.6	210.8	124.8	0.0
39	1.2	33.8	172.1	207.1	12.3	0.0	0.0	12.3	0.0	0.0	12.3	223.1	124.8	0.0
40	1.2	33.8	183.7	218.7	11.5	0.0	0.0	11.5	0.0	0.0	11.5	234.6	124.8	0.0

Table 18 - Long term average calculation teak cacao mixture (new cacao) – Siuna areas

	C_{TREE_BSL}	C_{SHRUB_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year
Year	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1	t CO2e ha-1
0	32.6	0.0	0.8	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	33.8	5.7	40.7	7.4	2.8	0.0	10.2	0.0	0.0	10.2	10.2	10.2	10.2
2	1.2	33.8	32.6	67.6	26.9	2.8	0.0	29.7	0.0	0.0	29.7	39.9	39.9	29.7
3	1.2	33.8	48.7	83.7	16.1	2.8	0.0	18.9	0.0	0.0	18.9	58.7	58.7	18.9

4	1.2	33.8	57.9	92.9	9.2	2.8	0.0	12.0	0.0	0.0	12.0	70.7	70.7	12.0
5	1.2	33.8	43.7	78.7	-14.2	2.8	0.0	-11.4	0.0	0.0	-11.4	59.3	59.3	-11.4
6	1.2	33.8	52.5	87.5	8.8	2.8	0.0	11.5	0.0	0.0	11.5	70.8	70.8	11.5
7	1.2	33.8	49.0	84.0	-3.5	2.8	0.0	-0.7	0.0	0.0	-0.7	70.1	70.1	-0.7
8	1.2	33.8	56.0	91.0	7.0	2.8	0.0	9.8	0.0	0.0	9.8	79.9	79.9	9.8
9	1.2	33.8	70.5	105.5	14.5	2.8	0.0	17.3	0.0	0.0	17.3	97.2	97.2	17.3
10	1.2	33.8	67.1	102.1	-3.5	2.8	0.0	-0.7	0.0	0.0	-0.7	96.5	96.5	-0.7
11	1.2	33.8	75.4	110.4	8.3	2.8	0.0	11.1	0.0	0.0	11.1	107.5	107.5	11.1
12	1.2	33.8	83.7	118.6	8.3	2.8	0.0	11.1	0.0	0.0	11.1	118.6	118.6	11.1
13	1.2	33.8	103.9	138.9	20.3	2.8	0.0	23.0	0.0	0.0	23.0	141.6	130.0	11.4
14	1.2	33.8	114.9	149.9	11.0	2.8	0.0	13.8	0.0	0.0	13.8	155.4	130.0	0.0
15	1.2	33.8	126.0	161.0	11.0	2.8	0.0	13.8	0.0	0.0	13.8	169.2	130.0	0.0
16	1.2	33.8	137.0	172.0	11.0	2.8	0.0	13.8	0.0	0.0	13.8	183.0	130.0	0.0
17	1.2	33.8	145.2	180.2	8.2	2.8	0.0	11.0	0.0	0.0	11.0	194.0	130.0	0.0
18	1.2	33.8	159.8	194.8	14.6	2.8	0.0	17.4	0.0	0.0	17.4	211.4	130.0	0.0
19	1.2	33.8	172.1	207.1	12.3	2.8	0.0	15.1	0.0	0.0	15.1	226.5	130.0	0.0
20	1.2	33.8	183.7	218.7	11.5	2.8	0.0	14.3	0.0	0.0	14.3	240.8	130.0	0.0
21	1.2	33.8	5.7	40.7	-177.9	0.0	0.0	-177.9	0.0	0.0	-177.9	62.8	130.0	0.0
22	1.2	33.8	32.6	67.6	26.9	0.0	0.0	26.9	0.0	0.0	26.9	89.8	130.0	0.0
23	1.2	33.8	48.7	83.7	16.1	0.0	0.0	16.1	0.0	0.0	16.1	105.9	130.0	0.0
24	1.2	33.8	57.9	92.9	9.2	0.0	0.0	9.2	0.0	0.0	9.2	115.1	130.0	0.0
25	1.2	33.8	43.7	78.7	-14.2	0.0	0.0	-14.2	0.0	0.0	-14.2	100.8	130.0	0.0
26	1.2	33.8	52.5	87.5	8.8	0.0	0.0	8.8	0.0	0.0	8.8	109.6	130.0	0.0
27	1.2	33.8	49.0	84.0	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	106.1	130.0	0.0
28	1.2	33.8	56.0	91.0	7.0	0.0	0.0	7.0	0.0	0.0	7.0	113.1	130.0	0.0
29	1.2	33.8	70.5	105.5	14.5	0.0	0.0	14.5	0.0	0.0	14.5	127.7	130.0	0.0
30	1.2	33.8	67.1	102.1	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	124.2	130.0	0.0

31	1.2	33.8	75.4	110.4	8.3	0.0	0.0	8.3	0.0	0.0	8.3	132.5	130.0	0.0
32	1.2	33.8	83.7	118.6	8.3	0.0	0.0	8.3	0.0	0.0	8.3	140.8	130.0	0.0
33	1.2	33.8	103.9	138.9	20.3	0.0	0.0	20.3	0.0	0.0	20.3	161.0	130.0	0.0
34	1.2	33.8	114.9	149.9	11.0	0.0	0.0	11.0	0.0	0.0	11.0	172.1	130.0	0.0
35	1.2	33.8	126.0	161.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	183.1	130.0	0.0
36	1.2	33.8	137.0	172.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	194.1	130.0	0.0
37	1.2	33.8	145.2	180.2	8.2	0.0	0.0	8.2	0.0	0.0	8.2	202.4	130.0	0.0
38	1.2	33.8	159.8	194.8	14.6	0.0	0.0	14.6	0.0	0.0	14.6	216.9	130.0	0.0
39	1.2	33.8	172.1	207.1	12.3	0.0	0.0	12.3	0.0	0.0	12.3	229.2	130.0	0.0
40	1.2	33.8	183.7	218.7	11.5	0.0	0.0	11.5	0.0	0.0	11.5	240.8	130.0	0.0

Table 19 - Long term average calculation teak cacao mixture (new cacao) – Bonanza areas

	C_{TREE_BSL}	C_{SHRUB_BSL}	C_{TREE}	C_{TREE_PROJ}	ΔC_{TREE_PROJ}	ΔC_{SOC}	GHGe	ΔActual	ΔBSL	Leakage	ΔAR_CDM	ΔC Sum	C LTA	ΔC per year
Year	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1	t CO_2e ha-1
0	32.6	0.0	0.8	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.2	33.8	5.7	40.7	7.4	2.6	0.0	10.0	0.0	0.0	10.0	10.0	10.0	10.0
2	1.2	33.8	32.6	67.6	26.9	2.6	0.0	29.5	0.0	0.0	29.5	39.5	39.5	29.5
3	1.2	33.8	48.7	83.7	16.1	2.6	0.0	18.7	0.0	0.0	18.7	58.2	58.2	18.7
4	1.2	33.8	57.9	92.9	9.2	2.6	0.0	11.8	0.0	0.0	11.8	70.0	70.0	11.8
5	1.2	33.8	43.7	78.7	-14.2	2.6	0.0	-11.6	0.0	0.0	-11.6	58.3	58.3	-11.6
6	1.2	33.8	52.5	87.5	8.8	2.6	0.0	11.3	0.0	0.0	11.3	69.7	69.7	11.3
7	1.2	33.8	49.0	84.0	-3.5	2.6	0.0	-0.9	0.0	0.0	-0.9	68.8	68.8	-0.9
8	1.2	33.8	56.0	91.0	7.0	2.6	0.0	9.6	0.0	0.0	9.6	78.4	78.4	9.6
9	1.2	33.8	70.5	105.5	14.5	2.6	0.0	17.1	0.0	0.0	17.1	95.5	95.5	17.1
10	1.2	33.8	67.1	102.1	-3.5	2.6	0.0	-0.9	0.0	0.0	-0.9	94.6	94.6	-0.9

11	1.2	33.8	75.4	110.4	8.3	2.6	0.0	10.9	0.0	0.0	10.9	105.5	105.5	10.9
12	1.2	33.8	83.7	118.6	8.3	2.6	0.0	10.9	0.0	0.0	10.9	116.3	116.3	10.9
13	1.2	33.8	103.9	138.9	20.3	2.6	0.0	22.8	0.0	0.0	22.8	139.2	127.2	10.8
14	1.2	33.8	114.9	149.9	11.0	2.6	0.0	13.6	0.0	0.0	13.6	152.8	127.2	0.0
15	1.2	33.8	126.0	161.0	11.0	2.6	0.0	13.6	0.0	0.0	13.6	166.4	127.2	0.0
16	1.2	33.8	137.0	172.0	11.0	2.6	0.0	13.6	0.0	0.0	13.6	180.0	127.2	0.0
17	1.2	33.8	145.2	180.2	8.2	2.6	0.0	10.8	0.0	0.0	10.8	190.9	127.2	0.0
18	1.2	33.8	159.8	194.8	14.6	2.6	0.0	17.2	0.0	0.0	17.2	208.0	127.2	0.0
19	1.2	33.8	172.1	207.1	12.3	2.6	0.0	14.9	0.0	0.0	14.9	222.9	127.2	0.0
20	1.2	33.8	183.7	218.7	11.5	2.6	0.0	14.1	0.0	0.0	14.1	237.0	127.2	0.0
21	1.2	33.8	5.7	40.7	-177.9	0.0	0.0	-177.9	0.0	0.0	-177.9	59.1	127.2	0.0
22	1.2	33.8	32.6	67.6	26.9	0.0	0.0	26.9	0.0	0.0	26.9	86.0	127.2	0.0
23	1.2	33.8	48.7	83.7	16.1	0.0	0.0	16.1	0.0	0.0	16.1	102.1	127.2	0.0
24	1.2	33.8	57.9	92.9	9.2	0.0	0.0	9.2	0.0	0.0	9.2	111.3	127.2	0.0
25	1.2	33.8	43.7	78.7	-14.2	0.0	0.0	-14.2	0.0	0.0	-14.2	97.1	127.2	0.0
26	1.2	33.8	52.5	87.5	8.8	0.0	0.0	8.8	0.0	0.0	8.8	105.9	127.2	0.0
27	1.2	33.8	49.0	84.0	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	102.4	127.2	0.0
28	1.2	33.8	56.0	91.0	7.0	0.0	0.0	7.0	0.0	0.0	7.0	109.4	127.2	0.0
29	1.2	33.8	70.5	105.5	14.5	0.0	0.0	14.5	0.0	0.0	14.5	123.9	127.2	0.0
30	1.2	33.8	67.1	102.1	-3.5	0.0	0.0	-3.5	0.0	0.0	-3.5	120.4	127.2	0.0
31	1.2	33.8	75.4	110.4	8.3	0.0	0.0	8.3	0.0	0.0	8.3	128.7	127.2	0.0
32	1.2	33.8	83.7	118.6	8.3	0.0	0.0	8.3	0.0	0.0	8.3	137.0	127.2	0.0
33	1.2	33.8	103.9	138.9	20.3	0.0	0.0	20.3	0.0	0.0	20.3	157.3	127.2	0.0
34	1.2	33.8	114.9	149.9	11.0	0.0	0.0	11.0	0.0	0.0	11.0	168.3	127.2	0.0
35	1.2	33.8	126.0	161.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	179.3	127.2	0.0
36	1.2	33.8	137.0	172.0	11.0	0.0	0.0	11.0	0.0	0.0	11.0	190.4	127.2	0.0
37	1.2	33.8	145.2	180.2	8.2	0.0	0.0	8.2	0.0	0.0	8.2	198.6	127.2	0.0

38	1.2	33.8	159.8	194.8	14.6	0.0	0.0	14.6	0.0	0.0	14.6	213.2	127.2	0.0
39	1.2	33.8	172.1	207.1	12.3	0.0	0.0	12.3	0.0	0.0	12.3	225.5	127.2	0.0
40	1.2	33.8	183.7	218.7	11.5	0.0	0.0	11.5	0.0	0.0	11.5	237.0	127.2	0.0

4.2.2.3 Reforestation type III: Protection

ΔC_{ACTUAL} for protection areas is determined analogously with ΔC_{ACTUAL} for the teak plantations, and therefore only relevant differences will be discussed below. The protection areas are composed of remnant forest patches (baseline carbon stock stratum 3), tacotales (baseline carbon stock stratum 2) and pastureland (baseline carbon stock stratum 1). These areas are protected and managed according to the management plan for protection areas [24], and are expected to gradually develop to natural forest areas. ΔSOC is only relevant for baseline strata 1 and 2, since these are degraded areas. Where forest patches exist ΔSOC is conservatively neglected.

What is notably different 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. Methods for determining the baseline carbon stock have been provided in chapter 4.1.

Carbon stock in indigenous tree biomass (C_{TREE})

The ex-ante calculations are based on the above-ground biomass (AGB) model for tropical moist forest in the Americas [94], as the ecological zone is classified as tropical moist deciduous forest [92]. This model has the following form:

$$AGB = -127.2 + 77.16\ln(x)$$

where x is stand age in years. Carbon fraction and root-to-shoot ratio were derived from IPCC [95]. For the root-to-shoot ratio an average value was chosen for moist deciduous forest with >125 ton DW ha^{-1} aboveground and <125 ton DW ha^{-1} aboveground, since this forest will change gradually from lower than 125 ton ha^{-1} to more than that.

The total carbon stock in the protection areas is estimated for the various baselines according chapter 4.1, since the protection areas have 3 different baseline scenario's. The baseline carbon stocks are plotted on the curve to determine the corresponding estimated age and expected carbon sequestration (Figure 19).

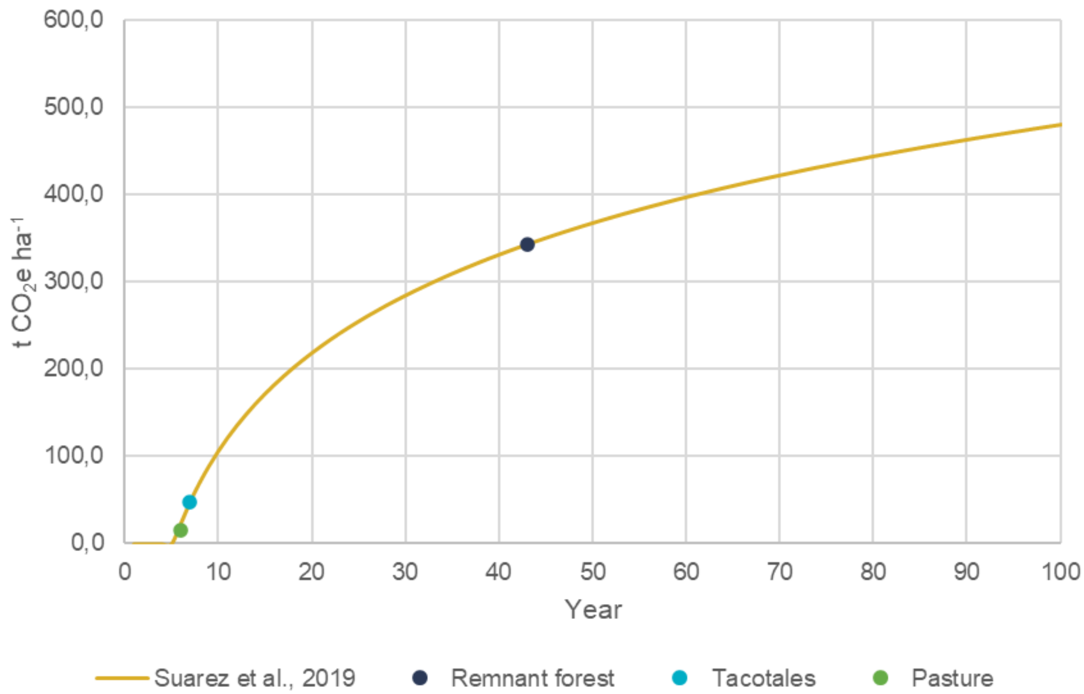


Figure 19 Observed baseline carbon stocks and expected carbon sequestration model

For ex-post estimation of carbon stock in trees and shrubs exactly the same approach is used as described in chapter 4.1.3.

Leakage

In the remnant forest patches leakage is zero, since no agricultural activities existed here. In the pasture lands and tacotales that are managed as protection area in the project activity, leakage is the same as for the other reforestation types and therefore considered not significant.

VCUs protection area

VCUs can now be calculated for the protection areas. As no harvesting is done in the protection areas, the calculation of a long-term average is not applicable.

$$\Delta C_{AR-VCS,t\_PROTECTION} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \quad \text{(Eq. 5 AR-ACM0003)}$$

The corresponding calculation of the annual carbon uptake is shown in Table x and Table x.

4.3 Leakage

Under the applicability of methodology AR-ACM0003, the only relevant type of leakage is due to displacement of agricultural activities.

Leakage emissions attributable to the displacement of agricultural activities as a result of the implementation of an A/R CDM project activity is estimated as the decrease in carbon stocks in the affected carbon pools of the land receiving the displaced activity.

The Social and Environmental Impact Study has identified the earlier owners and users of the properties (before it was part of the project) as a mix of large land-owners and some smallholders [2]. The study notes that the larger land-owners continued their cattle ranging activities in the more economically developed zones, close to populated and urban centers. These areas have not been specifically identified or documented, and this has been more than 10 years in the past. The characteristics of these zones (close to urban centers) indicate these land-users have been moving towards already deforested zones.

The former smaller land-owners are known to have moved to the Matagalpa zone or to neighboring locations or municipalities [2]. The zone of Matagalpa has been historically deforested. This is further underlined by the 2017 study 'Study of the causes of deforestation and forest degradation in Nicaragua', developed for the National ENDE-REDD+ programme [96]. The Matagalpa zone, to which larger land-owners have been moving, have been historically degraded and show no significant deforestation during the 2005-2015 period.

As for the smaller land-owners, which generally moved to nearby communities in the wider Siuna area, no leakage could be determined. The areas which are expected to have received the displaced activity, had the same characteristics or were even with higher vegetation cover after the displacement, compared to the situation before lands were acquired. A land-use change study indicated that of the overall 54,706 hectares of the wider Siuna area, forest cover increased from 37.61 to 42.51% between 2003 and 2010 [23] (the period in which the project acquired the principal areas). This is proven in Figure 20 by satellite imagery analysis.

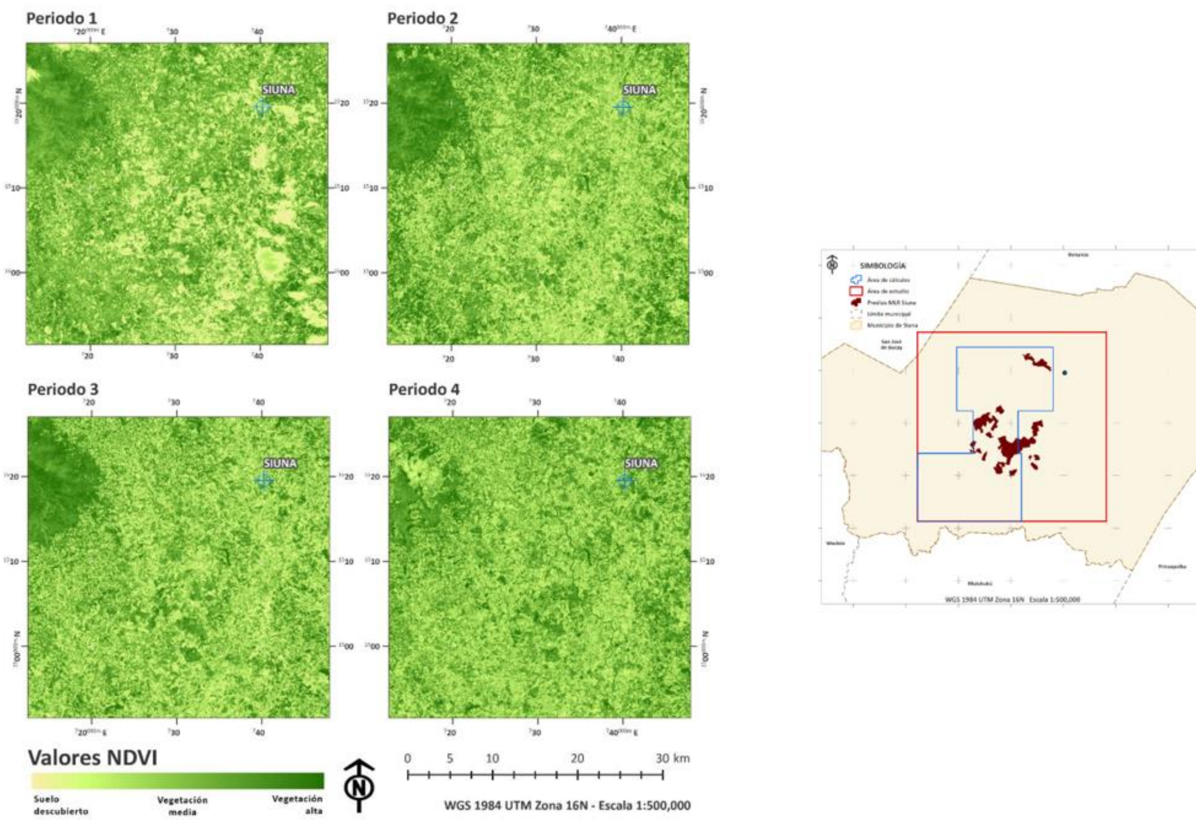


Figure 20 - NDVI vegetation cover of wider Siuna area. Period 2 refers to 2003, Period 3 refers to 2010 – reflecting the period when the principal parts of the actual MLR properties were acquired, and where impact of displacement would be expected. As such, these images have to be compared to understand the potential impact of leakage in the region.

Because of these conditions, it is very unlikely that the displacement has resulted in leakage emissions. 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", displacement of an agricultural activity by itself does not result in leakage emissions. Leakage emissions occur only when the displacement leads to a decrease in carbon stock in the areas that received the displaced activity. Therefore, leakage is considered to be insignificant.

4.4 Estimated Net GHG Emission Reductions and Removals

Table 20 Estimated Net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or

	removals (tCO_2e)			removals (tCO_2e)
2016	0	0	0	0
2017	0	2 970	0	2 970
2018	0	5 688	0	5 688
2019	0	7 508	0	7 508
2020	0	46 471	0	46 471
2021	0	50 717	0	50 717
2022	0	48 107	0	48 107
2023	0	51 672	0	51 672
2024	0	55 107	0	55 107
2025	0	56 556	0	56 556
2026	0	58 499	0	58 499
2027	0	57 416	0	57 416
2028	0	63 279	0	63 279
2029	0	60 618	0	60 618
2030	0	55 866	0	55 866
2031	0	57 992	0	57 992
2032	0	52 156	0	52 156
2033	0	41 481	0	41 481
2034	0	39 377	0	39 377

2035	0	32 816	0	32 816
2036	0	29 911	0	29 911
2037	0	22 625	0	22 625
2038	0	17 953	0	17 953
2039	0	17 892	0	17 892
2040	0	9 377	0	9 377
2041	0	8 702	0	8 702
2042	0	8 424	0	8 424
2043	0	8 165	0	8 165
2044	0	7 882	0	7 882
2045	0	7 615	0	7 615
2046	0	7 361	0	7 361
2047	0	7 080	0	7 080
2048	0	6 810	0	6 810
2049	0	6 550	0	6 550
2050	0	6 381	0	6 381
2051	0	6 222	0	6 222
2052	0	6 070	0	6 070
2053	0	5 926	0	5 926
2054	0	5 788	0	5 788

2055	0	5 658	0	5 658
Total	**0**	**1 046 688**	**0**	**1 046 688**

5 MONITORING

5.1 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 [97, 98]
Value applied:	Value varies per species. See for more details Appendix I: Calculation file.
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	[95]
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	[89]
Value applied:	161
Justification of choice of data or description of	Default value from IPCC

measurement methods and procedures applied	
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	[95]
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	Default value from methodological tool

measurement methods and procedures applied	
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	[89]
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	[91]
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	[91]
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	[90]
Value applied:	-
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	Ultisols are a Low Activity Clay soil type. Alfisols are a High Activity Clay soil type. The climate region is a tropical moist region [92].

measurement methods and procedures applied	
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) pastureland
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	

5.2 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 5.3 of this PDD
Frequency of monitoring/recording	Annual for teak and cacao 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 cacao monitoring 1 sample plot of 72m^2 is used for every 2.5 ha. For this monitoring period 4.15 ha was monitored in sample plots in the teak plantations, and 1.9 ha in sample plots in the protection areas.
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 5.3 of this PDD for elaboration.
Frequency of monitoring/recording	Annual for teak and 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 5.3 of this PDD for elaboration.
Frequency of monitoring/recording	Annual for teak and cacao At least before every monitoring event for the protection areas.
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	

Data / Parameter	CC_{SHRUB}
Data unit	%
Description	The crown cover refers to the percentage of live or dead cover that the cacao plants have in the sampled area.
Source of data	Measured by project proponent
Description of measurement methods and procedures applied	Is measured in permanent sample plots, see chapter 5.3 of this PDD for elaboration.
Frequency of monitoring/recording	Annual for teak and cacao At least before every monitoring event for the protection areas.
Value applied:	Value varies per sample plot.
Monitoring equipment	Measurement 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 project emissions
Calculation method	Not applicable
Comments	

5.3 Monitoring Plan

5.3.1 Description of the Monitoring Plan

Forest development is monitored in all forest types: Teak plantations, Teak with cacao plantations, and protection areas. The measurements are taken in permanent sample plots (PSP), which are established throughout the project area, in different forest stands. With expansion of the project area the number of plots is also increasing, as new plots are established in new areas.

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 and volumetric growth of the plantation. Sampling is done through circular permanent sample plots (PPM), 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. Per plot the GPS coordinates are recorded, the center of the plot is marked and the individual trees are marked with sequential numbers. Monitoring of the teak plantation starts at an age of 2 years. In earlier years the plantation is too young and too variable to obtain reliable estimates of standing tree volumes. Plots are measured annually. 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 [99]. Internal audit procedures exist to ensure precision [99].

It must be noted that due to the exclusion of areas (and thus PSPs) due to the hurricane, the overall % of remaining PSP plots for the 2016-2018 stands is slightly lower than originally, at 1.7% (hurricane-excluded areas were having slightly more PSPs than non-excluded areas). However, this still leads to low uncertainty intervals for the actual monitoring data period, namely 5.9% (<10%) (also elaborated on in Section 6).

An external audit is performed yearly on the teak monitoring [100].

Mixture teak with cacao PSPs

Procedures for PSP monitoring in the agroforestry system of teak with cacao are the same as for Teak plantations. In addition to measurement of teak in this stratum also the shrub cover is measured. This is done using specific sample plots for cacao, where 1 plot is used for every 2.5ha [93].

Protection areas

For protection areas circular sample plots are used, which are laid down in the different baseline strata. A distinction per baseline strata is made when the plot is established, since these baselines have a considerable difference in carbon stock. A minimum sampling density of 0.5% is applied for the protection area, and per plot the GPS coordinates are coordinates. All trees with a DBH ≥10 cm are measured following the regular monitoring protocol, although where known the tree species is also recorded. To estimate shrubs the plot is divided into 4 quadrants and per quadrant the shrub cover is visually estimated. Based on the obtained shrub cover per quadrant the average total shrub cover for the plot is calculated. The protection areas are monitored at least before every verification event. Protection areas have an uncertainty level of 30%, and as such a 75% uncertainty discount is applied on C_{TREE} for the baseline (see ER sheet) in line with Appendix 2 of the CDM tool.

Environmental monitoring

As an FSC certified company PP commits strongly to environmental values. Therefore, flora and fauna, water quality and erosion monitoring are also undertaken.

5.3.2 Organizational structure, responsibilities and competencies

A number of staff are involved in the monitoring of the plantations and buffer zones. This is elaborated, including qualification requirements and responsibilities, in the description of the positions for monitoring, measuring and cartography [101]. 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 be in charge of collecting the field data, in the plots that were previously identified.
- Group # 3: This is made up of the audit group that includes 2 people.

The team receives annual training by the head of Monitoring, Measurement and Cartography [102]. The procedure document used for trainings is the PPM Inventory and Installation Procedures Manual [99], 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 either).

5.3.3 Methods for recording, storing and aggregating data on parameter

Annually, PSPs are assessed using a specific monitoring procedure. The basic shape of a PSP is a circular plot of 500m^2. Per plot the GPS location is recorded and used in the data files 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. 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 [99].

5.3.4 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 [89]. These are elaborated in the monitoring protocol [99]. Additionally, an independent verification is carried out by an external auditor on the inventory [103, 100].

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

See chapter 5.2 as the information is identical.

6.2 Baseline Emissions

As elaborated above, the change in carbon stock in remnant indigenous trees is accounted as zero since the trees are protected and excluded from further estimation of project net GHG removals by sink.

The change in carbon stock as a result of land preparation, which is the quantification of trees that are removed with land preparation, is provided in chapter 4.1. To provide a solid estimation of the carbon stock in this pool, the number and dimensions of the trees felled for land preparation in a significant area were recorded and further analyzed and summarized in Appendix I. These values are based on data covering 620 hectares, which is representative for the whole project area. The covered verification period concerns 1-7-2016 till 1-3-2021. This resulted in a weighed estimated of 21.6 t CO_2e ha^{-1} being removed (including shrubs) and 1.2 t CO_2e ha^{-1} remaining for pastureland and tacotales.

To determine the carbon stocks of the remnant forest areas at the start of the project activity, 39 sample plots of 500 m^2 were laid out in this stratum. Tree height, tree diameter at breast height (DBH) and tree species were recorded, among other parameters. The estimation of total biomass follows the approach as described in paragraph 4.1.1. Using this data, a total above ground biomass of all trees in the sample plots was calculated and the total aboveground biomass per hectare is derived from this number. The calculations and associated uncertainty are further elaborated in Appendix I.

As elaborated in chapter 4.1, for the teak and agroforestry areas the change in carbon stock in remnant indigenous trees in the monitoring period is accounted as zero since the trees are protected and excluded from further estimation of project net GHG removals by sink. For the protection areas the project intervention is the accumulation of biomass compared to the baseline. These areas are actively managed as protection area since 2020 [24] and change of baseline emissions is not relevant as the change of biomass is due to the project intervention.

Therefore, $\Delta C_{TREE\_BSL,t} = 0$ and because of the exclusion of carbon stock changes in dead wood, litter and soil organic carbon, and shrubs hardly present in the area, $\Delta C_{BSL,t} = 0$.

6.3 Project Emissions

The project consists of three different reforestation types. The long-term average shall be calculated following the AFOLU requirements 4.5.5 when harvesting is applied. Clearfelling is only done in the teak plantation and the teak within the cacao areas. Since AFOLU requires all emissions such as leakage and all carbon pools to be included, the project is first stratified per reforestation typology and then for plant year. For each reforestation typology the methodology AR-ACM0003 version 02.0 is followed.

The estimated net GHG emission removals (t CO_2-e) per year are calculated as:

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

Usually, MLR starts monitoring for the first time 2 years after planting. Before the 2 years there is usually no volume that can be measured because of the size of the trees. The teak with cacao in the project area was firstly planted in 2019, and the protection areas were only put under management in 2020. Therefore, for this monitoring period only the project emissions from teak are relevant.

Estimating change in carbon stock in tree and shrub biomass

The change in tree biomass is estimated using the following equation:

$$\Delta C_{TREE\_PROJ} = C_{TREE,t2} - C_{TREE,t1} \qquad \text{(Eq. 1 AR-TOOL14)}$$

The tree biomass in the first year is the same as the baseline biomass in indigenous trees at the start of the project activity, which are the remnant indigenous trees ($C_{TREE\_BSL\_1}$) and the trees that are felled with land preparation ($C_{TREE\_BSL\_2}$). The tree biomass cleared ($C_{TREE\_BSL\_2}$) and shrub biomass cleared ($C_{SHRUB\_BSL\_1}$) is deducted from the baseline carbon stock and the increment of the planted teak trees (C_{TREE_TEAK}) added. As change in remnant indigenous trees is accounted as zero (see chapter 6.2), the following applies.

$$\Delta C_{TREE\_PROJ} = C_{TREE\_TEAK} - C_{TREE\_BSL\_2} - C_{SHRUB\_BSL\_1}$$

The baseline carbon stocks in trees and shrubs that are removed have been explained in chapter 4.1 and are further elaborated in Appendix I. The total tree biomass in teak (C_{TREE_TEAK}) is estimated based on field measurements in Permanent Sample Plots as elaborated in the monitoring plan. These calculations are elaborated in Appendix I.

Based on the mean biomass of the plots per stratum, as well as the associated variance, the mean carbon stock in teak (C_{TREE_TEAK}) within the teak biomass estimation strata and the associated uncertainty (u_C) are estimated following the methodology as described in chapter 4.2.2. The mean biomass per hectare is 41.70 t in the measured teak strata (2016-2018) and the associated uncertainty is 5.9%. Since the uncertainty in tree biomass is less than 10%, there is no need to make C_{TREE} conservative by applying an uncertainty discount.

Trees that have experienced damage due to hurricane (e.g. breaking of stem, uprooting) were conservatively excluded from the biomass calculation (0 height and diameter was assumed); some of these trees have already been extracted from the field, others still alive remain in site, but unsure is if they remain healthy and continue growth sufficiently for commercial use.

Table 21 shows the change in tree biomass for the different teak strata. For the 2018 area there is still a loss in carbon stock due to land preparation, while for the other areas the land preparation losses have already been compensated by biomass in teak as a result of the project activity.

Table 21 Tree biomass at the beginning and end of the monitoring period

Project Activity	Area	Plant year	Area (ha)	$C_{TREE,t1}$ (t CO_2e)	$C_{TREE,t2}$ (t CO_2e)	ΔC_{TREE} (t CO_2e)
I. Teak	Siuna	2016	93.6	2940	14297	11358
I. Teak	Siuna	2017	85.0	2669	7957	5288
I. Teak	Siuna	2018	69.1	2170	64	-2106
Sum			247.70	7,778	22,318	14,540

Estimating change in Soil Organic Carbon

The change in Soil Organic Carbon is 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 chapter 4.2. 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 results are summarized in the table below. $\Delta SOC_{AL,t}$ represents the fixed amount of annual carbon storage. The calculation can be found in Appendix I. Multiplying the number of years and hectares with the $\Delta SOC_{AL,t}$ results in the amount soil organic carbon change (ΔSOC) within the relevant strata. For the protection areas the remnant forest patches are excluded, as there the increase in Soil Organic Carbon is conservatively excluded (see chapter 0).

Table 22 Change in Soil Organic Carbon

Project Activity	Area	Plant year	Years	$\Delta SOC_{AL,t}$ (t CO_2e ha^{-1} yr^{-1})	Area (ha)	ΔSOC (t CO_2e)
I. Teak	Siuna	2016	4	2.77	93.6	1038.1
I. Teak	Siuna	2017	3	2.77	85.0	707.0
I. Teak	Siuna	2018	2	2.77	69.1	383.1
I. Teak	Siuna	2019	1	2.77	264.0	731.9

I. Teak	Siuna	2020	0	2.77	165.2	0.0
II. Teak with cacao	Bonanza	2020	0	2.59	80.9	0.0
II. Teak with cacao	Siuna	2019	1	2.77	101.2	280.5
III. Protection	Bonanza	2020	0	2.59	46.7	0.0
III. Protection	Siuna	2020	0	2.77	718.3	0.0

Sum of changes in selected carbon pools

The total change in selected carbon pools is the change in tree biomass and soil organic carbon. Total $\Delta C_{P,t}$ is therefore:

14 540 (ΔC_{TREE}) + 3 140 (ΔSOC) = 17 680 ton CO_2e ($\Delta C_{P,t}$).

Since $GHG_{E,t} = 0$, $\Delta C_{ACTUAL,t} = \Delta C_{P,t}$.

6.4 Leakage

Under the applicability of AR-ACM0003 the only relevant type of leakage is due to displacement of agricultural activities.

$LK_t = LK_{AGRIC,t}$ (Eq. 4 AR-ACM0003)

As demonstrated in chapter 4.3 leakage is deemed de minimis, and therefore set to zero.

6.5 Net GHG Emission Reductions and Removals

GHG credits can now be calculated using the following equation:

$\Delta C_{AR-VCS,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$ (Eq. 5 AR-ACM0003)

Since $\Delta C_{BSL,t} = 0$ (paragraph 6.2) and $LK_t = 0$ (paragraph 6.4), $\Delta C_{AR-VCS,t} = \Delta C_{ACTUAL,t}$.

The covered verification period concerns 1-7-2016 (project start date) till 1-3-2021 (latest verification of 2020 measurements after hurricane were realized in February 2021).

$\Delta CACTUAL,t$ has been established in paragraph 6.3, and 17 680 ton CO_2e ($\Delta C_{P,t}$) is the number of generated GHG credits. As established in the non-permanence risk report, the risk rating is 10%. This means that 1768 GHG credits need to be deposited into the AFOLU pooled buffer account. Therefore, a total number of 15 912 GHG credits are eligible to be issued as VCUs. This is summarized in the table below.

Table 23 Summary of key results

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation	VCUs eligible for Issuance
2021	0	17 680	0	17 680	1768	15912
Total	0	17 680	0	17 680	1768	15912

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APPENDIX I: CALCULATION FILE

Shared with VVB as appendix to the final report.