REFORESTATION OF DEGRADED FOREST RESERVE AREAS IN GHANA, WEST AFRICA

Project Title	Reforestation of degraded forest reserve areas In Ghana, west Africa
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1 PROJECT DETAILS

1.1 Summary Description of the Project

Currently, Miro Forestry Developments Limited (Miro Forestry) has over 10,000 hectares established in Ghana with five species: Eucalyptus, Teak, Acacia, Gmelina and Corymbia in the Boumfoum, Chirimfa and Awura Forest Reserves. The company aims to produce sustainable timber products including plywood, rotary veneer, poles, sawn timber and wood biomass chips.

The proposed AR-VCS project involves reforestation activities in 4,174 hectares of highly degraded forest reserves. The project forecast an average expansion of 1,500 hectares per year for six years more until reaching approximately 14,000 hectares of holdings in 2025 through the addition of new project areas. The Chirimfa and Awura Forest Reserves were once productive reserves covered with high, -elevation semi-deciduous forest. However, the reserves have been severely degraded by overexploitation, bush fires and conversion to agricultural land, particularly between 1980 and 2000, and has since been declared degraded by the Government of Ghana. Without the reforestation project, the area would be degraded and degrade even further due to agricultural and farming activities, bushfires and logging of the last remaining trees.

The project proponent, Miro Forestry, has land lease agreements and a benefit share agreement[1] with traditional landowners and the Forestry Commission of Ghana to restore the degraded forest reserves into productive planted forests. This lease construction is part of the presidential policy to restore degraded forest reserves in Ghana, which is a strong policy instrument demonstrating the commitment of the Ghanaian government to conserve, restore and promote the sustainable use of forest resources in the country.

Miro Forestry aims to conform to high environmental, ethical, financial and social standards, and achieve international forestry certification on all plantations. It aims to be the preferred partner for local communities, the national government and international development and finance.

Miro Forestry was established in 2007 under Ghanaian law. It has been certified according to the principles and criteria of the Forest Stewardship Council (FSC) since January 2010. The FSC certificate demonstrates the commitment and adherence of Miro Forestry to the highest sustainability standards encompassing both social and ecological aspects. The VCS carbon was implemented according to the same high operational standards. Project activities are carried out and monitored according to approved project methodology AR-ACM0003 for a project period of 30 years, the project estimates to remove 113,776 tCO_2e annually and 3,413,279.2 tCO_2e during its entire life.

[1] Supports\1. PDD\1.2 PO Information\Land Leasing

1.2 Sectoral Scope and Project Type

The sectoral scope of this project is 14, Agriculture, Forestry, and Other Land Uses (AFOLU). Within this category, the project is of the Afforestation, Reforestation, Revegetation (ARR) type.

1.3 Project Eligibility

This analysis was performed on the 5,472.54 hectares planted by Miro Forestry in the 2016-2019 period, the study was carried out in six stages (Table 1) for the 10 years prior to the establishment of the plantation, where the stable non-forest is the eligible area and the rest is defined as an ineligible area.

Table 1. Eligibility analysis stages

Stage 1	Data acquisition
Stage 2	Radiometric and atmospheric corrections
Stage 3	Coverages dissolution
Stage 4	Classification accuracy calculation
Stage 5	Final layer for forest – no forest
Stage 6	Eligibility analysis for the years evaluated

For the country, forests are understood as an area greater than 0.1 ha, with a canopy density greater than 15% and a height greater than 5 m. Non-forest areas are composed of remaining areas, which do not meet the definition of forest[2].

The analysis was performed using Landsat[3] 7 and 8 medium-resolution multispectral images to obtain forest and non-forest coverage through supervised classification. The period analysed was 2016 to 2019; therefore, the period of eligibility includes the pairs of years: 2006-2016, 2007-2017, 2008-2018 and 2009-2019.

Of the 5,472.54 hectares analysed for the period, just 4,174.28 hectares are eligible, which corresponds to 77% of the total area analysed for the period, while 1,251.55 ha are ineligible (23%) and 24.84 ha correspond to the area without information (Table 2) (Figure 1):

Table 2. Eligible areas for the selected periods

Period	Eligible	Non-eligible	No information
2006-2016	1,277.87	62.83	10.69
2007-2017	693.43	807.28	4.98

[2] Forest definition for Ghana: http://www.fao.org/forestry/20338-0d886aa3af31818cf013633588910a39a.pdf Available at Supports/1.PDD/1.1Library/Forest_Ghana_2010

[3] Type of satellite images: https://earthexplorer.usgs.gov/

Period	Eligible	Non-eligible	No information
2008-2018	1,248.86	94.49	9.16
2009-2019	954.12	286.94	0.00
Total	4,174.28	1,251.55	24.84

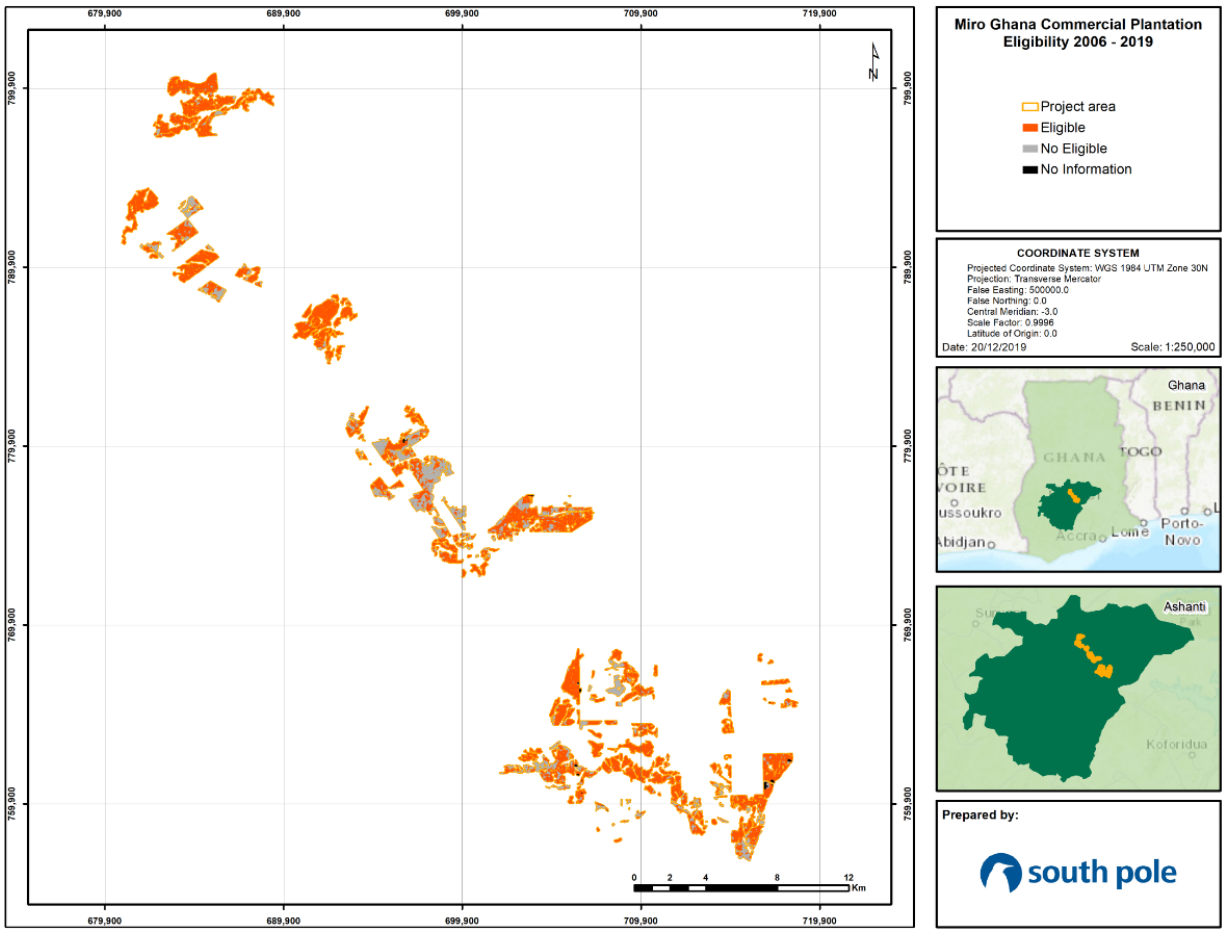

Figure 1. Eligibility for Miro Forestry plantations, Ghana

The complete eligibility report can be found in the supports folder[4].

[4] Supports\1. PDD\1.4 Apendix\Eligibility_AR_MIRO - Ghana

1.4 Project Design

The project has been designed to include a single installation of activity, since it is the only plantation that Miro Forestry has in Ghana.

1.5 Project Proponent

Miro Forestry is a UK-based forest investment company seeking to expand its forest operations in the West African sub-region, including a 21,000-ha plantation in Sierra Leone.

The National Interest Ltd. (NICOL) is a company founded by a group of conscientious individuals who hold a strong background in conflict prevention and transformation, preventive diplomacy and the sustainable development of local communities. NICOL's mission is the development of business and investment models for environmentally friendly social development projects designed to alleviate poverty and environmental degradation. Since its founding in 2005, NICOL has been investigating the d7evelopment of new businesses to improve living conditions, sanitation and health, as well as care for the environment in Ghana.

Nicol-Miro Forestry Company Ltd. was founded in Ghana as a joint-venture company between Miro Forestry Company UK Limited and NICOL in April 2009. Nicol-Miro Forestry Company is managed and financed by its parent company, Miro Forestry Developments Ltd; with NICOL providing local support. In this report, the company is hereinafter described as "Miro Forestry".

Organisation name	MIRO FORESTRY COMPANY Miro Forestry Developments Ltd.
Contact person	Mr. Andrew Collins
Title	Co-Founder, CEO
Address	Office 4.01, 1-2 Paris Gardens, London, SE1 8ND, the United Kingdom
Telephone	Tel: +44(0)7899074158
Email	info@miroforestry.com

1.6 Other Entities Involved in the Project

Organisation name	Miro Forestry (Ghana) Ltd.
Role in the project	Wholly owned subsidiary of Miro Forestry Developments Limited / Ghana operating subsidiary.
Contact person	Mr. Andrew Collins
Title	Co-Founder, CEO
Address	Office 4.01, 1-2 Paris Gardens, London, SE1 8ND, the United Kingdom
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Email	info@miroforestry.com

Organization name	Swiss Carbon Value Ltd.
Role in the project	Project developer
Contact person	Mr. Christian Dannecker
Title	Director Global Sourcing Team
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1.7 Ownership

Land Use and Tenure Rights

The 1992 Constitution of Ghana states at Article 267 that "All degraded or stool lands in Ghana shall vest in the appropriate use and be held in trust for the subjects of the land in accordance with customary law and usage". In practice, all degraded lands belong to the Traditional Council through its President, the paramount chief who is the traditional head of the stool(s) and is duly recognised as the allodial owner of the land.

Under this Article, Miro Forestry cannot claim title to degraded lands allocated to it for the reforestation project but will lease the land in agreement with the landowners and the Forestry Commission for a period of 50 years renewable for a further 50 years.

Tree tenure in respect of commercial forest plantation development in Ghana is catered for under the Timber Resources Management Act [5] (TRMA) (Act 547), 1997 as amended by the TRM (Amendment) Act, 2002 (Act 617) and excludes from its application, land with private plantations. It specifies that no timber rights shall be granted in respect of land with private plantations or land with any timber grown or owned by any individual or group of individuals without the written authorisation of the individual, group or owner concerned.

The Forestry Commission is the mandated custodian of the reserve lands and has been entrusted by the stool landowners to manage and maintain the reserve as a forest on behalf of the stool landowners. The current land use of the reserves can be described as varied. Some parts of the reserves are being used by locals for farming crops such as onions, cassava, maize and plantains, while other parts have been previously used for the establishment of Teak plantations. Field surveys of Miro Forestry have also identified illegal migrant settler farmers who have encroached upon the reserve and established plantain and maize farms, and are also undertaking cattle grazing in many parts of the reserve.

History Ownership and Administration of the Project Site

The Boumfoum Forest Reserve covers an area of 26,000 ha, Chirimfa covers an area of 10,925 ha and Awura covers an area of 12,526 ha; these were constituted under the Forest Ordinance in 1928 and vested in the Government of Ghana. The Boumfoum Forest Reserve is in the Ashanti Region and is under the administration of the Kumawu District Office of the Forest Services Division (FSD), while Awura and Chirimfa Forest Reserve are under the administration of the Mampong District Office of the FSD. The reserves land is owned by the people of Agogo, Kwamang, Mampong and Kumawu Traditional areas and managed by the Kumawu and Mampong Forestry District Office, which is the Government Agency responsible for forest management in the country. Politically, the reserves are under the Asante-Akyem North, Sekyere Kumawu, Sekyere Afram Plains and Sekyere Central Municipal Assemblies. Under the reservation agreement, locals have hunting rights in the Reserve and can collect firewood and non-timber

[5] http://extwprlegs1.fao.org/docs/pdf/gha16665.pdf Available at: Supports\1. PDD\1.1 Library\Document References\Timber Resources Management Act - 1997 (Act 547)

forest products (NTFPs). Admitted farming rights were granted to some families, and the village of Ananekrom was designated as a legal settlement just inside the far eastern boundary of the reserve.

The reserve has been the subject of encroachment by illegal migrant settlers. These settlers engaged in illicit financial transactions with private plantation developers to gain access to reserve lands. Farming is the economic mainstay of the people of Agogo, and since the ban of logging activities and with weak monitoring of the reserve, this activity has illegally spread into the reserve lands. The Forestry Commission, who is the management custodian of the reserve lands, has previously evicted illegal settlers from the reserve, with a long term aim of deterring other migrant farmers; however, there are still illegal migrant farmers on the reserve as well as larger commercial farms run by business men. Communicating with these farmers makes up a large part of Miro Forestry's Social Management Plan.

Actual situation

Miro Forestry has signed a land lease agreement[6] with traditional landowners and the Government of Ghana for the reforestation of the project area to restore productive forest in the degraded forest reserves. This leases construction and benefit sharing contracts are part of the national policy to restore degraded forest reserves in Ghana. The company has signed a Land Lease and Benefit Sharing Agreement with the Forestry Commission and other relevant stakeholders for the statutory rights of entry into the Boumfoum Forest Reserve. The terms of this are similar to those of public-private partnership agreements. The Company's current total land holding is 17,983 hectares. Table 3, below, indicates hectares by lease year:

Table 3. Land lease area (ha) per year

Lease year	Area (Ha)
2009	4,037
2011	34
2015	1,542
2016	5,138
2017	3,753
2018	2,815
2019	664
Total	17,983

[6] Supports\1. PDD\1.2 PO Information\Land Leasing

The total land hold split into the different forest reserves as indicated in below in Table 4.

Table 4. Land lease area per forest reserve

Forest reserve	Area (Ha)
Awura	2,892
Boumfoum	10,707
Chirimfa	4,314
Private	70
Total	17,983

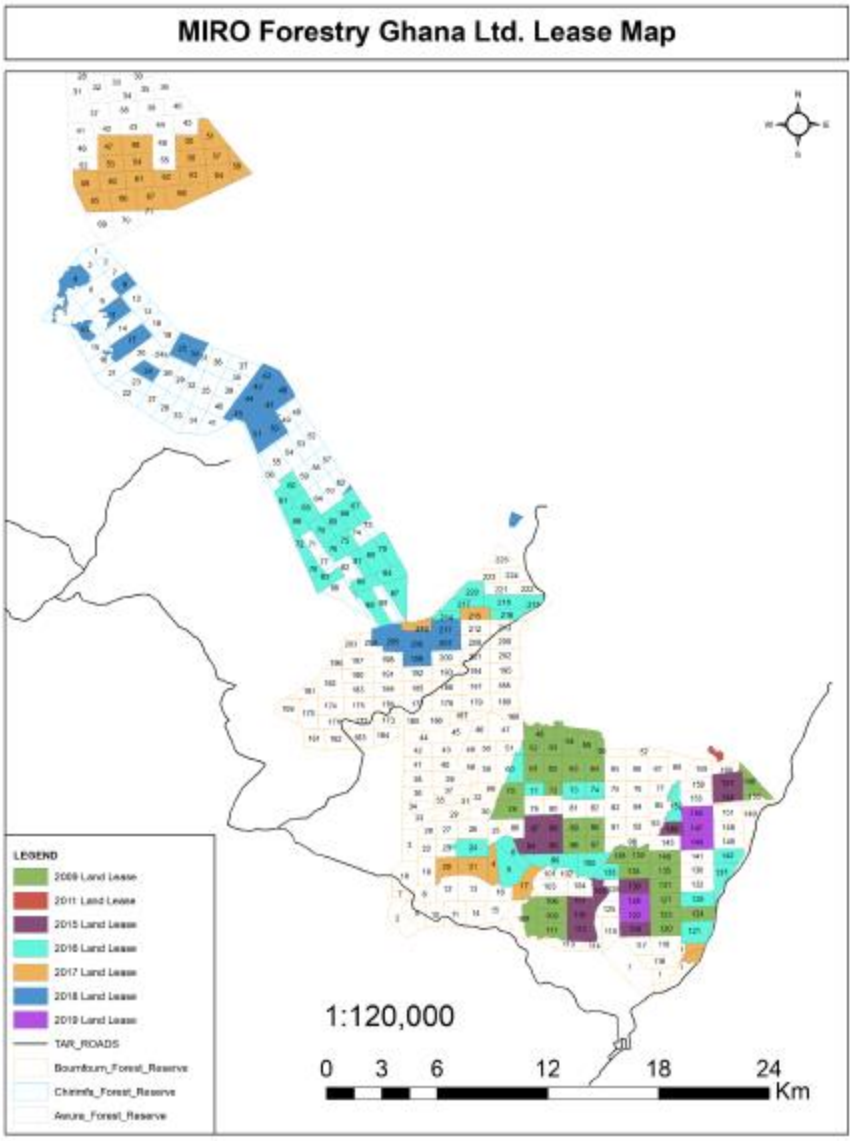

Figure 2. Ghana plantations land lease map

Land for Future Development

Miro Forestry works in partnership with the Forestry Commission of Ghana, the National Head Office and District Management, to identify, secure and develop degraded land for sustainable forestry plantations. Miro Forestry, in conjunction with the Forestry Commission and with the support of local stakeholders, is identifying strategic land areas for development. All such land is located on the Boumfoum, Awura and Chirimfa Forest Reserves, a degraded land area under the control of the Forestry Commission for commercial afforestation.

It is possible that, beyond this timeframe and dependent on the final land area available (dependent on soil types, high conservation values (HCV) and conservation zones, Miro Forestry will expand its

plantation forestry operations beyond the bounds of the Boumfoum, in Awura and Chirimfa Forest Reserves.

1.8 Project Start Date

24/03/2016

This date corresponds to the establishment of the compartment A6 of E.pellita for that year.

1.9 Project Crediting Period

The Ghana project is projected until 2045 – a 30-year lifespan.

Table 5. Project crediting period

Start date	24/03/2016
End date	30/06/2045
Total number of years	30

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The project is located upon a large-scale project:

Project scale	
Project	N/A
Large project	X

Table 6. Estimated GHG emission reductions or removals (tCO_2e)

Year	Estimated GHG emission reductions or removals (tCO_2e)
2016	394
2017	48.203
2018	68.344
2019	111.353
2020	134.691
2021	186.393
2022	233.376
2023	281.496
2024	328.680

2025	377.397
2026	425.851
2027	424.580
2028	430.354
2029	388.743
2030	412.937
2031	389.055
2032	405.873
2033	380.590
2034	383.425
2035	381.352
2036	380.264
2037	378.115
2038	377.397
2039	425.851
2040	424.580
2041	430.354
2042	388.743
2043	412.937
2044	389.055
2045	409.743
Total estimated ERs	9.810.123
Total number of crediting years	30
Average annual ERs	**327.004**

These average annual ERs does not incorporate the Long-term average applied. For seeing the complete calculation and the LTA reduction, please check the ex-ante estimations excel sheet.

1.11 Description of the Project Activity

Miro Forestry is not located within a jurisdiction covered by a jurisdictional REDD+ program[7]. Miro Forestry has already developed the policies and procedures needed to establish a world-class forestry plantation.

[7] South Pole research under the verification standards database

This is reflected in their Forestry Management Plan, which covers all stages after the land is acquired, including silviculture through to road construction and harvesting operations (shown in Figure 3).

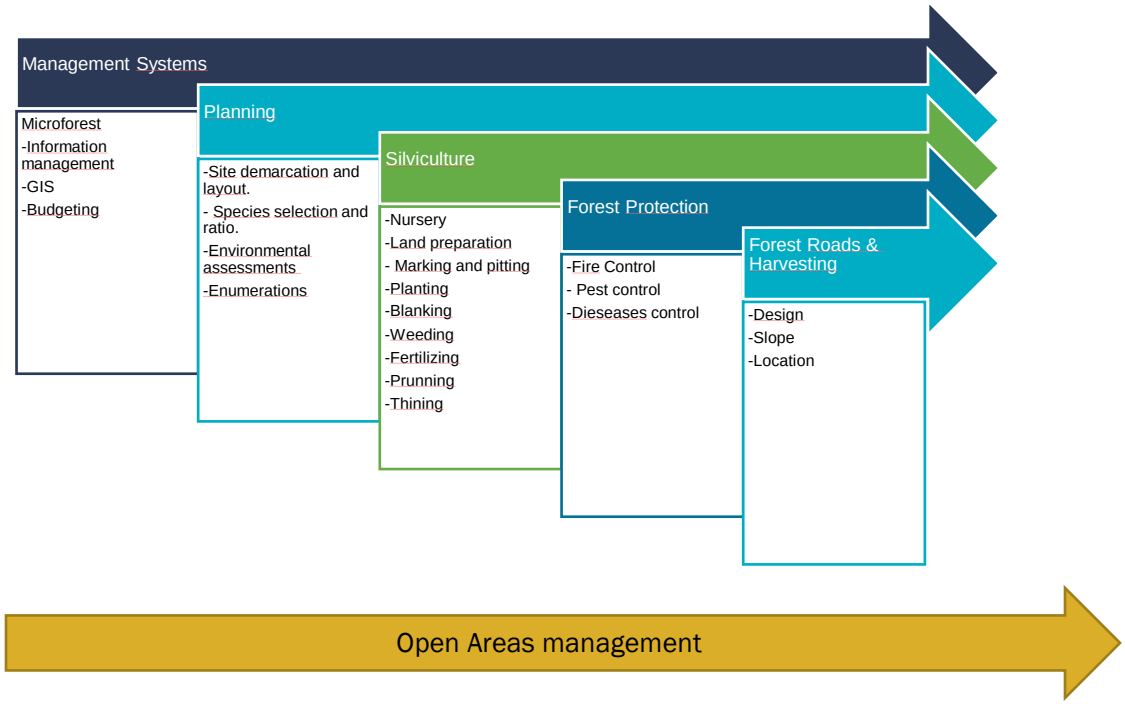

Figure 3. Miro Forestry's main management units

1.11.1 MANAGEMENT SYSTEMS

One of the objectives of Miro Forestry is to guarantee the application of and access to information global experiences of forest management. To achieve this, the company uses a forest management information system called "Microforest". Microforest is a web-based plantation management system that encompasses the entire lifecycle of forestry operations. The system provides access to specialised information and establishes forest support systems that ensure that all levels of management can quantify their decisions on reliable data based on plans strategic plans covering 10 to 20 years, tactical plans (three to five years) and the annual planting operations (APO), which include monthly and daily financial and operative controls.

This software has been developed specifically for the forestry industry and has two main characteristics that make it unique for project management. Firstly, it is an integrated system for the management of plantations and natural resources that covers the entire lifecycle of forest operations and includes modules that manage inventory, modelling, planning, scheduling, operations and logistics (budgets). It also has a Geographic Information System (GIS) that provides the user with all the necessary attribute data in a map format, which allows for permanent planning and efficient control.

Microforest consists of two main modules. The first is the Plantation Manager module, which enables the management of all forest issues related to the compartments (minor management unit). From this set of data, the requirements for the strategic plan and the different tactical plans can be developed. The

second module that connects directly with the Manager of the Plantation is the Business Suite module, which provides the APOs. It provides day-to-day management controls associated with the different activities and the financial and reporting controls related to the budget plan.

All the permissions and management of the information are divided into three levels: macro users, super-users and users. Company personnel are assigned a level depending on their level of responsibility and associated information management permits.

The company also uses a Dropbox-like information management tool to store and share all company files, with the support of online service providers to prevent the loss of information. The Miro Management System (MMS)[8] is used purely for working documents and is the place to find policies, best operating procedures, templates and checklists.

1.11.2 PLANNING

Land mapping and planning

As part of the initial project activities, Miro Forestry and the Forestry Commission have mapped out the boundaries of the proposed development using GIS and the field verification of boundary pillars to build a forestry utilisable area that follows all regulations and laws.

Miro Forestry assesses the terrain and examines the basic structure of soils and grass vegetation. Special consideration is given to important land planning issues such as land slope, water bodies, the identification of any cultural sites, the identification of riparian strips and sites for conservation protection, the existence of agricultural farms, the condition of old logging roads and wildlife habitats. Miro Forestry is currently using satellite images to identify and describe land and vegetation for the mapping exercises to be carried out in some areas. This will provide a very detailed mapping of the reserves. This information will enable Miro Forestry to identify areas for conservation, boundary verification and silvicultural planning, assist in site and species matching, and determine the best possible options for achieving a balance between land use, sustainable forest practices and care for the environment.

Management of natural areas

Environmentally sensitive and conservation areas are identified during the planning phase and are designated as conservation zones protected to encourage natural regeneration. It is the Company's policy to enable natural recovery and succession in conservation zones, and as such, the primary management activity is to protect these areas by removing alien invasive exotics.

Conservation areas are delineated using GPS coordinates. Vegetation classification is done wherever possible, allowing the current vegetation to recover and climax. An alternative vegetation class be set as the desired vegetation class only if biodiversity experts deem it to be necessary. At the time of land

[8] MMS File Structure, Responsibility and Naming Policy

acquisition, a mini governance study is done; part of this includes a Rapid Environment Assessment (REA) to identify any potential sensitive areas and areas of degradation that will require remediation work.

Conservation areas

Initially areas on plantation have been identified as conservation rehabilitation areas. These are:

rivers, wetlands, stream banks and riparian areas with a buffer zone of 30 metres;

buffer zones and corridors for fauna movement, this conserves any existing biodiversity and wildlife. Buffer zone vegetation provides a suitable habitat for any wildlife that may exist; and

representative samples of natural vegetation, including grassland, shrub land and rocky outcrops.

Additional sites may be identified as plantation expansion continues.

Based on the desired vegetation classification and status, management plans will be developed annually to remove alien invasive species depending on the infestation levels identified in the Microforest weed management module. This module facilitates the identification of current infestation levels and the creation of plans to ensure that these areas are returned to maintenance level.

All conservation zones are captured in the GIS system (Figure 5) and Microforest conservation database (Figure 4).

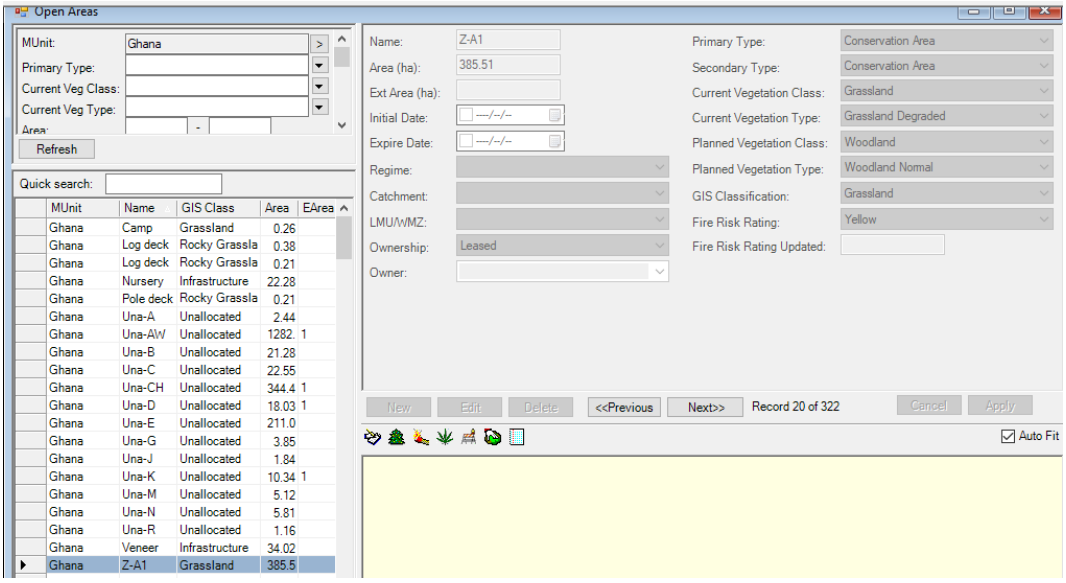

Figure 4. Microforest Open Areas Management

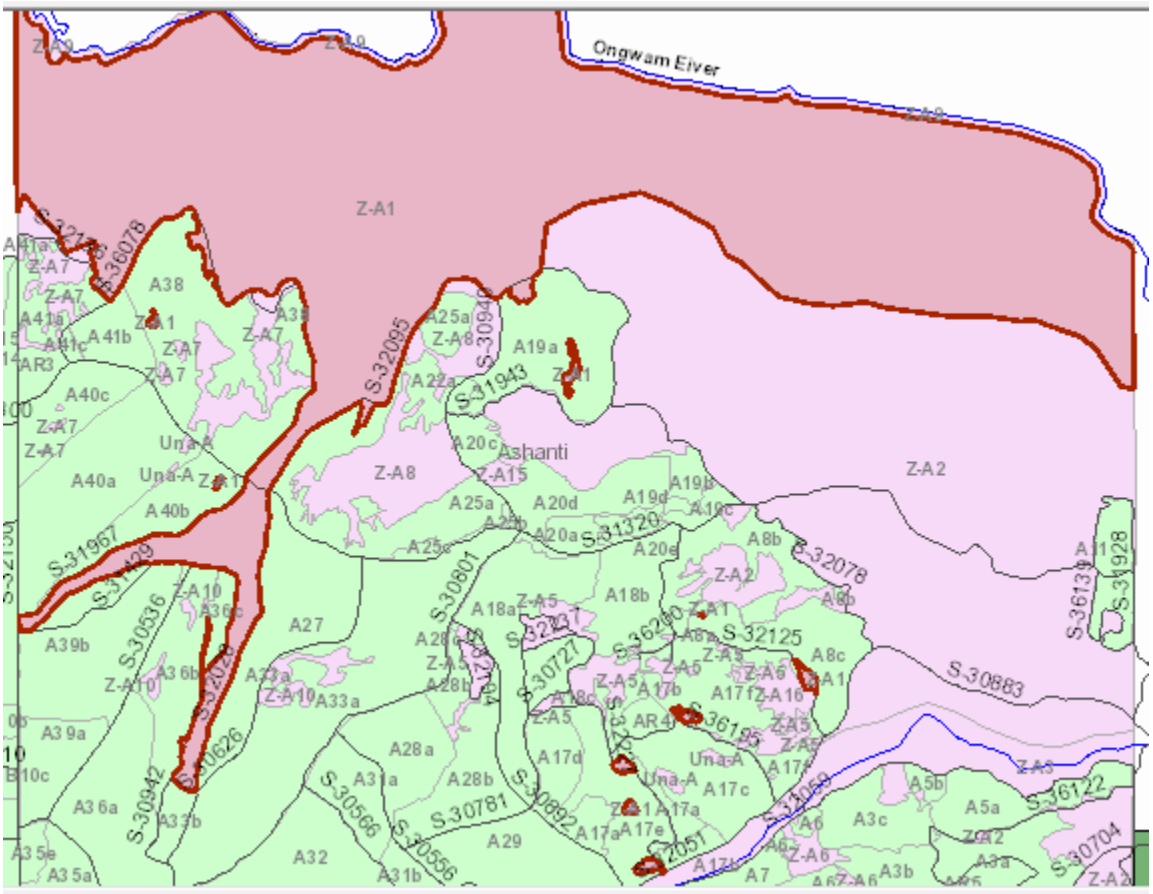

Figure 5. Mapping module from Microforest for open areas management

Management of commercial areas

Site demarcation and layout

The entire project area is constituted into groups (“blocks”) of compartments for the planting of commercial forestry species.

The planting blocks may comprise one or more annual groups and will be further divided into planting units (“compartments”) of approximately 20-30 hectares each with roads around them. As much as possible, the compartments will be based on on-site classification informed by topography, soil data, as and transportation logistics.

Miro Forestry assesses the terrain and examines the basic structure of soils and grass vegetation. Special consideration is given to important land planning issues such as land slope, water bodies, the

identification of any cultural sites, the identification of riparian strips and sites for conservation protection, the existence of agricultural farms, the condition of old logging roads and wildlife habitats.

Species used

Eucalyptus and Teak have been approved by the Forestry Commission for the project and due to the suitability of species for the rehabilitation of the country's degraded forest reserves. Teak has been planted in Ghana since the 1920s when the colonial government used it for fuelwood in boiler plants to generate electricity. Teak and Eucalyptus have also been planted in Ghana's forest reserves for over 70 years without any adverse effects.

Eucalyptus is a versatile timber of high density and close grain formation. It is currently the major source of pulpwood for the international paper industry and is the major timber used for transmission poles across the tropics because of its high bending strength and natural durability characteristics. Ghana already imports about 70,000 Eucalyptus poles for use as transmission poles in its electricity system. The species can also be used in the construction of wood-based panels including plywood, orientated strand board, particle board and medium density fibreboard. With improved wood stains, it is becoming an increasingly popular sawn-timber and for the ever-expanding bio-mass market.

As a result of the widespread adoption of Eucalyptus by the international commercial industry, there is a considerable base of international experience available in its management. A huge amount of research and development work has been done on Eucalyptus, particularly concerning the development of hybrid species, which seek to combine the favorable tree characteristics (e.g. high growth rates, fire and drought resistance, good stem form, resistance to pests/diseases and favorable density characteristics) of more than one Eucalyptus species. The company aims to import Eucalyptus species and work alongside the Forestry Commission to develop the best species technology for various sites and climatic conditions in Ghana.

Ghana has a tropical climate and it is principally for this reason that Teak has been the most widely planted exotic tree species in Ghana. Unfortunately, there are no large, well-managed commercial Teak plantations, and most mature Teak plantations have long been harvested and the products exported in various forms (poles, air-dried lumber and billets). However, it has recently become a familiar and suitable species for the replacement of many of Ghana's natural forest species that have seriously dwindled in population. Besides its economic importance, Teak has been selected primarily because of its suitability to soil and ecological conditions and the fact that there is much local knowledge in silviculture about the species.

The Forestry Commission also mandates that a minimum of 5% of planting area within riverine areas should be planted with indigenous species for conservation purposes. The Company has identified *Ceiba pentandra, Terminalia superba, Triplochiton scleroxylon* and *Nauclea diderichii* to be planted in conservation areas and along streams and rivers to enrich the forest cover along with the water bodies and provide maximum protection to the various watercourses in the reserve. In further support of

conservation objectives, Miro Forestry has also identified small mosaics and clusters of old indigenous tree species, such as Sterculia, that will be turned into conservation areas, protected and maintained.

These are the commercial species used by Miro Forestry:

Table 7. Species used

Species	Common name	Provenance
Eucalyptus pellita	Eucalyptus	Brazil
Tectona grandis	Teak	Ghana
Corymbia citriodora	Corymbia	Brazil
Acacia mangium	Acacia	Brazil/South Africa
Gmelina arborea	Gmelina	Vietnam, Costa Rica, Brazil

Other commercial species the Company is trialing in the project area include Pine, *Cedrela* and other timbers suitable for short to mid-rotation plantations. Due to the low percentage and representativity, these species are grouped later like "other species".

1.11.3 SILVICULTURE

Nursery

The nursery is an important component of the proposed project. Miro Forestry has been using potted seedlings of Eucalyptus species and Teak for its plantings. The Company can produce 2 to 2.5 million seedlings per annum and is largely self-sufficient, as it sources Teak and Eucalyptus seedlings from its permanent nursery located near Serebuoso on the northern boundary of the Reserve.

The nursery is used to raise seedlings for transplanting into the field and to ensure that the Teak and Eucalyptus seedlings are properly prepared and selected for planting. The seeds are first planted in trays with coco-peat medium and then germinated under 35% shade netting. After 3-4 weeks, the seedlings are transferred to steel tray tables to harden for a further 3-4 weeks with the roots being air-pruned. Water sources for the seedlings were initially to be derived from the nearby Ongwam River, but due to the low water quality after water testing, the Company has opted for use of a borehole and has applied to the Water Resources Commission for the appropriate permits[9].

Planting target

The land that the Company currently has under lease is approximately 12,000 hectares, which means that 65% of the total area is suitable as productive area for planting. As a result, to provide certainty of available land to fulfil the Company's future planting strategy, which requires 20,000 ha, the Company is pursuing opportunities to secure an additional 10,000-15,000 ha of land. The amount projected to be

[9] Supports\1. PDD\1.2 PO Information\EPA Licences

planted since 2020 is 1,500 hectares per year and will focus on three main species: *Eucalyptus pellita* (60%), *Gmelina arborea* (30%) and *Acacia mangium* (10%).

Table 8. Planted area by the company 2016-2019 period

Year	Age (yr)	Effective area (ha)	Eucalyptus	Teak	Corymbia	Acacia	Gmelina	Other and trials
2019	0.593	1,566.6	679.08	26.99	25.62	86.03	742.5	6.34
2018	1.425	1,378.3	852.91	67.07	142.2	203.9	100.8	11.48
2017	2.483	1,478.3	862.72	147.7	157.1	279.4	31.28	0.09
2016	3.449	1,345.7	749.7	253.5	146.1	196.4	0	0
Total hectares		5,768.8	3,144.4	495.3	470.9	765.7	874.6	17.91
%		100%	55%	9%	8%	13%	15%	0%

The total number of hectares specified above is the total gross area established between 2016-2019 without the eligibility analysis. The eligible area for the same period was 4,174.28 hectares, as shown below.

Table 9. Eligible Area

Period	Eligible	Non-eligible	No Information
2006 - 2016	1,277.87	62.83	10.69
2007 - 2017	693.43	807.28	4.98
2008 - 2018	1,248.86	94.49	9.16
2009 - 2019	954.12	286.94	0.00
Total	4,174.28	1,251.55	24.84

The Company planned to plant an estimated 1,500 hectares per annum from 2016 - 2019. A provision of 10% of the total area was made to cover the land-take for roads, rides, Special Management Zones (protection areas) and unproductive areas that will not be planted. This projection was adjusted accordingly when additional areas in the Boumfoum, Awura and Chirimfa Reserves become available and are allocated to the Company. The planting target from 2020 onwards is 1,000-1,500 hectares per year,

but this number is under revision as the company need additional income (including through VERs) to strengthen the cashflow it needs to reach that goal.

Slash management

Predominantly, the vegetation on the land currently under lease is degraded scrubland with fast-growing elephant grass, numerous small trees and shrubs. As part of the land preparation activities, weeds will be controlled through the use of glyphosate as a pre- and post-plant spray application.

Land preparation

Various mechanical land preparation techniques are employed by the Company including the use of large mechanical chopper-rollers, roam disc harrows, tractors and bulldozer-drawn rippers, ploughs and other land preparation implements. Where the use of such mechanical systems is difficult, manual methods are used, though the result is often of a lower quality and planting surfaces have a greater presence of weeds.

Land preparation involves appropriate soil preparation and soil testing and analysis. This ensures optimization of the site as soil preparation, to a large extent, determines the success of the planting.

Marking and pitting

The Company's preferred method for pegging out the planting points at the desired spacing for planting, is to lay out a line, marked at intervals with the desired spacing, along the edge of the area to be planted. Two crosslines are then laid out at 90° at each end of the baseline and are marked again with the desired spacing. The baseline is then moved up the two crosslines and pits are made at each of the desired planting locations. The pit is dug by working the pick from different sides to ensure that the pit is straight. Soil is loosened and large clods of earth are broken up. Pits are dug not more than a few days before, or concurrent to planting when the ground is moist from early rains.

Planting

Planting is targeted for between April and October annually (funding timing and other constraints permitting); the exact timing depends on the weather during that period. All planting materials are transported from the nursery using flat-bed trucks and brought to the planting site on the day of planting to limit the transplantation shock to the plants. The project adopts a general spacing of 2.3 m x 3.6 m for all species. (stocking: 1,207 stems per hectare). This activity will be completed by the end of October of each planting year, weather permitting.

In the case of Eucalyptus, the seedlings are removed from the seedling tray insert and placed upright in the planting hole deep enough to cover the root plug and a short portion of the stem. Soil is then placed around the roots, ensuring that the seedling remains in a vertical position, and is firmed down with

fingertips. A water-retention gel is then used to assist the seedling by providing access to water if there is a break in rainfall during the early days of establishment.

Survival survey and blanking

Where the planting has been done on schedule between April and October, survival surveys are carried out within the two weeks following planting to determine the need for blanking which, if necessary, is completed within three weeks to prevent an uneven stand. Blanking is carried out when seedling mortality surpasses 10% or is concentrated in various spots. A second assessment is carried out in March/April of the following year to determine any casualties following the dry season. In all cases, blanking is done using large healthy nursery stock.

Weed control

It should be noted that most common weeds grow faster than newly planted trees and unless the weeds are controlled effectively, the plantation investment suffers greatly (and may even fail completely). Weeding, whether performed manually or mechanically, can only remove weeds that have germinated – seeds will continue to germinate, and follow-up inspections and weeding will always be required. Weeding must therefore be performed before the weeds are able to seed to be effective. Weeding is done to prevent or minimise any competition to the planted seedling.

Manual weed control

Slashing and hoeing

Slashing is done either as a full cover operation whereby the entire area is slashed or a spot is operation carried out where the weeds are only high in certain areas, such as the inter-row. Slashing is carried out as low to the ground as possible to ensure that the frequency of the weeding necessary is reduced. Care is taken to ensure that the tops of the trees are not damaged. Where appropriate, a spot weeding is undertaken around the tree first to ensure that there is a visible gap between the tree and the weeds, thus minimising damage.

Hoeing on the other hand is undertaken using one of two methods, as appropriate:

ring hoeing: an area of 50 cm to 1 m in radius around the tree is hoed and the rest is left, slashed or sprayed with herbicide; and

line hoeing: the tree line is hoed, and the inter-row is left, slashed appropriate. Line hoeing on slopes is carried out along the contour to prevent erosion.

Mechanical weed control

Tractors are used to tow a disc or a slasher, or herbicide spraying with a wind box. This can be very cost-effective if carried out under the correct conditions – great care is taken to ensure that the conditions are suitable and there is sufficient inter-row space.

Chemical weed control

Chemical weeding is undertaken, when necessary, using glyphosate (herbicide) or other approved herbicides. With timely application, this is the most effective and preferred way of weed control in areas where weeds grow faster than tree crops. It is good practice to follow up land preparation for planting with chemical broadcast weed control to create a weed-free area when planting. Appropriate measures should be taken to prevent chemicals damaging crops when doing any chemical weeding after planting. An example is using plastic cones to cover small trees before applying chemicals or herbicides in close proximity to the trees.

Before undertaking chemical weed control, any spraying team will be well-trained in the use of the chemical and equipment and provided with personal protective equipment. A chemical store worker has also been trained in how to store large quantities of chemicals and herbicides.

Use of cover crops

In line with the Company's objective of introducing alternative livelihood schemes to the local farmers, the project allows select registered farmers to intercrop the tree seedlings with selected seasonal food crops (preferably vegetables, legumes and non-woody fruit plants). In subsequent years, other non-timber NTFPs that will grow well in shade may be introduced to serve as cover crops to suppress weed growth and provide additional income to the growers.

Fertilising

As part of the land preparation activities, a nitrogen, phosphorus and potassium chemical fertiliser and a trace element mix fertiliser is applied. Any intercropping of trees with leguminous crops such as cowpeas, soya and onions by farmers can contribute to improving the nitrogen content in the soils.

Pruning

This operation is carried out to provide a knot-free timber from the growing tree. Branches that develop up to, at least, approximately a third of the tree height is removed during the first through fifth years of establishment. Intensive pruning of buds and branches is also undertaken regularly after the first pruning operation. As a cost saving measure, this operation is run concurrently with singling where necessary.

1.11.4 FOREST PROTECTION

Fire protection

Miro Forestry considers fire protection a key issue since it poses the greatest physical risk to the Company's biological assets and to the already heavily degraded reserve. Fire protection, therefore, focuses on fire prevention, fire risk reduction and fire preparedness and suppression.

Fire prevention measures require active engagement with the local community. Most fires are man-made, started to clear land or for hunting purposes. Agricultural methods using fire to clear land are less efficient in terms of retaining nutrients and organic matter in the soil, and efforts are being made through education programmes to re-educate local farmers who clear land in this way.

Fire risk reduction methods focus on physical methods of preventing fires from occurring or reducing the potential severity of fires. Weed control methods aim not only at preventing competition with young trees but also at reducing the volume of combustible material that builds up beneath the trees. Intensive weed control methods, as outlined above, are used for both purposes. Fire breaks are another tool used to reduce the impact of fires and aid in the ability to fight them. Fire breaks 10 m wide are created around planting units within the plantation and serve as access routes. Compartment roads, external boundary roads, crest roads, secondary roads and valley bottom cut-off roads serve as fire breaks. Vegetation management (weed control) is also done to reduce the risk of fire spread. Some green belts have been established and extended further into other high-danger areas at strategic locations along the perimeter of the reserve.

Fire preparedness is of high importance during the fire season (December to April). Miro Forestry has acquired equipment to manage fire outbreaks. Three pickups are permanently fitted with high-pressure, low-volume water deployment devices known as 'bakkie-sakkies'. Firefighting staff and tools are already in place and fully functional.

Each day during the fire season, a member of the senior management team is designated as being on call for fire management duties. Roaming security guards are deployed on 24-hour patrols of the plantation during the dry season. The guards are provided with transport and communication to facilitate communication between the groups for rapid response to manage fire outbreaks. The Company has introduced a fire index system that takes temperature, wind speed and humidity into account and the staff is alerted every morning at 10:00 and 13:00 as to the current index, the fire risk for the day and the forecast for the next day.

To date, more than 400 hectares are threatened each dry season by wildfire, and occasionally by incendiarism, but the plantations have suffered minor losses due to the implementation of an effective management plan. As the area of land managed by the Company increases, the Company will increase investment into its fire protection infrastructure and resources to ensure adequate and continuing coverage.

Pest and disease control

Pest and disease control are important in plantation forestry. There tends to be a narrower genetic base in plantation forests as compared to natural forests and increased movement of material, leading to a higher risk of pest and disease transmission.

Pest and disease issues can include fungal, bacterial and biological pathogens. The impact of pests and disease vary but can lead to reduced growth rates, reduced yields, lower quality timber and total crop failure – all of which have a significant financial impact.

The Company actively employs a range of preventative and control methods to combat pest and disease. It aims to maintain a diversity of planting stock to ensure that the genetic base of the plantation is wide and varied. It has a dedicated research and development department that trials new commercial species for deployment, continuously evaluates its planted material and engages with leading research institutions including FABI in South Africa to ensure that it is abreast of the latest information on pests and diseases.

Within the nursery, the Company aims to keep conditions as sanitary as possible to ensure that the planting stock is free of pests and disease. The Company aims to avoid exposing trees to temperature extremes or abnormally high or low levels of water or fertiliser to eliminate, wherever possible, unhygienic conditions and weeds. It also regularly removes dead or dying plants. Where necessary, pesticides and fungicides are employed to combat pathogen outbreaks. The Company is aware that chemical control is mostly unsuccessful unless backed up by thorough cultural management strategies and aims to ensure that the Company's staff is aware of the need for plant sanitation throughout all operations.

1.11.5 HARVESTING

Forest roads

Due to the history of the reserves, future functions and the use of the reserves, road construction within the reserves was based on the following factors/impacts:

- road densities in relation to land type, slope and gradient;
- avoiding road construction near water bodies;
- identifying seasonal streams within planting blocks;
- limiting soil erosion and run off and the contamination of water bodies;
- designing roads to meet planting and future harvesting requirements;
- limiting noise and dust pollution;
- vegetation clearing; and
- limiting access to the reserves to reduce access routes for future illegal logging activities.

To facilitate proper planning and the construction of roads, and to mitigate against some of the possible impacts identified above, the Company also employed the use of GIS techniques to map its land areas

and conducted field surveys to ensure the proper slope and gradient alignment of road construction to planting areas.

Thinning

Singling/stem reduction

Thinning and stem reduction/singling are undertaken to reduce total stems per hectare. This allows the trees greater space to increase girth and enhance its eventual end timber use and value. Stem reduction is carried out to reduce multiple shoots on the main stem. Multiple stems might develop because of damage to the main stem or when management decides to grow a crop out of live stumps after clear-felling suitable (for stem reduction) species. Shoots of undesirable qualities (the smallest or worst stem form) are removed to maintain one stronger and healthier shoot to develop it into a good pole size or small-sized timber. The first round of singling is done in the year following the year of planting. A second stem reduction might be required at a later stage to ensure a good stand.

Thinning

Thinning out of trees are done to reduce the number of planted stems per hectare to allow the remaining trees more growing space to increase diameter.

Typically, unwanted trees are marked out by a trained tree marking team to the management prescription, by painting a white mark on one side of a tree. Trees with poor form or size will be marked out first before marking out the remaining trees.

The number of trees remaining after a thinning varies because of species and product specifications.

Marked trees are harvested where suitable markets for these smaller diameter products exist, or felled too waste where no such market exist, or when removed tree form are very poor.

There are three main working circles used un Miro Forestry, them are referred for the time of the rotation, thinning and pruning activities:

- ES - ES - Euc Sawlogs
- HS - HS - Hardwood Sawlogs; and
- TS - TS - Teak Sawlogs.

All species are grouped inside one these Working Circles with these specifications:

Eucalyptus group have 12-year rotation with one thinning at year two of 33% of the standings per hectare.

Table 10. Silviculture for Eucalyptus group

WC	Age	Operation	Quantity after (stems/ha)	Thin rate (%)
ES - ES - Euc Sawlogs	0.00	Plant	1,207	

WC	Age	Operation	Quantity after (stems/ha)	Thin rate (%)
ES - ES - Euc Sawlogs	1.00	Prune		
ES - ES - Euc Sawlogs	2.00	Thin	800	33%
ES - ES - Euc Sawlogs	2.00	Prune		
ES - ES - Euc Sawlogs	3.00	Prune		
ES - ES - Euc Sawlogs	12.00	Fell	0.00	

The Hardwood Sawlogs group, where Acacia is located, have a 10-year rotation with one thinning at year two of 33% of the standings per hectare.

Table 11. Silviculture for the Hardwood group

WC	Age	Operation	Quantity after (ha)	Thin rate (%)
HS - HS - Hardwood Sawlogs	0.00	Plant	1,207	
HS - HS - Hardwood Sawlogs	1.00	Prune		
HS - HS - Hardwood Sawlogs	2.00	Prune		
HS - HS - Hardwood Sawlogs	2.00	Thin	800	33%
HS - HS - Hardwood Sawlogs	3.00	Prune		
HS - HS - Hardwood Sawlogs	10.00	Fell	0.00	

Teak group have a longer rotation (20-year) with two thinnings at year three and eight with 46% and 27% of the standings taken respectively.

Table 12. Silviculture for Teak group

WC	Age	Operation	Quantity after (ha)	Thin rate (%)
TS - TS - Teak Sawlogs	0.00	Plant	1,111	
TS - TS - Teak Sawlogs	1.00	Prune		
TS - TS - Teak Sawlogs	2.00	Prune		
TS - TS - Teak Sawlogs	3.00	Thin	600	46%
TS - TS - Teak Sawlogs	3.00	Prune		
TS - TS - Teak Sawlogs	4.00	Prune		
TS - TS - Teak Sawlogs	8.00	Prune		
TS - TS - Teak Sawlogs	8.00	Thin	300	27%
TS - TS - Teak Sawlogs	20.00	Fell	0.00	Fell

The Gmelina group have a rotation of 12 years without thinning.

1.11.6 RESEARCH

To date, the Company has established trial blocks of some different eucalypt species, including *E. grandis x urophylla*, *E. grandis x camaldulensis*, *E. pellita*, *E. cloeziana* and others. Several of these species have performed well in a trial environment and have been selected for commercial plantings. The Company continues to establish trial blocks of a wider range of eucalypts to further inform its future planting mix, with a view to improving growth rates and pest/disease resistance.

The Company does not anticipate major soil fertility management but will review this decision following soil quality monitoring in permanent sample plots established across the reserve. Working in collaboration with the FSD and the Forestry Research Institute of Ghana (FORIG), the project is establishing the sample plots within annual revisions for growth studies to provide guidance for future treatments within the plantation.

Miro Forestry will also collaborate and support FORIG in its research and development of lesser known fast-growing indigenous tree species such as *Terminalia superba*, *Terminalia ivorensis*, *Pericarpsis elata, Albizia zygia and Nauclea diderrichii*, which have commercial potential if well promoted.

1.12 Project Location

The Miro Ghana Commercial Plantation project area is located in Ghana's Ashanti region, in the Asante Akim North, Sekyere East and Sekyere West districts, between 7°1'26.77"N and 1°12'43.81"W[10]. It is composed of 763 compartments with a total area of 5,768 ha; these have been planted with different species of trees between 2016 and 2019.

The proposed project will be implemented in the Awura and Chirimfa Forest Reserves, which is an extension of the existing plantation in the Boumfoum Forest Reserve. The Boumfoum Forest Reserve is located in the Ashanti Region (See Figure 6 below) and is under the administration of the Kumawu District Office of the FSD, while the Awura and Chirimfa Forest Reserves are under Mampong District office of the FSD.

[10] Supports\1. PDD\1.2 PO Information\Project_location

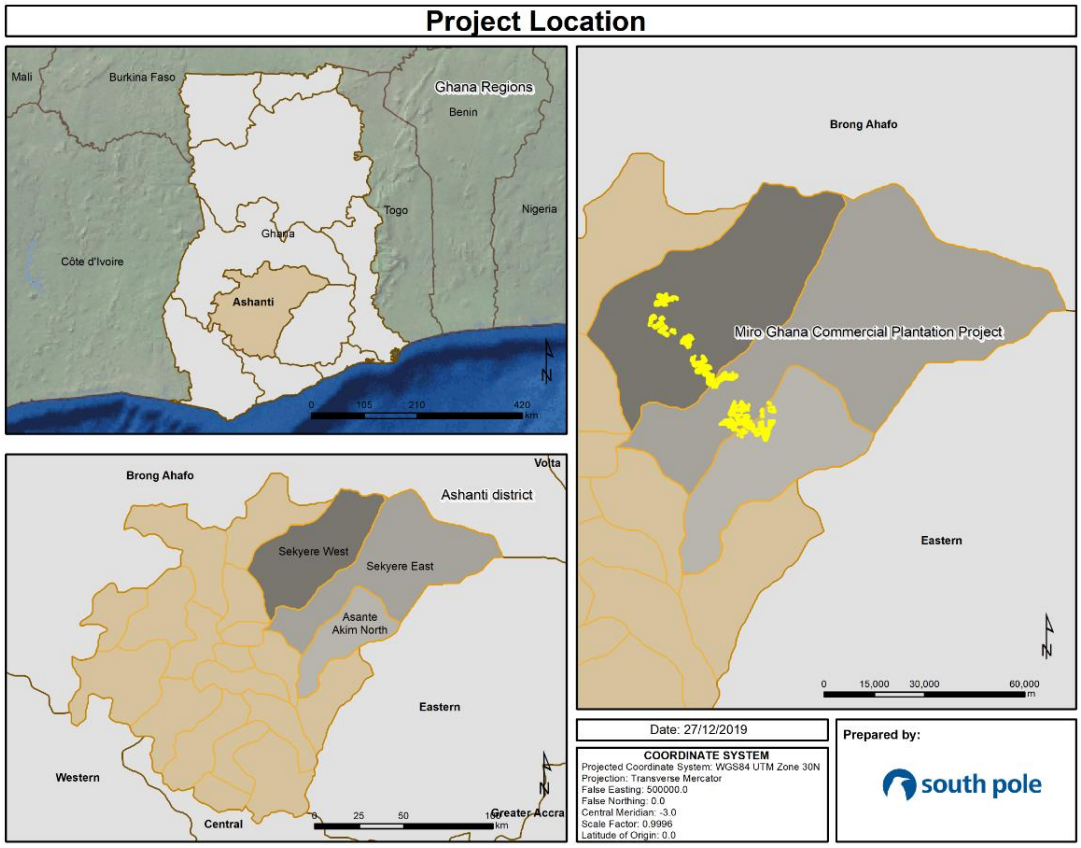

Figure 6. Project location

1.13 Conditions Prior to Project Initiation

The project area lies within the Afram Plains portion of the Forest-Savannah agro-ecological zone of Ghana, characterised by pronounced wet and dry seasons. The area is located between the cities of Mampong and Ejura, which have climate stations and data available from the Gmet[11].

Rainfall (mm)

The rainfall pattern is bimodal, characterised by two rainy seasons, which are separated by two dry seasons. The main rainy season starts between March and July with a peak in May/June. August experiences a short dry spell. The minor rainy season starts from mid-September to the end of November. A long dry period is experienced from November to the end of March with the possibility of occasional rains. During this period, there is severe drought accentuated by the desiccating harmattan weather conditions. At this time, most plants shed their leaves and some tributary rivers and streams of the Afram River dry up completely or appear in discontinuous pools. Some months of this period are rainless and bushfires are rampant. It should be noted that the start and end of rainfall events are not clear-cut and great variations exist in the total monthly and annual rainfall amounts. The total annual rainfall amounts

[11] Ghana Meteorological Agency

for the Awura and Chirimfa Forest Reserves are approximately 1,370 mm in Ashanti Mampong and 1,444 mm in Ejura.

The high total rainfall in southwest Ghana results from higher monthly totals in the rainy season, but the total length of the two dry seasons is similar (4-5 months with a mean rainfall < 100 mm) to that in the Moist Evergreen and southeast subtype of the moist semi-deciduous forest-types. Throughout the forest zone, the rainfall pattern is of the two-peak type with maxima in May-June and September-October (Swaine, 1981).

Temperature (ºC)

Temperatures within the study area are uniformly high throughout the year with a yearly average around 33.2°C maximum and 20.2°C minimum (see Table 13, below). The highest mean temperatures usually occur just before the onset of the rains at the end of February or in early March. Temperatures are relatively low during the wet months, from April to July. The lowest minimum temperatures, however, occur during the harmattan months of December and January. December, January and February also have the greatest daily ranges in temperature with the nights being very cold and the afternoons being very hot.

Temperature variation in the forest zone is rather slight; the mean monthly maximum in the hottest month (February or March) is 31-33°C, and the mean monthly minimum in the coldest month (December-January in the northern part and August in the south) is 19-21°C (Swaine, 1981) The average daily range is 8-9°C, and the seasonal range of daily mean temperature is 3-4.5°C . Mean temperatures on the summits of the highest hills (700 m) in the forest zone are roughly 3-5°C lower than those of the surrounding plains.

Temperatures are generally high during the dry season with daily temperatures reaching 30-34°C during the hottest months from December to February and minimum temperatures between 18 and 22°C during the coldest months. Relative humidity is high during the wet season, reaching an average monthly high of 75%, but falls to a low average of 30% during the dry season.

Relative Humidity (RH%)

Humidity is relatively high all year with an average of 75%, even in the dry season when the temperature increases.

Table 13. Mean monthly temperatures (°C) and RH (%) for Mampong (Ashanti) and Ejura

Station	Main dry season			Main wet season					Minor dry season	Minor wet season		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Mampong (°C)	24.9	25.2	26.8	26.6	26.3	23.6	24.9	23.6	23.6	24.1	24.7	25.2
Mampong RH (%)	86	78.1	79.1	82.5	82.7	84.4	86.1	88.5	89.2	88.1	88.1	84

Station	Main dry season			Main wet season					Minor dry season	Minor wet season		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Ejura (°C)	26.3	26.4	21.6	21.8	27.9	26.3	19.7	25.4	25.2	25.4	26.1	26.6
Ejura RH(%)	74.1	69.9	71.8	85.5	77.1	80.3	82.5	81.9	80.2	83.3	82.4	77.5

(Source: Compiled from Ghana Annual weather summaries, Ghana Meteorological Services, Accra)

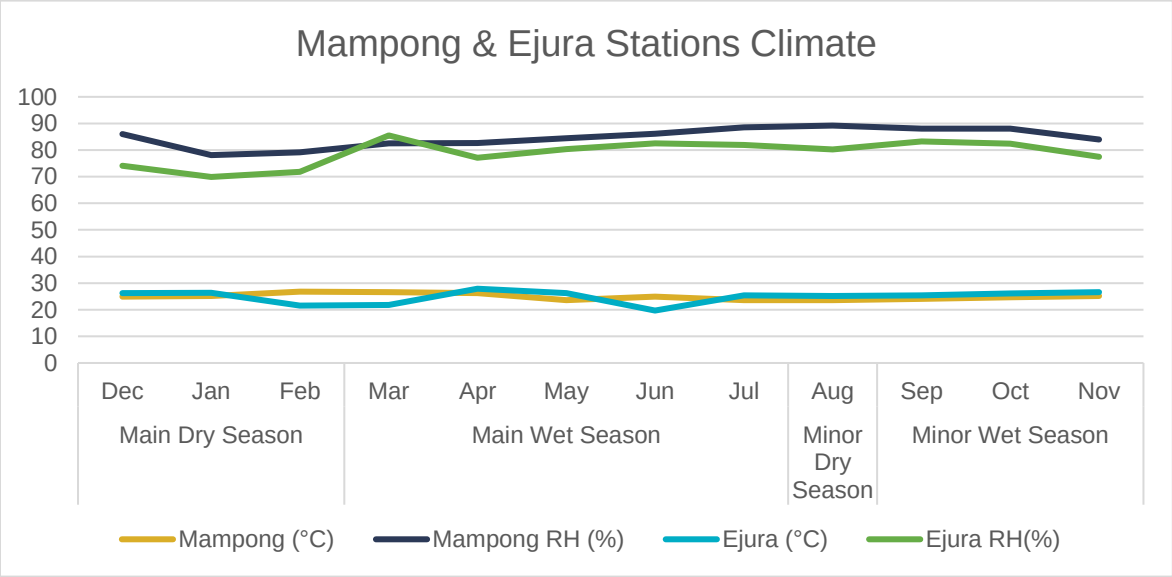

Figure 7. Mean monthly temperatures (°C) and RH (%) for Mampong (Ashanti) and Ejura

Source: Compiled from Ghana Annual weather summaries, Ghana Meteorological Services, Accra

Geology

Almost one third of Ghana is covered by sediments of the inland Voltaian Supergroup, which covers an area of about 103,600 km². The Voltaian strata are nearly horizontal beds of sandstone, shale, mudstone and conglomerate thought to be of Late Precambrian to Paleozoic age (Yidana, 2011). In most places, the flat lying Voltaian strata overlie the Birimian rocks with a marked angular unconformity. Junner and Hirst (1946) in (Yidana, 2011) subdivided the Vol-taian sediments on the basis of lithology and field relationships into lower (Kwahu-Bombouaka Group), middle (Oti-Pendjari Group) and upper (Obosum Group) units.

The study area falls within the Afram Plains portion of the Voltaian Basin with the underlying geology consisting entirely of sedimentary rocks, mainly coarse-grained sandstone, thin-bedded, flaggy, impure, ferruginous or feldspathic and locally interbedded with shale and mudstone. These sedimentary formations are of the Devonian or early Carboniferous age (Junner and Hirst, 1946 in (Yidana, 2011).

Hydrology and topography

The hydrological characteristics of the reserves are such that the low-lying parts and valleys are prone to flooding due to poor drainage and some soil erosion. This natural occurring phenomenon can lead to siltation and sedimentation in the water bodies in and around the reserves. The flooding is mainly due to the Boumfoum and Ongwam Rivers, which tend to overflow their banks in the low-lying valleys of the Boumfoum Reserve. The Afram River and its tributary streams drain the Awura Reserve, while the Drobon and Atonu Rivers and their tributaries drain the Chirimfa Reserve.

Testing water samples (during environmental, social impact assessment; ESIA (2014) and ESIA (2018))[12] from these rivers has revealed that the water quality is much lower. This may be due to the large catchment area of the river, which leads to it collecting a high level of the organic waste deposited upstream.

The riparian ecosystems (stream buffer zones) form a very small portion of the landscape in the Miro Forestry compartments, yet they exert substantial influence on plants and animals within the inter-connecting seasonal streams. Illegal migrant farmers have farmed close to the streams in all of the strips, leaving some stream channels without buffer strips. The riparian strips in the Boumfoum Forest Reserve, for example, are made up of savannah regrowth. In some areas, the strips are of shrubby vegetation protecting the stream channel, while in other areas, the strips are thickets of about 20 m on each side of the river (depending on the specific conditions of each place).
The Awura and Chirimfa Forest Reserves have a gently undulating topography with slope gradients of 1-5% from the summits to the edge of the lowlands. Locally, areas where some rock outcrops occur have steep slopes (5-8%). The altitude ranges between 137 m to 162 m above sea level. During the peak rainy seasons in June/July and September/October, the low-lying areas may be waterlogged. The Afram River and its tributary streams drain the study area (Figure 8).

[12] Supports\1. PDD\1.2 PO Information\ESIA

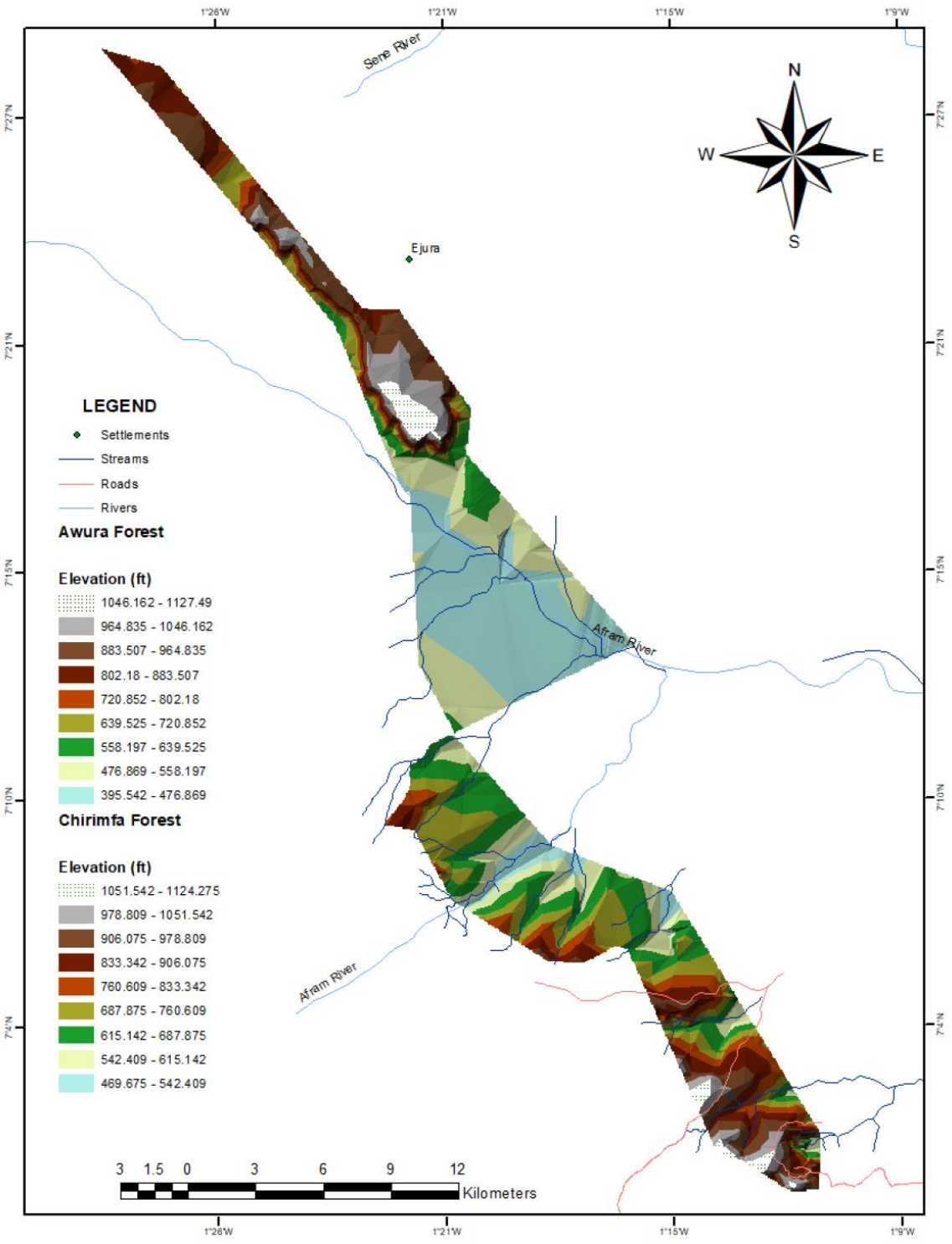

Figure 8. Relief and drainage for the Awura and Chirimfa Forest Reserves

Source: Project Data

Relief, topography and soils

The Forest Reserves where the project is located have a gently undulating topography with slope gradients of 1-5% from the summits to the edge of the lowlands. Locally, areas where some rock outcrops occur have steep slopes (5-8%). A soil survey carried out in 2017 by Miro Forestry in the project area identified and mapped five major soil types within the Awura Forest Reserve, including: Bediesi series (Dystric Nitisol); Sutawa series (Gleyic Arenosol); Kaple series (Umbric Gleysol); Bejua series (Dystric Gleysol); and Volta series (Eutric Gleysol). Five soil types were also identified in the Chirimfa Forest Reserve: Damongo series (Ferric Luvisol); Murugu series (Haplic Luvisol); Kintampo series (Lithic Leptosol); Techiman series (Ferric Acrisols); and Tanoso series (Eutric Gleysol). With the exception of the valley bottom soils (e.g. Volta series) and shallow rocky soils (e.g. Kintampo series), all the major soils are generally good for tree plantations (Bationo, 2008).

Main soil types of selected compartments within the Awura Forest Reserve

The soils in both Awura and Chirimfa Forest Reserves are largely (> 90%) developed over Voltaian sandstone with a small area developed over Voltaian clay shale. The river and stream valley bottoms are occupied by alluvial deposits (Mensa-Ansah, 1995).

From the field survey, five main soil types were identified based on their characteristics as observed in the field. Summary descriptions of these soil types, supported by soil profile descriptions and soil laboratory analysis data for the representative pits, are presented below.

Bediesi series (Dystric Nitisol)

Bediesi series include the most important soils developed over Voltaian sandstone. These are deep to very deep (> 150 cm), well-drained, dark reddish-brown to dusky red, non-gravelly, sandy clay over sandstone on summits (2-5%) and upper slopes of gentle topography. The topsoils are thick (20-30 cm) with dark brown to reddish brown humus, loam, very friable fine granular, over red to dusky red, sandy clay to clay, non-gravelly, weak fine sub angular blocky, friable to firm and slightly sticky subsoils.

Sutawa series (Gleyic Arenosol)

These are moderately well drained, brownish yellow drift soils on middle slopes (2%) of gently undulating topography below the Bediesi series. They are deep to very deep (> 150 cm) and brownish yellow to yellowish, red sandy loam to loamy sand. The topsoil consists of brown, sandy loam, weak fine granular, very friable, non-gravelly, non-sticky non plastic, porous, humus with many rootlets underlain by brown to reddish brown, loamy sand, weak fine and medium subangular blocky, gradual smooth boundary, porous, non-stony and non-gravelly subsoil.

Kaple series (Umbric Gleysol)

The Kaple series comprise seasonally imperfectly drained, pale coloured sands on gentle lower slopes (< 2%) and developed in slope wash derived from the Bediesi and Sutawa series. They consist of 0-30 cm of grey brown fine sandy loam grading downwards into very pale brown loamy sand to sandy loam that

becomes mottled with brownish to reddish yellow colouration. The layer may extend to a depth of 145 cm or more. Towards its base there is a stone-line consisting of ironstone and pebbles, which overlie a mottled weathered substratum of sandstone.

Bejua series (Dystric Gleysol)

The series comprise the lower slope towards the valley bottom soils. Normal profiles consist of about 30 cm of dark grey, loose, sandy loam over 30-60 cm of light yellowish brown loamy fine sand, which is loose, porous and crumbly. The layer extends downwards to 140-160 cm and consists of pale grey strongly mottled brown sandy loam. It is possible to encounter seepage iron pan at this depth.

Volta series (Eutric Gleysol)

Volta series is a major valley bottom soil developed over clay shale formation along the Afram River. These alluvial soils have a simple profile consisting of grey brown slightly mottled yellow, porous, silty loam with a thin dark grey slightly humus surface layer over 120-180 cm or more of grey and orange or red mottled silty clay loam. The profiles have a well-developed, sub-angular blocky structure. The texture in some profiles tends to lighten below about 120 cm, while in others, the tendency to develop groundwater laterite is indicated by the presence of soft iron concretions. The light texture of the profiles at depth is characteristic of the Volta series.

Soils types of compartments within the Chirimfa Forest Reserve

Damongo series (Ferric Luvisol)

The Damongo series consists of dark reddish brown, humous, loamy sand topsoils developed over fine-grained Voltaian sandstone. Damongo soils are characteristically deep to very deep, well-drained, medium textured and gravel-free. The subsoils are red sandy loam or sandy clay loam extending downwards to a depth of about 120 cm. It may be underlain by iron pan or sandstone. The series occurs on upper slopes to summit positions on gently sloping topography (2-5%). They possess good tilth and permit easy root development. They have developed under savannah and transitional savannah vegetation consisting of tall grass and savannah tree species, and with some forest tree species and less grass in the transitional zone.

Murugu series (Haplic Luvisol)

The series occurs as a colluvium on the lower slopes of Damongo, and there is little difference between the Murugu and Damongo series in profile morphology. Murugu series are deep, going downwards from 150 cm to well over 200 cm. Surface horizons range from dark brown to brown, while subsurface horizons have colours ranging from bright reddish brown to yellowish red. Textures do not vary much; surface

horizons are sandy loam while subsurface ones are fine sand. The Murugu series is characteristically sandy throughout its profile. It has few dark red ironstone concretions.

Kintampo series (Lithic Leptosol)

The Kintampo series comprise greyish brown to reddish brown, very shallow, eroded, excessively drained skeletal soils occurring on summits of rocky scarps and inselbergs developed over sandstone. Kintampo series may also occur as rock outcrops on upper, middle and lower slopes in eroded areas. The depth of soil to rock varies from 10 cm to 30 cm. These shallow soils are mainly colonised by very short grasses and stunted trees.

Techiman series (Ferric Acrisols)

Techiman series comprises moderately shallow, slightly humous, well-drained, reddish brown, ironstone concretionary soils. The concretionary layer may overlie sandstone rock or iron pan. They are usually found in association with the Kintampo series.

Tanoso series (Eutric Gleysol)

Tanoso series occur as alluvium in valley bottoms. They are deep and poorly drained and generally not extensive. The depth of the alluvium ranges between 140 cm to 220 cm. Textures vary from loamy fine sand to sandy loam. Subsurface horizons occur in bands of varying textures because of the deposits that come with seasonal flooding.

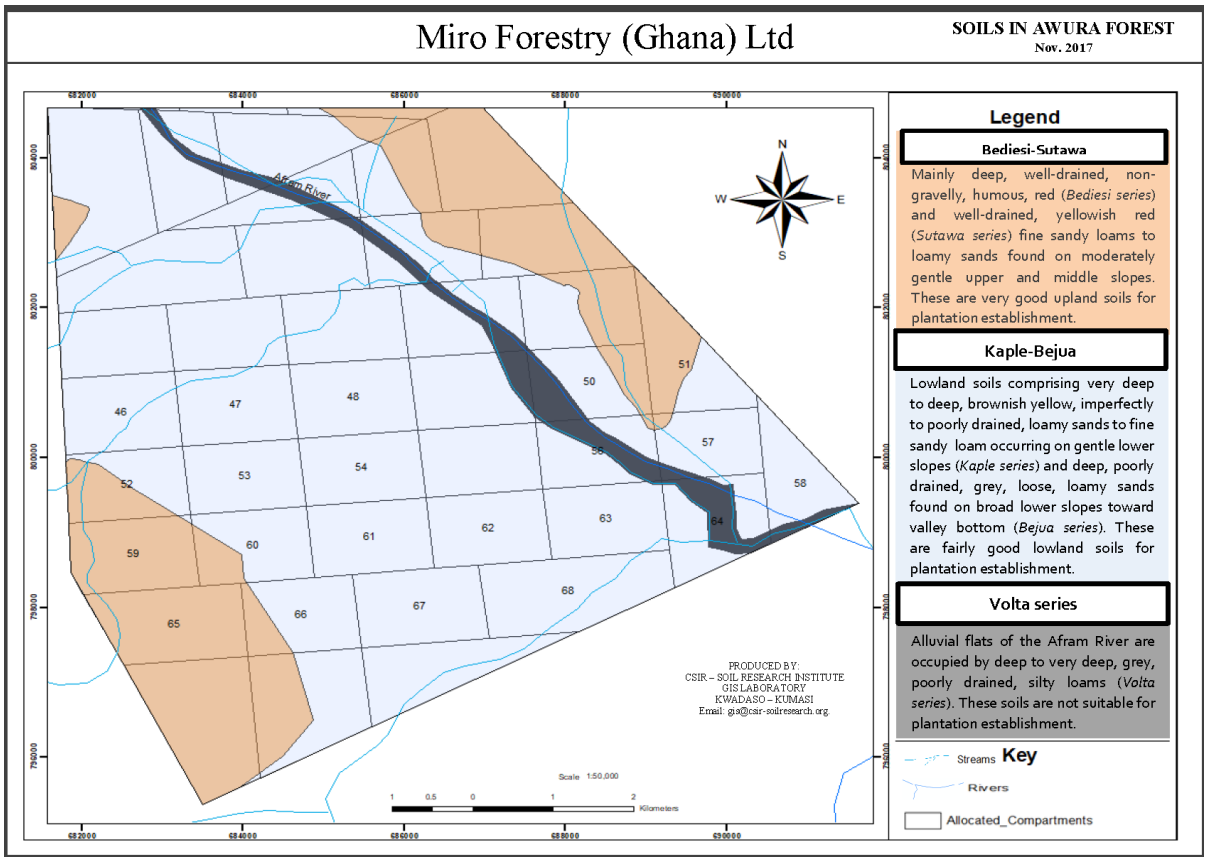

Figure 9. Soil map of selected compartments in the Awura Forest Reserve

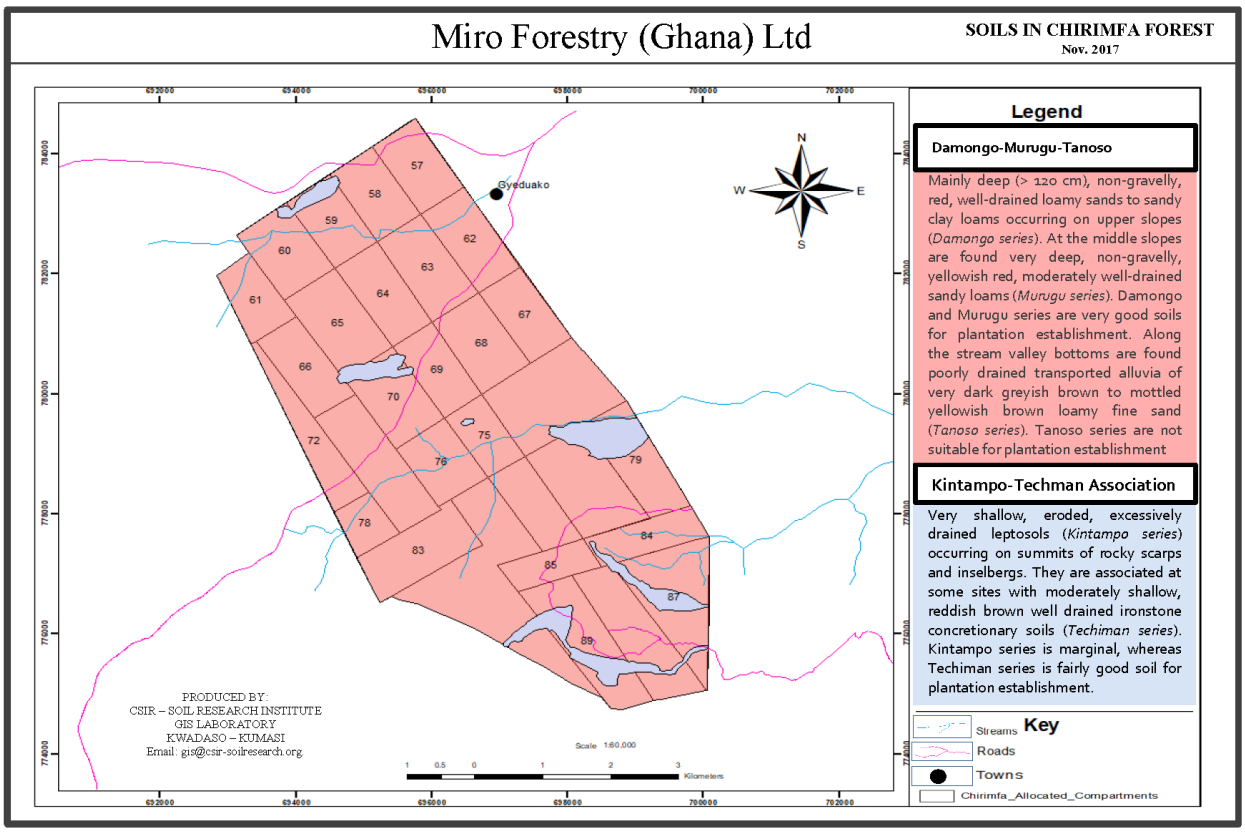

Figure 10. Soil map of selected compartments in the Chirimfa Forest Reserve

Biodiversity in the environment

Fauna and flora

The original vegetation at the time of the creation (1928) of the Boumfoum Forest Reserve was described as moist semi-deciduous tropical forest with three levels of canopy architecture: emergent, middle and lower. It was also described as a forest typified by the preponderance of *Antiaris toxicaria* and *Chlorophora excelsa* species. Later ecological studies showed that Boumfum Forest Reserve lies more in the dry semi-deciduous forest zone where both high forest and savannah species are shared. The vegetation appears to be heavily influenced by the topography. It can be observed that the southwestern facing slopes and valleys have tree species found in the moist semi-deciduous forest type and the northeastern slopes and plateau tend to have dry forest and savannah species.

The Awura and Chirimfa Forest Reserves on the other hand, fall within the Forest-Savannah Agro-ecological zone, as the Boumfoum Forest Reserve does. The natural vegetation on these reserves consists of deciduous, fire-resistant trees that are often widely spaced and a ground flora composed of different species of grasses of varying heights (Taylor, 1952). The original vegetation of these reserves has been degraded through intensive human activities, such as settlement, agriculture, lumbering, fuelwood harvesting, charcoal production and annual bush fires, that have resulted in only a little of the

original true climax vegetation remaining. Some of the forest economic tree species that were listed to be present in Boumfum, Awura and Chirimfa Forest Reserves include:

Table 14. Natural vegetation prior to project initiation

Common trade name	Scientific Name
Sapele	*Entandrophragma cylindricum*
Utile	*Entandrophragma utile,*
Omu/Candollei	*Entandrophragma candollei*
Afrormosia	*Pericopsis elata,*
Opepe	*Nauclea diderrichii*
African Mahogany	*Khaya grandifoliola,*
Emire	*Terminalia superba*
Kane	*Anogeissus leiocarpus*
Brown Sterculia/Wawabima	*Sterculia rhinopetala*
Iroko	*Milicia excelsa*
Wawa	*Triplochiton scleroxylon*
Opepe/Kusia	*Nauclea diderrichii*
Danta	*Nesogordonia papaverifera*
Dahoma	*Piptadeniastrum africanum*
Bombax	*Bombax buonopozense*
Mansonia	*Mansonia altissima*

Field surveys of the Miro Forestry compartments show that the above-mentioned species are no longer available in commercial quantities in the reserve, but only occur as scattered remnants and small isolated clusters of the old forest structure.

Currently, the natural vegetation cover is predominantly shrubs and herbaceous plants. In most locations the vegetation is mainly tall elephant and guinea grass with scattered remnants of trees from the old forest and patches of secondary forest developing in the valleys or along streams.

There are no cultural heritage resources identified within the project areas. There is no cemetery at the project sites. The major occupation of the local communities is farming, with some minor activities such as fishing, hunting and charcoal processing.

Forest condition

Recurrent wildfires largely in 1983 have rendered the reserves seriously degraded and have made it virtually impossible that any considerable natural regeneration, or the survival of older trees, will occur. Before the destructive factors set in to progressively degrade the reserve, the vegetation was predominantly a mixture of moist and dry semi-deciduous forest types. The current state of the vegetation in the project area is that of sparsely dispersed trees and riparian forest vegetation dominated by *Ceiba*

pentandra, Triplochiton scleroxylon, Terminalia superba, T. ivorensis, Antiaris toxicaria and *Mansonia ultissima*. The non-woody vegetation is largely of *Panicum maximum*, *Imperata cylindrica* and *Chromolaena odorata* varieties. The reserves are currently categorised as a 'condition 5 forest reserve' (seriously degraded) and therefore require complete reforestation.

Fauna

Historically, records show that large mammals were prevalent in the reserves, particularly in the Boumfoum Forest Reserve. This led to the delineation of the northern portion of the reserve for conservation as a wildlife sanctuary. Due to illegal logging in the reserves, very few large and medium mammals can still be found in the area, but there have been reports of bushbuck, duikers, bongo and monkeys (mona and spotted nose) being spotted in the past five years. Dominant bird species include plantain-eaters, falcon, owl, doves, partridge and pigeons. Reptiles include snakes and lizards; there are also many insect and butterfly species in the reserve.

Few species, including lizards, rodents (ground squirrel, grasscutter), tortoise, snakes (royal python, black cobra, green mamba), butteries, birds (African hornbill, blue-billed, weaver birds, and partridge), have been identified in the Awura and Chirimfa Reserves. So far, no threatened or endangered species have been identified. However, an up-to-date species register of all those spotted or sited is being kept by the environmental team. The complete fauna and flora report can be consulted in the EIA.[13]

Other fragile eco-sites and areas of high conservation value

During the EIA, a Soil erosion study was undertaken, and this showed that the erosion hazard for the soils within the compartments is moderate to high. Since this is a forest plantation, it is expected that soil erosion will remain low when the surface litter is not burnt. However, during initial planting, the soils could be exposed to severe erosion. This implies that erosion rates could be initially high and then decline after the first two years. Some areas where crops were planted prior to Miro Forestry Ghana acquiring the land showed significant gully erosion and MFGH has rehabilitated these areas as they established commercial forest compartments in the areas.

Relevant historic conditions

Roads

Existing road infrastructure serving the project area includes old hauling roads and tracks usable by four-wheeled drive vehicles. Most parts of the reserve are accessible during the dry season using these

[13] Supports\1. PDD\1.2 PO Information\ESIA

hauling roads and tracks, but accessibility becomes very difficult and challenging during the rainy season when the Boumfoum and Ongwam Rivers and their major tributaries overflow their banks.

The Boumfoum Forest Reserve is located about 8 km from Agogo, 20 km from Kumawu and 3 km from the Ananekrom along the Murum roads. The Chirimfa Forest Reserve is located about 45 km from Agogo and 19 km from Kumawu, and Awura is located about 84 km from Agogo and 24 km from Mampong.

Infrastructure

The Company has one office, both of which are rented houses in Agogo. The nursery and workshop are located just outside the forestry reserve near Serebouso village. The land is leased by the Company, which has erected a nursery and workshop infrastructure. The nursery consists of a few offices and stores but is mainly nursery infrastructure (irrigation, shade netting, seedling tray tables, reservoir, cutting shed, green house and species trial areas), water at the nursery is supplied by a borehole and electricity is generated on-site. The workshop consists of a small amount of containerised storage and a workshop area with electricity generated on-site and water supplied from a borehole and the Boumfoum River.

The company also recently constructed a veneer plant just outside Drobonso with the long-term plan to move the offices and staff quarters from Agogo to this site. Electricity is generated using diesel generators and water is pumped from an on-site borehole. The veneer mill currently consists of a single debarker, a spindle peeler, oil heated veneer dryers and a storage area.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The following key laws and government regulatory documents were identified and are relevant to the proposed project.

Table 15. The regulatory framework for Ghana

No.	Year	Name	Detail
1	1927	The Forest Ordinance	Cap 157
2	1962	The Concessions Act	Act 124
3	1963	The Companies Code	Act 179
4	1971	Wildlife Conservation Regulations	LI 685
5	1992	Constitution of the Republic of Ghana	Article 267 of the 1992
6	1994	Ghana Forest and Wildlife Policy	N/A
7	1994	The Trees and Timber Act	Act 493
8	1999	The Environmental Assessment Regulations	LI 1652
9	1999	The Forestry Commission Act	Act 571
10	2000	The Forest and Plantation Development	Act 583

No.	Year	Name	Detail
11	2000	The Internal Revenue Act	Act 592
12	2001	Water Use Regulations	LI 1691
13	2002	Timber Resources Management Act	Act 617
14	2002	The Forest Protection Act	Act 624
15	2003	Ghana Labour Act	Act 651
16	2012	Riparian Buffer Zone Policy for Managing Freshwater Bodies	N/A
17	2012	National Integrated Water Resources Management Plan, Water Resources Commission	N/A
18	2012	Ghana Forest and Wildlife Policy	N/A

A brief description of each policy and act concerning the company is provided below.

The Forest Ordinance (Cap 157), 1927

The Forest Ordinance (Cap 157), 1927 section 18(1) states that "the ownership of land is not altered by its declaration as a forest reserve". The stool landowners, therefore, have the right to a share of the benefits from the development of plantations in forest reserves. The Benefit Sharing Agreement signed by Miro Forestry and the Forestry Commission in May 2009 for Commercial Forest Plantation Development states that the "Landowner is entitled to 6% of the standing tree value (STV) of thinning and final harvest, the Forestry Commission is entitled to 2% of standing tree value of thinning and final harvest, the Local community shall also receive 2% of standing tree value of thinning and final harvest. The balance of 90% shall accrue to the plantation's investor".

The Concession's Act (Act 124), 1962

The Concession's Act (Act 124), 1962 indicates that "the timber and land in forest reserves or subject to timber concessions (both within and outside the reserved forests) are vested in the State in trust for the landowning communities". The exploitation of the production forest reserves is administered by the central government through the Ministry of Lands and Natural Resources (MLNR) and the Forestry Commission. Under this arrangement, the landowners have a right to a share of the revenue from both natural timber harvesting and forest plantation development within the forest reserves. Miro Forestry has therefore entered benefit sharing agreements with stool landowners and other stakeholders.

The Companies Code (Act 179), 1963

This Act provides for business entities to register their firms with the Registrar-General of Ghana for the issuance of business registration certificates and commencement of business certificates. Miro Forestry

has complied with this Act and the Company is registered as a limited liability company with the registration number C0005490863.

Wildlife Conservation Regulations (L.I. 685), 1971

The Boumfoum Reserve, where the Miro Forestry project is being proposed, contains some game and wild animals. This legislative instrument places restrictions on the hunting of game, the need to apply for game licenses and permits for the export of game. Miro Forestry does not intend to hunt any game. However, by its presence in the reserve, Miro Forestry has a responsibility to inform the Forestry Commission of any persons that may be in contravention of this regulation.

Article 267 of the Constitution of the Republic of Ghana, 1992

Article 267 of the 1992 Constitution stipulates that "all stool lands in Ghana shall vest inappropriate stool on behalf of and in trust for the subjects of the stool following customary law and usage". In practice, all stool lands belong to paramount chiefs who are the traditional heads of paramount stools. Ownership is often hierarchical with paramount divisional, town or village stools all having an interest in the land according to the mode of acquisition. Under this Act and Article, Miro Forestry cannot claim title to stool lands but may lease lands in agreement with the stool landowners and the Forestry Commission, the management and monitoring agency of forest reserves in Ghana.

Ghana Forest and Wildlife Policy, 1994

The Forest and Wildlife Policy 1994 promotes conservation and sustainable development of the nation's forest and wildlife resources. The policy aims to provide for the maintenance of environmental quality and the perpetual flow of optimum benefits to all segments of society. The Policy outlines the enabling conditions under which the Forestry Commission aims to achieve its objectives. It encourages local stakeholder participation in forestry and highlights the need for reforestation of the country's degraded forest reserves. Miro Forestry proposes to reforest 5,000 hectares of Boumfoum Reserve, and therefore, this policy provides the company with guidelines on how it can contribute to the policy and realisation of the Forestry Commission's vision. Miro Forestry has also engaged local stakeholders to gain a proper understanding of their interests and concerns.

The Trees and Timber (Act 493), 1994

This Act defines the level of export levy attributable to different processed and unprocessed timber products for export. Under Schedule 1 of the Act, Teak (logs and billets) attract a special levy of 10% on free on board value. Therefore, any future exports of Teak logs or billets by the Company will be subject to the levy.

The Environmental Assessment Regulations (LI 1652), 1999

This legislative instrument empowers the Environmental Protection Agency (EPA) to ensure that project undertakings in Ghana are subjected to environmental impact assessments (EIAs) following the country's environmental regulations. The Agency is also responsible for issuing environmental permits and issuing

enforcement notices, where the agency deems that an undertaking poses a serious threat to the environment or public health. The Agency is also mandated under the regulations to conduct monitoring activities on projects.

Miro Forestry is complying with the requirements of environmental legislation by submitting this EIA for assessment by the EPA and intends to submit itself to the Agency for periodic monitoring of its undertakings and the renewal of environmental permits as required.

The Forestry Commission Act, 1999 (Act 571)

This Act established the Forestry Commission as a semi-autonomous body responsible for all the forestry sector agencies implementing the functions of protection, development, management and regulation of forest and wildlife resources. Under this Act, MFGH is obliged to collaborate with the Forestry Commission on all matters about the establishment of its plantations on lands leased to it by the Forestry Commission.

The Forest and Plantation Development Act (Act 583), 2000

The Act establishes a fund for plantation development in Ghana. The aims of the Fund are to provide financial assistance for the development of forest plantations on lands suitable for timber production, and for research and technical advice to persons involved in plantation forestry.

As the project evolves, Miro Forestry will embark on research in soils, water and tree species and may wish to apply to the Forestry Commission for technical assistance in these areas.

The Internal Revenue Act (Act 592), 2000

This Act prescribes regimes for taxation of individuals and other business entities. MFGH is therefore mandated under this Act to ensure that appropriate taxes are deducted from the salaries and wages of workers and paid to the Ghana Revenue Authority.

Water Use Regulations (LI 1691), 2001

This regulation lays down the procedures and conditions for the use of water resources. The Water Resources Commission administers and enforces this regulation. Miro Forestry does not intend to use water from the nearby Onwang river for its nursery because of its lower quality, which poses a risk to the survival of seedlings. The Company has instead opted for a borehole and, in compliance with the provisions of this regulation, it has applied to the Water Resources Commission for a water use permit to drill the borehole. This application is currently being reviewed by the Water Resources Commission.

Timber Resource Management Act (617), 2002

The function of this provides for incentives and benefits applicable to investors in forestry and wildlife and to provide for matters related to these. Miro Forestry is a joint venture between the National Interest

Company Ltd (NICOL) and Miro Forestry UK Ltd (MIRO), registered with the Ghana Investments Promotion Council and entitled to investment incentives as outlined by the GIPC.

The Forest Protection Act (624), 2002

The function of this Act pertains to forest reserves and defines the offenses and corresponding penalties that may be imposed by the Forestry Commission in the event of the unauthorised setting of fires that burn out of control, the obstruction of rivers and waterways, erection of buildings or the moving or destroying a forest reserve boundary marker. This Act, therefore, imposes strict guidelines on how Miro Forestry should operate in the Boumfoum Forest Reserve regarding the management of fires, erection of permanent structures and use of water bodies.

Ghana Labour Act (651)

This Act provides a framework for labour relations and employment in Ghana. The Act defines the rights, duties and responsibilities of the employer and employee, the conditions of employment, the protection of remuneration, trade unions and collective bargaining arrangements (for occupational health and safety and the employment of women). MFGH is ensuring compliance with all the requirements of the Act and in some areas, hopes to exceed the minimum requirements in the Act.

Riparian Buffer Zone Policy for Managing Freshwater Bodies, 2012

This policy lays down prescriptions for the effective management and protection of water systems. The policy provides guidelines and recommendations for the establishment of buffers nearby water systems. Within forest areas, the policy makes recommendations of establishing a minimum of 10 m buffers near water systems. Miro Forestry has exceeded this minimum requirement by specifying 20-30 m buffers.

National Integrated Water Resources Management Plan, Water Resources Commission, 2012

This national plan provides a framework and strategy for managing water resources and the impact of growing demand on water resources. It provides Miro Forestry with background information on national policy and an overview of the level of water resources currently available. Miro Forestry evaluated key data during its hydrology assessment of water resources in the Company's allocated compartments to gain a proper understanding of the water resources available in the reserve.

Ghana Forest and Wildlife Policy, 2012

The Forest and Wildlife Policy 2012 promotes the conservation and sustainable development of the nation's forest and wildlife resources. The policy aims to provide for the maintenance of environmental quality and the perpetual flow of optimum benefits to all segments of society. The policy outlines the enabling conditions under which the Forestry Commission hopes to achieve its objectives. It also encourages local stakeholder participation in forestry and highlights the need for reforestation of the country's degraded forest reserves. MFGH has conducted several consultations with the local

communities and Traditional Authorities to gain a proper understanding of their needs, interests and concerns and how these impact on the project.

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 and is not seeking registration under any other GHG programme.

1.15.2 Projects Rejected by Other GHG Programs

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

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

Not applicable.

1.16.2 Other Forms of Environmental Credit

The project involves reforestation and no other credits than the VCU are aspired for by the project proponent. The project's FSC certification will not generate environmental credits.

1.17 Additional Information Relevant to the Project

1.17.1 Leakage Management

Activity shifting leakage is limited since country's policies prohibit this although continued risk of encroachment into conservation areas. Social mitigation measures offer alternative livelihood solutions – predominantly employment. In the same way, Miro Forestry has a strong policy for leakage management: some of the farmers employed by the company has legal access to land and can benefit the local communities with the land leasing and benefits agreement.

Also, the probability of leakage occurring due to people moving inside of the project area is limited, due to the land management policies created by the forestry commission and because most of the land outside the project area is already at a very low baseline for agriculture. This activity is not fixed as fires occur in numerous areas throughout the year.

1.17.2 Commercially Sensitive Information

This PD does not contain any commercially sensitive information.

1.17.3 Sustainable Development

An environmental and social impact assessment (ESIA) of the forest area in the Boumfoum Forest Reserve was conducted in 2014 by Winniwood Consulting, with the EPA issuing a permit of approval (Permit Number: CF00580102) on 7 August 2014, with a number of prescribed conditions that the Company has incorporated into management plans. This permit was subsequently renewed (Permit Number: CA58/02/05) by the EPA on 29 September 2016 to allow the company to continue its operations and plant new land in the Awura and Chirimfa Forest Reserves.

Miro Forestry has also been working with the most relevant entities regarding sustainable development in the country, as follows:

- Forestry Commission;
- Ministry of Lands and Natural Resources; and
- EPA.

Forestry Commission

The Forestry Commission of Ghana is responsible for regulating the utilisation of forest and wildlife resources, the conservation and management of those resources and the coordination of policies related to them. The Climate Change Unit, established in 2007 as a unit of the Commission, has a mandate to manage forestry-sector initiatives related to climate change mitigation. It is the aim of the Commission to be a corporate body of excellence in the sustainable management and utilisation of Ghana's forest and wildlife resources, meeting both national and global standards for forest and wildlife resource conservation and development.

The project contributes to the aim of the Climate Change Unit by advancing sustainable forest management and carbon sequestration.

Ministry of Lands and Natural Resources

The Ministry has the oversight responsibility for the land and natural resources sector and its functions include: policy formulation, co-ordination, monitoring and evaluation, the validation of policies, programmes and projects, the supervision of sector departments and agencies; and negotiations with development partners.

The Ministry's aims and objectives are to:

- develop and manage sustainable lands, forest, wildlife and mineral resources;
- facilitate equitable access, benefit sharing from and security to land, forest and mineral resources;
- promote public awareness and local communities' participation in sustainable forest, wildlife and land use management and utilisation;
- review, update, harmonise and consolidate existing legislation and policies affecting land, forest and mineral resources;
- promote and facilitate effective private sector participation in land service delivery, forest, wildlife and mineral resource management and utilisation;
- develop and maintain effective institutional capacity and capability at the national, regional, district and community levels for land, forest, wildlife and mineral service delivery; and

research problems related to forest, wildlife, mineral resources and land use, and develop strategies to address them.

MLNR is the sector Ministry to which the Forestry Commission reports. It is also responsible for Ghana's Forest Investment Program.

This project contributes to the achievement of several of the listed aims and objectives because it implements sustainable forest management according to the principles and criteria of the Forest Stewardship Council, has a benefit sharing agreement (Forestry Commission), raises public awareness within the surrounding communities through community engagement and is part of the private sector that manages parts of some national forest reserves.

Environmental Protection Agency (EPA)

The EPA is statutorily mandated to ensure that the implementation of all undertakings do not harm the environment. The Agency has 11 regional offices in Ghana that are accessible and staffed and equipped to perform its functions. It is expected that sub-projects that will require the preparation of EIAs will abide by statutory requirements and the implementing institutions will liaise sufficiently with the Agency to ensure compliance. The EPA is the National Focal Point for Climate Change and is responsible for all national communications to the United Nations Framework Convention on Climate Change.

The Miro Forestry project is covered by EIAs (Abeney, et al., 2008) (Tollenaar, 2012) and is certified under the principles and criteria of the FSC. Further, with the implementation of the project, it contributes to the mitigation of climate change.

High conservation value (HCV)

An internal assessment was conducted in 2016 to identify HCV presence in Miro Forestry's operational areas within the Boumfoum Forest Reserve. At the time of this study, no HCV areas have been identified within Miro Forestry's landholding in Reserve. The Company already Conservation Management

Prescriptions in place for managing its conservation areas but will incorporate management recommendations made by the consultancy in the management of the HCV area.

A consultancy firm, SAL Consult, was tasked with identifying HCV areas in its holdings in the Awura and Chirimfa Forest Reserves during the ESIA process. As Miro Forestry continues to acquire new blocks within the Boumfoum Forest Reserve, these blocks will be assessed under existing prescriptions in the Company's management system for areas HCV and conservation value.

2 SAFEGUARDS

2.1 No Net Harm

Miro Forestry uses an environmental management system based on the internationally recognised 'Plan, Do, Check, Act' mechanism:

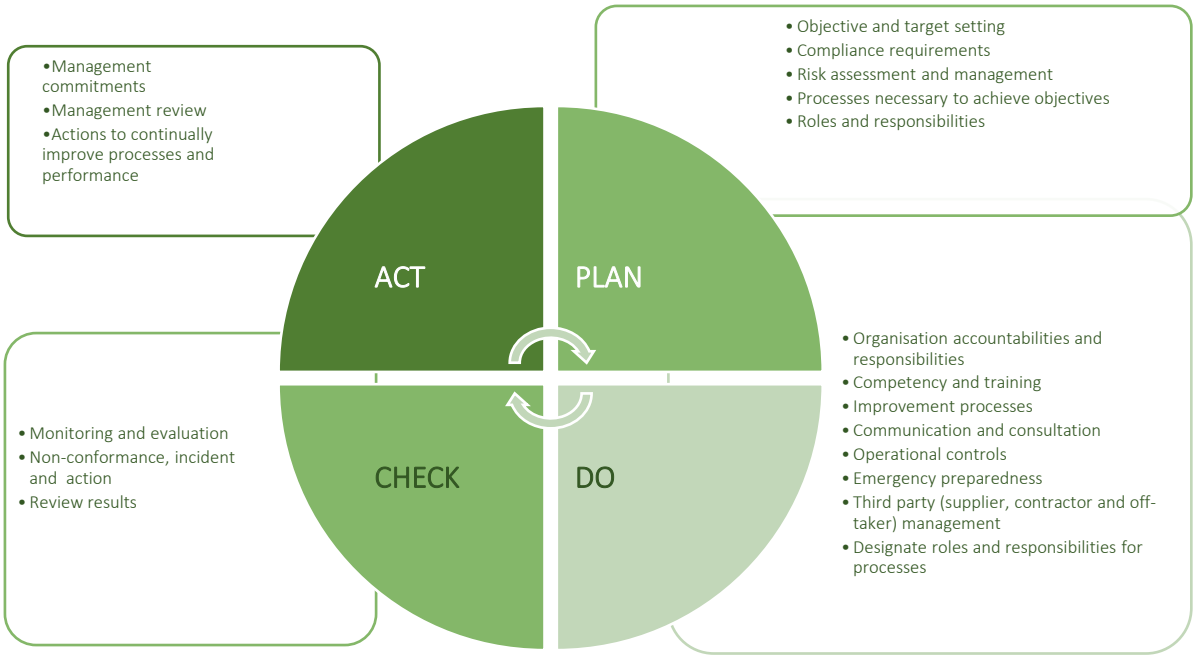

Figure 11. Environmental management system

A list of impacts was identified during the development stages, including preparation, construction, and operation. The mitigation measures proposed are given below.

Table 16. Impacts identified in the preparatory stage

Impact issue 1	**Acquisition of farmlands and impact on the livelihood of farmers**
Project activity	Land/forest compartments acquisition
Receptors	Landowners and migrant land users/farmers
Impact magnitude	Major
Mitigation measures proposed	Miro Forestry has proposed to allow short-term intercropping of certain crops alongside the planting of tree seedlings by local legitimate farmers. Affected farmers will have the option to participate in the scheme as farmers to improve their livelihoods, which additionally includes bee keeping, access to literacy and other programs. Project affected farmers have been identified and will be considered first by Miro Forestry for the intercropping scheme and/or employment. All farmers will be allowed to harvest their crops before the commencement of work.
Impact issue 2	**Occupational health and safety issues**
Project activity	Soil testing and field investigations
Receptors	Staff/experts
Impact Magnitude	Local/moderate

Mitigation measures proposed	Staff, experts and contractors involved in land and field investigations follow Miro Forestry's health and safety policy. The adoption of a health and safety policy at the site during field investigations will serve as a precautionary measure to prevent or minimise the possibility of accidents and reduce health risks. Workers will also be provided with the necessary PPE and its use will be enforced. All workers with ailment or injuries will be referred to the nearest health facility for treatment.
Impact issue 3	Social conflict with the local community, migrant settlers and farmers
Project activity	Education and sensitisation of local farmers/communities
Receptors	Local farmers/community and identifiable groups
Impact magnitude	Major
Mitigation measures proposed	Community sensitisation programmes will continue and will include: • holding meetings at the community level to further explain the project and its socio-economic benefits to the people; • facilitate the formation of a consultative group with selected representatives from the communities to meet periodically with Miro Forestry and plan for peaceful co-existence, and build capacity for community relations works to ensure the successful implementation of the project; and • the programme will help avoid unnecessary tension between misinformed communities and Miro Forestry and establish better rapport between the parties. Sensitisation and training aimed at local and migrant farmers to acknowledge their illegal entry into the reserve for farming activities and the need to preserve the reserve through plantation development. Miro Forestry will make known to them their intention of allowing farming to co-exist alongside the establishment of plantations while observing the rules and regulations governing the reserve. Farmers will be well educated on modern farming practices including the use of agrochemicals, land preparation and conservation techniques.

Table 17. Impacts identified during the constructional stage

Impact issue 1	Public/community safety
Project activity	Transportation of construction materials and equipment to the project site
Receptors	Local communities/general public
Impact magnitude	Moderate
Mitigation measures proposed	Communities along the haulage route may suffer from elevated traffic, dust and noise levels during the transportation of construction materials and equipment. The following mitigation measures are implemented to reduce these nuisances and health concerns: • use of regularly serviced and well-maintained vehicles to prevent frequent breakdowns on the roads; • all temporary traffic controls will be done in consultation with the Department of Urban Roads and the Police Motor Transport and Traffic Division; • adherence to traffic and road regulations including speed limits, warning signs and flags. There would be a mandatory speed limit of 50 km/hr when moving through human settlements and speed ramps would be provided at 50 m intervals within these settlements; • a code of conduct for drivers on the road would be developed and implemented; • community complaints handling arrangements would be instituted. • additionally, alternative haulage routes will be considered where necessary; and any accidents on the road involving trucks and humans or domestic animals would be investigated immediately, and corrective actions are taken to avert re-occurrence.
Impact issue 2	Loss of vegetation and impact on terrestrial life/biodiversity (flora and fauna)
Project activity	Land preparation (land clearing, soil preparation, ripping, ploughing)
Receptors	Terrestrial habitat flora and fauna

Impact magnitude	Moderate
Mitigation measures proposed	Significant ecological areas such as patches of remnant semi-deciduous forest vegetation and indigenous species, swamps, and riparian strips and habitats areas within the concession of the Chirmfa and Awura Forest reserves have been identified and mapped out to ensure the preservation of original plant and animal species within the project area. All Rare, Threatened and Endangered ecosystems and habitats are being protected as part of the companies Conservation Management plans. The project does not carry out the total mass clearance of vegetation in one phase. Phasing of development activities will allow some time for mobile fauna to seek refuge in adjacent and similar habitats or establish new ones nearby. Critical habitat such as the gallery forest along the banks of the river are left undisturbed and further enhanced through tree planting. Patches of remnant forests and areas with indigenous species are left undisturbed and protected. Enrichment planting is encouraged to restore and enhance such species Buffer zones and strips of vegetation are being created along riparian areas to reduce the impact on habitat and threatened fauna/wildlife as well as for the promotion of soil stability and climate change adaptability There are minimal cutting of trees unless it is very necessary. Miro Forestry will consult the FSD to plant and nurture trees at suitable locations.
Impact issue 3	Surface run-off and material transport into water-bodies
Project activity	Land preparation/road construction
Receptors	Soil/surface water bodies, aquatic flora/fauna
Impact magnitude	Moderate

Mitigation measures proposed	Clearing is limited to the area required for the reforestation project to reduce the exposure of bare soil to agents of erosion and deposits of debris in water systems that affect aquatic life. Clearing is by slashing and the cleared material (thrash) are left on the surface to decompose and used as mulch or ploughed and mixed into the soil to act as a soil nutrient, so as not to leave the soil completely bare. The use of heavy machinery for clearing is limited as much as possible. Miro Forestry establishes and maintains a vegetative buffer zone of 15 m each side (30 m in total) from the water bodies to reduce the risk of pollution of the water systems. Culverts and drains are being constructed along access roads to check erosion and control any runoff. Seasonal streams are being identified during the road planning stage. Access roads are compacted to minimise erosion.
Impact issue 4	Clearing of Illegal settler farms and impact on livelihoods
Project activity	Land preparation (land clearing, soil preparation, ripping, ploughing)
Receptors	Migrant and settler farmers
Impact magnitude	Major
Mitigation measures proposed	Miro Forestry allows short-term intercropping of certain crops alongside the planting of tree seedlings by local legitimate farmers. Affected farmers will have the option to participate in the scheme as farmers to improve their livelihoods. MF consider future employment opportunities for farmers. Project affected farmers will be considered first in the intercropping scheme and any employment by MFGL before other interested persons for the reforestation project. Farmers are allowed to harvest their crops before the commencement of work. MFGL collaborates with landowners and stakeholders in educating illegal settlers and local farmers to desist from future encroachment of the reserve.
Impact issue 5	Air quality impact/noise nuisance

Project activity	Transportation of construction materials Land clearing Road construction
Receptors	Workers, the community
Impact magnitude	Minor
Mitigation measures proposed	MF ensure that noise abatement devices such as earphones and earplugs are worn by all those operating machinery. Work involving forest machinery is intermittent and restricted to the day time to minimise noise nuisance, particularly in a settlement located just on the boundary of Miro's compartment. Reasonable speed limits and a limit on the frequency of use of forest machinery will be ensured to minimise dust emissions. The burning of large amounts of biomass or cleared vegetation will not be encouraged, as reasonably practical. Equipment will be serviced regularly to avoid excessive noise generation.
Impact issue 6	Occupational health and safety issues
Project activity	Land clearing and preparation
Receptors	Workers, contractors
Impact magnitude	Moderate

Mitigation measures proposed	Adoption of Health and Safety Policy All workers are required to adopt MFGL's Health & Safety Policy to guide the construction phase activities. The adoption of the policy at the site serves as a precautionary measure to prevent/minimise the possibility of accidents and reduce health-associated risks. A health and safety officer will be appointed to ensure compliance with the Policy, and the provision and use of PPE. Miro Forestry provide and enforce the use of appropriate PPE such as safety boots, reflective jackets, hand gloves, earplugs and nose masks. Sanctions will be implemented where workers do not use the PPE provided. Use of road worthy vehicles Miro Forestry regularly maintain and service its bulldozers, excavators and tractors to ensure they are in good condition. Well-maintained equipment reduce breakdowns, noise nuisance and smoke emissions, which could affect the operators' and other workers' health and safety. Use of qualified personnel Miro Forestry employ only qualified machine operators with requisite skills and experience to operate the machines. Miro Forestry carry out regular training on standard operating procedures, and health and safety, is provided for machine operators. First aid Miro Forestry provide first aid training for its workers and provide first aid kits at the project site during land preparation and construction activities to treat minor ailments. However, major cases will be referred to the nearest hospital or health post (Mampong Municipal Hospital).
Impact issue 7	Generation of biomass and fire risk
Project activity	Land clearing (slashing)
Receptors	Entire plantation, forest
Impact magnitude	Moderate

Mitigation measures proposed	Biomass Salvaging of useable biomass will be encouraged to significantly reduce the volume of waste that has to be disposed of. The burning of large biomass or cleared vegetation will be avoided, as reasonably practical. In the event burring is required, controlled burning according to well-designed protocols will be employed. Miro Forestry will ensure workers are properly trained in slash burning protocols and observe favourable weather conditions for burning and ensure proper disposal. General waste Miro Forestry will ensure the contractor(s) provides bins on-site for the collection and disposal of plastic waste and polythene materials such as lubricant containers, drinking water sachets and carrier bags, which will be regularly emptied at an approved dump site.
Impact issue 8	Sanitation issues
Project activity	General construction phase activities
Receptors	Local communities, workers
Impact magnitude	Moderate
Mitigation measures proposed	The contractor provides toilet facilities at the site to discourage free-range defecation among workers. Also, field workers will be encouraged to use the facilities available at nearby communities. The project collaborates with the municipal/district assemblies in the provision of additional toilet facilities in the affected communities to help prevent health threats. Waste bins are provided at the appropriate places to minimise littering on the site. Changing rooms will also be provided for the construction workers.
Impact issue 9	Demographic and population change impacts
Project activity	Marketing
Receptors	Communities

Impact magnitude	Moderate
Mitigation measures proposed	The project ensures close collaboration with the local police personnel and traditional authorities to minimise the incidence of crime in the project area and its immediate environs. Miro is developing a safeguarding policy and is currently undertaking a deep dive assessment of safeguarding and gender risks in the workplace and community with a local Civil Society Organization Rigorous awareness-raising and campaigning against HIV/AIDS and other sexually transmitted diseases (which are likely to be prevalent as a result of the presence of migrant workers and increased income, which tends to encourage liberal sexual behaviour). Workers will be encouraged during regular meetings to practice safe sex. Miro Forestry will ensure the contractor(s), together with opinion leaders such as the assembly member and traditional leaders, sensitises migrant workers on societal norms, taboos and other cultural practices in the area.

Table 18. Impacts identified during the operational stage

Impact issue 1	Impact of agrochemical on soil and contamination of water bodies and aquatic life
Project activity	Application of agrochemicals for weed control and fertilisation
Receptors	Soil, terrestrial, flora and fauna, surface and groundwaters, aquatic species
Impact magnitude	Moderate

Mitigation measures proposed	Mechanical weed control, to the extent possible, is adopted to minimise the use of weedicides, under the FSC Pesticides Policy (2005). Miro Forestry ensure that only EPA-approved agrochemicals, from licensed agrochemical shops, will be purchased and used. All agrochemicals on the FSC list of 'highly hazardous' pesticides will be avoided. Miro Forestry control the application of weedicides and fertilisers by adhering to limits and recommended dosages to avoid overspills and over concentrations. Miro Forestry use selective pesticides with a low environmental impact quotient rather than broad-spectrum products to minimise impacts on non-target species The application of agrochemicals follows an integrated pest management approach. Ensure workers and farmers for the intercropping scheme are properly trained in the use and disposal methods for chemicals. Avoid using weedicides in areas close to water bodies and avoiding using them on steep slopes near water bodies. Limit the application of fertiliser to farmland that may subsequently leach/seep into underground water.
Impact issue 2	Open animal grazing and impacts on tree seedlings
Project activity	Planting
Receptors	Tree seedlings
Impact magnitude	Major
Mitigation measures proposed	Miro is implementing a Fulani Action Plan and Road.tmap to address the challenges of grazing (usually by Fulani Herdsmen). This roadmap includes de formation of an advisory committee of local expers on indigenous tribes and pastoralists and focuces on engagement and participation.
Impact issue 3	Sedimentation runoff into water bodies
Project activity	Land/soil preparation (ripping, ploughing),
Receptors	Ground surface, water bodies
Impact magnitude	Moderate

Mitigation measures proposed	Soil preparation on steep slopes close to water bodies will be avoided. Miro Forestry will create vegetative buffers alongside water bodies to protect them from soil sedimentation. Regular visual inspections of water bodies will be conducted to ascertain any sedimentation of water bodies. Riparian vegetation will be maintained to sieve off sediment from plantation runoff. Planting will occur between contour bunds. Ploughing without harrowing will be encouraged. The planting of seedlings will be done on ridges across the slope. Planting will be done in contour strips.
Impact issue 4	Occupational health and safety issues
Project activity	Planting of tree seedlings and handling of agrochemicals
Receptors	Workers, farmers
Impact magnitude	Moderate

Mitigation measures proposed	The Project has an occupational Health and Safety Policy and strictly enforce its regulations. The adoption of the Policy at the site serve as a precautionary measure to prevent/minimise the possibility of accidents and reduce health risks. Miro Forestry ensure that machinery and equipment is effective for the tasks and is in good condition to prevent accidents and injury. Workers and farmers are given adequate training on health and safety, as well as on the job training, and ensure adherence to health and safety procedures to minimise accidents. Workers are also provided with the necessary PPE and its use is enforced. The project provides, train and equip selected members of the workforce on first aid administration. Miro Forestry ensure that any pesticides used are applied according to the FSC Pesticides Policy. Miro Forestry ensure that all pesticides listed in WHO Hazard Class II (moderately hazardous) will be avoided unless appropriate controls established concerning the manufacturing, procurement, distribution and use of these chemicals are in place. These chemicals would not be accessible to personnel without proper training, equipment and facilities in which to handle, store, apply and safely dispose of these products. Miro Forestry educate its workers and farmers on the safe use of agrochemicals and safe disposal of chemical containers. All agrochemicals on the FSC list of 'highly hazardous' pesticides will be avoided.
Impact issue 5	Alteration of landscape aesthetics
Project activity	Harvesting and felling
Receptors	Workers
Impact magnitude	Moderate
Mitigation measures proposed	Miro Forestry will avoid the contiguous harvesting of large areas to minimise landscape disruptions and ensure the proper disposal and management of slash material.
Impact issue 6	Noise pollution from forest machinery

Project activity	Harvest
Receptors	Workers, farmers
Impact magnitude	Moderate
Mitigation measures proposed	Ensure all workers use noise protective gear such as earplugs and headphones to minimise noise from harvesting machinery. The prolonged operation of machinery will be avoided.
Impact issue 7	Damage to corridors used by fauna and loss of flora
Project activity	Harvest
Receptors	Soils, roads
Impact magnitude	Moderate
Mitigation measures proposed	Miro Forestry has identified significant ecological areas within the concession of the Chirmfa and Awura Forest Reserves to ensure the preservation of native plant and animal species within the project area. Miro Forestry has prepared a forest management plan that will be implemented to guide tree harvesting, which includes: the maintenance a 15 m buffer (30 m total) along the streams to maintain riparian vegetation and the lifeforms they support; indigenous trees species will be retained for regeneration purposes, and because they provide den and nesting sites, food sources, cover and travel corridors for wildlife; directional felling is employed by trained personnel to minimise canopy damage and the distance to skid trails; and ensure that large canopy holes are avoided by limiting the proximity of trees to be harvested.

2.2 Local Stakeholder Consultation

The consultation process took place during September 2020. The preparation of the process began with the construction of the map of actors[14] with influence on the carbon project and the identification of

[14] Supports\ 1. PDD\1.3 Stakeholder consultation\Supports_LSC Ghana \Stakeholder mapping carbon project 2020

easily accessible communication mechanisms for each type of actor through which the meetings were called.

Educational material[15] was developed to support the explanation of each of the project's components, for example, the soil cycle, climate change and conservation of environmental resources. Also, a PowerPoint[16] presentation was prepared for the meetings with government authorities and physical material (images)[17] was prepared for the rural communities (Figure 12).

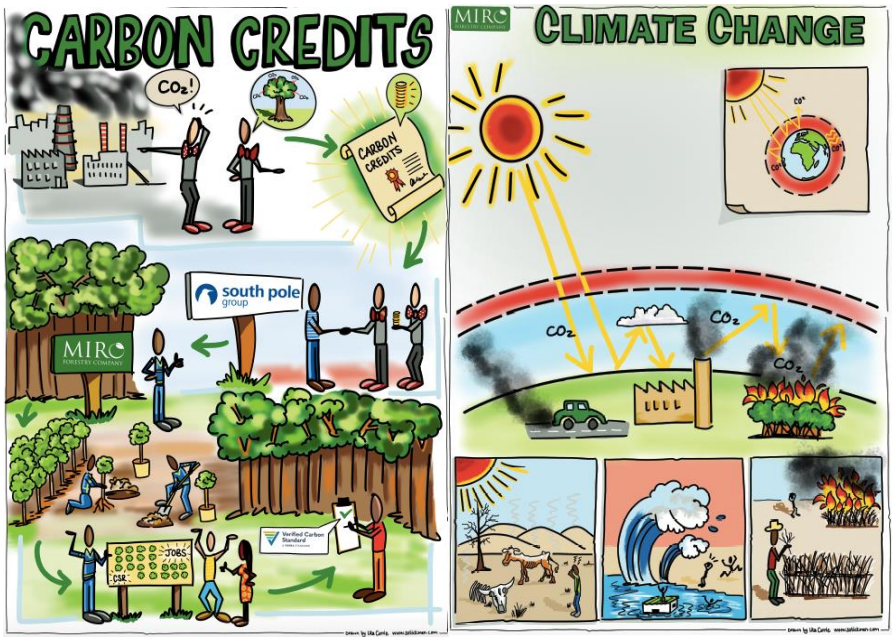

Figure 12. Instructional materials presented during meetings

Subsequently, the convening of the actors to the meetings was initiated through formal letters[18] to the presidents of the traditional councils and municipal and environmental authorities. The invitation letters explained Miro Forestry's interest in certifying its plantations as part of the climate change mitigation strategies and invited the stakeholders to discuss the issue in subsequent meetings.

[15] Supports\1. PDD\Soports_LSC Ghana\Miro Environmental Educational Programme

[16] Supports\1. PDD\Soports_LSC Ghana\Carbon credits working document

[17] Supports\1. PDD\Soports_LSC Ghana\Report on environment an carbon credit training for selected communities

[18] Supports\1. PDD\Soports_LSC Ghana\letters


Ilustration 1. Participants meetings

In this way, six meetings were held in the communities: Droposo, Serebroso, Nhyiaeso, Ankamadua, Jadeako and Bunuso[19].

Tabla 1. Date and attendance meeting with communities

Communities	Meeting date	Female	Male	Total attendance
Droponso	15/09/2020	0	7	7
Serebroso	10/09/2020	28	25	53
Nhyiaeso	11/09/2020	61	31	92
Ankamadua	14/09/2020	27	17	44
Jadeako	16/09/2020	18	29	47
Bunuso	18/08/2020	21	30	51

During the meetings the topics concerning the project were presented in a participatory way: Environment and Climate Change, Water - Water Cycle, Water Use, Soil - Importance, Soil Cycle, Conservation - Ecosystems and Conservation and Carbon Credits. The participants had the space to ask questions concerning the topics addressed[20]. Table 19 presents the comments received during the consultation meetings

Table 19 Comments collected during communities' meetings

Comments	Answer
	Droponso
How can we prevent the pollution of the water bodies near our farms?	*Referring to the learning map, participants gave the following as answers: We should not plant our crops very close to rivers/streams, we should not use chemicals for fishing, should not dump refuse into streams, we should not pour excess weedicides or fertilizer into*

[19] Supports\1. PDD\ 1.3 Stakeholder consultation\Supports_LSC Ghana\Attendance 1- Attendance 2

[20] Supports\1. PDD\ 1.3 Stakeholder consultation\Supports_LSC Ghana\Report on environment an carbon credit training for selected communities

Comments	Answer
	streams. Facilitator added that mixing of chemicals for spraying should not be done close to the riverbanks. Instead, a drum should be put at least 10m from the riverbank and filled with water for the mixing. Empty chemical containers should not be rinsed/washed into the water body.
Congratulated Miro Forestry Ghana for the work down on the tree planting. *Thank Miro Forestry Ghana for the teachings however, he entreated Miro for more teachings with videotape; such as a recording of a motion picture. A digital recording of an image or set of images that tells a story or animation to the general community*	
	Serebroso
Please listening to you has aroused my interest in tree planting but I do not have land available now. Can Miro assist me in future when I have land available to plant trees?	*It is good you appreciate the importance of tree planting. For a start, you can integrate trees on your farm by either planting or allowing natural regeneration of indigenous seedlings/saplings on your farm. Miro is currently piloting an outgrower scheme in Drobonso. If it is successful, the company may scale it up to cover your area and bring on board those of you interested in this community.*
I have nursed some indigenous species like 'Ofram' (Terminalia superba) and Mahogany (Khaya spp.) and planted them on my farm. Can Miro provide me with more seedlings of indigenous trees to plant?	*We encourage you to continue with the good work you are doing. The indigenous trees being nursed by Miro is primarily for our enrichment planting program. We actually buy seeds from the Forestry Research Institute of Ghana (FORIG) to nurse for our program. We do not have any in stock to give to communities at the moment. However, we plan to collect seeds when the trees grow, and nurse them for further planting. If we are successful at this, then we could share some of the seedlings with you farmers who are interested to plant.*
It is very true that trees are important in our environment. Are we to plant only the species Miro is planting or any tree is good?	*No, you do not necessarily have to plant the species Miro is planting. Miro has some end uses in mind, and that informs us on the types of species to select for planting. In fact, you should be planting the indigenous seedlings on your farms or within your community since they are 'familiar' with the soils, and which you can tend easily rather than the exotic species.*
This session has been very fruitful and educative for us. One particular lesson for me is that we do not have to sweep and throw away the leaf litter under the trees in our community. We can gather and leave them under the trees to decompose and fertilize the soil for tree growth. Hitherto, we had been sweeping the litter and soils such that portions of the roots of the tree (pointing to the roots of the tree under which the training was being done) are even exposed. We are grateful to Miro for the education. *I can see you really came prepared this time with all those photos and illustrations to aid our learning. We have all learnt a lot today. Thank you.*	
	Nhyiaeso
You mentioned that we should protect wild animals. I want to find out if the animals which destroy our crops are also to be protected?	*The animals which destroy your crops are referred to as pests. Pests are to be controlled such that they do not cause destruction to crop*

Comments	Answer
What can we do to restore that river (in the photo activity) which had been filled with waste?	*Question referred to participants for possible answers - The river could be dredged to remove the waste materials, de-silted to remove any excess sand/other particles, and waste dumping stopped. Trees should be planted along the riverbank to further protect the river.*
What are we supposed to do about the Fulani herdsmen who set fires, allow their cattle to graze on our land and eat our crops?	*The Fulani issue has become a national one which needs to be dealt with at the national level. Unfortunately, Miro does not have the authority to stop their activities. We are leasees of the land we plant our trees on and can only report their activities in our concession area to the Forestry Commission, District Assembly or the Police. Miro is commencing an engagement program with the Fulani and some experts on pastoralists to try to help identify a peaceful way forward.*
Will the communities' benefit from your carbon selling?	*Yes, it will come in the form of corporate social responsibility projects which will benefit the entire community*
We are very grateful to Miro for this in-depth training. Let me add that we discourage forest/bush clearing in our community. *I am a migrant from the northern part of the country. Before moving down here, I was told that the south had more trees, so people did not experience heavy winds destroying their buildings like we in the north did. It was so when I migrated to the south but now, people are harvesting trees (big/small) for charcoal production and we have started experiencing destruction from the winds (roof of houses being taken away). So, all the effects of bad environmental management practices being discussed here are very true.* *Bush fires are destroying forests and making the land infertile. Yet some farmers have gone in for a new chemical which they are using to kill trees on their farms. We all need to change our way of doing things.* *All of us here need to keep our waste well (especially, the polythene wrappers) to prevent them from flying around.* *Composting is a good practice because I have been doing it on my farm and can attest to its benefits for crops.* *I know from experience that trees are very important. I have a big stretch of land but I only farm 2 acres. I have left the rest to fallow/regenerate, so a lot of animals visit my farm quite often.*	
	Ankamadua
If I understand correctly, companies producing carbon would buy from Miro with cash?	*Yes, so that Miro can plant more trees to absorb more carbon.*
Can Miro assist us to plant trees on our lands so we could also earn some carbon credits? If we are to plant trees in our community, what type of trees should we plant?	*Miro is currently piloting an out-grower scheme in Drobonso. If it is successful, the company may scale it up to cover your area and bring on board those of you who may be interested within this community. Regarding the trees which could to be planted in your community, you can plant any indigenous tree which you see/used to see around the community.*
If you say we should not cut down trees in the forest/newly	*We are not saying you should stop farming. All we want to emphasize is that you should leave some trees on your farm which can help*

Comments	Answer
allocated plots, where are we going to plant the food crops? I ask because some of the trees shade our crops and prevent them from growing	*improve the fertility of soils in the farm. You will be exposing the soils too much if you do a total clearing of all vegetation on your farm*
We need trees to be planted in our communities because when you look around, you can see most of the trees have been cut down. Can Miro give us some of their seedlings to plant around our houses?	*Looking at the cost of producing a seedling, planting it until it grows to become a tree, Miro spends a lot and I think that would be too much for you as small-scale farmers. It would be better if you could collect seeds from indigenous trees in the forest or your farms to nurse and transplant. When you see seedlings or saplings of indigenous trees on your farm, do not destroy them but rather nurture them to grow. Miro is starting a forestry outgrower project that might be of interest to you if it expands further*
How can we prevent air pollution from moving vehicles which travel on our roads?	*Vehicle owners should do regular servicing/maintenance of the engine of machines/vehicles to prevent excessive smoking.*
How can we prevent pollution to our water bodies	*We can prevent pollution to our water bodies by not spraying chemicals into it/rinsing chemical bottles in them, not dumping waste into them, preventing siltation, planting trees along rivers/water bodies, etc.*
I wish to affirm that Miro is indeed protecting the animals in their concession. I was onsite as a contractor and once came across a grasscutter but I was not allowed to chase and kill it.	
	Jadeako
How can we get the trees to plant?	*You can collect seeds from the forest or your farms to nurse and transplant. When you see seedlings or saplings of indigenous trees on your farm, do not destroy them but rather nurture them to grow.*
commend Miro Forestry Ghana Ltd. for the good work done. However, I will like to know how the community would benefit (from carbon credits)?	*The community will benefit through social responsibility projects like schools, toilet facilities, boreholes etc*
Does the spraying of weeds help the land?	*We are not saying you should not spray weeds on your land, but it would be good to consider chemical spraying as the last resort in your fight against weeds and pests. Try and do manual farm weeding if your plot of land is small.*
Can we plant teak in our land?	*You can plant teak trees in your land but you must bear in mind that once the canopy closes, you may no longer be able to plant your crops as they will not do well. It is good to integrate indigenous trees on your farms.*
If I plant trees on my land, can you facilitate for me to sell the carbon?	*You would have to be certified first as an individual, group or company before you can sell carbon through a recognized coordinating organization like South Pole*
Every time we have enquired about when our community will benefit from a CSR project, we have been told to hold on a bit till it gets to our turn. Now I believe it will soon get to our turn so I want to suggest that a senior secondary school be built for us	
We need trees to plant in our community so we will be grateful if Miro could assist us in the direction.	

Comments	Answer
	Bunuso
You said, we should not spray and burn the weeds so, what should we do?	*We are not saying you should stop spraying or burning the weeds. All we are saying is that you should spray and/or burn the weeds intermittently, alongside manual weeding/slashing. For instance, if you reduce spraying this year by spraying just once instead of twice/thrice in the year and you weed manually, the slash on the soil surface will serve as mulch and decompose further to fertilize the soil naturally.*
How can we protect our water bodies or the river banks?	*Referring to the learning map, participants gave the following as answers: We do not remove vegetation close to the riverbanks, we should plant trees along the river banks, we should not use chemicals for fishing, should not dump refuse into water bodies, we should not pour poisonous substances into the rivers, and we should avoid washing in streams. Facilitator added that mixing of chemicals for spraying should not be done close to the river banks. Instead, a drum should be put at least 10m from the river bank and filled with water f*
How can we prevent bush fires?	*Prevention of bush fires is everyone's responsibility. We all have a role to play if we want to put a stop to bush fires. For instance, we need to avoid the use of naked fires on farms. If possible, food should be prepared at home and taken to the farm rather than cooking on the farm. Smokers should avoid throwing away cigarette pieces indiscriminately, avoid using fires for hunting purposes, make clean boundaries if you need to burn your farms, etc.*
I want to appeal for more training to be done for the farmers to enable them to use proper farming methods in their farms. Farms should also be visited to ensure that farmers are practising the recommended methods.	*A training session like this could be arranged by Miro in future to be done by our Extension officer for farmers. However, farm visits can only be done by agriculture extension officers in the district. You may discuss with your Assemblyman/unit committee member your need for visits by the extension officer, and they can check with the district Ministry of Food & Agriculture (MOFA) office.*
I personally always commend you for your effort in planting more trees to bring back our forest. I wish to call on Miro for social support in our community. We need a toilet facility. Due to the absence of such a facility, people have been using the bush or riverbanks as places of convenience. If we have a toilet in the community, then all this pollution to the water bodies especially would be reduced.	

In the comments received, the understanding that the participants of the different meetings had regarding the topics presented is appreciated; additionally, the inertia of increasing the amount of forest in the area corresponding to the communities is perceived, and the project is asked to collaborate to encourage the planting of trees; however, the project currently does not have the possibility of supporting the communities with this activity.

The meetings with the government entities were carried out through personal meetings, which the representatives had the opportunity to present to their representatives the objective of the certification of the carbon project and in the same way, give answers to the doubts generated on the subject,

Below (see Table 20) is the list of entities that were consulted.

Table 20. Government entities consulted

	Communities	Meeting date
The representative of Sekyere Afram Plains	District Coordinating Director	30/06/2020
Representatives of Asante Akyem North District Assembly	District Coordinating Director Deputy District Coordinating Director	07/07/2020 07/07/2020
The representative of Kwamang Traditional Council	Chief Linguist	08/07/2020
Representative Of Sekyere Central District Assembly	District Coordinating Director	08/07/2020
Representative Environmental Protection Agency (Epadeputy Director - Konongo Area Office	Deputy Director - Konongo Area Office	10/07/2020
The representative of Sekyere Kumawu	District Coordinating Director District Planning Officer	10/07/2020 10/07/2020

The issues addressed during the meeting with the representatives of the government entities can be found in the minutes[21] that reflect the issues discussed and the comments made during the consultation process. A summary of the main questions that arose with this stakeholder category can be found in the table.

Table 21 Comments collected during representatives government meetings

Comments	Answer
does this certification go with money?	*Yes, there would be some economic benefits available for the Company*
What are some of the economic benefits to the communities?	*Miro can beef up its CSR projects in our communities if certified*
Specifically what role do you want the Assembly to play in getting the certificate?	*South Pole, our coordinator for the certification requires that we engage all relevant stakeholders even though you do not have a specific role here. By engaging you, we have satisfied the requirement.*
What do you mean by carbon credit?	*Is a certificate or permit given to a company who participates in the international carbon markets after going through the certification process. The district representative said he understands everything except the meaning of the carbon credit and after getting the explanation, there was no question again and the meeting brought to a close.*
What will be the benefit to the community?	*The Company will continue its social responsibility programmes in all our engaged communities. Environmental awareness creation and road safety education will also continue in all communities.*

[21] Supports\1. PDD\1.3 Stakeholder consultation\Supports_LSC Ghana\Minutes

Comments	Answer
How many jobs will be created?	*The Company will continue to employ as the project expands. About 10,000 hectares roughly needed before rotation starts and this will create more jobs. Expansion of the veneer mill will create additional jobs as well.*
Do you have skills development plan for the local community workers?	*There is a management training scheme where National Service personnel are trained and drafted into the management staff bracket. A second training scheme is a hands-on approach where workers are allowed to learn on their jobs, an example vehicle maintenance, planning forestry, Tractor and Dozer operations etc.*
I can see Miro is a dynamic company, anytime you want to come up with a different project. You were here some time ago to inform us you want FSC Certification and this time round carbon credit certification. I like a company like that, always trying to be innovative.	*Thanks so much for your commendation. We will continue to do our best*
Am sure you will remember the Assembly when you start to reap the benefits	*Yes, this will come in the form of corporate social responsibility for communities under the Assembly.*
I am impress with Miro Forestry reforestation project and progress made so far, I fully support the project.	*Miro will continue to develop degraded areas leased by the Forestry Commission*
Management should do well to secure the carbon credit certification in order to finance more projects.	*we shall do our best to secure it for the benefit of the business and the communities.*
The district Assembly has a teak farm along Bahankra road and managing it is a big challenge. *Will it be possible Miro takes over the management aspect for us, as we are broke?*	*The Assembly can call for technical support and the Company can consider that but managing another developer's project will not be possible.*
Commendation: The climate change impact is becoming severe therefore I commend Miro for their tree plantation activities. If we have more of such companies in Ghana, the climate change situation will remain better	

The meeting ended successfully, and participants commended Miro for the recognition given to the Assembly and also involve them any time we embark on new projects. They encouraged the company to do more to better the lives of the communities in which it operates.

The comments obtained during the consultation process do not lead to changes in the project design. The interest of the communities in Miro Forestry supporting the planting of trees on communal lands is not possible, as it is currently not within the scope of the company's management; however, it is an initiative that will be studied to see if it is possible to implement it in the future.

2.3 Environmental Impact

An EIA has been conducted by Winniwood Consulting, an independent consulting firm. The study was performed in July of 2014 to evaluate and assess the potential social and environmental impacts that may occur because of the proposed development. The EIA has been conducted under the statutory requirements of the Environmental Assessment Regulations 1999[22] (LI 1652). The proposal from Miro Forestry falls into the category of undertakings (Regulation 3) for which an EIA is required.

The consultants have evaluated all potential impacts on the environment in six stages to determine the significance of each impact, as shown below.

Table 22. Stages of EIA

Stage	Name
1	Description of the nature of the impact
2	Description of the magnitude of the impact
3	Duration of impact
4	Potential consequences
5	Likelihood of occurrence/probability
6	Severity/degree of significance

[22] Ghana Environmental Assessment Regulations 1999 Available at: Supports\1. PDD\1.1 Library\Document References\ENVIRONMENTAL ASSESSMENT REGULATIONS 1999

Each stage has been fully described in the ESIA[23] report (see the Annex).

One of the critical steps in defining the environmental and social impacts is the identification of key activities that the forestry project is currently doing and has planned. The grouped key activities identified for Miro Forestry are as follows:

Table 23. Key groups identified for the EIA

No.	Group
1	Nursery establishment
2	Landscape planning
3	Creation of special management zones (cliff edges and rocky outcrops, wetlands and riparian strips, archaeological/cultural sites, indigenous species and forests, conservation areas)
4	Site and tree species matching
5	Road construction and maintenance
6	Land clearing and preparation
7	Soil preparation
8	Slash management
9	Planting of trees
10	Weed control
11	Thinning and maintenance
12	Harvesting and felling
13	Forest fire management
14	Establishment of sawmill and timber treatment plant
15	Labour and staff recruitment

The environmental sensitivities likely to be affected by the proposed development activities have been identified by evaluating the impact of each Miro Forestry project activity on various environmental and

[23] Final Environmental Impact Statement for Proposed Reforestation of 5,000 hectares of Degraded Forest Lands in Boumfoum Forest Reserve, Near Agogo, Ashanti. Available at: Supports\1. PDD\1.2 PO Information\ESIA

socio-economic conditions. This is because each key activity is likely to impact many environmental/social factors. The key activities and their respective likely impacts are listed below.

Table 24. Activities considered within the EIA

Activity	Overall impact rating		
	Positive	Negative	Rating after mitigation
Use of groundwater and rivers		x	Minor
General land use	x		Highly beneficial
Land for expansion		x	Minor
Harvesting and slash management	x		Major benefits
Protection of rich biodiversity habitats	x		Major benefits
Protection of indigenous tree species	x		Highly beneficial
Wetlands and riparian strips		x	Moderate
Protection of archaeological and cultural sites	x		Major benefits
Site and species matching on soil nutrients		x	Moderate
Site and species matching on soil properties	x		Major benefits
Colonisation by invasive species		x	Minor
Soil erosion from road construction and maintenance		x	Major
Surface run-off from road construction		x	Major
Impoundment of seasonal streams from road construction		x	Moderate
Contamination of water bodies from road construction		x	Moderate
Noise pollution from road construction		x	Minor
Dust dispersion from road construction		x	Minor
Road construction on vegetation clearing		x	Moderate
Road construction on unauthorised access to the reserve		x	Moderate
Land clearing on loss of vegetation and flora		x	Major
Land clearing on wildlife habitats, food and biodiversity		x	Moderate
Land clearing on soil erosion and soil nutrients		x	Moderate
Land clearing on the recharge of aquifers		x	Moderate
Land clearing on material transport into water bodies		x	Minor
Land clearing on eutrophication		x	Moderate
Land clearing on seasonal floods		x	Major
Land clearing on aquatic life		X	Minor
Clearing of illegal plantain and maize farms		x	Major

Activity	Overall impact rating		
	Positive	Negative	Rating after mitigation
Land clearing on livelihoods of illegal farmers		x	Major
Land clearing on the control of illegal migrant activity	x		Highly beneficial
Soil tillage on the enhancement of soil nutrients	x		Major
Soil tillage on soil erosion		x	Major
Soil tillage on sedimentation of water bodies		x	Moderate
Poor slash management on workers' health		x	Minor
Slash effect on improving soil nutrients	x		Moderate
Soil damage		x	Minor
Protection of soil moisture	x		Major
Development of a microclimate	x		Major
Transformation of reserve landscape	x		Highly beneficial
Carbon sequestration	x		Major benefits
Intercropping by local farmers	x		Moderate
Use of agrochemicals for weed control		x	Moderate
Aquatic life		x	Moderate
Use of chemicals on health and safety of workers		x	Moderate
Soil compaction and erosion from thinning and maintenance		x	Moderate
Sedimentation runoff into water bodies		x	Moderate
Harvesting and felling on landscape aesthetics		x	Moderate
Damage of fauna corridors and loss of flora		x	Moderate
Soil compaction and erosion from harvesting		X	Moderate
Dust dispersal on the health of workers and community		X	Minor
Fire management and prevention	x		Highly beneficial
Job creation from the treatment plant and sawmill	x		Highly beneficial
Migration of labour to Agogo from surrounding areas		X	Moderate
Employment from labour recruitment	x		Highly beneficial
Gender balance	x		Highly beneficial
Stakeholder revenues from forest outputs	x		Highly beneficial
Benefit sharing among the three stool landowners	x		Highly beneficial
Development of a vocational training centre	x		Highly beneficial
Support for local good causes	x		Moderate

Activity	Overall impact rating		
	Positive	Negative	Rating after mitigation
Monitoring and management of the reserve	x		Highly beneficial
Poverty alleviation and health	x		Highly beneficial
Job creation and demographics	x		Highly beneficial
Limiting Illegal allocation of forest lands	x		Highly beneficial
Squatter farming and cattle grazing		X	Major

Main outcomes from the ESIA

The reserves are severely degraded that no longer contribute positively to the socio-economic development of nearby communities, especially Agogo. This is mainly due to the cessation of forest and commercial logging activities. In its current form, the reserve is at major risk of further degradation due to the settlement of illegal migrant farmers in the areas and the forest fires associated with their presence. The consequences of such a development are dire and could have serious environmental and socio-economic consequences.

- The project proposed by Miro Forestry presents an opportunity for much-needed interventions to be made in the restoration of the reserve. This is not without its challenges and requires strong stakeholder collaboration and participation in what could be a major success story for Agogo and its surrounding communities. The potential economic spin-offs from the successful implementation of the project are very substantial.
- These accruable benefits would reach stool landowners, the local community, the district assembly and forest agencies.
- The proposed development poses some environmental risks which require mitigations to minimise the effect on the environment and stakeholders. Of concern is the effect of soil erosion on some areas of the reserve on water bodies near some of the allocated compartments. These parameters require Miro Forestry to closely monitor its proposed activities concerning soils and water bodies and ensure that international best forestry practices are adopted wherever possible for effective mitigation activities that they are currently implementing.
- The impact of the development on farming in the reserve poses some serious challenges. These challenges can be addressed as long as the various legislative instruments related to the setup, management and operation of the reserve remain effective at solving complex socio-economic issues. Therefore, skilful and timely management interventions and close stakeholder collaborations

are being conducted to ensure that a balance is achieved between compliance with the legal frameworks and ensuring the farming livelihoods of the local community.

- Although proposed as a longer-term, value-added element of the project, Miro Forestry is currently collaborating with the necessary stakeholders to gain land for the proposed establishment of a timber treatment plant. This would ensure that the value-adding element of the plant can be established in time to process the tree outputs from the Eucalyptus plantations.
- Collaboration with institutional and local stakeholders is critical to the successful execution of the project. Miro Forestry should, therefore, seek to develop strong collaborative and participative stakeholder relationships capable of assisting the project in achieving its commercial and socio-economic objectives.
- The Boumfum Forest Reserve was previously a natural forest, which is very difficult to replicate without allowing for about 50-60 years of natural regeneration minimal human activity in the Reserve. Therefore, the proposed use of fast-growing Teak and Eucalyptus plantation species accelerates the regeneration process. However, care should be exercised to ensure that a harmonious landscape is achieved from a combination of the proposed species and the reintroduction of indigenous species as part of the plans to restore the reserve.
- Since the Eucalyptus species are mainly hybrid varieties, Miro Forestry should provide regular growth and general performance data to the Forestry Commission. This will serve to inform the Commission and its agencies on the best plantation practices, as well as the performance and growth characteristics of these species.
- Soil improvement measures such as the application of fertilisers should be undertaken in a carefully controlled manner, ensuring that the excessive application of fertilisers is avoided at all costs. Also, consideration should be given to encourage natural soil enrichment from decomposed leaves, twigs and vegetation wherever possible.
- Miro Forestry should ensure that soil erosion is kept at a minimum by adopting the prescribed mitigations and adopting preventive measures to limit the effects of run-off from slopes during the rainy seasons. Ridging parallel to the terrain contours should be used to avoid soil erosion. Where mechanical ploughs are used, it should be done along the contours not on gradients exceeding 10%. By mixing cleared vegetation into the soils to act as mulch, soil erosion will be greatly minimised and soil nutrients enhanced from decomposed vegetation. Miro Forestry should also ensure that appropriate expertise and supervision are deployed in the field during soil preparation activities.
- The reserve is traversed by many seasonal streams that are likely to flood low lying valley areas in the reserve during the rainy seasons. Care must, therefore, be exercised in soil and land preparation activities to limit soil erosion and the sedimentation of water bodies.
- Road construction and maintenance activities can lead to increased surface run-off from slopes, leading to soil erosion. Care must, therefore, be exercised in the construction, maintenance and

alignment of roads to ensure that gradients and contours are taken into consideration during the planning process. The use of drainage bars and culverts is recommended wherever possible.

- It is well known that most of the wildlife animals have migrated to the nearby Bomfobiri Wildlife Sanctuary. Nevertheless, there are occasional sightings of some fauna operating in and around Miro Forestry's allocated compartments near riparian strips and water bodies. Miro Forestry should, therefore, instruct workers to desist from poaching game or fauna. Wherever possible, they should also protect fauna habitats, especially when creating new conservation areas within the reserve.
- Since farming is the mainstay of Agogo's population, Miro Forestry should develop agroforestry schemes such as controlled intercropping within its allocated areas. This may be done in small patches of land that may not be suited to tree planting but are adequate for small subsistence farming. Nevertheless, strict monitoring is required, together with permission from the Forestry Commission and stool landowners, to ensure that reserve lands are not over-run by farmers.
- Miro Forestry should consider adopting out-grower schemes whereby farmers are supported with all necessary technical and financial inputs for the planting of trees under the company's supervision. The farmers can then share in the financial returns gained from the trees after the deduction of the plantation investment costs. This arrangement must seek the approval and participation of the Forestry Commission and the management custodians of the reserve, who have already indicated a keen interest in establishing out-grower schemes.
- The management of fire is an essential part of protecting the reserve. Miro Forestry should, therefore, hold local stakeholder consultations to identify a pool of locals who will be able to support their firefighting efforts in the unfortunate event of a large fire outbreak on the reserve. This is a necessary, collaborative stakeholder initiative aimed at protecting Agogo and its surrounding communities from the damaging effects of fire and smoke inhalation.
- Periodic and annual stakeholder meetings and consultations should be undertaken with all local and institutional stakeholders to share best practices and communicate project progress, successes and challenges.

Additional to this main EIA, the company undertakes Rapid Environmental Assessments specific to each block prior to development and the specific mitigation plans

2.4 Public Comments

Stage to be developed when documents are uploaded to Verra.

2.5 AFOLU-Specific Safeguards

The project's stakeholder strategy is to develop fruitful working relationships with its key stakeholders; thereby leveraging their support to enable the company to achieve its planting, commercial, environmental and social objectives. The company acknowledges that to be successful, it must ensure a

proper engagement between stakeholders. Thus it has developed a strategy with the following objectives[24]

- To ensure proper engagement between stakeholders and NMFC.
- To ensure that all stakeholders are kept abreast of project developments.
- To highlight and communicate the roles and functions of stakeholders in the project.
- To obtain stakeholder feedback of project impact in the local area.
- To develop a regular forum for periodic exchange of ideas and local issues.
- To inform NMFC management on effective stakeholder management and public relations strategy

A Stakeholder mapping was developed to identify the relevant stakeholders and their influence in the project's activities. In the next figures a diagram of influence is represented.

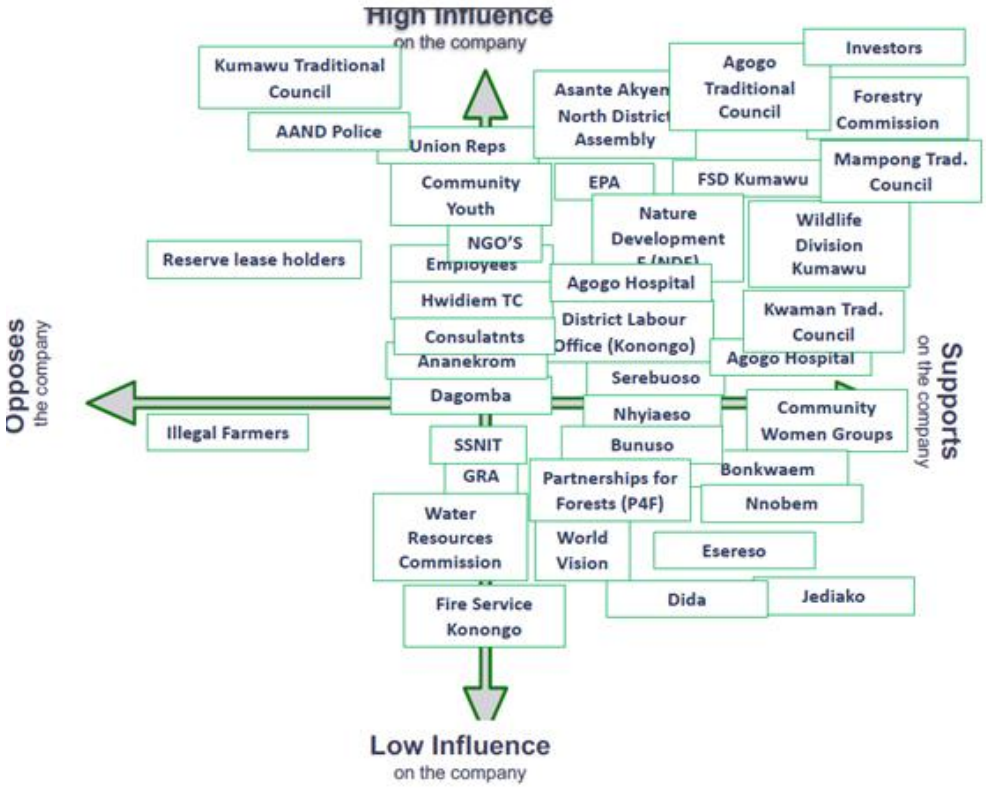

Figure 13. Stakeholders identification I

[24] To have more details please refer to the following documents: Final Environmental Impact Statement for Proposed Reforestation of 5000 hectares of Degraded Forest Lands in Boumfum Forest Reserve, Near Agogo, Ashanti. Livelihood Study and development plan (2014), Stakeholder mapping, analysis and engagement plan (2020). Grievance Procedure (2020)

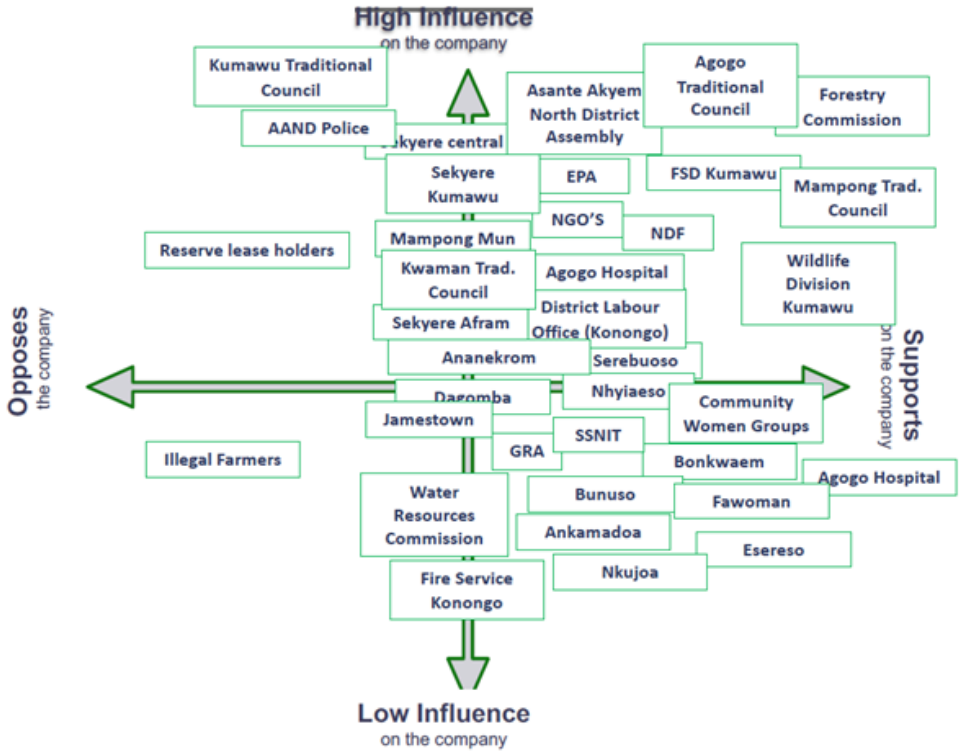

Figure 14. Stakeholders identification II

Stakeholders Risks assessments and mitigation

Stakeholder discussions have revealed general support for proposed development; key areas of concern and interest centre on the need for effective management and monitoring of the reserve, controlling the spread of illegal migrant settlers in the reserve, limiting forest fires, limiting poaching of game, preventing damming of water courses for irrigation, controlling the use of agro-chemicals, establishment of buffer and riparian strips near water bodies, controlling use of water resources, creation of employment, skills development and capacity building, allocating portions of the eastern part of the reserve for future expansion of Ananekrom and requests for permission to farm and herd cattle in the reserve.

Based on the most recent stakeholders stakeholder engagement report (2020), these are the main concerns of the community and the key stakeholders, and also there are indicated measures to address them:

Community Concerns	Mitigation Measures	How the impact can be addressed through the SEP
Loss of farming land leading to increased food insecurity	• Information Dissemination • Agro-forestry initiatives • Additional income opportunities through employment • Grievance Mechanism	The overall issue here relates to land development. As the company continues to develop the land it has been leased by the Forestry Commission, illegal farmers and communities complain about the loss of farming land. Through the dissemination of clear messaging by the CR Manager and through regular informal and formal meetings, issues can be discussed and information disseminated; such as the legal status of the land, inter-cropping access, recruitment policy and access to the grievance mechanism
Land for village expansion	• Information Dissemination	This is the case for one community only (Ananekrom). Concern was voiced over space for expansion of the village, through the CLO. The legal status of the land (being part of the forest reserve) should be made clear as well as accessibility to the grievance mechanism procedure
Reduced access to forest reserve for traditional rights	• Access still allowed to the reserve • All significant sites demarcated	Through regular informal and formal meetings the CR Manager can disseminate the company's commitment to preserving traditional rights
Personnel Health & Safety Risks	• Health and Safety Policy w/ regular meetings • PPE • Health awareness campaigns • Grievance Mechanism	As part of the SEP, H&S personnel and management must disseminate OHS messages to employees on a regular basis, Best Operating Practices (BOP's) to be disseminated, weekly Toolbox Talks
Provision of basic social services	• Community Development Plan based on consultation	The plan to be disclosed to stakeholders and community members as part of the SEP through workshops and meetings
Employment opportunities	• Prioritise Local employees • Recruitment within communities	Job opportunities should be advertised within the local communities first as part of the SEP

Figure 15. Community concerns and mitigation measures

Stakeholder Concerns	Mitigation Measures	How the impact can be addressed through the SEP
Land disputes, incorrect forest reserve demarcation	• Information Dissemination • Grievance mechanism • FC	The FC should lead the boundary demarcation process with involved parties to make sure there is a common understanding of where one boundary ends and where one begins.
Reallocation of compartments by FC	• Information Dissemination • Background of allocated compartments	There could be background checks on newly allocated compartments to know the history behind them. Old lease holders must be made aware of the reallocation on time.
Company Perception, Company Future	• Information Dissemination	Annual reports, major management decisions/statements should be well disseminated to all stakeholders to avoid negative perceptions about the company.
Lack of donations	• Information Dissemination • CSR projects/Community Development Plans	Stakeholders must be made aware of the existence of CSR plans and how the plan works.
Presence of Fulani	• Collaboration with Rapid Response Task Force • Attempt to engage with Fulani	The Fulani issue keeps coming up at community meetings. Community members feel unsafe with the Fulani around. They are entreated to try as much as possible to avoid any confrontations with the herdsmen for the sake of their own safety.

Figure 16. Stakeholder concerns and mitigation measures

Current community projects include:

- MFGH has committed funding towards the establishment and running of a vocational training centre primarily for skills and entrepreneurial development of the youth at Hwediem-Agogo.
- New kindergarten school at Ananekrom.

- Establishment of two boreholes in Agogo for the provision of clean drinking water for the local community.
- Health awareness outreach campaigns in the towns of Ananekrom and Serebuoso.

Ongoing Communication and Consultation

The company's community department is currently made up of Community Relations Assistant reporting to Community Relations Manager who also reports to the Business Operations Manager (BOM) for Stakeholder Engagement Plan deliverables. The BOM in turn reports to the Group EHSS Director

- Stakeholder Engagement is managed on a daily basis by the Community Relations Mananger, reviewed and supervised by the BOM
- Progress and setbacks are reported to management at weekly management meetings. A summary of stakeholder engagement and any changes to the plan are reported at the quarterly Environmental, Social and Governance (ESG) Committee meeting.

The Company's grievance mechanism[25] provides employees and stakeholders with a mechanism to express grievances without fear of reprisal and ensure concerns are appropriately addressed in a timely manner. The grievance mechanism offers a set of approaches whereby the grievant and the Company can find effective solutions together.

The Company has erected notice boards in the communities surrounding the operations, attached to these are a suggestion box that is checked monthly. The Community Liaison Officer is responsible for hosting workshops on the grievance mechanism. A notice is published in all communities stating how to contact the Company and how the grievance will be dealt with.

[25] Supporting documents/PO Information/ESIA/MFC Grievance Procedure

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

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

Also, the following tools were applied to 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 the carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2).

tool for estimation of the change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0); and

VCS AFOLU Non-Permanence Risk Tool (Version 3.3).

3.2 Applicability of Methodology

This section demonstrates that AR-ACM0003 version 02.0 is applicable to the project. 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 the wetland category.

To verify whether the project area falls on a wetland area, the model for mapping tropical wetlands[26] suggested by (Gumbricht, 2017)[27] was used to find that 20 hectares described as 'marshes' overlap with the eligible area. This area was discounted from the geographic supports and all estimations.

[26] Supports\1. PDD\1.4 Appendix\ TROP-SUBTROP_Wetlands_2016_CIFOR

[27] Gumbricht et al. (2017) An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. Global Change Biology

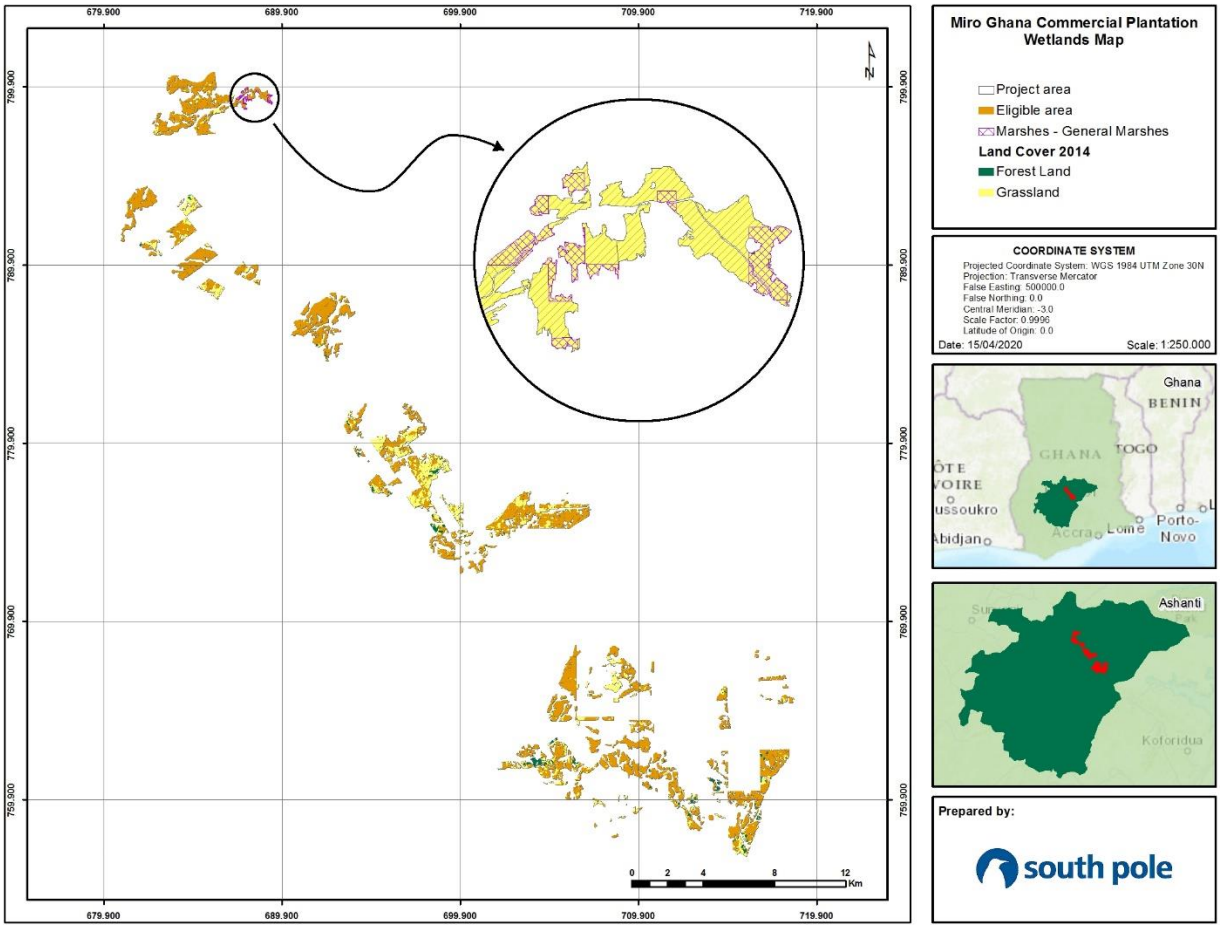

Figure 17: Miro Forestry Ghana wetlands map

Accordingly, in chapter 1.3 of eligibility, the net eligible area is 4,174.28 hectares.

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

(i) Land containing organic soils.

The soils of the project area consist predominantly of sandy loam over sandy clay loam and belong to three well-described soil series. Among the encountered soil series, no organic soils are present within the project boundary (Asiamah, et al., 2007).

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

The baseline before the project start date was grasslands without any inputs, as described in section 3.4.

Several tools were also applied to the project. The applicability conditions of these tools were met and are described below.

The applicability conditions of the combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (Version 01) are as follows:

a) Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law even if the law is not enforced.

The project activities will not lead to the violation of any applicable law.

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

The project is not classified as small-scale.

The tool used for estimation of carbon stocks and change in the carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2) has no internal applicability conditions.

The applicability conditions for the tool for estimation of the change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0) has the following applicability conditions:

(a) The areas of land to which this tool is applied:

(i) Do not fall into wetland category; or

As described above the under the demonstration of the applicability of AR-ACM0003 version 02.0, to verify whether the project area falls on a wetland area, the model for mapping tropical wetlands[28]

[28] Supports\1. PDD\1.4 Appendix\ TROP-SUBTROP_Wetlands_2016_CIFOR

suggested by (Gumbricht, 2017)[29] was used to find that 20 hectares described as 'marshes' overlap with the eligible area. This area was discounted from the geographic supports and all estimations.

(ii) Do not contain organic soils as defined in Annex A: Glossary of the IPCC GPG LULUCF 2003;

No organic soils are present within the project boundary. The soils of the project area consist predominantly of sandy loam over sandy clay loam and belong to three well-described soil series (Asiamah, et al., 2007).

(iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2;

The area of land on which this tool has been applied is not subject to any of the cropland or grassland management practices listed in Table 1 and 2. The baseline before the project start date was grasslands without any inputs.

(b) The A/R CDM project activity meets the following conditions:

(i) Litter remains on site and is not removed in the A/R CDM project activity; and

Since project is made of different compartments, of different species and ages, there will be always litter on site.

(ii) Soil disturbance attributable to the A/R CDM project activity, if any, is:

In accordance with appropriate soil conservation practices and limited to soil disturbance for site preparation before planting. Such disturbance is not repeated in less than twenty years. All land preparation involves appropriate soil preparation and soil testing and analysis. This ensures optimization of the site as soil preparation, to a large extent, determines the success of the planting.

Finally, the VCS AFOLU Non-Permanence Risk Tool (Version 3.3) was used to perform the non-permanence risk analysis and buffer determination. All requirements set out in this document were met. More details can be found in the Non-Permanence Risk Tool report.

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 Table 25.

Table 25. Selected carbon pools for the project

Pool/source		Gas	Included?	Justification/explanation
Baseline	Above-ground biomass	CO_2	Yes	Major carbon pool in the baseline and project activity

[29] Gumbricht et al. (2017) An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. Global Change Biology

Pool/source		Gas	Included?	Justification/explanation
	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, is only included in the project and not the baseline.
	Dead wood	CO_2	No	Since degraded lands are reforested, deadwood can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool conservatively has not been considered.
	Litter	CO_2	No	Since degraded lands are reforested litter, they can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool conservatively has not been considered.
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	Independent research showed a significant increase in this carbon pool due to the project activity.
	Dead wood	CO_2	Yes	This carbon pool has been considered due to the pruning and thinning activities in the plantations that left a considerable amount of biomass like branches and stumps.
	Litter	CO_2	Yes	This carbon pool conservatively has not been considered.

Geographic project boundary

The Boumfum Forest Reserve, near Agogo, in which the majority project is being proposed, is a 26,000-hectare reserve that has been logged over several times. In 1983, large areas of the reserve were destroyed by wildfires, resulting in damage to trees, vegetation, habitats and the overall ecosystem. The

Reserve is now seriously degraded and requires effective management and technical interventions to restore it.

3.4 Baseline Scenario

The combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (Version 01) was used. Below are the steps that were followed to identify the baseline and assess the additionality of the project:

Step 0. preliminary screening based on the starting date of the A/R project activity;

Step 1. identification of alternative scenarios;

Step 2. barrier analysis;

Step 3. investment analysis (not conducted); and

Step 4. common practice analysis

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

The project start date was after 31 December 1999. Compartment A6 of E.pellita was established on the 24th of March, 2016 which is the project start date.

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

With this step, alternative land-use scenarios were identified for the proposed activities of the project. The baseline scenario was identified, through the following sub-steps.

Sub-step 1a. Identification of credible alternative land use scenarios to the proposed A/R project activity

Alternative land-use scenarios were identified according to the proposed project activities, which could be defined as a baseline scenario. In addition to this, historical land uses, trends in the economic sectors and economic activities that take place in the region of the project area were considered.

Alternative scenario 1: Continuation of pre-project land use

In Ghana, forest reserves are owned mainly by the local communities, but the government is responsible for management. The reservation of permanent forest estates reflects the major ecological zones; this was done to preserve representative samples of the ecological and genetic diversity of the range of habitats found in the country. This is consistent with the first objective of the 1994 Forest and Wildlife Policy, which aims to manage and enhance Ghana's permanent forest and wildlife resources, conserve

biological diversity and the environment, and promote the sustainable production of domestic and commercial products (MLNR, FORESTRY DEVELOPMENT MASTER PLAN, 1996).

Ghana is an agriculture-dependent nation, but mechanised agriculture is almost non-existent. Although agriculture is heavily dependent on weather (particularly sufficient rain), the country has unpredictable weather conditions, as shown in section 1.13 Challenges in the agriculture sector are not limited to cultivation – there are also serious concerns when it comes to post-harvest storage and marketing. The major cause of food insecurity in Ghana is attributable to the greater percentage of post-harvest losses. (Darfour, 2016).

Ghana's agriculture production is mainly based on annual crops and cash crops, fish, livestock and cereal production, but the country still imports about 70% and 15% of rice and maize consumed, respectively. The rise in incomes in the country and increasing urban growth rate is expected to increase the demand for both crops (Darfour, 2016).

The historical land-use change, which shows an increase of 147% and 1,700% of non-irrigated and irrigated agriculture from 1975 to 2013 (see **Table 26**), due to agricultural expansion in Ghana will continue increasing to satisfy the actual demand of the population (Tappan, 2016).

Table 26. Land cover variance 1975-2013

Land cover classes (ha)	1975	2000	2013	Variance (Ha)	Variance (%)
Gallery forest and riparian forest	6,172	5,636	3,756	2,416	-39
Forest	16,444	15,560	12,420	4,024	-24
Agriculture	31,600	67,364	77,896	46,296	147
Irrigated agriculture	28	164	504	476	1700
Savannah	121,580	103,368	96,736	24,844	-20

(Source: Tappan, et al 2016[30])

Even with the increase in land use for agricultural purposes, Ghana is not self-sufficient in food production, and it has been difficult to ensure food availability all year round because the rapidly growing population poses another challenge to food security in the country. Protein Energy Malnutrition (PEM) is the most widespread and serious nutritional disorder in Ghana, especially among children. It is manifested in mild to severe stunting and wasting and causes underweight children. Food availability varies from season to season and from year to year depending on rainfall amount and its distribution in space and time.

Ghana faces imminent food insecurity as the average yield has not been growing. In almost two decades, the importation of commercial food and food aid has reached about 4.7% of food needs. Food production

[30] https://eros.usgs.gov/westafrica/data-downloads

and availability per year are dependent on rainfall during and between growing seasons and the level of production (Darfour, 2016).

Local communities, many of which are located within forest reserve boundaries, have their activities (like agriculture) to satisfy their needs and these activities are not aligned with the reserve's objectives and functions. With increasing population growth over the last two decades, the demand pressure on land has been considerable.

Demand for subsistence agricultural cultivation has been compounded by increased cash-cropping, urbanisation, and infrastructural development. 70%[31] of deforestation is attributed to shifting cultivation (bush fallow), and many areas have been badly blighted by farming due to local pressure for land (MOFA, 2007). The adjoining areas of forest outside the forest reserves were converted to agricultural lands during the 20th century. Currently, trees outside forest reserves are found in a mosaic of agricultural fields, fallow land, secondary forest patches and settlements.

It is credibly assumed that without correct development projects in the area, this pressure against the forest will continue as it was. The subsistence agriculture, which was a common practice before the project, will continue to exist even if it is not permitted under the current denomination of the land as a forestry reserve. The subsistence agriculture is one of the most important economic activities that can be developed by rural communities that do not have access to other livelihood and development opportunities.

Alternative scenario 2: Cocoa crops

Since the introduction of cocoa in Ghana in the late 19th century, the crop has undergone a series of major expansions and contractions, indicating that cycles are intrinsic to cocoa production as it is influenced by environmental factors such as the availability of forest land, ecological factors such as deforestation, outbreaks of disease and geographic shifts in production. Due to economic and social

[31] Forestry Development Master Plan, Ghana Ministry of Lands and Forestry

factors such as migration, Africa is expected to remain the world's leading cocoa-producing area over the next decade (Shashi, 2011).

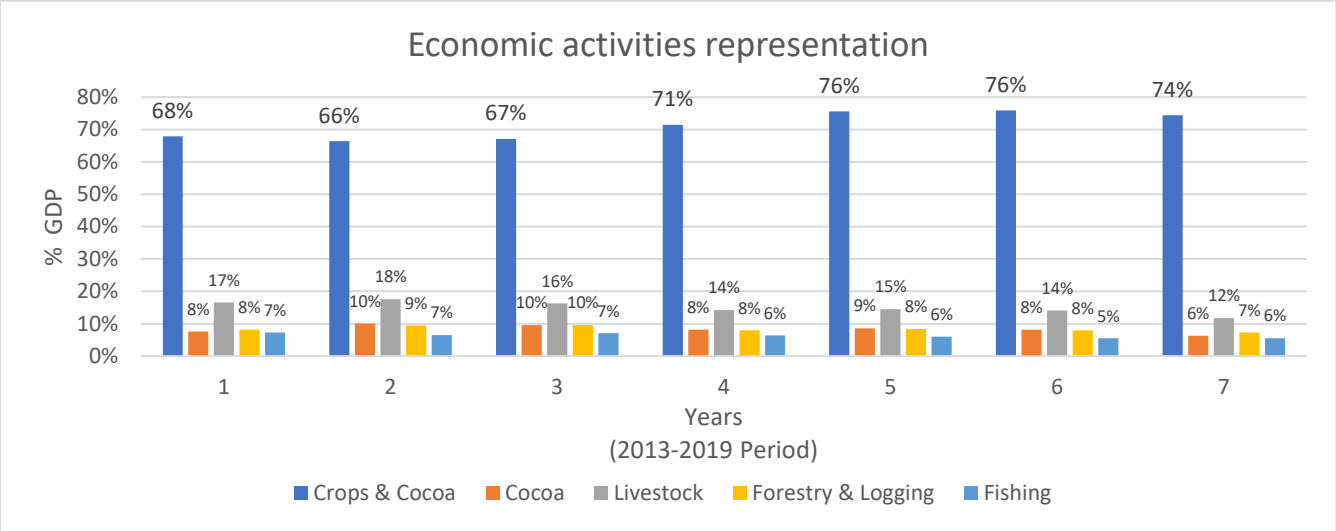

Figure 18: Ghana's historical Cocoa production (%)

Source: (Shashi, 2011)

Zero-deforestation cocoa only exists where all forest land has already disappeared in a given area and, with few exceptions, protected areas and classified forests are not protected in any way. The removal of trees on smallholder farms was ongoing throughout the 1990s and 2000s and is only slowing down now because so few trees remain (Ruf, 2017).

Despite efforts to diversify agricultural exports, cocoa remains the largest export commodity and remains the driving force of agricultural growth in the country. The key strategy for the development of cocoa has been the promotion of a high technology package of improved hybrid seed, a set of fertilisers, pesticide and fungicide recommendations, and improved husbandry practices. This is backed by improvements in producer prices, which have increased almost three-fold since 2001. Also, since 2001, farmers have been supported with credit for the acquisition of fertiliser, and there is a cocoa disease and pest control programme funded from cocoa taxes (MOFA, 2007).

Although cocoa can be grown under cultivated tree crops, Ghanaian farmers usually cultivate it under (natural) forest shade trees. Farmers achieve this by clearing forest undergrowth or by acquiring land that has been partially logged by timber merchants. Cocoa production is often considered a direct cause of deforestation because the planting area is sometimes located in forest reserves, which are usually treated as intact forest reserve areas in forest inventories (Yiridoe, 2011). Sub-sectors within the agricultural industry, particularly food crops and cocoa production, are the dominant agricultural activities in the forest zone and better reflect forest degradation than livestock grazing effects (Yiridoe, 2011).

In April of 2015, USAID's Office of Land teamed up with the World Cocoa Foundation and the Ghana Cocoa Board's Cocoa Research Institute of Ghana to conduct a joint assessment of the land tenure-

related constraints to productivity in Ghana's cocoa sector. The purpose of the assessment was to determine the relationship between land tenure security among Ghana's cocoa farmers and overall cocoa productivity. There are particular land tenure constraints relevant to the cocoa sector and possible interventions to improve tenure security for cocoa farmers[32]. Cocoa farming is a land use activity that can be developed within the project area as it occurs on private land and inside forest reserves, though often illegally.

Alternative scenario 3: Project activity without being registered as the A/R VCS project activity.

The degraded forest reserves are of major concern to the Government of Ghana because approximately 94% of this land is in deplorable condition because of unsustainable harvesting and encroachment. Restoring these areas is, therefore, a key component of Ghana's 1994 Forest and Wildlife Policy and the 1996-2020 Forestry Development Master Plan as well as other related sector policies including the Ghana Poverty Reduction Strategy paper. The reforestation project initiated by Miro Forestry in the Bomfoun Forest Reserve fits well within this policy. The reserve has been declared degraded by the Forestry Commission and has suffered from ongoing degradation, even with policies in place.

Miro Forestry has signed a land lease agreement with traditional landowners and the Government of Ghana for the reforestation of the project area to restore the productive forest in the degraded forest reserves. This lease construction and benefit-sharing are part of the national policy to restore degraded forest reserves in Ghana, which is a strong policy instrument demonstrating the commitment of the Government to conserve, restore and promote the sustainable use of forest resources in the country.

Outcome from sub-step 1a:

Alternative land-use scenarios that would have occurred on the land within the project boundary of the project:

- continuation of pre-project land use;
- cocoa crops; and
- A/R activities without being registered as such in VCS.

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

The scenarios presented above were selected based on the most plausible activities that can be developed in the project area, below is a description of its consistency or not with enforced mandatory applicable laws and regulations.

The scenario 1, subsistence agriculture as a continuation of pre-project land use, even though is not permitted under the forestry reserve, was the activity performed before the project, which shows that the

[32]Supports\1. PDD\1.1 Library\Document References\USAID_Land_Tenure_Ghana_Cocoa_Report

regulation is not systematically enforced, and the communities can perform its subsistence activities without strong law enforcement from the authorities.

The scenario 2, cocoa crops, is a major activity in the country representing the largest export commodity and the driving force of agricultural growth in the country, however, this activity could not be performed legally under the current circumstances or land use rights in the project area, therefore, any intention to undertake the activity will be under illegal actions.

In regards to the scenario 3, A/R activities without being registered as such in VCS, as stated in section 1.7 Ownership, Miro Forestry cannot claim title to degraded lands allocated to it for the reforestation project but has signed a land lease agreement with traditional landowners and the Government of Ghana for the reforestation of the project area to restore productive forest in the degraded forest reserves. This leases construction and benefit sharing contracts are part of the national policy to restore degraded forest reserves in Ghana. The company has signed a Land Lease and Benefit Sharing Agreement with the Forestry Commission and other relevant stakeholders for the statutory rights of entry into the Boumfoum Forest Reserve, which proves the scenario is consistent with the laws and regulations.

Outcome from sub-step 1b:

According to the information presented above, scenarios 1 and 3 are maintained, since they are fully viable to be developed in the region where the project is located.

On the other hand, scenario 2: cocoa crops, does not seems realistic and consistent with enforced mandatory applicable laws and regulations, because even though the cocoa plantations are widely distributed within the country, it is not permitted under the current land title and there are no chances a company will stablish any business related with this crop in a forestry reserve, since it could represent major reputational risk as well as legal risks.

Therefore, the alternative scenarios are:

- continuation of pre-project land use; and
- A/R activities without being registered as such in VCS.

Step 2. Barrier analysis

With this step, barriers were identified, and the land-use scenarios identified in sub-step 1b were assessed to determine which were not prevented by these barriers.

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

Economic barriers

The World Bank's Doing Business 2020[33] Report ranked Ghana at 60 out of 190 economies in terms of its ability to attain credit. The category was assessed by reference to (a) movable collateral laws (that is the strength of legal rights of borrowers and lenders in secured transactions) and (b) credit information systems (the sharing of credit information).

Access to credit is a major barrier to the forestry project because it limits the possibilities of financing additional reforestation activities, which have a considerable payback period Table 27.

Table 27. Crediting access in Ghana

Indicator	Ghana	Sub-Saharan Africa	OECD high income	Best regulatory performance
Strength of legal rights index (0-12)	6	5.1	6.1	12 (five economies)
Depth of credit information index (0-8)	6	3.9	6.8	8 (53 economies)
Credit registry coverage (% of adults)	0	8.3	24.4	100 (two economies)
Credit bureau coverage (% of adults)	33.2	11	66.7	100 (14 Economies)

Source: The World Bank's Doing Business 2020 Report, 2019

Given these conditions, there is a risk that transfers to the beneficiaries of social programmes, budgetary plans and financial resources that are intended to help reduce systemic gender inequalities, eliminate poverty, malnutrition and access to education will be affected. The role of Miro Forestry in contributing to social development cannot be overlooked. This includes a benefit-sharing provision for the local community of 5% of pre-tax operating profits, contributing significantly to the narrowing of social gaps.

Financial barriers

Miro Forestry is engaged in commercial reforestation activities on 8,945 ha in Ghana as of the end of 2019. The company's financial projections in this country include the planting of 18.4 thousand hectares in the next 24 years. MIRO's economic activities in Ghana that include commercial reforestation must make a large initial investment to establish the plantation and recurrent investments for its maintenance, which carries a high risk. In MIRO's financial analysis in Ghana, the return on investment is expected in nine years from 2019. The risk capital invested according to the negative cash flows in the project's life horizon is close to USD 27.1 million and the project's net present value (NPV) is close to USD 61.5 million, so the financial return risk is 44.1%.

However, in a scenario in which a reduction in GHG emissions is verified and there is income from the commercialisation of VCUs (according to the previous consideration, income from VERs has been

[33] See https://www.doingbusiness.org/content/dam/doingBusiness/country/g/ghana/GHA.pdf Available at: Supports\1. PDD\1.1 Library\Document References\ World Bank's Doing Business 2020 Report Ghana

considered), the financial risk drops to 38.3% with a difference of 5.8 percentage points (see Table 28). Therefore, the VER scheme represents an opportunity to add restoration actions and comply with desirable environmental objectives. The incentive is the expansion of reforested areas, which would lead to a reduction in the financial return risk for investors.

Table 28. Financial indicators

Financial indicators	Before VERs	After VERs	Difference
NPV	USD 61,488,826.35	USD 63,611,736	USD 2,122,909.71
Risk investment	USD 27,091,631.19	USD 24,338,575	USD 2,753,055.96
Risk/return	44.06%	38.3%	5.80%
Payback period	9	9	0

Source: South Pole, 2019

Table 29 shows the percentage of variations in each of the parameters, the quantity of wood produced, direct production costs and discount rate according to three pre-established scenarios: positive, moderate and pessimistic.

In the positive scenario, it is assumed that 100% of the production plan is fulfilled (i.e. 0% variation) and that direct production costs are reduced by 5% and the discount rate by 33.3%. In the moderate scenario, a 5% decrease in the quantities produced and a 5% increase in the direct production costs and 33.3% in the discount rate are assumed. Finally, the negative scenario assumes a 10% decrease in the quantities produced and a 10% and 66.6% increase in the direct production costs and discount rate respectively.

Table 29. Variations (%) in parameters by scenario

Variables	Positive scenario	Moderate scenario	Pessimistic scenario
Amount of wood produced	0%	-5%	-10%
Total direct costs assumed	-5%	5%	10%
Discount rate	-33.3%	33.3%	66.6%

Source: South Pole, 2019

Analysis of variations in the quantities of wood produced

In the positive scenario, meeting the projected production by 100%, the risk-return (RR) indicator without VERs is 44% and 38% with VERs, which represents a risk reduction of 6%. In the moderate scenario, a 5% decrease in timber production leads to a RR indicator of 65% without VERs and 57% with VERs,

representing a risk reduction of 9%. In the pessimistic scenario, the RR indicator without VERs is 106% and 91.4% with VERs, a decrease in risk reduction of 15%. This shows the strong sensitivity of the variable quantity of wood produced on the RR indicator, especially when the VERs are not considered. It can be concluded that having the VERs greatly reduces the RR indicator.

Analysis of variations indirect production costs

The direct production costs variable and its impact on the RR indicator without VERs in each of the three scenarios is greater than with VERs. For the positive scenario, the RR indicator without VERs exceeds the RR indicator with VERs by 5%; in the moderate scenario it exceeds it by 7% and in the negative scenario it exceeds it by 7%. As the scenario becomes more unfavourable for the company due to costs, the RR indicator becomes much greater, widening the gap without the VERs.

Analysis of variations in the discount rate

The RR indicator is very sensitive to variations in the discount rate. The worst case is the negative scenario, where a 66.6% increase in the discount rate leads to a variation in the RR indicator at high levels of more than 200% in the case without VERs, which represents a gap concerning the case with VERs of 48%. In the moderate scenario, the gap is 15%, while in the positive scenario, it is 3%.

The above shows that in the face of variations that negatively affect the operation of the company, either due to smaller quantities of timber being produced or increases in production costs, the financial indicators are very sensitive and the risk of return increases in a greater proportion than the variations in quantities and costs. The results obtained in each of the scenarios mentioned above are shown below in Table 30.

Table 30. Results of the sensitivity analysis in Ghana

Variables	Risk-return	Positive scenario	Moderate scenario	Pessimistic scenario
Amount of wood produced	Before VERs	44.06%	65.3%	105.9%
	After VERs	38.26%	56.8%	91.4%
Total direct costs assumed	Before VERs	38.63%	50.79%	58.76%
	After VERs	33.40%	44.29%	51.37%
Discount rate	Before VERs	20.10%	97.83%	244.1%
	After VERs	17.65%	83.06%	196.4%

Source: South Pole, 2019

This information indicates that if the VERs are not registered with the VCS, the financial risk undeniably increases, moving the project towards the pessimistic scenario. This scenario implies that wood

production will slow, and production costs will rise, threatening the direct and indirect jobs associated with this commercial activity.

Climatic conditions barriers

On the other hand, analysing the covariant risk in the country – which considers events that could affect plantations and influence financial return – it is evident that Ghana is a country with a high vulnerability to climatic conditions, such as extreme heat and forest fires (Figure 19)[34]. In Ghana, the danger of extreme heat is classified as 'high' according to the available information (Think Hazard[35], 2019). This means that prolonged exposure to extreme heat is expected to occur at least once in the next five years, causing heat stress as a result. The danger of forest fires is classified as 'high' according to the information available. This means that there is more than a 50% probability of favourable weather conditions for a major forest fire that could cause loss of life and property each year. As in many African countries, there are no financial institutions offering products to insure against climate risk, especially for activities with long payback periods such as forest plantations. In this case, the possibility of events occurring that are unfavourable to agricultural and forestry activities may discourage investment.

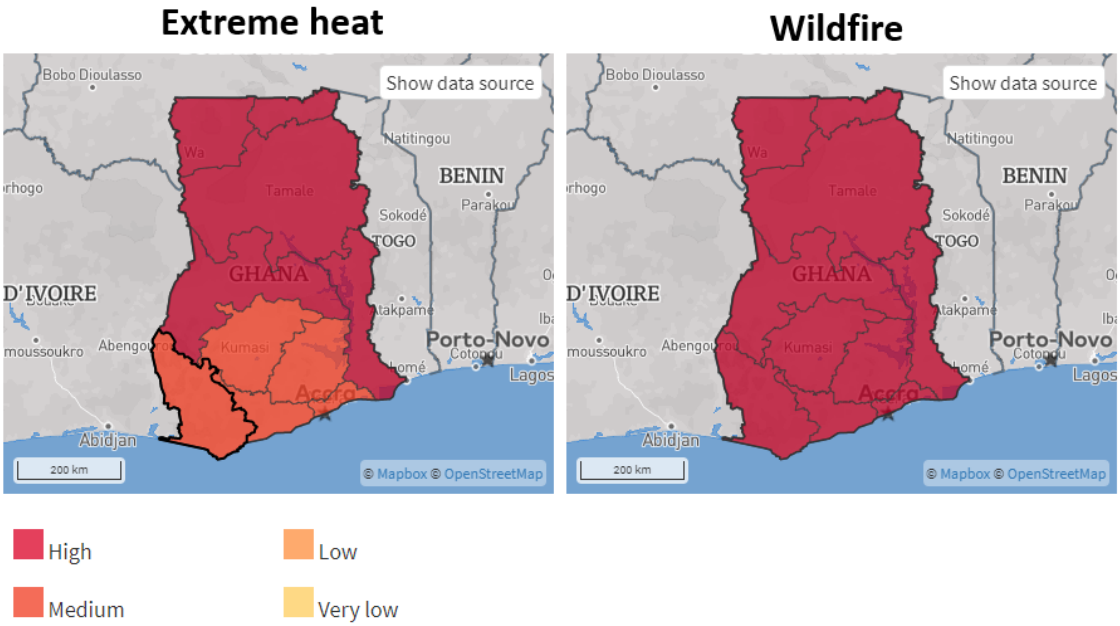

Figure 19. Climate risk in Ghana

Source: Think Hazard, 2019[36]

Land tenure barriers

[34] See https://www.coface.com/Economic-Studies-and-Country-Risks/Ghana Available at: Supports\1. PDD\1.1 Library\Document References\ Ghana Economic Studies - Coface

[35] See http://thinkhazard.org/en/report/94-ghana Available at: Supports\1. PDD\1.1 Library\Document References\2020 ThinkHazard - Ghana

[36] http://thinkhazard.org/es/report/94-ghana

There are four mainland tenure systems in Ghana: individual, family, communal and government or state lands. Most of the agricultural land is under communal ownership, which is controlled by the Forestry Commission (FUND, 2001).

MIRO is one of the main forestry development opportunities that lies in the establishment and management of large-scale timber plantation. For this activity, one major constraint is land tenure (MLNR, FORESTRY DEVELOPMENT MASTER PLAN, 1996).

Although the state established elaborate institutional and administrative machinery to govern land tenure and land administration, it has not been effective. There is a lack of networking and even conflict between some of the institutions. The National Land Policy identifies problems and constraints that have long plagued land administration, such as a weak land administration system; a general lack of discipline in the land market; indeterminate boundaries of stool/skin lands; compulsory acquisition by the government of lands without compensation; inadequate land tenure security due to the conflict of interest among and within land-owning groups and the state; and land racketeering and the slow disposal of land cases by the courts (Sarpong, 2006).

There are no formal arrangements for access to this resource where it has not been improved. Where there has been an improvement, those taking part in the improvement at a village or association level control the land.

Outcome from sub-step 2a:

The table below shows the barriers that may prevent one or more land use scenarios identified in the sub-step 1b.

Table 31. Outcome from sub-step 2a:

Identified barrier	Key points
Economic barriers	Access to credit
Financial barriers	High financial return
Climatic conditions barriers	Droughts, floods, fires, heavy rains, pests and disease
Land tenure barriers	Mainland tenure systems are not sufficient to cover the needs of the population with regard to sustainable development.

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

Within the alternative land-use scenarios, the continuation of pre-project land use is not as strongly affected as the project activity and could manage to continue, as has been doing it historically, even though the barriers are affecting it. Table 32 shows the list of land-use scenarios and the respective limitations or constraints identified for each.

Table 32. Alternative scenarios and barriers identified

Alternative scenario	Identified barriers
Continuation of pre-project land use	Economic barriers: In recent times, the adoption of modern agricultural technologies and cultural practices such as irrigation, fertiliser application, the use of resistant varieties, good planting and harvesting times, among others, are improving the quality and the production of crops. The adoption of these modern practices is hindered by financial constraints as these farmers are smallholder farmers with limited financial support. Moreover, commercial banks, private partners and insurance companies are not ready to support them to adopt and apply these technologies. Climatic barriers: The agriculture is heavily dependent on weather (particularly sufficient rain) and the country has unpredictable weather conditions which represents a risk for the crop yields. Land tenure barriers: Local communities, many of which are located within forest reserve boundaries, have their activities to satisfy their needs and these activities are not aligned with the reserve's objectives and functions. With increasing population growth over the last two decades, the demand pressure on land has been considerable.
Project activity without being registered under VCS	The same barriers as the one identified for the project activity but the financial barriers will present a higher financial return as shown in Table 28.

According to the information presented, the potential baseline scenarios are reduced to:

- continuation of pre-project land use.

The proposed project area has been considered partially forested since 1989, though the land was not a forest at the project start. This is because the land is officially a Forest Reserve; however, due to increased population pressure in recent years and insufficient law enforcement, agricultural encroachment in the area has caused severe deforestation and soil erosion. Farmers still inhabit the

area, using it for agricultural practices, and the area is frequently burned, which makes it highly improbable for the forest to return by means of natural regeneration.

Outcome from sub-step 2b:

The land-use scenario that is not prevented by any barriers is:

- continuation of pre-project land use.

Sub-step 2c. Determination of baseline scenario

Forestation without being registered as an A/R VCS project activity is not included in the list of land use scenarios that are not prevented by any barrier. The outcome from sub-step 2b contains only one land use scenario. As a result, the continuation of pre-project land use is the baseline scenario.

Step 3: Investment analysis

No investment analysis was required as there was only one land-use scenario that was not prevented by any barrier.

Step 4. Common practice analysis

The establishment and management of forest plantations is not a common practice in the reference area of the project, considering the total area and the number of lands that have reforestation as the main activity. This is much more evident when these figures are compared with the areas occupied by agriculture and livestock.

Although the development of commercial forest plantations has been identified as a priority economic activity in the country, different barriers hinder its implementation in the project area, with financing, technological management and the participation of state entities being the most significant. Additionally, existing forest plantations have had a strong dependence on various technological packages and the local communities' knowledge of timber species.

The only forestry project identified in the region is "FORM plantations" and is the only one in the country already registered as a carbon project. As a result, this project was excluded from the analysis.

As stated by the additionality tool, if it is proved the activity is not a common practice, the proposed VCS AFOLU project activity is not the baseline scenario and, hence, it is additional.

3.5 Additionality

The additionality of the present project was performed using the combined tool to identify the baseline scenario and demonstrate additionality in A/R VCS project activities (Version 01). See section 3.4 for more details.

3.6 Methodology Deviations

There are no methodology deviations.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The methodology "AR-ACM0003 A/R Large scale Consolidated Methodology: Afforestation and reforestation of lands except for wetlands (Version 2.0)" was considered. However, in the districts where the project area is located, the most common vegetation type are grasslands, a result of agriculture and fire. Due to the dynamic of the agricultural practice in the area, the fallow periods are short, which is insufficient for forest regeneration or the establishment of the local flora, which leads to a non-significant carbon stock in the baseline scenario and thus, it was considered to be zero.

4.2 Project Emissions

The current net estimate of carbon removals was made for the entire plantation eligible area in the period 2016-2019 to be verified in 2020, following section 5.5 of the methodology AR-ACM0003 A/R "Large scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands version 2.0", using the following equation:

$$\Delta CACTUALt = \Delta Cp,t - GHGE,t$$

Where;

$\Delta \boldsymbol{CACTUALt}$ Net current GHG removal by reservoirs in year *t*; tCO_2e.

$\Delta \boldsymbol{Cp, t}$ Change in the carbon stock of the selected reservoirs in the project, in year *t*; tCO_2e

$\boldsymbol{GHGE, t}$ Increase in non-CO_2e GHG emissions within the limit of the project area because of the implementation of the project activities, in year *t,* according to the procedure presented in the tool.

4.2.1 Stratification area

According to the "AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0", if biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios to achieve optimal precision of the estimation of net GHG removals by sinks.

In particular:

For actual net GHG removals by sinks, the stratification for ex-ante estimations is based on the project planting schedule plan (see Table 33).

Table 33. Stratums defined for GHG emission reductions and removals estimations

Species	Year	Eligibility	Area (ha)	Strata
Acacia mangium	2016	Eligible	188.4	1.1
Eucalyptus pellita	2016	Eligible	708.4	1.2
Tectona grandis	2016	Eligible	240.6	1.3
Corymbia citriodora	2016	Eligible	140.5	1.4
Acacia mangium	2017	Eligible	132.8	2.1
Eucalyptus pellita	2017	Eligible	448.7	2.2
Gmelina arborea	2017	Eligible	7.4	2.3
Tectona grandis	2017	Eligible	54.1	2.4
Corymbia	2017	Eligible	50.5	2.5
Acacia mangium	2018	Eligible	198.0	3.1
Eucalyptus pellita	2018	Eligible	763.1	3.2
Tectona grandis	2018	Eligible	56.4	3.3
Gmelina arborea	2018	Eligible	84.8	3.4
Corymbia citriodora	2018	Eligible	138.3	3.5
Other species	2018	Eligible	8.2	3.6
Acacia mangium	2019	Eligible	36.6	4.1
Eucalyptus pellita	2019	Eligible	365.1	4.2
Tectona grandis	2019	Eligible	18.3	4.3
Gmelina arborea	2019	Eligible	515.1	4.4
Corymbia citriodora	2019	Eligible	14.8	4.5
Other species	2019	Eligible	4.2	4.6
TOTAL			4,174.3	

4.2.2 Removals by sinks

The quantification of project emissions and/or removals was calculated following the section 5.5 of the AR-ACM003 methodology ""A/R Large-scale Consolidated Methodology Afforestation and reforestation of lands except wetlands".

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

Where:

$\Delta C_{ACTUAL,t}$ Actual net GHG removals by sinks, in year t; tCO_2e

$\Delta C_{P,t}$ Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; tCO_2e

$GHG_{E,t}$ Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t, as estimated in the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; tCO_2e

And,

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

Where:

$\Delta C_{TREE\_PROJ,t}$ Change in carbon stock in tree biomass in project in year t, as estimated using the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; tCO_2e.

$\Delta C_{SHRUB\_PROJ,t}$ Change in carbon stock in shrub biomass in project in year t, as estimated using the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; tCO_2e.

$\Delta C_{DW\_PROJ,t}$ Change in carbon stock in dead wood in project in year t, as estimated using the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; tCO_2e.

$\Delta C_{LI\_PROJ,t}$ Change in carbon stock in litter in project in year t, as estimated using the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; tCO_2e.

$\Delta SOC_{AL,t}$ Change in carbon stock in SOC in project in year t, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", as estimated in the same tool; tCO_2e.

Estimating carbon stock in trees at given point in time

Tree carbon estimation

To estimate the carbon stock in tree biomass at a given point in time, the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14 Version 04.1" was used. According to section 8.2 of this tool, this method is used for ex-ante estimation of the carbon stock in tree biomass.

Step 1. Volume estimation

Since the beginning of the plantation project, Miro Forestry has been recording and analysing crop data using the Microforest software and enumerations in the field37. The following table summarises the annual average increase (MAI) per species:

Table 34. Average MAI data per species

No.	Species	MAI (m^3/ha/yr)	Source
1	*Eucalyptus pellita*	20.0	Yepes et al. (2011). Protocol for national and subnational biomass-Carbon estimation in Colombia. Table 11.
2	*Acacia mangium*	26.0	Yepes et al. (2011). Protocol for national and subnational biomass-Carbon estimation in Colombia. Table 11.
3	*Corymbia citriodora*	16.0	FAO - Forest Resources of Tropical Africa (The MAI value employed is an average between 12 and 20 m3/ha/yr)
4	*Gmelina arborea*	13.7	UST, P. (1994). Growth and biomass production of Gmelina arborea in conventional plantations in Ghana. Ghana Journal of Forestry, 1, 5.
5	*Tectona grandis* Gr1	10.3	Mattia, S. B., & Sesay, S. (2020). Ground Forest Inventory and Assessment of Carbon Stocks in Sierra Leone, West Africa. In Natural Resources Management and Biological Sciences.
7	Other species	6,8	Project data

Ex-ante or projected estimations were made based on the MAI of each species planted in the project area, which is the average growth per species extracted from the database of the Microforest software. The MAI per species is averaged from the project start date to obtain a more representative and realistic value.

Step 2. Biomass estimation

The estimation of standing tree biomass for each stratum was calculated according to equation 13 of the AR-TOOL14 and the equation 5 of the Appendix 1 of the AR-TOOL14:

$$B_{tree} = A \times b_{tree}$$

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

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

[37] Supports\2. Estimations\Ex-ante\2012-2019 GN - Enumeration report

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

And,

$$b_{TREE} = [V_{TREE} \times D\ x\ BEF_2] \times (1 + R)$$

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

V_{tree} = Mean tree volume per hectare in the tree biomass estimation strata; m^3 ha^{-1}. For this case, it will be the MAI value of each species multiplied by the respective year of plantation establishment.

D = Basic wood density; t m^{-3}

BEF_2 = Biomass Expansion Factor; dimensionless

R = Root-to-shoot ratio; dimensionless

Step 3: Mean carbon stock in terms of CO_2e

The conversion of the standing tree biomass for each stratum in term of carbon units was calculated according to equation 12 of the AR-TOOL14:

$$C_{TREE} = \frac{44}{12} \times CF_{tree} \times B_{tree}$$

C_{TREE} = Carbon stock in trees in the tree biomass estimation strata; tCO_2e

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

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

Carbon in deadwood and litter was calculated using equations 9 and 15 of "A/R Tool 12 Estimation of carbon stocks and change in carbon stocks in dead Wood and litter in A/R CDM projects activities" of the AR-ACM0003 methodology, which accepts the use of a conservative default value that relates the carbon content (in deadwood and litter) as a percentage of the total carbon in the tree's biomass.

$CDW,i,t = CTREE,i,t\ x\ DFDW$

Where,

$\boldsymbol{CTREE}$, $\boldsymbol{i}$, $\boldsymbol{t}$ Carbon stock in the biomass of trees in stratum *I* at a time point in year *t* (tCO_2e).

Conservative default value expressing carbon stock in deadwood as a percentage of carbon stock in tree biomass (tCO_2e).

$CLI,i,t = C_{TREE,i,t}\ x\ DF_{LI}$

Where,

$\boldsymbol{CLI}$, $\boldsymbol{i}$, $\boldsymbol{t}$ Leaf litter carbon stock in stratum *I* at a time point in year *t* (tCO_2e)

$\boldsymbol{CTREE}$, $\boldsymbol{i}$, $\boldsymbol{t}$ Carbon stock in the biomass of trees in stratum *I* at a time point in year *t* (tCO_2e)

The conservative default value that expresses the carbon stock in the litter as a percentage of the carbon stock in the tree biomass (tCO_2e).

SOC was calculated using equations 1, 2, 6 and 8 of the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" of the AR-ACM0003 methodology.

$SOCInitial,i = SOCRef,i\ x\ fLU,i\ x\ fMG,i\ x\ fIN,i$

Eq. 1

Where,

$\boldsymbol{SOCInitial}$, SOC stock at the start of the project activity in stratum *i* of the soil areas (tC/ha).

$\boldsymbol{fLU}$, $\boldsymbol{i}$ Relative factor of change of stock for land use at baseline in stratum *i* of soil areas (dimensionless).

$\boldsymbol{fMG}$, $\boldsymbol{i}$ Relative factor of change of the stock for the management regime in the baseline in the stratum *i* of the soil areas (dimensionless).

$\boldsymbol{fIN}$, $\boldsymbol{i}$ Relative factor of change of the stock for the regime of reference inputs in stratum *i* of the soil areas (dimensionless).

$\boldsymbol{SOCRef}$, $\boldsymbol{i}$ Reference of the soil organic carbon stock corresponding to the reference of native soil condition by climatic region and soil type applicable to stratum *i* of the soil areas (tC/ha).

$SOC_{LOSS},i = SOC_{INITIAL}$, i*0.1

Eq. 2

Where:

SOC_{LOSS},i, SOC loss caused by disturbances attributable to the AR project activity, in stratum *i* of the soil area; tC/ha

0.1 Approximate proportion of SOC loss within the first five years from the year of preparation

The values of $SOC_{Ref,i}, f_{LU,i}, f_{MG,i}, f_{IN,i}$, are taken from tables 3 and 6 of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". The values taken are consistent with the type of soil and the management used in the project baseline.

The project did not use machinery for silvicultural activities; therefore, there was no disturbance in the soil. Thus, carbon loss is accounted for as follows:

$$SOC_{LOSS,i} = 0$$

$$dSOC_{t,i} = \frac{SOC_{Ref,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years}$$ Eq.6

Where:

$dSOC_{t,i}$, Rate of change in the SOC stock in stratum *i* of the soil areas, in year *t*; tC/ha * year.

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

Where:

$\Delta SOC_{AL,t}$ Change in the SOC stock in the soil areas that meet the applicability conditions of this tool, in the year; tCO_2e

A_i Area of stratum *i* of soil areas; ha

4.2.3 Calculation of tCERs and lCERs

According to the standard requirements, for those projects where harvesting practices is contemplated on project activities, the loss of carbon due to harvesting shall be include in the quantification of the project emissions. Due to the project activities contemplate an increment on project area with different rotation periods per specie, the long-term average (LTA) GHG benefit was calculated as follows:

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

Where:

LA The long-term average GHG benefit

PEt The total to-date GHG emission reductions and removals generated in the project scenario (tCO_2e). Project scenario emission reductions and removals shall also consider project emissions of CO_2, N_2O, CH_4 and leakage.

BEt The total to-date GHG emission reductions and removals projected for the baseline scenario (tCO_2e). Accounted

t Year.

n Total number of years in the established time-period

The procedure to calculate *PEt* and *BEt* parameters is explained in Section 3.2.4 of this document. In the case of *BEt*, it is accounted as zero as explained in Section 3.2.1. The *LA* estimated for the project is shown in Table 35 and **Error! Reference source not found.**.

4.3 Leakage

Due to the agreements made between the landowners in the forest reserves and Ghana's Forestry Commission, as well as the intercropping activities developed among the parties, it can be concluded that these agriculture activities will not be displaced to another area and instead will be improved with the support of Miro Foresty.

4.4 Estimated Net GHG Emission Reductions and Removals

The anthropogenic net removal of GHG by the reservoirs was estimated according to the equation of the AR-ACM0003 presented below:

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

Eq.5

Where:

$\Delta C_{AR\text{-}CDM,t}$ Net anthropogenic removal of GHG by reservoirs in year *t*; tCO_2e

$\Delta C_{ACTUAL,t}$ Net current GHG removal from reservoirs in year *t*; tCO_2e

$\Delta C_{BSL,t}$ Net GHG removals by reservoirs at baseline in year *t*; tCO_2e

LK_t GHG emissions due to leaks in year *t*; tCO_2e

Since baseline removals and emissions due to leaks were considered zero, net anthropogenic removals are expressed according to the formula:

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

Project proponent applied a discount of a reserve of 18% to cover the aspects related to the risk of non-permanence. The complete non-permanence risk tool can be consulted in the supports folder[38].

[38] Supports\1. PDD\1.4 Appendix\NPRT - Ghana

Table 35. Net ex-ante removal of GHG emissions

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated GHG emission reductions or removals (tCO_2e)
2016	0	0	0	394
2017	0	0	0	48.203
2018	0	0	0	68.344
2019	0	0	0	111.353
2020	0	0	0	134.691
2021	0	0	0	186.393
2022	0	0	0	233.376
2023	0	0	0	281.496
2024	0	0	0	328.680
2025	0	0	0	377.397
2026	0	0	0	425.851
2027	0	0	0	424.580
2028	0	0	0	430.354
2029	0	0	0	388.743
2030	0	0	0	412.937
2031	0	0	0	389.055
2032	0	0	0	405.873
2033	0	0	0	380.590
2034	0	0	0	383.425
2035	0	0	0	381.352
2036	0	0	0	380.264
2037	0	0	0	378.115
2038	0	0	0	377.397
2039	0	0	0	425.851
2040	0	0	0	424.580
2041	0	0	0	430.354
2042	0	0	0	388.743
2043	0	0	0	412.937
2044	0	0	0	389.055
2045	0	0	0	409.743
Total estimated ERs				9.810.123
Total number of crediting years				30
Average annual ERs				**327.004**

5 MONITORING

5.1 Data and Parameters Available at Validation

The data and parameters used in the quantification of project removals are shown below. Most of the parameters were defined based on the environmental and climatic conditions described in the project location section.

Data/parameter	Root to shoot ratio for mixed tropical broadleaf species (R_{mix})
Data unit	N/A
Description	Converts the above-ground biomass to the above- and belowground biomass
Source of data	*IPCC "Good Practice Guidance for LULUCF". 2003. Table 3A.18*
Value applied:	0.42
Justification of choice of data or description of measurement methods and procedures applied	Conservatively chosen for Primary tropical/subtropical moist forest
Purpose of data	Calculation of project emissions
Comments	N/A

Data/parameter	Biomass expansion factor (BEF)
Data unit	N/A
Description	Converts trunk biomass to total above and belowground tree biomass
Source of data	IPCC 2003, Good Practice Guidance for Land Use, Land-Use Change, and Forestry
Value applied:	1.5

Justification of choice of data or description of measurement methods and procedures applied	Tropical, broadleaf, over bark
Purpose of data	Estimation of belowground biomass
Comments	N/A

Data/parameter	Carbon fraction
Data unit	N/A
Description	Tonnes of carbon per tonne of biomass dry matter
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 4.3
Value applied:	All species: 0.47
Justification of choice of data or description of measurement methods and procedures applied	It is used for the whole tree part calculation
Purpose of data	Calculation of project emissions
Comments	N/A

Data/parameter	SOC_{REF},i
Data unit	tonne C ha^{-1}
Description	Reference soil organic carbon stock
Source of data	*CDM_AR_tool_16."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:	56

Justification of choice of data or description of measurement methods and procedures applied	Tropical, moist. Average (HAC and LAR) for the tropical forest as PP project lies on the border of the moist forest zone.
Purpose of data	Baseline estimations
Comments	N/A

5.2 Data and Parameters Monitored

Data/parameter	DBH (Diameter breast height)
Data unit	Centimetres (cm)
Description	Diameter of the tree at 1.37 m of height
Source of data	Measured by the project proponent
Description of measurement methods and procedures applied	Is measured in temporal sample plots, see chapter 5.3 of this PDD for elaboration
Frequency of monitoring/recording	According to the management objectives shown on the monitoring plan (chapter 5.3)
Value applied:	Variable
Monitoring equipment	Masser Excalliper II
QA/QC procedures applied	Microforest platform database check, outliers revision and measurement approval, according to the enumeration procedure
Purpose of data	Calculation of project emissions/reductions
Calculation method	N/A
Comments	N/A

Data/parameter	Ht (height)

Data unit	Meters (m)
Description	Total height of the trees
Source of data	Measured by the project proponent
Description of measurement methods and procedures applied	Measured in temporal sample plots, see chapter 5.3 of this PDD for elaboration
Frequency of monitoring/recording	According to the management objectives shown on the monitoring plan (chapter 5.3)
Value applied:	Depending on age between 0.5 and 30 m
Monitoring equipment	Vertex IV Hypsometer: accuracy +/-10 cm Measuring tape: accuracy +/- 1 cm
QA/QC procedures applied	Microforest platform database check, outliers revision and measurement approval, according to the enumeration procedure
Purpose of data	Calculation of project emissions/reductions
Calculation method	N/A
Comments	N/A

Data/parameter	Plot location
Data unit	Latitude, longitude
Description	Plots location coordinates
Source of data	Project proponent measurements
Description of measurement methods and procedures applied	The geographic coordinate of each monitoring plot
Frequency of monitoring/recording	According to the management, objectives showed on the monitoring plan (chapter 5.3)
Value applied:	Variable
Monitoring equipment	GPS of the caliper with an accuracy of 0.5 m GPS navigator
QA/QC procedures applied	Internal audit, according to the data quality steps, described in chapter 5.3
Purpose of data	Sampling error

Calculation method	Direct measurement
Comments	N/A

Data/parameter	*Plot area* A_{plot}
Data unit	Square meters (m^2)
Description	Total area of sample plots
Source of data	PP field monitoring
Description of measurement methods and procedures applied	Plot area is measured to guarantee quality and accuracy in the estimations.
Frequency of monitoring/recording	According to the management, objectives showed on the monitoring plan (chapter 5.3)
Value applied:	*Circular plots:* 500 m^2 (Radius: 12.62 m) *Square plots: 400* m^2 (Side: 20 m)
Monitoring equipment	Vertex IV Hypsometer: accuracy +/-10 cm
QA/QC procedures applied	Internal audit, according to the data quality steps, described in chapter 5.3
Purpose of data	Sampling error and calculation of project emissions
Calculation method	Direct measurements
Comments	N/A

5.3 Monitoring Plan

Monitoring management

Miro Forestry already has a procedure in place that addresses the management of the timber growing stock (volumes) on the plantations and ensures that timber is harvested sustainably within current

market dictates. The forest inventories are called "enumerations" by the company and are managed through the following organisational structure:

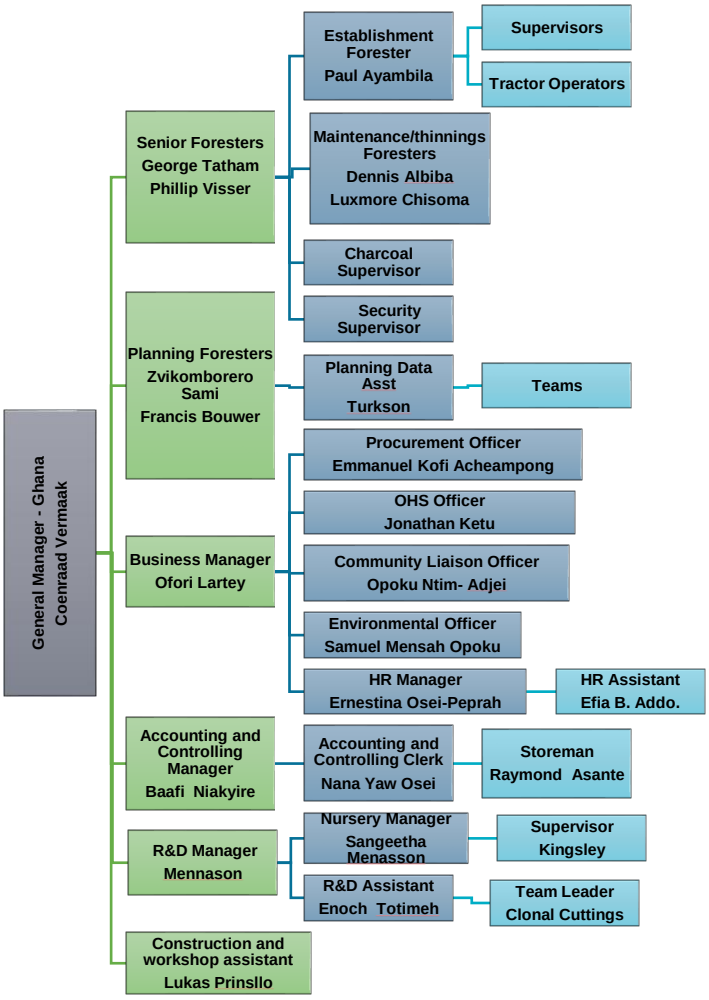

Figure 20. Miro Forestry organigram

The following positions in the organisation are responsible for ensuring compliance with the enumeration (inventory) procedure and performing the corresponding audits to the measurements:

Table 36. Positions in the organisation responsible for enumerations

Overall:	Country general manager
Data management and quality control:	Planning forester/manager
Enumerations:	Planning forester/manager
Marking for thinnings:	Enumerators
Audits:	Planning forester/manager

The outcomes from the enumerations are saved directly into these sites:

Table 37. Monitoring data record

Record	Responsibility	Location	Retention
Microforest database	Planning forester/manager	Microforest	Ongoing
Enumeration sheets	Planning forester/manager	Microforest	Permanent
Audits	Planning forester/manager	Planning office	Five years

Data quality

The following steps are required to make sure the data collected is real, logical and representative:

Table 38. General steps for monitoring

Step	Description
1	The overall accountability for the thinning and thinning control processes being carried out correctly and efficiently remains with the planning forester/manager.
2	The general manager will approve the analyses and give the final decisions regarding thinning (or remarking) by authorising the inventory analysis record in Microforest.
3	This shall become a permanent record in the database.
4	The concerned forester is responsible for the effective and timely execution of the marking and thinning operations.
5	The planning forester/manager is responsible for the inventory process, which consists of the planning and execution and reporting of the inventory by their team, the data analysis and presentation of the results, with recommendations, to the plantation manager for final approval and the incorporation of the inventory data into the plantation database.
6	With the inventory and analysis of the data, the forest planner will give special attention to the following:
	a) The correct execution of the inventory and data collection by the team
	b) The statistical validation of the inventory, i.e.:
	i. sample size (3-10% by area depending on compartment size and variability)
	ii. keeping the standard error of the individual components (DBH, height and SPH) as far as possible to 5% or lower and the combined standard error (DBH + height + SPH + volume regression) to 10% or lower
	iii. acceptable DBH/height regression
	c) The analysis of the marking process. The following must be checked in detail on the analysis sheets

Step	Description
	d) Increase in mean DBH of the remaining stand (thinning from below)
	e) Improvement (narrowing) of DBH distribution after thinning
	f) More uniform SPHA distribution in the stand after thinning
	g) SPHA after thinning must be as prescribed in the thinning policy
	h) Volume from analysis must be made available to the general manager
	i) Adjust thinning regime prescriptions, where applicable, using the results of the inventories
	j) Capture the additional information (comments on weeds and pests) that has been gathered by the inventories in the compartment register (MF).
	The planning forester/manager is responsible for an annual audit of inventory teams.

Type and frequency of inventory

Two basic types of plantation inventories are common for managing a company's growing stock. Both inventory types should be used extensively to form the backbone of growth and yield prediction and projection in the plantation database.

Table 39. Type of inventory

Type	Description
1	Management Inventories, with the main purpose of determining current volume and quality of stands, and a secondary aim of using this information for predicting their future growth and yield with growth models. An additional advantage is standing information gathering (weeds, pests, etc.).
2	Thinning Control Inventories, which can be used for the same purposes as the management inventories above but have the additional advantage of quality control of the marking operation.

The frequency of the enumerations is based on the management objective of the plantation there are two types: sawtimber and fibre.

Table 40. Frequency of inventories

Management objective	Type of inventory/enumeration	
	Thinning control	Mature stand
Sawtimber	Before thinning	One to two years before harvesting
	Before thinning	One to two years before harvesting
Fibre	N/A	One to two years before harvesting

The following indicator table shows how many plots per hectare can be established and the sample intensity of the compartment area. The typical plot size used is 500 m^2.

Table 41. Inventory intensity

Compt. area (ha)	% sample (area)	Number of plots per hectare required	
		500 m^2 plot	300 m^2 plot
1-3	1%	2	3.3
3-5	7.5%	1.5	2.5
5-10	5%	1	1.7
> 10	3-5%	0.5-1.0	1-1.7

All plots use for monitoring purposes of this document have an area of 500 m^2.

Field monitoring

To estimate the total CO_2e content captured by the plantations with a sampling error of 10% or less, circular plots of 500 m^2 were established and stratified sampling (systematic or random) was used. This sampling was selected because it can control the effect of variance on the estimates generated by the differences between species and farms.

The following steps are crucial for effectively capturing the field data:

Table 42. Plot measurements

Plot measurements	
Step	Description
1	Determine the correct plot boundaries and boundary trees for a 500 m^2 plot. The diameter of the plot 12.62 m.
2	DBH at 1.37 m of all trees in the plot shall be measured and recorded to the nearest cm.
3	A minimum of three plot measurements are required per compartment inventory.
4	DBH/height pairs of at least 36 trees spread across the entire DBH range shall be measured per compartment.
5	DBH shall be measured to the nearest mm while height shall be recorded to the nearest 10 cm.
6	Ensure that the sampling intensity regarding stem count is high enough, especially in small and patchy compartments.
7	Record details on pruned height, tree species, defects, weeds, insects, fungi and climatic damages

Plot measurements	
Step	**Description**
1	Determine the correct plot boundaries and boundary trees for a 500 m^2 plot. The diameter of the plot 12.62 m.
8	Evaluation of open spaces and gaps and recommendations for the adjustment of the compartment area (effective area) at the end of the cruise shall be done as specified.
9	If none of the above is seen in the compartment, a record of 'clean' shall be recorded.
10	All unusual observations of insects and pest damage shall be reported to the Manager of Research and Development.

Is important to verify the compartment shape before being in the field, to cover all the area and prepare a route plan to improve the measurements yield:

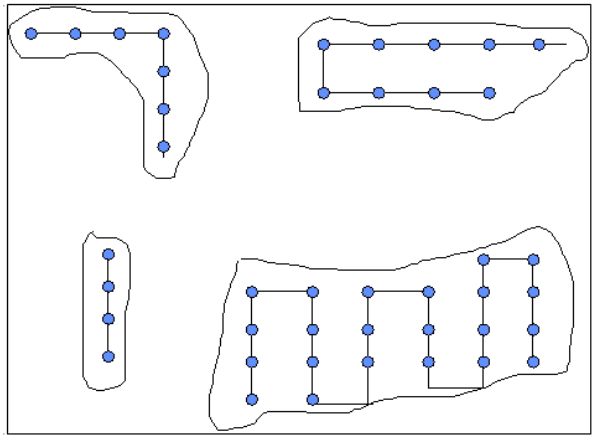

Figure 21. Compartment shape layout

Data collection

DBH and location

The equipment used to collect the DBHs and the plot coordinates is a digital caliper from Masser® Excalliper II. This machine guarantees +/-0.1 cm of error in capturing diameter, and 1 m of error in capturing the plot coordinates.

Figure 22. Digital caliper

Heights and plot size

The equipment used to measure the heights is a digital hypsometer from Haglof (Vertex IV® series). This machine guarantees +/-10 cm of error in capturing height. With the same machine, the plot diameter is measured with a +/-10 cm error.

Figure 23. Digital hipsometer

Monitoring of the carbon stock in trees $\Delta C_{TREE\_PROJ,t}$

The estimation of the carbon stock was carried out under section 8.2 of the tool "Estimation of carbon stocks and change in carbon stocks in trees and shrubs in A/R CDM project activities", of the AR-ACM0003 methodology. Under this first verification is presented monitored data from 2016-2019 plantations.

Stratum definition

The management units (stratum) used to manage the information database were defined by plantation age and species, as shown in the table below.

Table 43. Monitoring stratum

Year	MU	Species	Eligible Area (Ha)
2016	1.1	*Acacia mangium*	188.4
2016	1.2	*Eucalyptus pellita*	708.4
2016	1.3	*Tectona grandis*	240.6
2016	1.4	*Corymbia citriodora*	140.5
2017	2.1	*Acacia mangium*	132.8
2017	2.2	*Eucalyptus pellita*	448.7
2017	2.3	*Tectona grandis*	54.1
2017	2.4	*Corymbia citriodora*	50.5
2017	2.5	*Gmelina arborea*	7.4
2018	3.1	*Acacia mangium*	198
2018	3.2	*Eucalyptus pellita*	763.1
2018	3.4	*Corymbia citriodora*	138.3
2018	3.5	*Gmelina arborea*	84.8
2018	3.6	*Other spp*	8.2
2019	4.1	*Acacia mangium*	36.6
2019	4.2	*Eucalyptus pellita*	365.1
2019	4.5	*Gmelina arborea*	515.1
Total	N/A	N/A	4080.6

The total area under monitoring for the first verification is 4,080.6 ha.

Volume and biomass models used

To estimate the biomass and volumes, literature models were used for all species.

Table 44. Volume and biomass models

Species	Volume	Biomass
Acacia mangium		X
Tectona grandis	X	
Gmelina arborea	X	
Eucalyptus pellita	X	
Corymbia citriodora		X

These models were selected according to section 1.1 (Conditions prior to project start) due to their credibility and accuracy. A complete description of each model is provided below.

Acacia Magnium

The above-ground biomass equation selected for monitoring estimations was developed by Traoré et al. [39] in their the study of *Acacia magnium* trees located in the Ivory Coast, southwest Africa, where precipitation reaches 1,766 mm per year and temperatures range from 24°C to 34°C, which are similar conditions to the Ghana plantation. In this study, the expansion factor decreased with stand age from 1.66 in a 3-year stand, to 1.37 in 7-year stand and 1.21 in an 11-year stand.

$$AGB = \exp(-1.073 + 2.081\ x\ ln(D))$$

Where;

AGB Above-ground biomass (kg)
D Diameter (cm)

[39] Soulemane, Traore & Djomo, Adrien & guessan, Anatole & Coulibaly, Brahima & Ahoba, Assandé & Gnahoua, Guy & guessan, Édouard & Adou, Yao & Kassi, N'Dja & Noël, Zontsika. (2018). Stand Structure, Allometric Equations, Biomass and Carbon Sequestration Capacity of Acacia mangium Wild. (Mimosaceae) in Côte d'Ivoire. Open Journal of Forestry.

Eucalyptus pellita

Volume equation developed by Nieto V et al[40] for *Eucalyptus pellita* trees grown under precipitations between 1800 to 2000 mm and a mean daily temperature ranging from 23 to 30°C was selected for this species.

$$V = 0.000051265 \times D^{1.8753} \times H^{0.9888}$$

Where;

V Individual tree volume (m^3)
D Diameter at breast height (cm)
H Tree height (m)

Tectona Grandis

The stem biomass and volume models[41] selected for *Tectona Grandis* were developed for trees grown in Benin, West Africa, which has a mean annual precipitation of 1,100 mm and temperatures ranging from 25 to 29ºC

$$ln(M) = X_O + X_1 ln(Dbh) + X_2 \ ln(H)$$

Where:

M: Biomass (kg)
Dbh: Diameter at breast height (cm),
H: tree height (m)
Model parameters:
X_O =−2.9489, X_1 = 2.2201, X_2 = 0.6945

$$ln(V) = X_O + X_1 ln(Dbh) + X_2 \ ln(H)$$

V: Volume (10^{-3} m^3);
Dbh: Diameter at breast height (cm),
H: tree stem height (m)
Model parameters:
X_O =−2.9489, X_1 = 2.2201, X_2 = 0.6945

Corymbia citriodora

Biomass model[42] selected for *Corymbia citriodora* developed for trees grown under mean annual precipitation of 1037 mm and temperatures between 13.3 and 26 °C in New south Wales, Australia. Wood density[43] of 637 kg/m^3 estimated for trees under mean annual precipitation of 1037 mm and temperatures between 13.3 and 26°C in South Africa.

[40] Nieto, Victor & Giraldo Charria, Diana & Oviedo, Monica & Borralho, Nuno. (2016). Effects of provenance and genetic variation on the growth and stem formation of Eucalyptus pellita in Colombia. Journal of Tropical Forest Science.

[41] GHS Guendehou , A Lehtonen , M Moudachirou , R Mäkipää & B Sinsin (2012) Stem biomass and volume models of selected tropical tree species in West Africa, Southern Forests: a Journal of Forest Science, 74:2,77-88

[42] Garcia_Florez, L., Vanclay, J. K., Glencross, K., & Nichols, J. D. (2019). Developing biomass estimation models for above-ground compartments in Eucalyptus dunnii and Corymbia citriodora plantations. Biomass and Bioenergy, 130, 105353.

[43] Gardner, Robin & Little, Keith & Arbuthnot, Athol. (2007). Wood and fibre productivity potential of promising new eucalypt species for coastal Zululand, South Africa. Australian Forestry. 70. 37-47. 10.1080/00049158.2007.10676261.

$$ln\ (Stem\ Biomass) = -2.91783 + 0.93012 \times ln\ (DBH^2 H\rho)$$
$$ln\ (Bark\ Biomass) = -4.04977 + 0.79689 \times ln\ (DBH^2 H)$$
$$ln\ (Branch\ Biomass) = -2.40071 + 2.32456 \times ln\ (BD)$$
$$ln\ (Crown\ Biomass) = 0.94724 + 1.01407 \times ln\ (DBH)$$

Where:

DBH: Tree diameter at breast height (cm)
H: Tree height (m)
ρ: Tree wood density (g/cm^3).
BD: Branch diameter (cm)

Gmelina arborea

Volume equation[44] selected for *Gmelina arborea* was developed for trees grown under precipitation from 2,500 to 3,000 mm and temperatures between 26.7 and 30°C in Moyamba district, Sierra Leone.

$$V = 0.24950005 + 0.000018027(DBH^2 ht)$$

DBH: Diameter at breast height (cm)
ht: Tree height (m)

Establishment of temporary sample plots

To estimate the total CO_2e content captured by the project plantations with a sampling error of 10% or less, 822 circular (313) and square (509) plots of 500 and 400 m^2 respectively, were established and distributed across all the defined strata.

Table 45. Monitoring plots intensity

Year	MU	Species	Eligible Area (Ha)	No. of plots	Monitored area	Intensity
2016	1.1	*Acacia mangium*	188.4	68	2.75	1.46
2016	1.2	*Eucalyptus pellita*	708.4	72	2.86	0.40
2016	1.3	*Tectona grandis*	240.6	20	0.80	0.33
2016	1.4	*Corymbia citriodora*	140.5	12	0.46	0.32
2017	2.1	*Acacia mangium*	132.8	24	1.01	0.76
2017	2.2	*Eucalyptus pellita*	448.7	149	5.96	1.33
2017	2.3	*Tectona grandis*	54.1	48	1.98	3.66
2017	2.4	*Corymbia citriodora*	50.5	20	0.80	1.58
2017	2.5	*Gmelina arborea*	7.4	8	0.32	4.34
2018	3.1	*Acacia mangium*	198	46	2.30	1.16

[44] Mattia, Stephen & A., and. (2015). Allometric equations for volume estimation of Gmelina arborea Roxb wood at Singamba forest reserve in Njama, Sierra Leone. Journal of Sustainable Environmental Management. 7. 1-10.

Year	MU	Species	Eligible Area (Ha)	No. of plots	Monitored area	Intensity
2018	3.2	*Eucalyptus pellita*	763.1	99	4.95	0.65
2018	3.4	*Corymbia citriodora*	138.3	18	0.90	0.65
2018	3.5	*Gmelina arborea*	84.8	9	0.43	0.51
2018	3.6	*Other spp*	8.2	10	0.50	6.10
2019	4.1	*Acacia mangium*	36.6	9	0.45	1.23
2019	4.2	*Eucalyptus pellita*	365.1	72	3.60	0.99
2019	4.5	*Gmelina arborea*	515.1	138	5.80	1.13
Total	N/A	N/A	4080.6	822	35.87	26.6

On average the monitoring inventory was performed at 1.56% intensity.

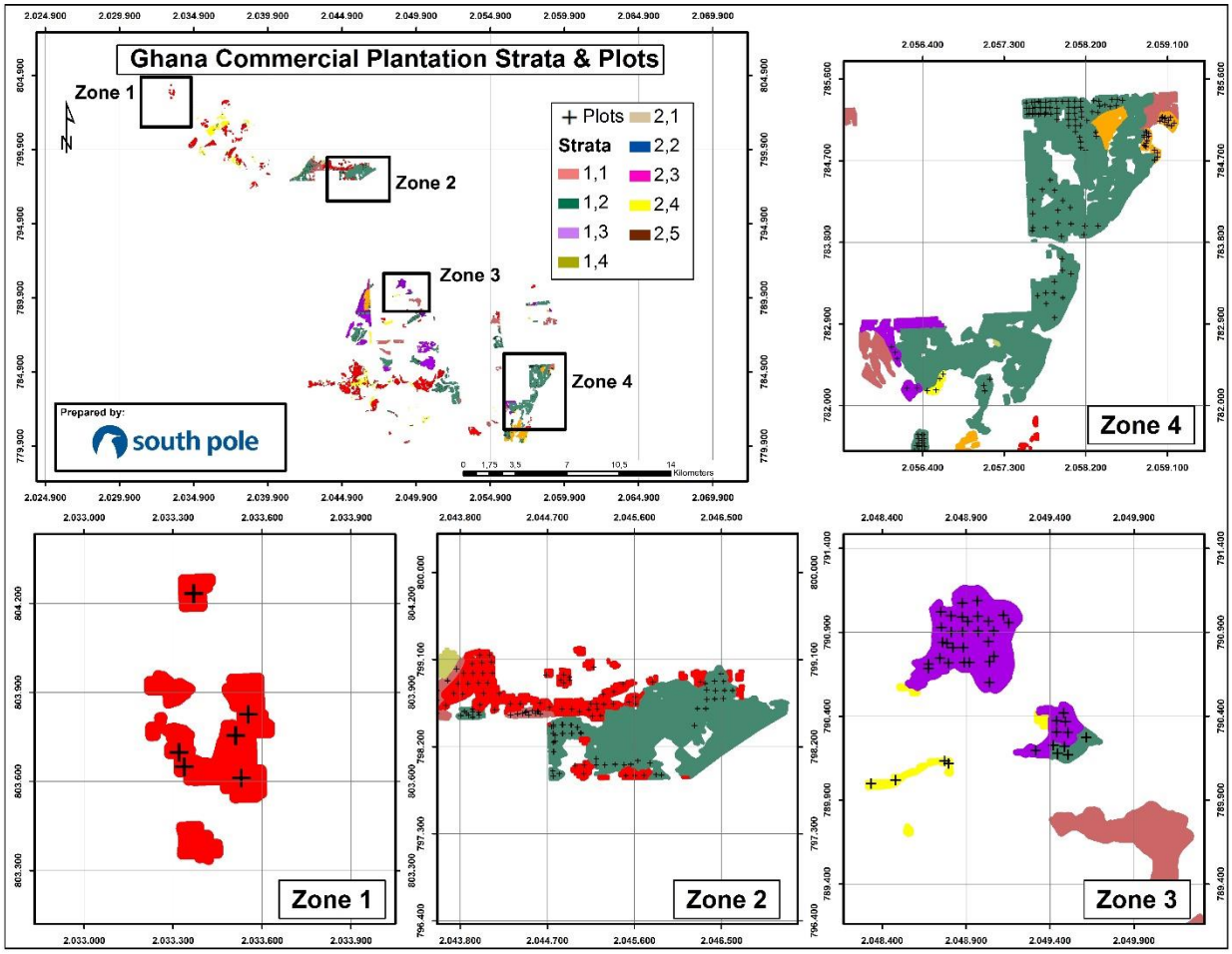

Figure 24. Monitoring plots

The map of the monitoring plots is zoomed into a few areas due to the scale of the polygons – the support's shapefile has the complete plot information.

Height models

Is important to highlight that the methodology used, which utilises the Microforest software, only requires a low sample of heights depending on the diameter frequency but uses 100% of the diameters to fit with the volume model used by Miro Forestry. This means that not all heights are being measured in the company enumerations, only the required frequency, and the sample of diameters is higher than the DHB-Ht pairs captured along the compartments measured.

The expression used to estimate the heights was:

Ht-DBH Regression: ln(Ht) = b0+b1/DBH

The coefficients and the expression were extracted from the regressions made by Microforest and can be consulted in the ex-post estimations spreadsheet[45].

Sampling error and uncertainly

The sampling error was determined using the following expressions suggested by Cochran (1997) and Gatz & Smith (1994):

$$\boldsymbol{E}(\%) = \frac{\boldsymbol{Sye} * \boldsymbol{Z}(\infty)}{\bar{\boldsymbol{X}}} * \mathbf{100}$$

$$(\boldsymbol{SEMw^2}) = \frac{\mathbf{1}}{\boldsymbol{n}}\left(\frac{\mathbf{1}}{\sum \boldsymbol{pj}}\right)\sum \boldsymbol{Pj}(\boldsymbol{Xi} - \boldsymbol{Xw})\mathbf{2}$$

The result after the process of the database was:

Table 46. Monitoring sampling error

Sampling error	
Plot area (m^2)	441.3
Total area (ha)	4080.6
No. of plots established	822
Mean standard error	0.31
t value(0.05; n-1)	1.96
E(%) sampling error	0.13

[45] Supports\2. Estimations\Ex-post

After filling all inputs in the required expression, it can be concluded that the monitoring inventory database is within the quality parameters required (< 10%).

The uncertainty regarding the change in tree biomass was estimated using the following equation from the Tool 14 of CDM:

$$U\Delta C = \frac{\sqrt{(u1\ x\ Bimass, t1^2) + (u2x\ Biomass, t2^2)}}{\Delta CBiomass}$$

Table 47. Uncertainty figures

Year	MU	No. of plots	Species	Total Area (Ha)	Sampled area (ha)	Percentage of the area sampled (%)	Biomass (tons/plot	wi	si	wi*bTREE,i	wi2*si2/ni
2016	1.1	68	*Acacia mangium*	188.4	2.75	1.46	47.37	0.05	13.01	2.19	0.01
2016	1.2	72	*Eucalyptus pellita*	708.4	2.86	0.40	20.12	0.17	10.40	3.49	0.05
2016	1.3	20	*Tectona grandis*	240.6	0.80	0.33	16.25	0.06	9.29	0.96	0.02
2016	1.4	12	*Corymbia citriodora*	140.5	0.46	0.32	52.17	0.03	11.26	1.80	0.01
2017	2.1	24	*Acacia mangium*	132.8	1.01	0.76	47.40	0.03	12.57	1.54	0.01
2017	2.2	149	*Eucalyptus pellita*	448.7	5.96	1.33	16.83	0.11	7.19	1.85	0.00
2017	2.3	48	*Tectona grandis*	54.1	1.98	3.66	17.66	0.01	11.23	0.23	0.00
2017	2.4	20	*Corymbia citriodora*	50.5	0.80	1.58	29.73	0.01	8.05	0.37	0.00
2017	2.5	8	*Gmelina arborea*	7.4	0.32	4.34	48.50	0.00	16.03	0.09	0.00
2018	3.1	46	*Acacia mangium*	198	2.30	1.16	29.08	0.05	8.49	1.41	0.00
2018	3.2	99	*Eucalyptus pellita*	763.1	4.95	0.65	12.43	0.19	5.96	2.32	0.01
2018	3.4	18	*Corymbia citriodora*	138.3	0.90	0.65	20.76	0.03	11.76	0.70	0.01
2018	3.5	9	*Gmelina arborea*	84.8	0.43	0.51	24.02	0.02	11.71	0.50	0.01
2018	3.6	10	*Other spp*	8.2	0.50	6.10	17.93	0.00	6.61	0.04	0.00
2019	4.1	9	*Acacia mangium*	36.6	0.45	1.23	39.81	0.01	2.15	0.36	0.00
2019	4.2	72	*Eucalyptus pellita*	365.1	3.60	0.99	12.22	0.09	3.54	1.09	0.00
2019	4.5	138	*Gmelina arborea*	515.1	5.80	1.13	16.45	0.13	8.23	2.08	0.01
Total	N/A	**822**	N/A	**4080.6**	**35.87**	**26.6**	**469**	**1**	**9.27**	**21**	**0**

Table 48. Uncertainty

# Plots:	822
t_val:	1.96
u_c:	3.38%

A total of 3.38% uncertainty was estimated for the current monitoring period – according to the methodological tool, there is no discount necessary (< 10% uncertainty). These estimations can be consulted in the ex-post estimations spreadsheet[46].

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

The following parameters were monitored and their results are shown in the following tables.

Data/parameter	DBH (Diameter breast height)
Data unit	Centimetres (Cm)
Description	Diameter of the tree at 1.37 m of height
Source of data	Measured by the project proponent
Description of measurement methods and procedures applied	Is measured in temporal sample plots, see chapter 5.3 of this PDD for elaboration
Frequency of monitoring/recording	According to the management and objectives stated in the monitoring plan (chapter 5.3)
Value applied:	Variable

[46] Supports\2. Estimations\Ex-post

Monitoring equipment	Masser Excalliper II
QA/QC procedures applied	Microforest platform database check, outliers revision, and measurement approval, according to the enumeration procedure.
Purpose of data	Calculation of project emissions/reductions
Calculation method	N/A
Comments	N/A

Data/parameter	Ht (Height)
Data unit	Metres (m)
Description	Total height of the trees
Source of data	Measured by project proponent
Description of measurement methods and procedures applied	Is measured in temporal sample plots, see chapter 5.3 of this PDD for elaboration.
Frequency of monitoring/recording	According to the management and objectives stated in the monitoring plan (chapter 5.3)
Value applied:	Depending on age between 0.5 and 30 m
Monitoring equipment	Vertex IV Hipsometer: accuracy +/-10 cm Measuring tape: Accuracy +/- 1 cm
QA/QC procedures applied	Microforest platform database check, outliers revision and measurement approval, according to the enumeration procedure
Purpose of data	Calculation of project emissions/reductions
Calculation method	N/A
Comments	N/A

Data/parameter	Plot location
Data unit	Latitude, longitude
Description	Plots location coordinates

Source of data	Project proponent measurements
Description of measurement methods and procedures applied	The geographic coordinate of each monitoring plot
Frequency of monitoring/recording	According to the management and objectives stated in the monitoring plan (chapter 5.3)
Value applied:	Variable
Monitoring equipment	GPS of the caliper with an accuracy of 0.5 m GPS navigator
QA/QC procedures applied	Internal audit, according to the data quality steps, described on chapter 5.3
Purpose of data	Sampling error
Calculation method	Direct measurement
Comments	N/A

Data/parameter	*Plot area* A_{plot}
Data unit	Square meters (m^2)
Description	Total area of sample plots
Source of data	PP field monitoring
Description of measurement methods and procedures applied	The plot area is measured to guarantee quality and accuracy in the estimations.
Frequency of monitoring/recording	According to the management and objectives stated in the monitoring plan (chapter 5.3)
Value applied:	500 m^2 (12.62 m)
Monitoring equipment	Vertex IV Hypsometer: accuracy +/-10 cm
QA/QC procedures applied	Internal audit, according to the data quality steps, described in chapter 5.3
Purpose of data	Sampling error and calculation of project emissions
Calculation method	Direct measurements

Comments	N/A

6.2 Baseline Emissions

As mentioned in previous sections, considering that the project has no Baseline Emissions, there is no measurement nor discount of carbon to the project scenario.

6.3 Project Emissions

Table 49. Monitoring reductions

Strata	Average biomass (AGB+BGB) (t/tree)	Dead wood (ton/strata)	Litter (ton/strata)	Total biomass (ton/Strata)	C Tree (tCO2e/stratum)	Cdw (ton/strata)	CLi (ton/strata)	Total Cabon (ton/strata)
1.1	0.07	770	128	12,840	22,128	1,328	221	23,851
1.2	0.04	1,235	206	20,591	35,485	2,129	355	38,624
1.3	0.03	330	55	5,500	9,478	569	95	10,364
1.4	0.08	634	106	10,560	18,199	1,092	182	19,603
2.1	0.08	547	91	9,116	15,711	943	157	16,933
2.2	0.03	654	109	10,897	18,780	1,127	188	20,509
2.3	0.04	82	14	1,367	2,356	141	24	2,571
2.4	0.05	129	21	2,142	3,691	221	37	3,996
2.5	0.09	30	5	500	861	52	9	928
3.1	0.06	509	85	8,486	14,624	877	146	15,831
3.2	0.02	814	136	13,571	23,387	1,403	234	25,729
3.4	0.05	245	41	4,079	7,030	422	70	7,650
3.5	0.04	174	29	2,898	4,994	300	50	5,422
3.6	0.04	14	2	234	403	24	4	439
4.1	0.05	126	21	2,100	3,619	217	36	3,906
4.2	0.02	398	66	6,640	11,442	687	114	12,581
4.5	0.03	726	121	12,098	20,849	1,251	208	22,784
Total	**0.85**	**7,417**	**1,236**	**123,619**	**213,037**	**12,782**	**2,130**	**231,720**

A gross total of 231,720 tCO_2e was estimated for the monitoring.

6.4 Leakage

This project is not considering any leakage, as was explained in section 4.3.

6.5 Net GHG Emission Reductions and Removals

Table 50. Net GHG Emission Reductions and Removals

Strata	Average biomass	Dead wood (ton/strata)	Litter (ton/strata)	Total biomass (ton/Strata)	C Tree (tCO2e/stratum)	Cdw (ton/stratum)	CLi (ton/stratum)	Total Cabon (ton/strata)	Baseline	Net carbon /strata Buffer 19% NPRT
1.1	0.07	770	128	12,840	22,128	1,328	221	23,851	0	19,320
1.2	0.04	1,235	206	20,591	35,485	2,129	355	38,624	0	31,285
1.3	0.03	330	55	5,500	9,478	569	95	10,364	0	8,395
1.4	0.08	634	106	10,560	18,199	1,092	182	19,603	0	15,878
2.1	0.08	547	91	9,116	15,711	943	157	16,933	0	13,716
2.2	0.03	654	109	10,897	18,780	1,127	188	20,509	0	16,612
2.3	0.04	82	14	1,367	2,356	141	24	2,571	0	2,083
2.4	0.05	129	21	2,142	3,691	221	37	3,996	0	3,237
2.5	0.09	30	5	500	861	52	9	928	0	752
3.1	0.06	509	85	8,486	14,624	877	146	15,831	0	12,823
3.2	0.02	814	136	13,571	23,387	1,403	234	25,729	0	20,841
3.4	0.05	245	41	4,079	7,030	422	70	7,650	0	6,196
3.5	0.04	174	29	2,898	4,994	300	50	5,422	0	4,391
3.6	0.04	14	2	234	403	24	4	439	0	356
4.1	0.05	126	21	2,100	3,619	217	36	3,906	0	3,164
4.2	0.02	398	66	6,640	11,442	687	114	12,581	0	10,190
4.5	0.03	726	121	12,098	20,849	1,251	208	22,784	0	18,455
Total	**0.85**	**7,417**	**1,236**	**123,619**	**213,037**	**12,782**	**2,130**	**231,720**	**0**	**187,694**

The table above summarises the complete figures of the net reductions for the first monitoring period corresponding to the 2016-2019 period, which has a net total of 187,694 tCO_2e.

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