

REFORESTATION OF DEGRADED FOREST RESERVES IN GHANA



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LIST OF ABBREVIATIONS

ARR	Afforestation, Reforestation and Revegetation
AFOLU	Agriculture, Forestry and Other Land Uses
ANR	Assisted Natural Regeneration
CDM	Clean Development Mechanism
CFMP	Community Forest Management Project
FC	Forestry Commission
FD	Forestry Department
FR	Forest Reserve
FSC	Forest Stewardship Council
FSD	Forest Services Division
ER	Emission Reduction
GIS	Geographic Information System
GHG	Greenhouse gas
GPDP	Government Plantation Development Program
GPS	Global Positioning System
HIPC	Heavily Indebted Poor Countries (program)
IPCC	Intergovernmental Panel on Climate Change
ILO	International Labour Organisation
IY	Invasive York
LK	Leakage
LTA	Long Term Average
MDF	Mixed Degraded Forest
MTS	Modified Taungya System
NFPDP	National Forest Plantation Development Program
NTFP	Non-Timber Forest Product
PD	Plantations Department
PDD	Project Design Document
PP	Project Proponent
PSP	Permanent Sample Plot
RIL	Reduced Impact Logging
RIT	Remnant Indigenous Trees
RT	Remnant Teak
SEIA	Social and Environmental Impact Assessment
SOC	Soil Organic Carbon
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit
WHO	World Health Organisation

1 PROJECT DETAILS

1.1 Summary Description of the Project

The proposed ARR VCS project aims at reforestation of approximately 20,000 ha in degraded forest reserves in Ghana. Currently, 3214 hectares of both teak and indigenous forest have been realized in Asubima Forest Reserve and Afrensu Brohuma Forest reserve. These two adjacent Forest Reserves in the north of the Ashanti region form the first 2 instances of this grouped project. The project foresees an average expansion of 1000 hectare per year, adding new project areas and instances.

Both Asubima and Afrensu Brohuma Forest Reserve 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 has 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 land lease agreements with traditional land owners 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. It has been certified according to the principles and criteria of the Forest Stewardship Council (FSC) since January 2010. The FSC certificate demonstrates the commitment and adherence of FORM Ghana to the highest sustainability standards of both social and ecological aspects. The VCS carbon project will be 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 version 02.0 for a project period of 40 years.

1.2 Sectoral Scope and Project Type

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

1.3 Project Proponent

Organization name	FORM Ghana Ltd.
Contact person	Mr. Willem Fourie
Title	Managing Director
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Telephone	+233 544 441 440
Email	w.fourie@formghana.org

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.
Contact person	Mr. Andries Polinder, Mr. Tieme Wanders
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Organization name	Sustainable Forestry Investments B.V. (SFI)
Role in the project	Owner and shareholder of FORM Ghana, but has no active role in VCS implementation.
Contact person	Mr. Paul Hol
Title	CEO
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1.5 Project Start Date

01-March-2008

The project start date is the date on which activities that lead to the generation of GHG emission removals are implemented, specifically land preparation and planting.

1.6 Project Crediting Period

Start date: 01 - March – 2008

End date: 01 - March - 2048

Total number of years: 40

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Table 1 Summary of the estimated GHG emission removals

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2008	0
2009	0
2010	0
2011	1 457
2012	7 791
2013	15 772
2014	27 103
2015	41 929
2016	53 878
2017	63 203
2018	71 785
2019	73 309
2020	62 719
2021	46 782
2022	29 896
2023	3 848
2024	3 615
2025	3 412
2026	3 234
2027	3 077
2028	2 936
2029	2 810
2030	2 695
2031	2 481
2032	2 313
2033	2 022
2034	1 943
2035	1 869
2036	1 801
2037	1 737
2038	1 678
2039	1 623
2040	1 572
2041	1 523
2042	1 478
2043	1 435

2044	1 395
2045	1 357
2046	1 321
2047	1 286
2048	1 254
Total estimated ERs	551 338
Total number of crediting years	40
Average annual ERs	13 447

1.8 Description of the Project Activity

GHG emission removals are achieved by establishing tree plantations of exotic and indigenous tree species and by restoring natural forest in riparian buffer zones. Therefore, three reforestation types are identified: teak plantation, indigenous plantation and buffer vegetation as illustrated in Table 2. The different reforestation types are elaborated on below. All these project activities are carried out and monitored according to the CDM consolidated methodology *AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 02.0*. PP aims at an ecologically sustainable plantation with a maximum of 90% of Teak (*Tectona grandis*) and 10% native tree species.

Table 2 Areas of the different reforestation types

Reforestation type	Asubima	Afrensu Brohuma	Area (ha)	Percentage
Teak Plantation (I)	1273,24	1477,30	2750,54	85,6
Indigenous Plantation (II)	43,80	108,97	152,77	4,8
Buffer vegetation (III)	159,28	151,59	310,86	9,7
Total	1476,32	1737,85	3244,31	100,0

1.8.1 Teak Plantation (reforestation type I)

Tectona grandis, commonly known as 'teak', is the principle species planted by Form Ghana in both Asubima Forest Reserve and Afrensu Brohuma Forest Reserve. It is a deciduous hardwood tree that can reach heights up to 40 meters. Its white flowers are small and fragrant, and the leaves have a papery feel with hairs on the bottom. The tree species originates from South-Asia but is currently widespread in plantations all over the world. The main reasons for its success are outlined below.

The wood is both weather-, termite- and pest-resistant because of the natural oils that are contained within its fibers. This makes the wood extremely suitable for outdoor use, such as furniture or boat decks, even without treatment with oils or varnish. The attractive appearance however, makes teak desired for interior use as well. Teak flooring, cutting board and veneer remain popular throughout the world.

In West-Africa the production of teak has also been adopted successfully. In comparison to indigenous as well as other exotic tree species, teak performs best economically (Maldonado & Louppe, 2000), (Dupuy, et al., 1999), (Keogh & Pentsil, 2001), (Behaghel, 1999).

Experience with the silviculture of teak plantations started in the 19th century (Behaghel, 1999) and this longstanding practice has resulted in sound management guidelines and good yield prognoses. This provides a solid technical basis for plantation establishment.

As an exotic tree species in Ghana, teak does not suffer much from diseases, which reduces the risk of plantation failure. Disease risk can be further reduced significantly by careful site selection (Keogh & Pentsil, 2001).

The environmental impact of sustainable teak production is low. It is planted on deep and level soils which are relatively insensitive to erosion, and the teak is not planted in the buffer zones or other ecologically valuable areas. No chemical treatments are required for pest control, because of the low susceptibility of teak to diseases. Therefore, no ecological damage is caused to the environment. Also, the spread of teak outside the plantation can easily be controlled, since dispersal distance of teak seeds is limited. Teak cannot invade areas with dense (high grass) vegetation without human interference because it is a high light demanding species. The presence of buffer strips and fire outbreaks around the plantation inhibits the spread of teak outside plantation boundaries. Most areas surrounding the plantation are in agricultural use for which teak poses no threat.

Teak plantations are managed as even-aged stands with a rotation cycle of 20 year and three (3) intermediate thinnings. This choice is based on economic and silvicultural considerations. Following AFOLU requirement 4.5.5, carbon removals due to harvesting are appropriately accounted for by claiming a maximum amount of sequestered carbon equal to the project's long-term average CO₂ sequestration.

1.8.2 Indigenous plantation (reforestation type II)

In addition to teak, several tree species native to Ghana are planted. These species are introduced to enhance biological diversity of the forest estate, diversify the number of commercial tree species and restore ecological functions of the area. These indigenous tree species are planted mainly, but not exclusively, near buffer zones along rivers, near natural forest remnants and in areas where the soil conditions are not favourable for teak. A list of utilized species is presented in Table 3, which may be expanded later in the project.

Table 3 Indigenous species planted as plantation and in the buffer zones

Scientific name	Local name
<i>Albizia ferruginea</i>	Awiefosamin
<i>Antiaris toxicaria</i>	Kyenkyen
<i>Blighia sapida</i>	Akyi
<i>Ceiba pentandra</i>	Onyina
<i>Cola gigantea</i>	Watapuo
<i>Erythroleum ivorense</i>	Potrodom
<i>Hildegardia barteri</i>	A.Kyewewa
<i>Khaya anthoteca</i>	Mahogany
<i>Mansonia altissima</i>	Mansonia
<i>Nauclea diderrichii</i>	Kusia
<i>Pericopsis elata</i>	Kokrodua
<i>Pteleopsis hylodendron</i>	Kwae-Kane
<i>Rhodognaphalon brevisuspe</i>	Bombax
<i>Terminalia ivorensis</i>	Emeri
<i>Terminalia superba</i>	Ofram
<i>Triplochiton scleroxylon</i>	Wawa

Indigenous plantations are planted with indigenous tree species to form even-aged forest stands. These stands are not managed actively, and no harvesting is done. It is expected that in the longer term these stands will transform in mixed and uneven-aged forest stands with permanent forest cover. To that end natural regeneration is conserved and included in carbon accounting.

This can be included as regeneration is only possible, because fires are kept out of the plantation by PP and remnant indigenous trees are protected in the project area.

1.8.3 Buffer vegetation (reforestation type III)

Riparian areas and forest remnants need protective cover of native vegetation to prevent erosion and pollution of water courses. Forest conservation strips of at least 30m wide are required to separate rivers from productive plantations. Apart from the prevention of erosion, sedimentation and water pollution, the buffer zones are developed to restore and maintain an ecological network of natural forest supporting a wide range of plant and animal species. No harvesting is allowed in the buffer zones, allowing for considerable carbon stock enhancement and maintenance. At the start of the project (baseline situation), the buffer zones are highly degraded and not homogeneous. There are patches of fallow grassland with remaining indigenous trees, agricultural land, and patches of degraded forest. This heterogeneity requires the application of various techniques to achieve the desired forest restoration and CO₂ sequestration. In the areas where virtually no trees are left (grassland and farmland) CO₂ removal is achieved in the same way as for the indigenous tree plantations.

In degraded forest areas with more remaining tree cover, PP prevents further degradation by the prevention of further logging, conversion to agricultural land and wildfires in these areas. Besides these protective measures, assisted natural regeneration (ANR) is applied to increase the speed of forest restoration in these areas. ANR techniques include:

- Liberation of indigenous seedlings and saplings by removing invasive species such as the woody *Broussonetia papyrifera* (York), the herbaceous *Chromolaena odorata* (Akyeampong) and grasses.
- Climber cutting.
- Enrichment planting with indigenous tree species.

1.8.4 Nursery practices and silvicultural practices

The nursery and silvicultural practices explained below apply for both teak and indigenous plantations.

1.8.4.1 Nursery practices and silvicultural practices

The FORM Ghana nursery has as a mission to produce high quality seedlings for the establishment of 1000ha of plantations per year in Ghana. This is realized through:

- A yearly production of 1.500.000 (genetically) high quality teak (*Tectona grandis*) seedlings
- A yearly production of 200.000 seedlings of indigenous species.

Important components of the nursery are:

- Nine hectares for teak stump production
- Shade shed of 1600 m² for indigenous seedling production, capacity of +/- 500.000 plants in polybags
- Water pump station near the pond
- A garage



Figure 1 Nursery of indigenous species

Teak stumps are produced and transported to the plantation. Indigenous seedlings on the other hand are grown in polybags under shade nets. Planting material is selected by high genetic and phenotypical quality to suit the local conditions. Systematic selection during production and before planting will assure the transfer of only the best material to the field.

1.8.4.2 Silvicultural treatments

Silvicultural treatments are executed from the plantation establishment till the final harvest. This paragraph describes general aspects of technical plantation management practises. Detailed technical plantation management procedures are elaborated in specific protocols.

Site preparation

First, the site must be prepared to facilitate planting and create optimal conditions for the seedlings. The area to be planted is cleared to remove weeds. This is mainly done by ploughing, depending on present vegetation. Slashed vegetation is burned. Where necessary, herbicides (Roundup) are sprayed to control weeds. Roundup (glyphosate) is a permitted herbicide by FSC and not hazardous when applied correctly. The intention is to use Roundup just once for soil preparation prior to planting. Employees that apply herbicides receive proper training and equipment to minimise health and environmental risks. Site preparation takes place between January and April. During site preparation damage to remnant indigenous trees is minimized.

Plantation establishment

A uniform planting density of 3x3m is chosen (1111 plants per ha). Planting takes place from April till June. Planting commences in the second half of April when the rainy season has really started, to avoid the risk of drought stress.

Beating up

A few months after planting, a balance is made of the mortality rate of the planted material. If more than 10% of all planted seedlings has not developed or died, the 'gaps' need to be filled in. This is done in the short rainy season in September after initial planting.

Weeding

Due to the degraded state, weed pressure before canopy closure is severe. Weeding is therefore very important to prevent weeds from restraining the performance of the seedlings. Weeding is carried out at least three times per year until canopy closure. The method applied is grass cutting completed with strip or circle weeding. Circle weeding takes place around a planted tree, strip weeding along the planting lines.

Climber cutting

Forest stands are checked every year to determine whether climber cutting is necessary to prevent the planted stock from being smothered by climbers. If this is the case, climber cutting is carried out.

Thinning

Wood distribution between stem and branches can be influenced by thinning and pruning. By timely thinning and pruning the trees can be directed to have optimal height growth and well-formed crowns, with little biomass going into the branches in early life stages. The moment and the intensity of thinning are determined based on available yield tables. Stumps of thinned trees are cut off low to the ground.

Pruning

Pruning is undertaken mainly to clean part of the stem from branches, which leads to higher timber quality. One year after each thinning, the stand is pruned.

Final harvesting

After 20 years, all remaining teak trees are harvested with the final harvesting. During final harvest of teak remnant indigenous trees will not be felled.

1.9 Project Location

Asubima and Afrensu Brohuma Forest Reserves are two adjacent reserves and are situated in the dry, semi-deciduous forest zone at about 100 km north of Kumasi in the Ashanti region in Ghana (Figure 2). It falls under the authority of the Offinso Forest District.

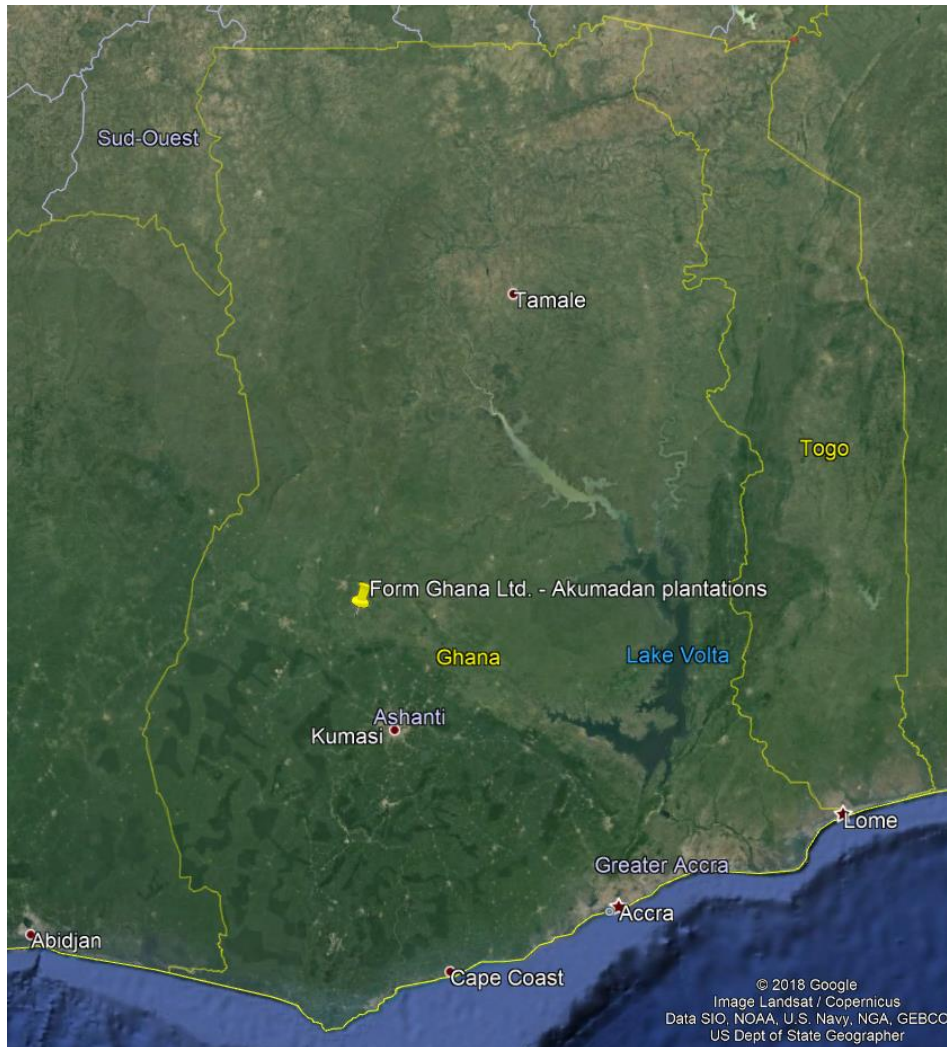


Figure 2 Location of the Form Ghana Akumadan plantations in Asubima and Afrensu Brohuma Forest Reserves

Asubima Forest Reserve and Afrensu Brohuma Forest Reserve are 2 adjacent Forest Reserves near Akumadan. The Form Ghana land leases (Figure 3) cover only a portion of these Forest Reserves. The land leases are located in the south-eastern part of Asubima Forest Reserve, and the north-eastern part of Afrensu Brohuma Forest Reserve.

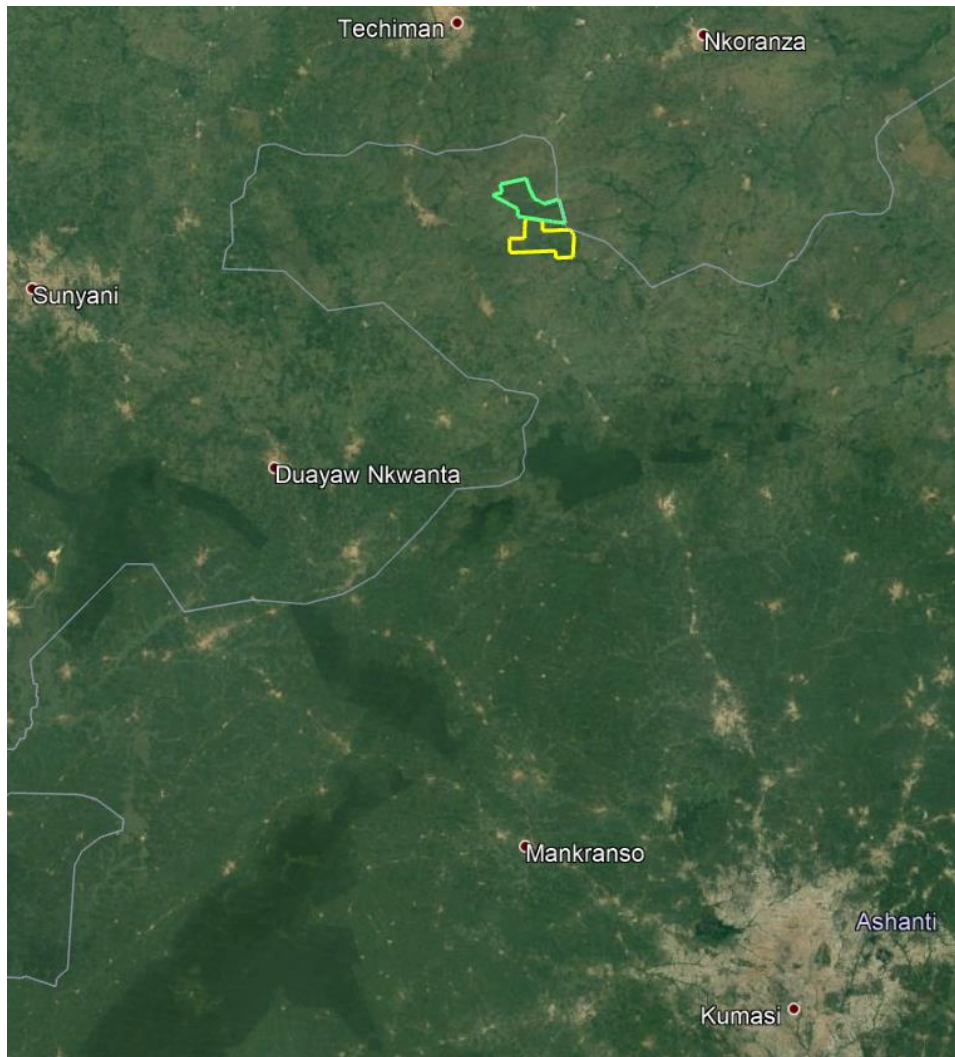


Figure 3 Outline of Form Ghana land leases in Asubima (green) and Afrensu Brohuma (yellow) Forest Reserves

1.10 Conditions Prior to Project Initiation

The project has not been implemented to generate GHG emissions for their subsequent reduction or removal, since the area has been degraded prior to the project start. The conditions prior to project initiation are described below.

Climate

The Asubima and Afrensu Brohuma forest reserves lie at the northern fringes of the semi-deciduous forest ecological zone of Ghana. The zone has a tropical monsoon climate with alternating wet and dry seasons. The long wet season starts around mid-March and ends in mid-July. It is followed by a short dry season until the end of August. From September till the end of October there is a short rainy season, followed by a long dry season from November till mid-March. Temperatures are generally high and uniform throughout the year. Mean annual temperature is about 26°C. February and March are the warmest months. The total average annual rainfall fluctuates around 1100 mm (Wanders & Tanson, 2017).

Soil

The soils in the area have developed in weathered sandstone. As a result, they generally have a sandy loam to sandy clay loam texture. Deeper horizons have a clay loam to clay texture due to illuviation of clay particles. The well-drained soils, the Bediesi series, are dusky red to reddish brown at the surface, and red in deeper horizons. The moderately drained soils, the Sutawa series, are dark brown to brown at the surface to dark brown in deeper horizons. The Pimpimso series are soils which are found in places where sandstone is at or near the surface. These soils are quite shallow and have highly weathered rock or rock fragments within 50 cm from the surface (Asiamah, et al., 2007), (Augustine & Scholten, 2012).

Topography

The topography of the area is undulating. Some rocky outcrops can be found in the forest reserves.

Hydrography

Forest degradation in the forest reserves of Ghana is so extensive that it has affected the existing water bodies. Analyses of samples of the water bodies at the start of the project showed severe reduction of water quality, measured in quality parameters such as pH, turbidity, dissolved oxygen, conductivity and nitrate content. There was also severe reduction of water volume/level due to siltation and evaporation due to slopes near the streams (Abeney, et al., 2008), (Tollenaar, 2012).

Vegetation

The vegetation of the reserve was mostly of the dry semi-deciduous forest type, containing valuable timber trees such as Wawa, Odum, Sapele and Kokrodua. Savannah conditions are observed in large areas of the reserve which are the result from human-induced land degradation. Due to intensive farming and reported annual wild-fires very little of the original forest remains and what is left are vast areas of grasslands, where climbers and weeds are abundant. In the past, farmers protected big trees on their farms, but the majority has been logged so very few remain today (Abeney, et al., 2008).

An inventory, conducted as part of a social and environmental impact assessment (SEIA) carried out for FORM Ghana, demonstrated that there is virtually no stretch of land within the project area covered with natural forest (Abeney, et al., 2008), (Tollenaar, 2012). Like most degraded forest reserves in Ghana, the area has been degraded by several activities such as farming, fire damage, over-exploitation and illegal logging (Abeney, et al., 2008). Without the proposed reforestation project, the area would remain degraded or degrade even further due to illegal farming, bushfires and logging of the last remaining trees. Figure 4 and Figure 5 illustrate the degradation of the project area over time.



Figure 4 Degradation of the project area in Asubima Forest Reserve over the years (source: Google Earth)



Figure 5 Degradation of the project area in Afrensu Brohuma Forest Reserve over the years. Left: 1973, Middle: 1986, Right: 2012. Source: Google Earth and RapidEye (right picture).

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

FORM Ghana adheres to strict compliance with all laws, statutes and regulatory frameworks in Ghana that apply to the company, including international conventions. Compliance with these laws and regulations is i.a. part of the annual FSC internal and external audits. Changes in legislation are registered and the company makes sure that legal compliance is maintained. The original articles entered in the register are kept in the FORM Ghana office as well as legislative texts and conventions. Detail on the individual laws and regulations, and international conventions that are ratified by Ghana, is elaborated in specific protocols (Protocol 1: Follow-up of legislation and international conventions), including a full list of relevant laws and regulations.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

FORM Ghana holds a legal title to the project area in the form of land lease agreements (Forestry Commission, 2008) (Forestry Commission, 2012) with the Government of Ghana and the traditional land owner, accompanied by an official benefit sharing agreement. The lease has a duration of 50 years and is renewable.

1.12.2 Emissions Trading Programs and Other Binding Limits

Not applicable.

1.12.3 Other Forms of Environmental Credit

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

1.12.4 Participation under Other GHG Programs

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

1.12.5 Projects Rejected by Other GHG Programs

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

1.13 Additional Information Relevant to the Project

Eligibility Criteria

This project proposes the reforestation of degraded forest reserves in Ghana, by means of four different types of reforestation, as described in section 1.8 of this PDD. PP aims at approximately 20,000 hectares of sustainable reforestation in Ghana with an average expansion of 1000 hectare per year.

The first two project instances for validation cover an area of 3214 ha of degraded forest and is geographically described in section 1.9 and 2.3 of this PDD. The baseline scenario and demonstration of additionality described in section 2.5 of this document are based on this area,

but future project areas will closely resemble this case. PP will manage the GHG information systems and monitoring of the proposed project in the first project area as well as in future project areas. All future project instances will conform to the following eligibility criteria:

- All new instances shall lie within Ghana
- Project activity shall be on degraded lands (determined with applicable CDM tool).
- Project activity shall not be on organic and/or drained soils.
- Project area shall not be a wetland.
- Litter shall remain on site.
- Ploughing/ripping/scarification as part of the A/R CDM project activity, is:
 - Done in accordance with appropriate soil conservation practices, (e.g. following the land contours); and
 - Limited to the first five years starting from the year of initial site preparation; and
 - Not repeated, if at all, within a time period of 20 years.
- Shall apply one or more of the project activities and reforestation types defined in section 1.8.
- Shall have the baseline scenario as identified in section 2.4.
- Shall be additional following the applicable CDM tool as applied in section 2.5.
- A non-permanence risk buffer assessment shall be performed for each new project area and applied for buffer determination.
- Leakage shall be assessed for each new project area following the applicable CDM tool.
- PP shall have the right of use for each new project area.
- Shall be managed according to the same sustainability principles as described in this PDD.

Leakage Management

Activity shifting leakage might occur as farmers move to an area outside of the project boundary and continue pre-project agricultural activities there. 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 legalised 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.

Commercially Sensitive Information

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

Sustainable Development

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, 2012);
- 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 do not harm the environment. The Agency has eleven (11) regional offices, which are accessible and staffed and equipped to perform its 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 are covered by Environmental Impact Assessments (Abeney, et al., 2008) (Tollenaar, 2012) and certified against 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.

Further Information

Not applicable

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

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

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

- 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)

2.2 Applicability of Methodology

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

- a) *The land subject to the project activity does not fall in wetland category;*
There are no wetlands within the project boundary.
- 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;

The soils of the project area consist predominantly of sandy loams over sandy clay loams and belong to three well-described soil series. Amongst the encountered soil series, no organic soils are present within the project boundary (Asiamah, et al., 2007) (Augustine & Scholten, 2012).

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

The lands of Appendix 1 refer to *cropland in which soil disturbance is restricted*. Farming in the area is characterized as shifting cultivation (Abeney, et al., 2008), which is characterized as cultivation with reduced tillage and limited use of inputs. Therefore, the project area does not classify as land listed in Appendix 1.

The lands of Appendix 2 refer to *grassland in which soil disturbance is restricted*. Grasslands in the project area are not managed as a grassland, but are the result of severe forest degradation, wild fires and shifting cultivation (Hawthorne & Abu-Juam, 1995), (Abeney, et al., 2008). Therefore, the project area does not classify as land listed in Appendix 2.

2.3 Project Boundary

2.3.1 Selected carbon pools and emission sources

The selected carbon pools and emission sources in the project methodology and the justification or explanation for the inclusion or exclusion of different pools are outlined in Table 4.

Table 4 Selection carbon pools and emission sources

Pool/Source		Gas	Included?	Justification/Explanation
Baseline	Above-ground biomass	CO ₂	Yes	Major carbon pool in the baseline and project activity
	Below-ground biomass	CO ₂	Yes	Major carbon pool in the baseline and project activity
	Soil Organic Carbon	CO ₂	No	This is estimated as an annual increase over 20 years according to the applicable tool and therefore only included in the project and not in the baseline.
	Dead Wood	CO ₂	No	Since degraded lands are reforested, dead wood can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool is conservatively neglected.
	Litter	CO ₂	No	Since degraded lands are reforested litter can be expected to increase in the project scenario compared to the baseline scenario. However, this carbon pool is conservatively neglected.
Project	Above-ground biomass	CO ₂	Yes	Major carbon pool in the baseline and project activity
	Below-ground biomass	CO ₂	Yes	Major carbon pool in the baseline and project activity
	Soil Organic Carbon	CO ₂	Yes	Independent research showed a significant increase in this carbon pool due to the project activity (Control Union Certifications, 2009)
	Dead Wood	CO ₂	No	This carbon pool is conservatively neglected.
	Litter	CO ₂	No	This carbon pool is conservatively neglected.
Emission source		Gas	Included?	Justification/Explanation
Project	Burning of woody biomass	CO ₂	No	CO ₂ emissions due to burning of biomass are accounted as a change in carbon stock
		CH ₄	Yes	Fire is used as a management tool for land preparation. Felled woody biomass is partially burned.
		N ₂ O	Yes	Fire is used as a management tool for land preparation. Felled woody biomass is partially burned.

Pool/Source		Gas	Included?	Justification/Explanation
	Leakage	CO ₂	Yes	Increase of GHG emissions due to displacement of pre-project agricultural activities.
	Fossil fuel	CO ₂	No	The use of fossil fuels is not included following VCS AFOLU requirement 4.3.3

2.3.2 Geographic project boundary

The first project instance is the FORM Ghana plantation in Asubima Forest Reserve. The second project instance is the Form Ghana plantation in Afrensu Brohuma Forest Reserve. The map below (Figure 6) shows the boundaries of the project area. In Asubima an established pilot teak plantation (53 ha) in 2001 and a patch of farmer's teak (117 ha) have been excluded from the scope, because they have been established before the project starting date. The same applies some patches of farmer's teak (30 ha) in Afrensu Brohuma.

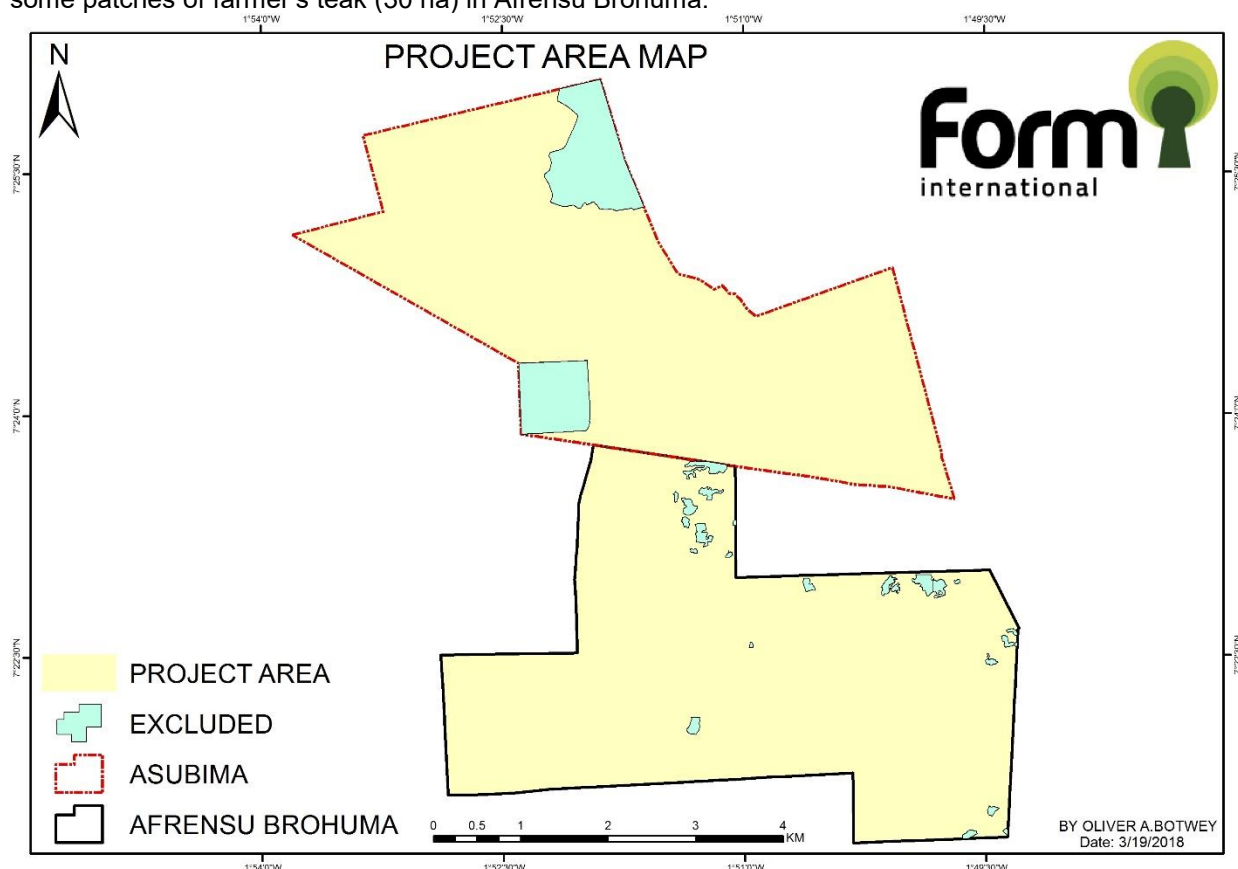


Figure 6 Map of project area

2.4 Baseline Scenario

The selected baseline approach is chosen as:

'Changes in carbon stocks in the pools within the project boundary from the most likely land use at the time the project starts.'

The baseline scenario is land encroachment forming a mosaic of illegal subsistence farming, grassland with scattered trees and patches of remnant forest.

The rationale for this approach and scenario is provided in section 2.5 and the quantification of carbon stocks is further elaborated in section 3.1.1.

2.5 **Additionality**

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

The tool has two *Applicability Conditions*, which are met:

- The proposed project activities do not lead to the violation of any applicable law, see section 1.11.
- The proposed project is not a small-scale project. The expected GHG sequestration is more than 8 kilotons per year and the project is not a low-income community project.

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

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

The project activity started in 2008, which is proven by the land lease agreement signed on the 14th of November 2008 (Forestry Commission, 2008) and the plantation establishment that started in March 2008. This is documented in the annual monitoring reports of FORM Ghana.

From the project start in 2008, the 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 technical, social and environmental benchmarks available, notably by certifying the plantation 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. Therefore, 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 2011 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 from 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. Both Asubima and Afrensu Brohuma Forest Reserves were already considerably degraded in 1995 (Hawthorne & Abu-Juam, 1995), and the figures in chapter 1.10. Despite recently developed regulations, social surveys conducted amongst farmers of the Asubima and Afrensu Brohuma forest reserves 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 reserves (Abeney, et al., 2008), (Tollenaar, 2012).

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 (Abeney, et al., 2008). Today, the herbaceous shrub *Chromolaena odorata* (Akyeampong), the invasive tree *Broussonetia papyrifera* (York) and *Pennisetum purpureum* (Elephant grass) are dominating the forest reserves, fueling wild fires.

Some patches of standing degraded forest remain on soils that are unsuitable for farming or in wet areas, where the wild-fires have little effect. However, almost all commercial timbers species have also been harvested from these forests. Without the activities proposed by the project proponent 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 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 are mostly 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. Labor conditions can be poor, with a lack of safety equipment and training, and employees are often underpaid (personal communication with Mans Vroom).

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 centuries 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 definition of sustainable commercial reforestation: a reforestation activity that commits to the enhancement of environmental, social and economic values in the project area. The project proposed by the PP has committed to the sustainability principles stated in Table 5. FSC certification independently demonstrates compliance with international sustainability standards. Currently, the plantation of PP is the only FSC certified timber plantation in West and Central Africa and FORM strives to certify all future project instances with FSC certification.

Table 5 Sustainability principles as applied to project proposed by PP.

Category	Sustainability principle	Management activity
Environmental	Increase biodiversity on the plantation	- Establishment of wildlife corridor network - Native flora and fauna protection 10% of the trees planted are indigenous species. - Indigenous and rare tree species are protected and planted - Buffer zones are planted with indigenous species - High Conservation Value (HCV) monitoring
	Minimize pollution	The use of pesticides, biodegradable only, is reduced to a minimum
	Erosion control	Erosion channels and respecting buffer zones
	Wild-fire control& Water quality protection	The construction of buffer zones along streams of at least 30m wide
	Reduced Impact Logging (RIL)	- Adequate planning of forestry operations - Best practice forestry operations (e.g. harvesting, road building) - Provision of training to the employees
Social	Maximum safety for employees	- An active fire patrol team and security force are employed for the prevention/control of wildfires and other illegal activities - Purchase of safety equipment - Providing safety training
	High standard working conditions	- Fair wages (above national minimum) - Health insurance provided
	Education	Training provided to the employees
	Empowerment	- A benefit sharing agreement signed with the local communities. - Possibilities to collective bargaining through unions
Economic	High-value species	A viable mix of indigenous and exotic species
	Ensuring optimal growth of the plantation	- Skilled management for: - Weeding - Thinning - Pruning
FSC Certification	Compliance with international sustainability standards	- Annual in- and external audit - Monitoring (plantation, flora/fauna)

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 are illegal. However, this is the prevailing land use practice, as can be observed from interviews with local farmers and satellite images of the area (Abeney, et al., 2008, Figure 4, Figure 5). 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 (PD) of the Forest Services Division (FSD) of the Forestry Commission (FC) 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 mentioned in Table 5, but these are also not enforced. There is no law to be FSC-certified.

Outcome of Sub-Step 1b:

- 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

This step serves to identify barriers and to assess which of the land use scenarios identified in the sub-step 1b are not prevented by these barriers.

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

The project scenario and other land use scenarios face several barriers. The barriers discussed in this section are categorized as follows:

- Social barriers
- Investment barriers
- Institutional barriers
- Technological barriers
- Barriers due to prevailing practice
- Barriers to local ecological conditions

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 have to 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, firefighter 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 have to 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. According to (Odoom, 2002), 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 (Statistics department Bank of Ghana, 2017). In addition, Odoom concludes that the illegal lumbering and timber trade activities cause price distortions in the domestic timber trade market. 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 land owner. 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 evidenced (Forestry Commission, 2008) existing infrastructure often cannot support proposed scenario activities, so roads and bridges will have to be built upon the initiation of project activities. 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 *Pennisetum purpureum* (Elephant grass) 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, which 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 firefighting 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 as follows: they tend to lend priority to the nursing of their food crops as they are 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 wild-fires 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 (Forestry Commission, 2008). 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 fires risks. The plantations are highly susceptible to wild-fires (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 fighting fires (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 reap 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, RIL, and monitoring) to ensure feasible and technically sound management of a sustainable plantation and comply with all requirements for FSC. This can be realized by employing skilled professionals from within and from outside Ghana and constantly training 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 high 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. 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 has to 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

The proposed project area was partially forested since 1989 and the land was not a forest at the project start. This is because the land 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) (see also chapter 1.10). Farmers still inhabit the area, using it for agricultural practices, and the area is frequently burned, which makes it highly improbable for the forest to return by means of natural regeneration.

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. On top, investment, technological and ecological barriers of implementing the activities according to the sustainability principles that PP committed to are added. 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 project proponent commits itself to manage its plantations in a socially, environmentally and economically responsible way according to the principles and criteria of FSC and even exceeding these requirements, as is detailed in table 7. This is a unique concept in Ghana.

The project is the only FSC-certified plantation in West-Africa until 2017 (Forest Stewardship Council, 2017), but the PP has decided to add goals to the general FSC requirements. For example, at least 10% of the planted seedlings are indigenous, as opposed to the 5% required by FSC (Forest Stewardship Council, 2015). 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 are being reintroduced in the area. In recent flora/fauna monitoring, sightings of endangered fauna species have been reported (Manu, 2011).

Social research showed the project proponent is a large provider of work in the area (Abeney, et al., 2008). Whilst setting up the plantation, the project proponent 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.

By adhering to all ILO 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 reduced impact logging (RIL) practices. This extensive educational programme 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 proposed project does not yet exist in Ghana. VCS certification is essential in the pioneering business model to ensure a viable revenue stream to overcome these barriers and to substantially reduce the investment gap. This can pave the road for increased future investors to initiate more reforestation projects in Ghana.

2.6 Methodology Deviations

The applicable methodology at project validation has been replaced by a newer version:

- *CDM consolidated methodology AR-ACM0003: Afforestation and reforestation of lands except wetlands --- Version 02.0*

Also, some tools were replaced by a newer version, specifically:

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

PP applies the updated version of the methodology and corresponding tools, which are considered to be improved versions of the older documents. These deviations do not impact the additionality or appropriateness of the baseline scenario, as the tool for determining additionality and appropriateness of the baseline scenario did not change.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

This chapter described the methodology, calculations and input variables for the quantification of GHG emission reductions and removals.

In case equations used in this chapter correspond to the CDM methodology, the equation number used in the CDM methodology is indicated behind the equation.

3.1 Baseline Emissions

Following the methodology carbon stock changes in dead wood, litter and soil organic carbon are not considered to determine baseline GHG removals by sink. Shrub biomass is neglected as they are hardly present in the area. The baseline net GHG removals are therefore determined as:

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

$$\Delta C_{TREE_BSL,t} = C_{TREE_BSL,t2} - C_{TREE_BSL,t1} \quad (\text{E1. 1 AR-TOOL14})$$

The C_{TREE_BSL} at start of the project activities must be 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.*

Stratum 1 has much lower woody biomass levels than stratum 2, with more remaining native vegetation. Table 6 shows the carbon pools and the mode of biomass calculation of these two baseline carbon stock strata. Calculation methods for the determination of $C_{TREE_BSL,t1}$ for stratum 1 ($C_{TREE_BSL_1}$) and stratum 2 ($C_{TREE_BSL_2}$) are elaborated in the next two sections.

Table 6 Characteristics of two baseline carbon stocks

Baseline carbon stock stratum	Relevant biomass pool	Mode of biomass calculation
$C_{TREE_BSL_1}$	Remnant Indigenous Trees (RIT)	Representative plots to calculate an average per ha
	Remnant Teak (RT)	Representative plots to calculate an average per ha
	Invasive York	Representative plots to calculate an average per ha
$C_{TREE_BSL_2}$	Mixed Degraded Forest (MDF)	Sample plots and satellite images
	Invasive York	Sample plots and satellite images

3.1.1 Baseline carbon stock stratum 1: Carbon stock in living trees at the start of the project activity in degraded grassland

Carbon stocks in this baseline stratum ($C_{TREE_BSL_1}$) are built up from two vegetation categories:

1. Remnant Indigenous Trees (RIT)
2. Remnant Teak (RT) & Invasive York (IY)

These two categories will be discussed separately in the section below, because trees from the first category (RIT) are protected while trees from the second category (RT & IY) are felled in the project scenario.

Remnant Indigenous Trees (RIT) carbon stocks ($C_{TREE_BSL_1,1}$)

The CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” is used to calculate the amount of CO₂ storage in remnant indigenous trees per ha ($C_{TREE_BSL_1,1}$).

The volume of aboveground biomass is calculated as follows:

$$V_{TREE_BSL_1,1} = \pi \times \frac{DBH^2}{4} \times H \times f_{IND}$$

The tree biomass in remnant indigenous trees is then calculated as follows:

$$B_{TREE_BSL_1,1} = V_{TREE_BSL_1,1} \times D_{IND} \times (1 + R_{mix}) \quad (\text{Eq.5 Appendix 1 AR-TOOL14})$$

We do not use BEF in this equation since $V_{TREE_BSL_1,1}$ is already total aboveground volume as described further below. The tree biomass per hectare in Remnant Indigenous Trees is obtained through the following equation:

$$b_{TREE_BSL_1,1} = \frac{B_{TREE_BSL_1,1}}{A} \quad (\text{Eq.1 Appendix 1 AR-TOOL14})$$

Since the amount of CO₂ storage in remnant indigenous trees is calculated per hectare, carbon stock in this baseline stratum is calculated as follows:

$$C_{TREE_BSL_1,1} = \frac{44}{12} \times C F_{IND} \times b_{TREE_BSL_1,1} \quad (\text{Eq. 12 AR-TOOL14})$$

Remnant Teak (RT) & Invasive York (IY) carbon stocks ($C_{TREE_BSL_1,2}$ & $C_{TREE_BSL_1,3}$)

The CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” is used to calculate the amount of CO₂ storage in remnant teak and invasive York per ha.

York is the most common invasive tree in the area, hampering growth of teak and indigenous trees. In the plantation and in the buffer PP policy is to eradicate York.

Some planted and regenerating teak is found in some parts of the project area. These trees are removed during land preparations as they are mostly of poor quality, unknown provenance and widely spaced. To provide a solid estimation of the carbon stocks in this pool, the number of trees felled for land preparation were counted for a significant area, which is assumed to be 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. This is considered a relative conservative sample for both Asubima and Afrensu Brohuma Forest Reserves as the amount of remnant teak was less based on PP management. This is supported by the SEIA, which showed 87% of the land was already being farmed or fallow, and 13% of the area was occupied with taungya or private teak plantation (Abeney, et al., 2008).

Remnant Teak (RT) calculation ($C_{TREE_BSL_1,2}$)

The biomass expansion factor for Teak (BEF_{TEAK}) is derived from specific scientific literature (Kraenzel, et al., 2003). This factor converts stem biomass to total tree biomass and is therefore a combination of BEF and root to shoot ratio R. BEF related to teak calculations in the rest of this PDD are always including R, and R is therefore not used in the equations.

The following equation is used to calculate the carbon stocks in remnant teak:

$$B_{TREE_BSL_1,2} = V_{TREE_BSL_1,2} \times D_{TEAK} \times BEF_{TEAK} \quad (\text{Eq.5 Appendix 1 AR-TOOL14})$$

$$b_{TREE_BSL_1,2} = \frac{B_{TREE_BSL_1,2}}{A} \quad (\text{Eq.1 Appendix 1 AR-TOOL14})$$

$$C_{TREE_BSL_1,2} = \frac{44}{12} \times CF_{TEAK} \times b_{TREE_BSL_1,2} \quad (\text{Eq. 12 AR-TOOL14})$$

Input parameters used to determine $C_{TREE_BSL_1,2}$ have been obtained through the fore mentioned inventory. The age of the trees was conservatively estimated at 5 years, based on expert judgement made by the FORM Ghana Management team. No tree measurement data is available. The evidence and supportive arguments for this age are as follows:

1. The tree size of a 5-year-old teak tree in the yield table is 13.6 cm DBH and dominant height 12.6 meters. These sizes were considered to be upper limits for the felled trees based on observations in the field. Most trees were smaller than these limits.
2. Many of these trees were coppices with multiple stems. All stems (also of the same tree) are separately included. This means that stem size in the ex-ante calculations is overestimated, because the size of multiple stems of five-year-old coppices are smaller than those of single 5-year-old stems, due to competition between individual stems of the coppicing tree.
3. Experience from managing the project area since 2008 shows that in general planted teak trees are cut down illegally before they reach 5 years. The tree sizes are then interesting for illegal loggers and hardly any trees are not harvested this way.

Based on the above arguments, the 5-year age and pertaining tree size are considered to provide a conservative figure, justified by direct and indirect evidence, which will rather underestimate than overestimate the net GHG benefit.

The volume of these trees ($V_{TREE_BSL_1,2}$) as well as the biomass are estimated following class 2 of Dupuy's yield table for teak (Dupuy, et al., 1999). Wood density, BEF and CF were derived from literature (IPCC, 2003), (Kraenzel, et al., 2003).

Invasive York (IY) carbon stocks ($C_{TREE_BSL_1,3}$)

The amount of York felled in 2011 was monitored through sampling in buffer zone plots, which provided the best estimate of York densities and sizes in the area. York trees were not measured outside the buffers.

York density and sizes in the buffer zone plots were 40 trees ha⁻¹ with an average tree height of 6.6 meters and 8.7 cm DBH. York density in the plantation areas was 12 trees ha⁻¹. The size of these trees was smaller than the buffer zone trees, based on field observation. These observations can be substantiated by understanding the land use dynamics in the area: Trees in the buffers are felled less frequently compared to areas outside the buffers, because these other areas were farmed intensively by illegal farmers with only 1 or 2-year fallow period. As can be observed from satellite images of the baseline, all areas have been completely cleared for farming, except some patches of riverine forest. Most of the cleared areas consist of fallow land. Social surveys showed that an average farmer actively farms about 2,5 ha. In total, 54% of the degraded area was farmed actively and 33% was fallow land." During farm preparation, farmers cut down the York (a weed to farmers too). In practice this means that every 1 or 2 years an area is cleared for agriculture and York does not get the time to reach the tree sizes it has in the buffer. York grows slightly faster than teak does but will also need 3 to 4 years to reach the sizes found in the buffer areas. This is longer than the fallow period known in this area. In addition, these areas burned almost entirely each year, also severely damaging or killing the aboveground York biomass. The buffers were affected to a lesser extent by fires due to the higher vegetation cover and higher humidity near the rivers.

Another observation is that York performs better in the buffer areas than outside these areas. In the buffer site conditions are very good for York, with moist and light soils. Away from the buffers, soil moisture declines and there the York is seen mostly in association with better, moister soils. It

is described that York prefers moist and light soil types (Orwa, et al., 2009). This difference in performance between buffer areas and areas outside the buffers was not quantified, but is an expert observation, substantiated by the ecology of the species.

These arguments demonstrate that it is conservative to use the York tree sizes found in the buffer (Baseline carbon stock stratum 2) as a proxy for the York tree sizes in the areas outside the buffer (Baseline carbon stock stratum 1) based on field observations, the baseline land use dynamics (farming and fire) and the ecology of the York tree.

The following equations are used to calculate the carbon stocks in invasive York.

$$B_{TREE_BSL_1,3} = V_{TREE_BSL_1,3} \times D_{YORK} \times (1 + R_{mix}) \quad (\text{Eq.5 Appendix 1 AR-TOOL14})$$

$$b_{TREE_BSL_1,3} = \frac{B_{TREE_BSL_1,3}}{A} \quad (\text{Eq.1 Appendix 1 AR-TOOL14})$$

$$C_{TREE_BSL_1,3} = \frac{44}{12} \times CF_{IND} \times b_{TREE_BSL_1,3} \quad (\text{Eq. 12 AR-TOOL14})$$

3.1.2 Baseline carbon stock stratum 2: Carbon stock in living trees at the start of the project activity in degraded forest

The CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” Carbon stocks in this baseline stratum 2 ($C_{TREE_BSL_2}$) consist of mixed indigenous trees and invasive York in the following two species groups:

1. Mixed degraded forest (MDF)
2. Invasive York (IY)

$C_{TREE_BSL_2} = \sum_j C_{TREE_BSL_2,j}$, which is the sum of the above- and belowground tree carbon stock in species groups j in baseline stratum 2.

It is important to calculate the carbon stock of the two species groups separately, because trees from the first category (MDF) are protected while trees from the second category (IY) are felled in the project scenario.

Mixed Degraded Forest ($C_{TREE_BSL_2,1}$)

To determine the carbon stocks of the mixed degraded forest at the start of the project activity in baseline carbon stock stratum 2, sample plots are laid out in this stratum. Tree height (H), tree diameter at breast height (DBH) and tree species are recorded, among other parameters. Over sixty different tree species were identified. An average form factor (f_{IND}) was selected for tropical broadleaf species (Cannell, 1984). 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 so that:

$$V_{TREE_BSL_2,1} = \frac{\pi \times \frac{DBH^2}{2} \times H \times f_{IND}}{A}$$

The form factor used to in the volume calculation above converts stem biomass to total aboveground biomass and therefore only R_{mix} is used in the equation below.

$$B_{TREE_BSL_2,1} = V_{TREE_BSL_2,1} \times D_{IND} \times (1 + R_{mix}) \quad (\text{Eq.5 Appendix 1 AR-TOOL14})$$

$$b_{TREE_BSL_2,1} = \frac{B_{TREE_BSL_2,1}}{A} \quad (\text{Eq.1 Appendix 1 AR-TOOL14})$$

$$C_{TREE_BSL_2,1} = \frac{44}{12} \times CF_{IND} \times b_{TREE_BSL_2,1} \quad (\text{Eq. 12 AR-TOOL14})$$

The precision of the baseline carbon stock is estimated following equation of the CDM tool.

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

If u_c is greater than 10%, $C_{TREE_BSL_2,1}$ is made conservative by applying uncertainty discount according to the procedure provided in Appendix 2 of the CDM tool. At the time of verification, the uncertainty is calculated again, and a confidence deduction will be applied according to this methodology in case the uncertainty is higher than allowed. This is adopted as the most conservative way to deal with variance in the mixed degraded forests.

Invasive York ($C_{TREE_BSL_2,2}$)

Part of the mixed degraded forest is invasive York. Tree carbon stocks for York are determined through the same sample plots as described above for $C_{TREE_BSL_2,1}$, but instead of including all tree species, carbon stock is determined only for York since these trees are felled as part of assisted natural regeneration. BEF is not relevant since volume is already aboveground volume. The volume calculation of $V_{TREE_BSL_2,2}$ is the same as for $V_{TREE_BSL_1,1}$.

The following equations are used to calculate the carbon stocks in invasive York:

$$B_{TREE_BSL_2,1} = V_{TREE_BSL_2,2} \times D_{YORK} \times (1 + R_{mix}) \quad (\text{Eq.5 Appendix 1 AR-TOOL14})$$

$$b_{TREE_BSL_2,2} = \frac{B_{TREE_BSL_2,2}}{A} \quad (\text{Eq.1 Appendix 1 AR-TOOL14})$$

$$C_{TREE_BSL_2,2} = \frac{44}{12} \times CF_{IND} \times b_{TREE_BSL_2,2} \quad (\text{Eq. 12 AR-TOOL14})$$

3.1.3 Baseline carbon stock changes in above and below ground tree biomass

Baseline carbon stocks are not assumed to be in steady state since tree biomass is increasingly reduced due to cutting of trees and use of fire.

According to paragraph 6.4 of the methodological tool “*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*” the change in biomass may be conservatively estimated as zero where the following conditions have been met in a stratum:

- No harvest has occurred in the stratum since the previous verification;*
In baseline stratum 1, indigenous trees are protected and excluded from further estimation of project net GHG removals by sinks. This procedure is part of the management plan and respected in the field. In ex post calculations the indigenous trees growth in the baseline are excluded and not claimed for carbon credits. Remnant teak and invasive York in baseline stratum 1 are removed by PP. In baseline stratum 2 indigenous vegetation is also allowed to remain. Here, only invasive York and climbers are cut as part of assisted natural regeneration.
- The stratum was not affected by any disturbance (e.g. pest, fire) that would decrease the carbon stock in trees;*
There is no evidence through monitoring (Wanders & Tanson, 2017) that the remaining indigenous trees in both stratum 1 and stratum 2 were affected by disturbances that would decrease carbon stock in trees. No pests were identified in the indigenous trees and no fires resulted in damage to the remaining trees.

- c) *Remote sensing data or inventory data, including participatory inventory or participatory photo-mapping data, demonstrate that tree crown cover in the stratum has not decreased since the previous verification.*

Remote sensing data showed that crown cover of the remaining indigenous trees in baseline stratum 1 has not decreased. The original locations of the sampled trees in the baseline study were identified and are verified again through remote sensing (Google Earth historical images) and the indigenous trees could easily be identified.

Since all the three conditions are met in both baseline strata, according to the methodological tool the change in carbon stock in trees in these strata may be conservatively estimated as zero. 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, $\Delta C_{BSL,t} = 0$.

3.2 Project Emissions

3.2.1 Stratification

Reforestation typology

PP applies different ARR techniques to achieve GHG emission removals. This is shown in Figure 7 and Table 7.

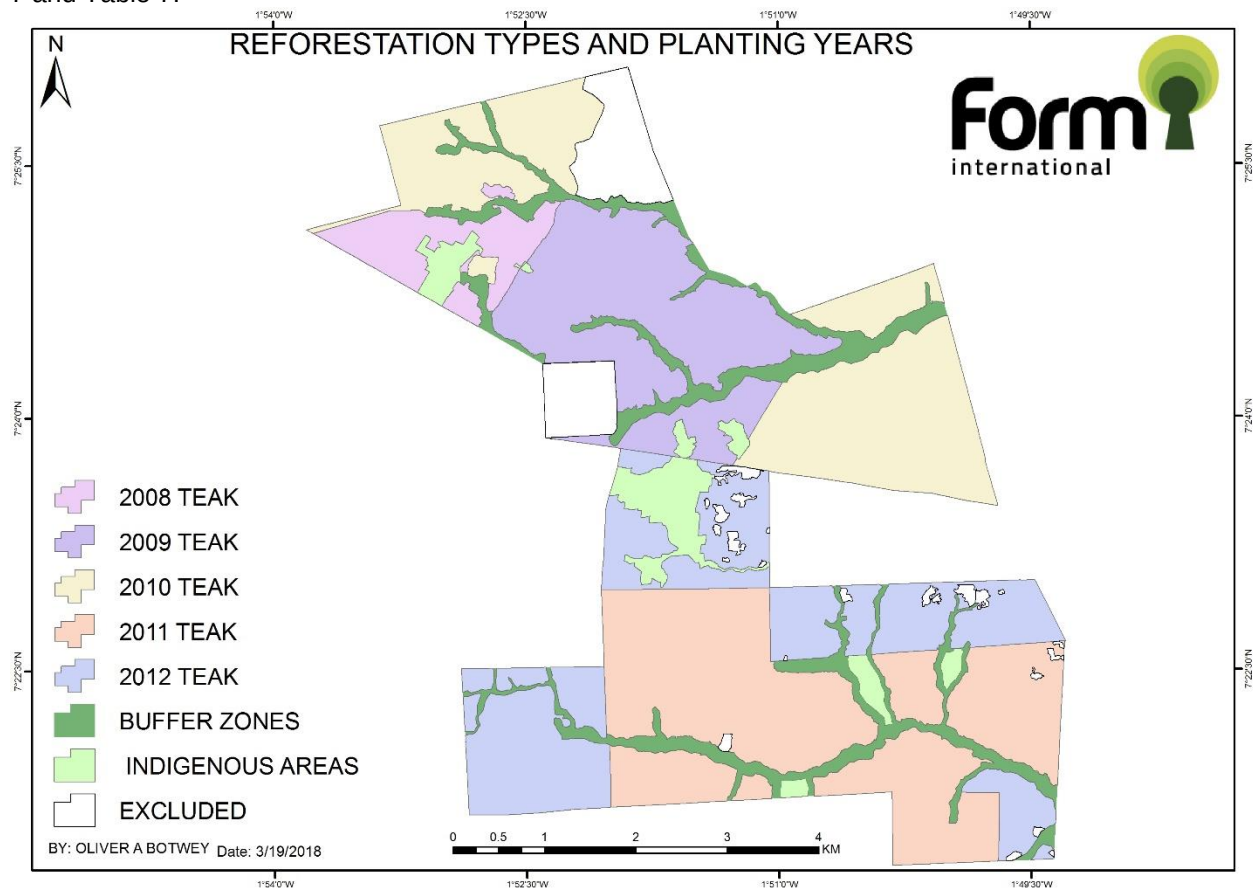


Figure 7 Reforestation types and area stratification

The selected carbon pools mentioned in section 2.3 are applied in all reforestation types. However, different ex ante calculations for carbon storage apply since there is difference in the management of certain areas. There are three identified types:

Table 7 Management of the different reforestation types

Reforestation Type	Baseline scenario	Clear felling	Selective harvesting	Thinning Pruning (management)	Planting	ANR
Teak Plantation (I)	1	Yes	No	Yes	Yes	No
Indigenous Tree Plantation (II)	1	No	No	No	Yes	Yes
Buffer vegetation (III)	2	No	No	No	Yes	Yes

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

As the project expands gradually for all the different reforestation types, the project is further stratified by planting year as shown in Table 8.

Table 8 Stratification

Forest Reserve	Year	Teak Plantation (I)	Indigenous Tree Plantation (II)	Buffer vegetation (III)
Asubima	2008	148,16		
Asubima	2009	512,57		
Asubima	2010	612,51	43,80	159,28
Afrensu Brohuma	2011	837,63	28,54	104,21
Afrensu Brohuma	2012	639,67	80,42	47,38
Total		2750,54	152,77	310,86

3.2.2 Actual net GHG removals by sinks

As described above, 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. As described in Table 7 above clear felling is done in the teak plantation, but no felling is done in the indigenous plantations and buffer zones. 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 therefore calculated as:

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

Table 9 Explanation of symbols used for GHG emission removal per reforestation type

Parameter	Unit	Description
$\Delta C_{AR-VCS,t}$	t CO ₂ -e	Net anthropogenic removals by sink (ΔC_{AR-CMD} from the CDM methodology Equation 5)
$\Delta C_{AR-VCS,t_TEAK}$	t CO ₂ -e	Teak plantation emission removals
$\Delta C_{AR-VCS,t_IND}$	t CO ₂ -e	Indigenous plantation emission removals
$\Delta C_{AR-VCS,t_BUFFER}$	t CO ₂ -e	Buffer zone emission removals

In the following sections, the actual net carbon emissions and removals per hectare are explained per carbon pool and per reforestation type. Some of the emissions and removals of the selected carbon pools are calculated differently for different reforestation types and some are calculated in the same way for different reforestation types. For example, the calculations for C_{TREE} are different for teak and indigenous forest areas, because different species have different growth, while the change in e.g. soil organic carbon is assumed the same for teak and indigenous plantation. How different and same calculation methods are applied is further elaborated in the following sections.

3.2.2.1 Reforestation type I: Teak Plantation

Every year the plantation expands, and additional teak is planted. The grouped project aims at planting 800 hectares teak per year. The plantation started in the most western corner of the original project area in 2008.

Since rotational harvesting will be done following AFOLU requirement, a long term average calculation is carried out over two rotation periods. The long-term average should include at least one rotation period, which is for teak 20 years. The LTA is therefore calculated over 40 years. Since the growth of teak varies among the plant years, the long-term average is calculated per plant year. All teak plantation strata can only generate VCU until the long-term average is reached. This long-term average is calculated following AFOLU requirement 4.5.5. Following this equation, the long-term average is reached in year 11 after planting.

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

Table 10 Parameters to calculate long-term average in Teak

Parameter	Unit	Description
LA	t CO ₂ -e	Long-term average GHG benefit
PE_t	t CO ₂ -e	The GHG emission reductions and removals generated in the project scenario calculated over all relevant carbon pools.
BE_t	t CO ₂ -e	The GHG emission reductions and removals projected for the baseline scenario
n	t CO ₂ -e	Total number of years in the established time period (40 years)

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

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

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

Increase in non-CO₂ emissions ($GHG_{E,t}$)

It must be noted that PP as a means of site preparation, clears existing herbaceous vegetation and invasive woody vegetation is cut and burned. This woody vegetation is mainly remnant teak and invasive York. Indigenous trees are protected by PP and are left standing, which is quantified according chapter 3.1.

Following the CDM methodology and the “tool for non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (v04.0.0)” under $GHG_{E,t}$ only the

non-CO₂ gases N₂O and NH₄ need to be quantified. CO₂ emissions due to biomass clearing and burning are accounted for under ΔC_{TREE_PROJ} .

GHG emission is specified as resulting from forest fires and burning of biomass within the project boundary so that:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t}$$

As this is the first planting cycle, fire is not used to clear the land of harvest residue prior to replanting and forest is not existent in this stratum. Only the emission of non-CO₂ GHGs resulting from use of fire in site preparation ($GHG_{SPF,t}$) is relevant because fire is used in site preparation.

However, the tool states that where “slash-and-burn is a common practice in the baseline and fire has been used in the area at least once during the period of ten years preceding the start of the A/R CDM project activity: $GHG_{SPF,t} = 0$.”

Fire due to anthropogenic and natural causes is common in the area (Hall & Swaine, 1976), (Swaine, 1992), (Hawthorne & Abu-Juam, 1995), (Abeney, et al., 2008). Each year farmers use slash and burn techniques to clear their land and each year dozens of fires have to be prevented from entering the plantations. The outcome of the above analysis is that $GHG_{E,t}$ due to site preparation can be neglected and accounted as zero. Therefore:

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

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

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t} + \Delta SOC_{AL,t} \quad (\text{Eq. 3 AR-ACM0003})$$

The relevant carbons pools are:

- Above and belowground tree biomass
- Soil organic carbon

Shrubs, litter and dead wood are conservatively excluded.

$$\text{Therefore, } \Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta SOC_{AL,t}$$

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 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 and the associated uncertainty are estimated using the following equations:

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

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

The tree biomass in the first year is the same as the baseline biomass in trees (remnant indigenous trees, remnant teak and invasive York) at the start of the project activity ($C_{TREE_BSL_1}$). The tree biomass cleared (remnant teak and invasive York) during land preparation

$(C_{TREE_BSL_1,2} + C_{TREE_BSL_1,3})$, will be 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 section 3.1. The remnant indigenous trees are a constant figure of 8,9 t CO₂ ha⁻¹ for Asubima and Afrensu Brohuma FR. 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.

To determine the total above- and belowground biomass of teak trees, volume increments are calculated based on growth data for teak plantations provided by PP. These are modelled by Form international per planting year, and continuously improved based on available data. In 2001, a pilot plantation of 64 hectares has been established in the project area. This plantation and its growth and performance serve as a model for the ex-ante volume increments of the rest of the plantation.

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

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

The BEF-value, which is based on peer reviewed scientific literature (Kraenzel, et al., 2003), includes roots, and therefore the proportion of the total biomass that accounts for trunk biomass (65.28%) provides for a BEF-value of 1.53 that includes R_{TEAK} .

The total tree biomass in a sample plot is calculated by summing the biomass of all individual trees measured in each sample plot.

$$B_{TREE,teak,p,i} = \sum_i B_{TREE,teak,j,p,i} \quad (\text{Eq. 3 AR-TOOL14} - \text{Appendix 1})$$

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 800 m². Tree biomass per hectare in the sample plots is calculated by:

$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}} \quad (\text{Eq. 1 AR-TOOL14} - \text{Appendix 1})$$

The mean tree biomass and the associated variance are estimated as follows:

$$b_{TREE,i} = \frac{\sum_{p=1}^{n_i} b_{TREE,p,i}}{n_i} \quad (\text{Eq. 16 AR-TOOL14})$$

$$S_i^2 = \frac{n_i \times \sum_{p=1}^{n_i} b_{TREE,p,i}^2 - \left(\sum_{p=1}^{n_i} b_{TREE,p,i} \right)^2}{n_i \times (n_i - 1)} \quad (\text{Eq. 17 AR-TOOL14})$$

The mean carbon stock in teak within the teak biomass estimation strata and the associated uncertainty are estimated following the four equations below:

$$b_{TREE} = \sum_{i=1}^M w_i \times b_{TREE,i} \quad (\text{Eq. 14 AR-TOOL14})$$

$$B_{TREE} = A \times b_{TREE} \quad (\text{Eq. 13 AR-TOOL14})$$

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

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

Soil Organic Carbon (ΔSOC)

In 2009, an independent auditor (Control Union Certifications, 2009) determined through soil samples that the soil organic carbon stock in the 64-ha pilot plantation increased from 10.1 (t C ha⁻¹) to 18.7 (t C ha⁻¹) in 8 years (1.07 t ha⁻¹ year⁻¹). Because of this considerable increase this carbon pool is included as $\Delta SOC_{AL,t}$.

CDM Tool: "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" is used to determine $\Delta SOC_{AL,t}$.

Step 1: For the purposes of this tool, the areas of land shall be stratified:

ΔSOC is relevant for reforestation types I and II (baseline stratum 1) since these are degraded areas. Where forest patches exist ΔSOC is conservatively neglected. The whole area has been cultivated and consisted of either fallow land, agriculture or taungya system (agriculture with teak) at the project start. No national inventory data is available for the amount of carbon that is stored in the soils. Therefore, the default figures from the tool are used to estimate the yearly increase in soil carbon. For the sake of simplicity, the whole area is considered as one stratum. When a choice must be made between two values, due to heterogeneity in the project area, the most conservative figure is chosen from the tables in the tool. It is assumed in the tool that SOC reaches a steady state after 20 years.

The following equations from the tool are used to estimate the yearly change in SOC.

Step 2: Initial SOC stock shall be estimated as follows:

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

Step 3: For each stratum of the areas of land which is subjected to ploughing/ripping/scarification attributable to project activity within the first five years from the year of initial site preparation and for which the total area disturbed is greater than 10% of the area of the stratum, the following carbon loss shall be accounted:

$$SOC_{LOSS,i} = SOC_{INITIAL,i} * 0,1 \quad (\text{Eq. 2 CDM-TOOL})$$

Over 10% of the area is ploughed and therefore SOC loss is accounted for.

Step 4: The rate of change in SOC stock in project scenario until the steady state in SOC content is reached (assumed in 20 years from the time of the initial site preparation) is estimated as:

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20 \text{ years}} \quad (\text{Eq. 6 CDM-TOOL})$$

SOC_{REF} is chosen following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). The project area is classified as tropical moist deciduous forest according to these guidelines. However, Hall and Swaine classify the area as dry semi-deciduous forest, and therefore we choose conservative values between dry and moist deciduous forest (Hall & Swaine,

1976). The soil texture is generally sandy loam to sandy clay loam. All the soils are classified as low activity clay.

f_{LU} is conservatively chosen as an average of short term cultivation 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) and land degradation.

f_{MG} is chosen as 'reduced tillage' as farming in the baseline is characterized by low intensity and reduced soil disturbance.

f_{IN} is considered to be low since residues are removed via collection and the land is burned afterwards.

ΔSOC_t is calculated per stratum for the first 20 years after plantation establishment. After that it is presumed SOC stock reaches steady state.

Leakage

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

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

As can be observed from satellite imagery (Figure 4, Figure 5) the area surrounding the forest reserves, which is expected to receive any displaced activity, had the same characteristics as the area within the reserves at the start of the project. Subsistence farming and wild fires were still present within and outside the project area until the start of project activities (Tollenaar, 2012). Even at the time of the current reporting the area outside the plantation is wholly subject to annual burning. Because of these conditions, it is also very unlikely that the displacement would result in leakage emissions.

Following the methodological tool "Estimation of the increase in GHG emission attributable to displacement of pre-project agricultural activities in A/R CDM project activity", displacement of an agricultural activity by itself does not result in leakage emission. Leakage emission occurs only when the displacement leads to an increase in GHG emissions relative to the GHG emissions attributable to the activity as it exists within the project boundary. Therefore, leakage is considered to be insignificant.

VCUs teak

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

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

3.2.2.2 Reforestation type II: Indigenous plantation

ΔC_{ACTUAL} for indigenous plantations is determined analogously with ΔC_{ACTUAL} for teak strata, and therefore only relevant differences will be discussed below.

Indigenous trees are planted in areas not suitable for teak, to conserve protected species such as the Kokrodua (*Pericopsis elata*) to increase biodiversity on the plantation. Planting has started in 2008 on small areas (less than 20 hectares). Since mortality rate was high all the areas were replanted in 2009 and 2010 and merged to one stratum.

Indigenous trees are planted in mixed stands but depending on site specifications and availability of species some areas may be planted with a single species also. These stands gradually develop to natural forest areas without further silvicultural management.

Table 11 Indigenous species planted

Scientific name	Local name
<i>Triplochiton scleroxylon</i>	Wawa
<i>Terminalia superba</i>	Ofram
<i>Terminalia ivorensis</i>	Emeri
<i>Mansonia altissima</i>	Mansonia
<i>Khaya anthoteca</i>	Mahogany
<i>Nauclea diderrichii</i>	Kusia
<i>Cola gigantean</i>	Watapuo
<i>Ceiba pentrandra</i>	Onyina
<i>Albizia ferruginea</i>	Awimfosamin
<i>Hildegardia barteri</i>	A.Kyewewa
<i>Pericopsis elata</i>	Kokrodua
<i>Pteleopsis hylodendron</i>	Kwae-Kane
<i>Antiaris toxicaria</i>	Kyenkyen
<i>Rhodognaphalon brevisuspe</i>	Bombax
<i>Erythroleum ivorense</i>	Potrodom
<i>Blighia sapida</i>	Akyi

The estimated emissions and removals in the indigenous plantation are calculated similar to the teak plantation. Carbon removals through clearing from the baseline ($C_{TREE_BSL_1}$), soil organic carbon (ΔSOC), GHG emissions (GHG_E) and leakage (LK) are the same as for the teak plantation. Therefore, only carbon removals by indigenous tree biomass (C_{TREE_IND}) will be discussed below.

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

Yield tables of the planted indigenous tree species are rare, of poor quality or non-existent so we therefore base the ex-ante calculation on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). Although the area is defined as tropical moist deciduous forest according to these guidelines, we assume that the climate is between this definition and the definition stated by Hall and Swaine (1976) for dry semi-deciduous forest (Hall & Swaine, 1976); so between tropical dry and tropical moist forest. This ensures a more conservative estimation of biomass growth in the project area.

Mean annual biomass increments are expressed as tons dry matter (DW) (Table 12). PP ex ante calculations are based on these figures and local literature. IPCC assumes faster growth the first 20 years and after that reduction, however local data of species planted by PP indicates a higher growth of $\pm 8 \text{ m}^3 \text{ year}^{-1}$ for 40 years (Lawson, 1994). The ex-ante growth curve is therefore assumed to be conservative (Table 12 and Figure 8).

Table 12 Mean annual increment adapted from IPCC Guidelines (IPCC, 2006)

MAI class	MAI (Ton DW Aboveground)
<30 year	4 per year
>30 year	1 per year
Max. DW	160

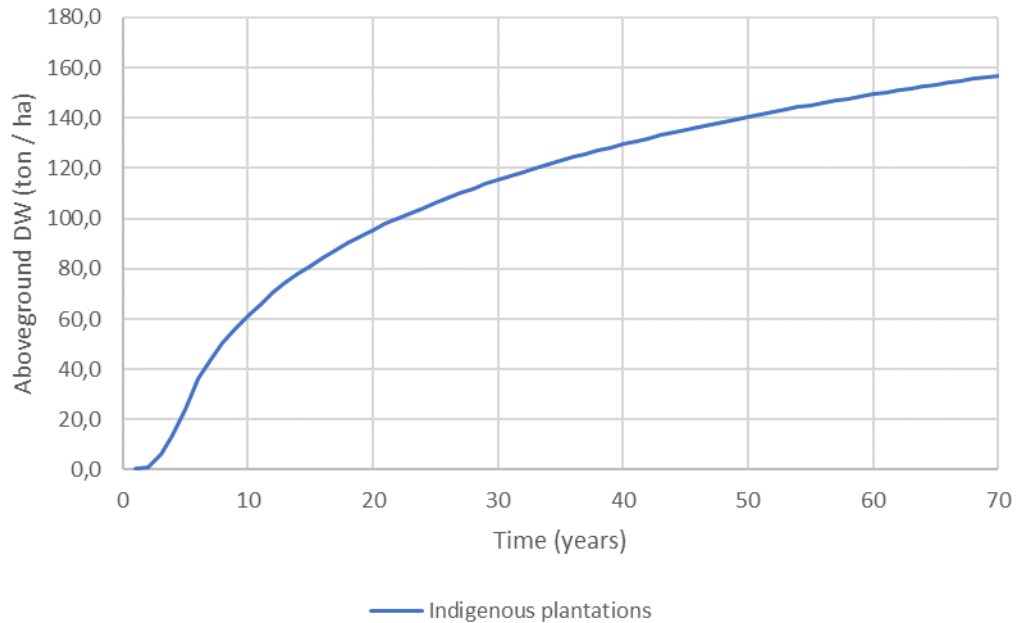


Figure 8 Biomass growth curve of the indigenous plantation based on logistic regression analysis and literature (IPCC, 2006)

Carbon fraction and root to shoot ratio (R_{mix}) were also derived from IPCC (IPCC, 2006). R_{mix} is conservatively chosen for moist deciduous forest as these values are lower than for tropical dry forest. For biomass increment an average value was chosen for forest $>125 \text{ ton DW ha}^{-1}$ aboveground and $<125 \text{ ton DW ha}^{-1}$ aboveground, since this forest will change gradually from lower than 125 ton ha^{-1} to more than that. The form factor is derived from Dawkins in (Cannell, 1984). This form factor converts DBH/height to total aboveground biomass.

VCUs planted indigenous

VCUs per year can now be calculated for one hectare of indigenous plantation.

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

3.2.2.3 Reforestation type III: Buffer vegetation

ΔC_{ACTUAL} for buffer zones is determined analogously with ΔC_{ACTUAL} for indigenous plantations, but for this reforestation type ΔC_{TREE} is calculated differently and leakage does not apply.

Estimating change in carbon stock in tree biomass (ΔC_{TREE})

What is notably different is that baseline stratum 2 applies (see section 3.1.2) with the following equation:

$$\Delta C_{TREE} = C_{TREE_BSL_2} - C_{TREE_BSL_2,2} + \Delta C_{TREE_BUFFER}$$

Methods for determining $C_{TREE_BSL_2}$ (total carbon in baseline stratum 2) and $C_{TREE_BSL_2,2}$ (York clearing) are given in section 3.1.2.

It should be noted that not all buffer zones consist of degraded forest as some parts of the buffer zones were completely deforested before start of the project activities. However, as the buffer gradually becomes a consolidated unit where a distinction between remnant forest and newly

planted forest cannot be made anymore, it is considered to be conservative to apply the baseline stratum 2 to the full buffer zone area.

Forest growth in the forest buffer is assumed to resemble the growth curve of the indigenous plantation, since the management scheme is the same and the vegetation type is highly similar. Because the initial carbon stock is higher for the forest buffer, the actual growth to estimate C_{TREE_BUFFER} is lower than the one used to determine C_{TREE_IND} .

Assuming a logistic growth curve based on the data in Table 12, Figure 9 shows the expected biomass increase in the buffer zone and the indigenous plantation. Note that the buffer zones follow the same growth curve as the indigenous plantation. The initial biomass in the buffer zone was determined, and it was assumed that the buffer zone follow the same curve as the indigenous plantation, starting from the baseline stratum 2 level explained in chapter 3.1. The maximum biomass stock will be reached earlier in degraded forests than in the indigenous plantations.

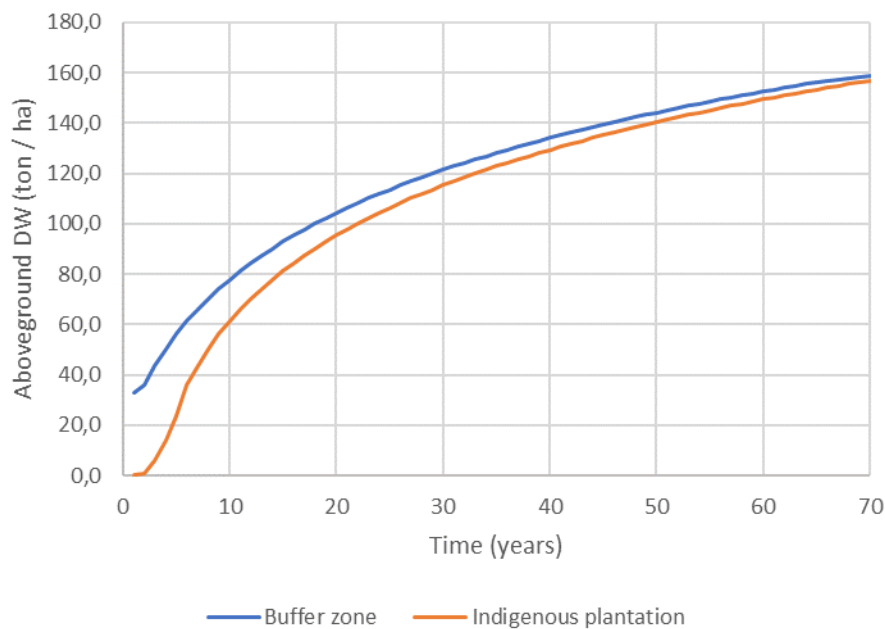


Figure 9 Biomass growth curve of the vegetation in the buffer zones and the indigenous plantation.

Increase in non-CO₂ emissions ($GHG_{E,t}$)

There is no fire used in site preparation in the degraded buffer zones. Only invasive York is felled, and this is further quantified in C_{TREE_BUFFER} calculations.

Leakage

In the degraded forest buffer leakage is zero, since no agricultural activities existed here. In the buffer zones that are fully planted leakage is the same as for the other reforestation types and therefore considered not significant.

VCUs degraded buffer

VCUs can now be calculated for one hectare of the buffer zone.

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

3.3 Leakage

According to the VCS AFOLU requirements, leakage should be included in the long term average calculation. The leakage determination methodology is therefore already elaborated in the teak plantation stratum section (3.2.2.1). Leakage is considered to be insignificant, which is the same for the teak plantation, the indigenous plantation and the planted buffer zone. The total project leakage is set to zero as it is considered to be insignificant, which is shown in the GHG emission reductions and removal summary (Table 13).

3.4 Net GHG Emission Reductions and Removals

Table 13 Net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	1 457	0	1 457
4	0	7 791	0	7 791
5	0	15 772	0	15 772
6	0	27 103	0	27 103
7	0	41 929	0	41 929
8	0	53 878	0	53 878
9	0	63 203	0	63 203
10	0	71 785	0	71 785
11	0	73 309	0	73 309
12	0	62 719	0	62 719
13	0	46 782	0	46 782
14	0	29 896	0	29 896
15	0	3 848	0	3 848
16	0	3 615	0	3 615
17	0	3 412	0	3 412
18	0	3 234	0	3 234
19	0	3 077	0	3 077
20	0	2 936	0	2 936
21	0	2 810	0	2 810

22	0	2 695	0	2 695
23	0	2 481	0	2 481
24	0	2 313	0	2 313
25	0	2 022	0	2 022
26	0	1 943	0	1 943
27	0	1 869	0	1 869
28	0	1 801	0	1 801
29	0	1 737	0	1 737
30	0	1 678	0	1 678
31	0	1 623	0	1 623
32	0	1 572	0	1 572
33	0	1 523	0	1 523
34	0	1 478	0	1 478
35	0	1 435	0	1 435
36	0	1 395	0	1 395
37	0	1 357	0	1 357
38	0	1 321	0	1 321
39	0	1 286	0	1 286
40	0	1 254	0	1 254
Total	0	551 338	0	551 338

4 MONITORING

4.1 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 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 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 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 Data	• Calculation of project emissions • Calculation of baseline 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 measurement methods and procedures applied	Peer reviewed publication
Purpose of 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 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 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 measurement methods and procedures applied	Literature
Purpose of Data	Calculation of baseline 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 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 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 Data	Calculation of project emissions
Comments	

Data / Parameter	$f_{IN,i}$
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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 Data	Calculation of project emissions
Comments	

4.2 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
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	Depending on age between 0,66 and 0,34
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 formula $-0,0996 \ln(\text{“age”}) + 0,6613$ is used to determine the form factor per teak plant year.
Comments	

Data / Parameter	$A_{PLOT,i}$
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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 this 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 this 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 this 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	

4.3 Monitoring Plan

4.3.1 Description of the Monitoring Plan

Forest health is monitored in all forest types: teak plantations, 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 plantation PSPs

Teak plantations are stratified according to plant year and PSPs are laid out randomly per teak stratum, based on an allocation procedure carried out in GIS. The cumulative PSP area is at least 1% of the Teak 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. PSPs have a fixed area of 800 m². At the 1% sampling density there is 1 PSP for every 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 at an age of 3 years, 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 at an age of 3 years, because 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

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

4.3.2 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.

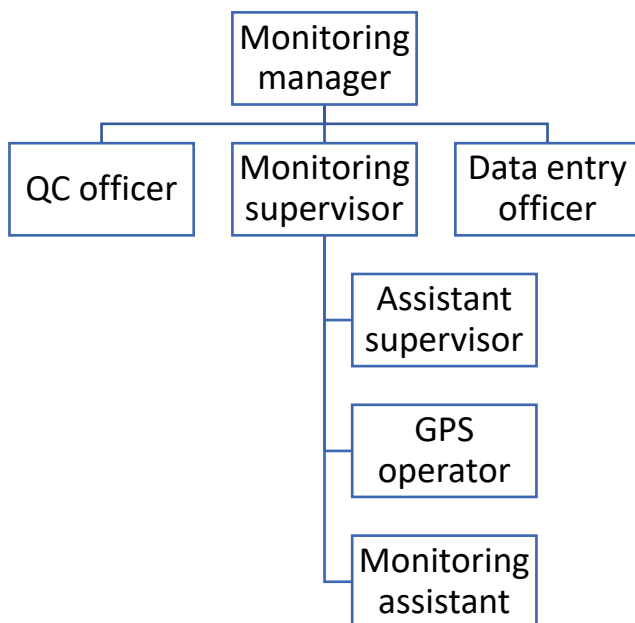


Figure 10 Overview monitoring staff

Table 14 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 - Erection of poles and numbered tags of new PSPs at the correct GPS position. - Assisting in plot measurements	- Correct operation of the GPS - Safe keeping of the GPS - Taking correct 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

4.3.3 Methods for recording, storing and aggregating data on parameter

Field measurements procedure

Annually, PSPs are assessed using the following procedure:

- The basic shape of a PSP is a circular plot with a pole in the centre.
- GPS coordinates as received from the GIS system determine the site location.
- At the plot centre a metal pole is placed
- An aluminium tag with the plot number punched into it is attached to the pole.
- The PSP size is 800m².
- Lay out the plot by measuring the plot radius with a measuring tape to eight directions and positioning temporary and visible pegs at the plot boundaries. The plot radius to attain 800m² is 15.96m.
- 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.

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 trees

- Qualifying trees are teak trees that have been planted, teak wildlings and teak coppice.
- 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 calliper.

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

4.3.4 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 (IPPC, 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 5 % of the permanent sample plots are re-measured plots and 5% of the data that is entered in a spreadsheet is re-entered. 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.

5 SAFEGUARDS

5.1 No Net Harm

Form Ghana's Akumadan plantations are certified according to FSC's 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 11.

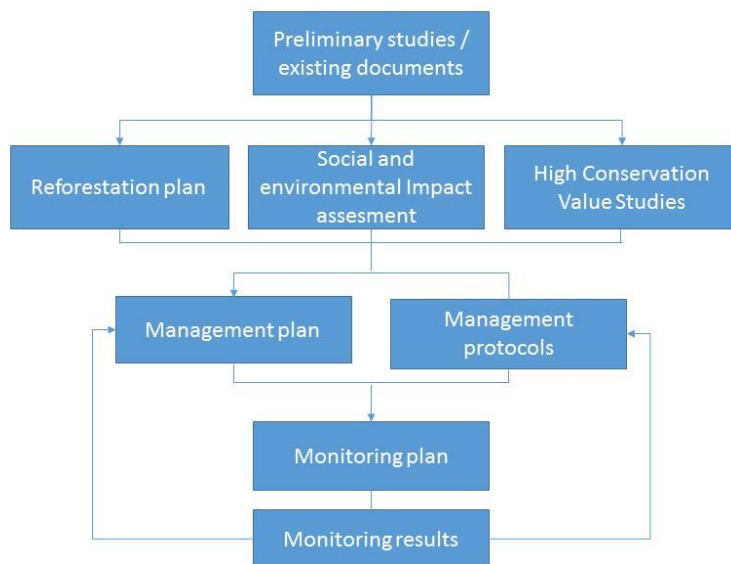


Figure 11 Relation between the various documents

The environmental and social management of Form Ghana addresses the recommendations and mitigation measures proposed in the impact assessments of Asubima (Abeney, et al., 2008) and Afrenso Brohuma (Tollenaar, 2012) Forest Reserves.

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. In 2015-2016 the company developed a Resettlement Action Plan for the farmers that run out of terrain to cultivate. The farmers were invited to join the company's activities in Tain II Tributaries Forest Reserve.

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.

5.2 Environmental Impact

A social and environmental impact assessment (SEIA) was conducted in 2007 before the start of the project and included an environmental survey. This showed that the area was severely degraded and water quality was below standard. In this study it was also predicted that the reforestation activities would have a positive influence on soil quality, water quality and biodiversity (Abeney, et al., 2008).

Further, the SEIA did not foresee any environmental and social negative impacts by implementation of project activity following AFOLU requirement 3.1.5. The project is FSC-certified demonstrating environmental and social benefits beyond GHG emissions removals.

Conservation and restoration of buffer zones, elimination of logging, forest conversion and the abandonment of fire and poaching has resulted in an increase of wildlife presence, water quality, and soil quality. Flora and fauna is monitored regularly (Ogoe, 2011). Rare and threatened tree species, such as the Kokrodua, are raised in the nursery and planted in the buffer zones. The water quality survey in 2011 showed that all values are now within WHO limits. This is a significant improvement compared to water analyses from 2007 showing that water quality was poor (Abeney, et al., 2008).

5.3 Local Stakeholder Consultation

A stakeholders committee consisting of traditional landowners, farmers, environmental NGOs, the Forestry Commission and FORM Ghana has been set up in 2009. The committee holds meetings three times a year 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 (Abeney, et al., 2008).

In 2010 and 2011 more than 100 intercropping agreements were signed between farmers and PP. 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

- *P 06 Information policy personnel and local population*
This document describes how personnel and the local population are informed on Form Ghana activities, and how stakeholders can engage with Form Ghana. This is a process that has been underway since 2009 and putting dates here would fetch a bit far.
- *P 07 Grievance and Redress*
This document describes how grievances are dealt with and how grievances are redressed.
- *Stakeholder engagement plan*
This plan identifies the stakeholders of Form Ghana and describes how stakeholders are engaged.
- *Resettlement Action Plan*
This document describes the resettlement activities that Form Ghana undertakes for people that need as a consequence of Form Ghana activities.
- *Community Development Plan*
This plan describes the community development activities that Form Ghana undertakes.

5.4 Public Comments

The public comment period was not included in the VCS program at project validation. Also, no comments were received regarding the VCS project. All stakeholder comments are recorded according to the stakeholder consultation protocols.

APPENDIX I: CALCULATIONS

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

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