

MONITORING REPORT

“REFORESTATION OF DEGRADED FOREST RESERVES IN GHANA”



Project Title	Reforestation of degraded Forest Reserves in Ghana
Version	1.0
Report ID	-
Date of Issue	19-July-2019
Project ID	987
Monitoring Period	02-April-2018 to 30-June-2019
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The project aims at reforestation of 20,000 ha in degraded forest reserves in Ghana. Currently, 1,476 hectares in the Asubima Forest Reserve are realized, which is the first project instance of this grouped project with the start date being 1 March 2008. In addition to this also 1,738 hectares are realized in Afrensu Brohuma Forest Reserve, which is the second project instance of this grouped project with a start date of 1 March 2011. A further 7,498 hectares have been planted in the TAIN II forest reserve, which is the third instance of this grouped project with a start date of 1 March 2013. The project foresees an average expansion of 1000 hectare per year, adding new project areas and instances.

The Asubima, Afrensu Brohuma and Tain II Tributaries Forest Reserves used to be productive reserves covered with high, 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 have been declared degraded by the Government of Ghana. Without the reforestation project the area would remain degraded and degrade even further due to illegal farming, bushfires and logging of the last remaining trees.

Project proponent (PP) Form Ghana Ltd. has a land lease agreement with traditional landowners and the Government of Ghana for reforestation of the project area to restore productive forest in the degraded forest reserves. This lease construction is part of the presidential policy to restore degraded forest reserves in Ghana, which is a strong policy instrument showing the commitment of the Government of Ghana to conserve, restore and promote the sustainable use of forest resources in the country.

Form Ghana is a company limited under Ghanaian law, established in 2007. Their plantations in Asubima and Afrensu Brohuma Forest Reserves are certified according to the principles and criteria of the Forest Stewardship Council (FSC) since January 2010. Tain II Tributaries Forest Reserve is managed along the same lines but currently not certified. The FSC certificate demonstrates the commitment and adherence of Form Ghana to the highest sustainability standards of both social and ecological aspects. The VCS carbon project is implemented according to the same high operational standards.

Project activities comprise CO₂ sequestration in tree plantations with exotic and indigenous tree species, natural forest restoration in riparian buffer zones and harvesting of high-quality timber. Project activities are carried out and monitored according to approved project methodology AR-ACM0003: *Afforestation and reforestation of lands except wetlands --- Version 02.0* for a project period of 40 years.

This monitoring period covers the period from 02-04-2018 to 30-06-2019 and in this period a total of 153 206 GHG emission removals have been generated.

1.2 Sectoral Scope and Project Type

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

1.3 Project Proponent

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Contact person	Mr. Willem Fourie
Title	Managing Director

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FORM Ghana is responsible for plantation establishment and maintenance. This includes, but is not limited to terrain preparation, plant propagation, planting, thinning, pruning, weeding, clear cutting, security and fire management.

1.4 Other Entities Involved in the Project

Organization name	Form international B.V.
Role in the project	Project development - Form international is contracted by FORM Ghana to deliver management support and technical assistance. This includes, but is not limited to, developing and managing the VCS certification and is as such responsible for all technical aspects of the VCS certification. This includes mapping and GIS, managing of the monitoring and analysis of data, training of FORM Ghana personnel and managing the FSC certificate.
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Organization name	Sustainable Forestry Investments B.V. (SFI)
Role in the project	Owner and shareholder of FORM Ghana, but no active role in VCS implementation.
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1.5 Project Start Date

01-March-2008

1.6 Project Crediting Period

Start date: 01 - March - 2008

End date: 01 - March - 2048

Total number of years: 40

1.7 Project Location

The Asubima and Afrensu Brohuma Forest Reserves are situated in the dry, semi-deciduous forest zone at about 100 km north of Kumasi in the Ashanti region in Ghana (Figure 1). It falls under the authority of the Offinso Forest District.



Figure 1 Location of the Form Ghana plantations in Asubima and Afrensu Brohuma and Tain II Forest Reserves

Asubima Forest Reserve and Afrensu Brohuma Forest Reserve are 2 adjacent Forest Reserves. Tain lies some 100 km to the east. The Form Ghana land leases (Figure 2) cover only a portion of

these 3 Forest Reserves. The land leases are located in the south-eastern part of Asubima Forest Reserve, the north-eastern part of Afrensu Brohuma Forest Reserve and the northeastern part of Tain II reserve.

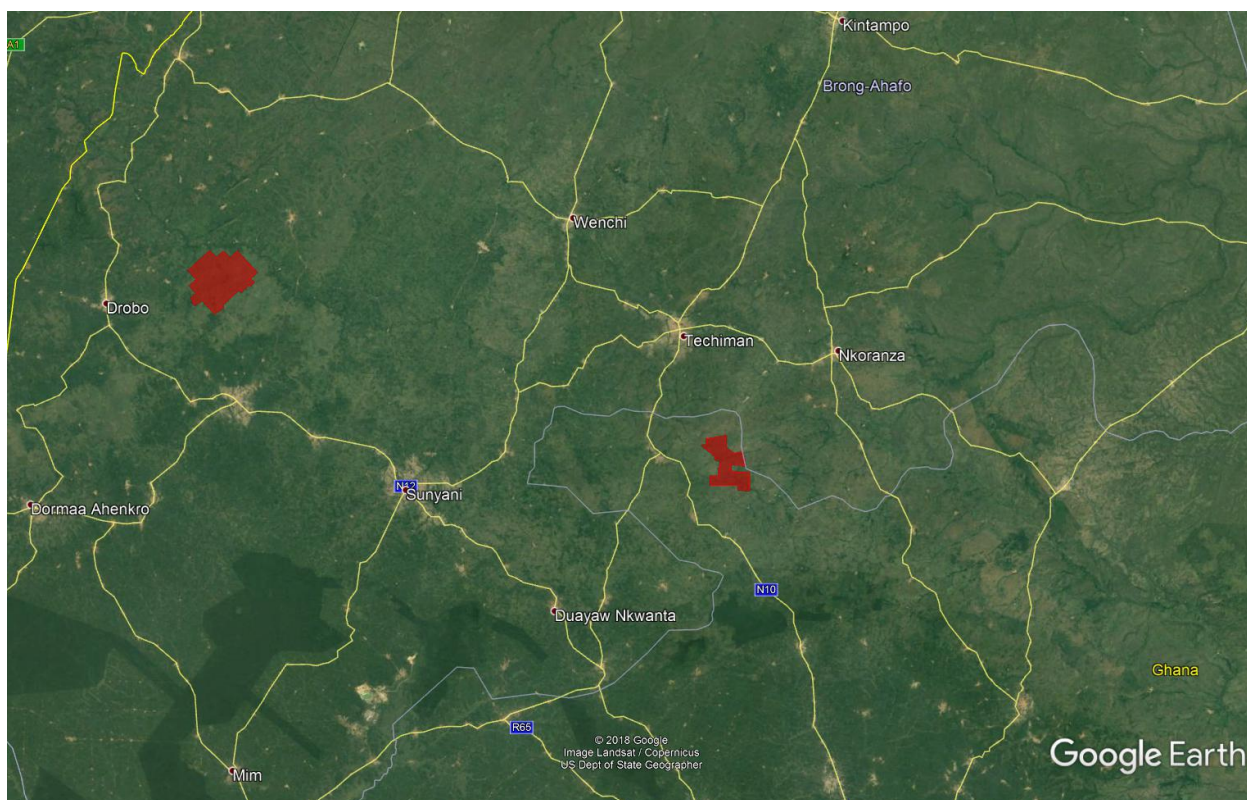


Figure 2 Outline of Form Ghana land leases (red) in Asubima, Afrensu Brohuma and Tain II Forest Reserves

1.8 Title and Reference of Methodology

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

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

- Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities (Version 01)
- Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (Version 01)
- Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity (Version 02.0)
- Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)
- Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (Version 01.1.0)
- VCS AFOLU Non-Permanence Risk Tool (Version 3.3)

1.9 Other Programs

Not applicable.

1.10 Sustainable Development

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, Validation of Policies, Programmes and Projects, Supervision of Sector Departments and Agencies; and Negotiations with Development Partners.

The Ministry's aims and objectives are:

- Develop and manage sustainable lands, forest, wildlife and mineral resources;
- To 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 utilization;
- To review, update, harmonise and consolidate existing legislation and policies affecting land, forest and mineral resources;
- To promote and facilitate effective private sector participation in land service delivery, forest, wildlife and mineral resource management and utilization;
- 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
- Develop and research into problems of forest, wildlife, mineral resources and land use.

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

The project contributes to the achievement of several of the listed aims and objectives, because PP:

- implements sustainable forest management according to the principles and criteria of the Forest Stewardship Council (Forest Stewardship Council, 2015);
- has a benefit sharing agreement (Forestry Commission, 2009; Forestry Commission, 2012; Forestry Commission, 2013);
- 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.

Forestry Commission

The Forestry Commission of Ghana is responsible for the regulation of utilization 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 development management and utilization 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 sustainable forest management and carbon sequestration.

Environmental Protection Agency (EPA)

As the law stipulates, the EPA is statutorily mandated to ensure that the implementation of all undertakings does not harm the environment. The Agency has eleven (11) regional offices, which are accessible and staffed and equipped to perform their functions. It is expected that sub-projects that will require the preparation of EIA 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 UNFCCC. PP's project is covered by Environmental Impact Assessments (Abeney, et al., 2008; Tollenaar, 2012; Tollenaar & Wanders, 2015) and adheres to the principles and criteria of FSC (Forest Stewardship Council, 2015). Further, with the implementation of the project it contributes to further mitigation of climate change.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The main change in the monitoring period is the inclusion of the areas planted in 2013 until 2019 in the adjacent Tain II Forest Reserve. This area is managed as a separate unit together with the areas planted in Asubima and Afrenso Brohuma Forest Reserve. Part of the project area (Asubima and Afrenso Brohuma) is included in the scope of the FSC certification. No new areas have been established within that part of the project area. Only regular management operations, such as pruning, thinning and forest protection have been carried out. Risks are monitored systematically through the monitoring system as elaborated in the PDD.

2.2 Deviations

2.2.1 Methodology Deviations

Not applicable.

2.2.2 Project Description Deviations

Reforestation types

In the new project instance PP has recently planted another commercial species (*Gmelina arborea*) on a small scale. This might be upscaled in the future, although teak will remain the main species at Form Ghana. As the reforestation type with *Gmelina* (or other commercial species) is currently not covered in one of the reforestation types, a new reforestation type has been added. The expected yield for *Gmelina* is determined based on external literature (Dupuy & N'guessan, 1991; Rodríguez, et al., 2004) and yield data from Form international. This will be further updated once PSP data for *Gmelina* become available. Since this deviation is a systematical change, the Project Description Document has been updated accordingly.

Yield determination of Teak

Based on new PSP measurements and additional yield modelling work done, the yield models have been updated accordingly. This deviation is a systematical change, and therefore the ex-ante calculations have been updated accordingly.

Tree volume equation Teak

Based on expert review (Alder, 2019) the volume equation used to determine tree volume for teak was changed. This formula is based on section measurements by PP, and is a better representation of the actual form of the teak trees in the project area. Since this deviation is a systematical change, the Project Description Document has been updated accordingly.

2.3 Grouped Project

The eligibility criteria for new instances that join in the Form Ghana grouped project have been described in the Form Ghana VCS Project Description document. These criteria are listed below as subheadings, with a description of their interpretation for the specific instance of Tain II Forest Reserve.

2.3.1 All new instances shall lie within Ghana

The plantation is located within Tain II Forest Reserve in Berekum District near Berekum, in the Brong Ahafo region, Ghana. It became a forest reserve in 1934, and last logging was recorded in the nineties of the last century (Hawthorne & Abu-Juam, 1995).

Tain II Tributaries Forest Reserve covers a total area of 51000 hectares. Approximately 14500 ha of this reserve constitute the area allocated to Form Ghana Ltd. for commercial plantation development. The entire reserve is located within the dry semi-deciduous forest zone (Hall & Swaine, 1976). The terrain is undulating and covered with a very open canopy alternating with sandy rock patches.

Originally, the main vegetation type in the reserve was the dry semi-deciduous forest, which generally contains valuable timber trees such as Wawa, Odum, Sapele and Kokrodua (Tollenaar & Wanders, 2015). Today however, most of the reserve is covered by savannah, resulting from human induced land degradation. Due to farming and reported annual fires very little of the original forest remains and what is left is secondary forest and grassland. In the past, farmers protected the large trees on their farms but most of them have been logged eventually so that very few remain today.

2.3.2 Project activity shall be on degraded lands

The project description defines that the determination of degraded land is done in accordance with the applicable CDM tool, which was *“Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities – (Version 01)”*. This tool is not part of the current CDM consolidated methodology AR-ACM0003: *Afforestation and reforestation of lands except wetlands --- Version 02.0* but was not replaced by a newer version of the tool. Therefore, PP continues to use this CDM tool for determination of degraded lands. According to this tool section III, it suffices if PP demonstrates the following:

“(a) Provide documented evidence that the area has been classified as “degraded” under verifiable local, regional, national or international land classification system or peer-review study, participatory rural appraisal, satellite imagery and/or photographic evidence in the last 10 years. If the documented evidence of degradation is older than ten years, then:

(i) Provide evidence that the natural or anthropogenic degradation drivers and pressures that led to the land becoming “degraded” are still present and/or that there are no insufficient land management interventions to reverse degradation.”

All the forest areas PP operates in are degraded land. The series of satellite images presented in Figure 3 shows the degradation of the reserve over the years.



Figure 3 Degradation of the project area in Tain II Forest Reserve over the years. Left: 1973, Middle: 1986, Right: 2012. Source: Google Earth. (right picture).

Forest reserve conditions in Ghana were mapped in 1995 by the IUCN. The results show that at that time, Tain II Forest Reserve was in ‘very poor’ condition, class 4 on a scale of 6 (Hawthorne & Abu-Juam, 1995). This can be clearly seen on the satellite image of the forest reserve from 2011 (Figure 4). The most important causes of this degradation are intense logging conversion to agricultural land and subsequently fire in the semi-deciduous zones. Subsistence farming and wild fires were still present within the project scenario boundaries until the start of project activities (Tollenaar & Wanders, 2015). Fire is now strictly forbidden, but fire outbreaks still must be combated regularly.

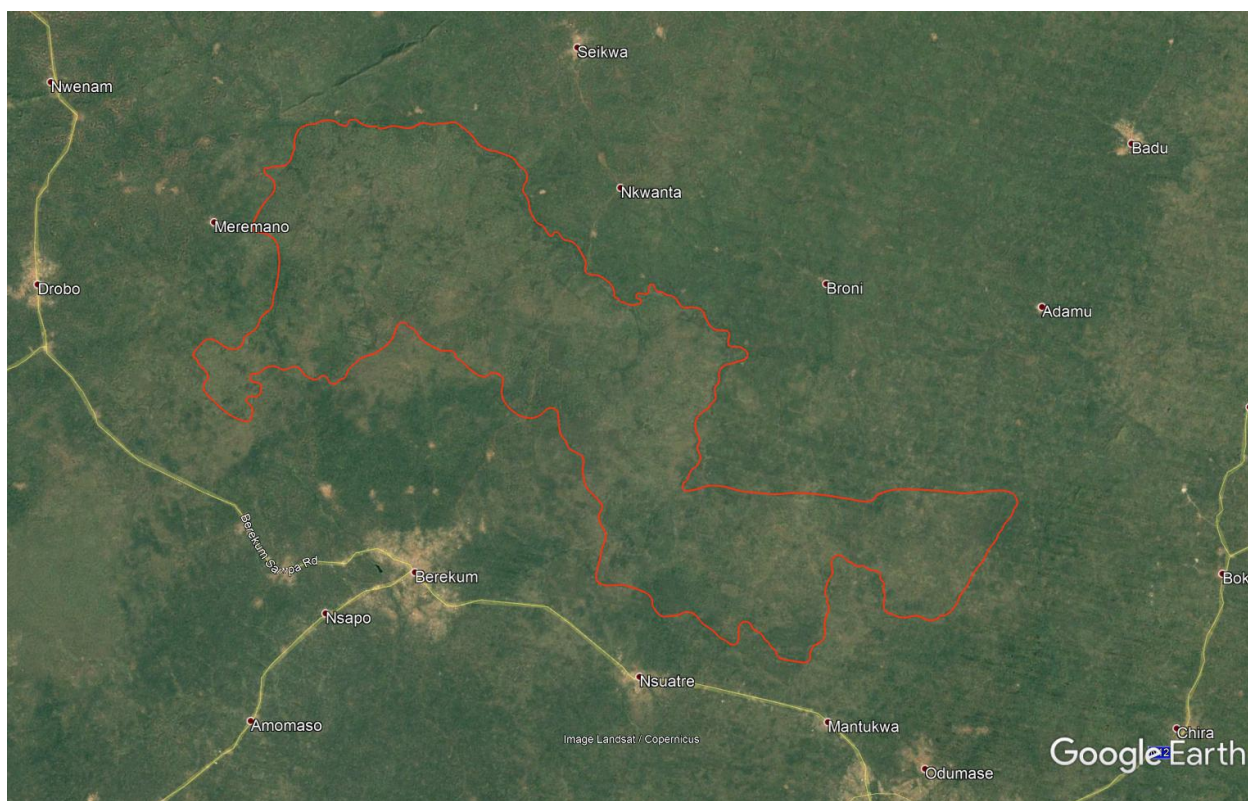


Figure 4 Satellite image of part of Tain II forest reserve in 2011 (Google earth image) showing forests remain mostly outside the reserve boundaries.

2.3.3 Project activity shall not be on organic and/or drained soils

The soil survey of Tain II Forest reserve exposed five different soil series present in the area; Bekwai, Nzima, Kokofu, Oda and Wenchi, three of which are suitable for teak cultivation, despite a relatively low nutrient content. None of the soils are of organic origin or have been drained for planting (Dwomo & Boafo, 2012).

The topography of the area is gentle undulating with moderately steep slopes between 5 – 12%. The summits are nearly flat and broad with slopes of 0 – 4%. There are streams and drainage grooves all over the area which drains north-wards into the Tain River. Drainage conditions range from well drained in the summits and upper slope sites to moderately to imperfectly drained on middle to lower slopes and poorly drained in the valley bottoms. The soils are of medium to low in plant fertility levels and are liable to mostly moderate sheet erosion.

The applicability section of the CDM methodology states in section “3. (b) *Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary:*

(i) Land containing organic soils;”

Since the project activity is not on organic soils the project activity meets this applicability criterion.

2.3.4 Project area shall not be a wetland

CDM methodology, section 3 (a): “*The land subject to the project activity does not fall in wetland category;*”

There are no wetlands within the project boundary.

2.3.5 Litter shall remain on site

PP wishes to include SOC as a carbon pool, and therefore also the requirement shall be met that *litter shall remain on site and not be removed in the project activity*. In the Form Ghana management plan for Tain it is stated that *'To maintain and enhance soil fertility dead wood, yearly shedding of leaves and crown biomass resulting from thinning and felling are left in the plantation for decomposition.'* (Westerlaan & Tollenaar, 2016).

2.3.6 Ploughing / ripping / scarification is subject to restrictions

"Ploughing / ripping / scarification attributable to the project activity, is:

- Done in accordance with appropriate soil conservation practices, e.g. follows the land contour; and*
- Limited to the first five years from the year of initial site preparation; and*
- Not repeated, if at all, within a period of 20 years."*

Ploughing is done to prepare the land where possible and is done in accordance with appropriate soil conservation practices following the land contour where relevant. About one third of the land is ploughed. Ploughing is only done before planting and is therefore not repeated, if at all, within a period of 20 year, since the rotation period is at least 20 years.

2.3.7 The project shall apply one or more of the project activities and reforestation types

The project activities and reforestation types are the same for Tain II FR as for Asubima and Afrenso Brohuma FR. There is a management plan for the Tain II project (Westerlaan & Tollenaar, 2016) and it is considered a management unit on its own separate from Asubima and Afrenso Brohuma. All project activities and reforestation types as described in the VCS Project Description are applied in Tain II. The GHG emission removals are achieved by establishing tree plantations of exotic and indigenous tree species and by restoring natural forest in riparian buffer zones. PP aims at an ecologically sustainable plantation with a maximum of 90% of Teak and Gmelina (*Tectona grandis* & *Gmelina arborea*) and 10% native tree species. Four reforestation types are identified and illustrated in Table 1, specifically (I) teak plantation, (II) indigenous plantation, (III) buffer vegetation for riparian forest restoration, and, more recently, (IV) Gmelina plantation.

Table 1 Areas of the different reforestation types in Tain II Forest Reserve

Reforestation type	Area (ha)	Percentage
Teak Plantation (I)	6570	82,2%
Indigenous Tree Plantation (II)	899	11,2%
Buffer vegetation / remnant forest (III)	155	1,9%
Old / remnant teak	46	0,6%
Gmelina plantation (IV)	30	0,4%
Rocks and unproductive	296	3,7%
Total	7996	100%

All the project activities are carried out and monitored according to approved project methodology AR-ACM0003: *Afforestation and reforestation of lands except wetlands --- Version 02.0.*

2.3.8 The project shall be additional following the applicable CDM tool

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

The tool has two Applicability Conditions, which are met:

- *The project activities do not lead to the violation of any applicable law.* See section 1.11 of the VCS Project Description Document
- *The project is not a small-scale project.* The expected GHG sequestration is more than 16.000 tons CO₂ per year and the project is not a low-income community project

Following the tool's section II.6, a few steps must be applied to demonstrate additionality. For Tain II Forest Reserve this can be considered equal to the additionality of Asubima and Afrenso Brohuma Forest reserve, considering that the forest reserves were in a similar state, and the same management applies in both areas.

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

In May 2013, a land lease agreement was signed between the Forestry Commission and Form Ghana (Forestry Commission, 2013). From the project start in 2008, PP has aimed for a sustainable reforestation project combining high quality timber production with carbon crediting for revenue generation. PP has set up the commercial reforestation project as an example for sustainable plantation establishment and management, thus attracting new investors in the sub sector. PP implements the project according to the highest available technical, social and environmental benchmarks, aspiring certification according to international FSC and Carbon Certification standards (Hol, 2007).

Carbon credit sales have always been an important part of the business plan to ensure diverse and early revenues and attract future investors. For this reason, in January 2009, an independent auditor determined the carbon balance of the plantation company considering the amount of GHG emitted and sequestered during the process. The results from the 64 hectares pilot plantation established in 2001 in Asubima showed that carbon sequestration is substantial (Control Union Certifications, 2009).

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

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

Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.

Prior to 1993, the forests of Ghana were poorly managed. Due to an unclear forestry policy of the government, no long-term vision and the lack of enforcement of existing regulations there was a widespread malpractice in timber trade; forest fees were not paid, illegal trading flourished, and concessions were illegally sublet to unlawful timber operations. These malpractices led to the overexploitation of the most marketable timber species, which caused severe degradation of forests throughout Ghana. Local communities were generally not involved in forest resource protection, leading to uncontrolled agricultural encroachment. Measures were taken to end these deficiencies, such as the ‘Forest and Wildlife Policy’ in 1994, the ‘Forestry Development Master Plan’ in 1996

and the 'National Forest Plantation Development Policy' in 2001 (Odoom, 2002; Hoogenbosch, 2010). Nevertheless, 94% of the Forest Reserve area is still in a deplorable condition today (Abeney, et al., 2008).

In the project forest reserve, timber has also been overexploited since the 1980's. Subsequently, natural and anthropogenic fires ravaged the remaining forest and illegal farming became rampant. Tain II Forest Reserve was already considerably degraded in 1995, as can be seen in Figure 3 and in the IUCN study for degraded forest reserves in Ghana (Hawthorne & Abu-Juam, 1995). Despite recently developed regulations, social surveys conducted amongst farmers of Tain II Forest Reserve and surrounding communities showed that little has changed until now. Customary and legal rules allow local people within forest reserve boundaries to collect non-timber forest products (NTFPs) for their subsistence only, but farmers admitted in interviews that they farmed illegally in the forest reserve (Tollenaar & Wanders, 2015).

Because of these unsustainable farming practices and of the human-induced fires that occur in the area, both soil fertility and water quality are still further reducing (Tollenaar & Wanders, 2015). Today, the herbaceous shrub *Chromolaena odorata* (Akyeampong) and *Pennisetum purpureum* (Elephant grass) are dominating the forest reserve, fueling wildfires.

Some patches of standing degraded forest remain on soils that are unsuitable for farming or in wet areas, where the wildfires have little effect. However, almost all commercial timbers species have been harvested from these forests. Without the activities proposed by the PP this situation is expected to continue, leading to further degradation of the forest and disappearance of the last remaining indigenous trees.

Land use scenario B: Conventional commercial reforestation / plantation without VCS certification.

The 'National Forest Plantation Development Policy' was launched by the Ghanaian government in 2001 to promote sustainable plantation development in degraded forest reserves. The policy consists of three strategies: subsidize more government-owned plantations, attract private investors for plantation management, and promote community forest management. The last strategy is regarded as a different scenario and will therefore be discussed below. The first two strategies are considered 'conventional commercial plantations' (Forestry Commission, 2008).

This policy made it possible for private actors to acquire a well-defined and carefully negotiated land lease for commercial reforestation on Forest Reserve land. A total of 15,032 ha was planted by private parties between 2002 and 2008. These plantations have mostly been developed by smallholders, are often inactive due to a lack of funding, their performance is under expectation and developers are expecting financial support from the government (Forestry Commission, 2007). The Government Plantation Development Program (GPDP) in this period was funded with money from the Highly Indebted Poor Countries (HIPC) program, launched by IMF and the World Bank in 1996 to ensure that poor countries do not face a debt burden they cannot manage (Hoogenbosch, 2010). The GPDP made use of hired labor and contracted supervisors for the establishment of industrial plantations. By 2008, a total of 33.652 ha was planted with funding from HIPC (Forestry Commission, 2008).

In general, both government-owned and private forest plantations in Ghana are often poorly managed and environmental and social laws are not always respected. Effective management of wild-fires and illegal activities as well as appropriate and timely silvicultural interventions in the plantation, such as weeding, pruning and thinning are often lacking, leading to low stocking levels, poor tree quality and losses due to fire and illegal logging. Labour conditions can be poor, with a lack of safety equipment and training, and employees are often underpaid (personal communication with Mans Vroom, long term forestry expert).

Land use scenario C: Modified Taungya system (MTS) and community forest management.

The conventional Taungya system is a specific type of agroforestry, applied worldwide in plantation forests. After clearance of the land, food crops are intercropped with the tree seedlings. This generates income in the first years of a plantation, reducing the establishment costs, but also benefits the seedlings because of the control of weeds on the bare land.

In Ghana, the Taungya system has been practiced for decades as solutions for the restoration of degraded land. Since 1984 however, use of the system was discontinued because of problems related to inequity between communities and forest managers on the level of ownership and benefits. This led to the development of the Modified Taungya System (MTS) in 2002, in which financial benefits and decision-making power were not just reserved for government officials and land-owners but also included farmers and local communities (Kalame, 2009).

The implementation of MTS is part of the National Forest Plantation Development Program (NFPDP). The design of MTS within this program involves a partnership between the Forest Services Division, which provides knowledge and equipment, and local farmers, that provide the labor. The returns from the investments are divided between the farmers (40%), government (40%), landowner (15%) and community (5%). By 2008, 78,569 ha of land had been allocated to MTS practices (Forestry Commission, 2008). In addition to MTS, the NFPDP also includes the implementation of the Community Forest Management Project (CFMP), funded with money from the African Development Bank. The objective of CFMP is to rehabilitate degraded forest reserves and at the same time increase agricultural, wood and non-wood forestry production (African Development Bank Group, 2010). In 2008, 9,095 ha were allocated to CFMP (Forestry Commission, 2008). The barrier analysis will concern the entire CFMP, without distinguishing between MTS and other community forestry schemes included in the program, because the barriers are to a large extent the same.

Land use scenario D: Sustainable commercial reforestation without VCS certification.

PP's definition of sustainable commercial reforestation: a reforestation activity that commits to the enhancement of environmental, social and economic values in the project area. FSC certification independently demonstrates compliance with international sustainability standards. Although the Tain II plantation has not been FSC certified yet, it adheres to the same sustainability principles as applied in the other project instances.

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

- Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.
- Land use scenario B: Conventional commercial reforestation without VCS certification.
- Land use scenario C: Modified Taungya system (MTS) and community forest management.
- Land use scenario D: Sustainable commercial reforestation without VCS certification.

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

Land use scenario A: Mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.

Since the project areas are all in degraded forest reserves, all farming activities within the project area are illegal. However, this is the prevailing land use practice, as can be observed from interviews with local farmers (Tollenaar & Wanders, 2015) and satellite images of the area (Figure 4). Hence, the law is currently not sufficiently enforced to prevent encroachment of the forest reserve.

Land use scenario B: Conventional commercial reforestation without VCS certification.

Reforestation is not mandated by any enforced law or regulatory framework.

Land use scenario C: Modified Taungya System (MTS) and community forest management.

The MTS is implemented by the Plantations Department of the Forest Services Division of the Forestry Commission as part of the National Forest Plantation Development Program, as part of the national forest policy.

Land use scenario D: Sustainable commercial reforestation without VCS certification.

Reforestation is not mandated by any enforced law or regulatory framework. There are laws concerning some of the social and environmental issues as covered by FSC certification, but these are also not enforced. It is not a legal requirement to adhere to the FSC principles and criteria.

Outcome of Sub-step 1b: List of plausible alternative land use scenarios to the A/R CDM project activity

- Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.
- Land use scenario B: Conventional commercial reforestation without VCS certification.
- Land use scenario C: Modified Taungya system (MTS) and community forest management.
- Land use scenario D: Sustainable commercial reforestation without VCS certification.

STEP 2. Barrier analysis

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

The project scenario and other land use scenarios face several barriers, which are discussed per barrier category.

Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees.

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

Land use scenario B: Conventional commercial reforestation without VCS certification

As mentioned above about 15,000 ha were planted by 300 private developers between 2002 and 2008, implicating that the average size is only 50 hectares per developer. As the Forestry Commission reports, many developers are inactive, they lack funds and technical expertise, suffer from poor roads and expect financial support from the government (Forestry Commission, 2007; Forestry Commission, 2008). Despite earlier mentioned policy initiatives, no large-scale commercial reforestation projects exist in Ghana because these projects face large barriers. Developments in the private sector have not survived without external support (Odoom, 2002). Experience shows that initiatives to establish large private plantations are of short duration, run out of funds, and therefore stop or cannot scale up. The total size of plantations that have been established is very limited and insignificant at national level.

- *Social barriers*

Illegal logging, farming, poaching and human-induced wild-fires for the preparation of agricultural land pose substantial barriers to sustainable forest management and reforestation. These activities originate from rational economic behavior of the local farmers to generate food and income, but are also caused by ambiguous tenure of trees and the limited availability of labor and capital (Odoom, 2002). These activities stand in the way of a healthy cooperation with the government or private plantation developers, but also mean that real options and incentives for rural communities to start reforestation are scarce.

To successfully manage a plantation, illegal activities must be mitigated or stopped completely. This requires continuous dialogue and collaboration of companies with the local communities, prohibition of illegal activities and law enforcement, effective fire management through planning of fire belts, fire-fighting teams, and the education, engagement, employment and training of local people. To successfully achieve these changes structural social adjustments are needed. Since local people usually work as farmers and lack formal education, the skilled labor necessary for these adjustments is often lacking in the area. Additional training is therefore essential. The complexities of the required social adjustments and additional training pose significant barriers for successful reforestation.

- *Investment barriers*

For the establishment of a forest plantation, several investment barriers must be overcome. First, there is a large initial investment required to set up a teak plantation; costs for plantation establishment and maintenance range from €1500 to €3000 per hectare for the first four years only.

Secondly, it takes a long time before the returns on investment are received. The first commercial thinning can take place twelve years after planting. There are no medium- or long-term loans available in the country and commercial bank lending rates are very high, interest base rates of 20-30% are normal in Ghana (Odoom, 2002; Statistics department Bank of Ghana, 2017). In addition, it is concluded that the illegal lumbering and timber trade activities cause price distortions in the domestic timber trade market (Odoom, 2002). This is worsened by the Forestry Department (FD) selling plantation timber below the market price.

Another factor hampering investments in Ghana is the poor investment climate. The credit rating for Ghana is B- to B (CountryEconomy.com, 2017), which is translated in higher interest rates on investment loans. Because of these investment barriers, complex financial strategies are needed to finance a large-scale reforestation plantation, such as making use of multiple investors and combining public and private funding. This is difficult to achieve. Hence, there is a lack of funding for these projects and no large-scale plantations, other than government-owned, exist in Ghana.

- *Institutional barriers*

Commercial reforestation in forest reserves requires a land lease contract with the Forestry Commission. A Benefit Sharing Agreement should be signed with the Forestry Commission (FC) and the traditional landowner. This process can be lengthy and related costs are a significant hurdle for some developers.

Since large teak plantations are not common practice, equipped sawmills and process facilities to handle teak are not yet present in Ghana. The establishment of more teak plantations would promote the establishment of more sawmills, thereby creating a more efficient industry altogether. However, this requires significant expansion and maturation of the forest plantations sector in Ghana.

- *Technological barriers*

As shown in the annual report of the National Plantation Forest Development Program, existing infrastructure often cannot support proposed scenario activities, so roads and bridges will have to be built upon the initiation of project activities (Forestry Commission, 2008). Plantation developers often lack the technical expertise for good quality plantation development, which leads to poor implementation and maintenance practices (Odoom, 2002; Forestry Commission, 2007; Forestry Commission, 2008).

- *Ecological barriers*

Due to the severe degradation, persistent invasive weeds such as *Broussonetia papyrifera* (York) and *Chromolaena odorata* (Acheampong) require initial clearing before planting is possible. These weeds are extremely difficult to eradicate in an environmentally friendly way and cause a significant competition pressure on the growing trees. This requires intensive additional weeding in the first 4 years to maintain the preferred growth scenario. Also, the presence of especially Elephant grass creates high fuel loads and thus fire risks in and around

the plantation, which makes fire prevention and fire-fighting an intensive and costly operation. Compared with environments with less weed pressure and fire risk this ecological environment poses a high barrier.

Land use scenario C: Modified Taungya system (MTS) and community forest management.

- *Social barriers*

An essential part of the NFPDP implementation is the cooperation with farmers. Problems have been reported concerning this cooperation, for example when preparation of land allocated for plantation establishment does not happen at the agreed time (NFPDP). This relatively small incident can have big consequences in case the juvenile trees can no longer profit from the rainy season. From a farmer's point of view on the other hand, the choice to delay tree planting can be explained by the fact that they tend to lend priority to the nursing of their food crops as they provide them with an immediate means of existence (Ghana Forest Service, 1998). Farmers may also be hesitant to cooperate because of bad experiences they had with the previous Taungya system, when the FD failed to provide seedlings or appropriate advice (Odoom, 2002).

Another issue that farmers cope with is that of illegal activities of cattle herdsmen in plantations, such as setting off wildfires within the plantation, as was reported in the Begoro, Kumawu and Juaso plantation areas. This not only threatens the survival of seedlings by trampling and browsing of cattle, but also affects the safety of the people working on the plantations. Incidents have been reported in the Fulani regions. The field staff generally lacks capacity for proper surveys to prevent these events in the future (Forestry Commission, 2007).

- *Investment barriers*

Both on the side of the farmers and on the side of the government there are challenges to be faced in financing the implementation of MTS. The program depends mainly on government funding, which is often delayed or insufficient. Hence, when funding is released, a large amount is used to disburse outstanding payments and not to finance new projects. Communities are often kept waiting for their payments and they are unsure about the distribution of revenues (Forestry Commission, 2008). These practices hinder project implementation.

Farmers on the other hand also lack capital to invest in equipment like Wellington boots or to cover the costs of tending the (large) plantation areas (Ledger, et al., 2010). They have been reported to abandon their land because of financial shortcomings. For example, in 2007 it was reported that only 14% of the MTS plantations received maintenance (Forestry Commission, 2007). The situation is so severe that the authors of the Annual Report of 2008 call for 'a revision of the roles and benefit sharing ratio for the participating Taungya Groups' (Forestry Commission, 2008).

- *Technological barriers*

Despite efforts of the Sector Ministry and the Forestry Commission, still a lack of transportation vehicles was reported. Several stations had to share vehicles, limiting the transport capacity of the plantation staff, for instance on field work or plantation assessments. According to the Annual Report of 2008, a minimum of 28 pick-ups, 5 station wagons and 16 tractors were said to be necessary to fully support the plantation activities. Other tools like GPS receivers, prismatic compasses, clinometers and pruning saws were also insufficiently present (Forestry Commission, 2008).

- *Ecological barriers*

As in scenario B, reforestation under this scenario suffers from high weed pressure and fire risks. The plantations are highly susceptible to wildfires (Amissah, et al., 2010). Fire outbreaks are common in many areas and as the staff lacks the capacity in numbers and knowledge to perform adequate surveying and firefighting (see the 'social barriers' section), no action can be undertaken to prevent this from happening.

- *Barriers related to land tenure, ownership, inheritance, and property rights*

Since the farmers working on the plantations are not the owners of the land, they are constantly suffering from great uncertainty regarding the future of the plantation. Their sense of responsibility for the plantation is therefore a lot smaller than in case the land would belong to them. The issue of long-term investment is also problematic. The revenues from the timber plantation take a long time to reach the investing farmers. Farmers are therefore hesitant to invest, especially those above the age of 50, when you are not likely to have the benefits (Kalame, 2009).

Land use scenario D: Sustainable commercial reforestation without VCS certification.

The barriers mentioned for land use scenario B also apply to scenario D. The barriers discussed below are in addition and apply to sustainable reforestation specifically.

PP reforestation project adheres to a set of sustainability principles, ensuring environmentally appropriate, socially beneficial, and economically viable forest management (Forest Stewardship Council, 2015). To ensure sustainability, additional barriers are faced.

- *Social barriers*
Skilled management and staff is needed (for e.g. planning, logistics, thinning, pruning, harvesting, and monitoring) to ensure feasible and technically sound management of a sustainable plantation and compliant with all FSC requirements. This can be realized by employing skilled professionals from within and outside Ghana, and constantly training of the employees. Building the right set of skills and expertise adds costs and takes time. Also, working on the social adjustments and countering illegal activities (logging, poaching) requires constant efforts, surveillance and stakeholder consultation, posing additional barriers.
- *Investment barriers*
Private investors will be withheld from investing in Ghana because of the higher insecurity of the Ghanaian economy (CountryEconomy.com, 2017). Loans are not provided by the government for plantation establishment, and banks demand high interest rates (Odoom, 2002). Investment for sustainable and commercial reforestation is therefore often tied to foreign investors, demanding high returns, extensive risk mitigation strategies and clear ecological and social co-benefits, including demonstrated positive contributions to climate change mitigation. These demands are difficult to bring together and efforts to mitigate risks and enhance co-benefits raise costs compared with conventional plantation development. This tension in the business case can be eased with the use of carbon finance. This is particularly the case, because carbon finance becomes available before income is generated from timber harvest. Income from timber harvest takes a full rotation, while carbon finance can be realized during plantation establishment. Therefore, without carbon finance, many of the additional goals that PP has set to ensure sustainability of the project could not be achieved.
- *Technological barriers*
For the appropriate management of plantations with indigenous tree species insufficient (scientific) guidance and information is available at present. Therefore, the company must deal with a high degree of uncertainty regarding the expected growth and management regime of this plantation type.
- *Ecological barriers*
The sustainability principles of FSC restricts the use of conventional pesticides. Manual application is required for the ecologically friendly pesticides and this makes the control of weeds considerably more labor-intensive, hence more expensive.
Because of the management objective to have a positive impact on biodiversity and ecological values, buffer zones and indigenous plantations are developed, also in areas that would under conventional plantation development be planted with teak. There is no profitability of these areas as there is no commercial activity here, while there are establishment costs.

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

Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees.

The project area is officially a forest reserve, but due to increased population pressure in recent years and insufficient law enforcement, agricultural encroachment in the area has caused severe deforestation and soil erosion (Odoom, 2002) (Figure 3, Figure 4). Farmers still inhabit the area, using it for agricultural practices, which makes it highly improbable for the forest to return by means of natural regeneration.

Land use scenario B: Conventional commercial reforestation without VCS certification.

Many barriers hinder the implementation of this scenario. The most important ones are of a social and financial nature. There is a lack of skilled labor in the area, investment costs are too high and there is no option for obtaining loans for plantation establishment. In addition, the existing infrastructure cannot support the transport required under this scenario, which means the investment costs rise even further. The significance of these barriers is demonstrated by the absence of large-scale private reforestation sites in the country and small size and poor performance of private developers in the NFPDP (Forestry Commission, 2007; Forestry Commission, 2008).

Considering these barriers, scenario B will be eliminated from further consideration.

Land use scenario C: Modified Taungya System (MTS) and community forest management.

A main barrier for implementation of scenario C is the cooperation between government and farmers. The government provides the funding of the program, but release of this funding is often delayed, and outstanding payments have yet to be disbursed. This hampers the progress of the project and de-motivates the cooperating farmers. The farmers on the other hand do not perform as desired when it comes to attending the seedlings. They tend to lend priority to the nursing of their food crops, thereby delaying the planting of seedlings or neglecting the planted trees.

Considering these barriers, scenario C will be eliminated from further consideration.

Land use scenario D: Sustainable commercial reforestation without VCS certification.

This scenario meets with all the barriers that scenario B is met with. Investment, technological and ecological barriers of implementing the activities according to the sustainability principles that PP committed to are added to the sum. Abandoning these principles, however, would significantly reduce ecological and social values of the project.

Considering these barriers, scenario D will be eliminated from further consideration.

Outcome of sub-step 2b.

Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.

The identified barriers do not affect the continuation of the status quo: mosaic of illegal subsistence farming and grassland with scattered trees. Although this type of land use is technically illegal in a forest reserve area, it is the prevailing means of existence in the area since laws are not sufficiently enforced. Without interference, prevailing practice is therefore expected to continue, leading to further deterioration of the remaining vegetation, soil and water quality.

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

Forestation without being registered as an A/R (CDM) carbon project activity is not included in the list of land use scenarios that are not prevented by any barriers, listed at sub-step 2b. This list contains only one land use scenario:

Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests.

This scenario is the baseline scenario.

STEP 4. Common practice analysis

In Ghana, large-scale commercial plantations are not common practice. Teak, but also other timber species, are mostly produced by smallholders, the government or government-owned companies (Odoom, 2002).

The PP commits to managing the plantations in an environmentally appropriate, socially beneficial, and economically viable way according to the principles and criteria of FSC.

The project is the first FSC-certified plantation in West-Africa (Forest Stewardship Council, 2017), but the PP has decided to add goals to the general FSC requirements. In the buffer zones along the rivers in the area, natural regeneration of the standing degraded forest is assisted by reforestation and ANR techniques. In addition, the buffer zone is actively expanded in severely degraded patches and endangered species, like the Kokrodua tree (*Pericopsis elata*), are being reintroduced in the area. In the latest fauna monitoring, sightings of endangered fauna species have been reported (Oduru, 2018).

Social research showed that the project proponent is a large provider of work in the area (Tollenaar & Wanders, 2015). Whilst setting up the plantation, the PP aims to establish a healthy cooperation with the local communities living in the area. Farmers that have illegally farmed within the project boundaries are therefore invited to intercrop their food crops within the teak plantation until canopy closure. In addition, a benefit sharing agreement has been signed, ensuring that 10% of the revenues flow back to the Forestry Commission, traditional landowners and the local communities (Forestry Commission, 2013).

By adhering to the ILO core conventions, PP ensures a safe working environment, pays more than the minimum wage, provides health care, free meals and transportation to the employees. Also, employees receive training in aspects such as firefighting, safety regulations and proper harvesting techniques. This extensive educational program empowers local communities and promotes private initiatives. The targeted employees are local people, and therefore provide a boost to the local economy.

Because of the substantial barriers described in the barrier analysis, the project does not yet exist in Ghana except for this project. VCS certification is essential in the pioneering business model to ensure a viable revenue stream to overcome these barriers, to provide for revenues during plantation establishment, and to substantially reduce the investment gap. This can pave the road for increased future investors to initiate more reforestation projects in Ghana.

2.3.9 The project shall have the identified baseline scenario

In Sub-step 2c of the previous paragraph the baseline scenario was determined following the applicable CDM tool. This is Land use scenario A: Continuation of the pre-project land use; mosaic of illegal subsistence farming and grassland with scattered trees and patches of degraded forests. This baseline scenario is the same as applicable for Asubima and Afrensu Brohuma Forest Reserves.

The quantification of carbon stocks is further elaborated in chapter 4.1 of this report.

2.3.10 A non-permanence risk buffer assessment shall be performed for each new project area and applied for buffer determination.

This is described in a separate document (Polinder & Wanders, 2019).

2.3.11 Leakage shall be assessed for each new project area following the applicable CDM tool.

Of the leakage types identified in paragraph 4.6 of the VCS AFOLU requirements, the applicable leakage in case of this project is activity-shifting leakage due to displacement of pre-project agricultural activities from the project area and continue pre-project agricultural activities outside the project area.

To reduce the increase of GHG emission due to displacement of pre-project agricultural activities, PP has a strong policy for leakage management: Part of the farmers are employed by PP, a system of intercropping is developed where intercroppers have legalized access to land and can benefit from prepared soils and plant permitted crops around the planted trees. This intercropping is possible until canopy closure. Since the PP plants new areas every year, intercroppers can also rotate together with the planting years. In addition, the likelihood of leakage occurring due to people moving outside of the project area is limited, as most of the land outside the project area is already at a very low baseline. It has been cleared for agriculture and does not build up due to annual fires occurring everywhere.

2.3.12 PP shall have the right of use for each new project area.

Form Ghana holds a legal title to the project area since 2013 in the form of land lease agreements with the Government of Ghana and the traditional land owner (Forestry Commission, 2013), accompanied by an official benefit sharing agreement (Forestry Commission, 2013). The lease has a duration of 50 years and is renewable. Before 2012, Form Ghana had the right to access the Forest Reserve and start project activities, as documented in the land access agreement (Forestry Commission, 2013).

2.3.13 Shall be managed according to the same sustainability principles as described in the PD

Form Ghana adheres to one management system. This system is described in the management plans for both the Tain II plantation as well as the Akumadan plantation (Asubima and Afrensu Brohuma Forest Reserve). Hence, the same principles apply to all FR under FG management.

2.4 Safeguards

2.4.1 No Net Harm

Form Ghana's Akumadan plantations are certified according to FSC's Principles and Criteria. The Tain II plantation is managed according to the same principles and criteria. Based on this Form Ghana has developed a management system of separate protocols that describe the process of environmental and social management. Together with the Management Plan, these documents form the Environmental and Social Management Plan, which is aimed to mitigate any negative environmental and socio-economic impacts. The systematics between the various documents is described in Figure 5.

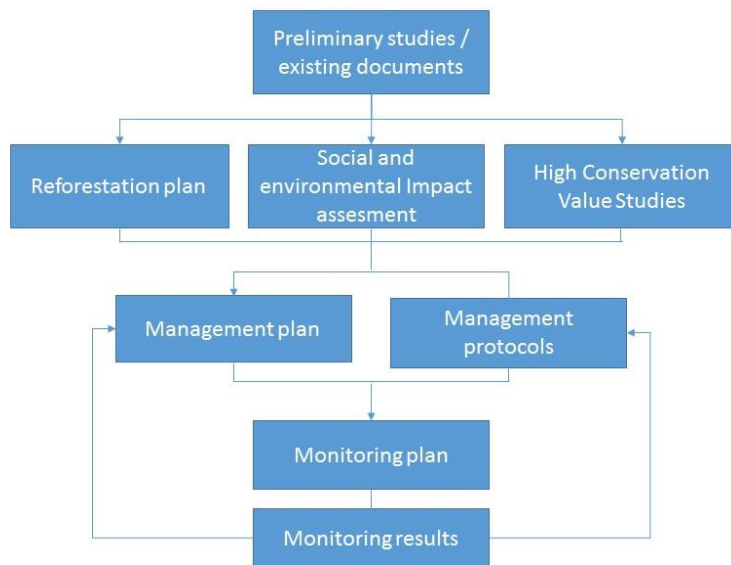


Figure 5 Relation between the various documents

The environmental and social management of Form Ghana addresses the recommendations and mitigation measures proposed in the impact assessments of Tain II Forest Reserves (Tollenaar & Wanders, 2015).

Form Ghana has found farmers on the plantation sites that were engaged in farming inside the Forest Reserves. This is an illegal activity. FG has however not engaged in any forceful removal of illegal occupants. People were invited to continue activities as intercroppers. As such they could plant crops amidst the young teak. Most of the intercroppers have moved with the planting, so occupying new terrain as the company developed it. Form Ghana now also implements a landscape activity which is partly oriented toward farmers providing them training and crop inputs.

The scope of the environmental and social management plan (ESMP) is the same as the scope for the Social and Environmental Impact Assessment. The goal is to give guidelines to all parties involved during establishment, maintenance and harvesting of the plantation in fulfilment of environmental and social requirements.

The environmental and social management plan has a long-term objective to ensure that:

- (i) Environmental management activities and requirements are implemented during the establishment, maintenance and harvesting of the plantation;
- (ii) The interests of the stakeholders are considered throughout the project;
- (iii) Damage to the environment, the biological diversity and sensitive habitats (where present) are avoided.

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

The effectiveness of management is checked annually through monitoring activities. Monitoring is done based on a matrix that identifies the fields of monitoring. This matrix is presented in the annual monitoring plan. Subjects covered during monitoring are:

- Mapping and map analysis;
- Fauna diversity;
- Buffer zone Permanent Sample Plots;
- Timber plantation Permanent Sample Plots;
- Water quality;
- Soil texture;
- Fire monitoring;
- Forest production;
- Section analysis of trees;
- Timber and carbon sales;
- Economic aspects;
- Social impact;
- Training and capacity building;
- Health and safety;
- Nursery development.

Findings from monitoring activities are fed back into the management system through the adaptation of protocols or management plans. A public monitoring report is produced for the general public. Reports on the specific monitoring activities are produced for Form Ghana management.

The responsibility for implementing the ESMP lies with Form Ghana who delegates part of the responsibilities to Form international, regarding monitoring, training and document maintenance.

2.4.2 Local Stakeholder Consultation

A stakeholders committee consisting of traditional landowners, farmers, environmental NGOs, the Forestry Commission and FORM Ghana has been set up in 2014. The committee holds meetings at least annually to discuss wishes, demands and complaints of the stakeholders. Minutes of the meetings are kept on file. Before the project start a social survey was conducted as part of the social and environmental impacts assessment (Tollenaar & Wanders, 2015).

Since 2013 more than 500 intercropping agreements were signed between farmers and PP (Wanders, 2019). During social monitoring surveys it became clear that many people living in the project area found either temporal or permanent employment with the PP, while they could still work as a farmer because of the possibility of intercropping and therefore PP presence has positively changed their income situation. Most people perceived the forest restoration as a positive activity and already see positive changes in the presence of wildlife (Ogoe, 2011).

The following documentation governs the local stakeholder consultation process

- *P06 Stakeholder engagement plan*
This plan identifies the stakeholders of Form Ghana and describes how stakeholders are engaged.
- *P 07 Grievance and Redress*
This document describes how grievances are dealt with and how grievances are redressed.
- *Resettlement Action Plan*
This document describes the resettlement activities that Form Ghana undertakes for people that need as a consequence of Form Ghana activities.
- *P28 Community Development Plan*
This plan describes the community development activities that Form Ghana undertakes.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	Form factor indigenous trees (f_{IND})
Data unit	-
Description	This converts DBH and height cylinder into total aboveground tree volume.
Source of data	Dawkins in (Cannell, 1984)
Value applied	0.6
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed data specifically for tropical broadleaved trees
Purpose of the data	- Calculation of baseline emissions - Calculation of project emissions
Comments	

Data / Parameter	Average wood density for Indigenous forest (D_{IND})
Data unit	kg m ⁻³
Description	This is a calculated parameter of the average wood density.
Source of data	The average wood density is determined based on relevant literature (The Wood Explorer, n.d.; Orwa, et al., 2009; IPCC, 2006)
Value applied	458
Justification of choice of data or description of measurement methods and procedures applied	Sample plots in the buffer zones have been laid out and the tree species identified. With various literature an average weighed wood density was calculated and is applied to calculate DW in the indigenous vegetation.
Purpose of the data	- Calculation of project emissions - Calculation of baseline emissions
Comments	

Data / Parameter	Root to shoot ratio for mixed tropical broadleaf species (R_{mix})
Data unit	-
Description	Converts the above-ground biomass to the above- and below-ground biomass
Source of data	(IPCC, 2006)
Value applied	1,22
Justification of choice of data or description of measurement methods and procedures applied	Conservatively chosen for moist deciduous forest as these values are lower than for dry forest. Average chosen of R-values for forest >125 ton DW ha ⁻¹ aboveground and <125 ton DW ha ⁻¹ aboveground, since forest will change gradually from lower than 125 ton ha ⁻¹ to more than that in the project period.

Purpose of the data	- Calculation of project emissions - Calculation of baseline emissions
Comments	

Data / Parameter	Carbon fraction indigenous trees (CF_{IND})
Data unit	-
Description	Amount of carbon in dry matter
Source of data	(IPCC, 2006)
Value applied	0.49
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC
Purpose of the data	- Calculation of project emissions - Calculation of baseline emissions
Comments	

Data / Parameter	Form factor remnant teak
Data unit	-
Description	Factor to convert cylinder measured from DBH and height to trunk volume
Source of data	(Dupuy, 1990)
Value applied	0.36
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication
Purpose of Data	Calculation of project emissions
Comments	

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

measurement methods and procedures applied	
Purpose of the data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	Teak wood density (D_{TEAK})
Data unit	ton m ⁻³
Description	The density for teak to determine dry weight
Source of data	(IPCC, 2003)
Value applied	0,55
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication
Purpose of the data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	Carbon fraction Teak (CF_{TEAK})
Data unit	-
Description	Fraction of carbon in dried teak
Source of data	(Kraenzel, et al., 2003)
Value applied	0,495
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication
Purpose of the data	• Calculation of project emissions • Calculation of baseline emissions
Comments	

Data / Parameter	York wood density (D_{YORK})
Data unit	kg m ⁻³
Description	The wood density of <i>Broussonetia papyrifera</i>
Source of data	(Orwa, et al., 2009)
Value applied	506
Justification of choice of data or description of	Literature

measurement methods and procedures applied	
Purpose of the data	Calculation of baseline emissions
Comments	

Data / Parameter	Cassia wood density (D_{CASSIA})
Data unit	kg m ⁻³
Description	The wood density of <i>Cassia siamea</i>
Source of data	(Mainoo & Ulzen-Appiah, 1996)
Value applied	640
Justification of choice of data or description of measurement methods and procedures applied	Literature
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	Gmelina wood density ($D_{GMELINA}$)
Data unit	ton m ⁻³
Description	The density for teak to determine dry weight
Source of data	(IPCC, 2003)
Value applied	0,45
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed publication
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	Biomass expansion factor Gmelina ($BEF_{GMELINA}$)
Data unit	-
Description	Converts trunk biomass to total aboveground tree biomass.
Source of data	Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)
Value applied	1,15
Justification of choice of data or description of measurement methods and procedures applied	Methodology default value

Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	$SOC_{REF,i}$
Data unit	ton C ha ⁻¹
Description	Reference soil organic carbon stock
Source of data	CDM "Tool for estimation of change of soil organic carbons stocks" (version 1) – Table 3
Value applied	41
Justification of choice of data or description of measurement methods and procedures applied	Average between dry and moist tropical forest as PP project lies on the border of the moist forest zone. Soil research showed that soils are mostly low activity and therefore all conservatively assumed low activity clay soils (LAC)
Purpose of the data	Calculation of project emissions
Comments	

Data / Parameter	$f_{LU,i}$
Data unit	-
Description	SOC stock change factor for land use
Source of data	CDM "Tool for estimation of change of soil organic carbons stocks" (version 1) – Table 4
Value applied	0,70
Justification of choice of data or description of measurement methods and procedures applied	Average between short term and long-term cultivation because the pre-project land use ranges from long term cultivation (>20 years) to short term cultivation (between 0 and 20 years). Following determination of $SOC_{REF,i}$ also an average is applied between dry and moist tropical forest
Purpose of the data	Calculation of project emissions
Comments	

Data / Parameter	$f_{MG,i}$
Data unit	-
Description	SOC stock change factor for management regime
Source of data	CDM "Tool for estimation of change of soil organic carbons stocks" (version 1) – Table 4
Value applied	1,12
Justification of choice of data or description of measurement methods and procedures applied	Pre-project land use management is 'reduced tillage', since farming is characterized by low intensity and reduced soil disturbance. Following determination of $SOC_{REF,i}$ also an average is applied between dry and moist tropical forest
Purpose of the data	Calculation of project emissions

Comments	
Data / Parameter	$f_{IN,i}$
Data unit	-
Description	SOC stock change factor for input of organic matter
Source of data	CDM “Tool for estimation of change of soil organic carbons stocks” (version 1) – Table 4
Value applied	0,935
Justification of choice of data or description of measurement methods and procedures applied	Inputs are considered to be low since residues are removed via collection and the land is burned afterwards.
Purpose of the data	Calculation of project emissions
Comments	

3.2 Data and Parameters Monitored

Data / Parameter	Form factor teak (f_{TEAK})
Data unit	-
Description	Factor to convert cylinder measured from DBH and height to trunk volume
Source of data	Calculated from section measurements in PP plantations. Equation obtained from literature (Burkhart & Tomé, 2012)
Description of measurement methods and procedures to be applied	For a selection of trees felled in thinning operations among others the DBH is measured at 1m intervals. Section measurements are carried out according PP's protocol 13.
Frequency of monitoring/recording	Section analysis is done during every thinning operation in the plant year where thinning takes place.
Value applied	Value depends on tree dimensions
Monitoring equipment	Calliper and measurement tape
QA/QC procedures to be applied	PP's protocol 13 for monitoring is implemented, including training of the monitoring team
Purpose of data	Calculation of project emissions

Calculation method	The following formula is used to calculate tree volume, based on which the form factor can be calculated: $\ln(V) = b_1 + b_2 \ln(d) + b_3 \ln(h)$ $b_1 = -9,605$ $b_2 = 1,955$ $b_3 = 0,799$
Comments	

Data / Parameter	$A_{PLOT,i}$
Data unit	ha
Description	Total area of sample plots
Source of data	PP field monitoring
Description of measurement methods and procedures to be applied	See chapter 4.3 of the PDD
Frequency of monitoring/recording	Annually
Value applied	Aim is to sample 1% of the stratum area
Monitoring equipment	GPS, measuring tape.
QA/QC procedures to be applied	Internal auditing on determining plot size by field monitoring teams
Purpose of data	Calculation of project emissions
Calculation method	Plot size x number of plots
Comments	

Data / Parameter	H
Data unit	m
Description	Total height of the trees
Source of data	Measured by project proponent
Description of measurement methods and procedures to be applied	Is measured in permanent sample plots, see chapter 4.3 of the PDD for elaboration.

Frequency of monitoring/recording	Annually
Value applied	Depending on age between 0,5 and 30 meters
Monitoring equipment	Suunto Inclinator PM5: accuracy +/- 1m for trees more than 10 meters high. +/- 1 m Measuring pole for trees under 10 meters high. Accuracy +/- 25cm Measuring tape for tree under 2 meters high. Accuracy +/- 5 cm
QA/QC procedures to be applied	Remeasurement of 5% of the trees is done as quality control during internal audit and check of correct implementation of procedures by monitoring team.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	

Data / Parameter	DBH
Data unit	cm
Description	Diameter of the tree at 1,3m height
Source of data	Measured by project proponent
Description of measurement methods and procedures to be applied	Is measured in permanent sample plots, see chapter 4.3 of the PDD for elaboration.
Frequency of monitoring/recording	Annually
Value applied	Depending on age, between 0 and 45 cm
Monitoring equipment	Diameter tape is used for accurate measurements. Accuracy +/- 1mm
QA/QC procedures to be applied	Remeasurement of 5% of the trees is done as quality control during internal audit and check of correct implementation of procedures by monitoring team.
Purpose of data	Calculation of project emissions
Calculation method	Not applicable
Comments	

3.3 Monitoring Plan

3.3.1 Description of the Monitoring Plan

Forest health is monitored in all forest types: commercial plantations with Teak and Gmelina, indigenous plantations and buffer zones. The measurements are taken in permanent sample plots (PSP), which are established throughout the project area, in different forest stands. Every year after planting, additional plots are created in the newly planted areas. The number of plots will therefore increase yearly.

Updating of strata

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

Teak / Gmelina plantation PSPs

Teak and Gmelina plantations are stratified according to plant year and PSPs are laid out per stratum, based on an allocation procedure carried out in GIS. The cumulative PSP area is at least 1% of the plantations: per stratum and overall. After monitoring the maximum allowable relative margin of error of the mean for estimation of tree biomass is 10% at 90% confidence level. PSP layout and size differs per plantation, and this is recorded per plot in the PSP database. At the 1% sampling density there is approximately 1 PSP for every 7 - 8 ha of plantation. GPS coordinates are obtained from the GIS procedure and are provided to the field monitoring team, along with a plantation map including all PSPs.

Every plant year is monitored every 2 years, starting in the 3rd year after planting, because at this age normally a DBH can be established.

Indigenous plantation PSPs

Procedures for indigenous plantation PSP monitoring are the same as for Teak plantations. Only, sampling density is 2%, meaning that PSP area is 2% of the indigenous plantation area, per stratum and overall. The higher percentage is needed because these are mixed species plantations, which are characterized by higher variability. Every plant year is monitored every 2 years, starting in the 3rd year after planting as at this age normally a DBH can be established.

Buffer zones

As elaborated before in this PDD, the buffer zones are divided in degraded forest buffer and planted buffers. Procedures are the same as for indigenous plantation. Since the same level of heterogeneity is expected PP aims at 2 % sampling density. The buffer zones are monitored every 5 years.

Environmental monitoring

PP commits strongly to environmental values. Therefore, monitoring of flora and fauna, water quality and erosion are also undertaken.

3.3.2 Organizational structure, responsibilities and competencies

A number of staff are involved in the monitoring of the plantations and buffer zones. They are listed in the table below, including their specific tasks and responsibilities.

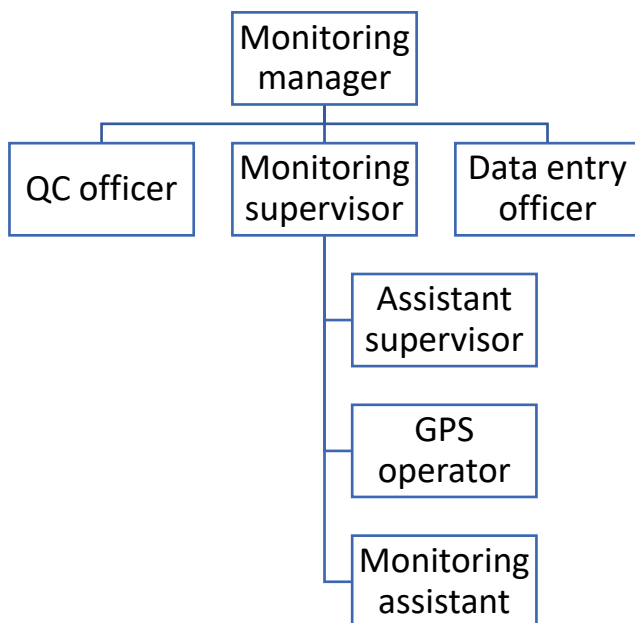


Figure 6 Overview monitoring staff

Table 2 Task and responsibilities of monitoring staff

Staff	Task	Responsibility
Monitoring manager	- Planning and management of the monitoring process - Training of dedicated personnel	- Quality assurance of PSP monitoring - Data analysis and reporting to FORM Ghana management
Monitoring supervisor	- Supervise implementation of PSP measurements - Recording on field sheets - Supervise correct data entry - Archiving of field data (on paper and digital) - Report/send progress and data updates to the monitoring manager	- Correct implementation of PSP measurements - Clear and correct recording on field sheets - Maintenance and completeness of equipment - Correct and timely data entry - Report progress
Assistant supervisor	- Assist supervision of field teams - Recording on field sheets - Deliver field data to monitoring supervisor - Report progress and updates to monitoring supervisor	- Clear and correct recording on field sheets - Correct implementation of PSP measurements - Maintenance and completeness of equipment
GPS operator	Localizing PSPs and navigating the field team	- Correct operation of the GPS - Safe keeping of the GPS - Taking correct measurements

	- Erection of poles and numbered tags of new PSPs at the correct GPS position. - Assisting in plot measurements	
Monitoring assistant	- Assisting in plot measurements - Clearing of PSP where necessary	- Taking correct measurements - Provide easy access in and between PSPs
Data entry officer	- Entering data from field sheets into the correct Excel data formats - Sending data updates to Monitoring supervisor	- Correct data entries - Timely provision of data updates to the monitoring supervisor
Quality control officer	Carry out quality control on field measurements and data entry	Quality control

3.3.3 Methods for recording, storing and aggregating data on parameter

Field measurements procedure Akumadan

Annually, PSPs are assessed using the following procedure:

- The basic shape of a PSP is a circular plot with a pole in the center.
- GPS coordinates as received from the GIS system determine the site location.
- At the plot center a metal pole is placed
- The PSP size is normally 800m², and the plot radius to attain 800m² is 15.96m.
- Lay out the plot by measuring the plot radius with a measuring tape to eight directions and marking the trees in the plot with paint.
- The plot size is the same for all plantation ages and stem densities.
- When a plot is on a slope additional guidance shall be followed stated in PP's protocol 13.

Field measurements procedure Tain II

Annually, PSPs are assessed using the following procedure:

- The basic shape of a PSP is a square plot with a pole at the four corners of the plot. Poles and tags are replaced in case they have decayed.
- The plots cover 9x9 planting positions, and planting density is 3x3m. This implies a PSP size of 729m² assuming equal spacing, where each side of the square has a length of 27 m.
- 5 poles are placed to mark the plot (in the picture these are the green dots with a ring around them). Four poles on the corners and a 5th pole to indicate the direction in which the first line of trees must be monitored (Figure 7) The four corner posts must be placed on a specific point in the middle of a cross made between 4 trees.

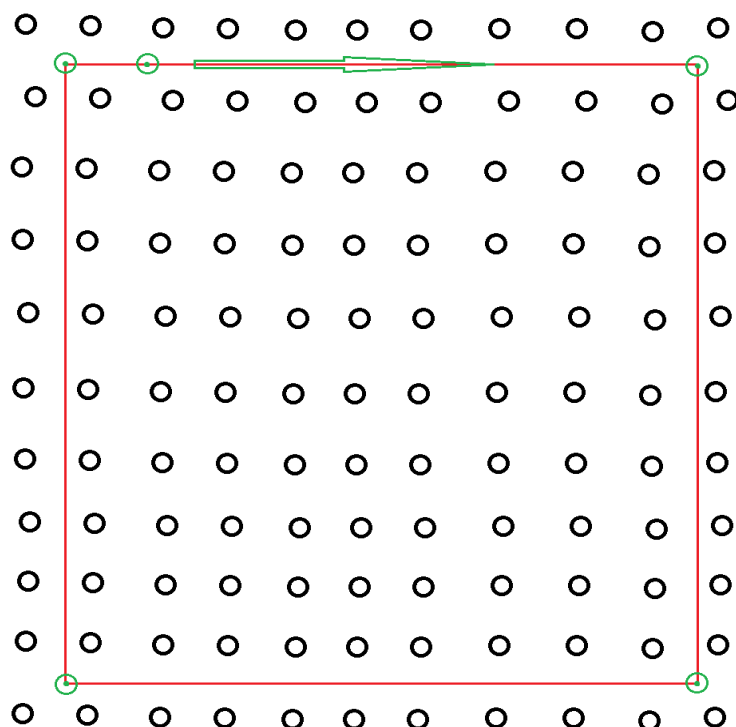


Figure 7 Design Permanent Sample Plots Tain II plantations

- On the corner post the GPS point must be taken for GIS positioning of the plots and to be able to calculate the plot surface. After the corner posts have been placed the distances between the poles are measured. This will later help the GIS to test if the coordinates were correct. The trees on the edge of the plot have to be marked with paint, so it is clear what is inside and outside of the plot.

The measurements to be taken in the PSPs are:

General data

- Plot number
- GPS coordinates
- Date of measurement
- Crew members taking the measurements

Terrain and soil

- Slope (inclination): with a clinometer the slope of the plot area is measured and recorded. This recording is only done in the first monitoring year.
- Soil depth: With a soil auger (Edelman type) and / or a spade the effective soil depth is determined to a maximum soil depth of 120 cm. Effective soil depth is the depth to which roots can grow unhindered. Gravel or other impenetrable soil layers limit effective rooting depth and the start of such layer is recorded as soil depth. This recording is only done in the first monitoring year.
- Soil erosion: any visual sign of erosion will be noted descriptively, especially washed away soil.

Undergrowth/weeds

- Plant species or type, coverage (%) and height range (m) is noted plant types covering at least 15% of the PSP area.
- For qualifying quantities of Acheampong, York and agricultural crops the species is recorded.

- For qualifying quantities of grass or herbs record only 'grass' or 'herbs'
- Coverage of each plant species or type is estimated as percentage of PSP cover.
- The height or height range is measured per plant species or type.

Teak / Gmelina trees

- Qualifying trees are commercial trees that have been planted, as well as wildlings and coppice of this species.
- Tree DBH (diameter at breast height, measured at 1.3m above ground level).
- Height: The height of all trees is measured as accurately as possible with a clinometer or a (telescopic) measurement pole.
- Tree health, pests and diseases: record as observation in case a tree is affected by a pest or disease.
- All trees standing in the plot are marked with paint to make sure that it is clear which tree falls in or outside the plot

Other trees

- Other trees are only measured if they are qualified
- Qualifying trees are trees that were present before plantation establishment. These are remnant, indigenous trees, typically with a DBH >10 cm.
- Tree DBH: From qualifying trees the tree DBH is measured with a caliper.

Detailed guidance on these measurements are recorded in PP's protocol 13.

Indigenous plantation PSPs and buffer zone PSPs

Procedures for indigenous plantation PSP monitoring are the same as for Teak plantations, with a few exceptions:

- Tree height and DBH of all planted trees are recorded the same as for Teak.
- Unplanted trees are only measured if they qualify.
- An unplanted tree is qualified if it not York and is ≥ 5 cm DBH (unplanted Teak is included).
- Tree DBH: From qualifying trees the tree DBH is measured with a diameter tape.
- All trees standing in the plot are marked with paint to make sure that it is clear which tree falls in or outside the plot

Detailed guidance on these measurements are recorded in PP's protocol 13

3.3.4 Quality assurance and quality control procedures

To increase the accuracy of the monitoring data quality assurance and quality control Qa/Qc procedures are established following IPPC good practice guidance for LULUCF (IPCC, 2003).

Hard copies of data sheets are kept on file by plant year and plot number and stored at least five years. Data is entered by the data entry officer in a data entry template in excel. The monitoring supervisor checks for typing mistakes that may occur from entering data from field sheets into the computer by comparing all hard copy data sheets with the digitalized records before sending to the monitoring manager. The excel sheets are then send to the monitoring manager for analysis. Digital data is backed up and stored until at least two years after the crediting period is expired.

The monitoring manager performs further quality control on the data by checking a number of possible errors, being:

- Missing diameter records for trees >1.3 m high.
- Extreme values for H and DBH that are outside the biological potential of the trees. This is checked through a 'max-min' check by filtering the records in the spreadsheet.
- Very unlikely height-diameter (H/D) ratios. An H/D ratio check is carried out by filtering the records in the spreadsheet. For plantation trees in regeneration and pole phases the ratio should be between 0.5 and 2.5. Deviations from this ratio will be checked.

When (possible) errors are found the source of the error will be searched. The mistake can be made during data entry or during field measurements. The monitoring supervisor will review problematic records on request and verify whether the records are correct or whether mistakes were made during data entry or in the field. In case a field check or re-measurement is required this will be done.

Training of the monitoring team is essential and is given on-site by an experienced monitoring professional. This is done yearly, and the tasks are assigned to different members of the monitoring team. Activities are cross checked to assess if the monitoring is carried out according to protocol

Internal auditing is done yearly. During this audit approximately 5% of the permanent sample plots are re-measured plots. The leader of the quality control measurements is not involved in the original measurements.

The data from the re-measurements will be compared with the monitoring data. Any errors discovered will be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error. If the difference is larger than 10%, the cause(s) will be identified and included in the next training session. This is to ensure accuracy and continuous improvement of the system

The task of monitoring manager and monitoring supervisor can at all times be carried out by two qualified and trained staff, to prevent that absence of one person per position might lead to insufficient supervision, management or quality control.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Following the methodology carbon stock changes in dead wood and litter can be excluded for accounting of carbon stock changes. Shrub biomass is neglected as they are hardly present in the area. The baseline net GHG removals are therefore determined as:

$$\Delta C_{BSL,t} = \Delta C_{TREE_BSL,t} \quad (\text{Eq. 1 AR-ACM-003})$$

The C_{TREE_BSL} at start of the project activities was determined for two different baseline carbon stock levels, because two clearly distinct strata have been identified with the use of satellite imagery and vegetation sampling. These baseline carbon stock strata are:

- *Stratum 1: Mosaic of agricultural land and degraded grasslands with some scattered trees remaining.*
- *Stratum 2: Patches of degraded forest in the buffer zones along watercourses.*

As can be observed in Table 3, stratum 1 has much lower woody biomass levels than stratum 2, with more remaining native vegetation. The table shows the carbon pools of these two baseline carbon stock strata for the Tain II plantations.

Table 3 Baseline carbon stocks determined for the Tain II plantations

Baseline carbon stock stratum	Relevant biomass pool	Value (ton CO ₂ e ha ⁻¹)
$C_{TREE_BSL_1}$	Remnant Indigenous Trees (RIT)	16.78
	Remnant Teak (RT) & Invasive Trees (IT)	0.52
	Total	17.30
$C_{TREE_BSL_2}$	Mixed Degraded Forest (MDF)	40.87
	Total	58.17

Remnant Indigenous Trees (RIT), Remnant Teak (RT) and Invasive Trees (IT) ($C_{TREE_BSL_1}$)

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

The Remnant Teak (RT) and Invasive Trees (IT) are cleared with land preparation, although regularly Remnant Teak plantings are conserved and managed by PP and consequently these areas are excluded from the project.

To provide a solid estimation of the carbon stock in this pool, the number of trees felled for land preparation in the 2013 area were counted and summarized in Appendix I. These values are based on data covering 600 hectares and are representative for the whole project area. Many of these trees are coppices with multiple stems. All stems (also of the same tree) are separately included in the numbers presented in the Appendix I. This is considered a relative conservative sample for the Tain II Forest Reserve, but the conservativeness of this figure is further verified by land clearing information in the subsequent planting years. This resulted in a weighed estimate of 0,41 ton CO₂e

ha⁻¹, which clearly demonstrates that the applied figure of 0,52 ton CO₂e ha⁻¹ is sufficiently conservative to be applied in the Tain II Forest Reserve for this stratum.

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

Mixed Degraded Forest ($C_{TREE_BSL_2}$)

To determine the carbon stocks of the mixed degraded forest at the start of the project activity in baseline carbon stock stratum 2, 13 sample plots of 2500 m² were laid out in this stratum during the environmental study (Oduro & Danquah, 2012) as part of the Social and Environmental Impact Assessment (Tollenaar & Wanders, 2015). Tree height (H), tree diameter at breast height (DBH) and tree species were recorded, among other parameters. The form factor and wood density as elaborated in the earlier Project Description Document (Sools, et al., 2013) were applied. Using this data, a total above ground tree volume of all trees in the sample plots was calculated and the total aboveground volume per hectare is derived from this number. The calculations and associated uncertainty are further elaborated in Appendix I.

A figure of 34,1 ton CO₂e ha⁻¹ was calculated, but with the calculated uncertainty of 26% a discount of 75% was applied. This resulted in a final figure of 40,87 ton CO₂e ha⁻¹ for Mixed Degraded Forest in the Tain II plantations.

As in the Tain II plantations no further clearing of invasive trees is done in the Mixed Degraded Forest, further change in carbon stock is determined in regular forest monitoring. This is however not part of the current verification period, and therefore not further elaborated in this monitoring report.

4.2 Project Emissions

4.2.1 Stratification

As the project expands gradually for all the different reforestation types, the project is further stratified by planting year as shown in Table 4.

Table 4 Stratification

Forest Reserve	Year	Teak Plantation (I)	Indigenous Tree Plantation (II)	Buffer vegetation (III)	Gmelina Plantation (IV)
Asubima	2008	148,2			
Asubima	2009	512,6			
Asubima	2010	612,5	43,8	159,3	
Afrensu Brohuma	2011	844,3	28,5	104,2	
Afrensu Brohuma	2012	688,4	80,4	47,4	
Tain II	2013	581,7	19,1		
Tain II	2014	1886,5	194,7		
Tain II	2015	1036,6	63,2	8,9	
Tain II	2016	87,4		15,2	
Tain II	2017	505,0	63,2	19,7	
Tain II	2018	1598,6	242,5	64,0	5,0
Tain II	2019	873,9	315,9	47,1	25,0
Total		9375,6	1051,3	465,8	30,0

The Teak and Gmelina Plantation (I and IV) and Indigenous Tree Plantation (II) strata for all planting years are submitted for verification and described in this monitoring report.

4.2.2 Actual net GHG removals by sinks

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

The estimated net GHG emission removals (t CO₂-e) per year are calculated as:

$$\Delta C_{AR-VCS,t} = \Delta C_{AR-VCS,t_TEAK} + \Delta C_{AR-VCS,t_IND} + \Delta C_{AR-VCS,t_BUFFER} + \Delta C_{AR-VCS,t_GMELINA}$$

In the following sections, the actual net carbon emissions and removals per hectare are elaborated per carbon pool and per reforestation type.

4.2.2.1 Reforestation type I: Teak Plantation

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

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

The change in tree biomass is calculated by estimating the biomass in each plant year. The tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” is used to determine tree carbon stock changes. Because shrub biomass is very low, this pool is conservatively excluded. The change in tree biomass is estimated using the following equation:

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

The tree biomass in the first year is the same as the baseline biomass in trees (remnant indigenous trees, remnant teak and invasive trees) at the start of the project activity ($C_{TREE_BSL_1}$). The tree biomass cleared (remnant Teak, York and Cassia) during land preparation ($C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}$), is deducted from the baseline carbon stock and the increment of the planted teak trees (C_{TREE_TEAK}) added.

$$C_{TREE} = C_{TREE_BSL_1} - C_{TREE_BSL_1,2} - C_{TREE_BSL_1,3} + C_{TREE_TEAK}$$

Methods for determining $C_{TREE_BSL_1}$ have been discussed in the PDD. The remnant indigenous trees are a constant figure where change in carbon stock is conservatively estimated to be zero. As discussed in the baseline, the amount of carbon in this pool is expected to decrease due to anthropogenic factors. The remnant trees are protected in the project area and are therefore expected to grow. However, these trees are conservatively assumed to reach a steady state in year zero and are therefore not monitored for ex post calculation but added as a constant to the total C_{TREE} of the relative stratum. Remnant indigenous trees will not be felled in the project scenario.

For the already verified teak strata during the previous verification in 2018, C_{TREE} is used as established in the previous monitoring report for these strata.

For the new teak strata in Tain II no verification has been done before, and therefore the tree biomass which is cleared during land preparation is deducted from the baseline carbon stock. As

for the Remnant Indigenous Trees (RIT) change in carbon stock is conservatively assumed to be zero, the baseline carbon stock ($C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}$) that is removed during land clearing is accounted as C_{TREE,t_1} . Therefore, for the new teak strata in Tain II the following applies:

$$\Delta C_{TREE_PROJ} = C_{TREE,t_2} - (C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}) \quad (\text{Eq. 1 AR-TOOL14})$$

This calculation assumes that no GHG emission reductions have been realized through teak trees from the planting date till the start of this verification period. This is justified as the carbon stock in teak was far below the carbon stock that has been removed with land clearing, and it can only be determined that the baseline carbon stock is exceeded after 3 years. Before the 3 years there is usually no volume that can be measured because of the size of the trees. Therefore, monitoring usually only starts 3 years after planting as elaborated in PP's protocol 13 'Monitoring' when the trees have a size where a DBH can be measured. Therefore, the planting years 2017 – 2019 have not been measured yet.

For the 2013 and 2014 area the first measurement was further delayed as these trees faced a stronger backlog in growth. In 2016 these areas faced a significant fire (Amoako & Wanders, 2016). Based on field observations it was expected that this caused a backlog in growth of 1 to 2 years, and a significant area had to be replanted. Consequently, regular and sufficiently homogeneous PSP measurements could only be expected at an age of 4 – 5 years. This observation was further strengthened as growth was delayed in these areas due to inadequate plantation maintenance due to the financial challenges at that time. The first PSP measurements that were carried out recently indeed show a backlog in growth in terms of diameters (Polinder, 2018), although height growth has caught up with the rest of the plantations. As before the 3 years there is no volume that can be measured because of the size of the trees, it is considered to be appropriate to apply the following for the teak strata in the Tain II plantations.

$$C_{TREE,t_1} = C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}$$

Table 6 contains shows the total value of C_{TREE,t_1} for the different teak strata.

The total tree biomass in teak at C_{TREE,t_2} is estimated based on field measurements in Permanent Sample Plots as elaborated in the monitoring plan.

The tree volume is calculated as:

$$V_{TREE,teak} = \pi \times \frac{DBH^2}{2} \times H \times f_{TEAK}$$

According to the methodological tool the amount of tree biomass is estimation using the following equations:

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

The total tree biomass in a sample plot is calculated by summing the biomass of all individual trees measured in each sample plot. The teak biomass equals the total tree biomass in the sample plot, since other tree species are not taken into consideration. The area of a sample plot is close to 800 m² in Akumadan, as the plot radius is 15.96m. In the Tain II plantations the plot size is 729 m². Tree biomass per hectare in the sample plots is calculated by dividing the total tree biomass in the sample plot by the size of the plot.

Based on the mean biomass of the plots per stratum, as well as the associated variance, the mean carbon stock in teak (C_{TREE}) within the teak biomass estimation strata and the associated uncertainty (u_C) are estimated following the methodology as described in the PDD. The results are shown in Table 5, where the uncertainty in t_1 is obtained from the previous monitoring report (Polinder, et al., 2018).

Table 5 Mean tree biomass and associated uncertainty in teak strata

Parameter	Unit	t_1	t_2	Δt
C_{TREE}	t CO ₂ e	202 764	337 320	134 556
u_C	-	3,9%	2,3%	8,2%

Since the uncertainty in C_{TREE} less than 10%, there is no need to make C_{TREE} conservative by applying an uncertainty discount. The summary of change in tree biomass in the teak strata is shown in Table 6. The negative values in ΔC_{TREE} are a result of thinning activities before the latest PSP measurements were carried out.

Table 6 Change in tree biomass in teak strata

Forest Reserve	Year	C_{TREE,t_1}	C_{TREE,t_2}	ΔC_{TREE}
Asubima	2008	13 612	13 162	-450
Asubima	2009	42 386	46 738	4 352
Afrensu Brohuma	2010	47 486	56 225	8 739
Afrensu Brohuma	2011	56 918	70 709	13 791
Afrensu Brohuma	2012	40 481	39 858	-623
Tain II	2013	305	27 699	27 394
Tain II	2014	988	62 899	61 910
Tain II	2015	543	19 246	18 703
Tain II	2016	46	786	740

Change in Soil Organic Carbon (ΔSOC)

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

The results are summarized in Table 7. $\Delta SOC_{AL,t}$ represents the fixed amount of annual carbon storage. The calculation can be found in the guiding excel document. Multiplying the number of years and hectares with the $\Delta SOC_{AL,t}$ results in the amount soil organic carbon change within the teak strata.

Table 7 Change in Soil Organic Carbon in teak plantations

Forest Reserve	Year	Years	$\Delta SOC_{AL,t}$ (t CO ₂ e ha ⁻¹ yr ⁻¹)	A (ha)	ΔSOC (t CO ₂ e)
Asubima	2008	1	2,54	148,2	376
Asubima	2009	1	2,54	512,6	1302
Afrensu Brohuma	2010	1	2,54	612,5	1556
Afrensu Brohuma	2011	1	2,54	844,3	2145
Afrensu Brohuma	2012	1	2,54	688,4	1748
Tain II	2013	1	2,54	581,7	1477
Tain II	2014	1	2,54	1886,5	4792
Tain II	2015	1	2,54	1036,6	2633
Tain II	2016	1	2,54	87,4	222

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

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

$$134\,556 (\Delta C_{TREE}) + 16\,251 (\Delta SOC) = 150\,807 \text{ ton CO}_2\text{e} (\Delta C_{P,t})..$$

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

4.2.2.2 Reforestation type II: Indigenous Plantation

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

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

The change in tree biomass is calculated by estimating the biomass in each plant year. The tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" is used to determine tree carbon stock changes. Because shrub biomass is very low, this pool is conservatively excluded. The change in tree biomass is estimated using the following equation:

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

The tree biomass in the first year is the same as the baseline biomass in trees (remnant indigenous trees, remnant teak and invasive trees) at the start of the project activity ($C_{TREE_BSL_1}$). The tree biomass cleared (remnant teak and invasive trees) during land preparation ($C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}$), is deducted from the baseline carbon stock and the increment of the planted indigenous trees (C_{TREE_IND}) added.

$$C_{TREE} = C_{TREE_BSL_1} - C_{TREE_BSL_1,2} - C_{TREE_BSL_1,3} + C_{TREE_IND}$$

Methods for determining $C_{TREE_BSL_1}$ have been discussed in in the PDD. The remnant indigenous trees are a constant figure. As discussed in the baseline, the amount of carbon in this pool is expected to decrease due to anthropogenic factors. These trees are protected in the project area and are therefore expected to grow. However, these trees are conservatively assumed to reach a steady state in year zero and are therefore not monitored for ex post calculation but added as a constant to the total C_{TREE} of the relative stratum. Remnant indigenous trees will not be felled in the project scenario.

$$C_{TREE,t_1} = C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3}$$

Table 8 contains shows the total value of C_{TREE,t_1} for the different indigenous strata.

The total tree biomass in indigenous trees at C_{TREE,t_2} is estimated based on field measurements in Permanent Sample Plots as elaborated in the monitoring plan.

The tree volume is calculated as:

$$V_{TREE,ind} = \pi \times \frac{DBH^2}{2} \times H \times f_{IND}$$

According to the methodological tool the amount of tree biomass is estimation using the following equations:

$$B_{TREE_IND} = f_{IND} \times R_{mix} \quad (\text{Eq. 4 AR-TOOL14 – Appendix 1})$$

The total tree biomass in a sample plot is calculated by summing the biomass of all individual trees measured in each sample plot. Tree biomass per hectare in the sample plots is calculated by dividing the total tree biomass in the sample plot by the size of the plot.

Based on the mean biomass of the plots per stratum, as well as the associated variance, the mean carbon stock in indigenous plantations (C_{TREE}) within the indigenous biomass estimation strata and the associated uncertainty (u_C) are estimated following the methodology as described in the PDD. The summary of change in tree biomass in the indigenous strata is shown in Table 8.

Table 8 Change in tree biomass in indigenous strata

Forest Reserve	Year	C_{TREE,t_1}	C_{TREE,t_2}	ΔC_{TREE}
Afrensu Brohuma	2010	1 709	1 709	0
Afrensu Brohuma	2011	1 616	2 087	470
Afrensu Brohuma	2012	401	401	0
Tain II	2013	10	431	421
Tain II	2014	102	1 819	1 717
Tain II	2015	33	166	133

Since the uncertainty in C_{TREE} is 28,9%, C_{TREE} is made conservative according to the methodological tool by applying an uncertainty discount of 75%. After application of the discount ΔC_{TREE} becomes 1 308 ton CO₂e.

Change in Soil Organic Carbon (ΔSOC)

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

The results are summarized in Table 9. $\Delta SOC_{AL,t}$ represents the fixed amount of annual carbon storage. The calculation can be found in the guiding excel document. Multiplying the number of years and hectares with the $\Delta SOC_{AL,t}$ results in the amount soil organic carbon change within the teak strata.

Table 9 Change in Soil Organic Carbon in indigenous plantations

Forest Reserve	Year	Years	$\Delta SOC_{AL,t}$ (t CO ₂ e ha ⁻¹ yr ⁻¹)	A (ha)	ΔSOC (t CO ₂ e)
Afrensu Brohuma	2010	1	2,54	43,8	111
Afrensu Brohuma	2011	1	2,54	28,5	73
Afrensu Brohuma	2012	1	2,54	80,4	204
Tain II	2013	1	2,54	19,1	48
Tain II	2014	1	2,54	194,7	494
Tain II	2015	1	2,54	63,2	160

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

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

$$1\,308 (\Delta C_{TREE}) + 1\,091 (\Delta SOC) = 2\,399 \text{ ton CO}_2\text{e} (\Delta C_{P,t}).$$

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

4.3 Leakage

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

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

As demonstrated in the PDD leakage is deemed *de minimis*, and therefore set to zero.

4.4 Net GHG Emission Reductions and Removals

GHG credits can now be calculated using the following equation:

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

Since $\Delta C_{\text{BSL},t} = 0$ (paragraph 4.1) and $LK_t = 0$ (paragraph 4.3), $\Delta C_{\text{AR-VCS},t} = \Delta C_{\text{ACTUAL},t}$. $\Delta C_{\text{ACTUAL},t}$ has been established in paragraph 4.2.2. Since $\Delta C_{\text{AR-VCS},t} = \Delta C_{\text{AR-VCS},t_TEAK} + \Delta C_{\text{AR-VCS},t_IND} + \Delta C_{\text{AR-VCS},t_BUFFER} + \Delta C_{\text{AR-VCS},t_GMELINA}$, and because GHG emission removals in the buffer vegetation and Gmelina (because of the age of the plantation) are not included in this monitoring report, $\Delta C_{\text{AR-VCS},t} = \Delta C_{\text{AR-VCS},t_TEAK} + \Delta C_{\text{AR-VCS},t_IND}$.

Therefore, $\Delta C_{\text{AR-VCS},t} = 150\,807 + 2\,399 = 153\,206$ t CO₂e which is the number of generated GHG credits.

As established in the non-permanence risk report (Polinder & Wanders, 2019), the risk rating is 10%. This means that 15 321 GHG credits need to be deposited into the AFOLU pooled buffer account. Therefore, a total number of 137 886 GHG credits are eligible to be issued as VCUs.

Table 10 presents a summary of the results of this monitoring report.

Table 10 Summary of key results

Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)	Buffer credits
0	153 206	0	153 206	15 321

APPENDIX I: CALCULATIONS

The calculations are attached to this report in a separate excel file.

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