

MONITORING REPORT *REFORESTATION OF DEGRADED FOREST RESERVES IN GHANA*



MONITORING REPORT

Project Title	Reforestation of degraded Forest Reserves in Ghana
Version	1.0
Report ID	-
Date of Issue	14-January-2013
Project ID	-
Monitoring Period	01-03-2008 until 01-08-2012
Prepared By	Form international: Rik Sools, Remi de Wilde
Contact	Bevrijdingsweg 3, 8051 EN, Hattem, The Netherlands Tel: +31 (0)38 444 89 90 r.sools@forminternational.nl ; r.dewilde@forminternational.nl www.forminternational.nl

Table of Contents

1	<i>Project Details</i>	3
1.1	Summary Description of Project	3
1.2	Sectoral Scope and Project Type.....	3
1.3	Project Proponent.....	3
1.4	Other Entities Involved in the Project	4
1.5	Project Start Date	4
1.6	Project Crediting Period.....	4
1.7	Project Location.....	5
1.8	Title and Reference of Methodology	5
2	<i>Implementation Status</i>	5
2.1	Implementation Status of the Project Activity	5
2.2	Deviations from the Monitoring Plan.....	9
2.3	Grouped Project	9
3	<i>Data and Parameters</i>	10
3.1	Data and Parameters Available at Validation	10
3.2	Data and Parameters Monitored.....	17
3.3	Description of the Monitoring Plan.....	19
3.3.1	Organizational structure, responsibilities and competencies	20
3.3.2	Methods for recording storing and aggregating data on parameter	21
3.3.3	Quality control.....	22
4	<i>Quantification of GHG Emission Reductions and Removals</i>	23
4.1	Baseline Emissions	23
4.2	Project Emissions.....	24
4.2.1	Stratification	24
4.2.2	Actual net GHG removals by sinks.....	26
4.3	Leakage	33
4.4	Summary of GHG Emission Reductions and Removals.....	33
5	<i>Additional Information</i>	34
6	<i>References</i>	34

1 PROJECT DETAILS

1.1 Summary Description of Project

The proposed ARR VCS project aims at reforestation of 15,000 ha in degraded forest reserves in Ghana. Currently, 1,506 hectares in the Asubima Forest Reserve in the north of the Ashanti region are realized, forming the first project instance of this grouped project. The project foresees an average expansion of 1000 hectares per year, adding new project areas and instances. An additional 1800 hectares are already planted in Afrensu Brohume Forest Reserve lying adjacent to Asubima. Only, Asubima Forest Reserve will be validated now.

The Asubima forest reserve used to be a productive reserve covered with high, semi-deciduous forest. However, the reserve has 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 a land lease agreement 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-ACM0001 version 05.2.0* 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

Proponent: FORM Ghana Ltd.
P.O. Box 8597 .
Ahensan Estate, Kumasi, Ghana

Contact: Managing Director: Mr. Willem Fourie
Tel: +233544 441440
E-mail: 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

Project development: FORM International B.V.
Bevrijdingsweg 3, 8051 EN, Hattem, The Netherlands

Contact: Mr. Rik Sools and Mr. Remi de Wilde
Tel: +31 (0)38 444 89 90
E-mail: r.sools@forminternational.nl; r.dewilde@forminternational.nl

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. In table 3 below the different roles of the monitoring staff are elaborated. The monitoring manager and quality control officer are part of Form international staff, while the rest of the team is part of the FORM Ghana staff.

Sustainable Forestry Investments B.V. (SFI)
Owner and shareholder of FORM Ghana, but has no active role in VCS implementation.
Contact: Mr. Paul Hol
Tel: +31 (0)38 444 89 90
E-mail: info@forminternational.nl

1.5 Project Start Date

01- March -2008

1.6 Project Crediting Period

Start date: 01- March -2008
End date: 01- March - 2048

Total number of years: 40

1.7 Project Location

The Asubima Forest Reserve is situated in the dry, semi-deciduous forest zone at about 100 km north of Kumasi in the Ashanti region in Ghana (figure 1). It falls under the authority of the Offinso Forest District.

The project location is in the south-eastern corner of the Asubima forest reserve.

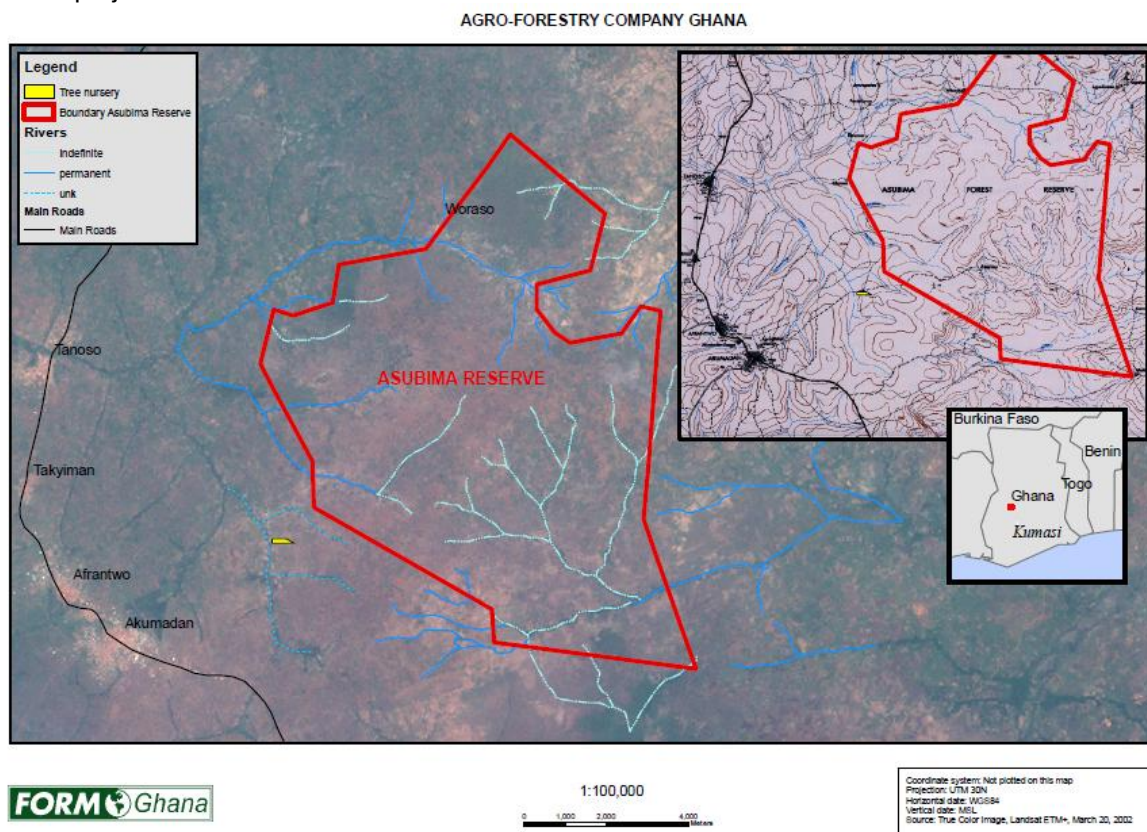


Figure 1: Area of Asubima forest reserve. The project area lies in the south eastern corner of the reserve.

1.8 Title and Reference of Methodology

The CDM consolidated methodology “Afforestation and Reforestation of Degraded Land” AR-ACM0001 version 05.2.0 is applied.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

1290 hectares of teak and 216 hectares of indigenous plantation and buffer restoration are realized in Asubima Forest Reserve since the project start in March 2008.

A pilot plantation of 64 hectares planted in 2001 and a patch of illegally planted farmer’s teak situated in Asubima Forest Reserve are also under PP’s management. These are, however, outside the scope of this audit, see table 1 below.

In 2011 and 2012 planting has started in Afrensu Brohuma Forest Reserve just south of Asubima Forest Reserve. A total area of 1783 is either planted with teak or indigenous species or managed as buffer zone are restoration following the same mangement principles as described in the PD.

In total, an area of 3468 hectares of reforestation is currently under FORM Ghana management.

Management of the planted areas is done according to the management plan and teak also according to the yield tables. Until now no thinning has been done yet (except the 2001 area outside the VCS scope), but is planned for the 2008 plantation after the 2012 growth season. Pruning is done yearly in the 2008 and 2009 planted areas. Weeding of grasses is done to reduce weed pressure on tree growth.

Table 1 Implementation of project activity

Forest Reserve	Stratum	Hectares	Validation	Verification
Asubima	Teak 2008 and 2009	606,3	Yes	Yes
Asubima	Teak 2010 & 2009 burned area	683,7	Yes	No
Asubima	Indigenous plantation 2008-2010	43,1	Yes	No
Asubima	Planted and Degraded buffer zone (2008-2010)	215,6	Yes	No
Asubima	Pilot teak plantation and bufferzone	63,9	No	No
Asubima	Illegally planted farmers Teak	116	No	No
Afrensu Brohuma	Teak 2011& 2012	1515,8	No	No
Afrensu Brohuma	Bufferzones & indigenous plantation	256,9	No	No

This grouped project is currently undergoing its first combined validation and verification audit. GHG emission removals of two strata, 2008 and 2009 teak plantation are quantified in this monitoring report. See figure 2 and table 5 below for the layout of the different strata. A description of the monitoring activities and events that effect GHG emission removals is given below.

Monitoring

Monitoring was done according to the monitoring plan described in section 3.3 between February and April 2012. One percent of the project area was sampled using plots of 800m²..

The margin of error as calculated in equation 9 of the A/R tool *“estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”* was 24% which is higher than the prescribed precision requirements stated in section 2.2 of CDM AR-ACM-0001 (v 05.2.0) 10 %. Therefore, additional sample plots were installed so that the margin of error would be conform the precision requirement. Almost three times (2,7% sampling density) as many plots were required when following the tool *“calculation of the number of sample plots for measurements within A/R CDM project activities”* (v 02.1.0).

The additional sample plots were measured in June and July 2012. The mean biomass increased, which is expected as the growth season starts in March. The relative margin of error did become smaller, but is still higher than prescribed in the methodology.

To avoid further increasing of the cost for the monitoring, an uncertainty deduction is applied so that only a conservative estimate of the mean biomass is claimed. This is further elaborated in section 4.2

Updating of strata

In the last fire season (Nov 2011-Feb 2012) a fire that started outside the project area burned through the buffer zone into the 2009 teak plantation. The fire was contained by project proponent (PP) but unfortunately 42.5 hectares burned of which 41 hectares in the 2009 teak plantation and 1,5 hectare in the buffer zone. The burned areas are shown in the figure 2 below. The survival rate of the teak is estimated at 80-90%, but most of the aboveground biomass was burned and coppices are growing at the base of the tree. Additional measures are taken to prevent repetition next fire season.

Following the CDM tool *“estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (version 0.4.0.0)”* non CO₂ emissions shall be accounted for if the accumulated area affected in a given year is more than 5% of the project area. 42,5 hectares is 3% of the project area (1506 hectares) and non CO₂ emissions are therefore not accounted for. Note that for ensuring a conservative approach the burned areas are removed from the 2009 teak stratum and monitored as a separate stratum. The one hectare burned in the buffer zone is less than one percent of that stratum and is therefore not separately managed or monitored.

During the monitoring it was discovered that the boundary between the 2008 and 2009 teak strata was not correctly drawn. This boundary was remade in GIS software. The sizes of the updated strata are shown in the table below.

Table 2: Update of stratification

Stratum	PDD (ha)	Updated size (ha)
Teak 2008	133,8	141,9
Teak 2009	513,5	464,4
Teak 2009 burned 2012	did not exist	41,0

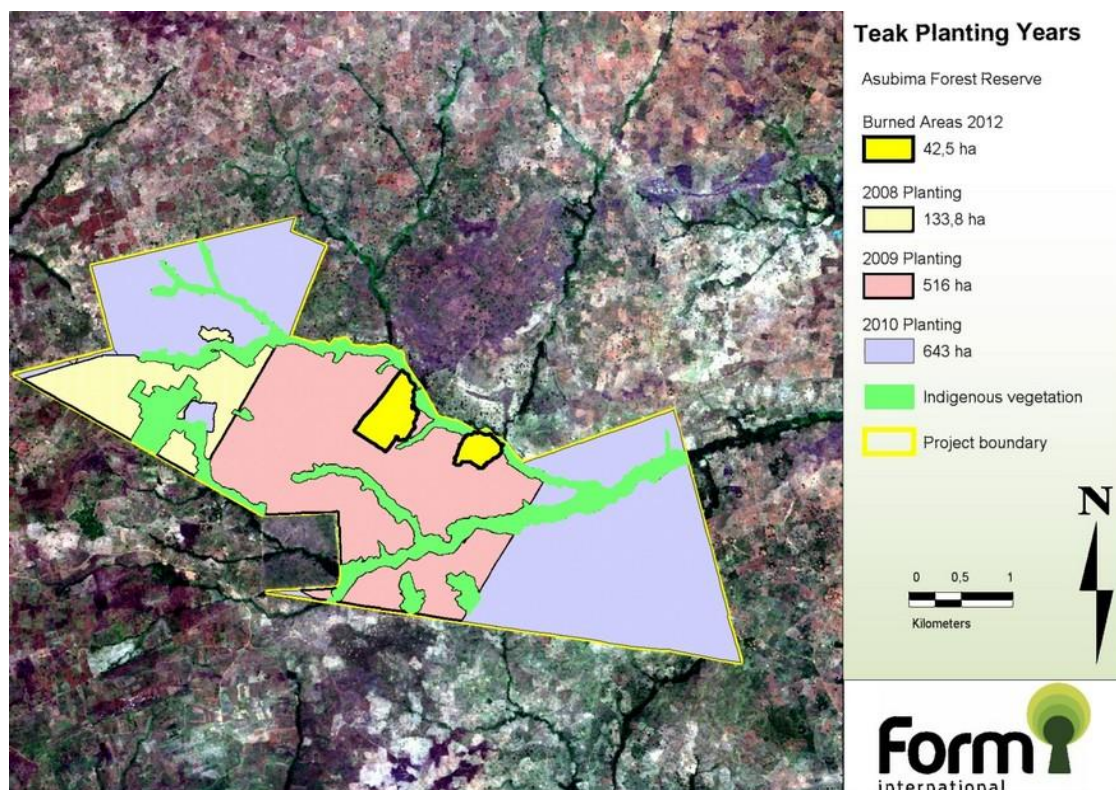


Figure 2: Teak planting years. The areas that got burned in 2012 are indicated in yellow. The light yellow and purple areas (2008 and 2009 plantations) are verified now.

Monitoring of leakage and non permanence risk factors.

Activity shifting leakage occurs 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 legalized access to land and can benefit from prepared soils and plant permitted crops around the planted trees. Intercropping is possible until canopy closure. Since the PP plants new areas every year, intercroppers can also rotate together with the planting years. Leakage can unfortunately not be completely avoided and is further quantified in section 4.3 of this report. The amount of intercroppers, number of people employed by PP is monitored and reported yearly. Stakeholder meetings and yearly social evaluation ensures monitoring of the effect that PP has on the people living in or near the project area (1).

The main non-permanence risk factors as elaborated in the non-permanence risk report are:

- Financial viability
- Project longevity
- Natural risks such as fire, pests and extreme weather

Financial viability is ensured until 2015 and the project has secured 15% to 40% of funding needed to cover the total cash out before the project reached break even. SFI and FORM International have an excellent track record regarding the attraction of investors and donor

funding and serious discussions with various interested investors are currently underway for follow-up funding. Callable financial resources are committed by SFI in case additional investors are not found after 2015.

The project has a legal requirement to replant after harvesting following the plantation lease for 50 years. FSC certification shows commitment by PP for long term sustainability of the project through replanting after harvesting.

FORM Ghana has a very intensive fire management protocol to combat fires and has ample experience combating fires. The frequency of fires is registered by PP. Through the PSP system pests and diseases are monitored and various strategies are employed by PP to control pests and diseases ((2) section 10.3).

The occurrence of heavy winds combined with heavy rainfall may damage especially young trees or recently thinned stands. Less than 5% of the carbon stock could be affected. This is not separately monitored, but any loss in biomass will be accounted for through the PSP monitoring system.

2.2 Deviations from the Monitoring Plan

A sampling density of 1% is foreseen in the monitoring plan. However, in 2012 additional monitoring was done (2, 7% sampling density) to reduce the variance in the data. Since, the variance did not reduce it is not foreseen that monitoring in the next year will be done at a sampling density of 2, 7%. Therefore, no changes are made in the monitoring plan; see section 4.3 of this report

2.3 Grouped Project

The proposed project is a grouped project. The instances that are subject to verification now are described in the project design document. This section is therefore not relevant in the current verification.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data Unit / Parameter:	Mean annual increment teak (ΔV_{teak})
Data unit:	m ³ /yr/ha
Description:	The expected average growth for teak of the stem volume.
Source of data:	Pilot plantation and literature (3)
Value applied:	14.2
Justification of choice of data or description of measurement methods and procedures applied:	Yield tables for teak in Ivory coast were established for different growth classes. Based on these tables site class was determined for the 64 hectare pilot plantation. The pilot plantation serves as a model for the rest of the plantation.
Any comment:	

Data Unit / Parameter:	Teak wood density (D_{teak})
Data unit:	kg/m ³
Description:	The density for teak to determine dry weight
Source of data:	(4)
Value applied:	660
Justification of choice of data or description of measurement methods and procedures applied:	Peer reviewed publication
Any comment:	

Data Unit / Parameter:	Carbon fraction Teak (CF_{teak})
Data unit:	-
Description:	Fraction of carbon in dried teak
Source of data:	(5)
Value applied:	0.5
Justification of choice of data or description of measurement methods and procedures applied:	Peer reviewed publication

Any comment:	
--------------	--

Data Unit / Parameter:	Form factor teak (ffteak)
Data unit:	-
Description:	Factor to convert cylinder measured from DBH and height to trunk volume
Source of data:	Calculated from pilot plantation and yield tables.
Value applied:	0.36 for trees <8 years old 0.40 for trees >8 years old
Justification of choice of data or description of measurement methods and procedures applied:	From yield tables (3) and will be updated regularly when possible.
Any comment:	

Data Unit / Parameter:	Biomass expansion factor teak (BEFteak)
Data unit:	-
Description:	This is BEF and R in one. Converts trunk biomass to total above and belowground tree biomass.
Source of data:	(5)
Value applied:	1.54
Justification of choice of data or description of measurement methods and procedures applied:	Peer reviewed publication
Any comment:	

Data Unit / Parameter:	Mean annual aboveground biomass increment Indigenous plantation (ΔB_{ind})
Data unit:	ton d.m./year/ha
Description:	Expected annual growth of aboveground biomass of indigenous plantation
Source of data:	IPCC guidelines for national greenhouse gas inventories 2006 (6)

	(7)
Value applied:	<30 years= 4 ton d.m./yr/ha >30 years= 1 ton d.m./yr/ha
Justification of choice of data or description of measurement methods and procedures applied:	Value is based on IPCC Guidelines 2006, 4.9 moist/dry semi-deciduous forest and published literature on selected tree species PP plants. IPCC assumes faster growth the first 20 years and after that reduction of growth. PP chose a modified growth scenario because local data of species planted by PP indicates a growth of +- 5 m3/year of more than 50 years (7) (8) which is 250m3 in 50 years. To be conservative, PP chose a faster growth over thirty years (instead of 50) and after 30 years a reduction in growth per year. This resulted in a total +- 280 m3 total above ground biomass, however includes branches and crown.
Any comment:	

Data Unit / Parameter:	Total biomass indigenous forest (Bind)
Data unit:	ton d.m. /ha
Description:	This is the maximum expected value for indigenous forest plantation.
Source of data:	IPCC guidelines for national greenhouse gas inventories 2006 (9) (6)
Value applied:	160
Justification of choice of data or description of measurement methods and procedures applied:	Value between default value of moist/dry tropical forest. Is considered conservative since literature showed values up till 356.6 t DW / ha in representative forests in Ghana.
Any comment:	

Data Unit / Parameter:	Average wood density for Indigenous forest (Dind)
Data unit:	kg/m3
Description:	This is a calculated parameter of the average wood density.
Source of data:	(10) (11) (4) (12)

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 calculated DW in the degraded forests.
Any comment:	

Data Unit / Parameter:	Carbon fraction indigenous trees (CFind)
Data unit:	-
Description:	Amount of carbon in dry matter
Source of data:	IPCC guidelines for national greenhouse gas inventories 2006, 4.3
Value applied:	0.49
Justification of choice of data or description of measurement methods and procedures applied:	Default value from IPCC
Any comment:	

Data Unit / Parameter:	Root to Shoot ration (Rj)
Data unit:	-
Description:	The weight of the roots divided by the weight of the shoot
Source of data:	IPCC guidelines for national greenhouse gas inventories 2006 table 4.4
Value applied:	0.21
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 aboveground and <125 ton dw/ha aboveground, since forest will change gradually from lower than 125 ton/ha to more than that in the project period.
Any comment:	

Data Unit / Parameter:	Form factor indigenous trees (ffind)
Data unit:	-
Description:	This converts dbh/height cylinder into total aboveground tree volume.
Source of data:	Dawkins in Cannel 1984, Woody biomass in forest stands. (11)
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
Any comment:	

Data Unit / Parameter:	SOCref
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)
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)
Any comment:	

Data Unit / Parameter:	flu
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)
Value applied:	0.82
Justification of choice of data or description of measurement methods and procedures applied:	Flu is chosen as an 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).

Any comment:	
--------------	--

Data Unit / Parameter:	fmg
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)
Value applied:	0.7
Justification of choice of data or description of measurement methods and procedures applied:	F_{MG} is chosen as severely degraded. The area previously consisted of forest.
Any comment:	

Data Unit / Parameter:	fin
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)
Value applied:	0.935
Justification of choice of data or description of measurement methods and procedures applied:	F_{IN} s considered to be low since residues are removed via collection and the land is burned afterwards.
Any comment:	

Data Unit / Parameter:	Dt
Data unit:	
Description:	Fraction of the area prone to leakage
Source of data:	SEIA, Abeney et al., 2008 (7)
Value applied:	0.87
Justification of choice of data or description of measurement methods and procedures applied:	Independent social and environmental impact assessment showed that this percentage of area is being farmed.
Any comment:	

Data Unit / Parameter:	f
Data unit:	-
Description:	fraction of forest cover in Ghana
Source of data:	FAO, state of the world's forests (13)
Value applied:	0.22
Justification of choice of data or description of measurement methods and procedures applied:	Peer reviewed literature. The value for Ghana has been chosen since no reliable data could be found for the forest cover in the Offinso district.
Any comment:	

Data Unit / Parameter:	York wood density (Dyork)
Data unit:	kg/m3
Description:	the wood density of <i>Broussonetia papyrifera</i>
Source of data:	(12)
Value applied:	506
Justification of choice of data or description of measurement methods and procedures applied:	Literature.
Any comment:	

3.2 Data and Parameters Monitored

Data Unit / 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:	Yearly
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.

Data Unit / 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:	Yearly
Value applied:	Depending on age, between 0 and 45 cm
Monitoring equipment:	Calliper 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.

Data Unit / Parameter:	Ap,i
Data unit:	ha
Description:	Total area of sample plots
Source of data:	PP field monitoring
Description of measurement methods and procedures to be applied:	See chapter 4.3 of 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
Calculation method:	Plot size times number of plots
Any comment:	-

Data Unit / Parameter:	Ai
Data unit:	ha
Description:	Area of tree biomass stratum i
Source of data:	Mapping
Description of measurement methods and procedures to be applied:	Demarcation with GPS (Garmin) making use of Forestry Commission coordinates and forest reserve boundary pillars. Calculation of the area size is done with GIS (Mapinfo)
Frequency of monitoring/recording:	Once at project start and updated when needed.
Value applied:	Between 1 and 1000 ha
Monitoring equipment:	GPS (garmin), compass
QA/QC procedures to be applied:	Geo referencing of coordinates in the field.
Calculation method:	-

Any comment:	-
--------------	---

3.3 Description of the Monitoring Plan

Forest health is monitored yearly in the teak and indigenous plantations. Forest health in the buffer zones is measured bi-annually. These measurements are taken in permanent sample plots (PSP), which are established throughout the concession 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 (MapInfo). 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.

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.

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.

Environmental monitoring

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

3.3.1 Organizational structure, responsibilities and competencies

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

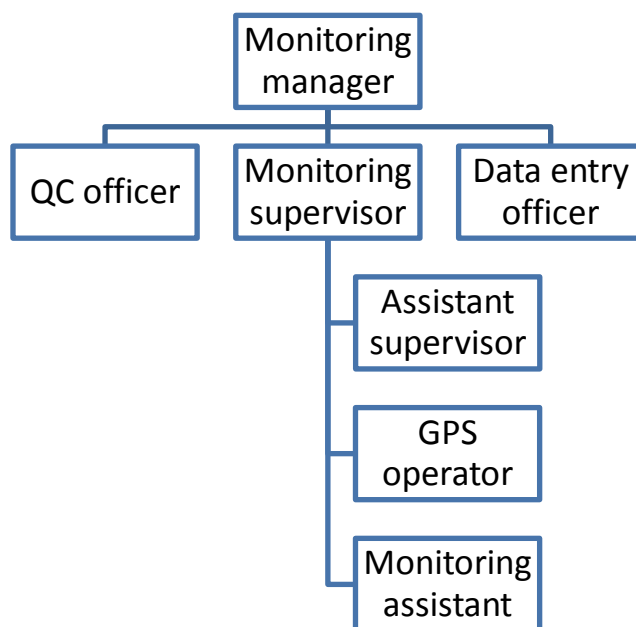


Figure 3: Overview monitoring staff

Table 3: Task and responsibilities of the 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 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	- Clear and correct recording on field sheets - Correct implementation of PSP measurements - Maintenance and completeness of equipment

	supervisor	
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

3.3.2 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 pole of durable wood is placed
- An aluminium tag with the plot number punched into it is nailed to the pole.
- Poles and tags are replaced in case they have decayed too far.
- 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, Annex 3.

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 *Chromolaena odorata* (Acheampong), *Broussonetia papyrifera* (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): The DBH of each teak tree is measured with a calliper.
- 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.
- When a tree is standing near the boundary, the distance from the center to the tree shall be measured to make sure the 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 Annex 3.

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 calliper.
- When a tree is standing near the boundary, the distance from the center to the tree shall be measured to make sure the tree falls in or outside the plot
- Detailed guidance on these measurements are recorded in PP's protocol 13.

3.3.3 Quality control

To increase the accuracy of the monitoring data quality assurance and quality control Qa/Qc procedure are established following IPPC good practice guidance for LULUCF, 2003 (45).

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 sent 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 remeasurement 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.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

Because the methodology AR-ACM0001 does not provide further guidance to determine the CDM “*guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant (v01)*” is followed to determine the baseline carbon stock change.

According to section II.2 (procedure) of this guideline, the change in carbon stocks of existing woody vegetation sinks may be accounted as zero if at least one of the conditions (i) to (vi) is met. Below is stated how the project area meets several of the conditions:

(i) Existing trees and shrubs are partly allowed to remain. 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.

(iii). Because of wild-fires, illegal logging of indigenous trees and continuous conversion to agricultural land, further degradation of the land is expected and it is expected that biomass in existing woody vegetation will decline in the baseline scenario (14) (15). The forest cover of Ghana reduced yearly by 2% over the last twenty years (13). In the project scenario, the remaining indigenous trees are protected and will not be felled, thus leading to reduced carbon emissions as opposed to the baseline scenario.

(v) Harvesting is expected to lead to declining biomass in existing woody vegetation since harvesting of remaining indigenous trees is common practice. Teak planted either by the Forestry Commission or local communities is harvested illegally and/or prematurely.

(vi) Offinso district in Ghana is especially prone to annual bushfires since it lies in the northern drier part of the fire belt in Ghana (16) (17). Anthropogenic fires occur yearly as farmers apply slash and burn techniques to clear the land. Every year 2-3 fires a day in the fire season have to be extinguished to prevent damage to the plantation.

Because several of the guidelines conditions are met the change in carbon stocks in existing live woody vegetation are deemed to be insignificant. Therefore, baseline carbons stock change is conservatively assumed to be zero so that:

Parameter	Unit	Description
	t CO ₂	Baseline net GHG removals sinks

4.2 Project Emissions

4.2.1 Stratification

Reforestation typology

PP applies different ARR techniques to achieve GHG emission removals. This is shown in figure 4 and table 4.

The selected carbon pools mentioned in section 2.3 are applied in all reforestation types. However, different *ex post* calculations for carbon sequestration apply, since there is

difference in the management of the different reforestation types. There are four identified types shown in the table below.

Table 4: Management of the different reforestation types

Reforestation Type	Baseline scenario	Clear felling	Selective harvesting	Thinning Pruning	Planting	ANR
I: Teak plantation	1	Yes	No	Yes	Yes	No
II: Indigenous trees plantation	1	Yes	Yes	Yes	Yes	Yes
III: Planted buffer	1	No	No	No	Yes	Yes
IV: Degraded buffer	2	No	No	No	No	Yes

In the teak and indigenous trees plantation clear felling, thinning and pruning are part of the management and therefore a long term average is applied. In the buffer zones there will be no harvesting, no pruning and no commercial thinning. The buffers are further divided into two areas; planted buffer and degraded forest buffer. Further elaboration on the achievement of carbon sequestration in the different reforestation types is found in the project description document (PDD).

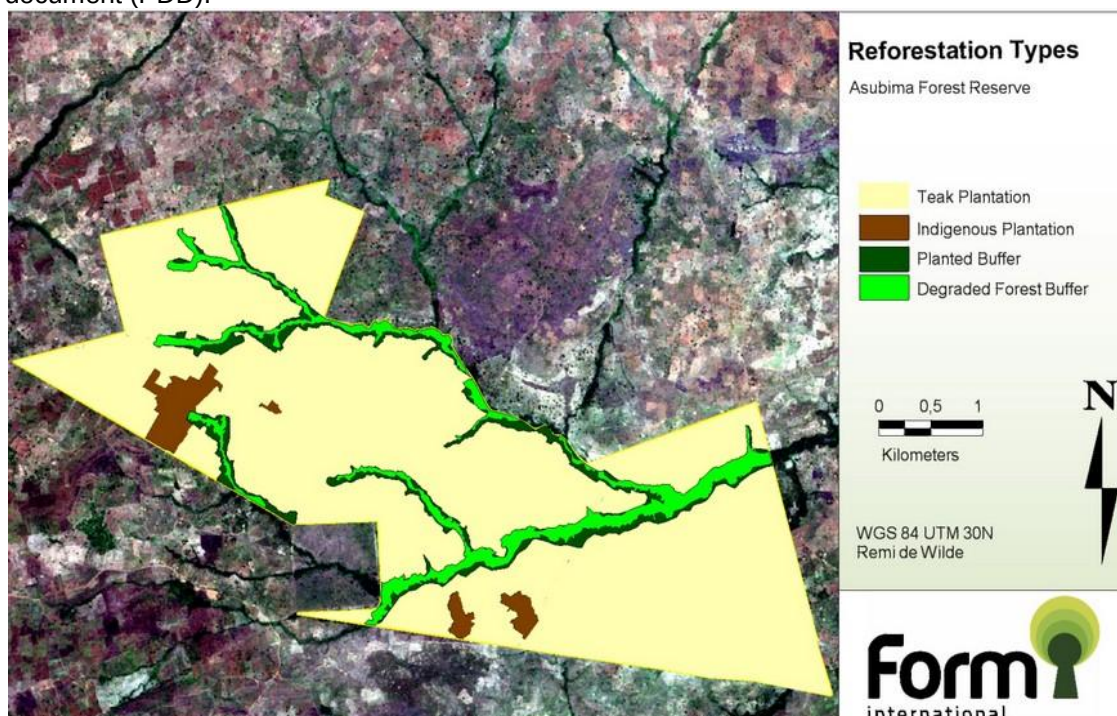


Figure 4: Reforestation types. The different colours represent the types accordingly. Yellow represents teak plantation, brown represents indigenous plantation, Light

green represents the degraded forest buffer and dark green represents the planted buffer zone. The pink area represents the pilot plantation that was established in 2001. This area is outside the scope of the project area.

As the project expands gradually for all the different reforestation types, the project is further stratified by planting year as shown in table 5. Stratum 1 and 2 are submitted for verification and described in this monitoring plan.

Table 5: Stratification

Stratum (i)	Year	Reforestation type	Size (ha)
1	2008	Teak Plantation	142
2	2009	Teak Plantation	464
3	2012 Burned Areas	Teak Plantation	41
4	2010	Teak Plantation	643
5	2010	Indigenous plantation	43
6	2010	Planted buffer	66
7	2010	Degraded forest buffer	106
Total			1,506

4.2.2 Actual net GHG removals by sinks

The CDM methodology AR-ACM0001 version 05.2.0 is followed to quantify project emissions.

Actual net GHG removals by sinks (ΔC_{actual})

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

(eq. 3 of CDM methodology)

Parameter	Unit	Description
	t CO ₂	Actual net GHG removals by sinks
	t CO ₂	Sum of change in selected carbon pools within the project boundary
	t CO _{2-e}	Increase in non-CO ₂ GHG emissions within the project boundary as a result of project implementation

As elaborated in section 2.1 of this report the increase in non- CO₂ is not accounted for since the relevant CDM tool is not applicable. The sum of change in selected carbon pools within the project boundary is further quantified below.

Sum of changes in selected carbon pools (ΔC_p)

The verifiable changes in the carbon stock in the selected carbon pools within the project boundary are estimated using the following equation:

(eq. 4 of CDM methodology)

Parameter	Unit	Description
	t CO ₂	Sum of changes in carbon stock in all selected carbon pools within project boundary since project start
	t CO ₂ * yr ⁻¹	Change in carbon stock in all selected carbon pools, in year t
T	Years	1,2,3 ... t* Time since the start of A/R project activity

The relevant carbon pools for ΔC_t are:

- Above and belowground tree biomass ($\Delta C_{tree_proj,t}$)
- Soil organic carbon ($\Delta C_{soc_al,t}$)

Shrubs, litter and dead wood are conservatively excluded.

Therefore, equation five of the CDM methodology results as follows:

(eq. 5 of CDM methodology)

Parameter	Unit	Description
	t CO ₂ * yr ⁻¹	Change in carbon stock in all selected carbon pools, in year t
	t CO ₂ * yr ⁻¹	Change in carbon stock in above and below ground tree biomass
	t CO ₂ * yr ⁻¹	Change in carbon stock in soil organic carbon

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

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 excluded.

The ‘stock change method’ is followed for *ex post* estimation of the change of carbon stock in trees within the two strata. Tree dimensions were obtained from field measurements as elaborated in the description of the monitoring plan.

Estimation of tree biomass using the BEF method

To determine the amount of tree biomass of the teak trees the biomass expansion factor (BEF) method is used. The values for BEF and D are based on peer reviewed scientific literature (5) (4). The following equation is used to calculate B_{tree_teak} :

(eq. 1 of CDM tool)

Parameter	Unit	Description
$B_{tree,teak,p,i,j}$	ton dm	Above- and belowground teak biomass of tree j, in plot p, in stratum i
	m ³	Above ground tree volume of teak tree j in plot p of stratum i, estimated by using the diameter at breast height (DBH), tree height (H) and tree form factor (f) as entry data into a volume calculation. The teak value for f is 0,36 and converts the DBH/Height cylinder to stem volume (3).
	d.m. m ⁻³	Basic wood density for teak (660 kg *m ⁻³)
	-	Biomass expansion factor including roots (1.54) This factor converts stem biomass to total tree biomass.

Estimation of total tree biomass within the project boundary

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

(eq 3. of CDM tool)

Parameter	Unit	Description
Btree_teak,p,i,	ton dm	Tree biomass in sample plot p in stratum i
Btree_teak,p,i,j,	ton dm	Above- and belowground teak biomass of tree j, in plot p, in stratum i

The area of a sample plot is 800 m². Tree biomass per hectare in the sample plots is calculated by:

————— (eq. 4 of CDM tool)

Parameter	Unit	Description
btree_teak,p,i,	ton dm * ha ⁻¹	Tree biomass per hectare in sample plot p in stratum i
Btree_teak,p,i,	ton dm	Tree biomass in sample plot p in stratum i
Ap,i	ha	Area of sample plot p in stratum i, (0.08)

Mean tree biomass and the variance per hectare is calculated using the equations:

————— (eq. 5 of CDM tool)

————— (eq. 6 of CDM tool)

Parameter	Unit	Description
btree_teak,i,	ton dm *ha ⁻¹	Mean tree biomass per hectare in stratum i
btree_teak,p,i,	ton dm*ha ⁻¹	Tree biomass per hectare in sample plot p in stratum i
Ni	-	Number of sample plots in stratum i
si ²	(ton dm * ha ⁻¹) ²	Variance of tree biomass per hectare in stratum i

The results of above equations and additional relevant statistics are presented in table 6 below. The results of equation 3 and 4 are found in the guiding excel document.

Table 6: Results of monitoring of 2008 and 2009 teak plantation

Overview of data Teak 2008 & 2009		
Stratum	Teak 2008	Teak 2009
btree (tool eq5)	8,98	3,51
s ² i (tool eq 6)	61,55	18,08
Number of plots (ni)	50	152
Sampling density	2,8%	2,6%
Ai - Hectares	141,9	464,4
Wi	0,23	0,77

The mean biomass in the project, variance and margin of error are calculated following the three equations below.

(eq. 7 of CDM tool)

— (eq. 8 of CDM tool)

(eq. 9 of CDM tool)

Parameter	Unit	Description
btree_teak	ton dm * ha ⁻¹	Mean tree biomass per hectare within the project boundary
btree_teak,i	ton dm *ha ⁻¹	Mean tree biomass per hectare in stratum i
Wi	-	Ratio of the area of stratum i at given point of time
s ² btree_teak		Variance of the mean tree biomass per hectare within the project boundary
Ni	-	Number of sample plots in stratum i
si ²	t dm *ha ⁻¹	Variance of tree biomass per hectare in stratum i
ebtree_teak	t dm *ha-1	Margin of error of the mean tree biomass per hectare within the project boundary
Tval		Two sided Student t value at 90% C.I. (1.65)
sbtree_teak	t dm *ha ⁻¹	Square root of the variance of the mean tree biomass per hectare within the project boundary

Relative ebtrees	-	Relative margin of error where the margin of error (ebtrees_teak) is expressed as a percentage of the mean.
Btrees_teak	t dm	Total biomass within the project area
A	ha	Project area

The results of the above equations are presented below.

Table 7 Mean biomass per hectare within the project boundary

CDM tool eq 7, 8, 9	
btrees (eq 7)	4,79
s²btrees	0,14
Tval	1,65
Ebtrees (eq9)	0,6
rel Ebtrees	13%
Btrees (eq 10)	2907

The margin of error is still higher (13%) than the maximum allowable margin of error (10% at 90% confidence level) as prescribed in section 2.2 of the CDM methodology. According to the methodology additional sample plots are needed to reduce the margin of error. However, this procedure has already been done and did not give the desired result. Further stratification into homogenous blocks is at this stage not possible, because the plantation is still too young and the variable growth is still caused by too many different factors.

The VCS standard provides an alternative method to address random uncertainty and precision requirements. In section 4.1.4 of the VCS standard 3.2 is states that: "Where a methodology applies a 90 percent confidence interval and the width of the confidence interval exceeds 20 percent of the estimated value or where a methodology applies a 95 percent confidence interval and the width of the confidence interval exceeds 30 percent of the estimated value, an appropriate confidence deduction shall be applied..."

The CDM methodology AR-ACM0003 confidence deduction method is based on the same 90% confidence interval and 10% allowable error as AR-ACM0001 and is therefore applicable. For precision requirements a reference is made to the "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities version 3.0.0"

Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities version 3.0.0

Uncertainty of tree biomass, $\mu_{btrees,t2}$, (equation 11 of the CDM tool v3.0.0) is calculated in exactly the same way as relative Ebtrees of table 7 above.

The maximum allowable margin of error (RE_{max}) is then 13%, as RE_{max}= $\mu_{btrees,t2}$ (equation 30 of the CDM tool v3.0.0). This means that a deduction rate (DR, table 8 of the tool v.3.0.0) of 6% is accepted to account for the margin of error following the equation:

$$\Delta C_{tree} = \Delta C_{tree} * (1 - DR) \text{ (equation 32 of the CDM tool v3.0.0)}$$

The quantification of the confidence deduction is shown in table 8 below.

Total amount of carbon stock

The total amount of carbon stock in the tree biomass within the project boundary is estimated following:

— (Eq. 11 of the CDM tool)

Parameter	Unit	Description
Ctree_teak	ton CO ₂	Total carbon within the project area at t2
Btree_teak,i	ton dm	Total biomass within the project area
44/12	-	Molecular ratio converting C to CO ₂
CF	-	Carbon fraction, default value (0.5)

Estimation of change in carbon stock in tree (ΔC_{tree})

The change of tree biomass over a period of time is then calculated:

(CDM tool eq. 12 + eq 13 combined)

Parameter	Unit	Description
	t CO ₂ * yr ⁻¹	Rate of change in carbon stock in tree biomass within the project boundary during the period between t1 and t2 for stratum i
	t CO ₂	Carbon stock in tree biomass within the project boundary in year t2
	t CO ₂	Carbon stock in tree biomass within the project boundary in year t1.. For the first year t1 is the baseline stock as calculated in section 3.2 of the PDD.

The equations up till equation 11 are used to estimate the carbon stock at t2 (1 august 2012). In the first verification event the tree biomass at year t1 is the same as the baseline biomass. This consists of remnant yolk and remnant teak that is cleared in the project scenario. Remnant indigenous trees are left standing and are excluded from both t1 and t2 and are not monitored. Further elaboration on the baseline biomass stock can be found in the PDD. The quantification of t1 and t2 is shown in table 8 below.

Table 8: Calculation of change in Ctree_proj

CDM tool eq 12, 13	
CF tree (default)	0,5
Ctree_teak t2 (eq11)	5329
Ctree_baseline t1	4135

ΔC_{tree_proj} (eq 12,13)	1194
ΔC_{tree_proj} (eq 12,13) deducted	1122

Soil Organic Carbon ($\Delta SOCal$)

The change in soil organic carbon (SOC_{cal,t}) is estimated using the “Tool for estimation of change in soil organic carbon stock due to the implementation of A/R CDM project activities” (version 01.1.0).

The implementation of this tool is elaborated in the PDD. The result of this tool is a fixed estimate of the change in soil organic carbon stock per year per hectare over a time period of twenty years.

The results are summarized in the table below. $\Delta SOC_{t,i}$ (eq7) represents the fixed amount of carbon change. The calculation can be found in the guiding excel document. The 2008 teak stratum is 141.9 hectares and 2009 teak stratum 464.4. Multiplying the amount of years and hectares results in the amount soil organic carbon change within the project area.

Table 9 Change in soil organic carbon

$\Delta SOCal$ (CDM tool)		
$\Delta SOC_{t,i}$ (eq7)	0,8	C * ha-1 *yr-1
Teak 2008	3	Yr
Teak 2009	2	Yr
$\Delta SOCal$	1084	C
$\Delta SOCal$ CO ₂	3973	CO ₂

Sum of changes in selected carbon pools (ΔCp)

Finally, the total change in selected carbon pools is the change in tree biomass and soil organic carbon. Total ΔCp is therefore:

$$1122 (\Delta C_{tree}) + 3973 (\Delta SOCal) = \mathbf{5095 \text{ ton CO}_2}.$$

Since GHGe is zero the sum of change in selected carbon pools (ΔCp) is the same as the actual net GHG removals by sinks (ΔC_{actual}).

4.3 Leakage

Under the applicability of AR-ACM0001 the only relevant type of leakage is due to displacement of agricultural activities. Therefore, leakage is estimated following the tool “*estimation of the increase in GHG emission attributable to displacement of pre-project agricultural activities in A/RCDM project activity*” Elaboration on the parameters is found in the PDD. The quantification of leakage is shown in the table below.

Table 10: Leakage

LK agric (CDM tool)	
A	606,3
Adt	527,5
Dt (eq 1)	0,87
ΔCdt (eq 3)	4433
F	0,22
Tcred	40
Lkagric (eq 4)	24,4

4.4 Summary of GHG Emission Reductions and Removals

VCU's can now be calculated for the two strata following:

(eq. 8 of the CDM methodology)

Parameter	Unit	Description
	t CO ₂	Net removal of CO ₂ in the project scenario
	t CO ₂	Net removal of CO ₂ by PP
	t CO ₂	Net removal of CO ₂ in the baseline scenario
	t CO ₂	Leakage attributable to pre-project agricultural activity displacement

The summary of GHG emission removals is provided in table 11 below.

Table 11

Calculation Carr-vcs (CDM methodology eq.8)					
ΔCp	GHG	ΔCactual	LK	ΔCbsl	Carr-vcs
5095	0	5095	-24,4	0	5071

5 ADDITIONAL INFORMATION

Raw data is included in the excel document.

6 REFERENCES

1. **Ogoe, F. et al.,** *Monitoring report Asubima forest reserve*. s.l. : FORM Ghana, 2011.
2. **Sools, R. & Wanders, T.** *Management Plan Asubima Forest Reserve - v3*. Hattem : s.n., 2011.
3. **Dupuy et al.** *Table de Production du Teck*. 261 (3), s.l. : Bois et Forêts des Tropiques, 1999.
4. **Wiselius, S.I.** *Hout Vandemecum*. Naarden : Stichting Centrum Hout, 1992.
5. **Kraenzel, M. et al.,** *Carbon storage of harvest-age Teak (Tectona grandis) plantations, Panama..* 173, s.l. : Forest Ecology and Management, 2003, pp. 213-225.
6. **Aalde, H. et al.,** *IPCC Guidelines for National Greenhouse Gas Inventories*. 2006.
7. **Lawson, G. J** *Indigenous trees in West African..* s.l. : Tropical trees: the potential for domestication and the rebuilding of forest resources., 1994.
8. **De Ridder et al.** *The potential of plantations of Terminalia superba Engl. & Diels for wood and biomass production (Mayombe Forest, Democratic Republic of Congo)*. s.l. : Annals of Forest Science, 2010.
9. **Adu-Bredu S., Abekoe M.K., Tachie-Obeng E., Tschakert P.** *Carbon stock under four land use systems in three varied ecological zones in Ghana*. 2008.
10. **The Wood Explorer.** [Online]
<http://www.thewoodexplorer.com/maindata/we63.html>.
11. **Cannel, M.G.R. et al.** *Woody Biomass of Forest Stands*. Forest Ecology and Management. 8, 1984, pp. 299-312.
12. **Orwa, et al.,** *Agroforestry Database 4.0*.
13. **FAO.** *State of the World's Forests*. 2011.
14. **Abeney, E.A. et al.** *Social and Environmental Impact Assessment (SEIA) of the FORM agroforestry project in Asubima Forest Reserve, Ghana*. s.l. : FORM Ghana Ltd., 2008.
15. **Hawthorne, W.D. and Abu-Juam, M.** *Forest protection in Ghana*. s.l. : IUCN, 1995.
16. **Hall, J.B., and Swaine M.D.** *Classification and Ecology of Closed-Canopy Forest in Ghana*. Vol. 64, 3, s.l. : Journal of Ecology, 1976, Vol. 1976.
17. **Swaine, M.D** *Characteristics of Dry Forest in West Africa and the Influence of Fire..* Vol 3, s.l. : Journal of Vegetation Science, 1992.