Forest Carbon Partnership Facility (FCPF) Carbon Fund ER Monitoring Report (ER-MR)	
ER Program Name and Country:	**Ghana Cocoa Forest REDD+ Programme (GCFRP), Ghana**
Reporting Period covered in this report:	*11-06-2019 to 31-12-2019*
Number of FCPF ERs:	*1,168,393*
Quantity of ERs allocated to the Uncertainty Buffer:	*122,409*
Quantity of ERs allocated to the Reversal Buffer:	*239,309*
Quantity of ERs allocated to the Reversal Pooled Reversal buffer:	*70,385*
Date of Submission:	*18-06-2021*

1 IMPLEMENTATION AND OPERATION OF THE ER PROGRAM DURING THE REPORTING PERIOD

1.1 Implementation status of the ER Program and changes compared to the ER-PD

The Ghana Cocoa Forest REDD+ Programme (GCFRP) is the first program to be developed under REDD+ in Ghana. It is jointly coordinated by the Climate Change Directorate of the Forestry commission which houses the National REDD+ Secretariat (NRS) of the Forestry Commission (FC), and Ghana Cocoa Board (Cocobod). The FC is responsible for the regulation of the utilization of forest and wildlife resources, the conservation and management of those resources, and the coordination of policies related to them, while the Cocobod's mission is to regulate the production, processing and marketing of good quality cocoa.

The GCFRP is centered on the development of a sustainable commodity supply chain that hinges upon the non-carbon benefits that will be channeled to farmers as a result of significant private sector investments into the landscape and the supply chain.

The projected ER benefits from a potential carbon payments of $50 million (against performance over time), coupled with the cocoa industry's annual $2 billion dollar investment into the sector, can together drive this transition to a more sustainable cocoa production landscape, while providing added incentives to farmers, traditional leaders, and communities that support landscape governance and management activities that reduce deforestation and support the adoption of climate-smart practices.

The program area covers 5.92 million ha and is located in the southern third of the country (Fig. 1). Given the size of the programme, the GCFRP has been designed to adapt the well-established Community Resource Management Area (CREMA) model for the purpose of landscape governance of cocoa farming areas. The adapted model is called a Hotspot Intervention Area (HIA) and envisages a multi-tiered, governance structure for the people in the landscape, including the cocoa farmers, communities, landowners and traditional leaders that live within and preside over the HIA landscape. Further, the HIA institution represented by the HIA Management Board is expected to work in collaboration with a Consortium body of private sector, government and civil society stakeholders who work together to support the implementation of activities towards a common landscape vision, including climate-smart cocoa and reducing deforestation. Carbon accounting will happen at the program scale, but GCFRP implementation will target at least six Hotspot Intervention Areas (HIAs) (Fig. 1) spread across the entire landscape. The establishment of the HIA areas is further supported by land scape scale initiatives such as the Cocoa and Forests Initiative which has adopted the HIAs as the implementation areas.

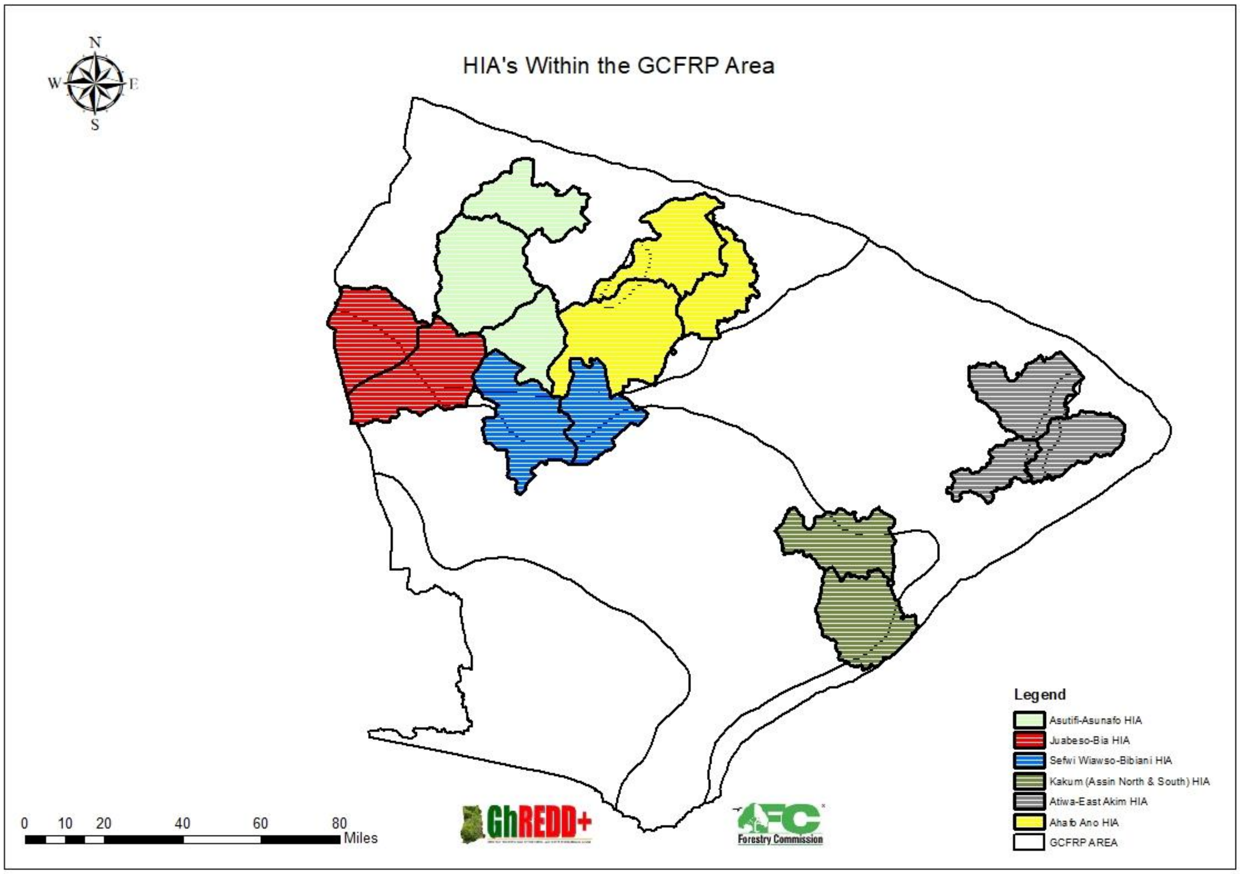

Figure 1 Map of the GCFRP with target HIA

The update of work in the six HIAs are summarized in Table 1 below.

Table 1 Update of work in the initially designated six HIAs as of December 2019

Name	Area	Partners	Status	Main Activities
Juabeso/Bia	243,560	SNV Ghana, Touton, Agro-Eco Louis Bolk Institute, Touton SA, Tropenbos Ghana, Nature Conservation Research Center (NCRC), Solidaridad West Africa	The governance Structures in this HIA are fully developed. A framework Agreement amongst Forestry Commission, Ghana Cocobod and the Hotspot Management Board has been signed. Some Partners have signed an addendum to support the signed	Currently there is one project on going in the HIA. The Project is called Partnership for Productivity Protection and Resilience in Cocoa Landscapes. Establishment of Rural Service Centers to guide farmers on the right inputs to apply in their farm lands.

			Framework Agreement.	Supply of shade trees to farmers to plant in Cocoa farms. Training of stakeholders on REDD+ safeguards tools (ESMF, SESA).
Kakum	212,863	NCRC, Hershey,	Governance Structures development on going. There are plans underway to develop 3 Sub-HIAs by close of 2021. Four Community Resource Management Areas (CREMA) have been developed forming 1 Sub-HIA. Additional Three CREMAs have been developed with CREMA executives selected for subsequent formation of a second Sub-HIA. Community entries have begun for the formation of Community Management Committees for the 3rd Sub-HIA development. After the third HIA, The next step will develop Hotspot Management Board (HMB) in this HIA. The Governance structures are expected to be fully developed by end	Supply of Shade Tree Seedlings to farmers to be planted in their farms. Training of stakeholders on REDD+ safeguards instruments (ESMF, SESA). Training of Farmers on Climate Smart Cocoa Practices and Farmer Business School.

			of December, 2021 with signing of Framework Agreement.	
Ahafo-Ano	365,673	Olam Ghana	Consultancy procured to develop governance structures for the HIA. Full establishment of Governance structures to be completed by end of September, 2021 with signing of Framework Agreement Consultancy procured to assist with processes to sign Framework agreement.	Supply of Shade Tree Seedlings to farmers to be planted in their farms. Training of stakeholders on REDD+ safeguards tools (ESMF, SESA).
Asutifi/Asunafo	328,512	Mondelez Cocoa life (Ghana), UNDP, Proforest Ghana	One CREMA (Ayum-Asuokow CREMA) has been developed in the HIA. Consultancy procured to develop the governance structures for the remaining portions to aggregate into HMB. Consultancy procured to assist with processes to sign Framework agreement. Full establishment of Governance structures to be completed by end of September, 2021 with signing of Framework Agreement.	Supply of Shade Tree Seedlings to farmers to be planted in their farms. Training of stakeholders on REDD+ safeguards instruments (ESMF, SESA). Mondelez Cocoa Life initiated a process to plant and restore degraded forest lands using the Modified Taungya System.

Sefwi Wiawso/Bibiani	209,495	Olam Ghana, Rain Forest Alliance, Landscape Management Board (LMB)	Developed Landscape Management Board (LMB) for one traditional section (stool) of the HIA which is analogous to the HMB. The key next step is to mainstream activities of the LMB into that of the broader HIA and also develop the governance structures for the remaining traditional stool land areas for inclusivity. Subsequently, the HMB would be elected and framework agreement signed by end of March 2022	Supply of Shade Tree Seedlings to farmers to be planted in their farms. Training of stakeholders on REDD+ safeguards instruments (ESMF, SESA).
Atewa	216,964	Proposed Partners are Arocha Ghana, CIFOR (as part of their on-going research on governance structures for small-holders in Cocoa and Oil palm).	No active work has begun in this HIA as formal commitments with partners are not yet agreed. It the HIA with less activity specifically for the program but has on-going work particularly on advocacy for the protection of the Atewa Forest reserve. The advocacy would usher development of governance structures from the	

			community level right up to the HMB level in this HIA. By the end of the September 2021, a consultancy to start the development of this HIA would be procured. By the end of June 2022 at the latest, the framework agreement for the HIA would be signed	

On June 11, 2019, Ghana signed Emission Reductions Payment Agreements (ERPAs) (Tranches A and B) with the World Bank as a Trustee for the Carbon Fund. On April 14 2020, the World Bank declared all conditions of effectiveness to the ERPAs to have been fulfilled. Subsequently an amount of 1.3 million USD as Upfront Advance Payment as negotiated under the ERPAs was released on September 3, 2020 released to support Program implementation. The Benefit Sharing Plan, which gives guidance on the sharing of Carbon Benefits that would be generated under the GCFRP has been finalized and disclosed. The GCFRP has also developed the right Safeguard architecture to tackle and report on all social and environmental safeguards issues (details in annexes).

In addition, under the auspices of the Cocoa & Forests initiative, the government of Ghana through the World Cocoa Foundation signed an agreement with 27 global cocoa companies and chocolate producers in 2017. They jointly agreed to transform the Cocoa sector from a major driver of deforestation to one that is enhancing the protection and reforestation of the High Forest Zone as well as the sustainable production of cocoa at the landscape level. Subsequently, in developing the implementation plan for the CFI, the HIAs have been adopted by companies as the implementation areas. This has therefore enhanced the level of engagements and companies see the GCFRP as the main program and vehicle to achieve their commitments.

1.2 Update on major drivers and lessons learned

In 2017 Ghana submitted its ERPD to the FCPF in which it identified the following four drivers of deforestation:

1. *Uncontrolled agricultural expansion at the expense of forests;*
2. *Overharvesting and illegal harvesting of wood;*
3. *Population and development pressure;*
4. *Mining and mineral exploitation*

The drivers of deforestation and forest degradation are believed to remain the same comparing the reference period to the monitoring period. The underlying causes of this deforestation were identified at the time the ERPD was drafted as forest industry over-capacity, policy and market failures, population growth, increasing demand for agriculture and wood products, low-tech farming systems which relied on slash and burn farming methods as well as a growing mining sector (including illegal mining). Clearing for new Cocoa farms was seen as the most significant driver of deforestation. Initial quantitative estimates of the impacts these drivers were having in the GCFRP area were captured as part of Ghana's initial ERPD submission with an additional amendment to this Reference Level submitted as an annex to this report. With the new data collected, the qualitative driver assessment does not change but the relative importance shifts somewhat: in the ERPD 61% of the forest emissions were believed to originate from deforestation, and 39% from forest degradation. The new assessment suggests deforestation to be responsible for 83% and forest degradation 17%.

Ghana's amended Reference level included the use of sample based point interpretation which is described fully in section 2.2 of this report. The sample-based assessment was used to quantify change for the period 2004-2015 as well as the monitoring period 2018-2019. For deforestation plots, the landuse replacing the forest was recorded, which can therefore provide information on the drivers of deforestation. The largest driver of deforestation is agriculture expansion as 82% of the forest land deforested over the reference period was converted into cropland, with 48% converted into perennial cropland (mostly cocoa) and 34% converted into annual cropland (Fig. 2).

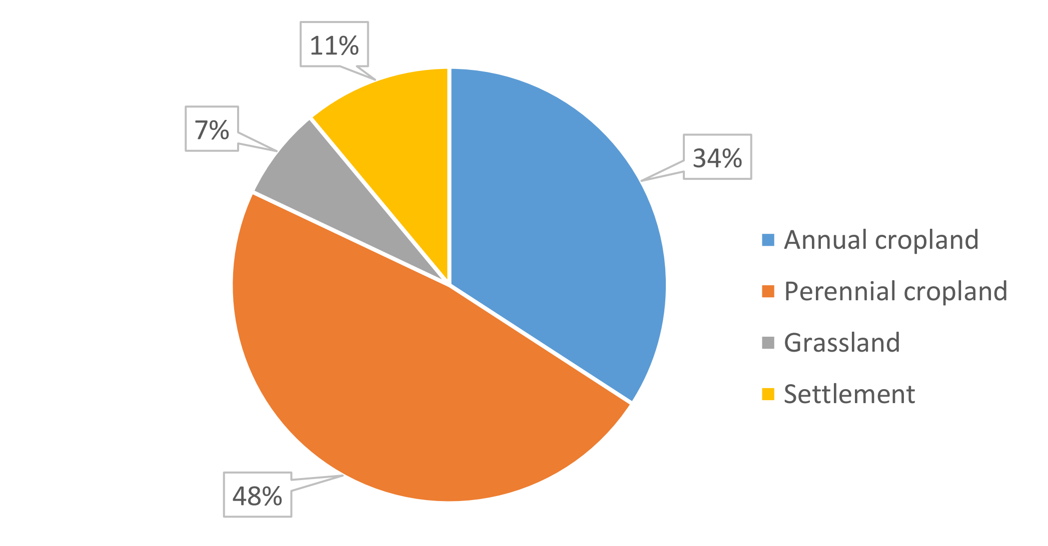

Figure 2 Post deforestation landuse

Through a combination of visual interpretation and a pre- and post-degradation forest cover assessment, it was possible to identify areas undergoing forest degradation. The final land use information associated with these points was always captured as forest, however, expert image interpreters were in a position to identify the activities driving degradation. Figure 3 below provides a breakdown of the drivers of degradation identified by the image analysts. Logging accounts for 55% of the degradation recorded in the GCFRP landscape while crops and settlement/other human impact accounted for 22% and 18% respectively, finally paths make up the remaining 5% of forest degradation.

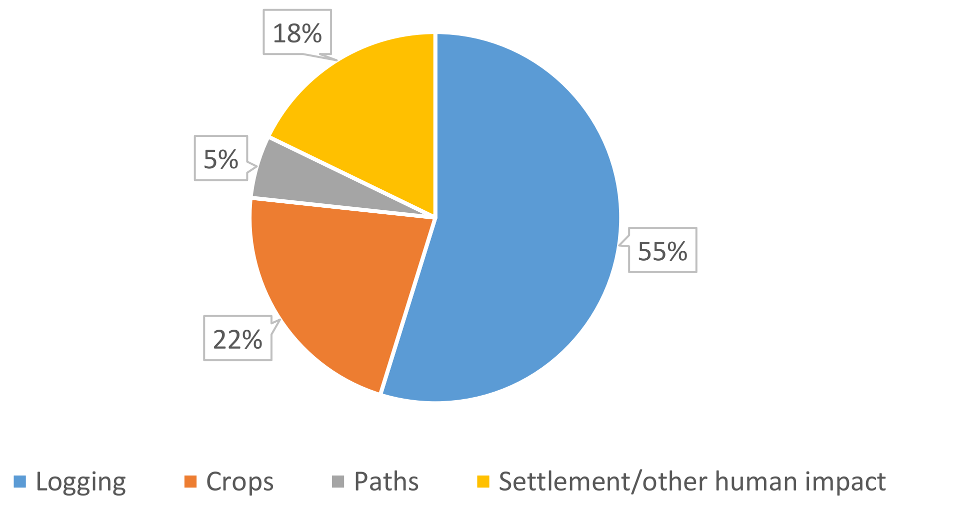

Figure 3 Causes of forest degradation

The results from the sample-based assessment undertaken to support the generation of activity data indicates that the drivers of deforestation and forest degradation remain largely unchanged in the project area. Agricultural activities still drive deforestation while logging drives forest degradation activities. Settlements within the GCFRP are still driving both degradation and deforestation. A positive, somewhat unexpected outcome is the fact that mining does not appear to be a major driver of either degradation or deforestation in the area. Ghana's initial ERPD identified this landuse practice as a concern, especially with regards to illegal mining (galamsey). In 2017 Ghana launched Operation Vanguard (Military Police Joint Task Force) to combat the illegal mining which could explain why mining activities have not been identified in the data presented above. In addition to the military action taken to curb the illegal mining activities, landuse planning within the HIA areas and the initiatives implemented as part of the cooperation between the public and private sector players are beginning to show positive results.

Table 2 Updates on displacement risks associated with different drivers of deforestation

Cocoa Farming	
Risk of displacement	Low
Progress of the strategy in Place	In the first place, Cocoa production in Ghana is central to the GCFRP landscape. Limited or no cocoa production happens outside this landscape. Again, the threat from a changing climate and its impacts on cocoa production outside the recommended growing areas further reduces the likelihood of displacement. The strategy therefore employed by Ghana to mitigate the potential for displacement of deforestation associated with Cocoa farming is anchored in the initiatives focused in the HIA areas. With an ageing population of Cocoa plantations leading to a decrease in farm yield, communities are most likely to shift their activities to forested areas within the GCFRP. Several initiatives underway within the HIA areas are mitigating this potential displacement. In this regard, the Ghana Cocoa Board is currently rehabilitating all diseased and old cocoa farms to reverse the trend in decrease in yield. As at 2020, 4199 hectares had been rehabilitated. In addition to this, government efforts in the form of projects are also complementing the efforts. For instance, in the Juaboso Bia HIA a consortium of stakeholders from both the private and public sectors are involved in the Partnership for Productivity, Protection and

	Resilience in Cocoa Landscapes (3PRCL). The project has established landscape governance and forest protection mechanisms and enhanced Cocoa productivity at the farm level while also providing incentives and income diversification options for farmers as conditions for forest protection and sustainable land-management. In the Asutifi/Asunafo HIA, the Environmental Sustainability project (Public and Private Partnership) has established community level governance structures, while also providing incentives and income diversification options for farmers as conditions for forest protection and sustainable land-management. In addition, through the partnership established under this project, degraded forest reserve landscapes are being reforested by a chocolate company. Finally COCOBOD in collaboration with Forestry Commission and other private sector participants have developed Climate Smart Cocoa (CSC) Standard, which is undergoing series of stakeholder engagements and reviews and to be finalized in 2021. The document is aimed at serving as a working document to be used in all cocoa growing regions to ensure sustainability in the face of climate change. The CSC manual would be to be used by Community Extension Agents (CEAs) to promote on-farm best agricultural practices. These initiatives and more have and will continue to reduce the potential for displacement in the program area.
Subsistence farming	
Risk of displacement	Low
Progress of the strategy in Place	While clearing forests for Cocoa production is considered one of the main drivers of deforestation in the program area, subsistence farming has also been shown to contribute to displacement. As outlined in the ERPD, shifting subsistence agriculture is constrained by the same ecological limits placed on Cocoa and therefore farmers are unlikely to shift their cultivation outside their farms. Cocoa farmers typically establish their subsistence agricultural fields adjacent to their Cocoa trees and typically engage in diversified farming practices. These practices have been enhanced and incentivized through the initiatives (as indicated above) which seek to reward good forest governance within the area. Farmers are now less likely to engage in the clearing of forested environments as there are specific mechanisms established to identify and sanction those engaging in clearing activities. With the development of farmers into the governance structures, and the signing of Framework agreements which highlight the role of farmers which include the protection of forest, sustainable agriculture practices, farmers are expected to practice sustainable agriculture. In furtherance to this, there is a sustained engagement with farmers on their roles in the Programme as a whole which also highlights sustainable agriculture production.
Illegal logging	
Risk of displacement	Medium

Progress of the strategy in Place	Illegal logging within the GCFRP was identified as a risk in the ERPD, however this risk is being mitigated as a result of the interventions discussed above. Improved landscape governance and planning along with enhanced skills and tools related to monitoring allow both communities and government entities to respond in near-real-time to identified acts of illegal logging. Freely available satellite data is used in combination with field inventory and monitoring to complement the activities of local law-enforcement and Forestry Commission staff. Enhanced monitoring capabilities partnered with improved agricultural production have and will continue to reduce the likelihood of displacement related to illegal logging activities. Further, the establishment of the Trees in Agroforestry program (a major component of Ghana' Forest Plantation Strategy) will in the future provide a sustainable source of timber to meet local needs. Again, Ghana has ratified a Voluntary Partnership Agreement with the EU, and has developed systems needed to control, verify and license legal timber. The value chain of timber would be guaranteed and thereby reduce the trade in illegal timber (illegal logging) Through this process, by the end of third quarter 2021, management plans would be developed for all production forest reserves.
Illegal small-scale mining	
Risk of displacement	Medium
Progress of the strategy in Place	The displacement of illegal small-scale Gold mining in the GCFRP project area was recognized as a medium risk in the original ERPD. Since then Ghana has made significant progress with regards to mitigating this risk. The practice known as galamsey was banned in 2017 when the new government took over. Some reports do indicate that the practice has returned however, in the project landscape changes in the policy related to illegal small-scale mining along with improved land use practices has resulted in a decrease in the likelihood of displacement. Improved livelihoods linked to Cocoa production have also resulted in less community members engaging in artisanal and small-scale mining (ASM). Government has also introduced community mining schemes[1] to guide community level mining in sustainable manner.

[1] https://presidency.gov.gh/index.php/briefing-room/news-style-2/1653-new-community-mining-schemes-to-create-12-000-jobs-at-aboso-gwira-akango-president-akufo-addo

2 SYSTEM FOR MEASUREMENT, MONITORING AND REPORTING EMISSIONS AND REMOVALS OCCURRING WITHIN THE MONITORING PERIOD

2.1 Forest Monitoring System

The management of GHG related data and information is performed by Ghana's Forestry Commission, with data collected through the National Forest Monitoring System (NFMS). The NFMS has several data collection components as indicated here below:

- *Satellite land monitoring system (SLMS) (providing AD on deforestation and forest degradation)*
- *Field inventory data from the Forest Preservation Programme (providing EF for deforestation and forest degradation through a field inventory exercise with data collected in 2012)*
- *National Forest Plantation Development Programme (NFPDP) (providing statistics on planted areas, including details on species and whether planting was in- or outside reserve areas. Removals factors for enhancement through the conversion of non-forest land into forest land through plantation establishment are obtained from IPCC)*

With respect to the implementation and updating of the MRV and RL for the ER program, and the operation of the data management system, this responsibility falls under the NRS and Program Management Unit (PMU). These two bodies are responsible for the activities at both national and programme(s) level. In this regard, the PMU is responsible for coordinating the accounting and monitoring procedures to clearly demonstrate the performance of the GCFRP against its FRL, annual monitoring and oversight of impacts and changing trends, and maintains the data management systems for housing key information related to REDD+ and Climate Smart Cocoa operations in the programme landscape. The PMU also monitors and records the implementation status of activities in each Hotspot Intervention Area (HIA), by verifying with communities what institutions in HIAs have reported and guarantees that the annual planning of activities is being followed and implemented.

The MRV team, which provides technical support has representation from the following institutions in Ghana: The Forestry Research Institute of Ghana (Chair), The NRS, The Resource Management Support Center (technical Wing of Ghana's Forestry commission), The Environmental Protection Agency, The Center for Remote Sensing and Geographic Information Services of the University of Ghana, Forest Services Division of Ghana's Forestry Commission, Kwame Nkrumah University of Science and Technology.

In addition, communities within the implementation area are involved during field data collection through participatory dialogues to verify information provided by other stakeholders within their landscapes who are implementing emission reductions activities. Members within communities also support as field assistants during field data collection. Their knowledge of the landscapes contributes to the appreciation/description of the landuse dynamics of the landscapes

Table 3 The following GHG related data and information is selected

GHG flux	Gases included	Parameter	Elements included	Source
Net emissions from deforestation	CO_2	Emission factor deforestation	Carbon pool measurements at plot level: • *Above Ground Carbon* • *Below Ground Carbon* • *Litter* • *Deadwood Soil Organic Carbon*	NFMS: FPP
			Post-deforestation carbon (measurements at plot level)	NFMS: FPP
		Activity data deforestation	Deforestation assessments at plot level	NFMS: SLMS
Net emissions from forest degradation	CO_2	Emission factor degradation	Carbon pool measurements at plot level: • *Above Ground Carbon* • *Below Ground Carbon* • *Deadwood*	NFMS: FPP
		Activity data degradation	Canopy cover reduction assessments at plot level	NFMS: SLMS
Net removals from enhancement (afforestation/reforestation)	CO_2	AD enhancement	Planted area assessment	NFMS: NFPDP
			Survival rate assessment	
		Removal factor enhancement	Teak	Adu-Bredu et al. (2008)
			Other broadleaf species	IPCC 2006 (Vol 4, Chapter 4, Table 4.8)

The responsibility of reporting the GHG data and information are divided between EPA and the Forestry Commission as follows:

- *Forest reference level – Ghana's Forestry Commission*
- *GHG inventory (national communication / BUR) – Environmental Protection Agency*
- *Technical annex to the BUR in case REDD+ results are reported –Environmental Protection Agency / Ghana's Forestry Commission*

The processes for collecting, processing and consolidating GHG data and information are described in detail in section 2.2 and Annex 4. In summary, for the estimation of emission factors, 168 plots within the GCFRP landscape were visited in 2012 and field measurements were undertaken. Ghana has not yet put in place a National Forest

Inventory with repeating cycles of data collection and putting this in place will be dependent on available funding as implementing an NFI on a regular basis is extremely costly. For the estimation of activity data, 7 689 spatial plots have been assessed in 2020 by a team of remote sensing experts. The spatial design used was based on several quality assessment exercises, including the accuracy assessment of multiple forest area change maps and algorithms as explained in detail in Annex 4. The spatial design, response design and quality management aspects are described in section 2.2 and Annex 4. Data collections exercises are organized in 'residential' format, meaning all interpreters sit together during the assessment such that plots where the application of the hierarchical key is not straightforward can be jointly assessed through consensus among the experts.

Systems and processes that ensure the accuracy of the data and information are described in detail in section 2.2 and Annex 4. In summary, for the field inventory, QA/QC measures consisted of random blind re-measurements. For the SLMS data, QA/QC measures were applied as follows: before the data collection started, experts jointly revised the classification hierarchy and reviewed a number of sampling plots together to enhance internal consistency; to improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as "low confidence" were re-assessed; after data collection ended, a random selection of plots were blindly re-assessed.

2.2 Measurement, monitoring and reporting approach

2.2.1 Line Diagram

The measurement, monitoring and reporting approach used by Ghana to develop its reference level is the exact same approach used for quantifying the emissions reductions reported. To address conditions raised by the Carbon Fund participants in 2017, Ghana applied technical corrections to the reference level (see Annex 4). Ghana assessed and reported deforestation and forest degradation per vegetation zone. In the GCFRP landscape 5 vegetation zones are present: Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen. The amended reference level is included in this report (Annex 4), which outlines the methods used for carbon accounting. The present document will only highlight the most relevant components of both the Satellite Land Monitoring System and the National Forest Inventory including all equations and or default values used in both the Reference Level and the Monitoring period. Ghana continues to work on improving the land cover maps assessing forest area changes and in the future may explore improvement to the SLMS e.g. by post-stratifying the systematic sample to improve the accuracy of the estimate.

Satellite Land Monitoring System (SLMS)
The SLMS is a sub-system of the National Forest Monitoring system and is used to produce activity data required for both the reference level and the monitoring period. Ghana's SLMS primarily produces activity data estimates which are used to determine the overall forest loss estimates as well as deforestation rates for the periods of interest. The SLMS team is located in the Resource Management support Centre (RMSC) of Forestry Commission of Ghana.
Section 2.2.1 visualizes the sampling design, response design, data analysis and QA/QC from the SLMS in a line diagram and section 2.2.2 provides a more detailed description and equations for all steps.

Forest Inventory
The forest inventory data is used for the EF calculation. Section 2.2.1 visualizes the EFs for deforestation and forest degradation in a line diagram and section 2.2.2 provides a more detailed description and equations for the EF calculations. This section provides details on the plot level carbon estimates for the different pools.

Forest inventory data was collected as part of the Forest Preservation Programme (FPP), under a Japanese Aid Grant and with technical support from Arbonaut. This study performed field measurements in 252 plots in the year 2012, of this sample, 168 plots fell within the GCFRP landscape. Full details of the inventory are available in the FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013). The reference level amendment attached in Annex 4 to this monitoring report provides additional details on the processing of the forest inventory plot level data. Figure 4 provides the line diagram of the forest inventory preparation, data collection and analysis. This work was undertaken in 2012 and forms the basis for the derivation of Emissions Factors used for both the Reference Level and the Monitoring Report. The available dataset used contained per hectare average aboveground carbon (AGC), belowground carbon (BGC), deadwood (standing and downed) carbon (DW), and litter (L), non-tree and soil carbon (SOC) at plot level. The following sections will explain how the different pools were calculated.

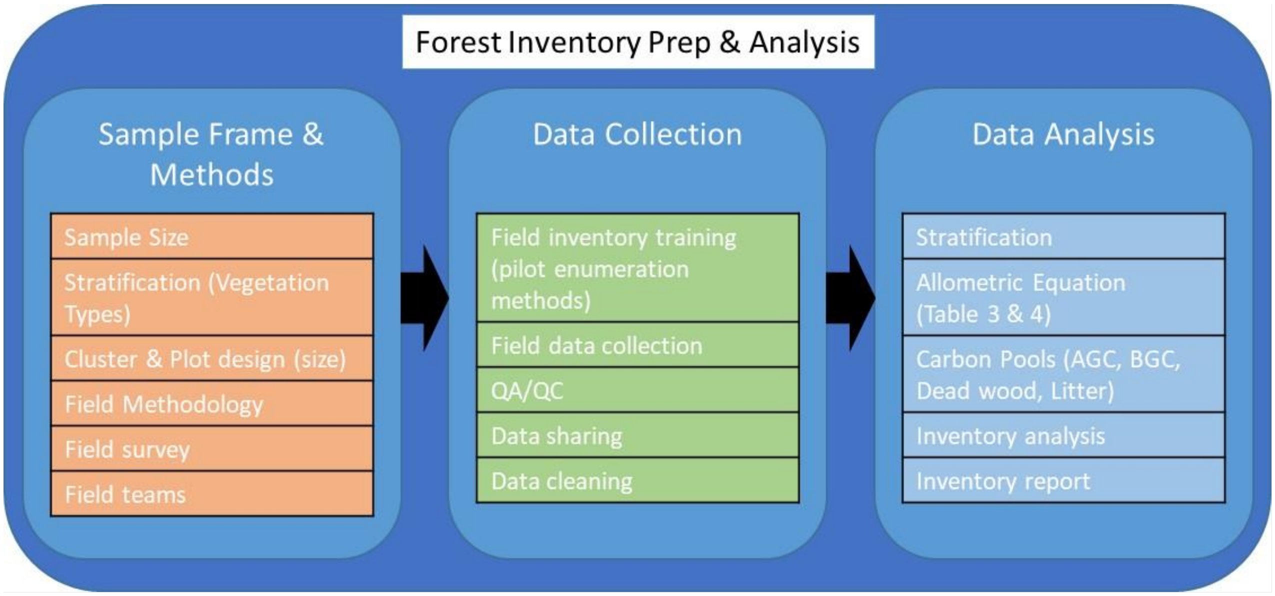

Figure 4 NFI field data collection and analysis

The following line diagrams provide a systematic representation of the different steps in the process. Figure 5 provides and overview of all different steps, while figure 6 to 11 provide a systematic representation of each step in greater detail.

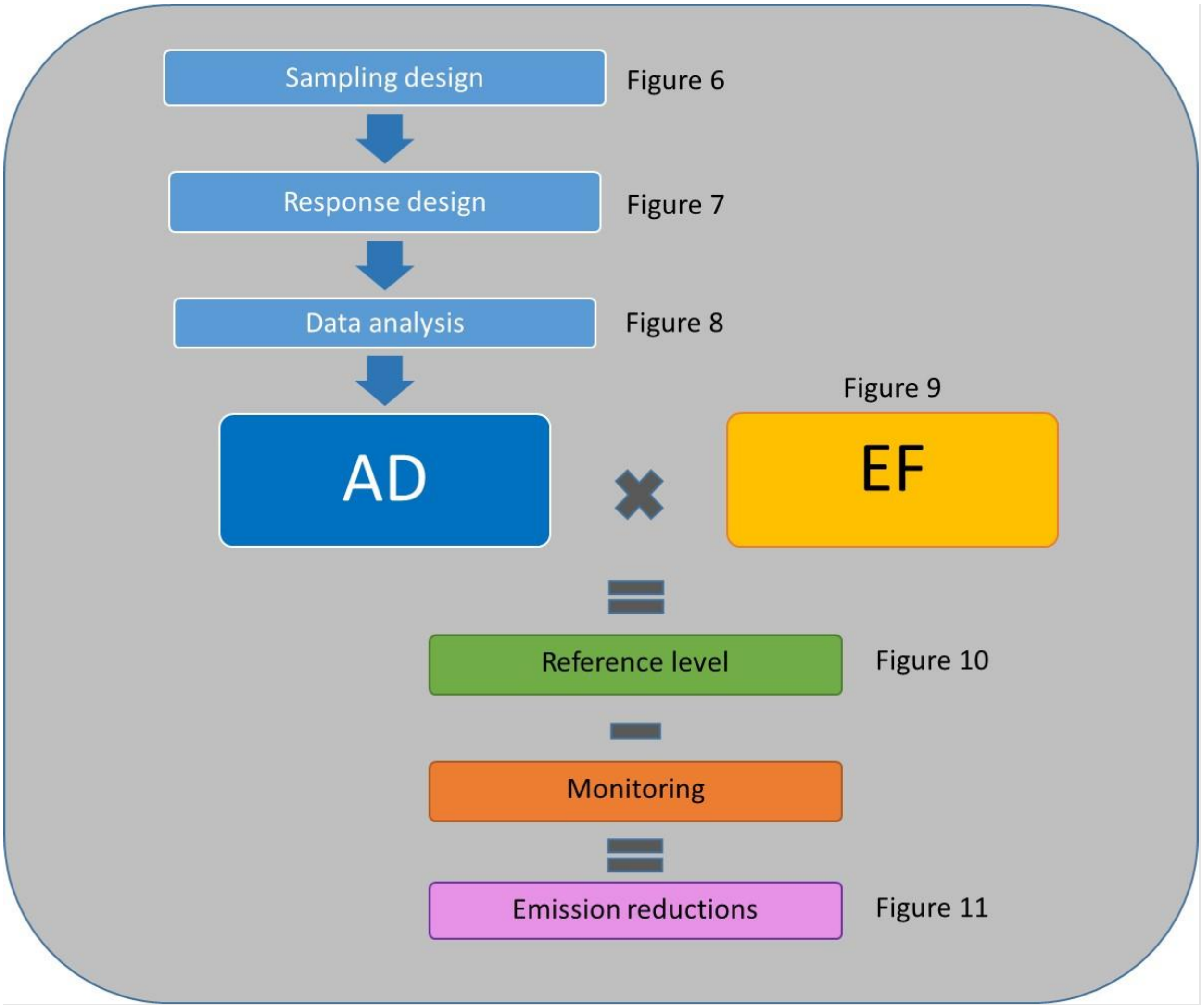

Figure 5 Overview of different steps

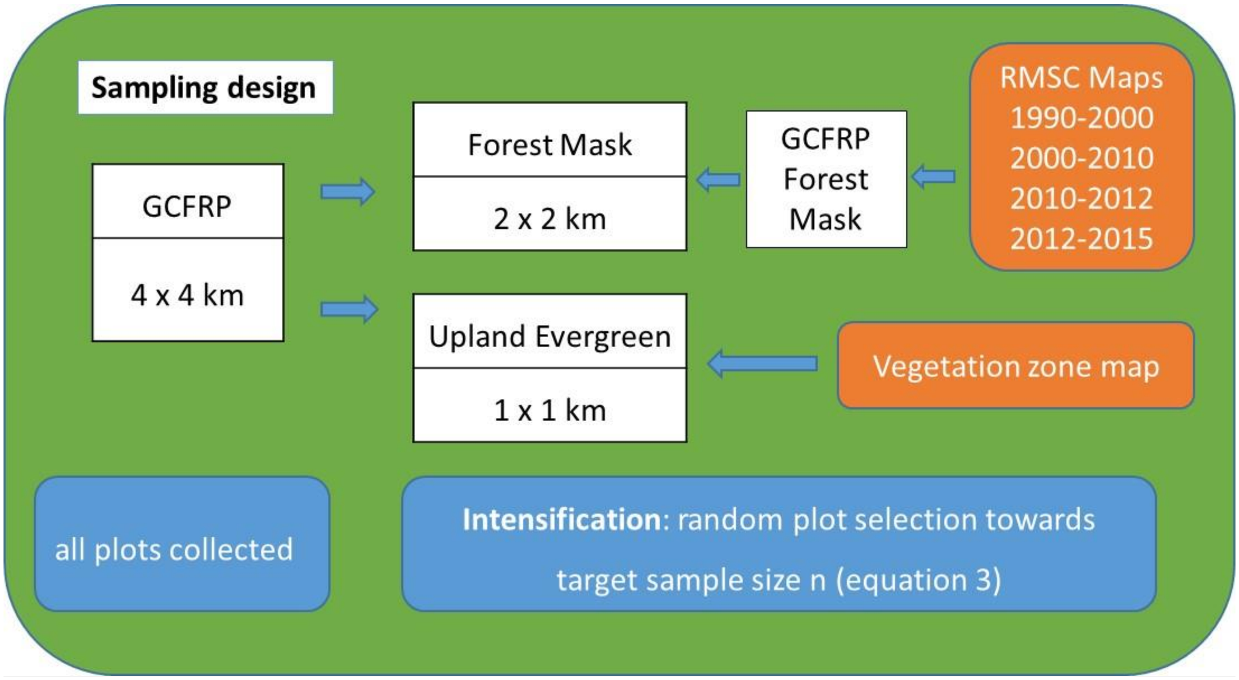

Figure 6 Sampling design

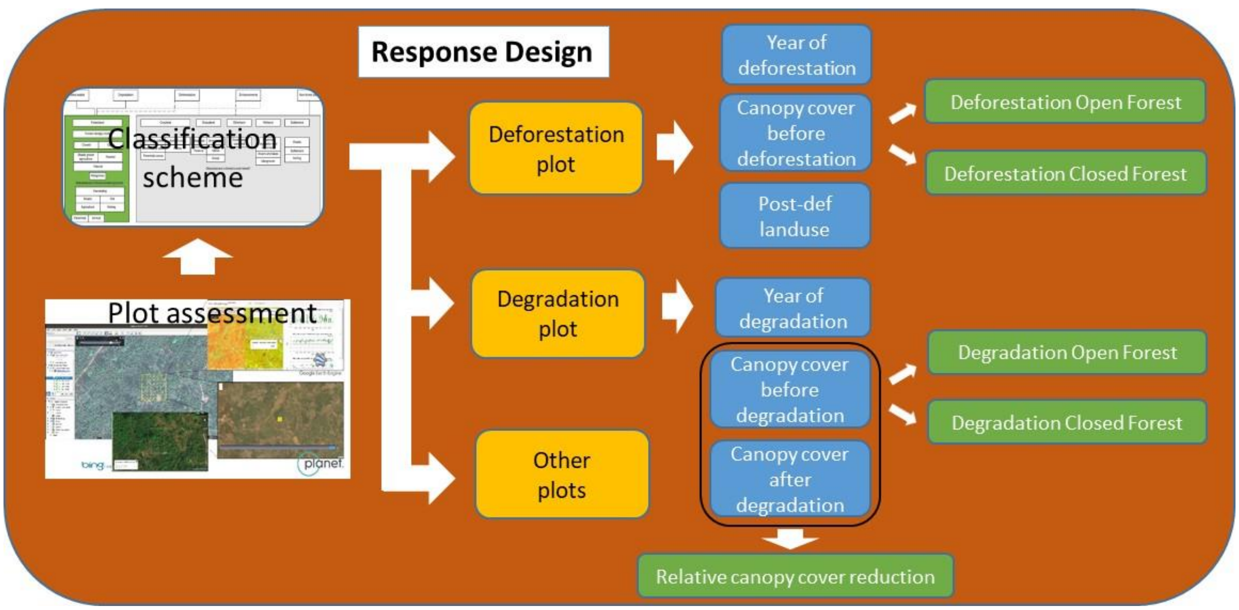

Figure 7 Response Design

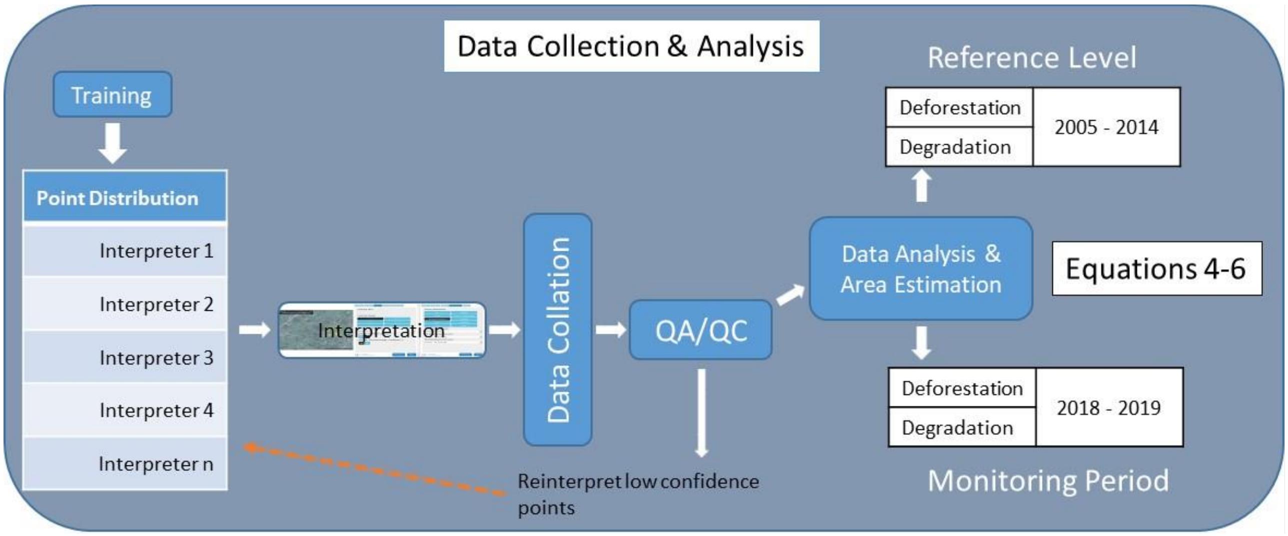

Figure 8 Data collection & analysis

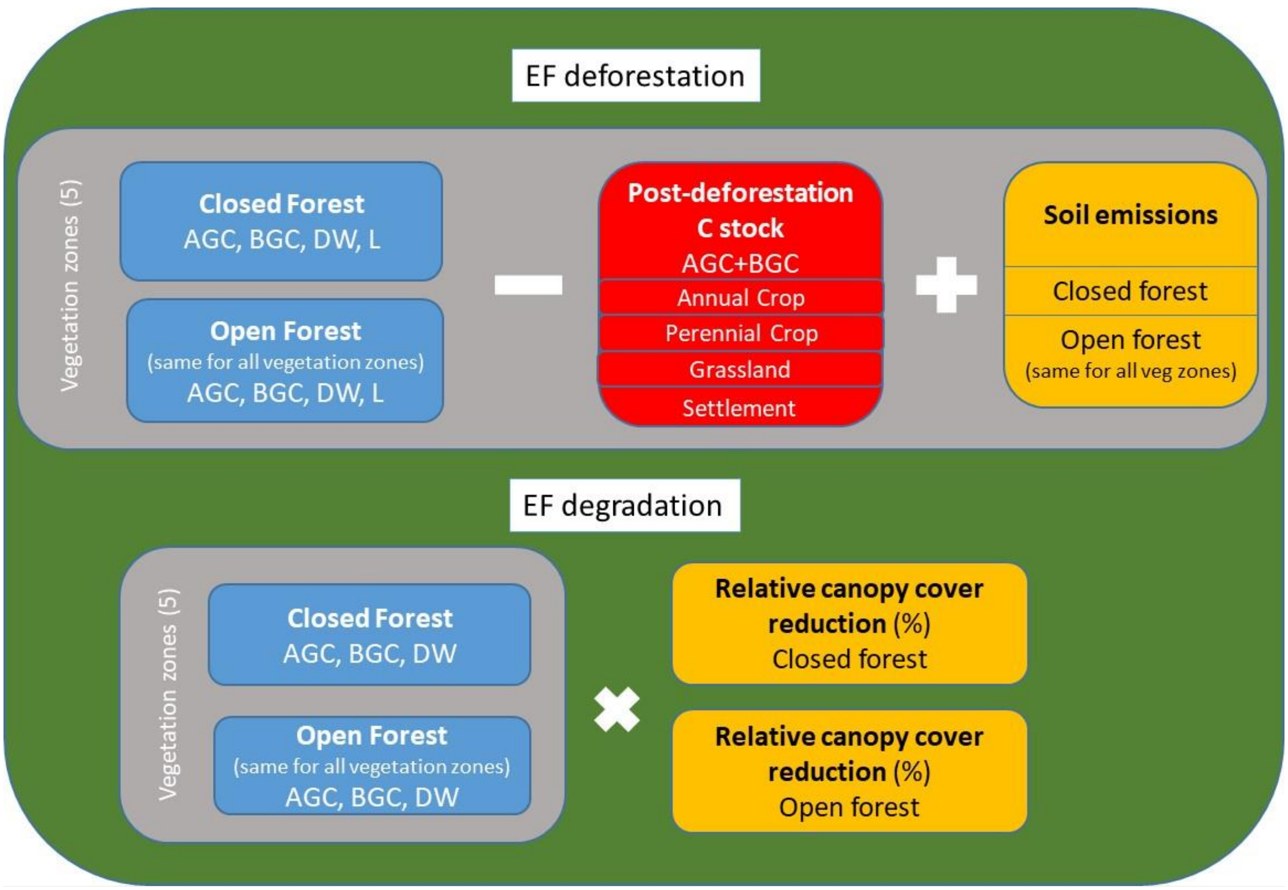

Figure 9 GCFRP Emissions Factors for deforestation and forest degradation

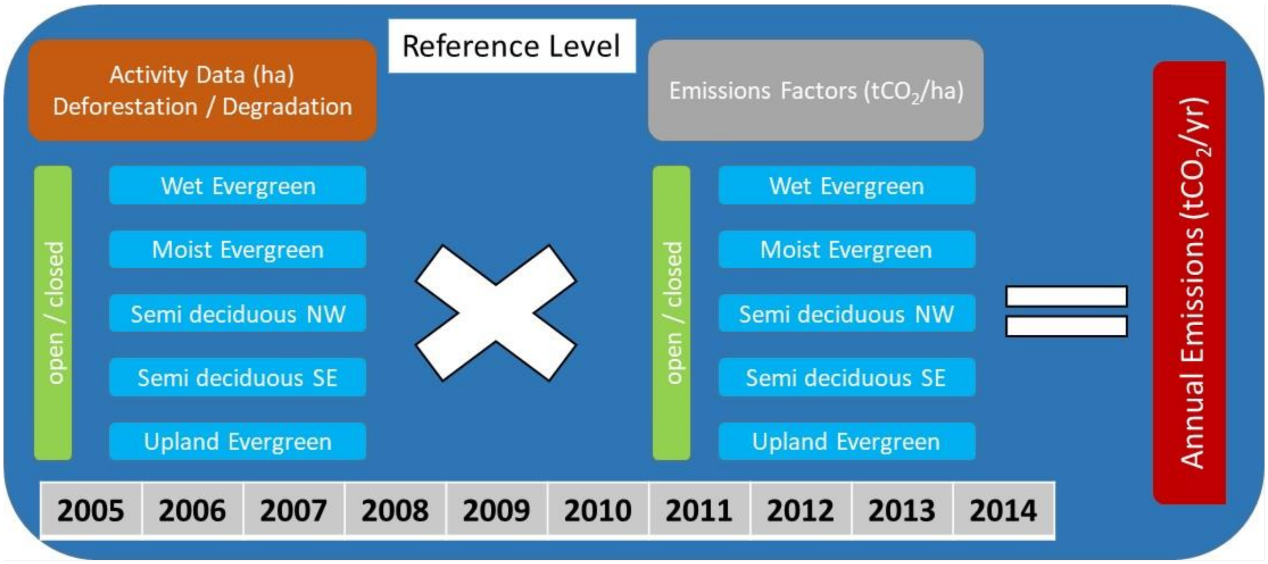

Figure 10 Ghana GCFRP Reference Level

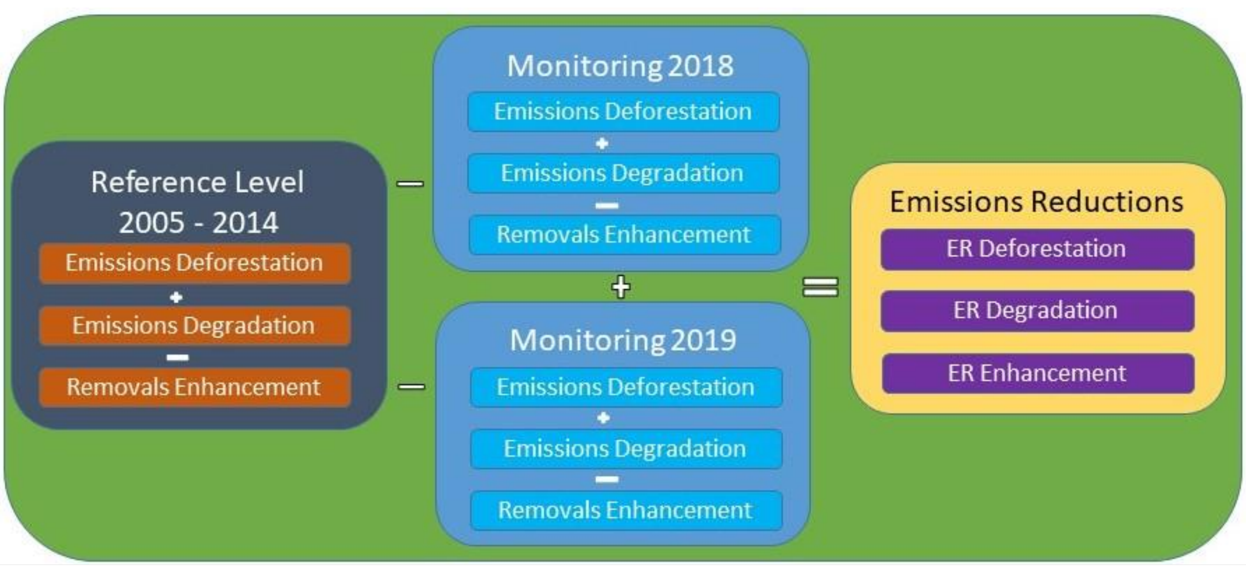

Figure 11 Ghana GCFRP Emissions reductions

2.2.2 Calculation

CALCULATION OF ACTIVITY DATA

Sampling design

Following extensive analyses of various maps, land use change products and combinations of land use change products, Ghana updated its SLMS to make use of a nested multi-scale systematic sampling grid, where the sampling intensities were as follows: outside the forest mask (and outside upland evergreen vegetation zone) the sampling intensity was 4 x 4 km, inside the forest mask (and outside upland evergreen vegetation zone) the sampling intensity was 2 x 2 km, and inside the upland evergreen vegetation zone the sampling intensity was 1 x 1 km. The forest mask is a combination of the four Landsat maps. The intensification on the forest mask was done to increase efficiency of the AD assessment since the expectation was to find more deforestation and forest degradation within the forest mask. The intensification in the upland evergreen was done since the upland evergreen constitutes a very small area, therefore a high plot intensity was needed for a statistically meaningful estimate. Not all plots on the 2 x 2 km and 1 x 1 km grids have been collected, instead a random selection of plots have been collected on this intensified grid until the overall sample size target was met, i.e. the intensified grid has random gaps. There are no gaps in the 4 x 4 km grid (see Figure 6). Given the confidence level (i.e., 90%), the significance level is α=1-confidence level, an approximate estimated total sample size n is assessed by equation 3.

Equation 1 Formula to determine overall sample size:

$$n \approx \frac{z_{\alpha/2}^2 \cdot \hat{O} \cdot (1-\hat{O})}{d^2} \qquad (3)$$

where

$\hat{O}$	=	expected *overall feature area* expressed as a fraction
z	=	percentile from the *standard normal distribution* (*z* = 1.645 for a 90% confidence interval)
d	=	the allowable margin of error. This is the maximum half-width of the confidence interval we aim towards in our estimate. It is given as area fraction, not as percentage. It should be the precision level, taken as a confidence interval, required for the feature to measure.

Following a national data collection campaign as part of the “National Land Monitoring and Information System for a transparent NDC reporting” project which made use of an 8 x 8 km grid, Ghana used equation 3 above to intensify the sampling grid using a nested multi-scale approach guided by a consolidated forest cover mask of the GCFRP area. Table 4 provides the sample size for each grid. With the revision of the reference level (Annex 4), data on deforestation and forest degradation over the reference and monitoring period (and for the years in-between these periods) has been assessed at the same data collection exercises. As such, the same overall number of sample units and the same interpreters were used for both assessments, though in general more high- to very high-resolution imagery was available for the monitoring period compared to the reference period, where in many cases the only imagery available was medium resolution (Landsat). We expect the availability of different image quality for the reference and monitoring period to have little impact on the assessment, but there is a possibility that the higher degradation assessed over the recent period (between 2005-2019 the years with the highest assessed degradation are 2013, 2015, 2017 and 2019) is (partially) explained by degradation being more visible in recent (very) high resolution imagery compared to Landsat-based assessments. This would, however, have a conservative impact on the results assessment.

Table 4 Sample plot size and distribution in GCFRP

	# plots	**Area (ha)**	**Proportion of area**
Outside forest mask (4 x 4 km grid)	2 063	2 555 905	0.4321
On forest mask (2 x 2 km grid)	5 234	3 295 919	0.5573
In upland evergreen ecozone (1 x 1 km grid)	392	62 601	0.0106
Total	**7 689**	**5 914 425**	**1.0000**

This sampling intensity will also be used for future monitoring periods. Ghana is constantly working on improvements for map creation testing new algorithms. Ghana may in the future apply post-stratification (in case this improves the precision of the assessment) or post-stratification with intensification in under-represented map classes of interest, and such an improvement would result in the re-assessment of emissions over the reference period as well.

Response design

The response design used for the collection of land use change data using the sampling grid mentioned above is outlined in Figure 7. A more detailed discussion regarding the decisions made by Ghana can be found in the FREL amendment document contained in Annex 4 to this monitoring report. The same response design was used for both the Reference Level analysis and the Monitoring activities documented in this report.

Information on the vegetation zone in which the deforestation or forest degradation occurred was not collected through the response design, so not collected through sample plot interpretation. Instead, this information was extracted from the vegetation zone map based on the sample plot location.

Data analysis

To calculate the deforestation and degradation area by vegetation zone the sample plots receive equal weights per vegetation zone and sampling density as shown in equation 4. Equation 4 is applied for Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East and Moist Semi-Deciduous North-West. For the vegetation zone Upland Evergreen the same equation is applied only it has one single grid spacing (1 x 1 km) meaning i = 1 in this case.

Equation 2 The area of variable v in vegetation zone e

$$A_{v,e} = \sum_{i=1,2} p_{v,e,i} \times A_{e,i} \tag{4}$$

where

$p_{v,e,i}$	=	the estimated probability of variable v in vegetation zone e falling in stratum i, calculated as $n_{v,e,i}/n_{e,i}$ where $n_{v,e,i}$ is the number of sample plots of variable v in vegetation zone e falling in stratum i and $n_{e,i}$ is the number of sample plots in vegetation zone e falling in stratum i,
$A_{e,i}$	=	the area of stratum i in vegetation zone e

The generalized estimator for unequal probability sampling was used for estimating the associated uncertainty. The half-width 90% confidence interval around the areas of variable v in vegetation zone e and stratum i is calculated with equation 5.

Equation 3 The half-width 90% confidence interval (CI) around the area of variable v in vegetation zone e and stratum i

$$CI\ (\pm)\ of\ A_{v,e,i} = 1.64 \times \sqrt{\frac{p_{v,e,i} \times (1 - p_{v,e,i})}{(n_{e,i} - 1)}} \times A_{e,i} \tag{5}$$

where

$p_{v,e,i}$	=	is the estimated probability of variable v in vegetation zone e falling in stratum i,
$n_{e,i}$	=	is the number of sample plots in vegetation zone e falling in stratum i,
$A_{e,i}$	=	is the area of stratum i in vegetation zone e

To obtain the CI around the deforestation and degradation areas per vegetation zone ($A_{v,e}$) and for the entire GCFRP landscape (A_v), the errors are propagated using equation 6 (which is the equivalent of equation 3.2 of IPCC 2019).

Equation 4 Propagation of errors for summation

$$U_{total} = \sqrt{(U_1)^2 + \ldots + (U_n)^2} \tag{6}$$

where

U_{total}	=	the absolute uncertainty in the sum of the quantities (half the 90 percent confidence interval), e.g. *CI (±) of* $A_{v,e}$ or *CI (±) of* A_v
U_j	=	the absolute uncertainty associated with each of the quantities j=1,..,n, e.g. *CI (±)* of $A_{v,e,i}$

Of the detailed information collected through the sample unit assessment, the proportion of post-deforestation land-use (annual cropland, perennial cropland, grassland, settlement) is used to calculate the weighted post-deforestation carbon contents. Equation 7 shows how the weighted post-deforestation carbon contents is calculated applying the area proportions in the deforestation sample observations per vegetation zone. The same weighted post-deforestation carbon content is applied to deforestation in open and closed forest.

Equation 5 Equation used for the weighted post-deforestation carbon contents ($Bafter_e$)

$$Bafter_e = \sum_{lu=1,4}\left(\frac{Adef_{lu,e}}{Adef_e} \times Bafter_{lu}\right) \tag{7}$$

where

$Adef_{lu,e}$	=	the total area of deforestation with post-deforestation landuse *lu* (either annual cropland, perennial cropland, grassland or settlement) in vegetation zone *e*
$Adef_e$	=	the total area of deforestation in vegetation zone *e*
$Bafter_{lu}$	=	biomass in the land use replacing forest (either annual cropland, perennial cropland, grassland or settlement)

Equation 8 provides the half-width 90% confidence interval (CI) for the post-deforestation ratios included in equation 7. It concerns a simplification since the correct calculation of the confidence interval should consider the stratification. However, this resulted in a highly complicated calculation for a detail (proportion of post-deforestation landuse) that has a relatively small importance and impact on the calculation of the reference level. As such, Ghana has opted to maintain the simplified equation 8 but double the resulting confidence interval to be conservative. The sensitivity of the aggregate uncertainty of the reference level to the confidence interval of this proportion calculation is tested, doubling the CI around the proportion increased the aggregate uncertainty around the reference level value with 0.50%. Ghana therefore concludes the impact is small enough to allow for this simplification and the CI around the proportion is multiplied by two to be conservative.

Equation 6 Equation used to calculate the half-width 90% confidence interval of the proportions (included in equation 7)

$$CI\ of\ p_{lu,e} = t_{0.05} \times \sqrt{\frac{\frac{ndef_{lu,e}}{ndef_e} \times \left(1 - \frac{ndef_{lu,e}}{ndef_e}\right)}{(ndef_e - 1)}} \tag{8}$$

where

$p_{lu,e}$	=	the proportion of the area of post-deforestation landuse *lu* as proportion of the total area of deforestation in vegetation zone *e*
$t_{0.05}$	=	the t-value for the 90% confidence level; given the relatively small sample size for some of the strata this value is calculated instead of using the value 1.64

$ndef_{lu,e}$	=	the number of deforestation plots with post-deforestation landuse *lu* in vegetation zone *e*
$ndef_e$	=	the total number of samples of variable v in vegetation zone e

Figure 8 provides the line diagram for the activity data collection and analysis. Full details of the process are available in Annex 4 to this report as well as the quality assurance activities which included the reassessment (as a group) of the low confidence points and the duplication of points between interpreters.

CALCULATION OF EMISSION FACTORS

The calculation of EFs for deforestation and forest degradation are described in Figure 9. The EF for deforestation includes emissions from the forest pools above ground carbon, below ground carbon, deadwood, litter and soil, while the emissions from forest degradation include emissions from the forest pools above ground carbon, below ground carbon and deadwood. The plot level carbon estimates and forest structure/vegetation zone specific for these pools are obtained from the FPP as described in detail in Annex 4.

Calculation EF deforestation

The EF for deforestation was calculated as the difference between average pre-and post- deforestation carbon contents, with pre deforestation biomass estimates per vegetation type estimated based on data collected as part of the FPP. Post deforestation estimates are based on both data from the FPP as well as data collected by the team undertaking the activity data analyses. Emissions factors used for both the Reference period and the Monitoring period have been calculated following guidance provided by the 2006 IPCC guidelines where post deforestation biomass (tC/ha) is subtracted from pre deforestation biomass estimates. This step is outlined in equation 9 below:

Equation 7 Emissions factor for deforestation for vegetation zone e and forest structure s during both the reference and monitoring period:

$$EF\ deforestation_{e,s} = \left(Bbefore_{e,s} - Bafter_e + \delta S_e\right) \times \frac{44}{12} \quad (9)$$

where

$B_{before,e,s}$	=	Total carbon of vegetation zone *e* for forest structure s (open or closed) before conversion, which is equal to the sum of AGC, BGC, deadwood and litter. For open forest a single B_{before} value is used for all different vegetation zones.
$B_{after,e}$	=	see equation 5, total weighted carbon biomass (AGC + BGC) in land uses after conversion (deforestation) per vegetation zone *e*.
δS_e	=	Change in soil carbon as a result of deforestation, calculated with different soil reference values per vegetation zone *e* from FPP where the change in soil contents after conversion is calculated with IPCC Equation 2.25 (IPCC 2019, volume 4, chapter 2). The Tier 1 stock change factors are provided in , Table 5).
44/12	=	Conversion of carbon to carbon dioxide

Table 5 Stock change factors for change in organic carbon in mineral soils

	Cropland	Grassland	Settlements
$F_{LU} \times F_{MG} \times F_I$	0.81	1.00	0.68

Uncertainty calculation EF

The uncertainty of the average carbon contents in the individual pools was calculated based on the sampling error (equation 10).

Equation 8 Confidence interval (±) around carbon contents in the different pools

$$CI\ of\ C_{p,e,s} = t_{0.05} \times \sqrt{\frac{StDev\ C_{p,e,s}}{(n_{p,e,s}-1)}} \tag{10}$$

where

$t_{0.05}$	=	the t-value for the 90% confidence level; given the relatively small sample size for some of the plot data this value is calculated
$C_{p,e,s}$	=	the carbon contents in pool *p* (AGB, BGB, DW, L, SOC_{REF}) from plot level FPP data, in vegetation zone *e* for forest structure *s* (*s* being open or closed)
$n_{p,e,s}$	=	the total number of sample plot measurements for pool *p* in vegetation zone *e* and forest structure *s*

For the EF calculation, the errors of the individual pools are aggregated using equation 6 (simple error propagation).

Calculation EF forest degradation

Emissions factors for forest degradation were derived based on the relative plot level canopy cover reduction captured for degraded plots during the activity data analysis (see equation 5 in section 2.2.2). The remote sensing interpreters assessed the average tree cover prior to and after a degradation event, after which for each plot the relative percentage reduction was calculated. Accordingly, the average relative canopy cover reduction was calculated for open and closed forest for all vegetation zones combined. The relative percentage tree cover reduction was applied to the forest carbon stock (AGC, BGC, DW) to approximate the carbon loss associated with degradation. The pools AGC, BGC and DW were selected in the ERPD as associated with logging. Since this is the largest cause of degradation and since DW is a significant pool, this selection was applied here. The calculation of the EF for degradation is provided in equation 11.

Equation 9 Emissions factor for forest degradation for vegetation zone e during both the reference and monitoring period

$$EF\ degradation_{e,s} = Cbefore_{e,s} \times\ reduction\ rate_s \times \frac{44}{12} \tag{11}$$

where

$C_{Before\ ,e,s}$	=	The pre-degradation carbon contents (AGC + BGC + DW) in vegetation zone *e* for forest structure *s* (open or closed). For open forest a single Bbefore value is used for all different vegetation zones
Reduction rate $_s$	=	Average relative canopy cover reduction in forest structure *s* (open of closed) as a result of forest degradation, which was identified as part of the activity data analyses
44/12	=	Conversion of carbon to carbon dioxide

GCFRP Reference Level

Annex 4 of this document outlines the full technical corrections to the ERPD submitted to the FCPF in 2017. Annex 4 provides extensive justification for the submission of an updated Reference Level including all additional and updated methods and data used to generate the reference level. Figure 10 provides the line diagram describing the final calculation of the reference level for the period 2005 to 2014. Weighted post deforestation/degradation biomass estimates used for the reference level are also used for the monitoring period. Using the same weighted approach for both periods avoids the introduction of changes associated with the methods rather than the actual emissions reductions. This method is considered transparent, conservative and consistent with best practices. It should be noted that the methods used for the reference level as well as the monitoring period remain unchanged. Equation 12 provides additional information on the method for calculating the final reference level.

Equation 10 Reference level for the GCFRP landscape (tCO_2/year)

$$RL_{GCFRP} = \sum_{e=1,5} \sum_{v=1,2} \sum_{s=1,2} \frac{(A_{v,e,s} \times EF_{v,e,s})}{t} + removals \qquad (12)$$

where

RL_{GCFRP}	=	Annual reference level emissions/removals for the Ghana Cocoa Forest REDD+ Program area
$A_{v,e}$	=	Area of variable *v*, in vegetation zone *e*, in forest structure *s*
$EF_{v,e}$	=	Emissions factor for variable *v* for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
t	=	Number of years in the reference period
removals	=	This is the reference level value for removals calculated as the projected annual removals from the average planted area over the period 2005-2014 (see Annex 4)

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Figure 11 presents the final line diagram used for describing the methods used for calculating the final emissions reduction for the monitoring period. Both the Reference Level and the Monitoring period make use of the same approach whereby emissions from both degradation and deforestation are combined on an annual basis with removals/enhancements to calculate annual gross emissions. Gross annual emissions are subtracted from the annual reference level to give the final annual emissions reductions for the Ghana Cocoa Forest REDD+ program. See equation 13 below. Emissions reductions are calculated for the GCFRP landscape only.

Equation 11 Equation for emission reductions in year 2018 and 2019

$$ER_{GCFRP,t} = RL_{GCFRP,t} - ML_{GCFRP,t} \qquad (13)$$

where:

$ER_{GCFRP,\,t}$	=	Emissions Reductions under the ER program in year t
$RL_{GCFRP,\,t}$	=	Annual reference level emissions for the Ghana Cocoa Forest REDD+ Program area
$ML_{GCFRP,\,t}$		Monitoring period reference level for the Ghana Cocoa Forest REDD+ Program area
t	=	Number of years in the monitoring period

3 DATA AND PARAMETERS

3.1 Fixed Data and Parameters

Parameter:	*Emission factors for deforestation*
Description:	Ghana uses 10 different emissions factors for deforestation. These emission factors do not change between the reference period and monitoring period assessments. The different EFs are as follows: Deforestation in open forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones. Deforestation in closed forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones Though the above mentioned 10 EFs for deforestation remain fixed, the average EF per deforested hectare over the reference and monitoring period will differ since deforestation may target forest structure (open or closed) and vegetation zones differently over both periods (see area of deforestation monitoring below). The EFs in open forest are calculated using the same forest carbon contents per vegetation zone but different post-deforestation carbon contents per vegetation zone resulting in factors that differ slightly.
Data unit:	tons of CO_2 equivalent per ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Emissions factors were derived from inventory measurements as described in section 2.2. Annex 4 (section 8.3) provides a detailed overview of the number of plot measurements underlying the average estimates of the different pool carbon contents: 97 observations were available for AGC, 80 for BGC, 88 for DW, 89 for litter and 96 for SOC). For annual cropland, perennial cropland, grassland and settlements, respectively 11, 34, 3 and 2 plot measurements were available. For AGC, BGC, dead wood and litter the average carbon contents in the different forest types are added and from this total, the weighted average carbon contents in the replacing land-uses are subtracted. In Ghana's monitoring report, only emissions from mineral soils were included. Soil emissions are estimated using GCFRP specific values for soil carbon in forest land (i.e., SOC_{REF} in IPCC equation 2.25 is provided through the FPP inventory) applying to this the IPCC equation and Tier 1 stock change factors. The assumptions and values used are elaborated in Section 8.3 in Annex

	Emission factors for deforestation The emission factor for deforestation considers emissions from all five carbon pools. The gross EF is calculated as the sum of above-ground carbon (AGC), below-ground carbon (BGC), dead wood (DW), litter (L) and emissions from soil organic carbon (SOC). The net EF is obtained by subtracting from the gross EF the carbon stock in the post-deforestation land-use (See additional fixed data parameters). The carbon contents in the replacing landuses are also obtained from plot measurements and a single value is established per vegetation zone (so the same post-deforestation carbon contents are applied to open and closed forest). Soil emissions are calculated as the difference of soil organic carbon in forest land and soil organic carbon in the replacing landuse after 20 years as suggested by IPCC. Ghana accounts for committed emissions, meaning the SOC emissions are not projected over 20 years but accounted as emission in the year of deforestation for the sake of transparency. Finally, the gross emission factor is converted into a net emission factor by subtracting the weighted post-deforestation carbon contents in landuses replacing forest land, which varies between 51.3 – 63.2 tCO_2/ha depending on the vegetation zone.
Value applied:	(see table below)

Emission Factors deforestation

		tCO_2/ha	*±90% CI (tCO_2/ha)*	*±90% CI (in percentage)*
Closed Forest	*Wet Evergreen*	*467.2*	*505.6*	*108%*
	Moist Evergreen	*938.6*	*283.8*	*30%*
	Moist Semi-deciduous NW	*481.1*	*81.7*	*17%*
	Moist Semi-deciduous SE	*686.7*	*313.0*	*46%*
	Upland Evergreen	*534.5*	*150.4*	*28%*
Open Forest	*Wet Evergreen*	*207.8*	*104.5*	*50%*
	Moist Evergreen	*211.9*	*62.3*	*29%*
	Moist Semi-deciduous NW	*200.4*	*58.0*	*29%*
	Moist Semi-deciduous SE	*209.4*	*57.3*	*27%*
	Upland Evergreen	*212.3*	*77.1*	*36%*

QA/QC procedures applied	The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were revisited as quality control plots. Finally 12 out of these plots were revisited in the field for quality control, being 3.3 per cents out of the total 358 planned plots and 4.1 per cents of the plots with measured data. The average differences between the original and quality control measurements are found statistically insignificant (t-test), the maximum average diameter and height differences are found to be up to 11.5 cm and 8.5 meter based on the field measurements excluding the outlier plots. For 75 percent of the plots AGC and BGC values deviate less than 30 percent between two measurement times. There are two outlier plots where the large deviation compared to the original measurements suggests that the plot locations are not matching precisely. Some of the differences can be attributed to harvesting activities. Source: section 4.1.4 of The FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013) Finally, the average carbon stock values per forest structure/vegetation zone have been compared against the IPCC default ranges available showing the values are within the expected ranges (see Annex 4).
Uncertainty associated with this parameter:	The table above provides the 90% confidence interval for all fixed variables reported. The uncertainty of the individual pools was calculated with equation 10 (see section 2.2.2) and the uncertainties are aggregated through simple error propagation (see equation 4)
Any comment:	Ghana does not have access to multiple inventory assessments over time. As such, the only component of the EF calculation that could change is the calculation of post-deforestation carbon contents since this is based on the AD observations of the LU replacing forest over the 2005-2014 period. Post-deforestation carbon contents are discussed in the following parameter box.

Parameter:	*Post-deforestation carbon content (interim in EF calculation)*
Description:	This is the average weighted carbon contents in the landuse replacing forest in case of deforestation. This value is subtracted from the forest carbon stock to get the net per hectare emission factor associated with deforestation. The post-deforestation carbon contents are averaged at the vegetation zone level and the same average value is used when open- or closed forest is deforested.
Data unit:	*tons of CO_2 equivalent per ha*
Source of data or description of the method for developing the data including the spatial level	This information is a combination of the SLMS and FPP. In the sample unit assessment of the SLMS, for each deforestation plot the land-use after deforestation is assessed. Accordingly, the proportion of post-deforestation land-use (annual cropland, perennial cropland, grassland, settlement) is calculated, and these proportions are used to calculate the weighted post-deforestation carbon contents. In analyzing the FPP inventory data, the value of perennial and annual cropland is recalculated using only plots for which field observations were available. The analysis suggests an average carbon contents of 5 tC/ha for annual cropland and 27.3 tC/ha for perennial cropland.

<table>
<tr><td>of the data (local, regional, national, international):</td><td></td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th></th><th>Wet Evergreen</th><th>Moist Evergreen</th><th>Moist Semideciduous NW</th><th>Moist Semideciduous SE</th><th>Upland Evergreen</th></tr>
<tr><td>Post-deforestation C contents</td><td>55.8</td><td>51.7</td><td>63.2</td><td>54.2</td><td>51.3</td></tr>
<tr><td>(in tCO_2/ha)</td><td>48.5</td><td>23.4</td><td>22.5</td><td>20.3</td><td>33.1</td></tr>
<tr><td>±90% CI</td><td>87%</td><td>46%</td><td>36%</td><td>38%</td><td>65%</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures applied</td><td>The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were revisited as quality control plots. Finally 12 out of these plots were revisited in the field for quality control, being 3.3 per cents out of the total 358 planned plots and 4.1 per cents of the plots with measured data.

The average differences between the original and quality control measurements are found statistically insignificant (t-test), the maximum average diameter and height differences are found to be up to 11.5 cm and 8.5 meter based on the field measurements excluding the outlier plots. For 75 percent of the plots AGC and BGC values deviate less than 30 percent between two measurement times. There are two outlier plots where the large deviation compared to the original measurements suggests that the plot locations are not matching precisely. Some of the differences can be attributed to harvesting activities. Source: section 4.1.4 of The FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013)</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>The tables above provide the 90% confidence interval for all fixed variables reported.</td></tr>
<tr><td>Any comment:</td><td>In the ERPD many different values are proposed for the post-deforestation carbon contents, originating from a mix of the FPP inventory, Kongsager et al 2013 and IPCC. The cropland estimates from the FPP inventory range between 30-51 tC/ha. The new analysis of the FPP inventory discussed above finds an average for open forest carbon stock in biomass at 37,7 tC/ha. Considering the description of cropland in the ERPD being “herbaceous and slash-and-burn”, the values between 30-51 tC/ha seem therefore too high. The newly calculated weighted average post deforestation carbon contents range between 51.3 – 63.2 tCO_2/ha for the five different vegetation zones, or a weighted average of 56.5 tCO_2/ha for all vegetation</td></tr>
</table>

zones combined. There is however a lot of uncertainty in the determination of the post-deforestation landuse, especially for the more recent years where a time series of the post-deforestation landuse is not yet available and it may be challenging to distinguish between annual and perennial cropland. Also, for annual or biennial estimates (monitoring period) the uncertainty is much larger than for 10-year estimates (reference period) since the observations will be much fewer. Given the high uncertainties around the estimation of post-deforestation landuse over the monitoring period, it was opted to keep this variable stable such that it will not impact the ER calculation.

Nonetheless, Ghana did calculate how the post-deforestation carbon contents would have impacted the ERs by recalculating the post-deforestation carbon contents based on the observations of post-deforestation landuse in the 2018-2019 deforested plots. The difference is displayed in the table below, showing there was less conversion into settlements and more conversion into annual croplands.

	Weighted average 2005-2014	Weighted average 2018-2019
Annual cropland	34%	48%
Perennial cropland	48%	49%
Grassland	7%	3%
Settlement	11%	0%

The average weighted post-deforestation carbon contents for 2005-2014 was 56.5 tCO_2/ha while the average weighted post-deforestation carbon contents for 2018-2019 was 58.5 tCO_2/ha, meaning if the EF would not be fixed it would have been slightly smaller for the monitoring period compared to the reference period, meaning it would have contributed to (slightly) more emission reductions. As such, it appears the choice of keeping the post-deforestation carbon contents fixed is conservative. However, the impact on emission reductions for the year 2019 would have been 0.2% only, which is not very significant.

Parameter:	Emission factors for forest degradation
Description:	Ghana uses 6 different emission factors for forest degradation. These emission factors will not change between the reference period and monitoring period assessments. The different EFs are as follows: Different EFs for degradation in closed forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones, and one EF for degradation in open forest (all vegetation zones)
Data unit:	tons of CO_2 equivalent per ha
Source of data or description of the method	This information is a combination of the SLMS and FPP. Emissions factors were derived from inventory measurements multiplied by the relative percentage canopy cover reduction observed in all degradation plots over the reference

for developing the data including the spatial level of the data (local, regional, national, international):	period. Total forest carbon stock by vegetation zone for open and closed forest was collected under the Forest Preservation Programme (FPP), as explained in detail in the parameter description of EF for deforestation. To make sure that the estimated amount of CO_2 emitted per hectare forest that is degraded corresponds to the assessed hectares of forest degradation, the remote sensing interpreters assessed the average tree cover prior to and after a degradation event. The underlying assumption is that canopy cover reduction is a good approximation of biomass reduction in a plot. This way, the average canopy cover reduction in open forest and closed forest is assessed. In the data set, 64 points for which forest degradation was assessed over the years 2005-2014 fall in the GCFRP landscape. For 55% of the forest degradation points the cause of degradation was assessed to be logging. The majority of forest degradation emissions were assessed to originate from logging though representing *a much higher share (95%).* **<u>Emission factors for forest degradation</u>** The average relative canopy cover reduction in closed forest was 25.6 %, while the average relative canopy cover reduction in open forest was 35.7 %. The carbon pools affected by forest degradation are AGC, BGC and DW. The percentage reductions assessed (using activity data) are applied to these pools to calculate the change in AGC, BGC and DW pools resulting from degradation. The emission factors for degradation are calculated by multiplying the percentage reductions with the pre-degradation carbon contents in the pools provided.
Value applied:	(see table below)
QA/QC procedures applied	Data are taken from SLMS and FPP project. See Annex 4, section 8.3 and the FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013), section 4.1.4 SLMS: It is good practice to implement Quality Assurance / Quality Control (QA/QC) procedures in the phases of design, implementation and analysis. QA/QC procedures

Emission Factors forest degradation

		tCO_2/ha	±90% CI (tCO_2/ha)	±90% CI (in percentage)
Closed Forest	Wet Evergreen	113.3	109.3	96%
	Moist Evergreen	232.5	66.2	28%
	Moist Semi-deciduous NW	125.2	17.3	14%
	Moist Semi-deciduous SE	180.2	74.4	41%
	Upland Evergreen	131.9	32.8	25%
Open Forest	All vegetation zones	76.2	15.1	20%

	contribute to improve transparency, consistency, comparability, and accuracy (IPCC, 2006). Experts in forestry and remote sensing with knowledge of the landscape were engaged to collect the sample data that was used to derive activity data. Training and calibration took place before the data collection, as well as during the data collection exercise to ensure consistency, comparability and accuracy. Before the data collection, a 6 day training[2] was carried out where experts jointly revised the classification hierarchy and reviewed several sampling plots together to enhance internal consistency. Experts documented examples of different land use and land use change classes in different sources of imagery in the SOP[3] to achieve a mutual understanding of the classification system and how to identify stable land use, land use change and degraded land use classes. The data collection efforts were conducted in a group setting, where experts gathered and interpreted the sample data in the same room. If an expert had any doubt in the sample classification, the plot was displayed on a projector and all experts intervened to accurately classify the sample. QA/QC measures were built into the response design, to avoid mistakes or inconsistencies in data collection. Errors such as inconsistencies according to the classification hierarchy, land cover classes adding up to more than 100% cover and missing information or incomplete responses are flagged with error messages and the expert must correct the errors before continuing to the next sample. To assess the level of interpreter agreement, 598 sample plots were blindly re-assessed by a different interpreter. This corresponds to approximately 8% of the entire sample. The exercise resulted in an interpreter agreement of 82%, which in comparison to interpreter agreement assessments in other countries is a fair level of agreement. To improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as "low confidence" were re-assessed and all forest, including forest degradation, as well as deforestation sample plots assessed in June 2019 were re-assessed since at that time the interpreters did not have access to Planet data. FPP project: The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were revisited as quality control plots. Finally 12 out of these plots were revisited in the field for quality control, being 3.3 per cents out of the total 358 planned plots and 4.1 per cents of the plots with measured data. The average differences between the original and quality control measurements are found statistically insignificant (t-test), the maximum average diameter and height differences are found to be up to 11.5 cm and 8.5 meter based on the field measurements excluding the outlier plots. For 75 percent of the plots AGC and BGC values deviate less than 30 percent between two measurement times. There are two outlier plots where the large deviation

[2] http://www.ghanaredddatahub.org/settings/uploadreports/
[3] http://www.ghanaredddatahub.org/settings/uploadreports/

	compared to the original measurements suggests that the plot locations are not matching precisely. Some of the differences can be attributed to harvesting activities.
Uncertainty associated with this parameter:	The table above provides the 90% confidence interval for all fixed variables reported. These intervals were calculated propagating the errors around the pre-degradation carbon contents and the error around the average relative canopy cover reduction (Table 35 in Annex 4, section 8.3).
Any comment:	The share of degradation happening in open and closed forest is not fixed (see area forest degradation in the next section) but the relative canopy cover deduction is fixed. The relative canopy cover reduction in closed forest was 30% over the reference period and 29% over the monitoring period. Degradation in open forest was rare over the reference period and not occurring over the monitoring period so the reduction percentages could not be compared for open forest.

Parameter:	Removal factor for teak
Description:	Calculated removal factor for carbon stock enhancement through plantation of teak in forest reserves (AGB and BGB)
Data unit:	t CO_2 ha^{-1} yr^{-1}
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Published literature (Adu-Bredu S., et al. 2008) on total tree carbon stocks in teak stands in Moist Evergreen forest in Ghana (98 Mg C/ ha) (included both aboveground and belowground carbon stocks). 98 Mg C/ ha = 358 t CO_2/ha Annual removals: 358 t CO_2ha^{-1} / 25 yr =14 t CO_2ha^{-1} yr^{-1}
Value applied:	14 t CO_2 ha^{-1} yr^{-1}
QA/QC procedures applied	N/A
Uncertainty associated with this parameter:	Adu-Bredu et al. (2008) was completed using temporary sample plots following standard operating procedures for the measurement of terrestrial carbon. While only the total tree carbon stocks were used for the development of removal factors, an estimation of statistical accuracy was offered in the form of the mean, minimum, and maximum carbon values for the total carbon stocks of the teak stands studied in the Moist Evergreen Forest strata, as well as the standard deviation: Mean: 138 Minimum: 133 Maximum: 144 Based on these values, uncertainty could be 6% of the mean. However, to be more conservative, uncertainties in the removal factors are approximated using an average

	standard error value for teak from Bombelli and Valentini 2011[4] and a standard error value from IPCC 2019[5] for the root-to-shoot ratio.
Any comment:	

Parameter:	Removal factor for other broadleaf species
Description:	Calculated removal factor for carbon stock enhancement through plantation of trees (non-teak) in forest reserves (AGB and BGB)
Data unit:	t CO_2 ha^{-1} yr^{-1}
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	IPCC AFOLU Vol. 4 table 4.8 above-ground biomass in forest plantations. Values for ‘Africa broadleaf >20 years’ for three ecological zones in the GCFRP Accounting Area (tropical rain forest, tropical moist deciduous forest, and tropical dry forest) were averaged, and converted to carbon (81 t C/ha) using a carbon-to-biomass ratio of 0.47. The belowground biomass value was generated by applying a root-to-shoot ratio of 0.24 for tropical/subtropical moist forest/plantations >125 Mg ha^{-1} (Mokany et al.2006). This rendered a total stock of 101 t C/ha. 101 Mg C ha^{-1}= 370 t CO_2 ha^{-1} Annual removals: 370 t CO_2 ha^{-1} / 40 yr =9 t CO_2 ha^{-1} yr^{-1}
Value applied:	9 t CO_2 ha^{-1} yr^{-1}
QA/QC procedures applied	N/A
Uncertainty associated with this parameter:	For the development of this parameter, IPCC defaults for aboveground biomass in forest plantations in Africa were applied. Given they are continental averages for all broadleaf species, uncertainty can be assumed to be high. Belowground biomass stocks are produced using a root-to-shoot ratio (Mokany et al., 2006), and therefore values are tied to the estimates for aboveground biomass Uncertainties are approximated using a standard error value from IPCC 2019[6] for the biomass values and root-to-shoot ratios.
Any comment:	

[4] Bombelli A., Valentini R. (Eds.), 2011. Africa and Carbon Cycle. World Soil Resources Reports No. 105. FAO, Rome. http://www.fao.org/3/i2240e/i2240e.pdf#page=108
[5] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf#page=26
[6] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf#page=26

3.2 Monitored Data and Parameters

Parameter:	Area of Deforestation & Forest Degradation (2018 and 2019)
Description:	Area of forest converted to non-forest and area of forest experiencing forest degradation.
Data unit:	Hectares per annum
Value monitored during this Monitoring / Reporting Period:	

Deforestation	Open Forest		Closed Forest	
	2018 Def (ha/yr)	2018 CI (ha)	2018 Def (ha/yr)	2018 CI (ha)
Wet Evergreen	-	-	-	-
Moist Evergreen	1,279	2,098	-	-
Moist Semideciduous NW	619	1,015	1,213	1,989
Moist Semideciduous SE	641	1,052	1,283	1,487
Upland Evergreen	-	-	160	261
	2019 Def (ha/yr)	2019 CI (ha)	2019 Def (ha/yr)	2019 CI (ha)
Wet Evergreen	-	-	-	-
Moist Evergreen	641	1,051	-	-
Moist Semideciduous NW	-	-	619	1,015
Moist Semideciduous SE	1,283	1,487	-	-
Upland Evergreen	-	-	-	-

Degradation	Open Forest		Closed Forest	
	2018 Deg (ha/yr)	2018 CI (ha)	2018 Deg (ha/yr)	2018 CI (ha)

Wet Evergreen	-	-	607	996
Moist Evergreen	-	-	640.88	1,051
Moist Semideciduous NW	-	-	1,238	1,435
Moist Semideciduous SE	-	-	-	-
Upland Evergreen	-	-	160	262
	2019 Deg (ha/yr)	2019 CI (ha)	2019 Deg (ha/yr)	2019 CI (ha)
Wet Evergreen	-	-	607	996
Moist Evergreen	-	-	1,282	1,486
Moist Semideciduous NW	-	-	3,095	2,267
Moist Semideciduous SE	-	-	4,426	3,084
Upland Evergreen	-	-	-	-

Source of data and description of measurement /calculation methods and procedures applied:	Activity data estimates reflecting deforestation and forest degradation were derived from sample-point interpretation. The sample point data set consisted of 7689 samples points systematically located across the GCFRP region on a nested, multi-scale grid with random gaps. During the preparation of the ERPD as well as the amendment to the ERPD, Ghana explored the use of several different data sets and analysis methods for stratifying the area into suitable land cover change classes. Post stratification did not appear to improve the reported confidence intervals and as such, no change maps were used to stratify the area (see Annex 4 for further details). A detailed description of the establishment of the sample size, sample design and response design is provided in Section 2.2 and Annex 4 (section 8.3).
QA/QC procedures applied:	It is good practice to implement Quality Assurance / Quality Control (QA/QC) procedures in the phases of design, implementation and analysis. QA/QC procedures contribute to improve transparency, consistency, comparability, and accuracy (IPCC, 2006). Experts in forestry and remote sensing with knowledge of the landscape were engaged to collect the sample data that was used to generate the activity data. Training and calibration took place

	before the data collection, as well as during the data collection exercise to ensure consistency, comparability and accuracy. Before the data collection, a 6-day training was carried out where experts jointly revised the classification hierarchy and reviewed several sampling plots together to enhance internal consistency. Experts documented examples of different land use and land use change classes in different sources of imagery in the SOP to achieve a mutual understanding of the classification system and how to identify stable land use, land use change and degraded land use classes. The data collection efforts were conducted in a group setting, where experts gathered and interpreted the sample data in the same room and resolve sub-tile difference in the landuse and associated changes. If an expert had any doubt in the sample classification, the plot was displayed on a projector and all experts intervened to accurately classify the sample. QA/QC measures were built into the response design, to avoid mistakes or inconsistencies in data collection. Errors such as inconsistencies according to the classification hierarchy, land cover classes adding up to more than 100% cover and missing information or incomplete responses are flagged with error messages and the expert must correct the errors before continuing to the next sample. To assess the level of interpreter agreement, 598 sample plots were blindly re-assessed by a different interpreter. This corresponds to approximately 8% of the entire sample. The exercise resulted in an interpreter agreement of 82%, which in comparison to interpreter agreement assessments in other countries is a fair level of agreement. To improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as “low confidence” were re-assessed and all forest, including forest degradation, as well as deforestation sample plots assessed in June 2019 were re-assessed since at that time the interpreters did not have access to Planet data.
Uncertainty for this parameter:	The uncertainty estimates (90% confidence intervals in hectares) are provided in the table above. The uncertainty around the areas of deforestation and forest degradation is calculated using equation 3 in section 2.2.2 and propagated using equation 4 in section 2.2.2 (simple error propagation).
Any comment:	

Parameter:	Areas of on- and off-reserve planting (2018 and 2019), discounted with failure rate
Description:	Area of non-forest converted to forest area (enhancement)
Data unit:	Hectares per annum
Value monitored during this	<table><tr><td></td><td>**NFPDP data**</td></tr></table>

<table>
<tr><td>Monitoring / Reporting Period:</td><td>
<table>
<tr><td></td><td>Off-reserve planted area (ha)</td><td>Survival Rate</td><td>On-reserve planted area (ha)</td><td>Survival Rate</td></tr>
<tr><td>2018</td><td>2,086</td><td>69%</td><td>8,352</td><td>69%</td></tr>
<tr><td>2019</td><td>43,694</td><td>55%</td><td>18,444</td><td>55%</td></tr>
</table>
</td></tr>
<tr><td>Source of data and description of measurement /calculation methods and procedures applied:</td><td>The activity data used for the estimation of removals was derived from national census data, reported by the National Forest Plantation Development Programme. Plantation's Department of Forestry Commission undertakes an annual survival survey of all planted sites from which the survival rates were derived.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Data from National Forest Plantation Development Program (NFPDP).

The plantation statistics are first collected at the Forest District Levels. These are then sent to the National through the Regional Levels. In the succeeding year of data collection. Teams are sent from the national level to verify the survival rate of each area planted. These are then used in annual plantation reports. The links to the annual plantation reports are indicated below.

https://www.oldwebsite.fcghana.org/library_info.php?doc=120&publication:National%20Forest%20Plantation%20Development%20Programme%20Annual%20Reports.&id=23

https://www.oldwebsite.fcghana.org/library_info.php?doc=119&publication:GHANA%20FOREST%20PLANTATION%20STRATEGY%20-%20BIENNIAL%20REPORT%202017%20&%202018&id=23</td></tr>
<tr><td>Uncertainty for this parameter:</td><td>Being national statistics, no sampling error can be calculated to approximate an associated confidence intervals around the area statistics. As such, no uncertainty is assumed around AD.

Moreover, neither the FCPF Methodological Framework nor the 2020 guidelines on uncertainty analysis speak to plantation data, no guidance is provided on how to treat national census data</td></tr>
<tr><td>Any comment:</td><td>ERs from enhancement (removal increases) have been assessed following FMT Note CF-2020-5 dating 29 January 2021. Following the FMT recommendation implies that the removal value in the reference level had to be re-assessed (see Annex 4). All information for the annual assessment of removals over the reference period remains unaltered.</td></tr>
</table>

Reference level		Average ha/year	Projected removals in 2018	Projected removals in 2019
Reference level projected reforestation in 2018	Teak	1,340	-19,203	-19,203
	Non-teak	574	-5,318	-5,318
Reference level projected reforestation in 2019	Teak	1,340		-19,203
	Non-Teak	574		-5,318
Total carbon stocks changes (tCO_2)			**-24,520**	**-49,041**

Monitoring period		ha/year	Actual removals in 2018	Actual removals in 2019
Actual reforestation in 2018	Teak	7,749	-111,032	-111,032
	Non-teak	3,321	-30,748	-30,748
Actual reforestation in 2019	Teak	9,505		-136,181
	Non-Teak	4,073		-37,713
Total carbon stock changes (tCO_2)			**-141,780**	**-315,673**

The ER (removal increases) for the reporting period are as follows:

Removals above the projected 2019 removals = (-49,041) – (-315,673) = 266,632 tCO_2

Removals for the reporting period = 266,632 x $\frac{203}{365}$ = 148,291 tCO_2

4 QUANTIFICATION OF EMISSION REDUCTIONS

4.1 ER Program Reference level for the Monitoring / Reporting Period covered in this report

Following Guidance document 3, and making reference to point 3a where the reporting period is not multiple of one year, the guidance suggests to extend the estimation of GHG emissions and removals to a period (i.e. monitoring period) that fully includes the Reporting Period and that is multiple of one year. *As such, following this guidance Ghana uses a Monitoring period of 1/1/2018 – 31/12/2019 and a Reporting period of 11/6/2019-31/12/2019. The pro-rata assessment for the monitoring period multiplies the 2019 assessment with the fraction* $\frac{203}{365}$ *= 0.56*

Year of Monitoring/Reporting period *t*	Average annual historical emissions from deforestation over the Reference Period (tCO_{2-e}/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO_{2-e}/yr)	If applicable, average annual historical removals by sinks over the Reference Period (tCO_{2-e}/yr)	Adjustment, if applicable (tCO_{2-e}/yr)	Reference level (tCO_{2-e}/yr)
2018	4,133,146	867,069	-24,520		4,975,695
2019	4,133,146	867,069	-49,041		4,951,174

Ghana applied technical corrections to the reference level to address concerns raised by the FMT. The reason why a technical correction was needed to ensure accuracy and reliability of the data and the final methodology and results applied are described in Annex 4.

4.2 Estimation of emissions by sources and removals by sinks included in the ER Program's scope

Section 2.2 provides all explanations, data and equations used for the quantification of the reference emissions level for the monitoring period as well as the reporting period. This information is used for the calculation of the reference level using Equation 12 and is represented in Figure 10. Emissions reductions calculations make use of Equation 13 and is represented in Figure 11.

Year of Monitoring/Reporting Period	Emissions from deforestation (tCO_{2-e}/yr)	If applicable, emissions from forest degradation (tCO_{2-e}/yr)*	If applicable, removals by sinks (tCO_{2-e}/yr)	Net emissions and removals (tCO_{2-e}/yr)
2018	2,079,140	460,253	-141,780	2,397,613
2019	702,249	1,813,414	-315,673	2,199,990

4.3 Calculation of emission reductions

The Reporting Period concerns the period 11/6/2019-31/12/2019, as such the values in below table are 0.56 x 2019 values in the Monitoring Period.

Total Reference Level emissions during the Monitoring Period (tCO_2-e)	2018: 4,921,648 2019: 4,896,800
Net emissions and removals under the ER Program during the Monitoring Period (tCO_2-e)	2018: 2,397,613 2019: 2,199,990
Emission Reductions during the Monitoring Period (tCO_2-e)	2018: 2,578,082 2019: 2,751,184 5,329,266
Length of the Reporting period / Length of the Monitoring Period (# days/# days)	203/730 (or 203/365 when applied only to 2019)
Emission Reductions during the Reporting Period (tCO_2-e)	1,530,111

5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

The monitoring period only covers the last 203 days of 2019. Hence annual emission reductions estimates for 2019 were multiplied by $\frac{203}{365}$ to cover that period. Since the timing of 203 days is a fixed constant and not a random variable (i.e., it does not present any standard error associated to it), no Monte Carlo component to execute this division was needed.

5.1 Identification, assessment and addressing sources of uncertainty

As per the requirements in criterion 7 of the methodological framework, a Monte Carlo simulation was undertaken.

The "Guideline on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions" lays out the following sources of (residual) uncertainty (details in table 6 below) that must be included in this analysis:

- *Activity data:*
    - *Measurement*
    - *Representativeness*
    - *Sampling*
    - *Extrapolation*
    - *Approach 3*
- *Emission factors:*
    - *DBH measurement*
    - *H measurement*
    - *Plot delineation*
    - *Wood density estimation*
    - *Biomass allometric model*
    - *Sampling*
    - *Other parameters (e.g. carbon fraction, root-to-shoot ratios)*
    - *Respresentativeness*
- *Integration:*
    - *Model*
    - *Integration*

These sources of uncertainty were considered as follows.

- *Activity data sampling uncertainty was taken into account by estimating the mean area change and its standard error from the systematic sampling of land-use change. The means and standard errors were estimated separately on a per forest stratum basis.*
- *Emission factor sampling uncertainty was taken into account by estimating the mean biomass and its standard error from the forest inventory plots. The means and standard errors were estimated separately for each forest stratum and separately for the carbon pools.*
- *The uncertainty related to the biomass allometric equations was not taken into account (see below)*
- *Other parameters related to emission factors that were modelled include the biomass of post-deforestation land use, the Carbon Fraction of biomass in tree plantations, the root-shoot ratio in tree plantations, the average carbon stock in tree plantations, the relative biomass reduction upon forest degradation. Where relevant, these parameters were modelled separately for carbon pools and for forest strata. Regarding the deforestation and forest degradation emission factors, the carbon fraction and the*

root-shoot ratio could not be separately modelled because biomass was calculated at the plot level and plot-level measurements were not available. Hence both are used as fixed parameters.

The absence of reliable tree level data in the 168 plots used for the emission factor estimation in the area, together with a lack of some basic error parameters in the allometric equations used, such as mean squared errors at the very least, make the calculation of errors at the tree scale impossible. Even counting on the original tree level data (as opposed to the current plot-level aggregates) the number of assumptions necessary to derive model errors might involve undesirable levels of risk.

Correlation between the input parameters was handled by ensuring that each parameter appears only once in the model. For example, the forest AGB of a given stratum is only simulated once and all other instances of forest AGB refer to it. This made the use of covariance matrices unnecessary.

Probability density functions for the modelled parameters were defined following the decision tree provided in the guidance. Accordingly, a goodness-of-fit test was undertaken where raw data were available, and an expert elicitation was undertaken where raw data were not available. Most PDFs chosen were based on Gaussian curves. Although in some cases with very low figures a Gaussian fit with a large standard error may give raise to unrealistic negative numbers, truncated normal approaches were discarded since they would be only useful for a handful of cases and, if correlations are to be taken, the computational complexity of choosing multivariate truncated normal becomes cumbersome. For degradation, a natural beta distribution of canopy cover reduction as an indicator of biomass reduction was used for the fraction of plots that underwent degradation. The choice of a beta model distribution encompasses the quantity of cover reduction. The choice may introduce some degree of bias. However since it is such a rare event, its contribution to overall uncertainty is small. Although the parallels are not clear, the beta distribution can ease the propagation of random errors, although biases are likely to appear because of the more than possible non-linear relationship between canopy cover and biomass reductions.

Table 6: Sources of Uncertainty to be considered under the FCPF Methodological Framework

Sources of uncertainty	**Systematic/ Random**	**Analysis of contribution to overall uncertainty**	**Contribution to overall uncertainty (High / Low)**	**Address through QA/QC**	**Residual uncertainty estimated?**
Activity Data					
Measurement	S/R	Source of error still being subject of academic research. It is potentially subject to both bias and random error and may also potentially contribute significantly to overall uncertainty. It was addressed through QA/QC protocols by : 1. Developing specific manuals and through several capacity building workshops. *Note: the workshop on Monte Carlo Analysis would be conducted in July 2021* *Link to manuals and training workshop reports and presentations indicated in the link below*	H (bias/random)	YES	NO

		http://www.ghanaredddatahub.org/settings/uploadreports/ 2. Dubiously identified sampling plots were discussed through consensus among interpreters. 3. Use of high resolution imagery (through different sources) that minimizes possible interpretation errors Other measurement errors may potentially be applicable, such as those associated to remote sensors and their spectral and spatial resolutions. However these are almost never applied beyond some academic exercises. The contribution of measurement error to the overall uncertainty is potentially high (both through random and systematic error) but the QA/QC (refer to points 1 -3 above) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.			
Representativeness	S	The sampling design followed strict procedures through the use of systematic grids (refer to SOPs), with the aim to produce proper allocation according to strata. As such, only possible errors in the definition of strata from satellite imagery seem plausible in regards to producing potential biases. However the sampling methodology within the strata was robust. The expected impact from representativeness on the overall uncertainty is low (through systematic error) but the QA/QC applied within the strata should have minimized the remaining error inasmuch as practicable. No residual uncertainty is included in the estimate.	L (bias)	YES	NO
Sampling	S/R	The choice of estimator was based on a ratio-based approach, which is in principle tend to provide higher biases, but the high number of samples in the stratified scheme is expected to minimize that bias. Random error has been shown to be lower than with the use of purely regression-based estimators or simple means. Yet, sampling errors in AD are in practical large-scale applications always high overall. QA/QC procedures (http://www.ghanaredddatahub.org/settings/uploadreports/ led to intensification and an increase in sampling size to minimize sampling errors, including revision of sample allocation through the strata. The contribution of sampling error to the overall uncertainty is high (both through random and systematic error) but the QA/QC applied should have minimized this as much as practicable. Residual uncertainty is included in the estimate.	H (bias/random)	YES	YES

Extrapo lation	S	This source of error has been minimized due to the alignment between forest types as reporting domains with strata in the design. Hence, for example deforestation is calculated independently for each stratum that is also a certain forest type reported. The expected impact from extrapolation on the overall uncertainty is low (through systematic error) but the QA/QC applied within the strata should have minimized the remaining error this as much as practicable. No residual uncertainty is included in the estimate.	L(bias)	YES	NO
Approa ch 3		The approach taken is a sampling approach that allows land-use conversions to be tracked on a spatially explicit basis			
Emissio n factor					
DBH measur ement error	R	Absence of tree-level data. Errors in DBH measurements are usually small (Picard 2015) and considered to cancel out when aggregation from tree to plots take place (Yanai et al. 2010, Holdaway et al. 2014). The expected impact from DBH measurment on the overall uncertainty is low (through random error). QA/QC (SOP 1.1 and 1.2 precribes the use of combining uncertainties) has been applied and should have minimized the remaining error as much as practicable. No residual uncertainty is included in the estimate.	L(rando m)	YES	NO
H measur ement error	S/R	Absence of tree-level data. Tree height tends to present lower precisions, and it is highly variable and site-dependent. Clinometer-measured heights have also shown to present consistent biases of approx. 1 m. for trees > 20 m. As a consequence per ha scale, it has been reported to give AGB uncertainties of 5-6% that can also present high biases. Although precision is reduced when aggregating at large scales due to cancelling out random errors, biases do propagate, in some cases reportedly showing 4% overestimation in AGB (Hunter et al. 2013). Field trainings took places with Arbonaut, linked to LIDAR measurements. (Refer to manuals 5.1.2, 5.3 and 5.4, link same as above) This linkage implicitly helps quality assurance through contrasting tree height measurements with those from LIDAR. As an add-on, risk for height measurement errors was already taken into account in the AGB model selection, minimizing even more this source of error. The expected impact from H measurment on the overall uncertainty is high where this concerns systematic error and low where this concerns random error. QA/QC has been applied and should have minimized the errors as much as practicable. No residual uncertainty is included in the estimate.	H (bias) & L(rando m)	YES	NO

Plot delineation	S/R	No analysis took place regarding plot delineation, which can also be considered a measurement error on its own. Systematic bias can be expected because crews in the field might aim to avoid large obstacles and deviate slightly from the originally designed plot boundaries. The expected impact from plot delineation on the overall uncertainty is low (through random and systematic error). As part of QA/QC, Systematic plots of 3 plots per cluster with 500 m distance among plots and 1,000 m between clusters. Within an inventory team there was navigational team and field measurement team. The two teams worked together but were independent. The navigational team extracted the center coordinate of each plot from the LIDAR strip in Arcmap, uploaded to handheld GPS and use that to locate the field plot. This was to ensure that the location of the plot remained unchanged. However, inaccessible plots such as flooded areas, mangroves were abandoned. Furthermore, when a plot laid the GNSS was used to pick the center coordinate and the four corners of the plot. The essence was to crosscheck the coordinates from the field and the ones extracted from the LIDAR image. Ground control points (GCP) with their associated coordinates were supplied by the Survey and Mapping Division. These were used to coordinate the survey of the plots. No residual uncertainty is included in the estimate.	L(bias/random)	NO	NO
Wood density measurement error	S/R	Wood density was not considered for live trees, since AGB models developed did not take it into account. However it had to be used to estimate AGB of dead standing trees. For that, species identity is needed. Lacking tree-level data, this source cannot currently be used in this exercise. However it is known that taxonomies were used (hence QA/QC was ensured), although average WD estimates per plot were produced. This may have masked some of the taxon WD variability, which can often be high. However, because deadwood carbon is very low compared live carbon, very low errors would be expected from WD. (The expected impact from wood density estimation on the overall uncertainty is low (through random and systematic error). Information on QA/QC is found in manual 5.3 and 5.4. (*all manuals in link provided above*) No residual uncertainty is included in the estimate.	L(bias/random)	YES	NO
Biomass allometric model	S/R	The absence of tree-level data makes extremely difficult to provide a quantitative estimation of the level of uncertainty at plot-scale due to this source of uncertainty. While RMSE exists for all models used, there is presently no information of the abundance of the different species in a plot. Hence the tree-based biomass model uncertainties cannot be properly propagated at	L(bias), H/L (random)	YES (local models)	NO

		plot level. Thus, neither the model choice error nor the model coefficients uncertainty can be used. As a counterargument and possible justification, the use of local BGB models like the ones used for this report has been shown to reduce possible biases as opposed to pantropical models (van Breugel et al. 2011), although pantropical models, such as Chave (2014) can significantly reduce precision. Thus we expect this source of uncertainty to have a low contribution to bias but possibly high to random error in a static estimation. In the case of emission reductions, the full correlation assumption will point to minimal effects of this source of error. The expected impact from the biomass allometric models (AGB and BGB) on the overall uncertainty is low (for systematic error) to medium (for random and systematic error) but the QA/QC (manuals 5.3 and 5.4) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.			
Sampling	S/R	Plots were distributed along LIDAR transects and randomly located along the lines, stratified by vegetation types. Estimators were SRS (over a systematic configuration of plots along LIDAR transects, by ecological zone) within each stratum, and carbon stock was expanded to a per ha. basis. The plots can be considered as a quasi-transect sample of the forests. The field plots have a square shape of 40 m by 40 m (Chen et al. 2015) Sampling could result in both systematic and random errors. Information is missing on the QA/QC applied. No residual uncertainty is included in the estimate. The within plot uncertainty should be low, the between plot uncertainty should be high.	L (bias/random)	NO	YES
Carbon fraction	S/R	Value taken from the literature. Hence it could lead to both random and systematic errors. The random error is usually considered to be low but the aggregated effect might be high. Different carbon fractions were applied to different parts of the tree in the plot measurements for the different pools so the expectation is that the aggregated value is as representative as possible. The carbon fraction could result in both systematic and random errors but by using different fractions for different pool components this error is expected to have been minimized. No residual uncertainty is included in the estimate.	H (bias/random)	NO	NO
Decomposition values	S/R	Uncertainty from decomposition values is assumed to have a low contribution because of the very small fraction of deadwood usually present in the forest. However in the specific case of this study some doubts were raised because of extremely high values of	H/L(random)	YES	NO

		deadwood in some cocoa areas. This was raised during the QA/QC revision and alternative default values were instead used. Yet we cannot calculate quantitatively the uncertainty because of the absence of within-plot data. The expected impact from the decomposition value on the overall uncertainty is medium (through random error) but the QA/QC (refer to SOPs) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.			
Removal aboveground biomass	S/R	Plantation AGB estimates are obtained from local documentation (for teak plantations) or IPCC default values (for other species) and are subject to random variation whose origins are difficult to identify and were given as a range. As such, they may increase total uncertainty. However, they are going to represent a small fraction of the overall uncertainty. The expected impact from the removal aboveground biomass estimates on the overall uncertainty is low (through both random and systematic error). No QA/QC was applied since these values were taken from literature and IPCC.	L (bias/random)	NO	YES
Root-to-shoot for removal factors	R	Root-to-shoot ratios tend to follow lognormal distributions. The mean value was taken from the refined IPCC (2019) default tables, which take them from Mokany et al. (2006). The IPCC tables take a SE value with asymmetric extreme values due to the lognormality of residuals stated by Mokany et al. (2006). Both mean and SE are used to calculate the lognormal distribution, after which values are back-transformed to natural (antilog) scales. Given the low contribution of removals overall to final emission reductions, they represent a very small contribution to overall uncertainty. The expected impact from the root-to-shoot values on the overall uncertainty is low (through random error). No QA/QC was applied since these values were taken from IPCC. No residual uncertainty is included in the estimate.	L (random)	NO	YES
Relative canopy cover reduction for degradation	S/R	Degradation is based on detected canopy cover reduction in a very small set of plots where it was detected. The variation is likely to be due mostly from sampling error over rare events. Since it is such a rare event, its contribution to overall uncertainty is small. The expected impact from the relative canopy cover reduction estimates on the overall uncertainty is low (through both random and systematic error) but the QA/QC (refer to SOPs) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	L(random/bias)	NO	YES

Representativeness error	S	LIDAR transects lines were parallel. Hence, a systematic approach relies over the overlapping of plots on these transect lines. As such we expect the possible bias due to representativeness to be minimized. Out of at total area of 15,153 km^2 of the study area, LiDAR scanning was required for only 770 km^2 (sampling intensity being 5.1%) (Sah et al. 2012) The expected impact from representativeness on the overall uncertainty is low (through systematic error). Information is missing on the QA/QC applied. No residual uncertainty is included in the estimate.	L (bias)	YES	NO
Integration					
Model	S/R	Integration of AD and EF through Monte Carlo can present potential biases and the random errors are naturally propagated. The combination of AD & EF does not necessarily need to result in additional uncertainty. Usually, sources of both random and systematic error are the calculations themselves and model errors in integration may arise because of the implicit simplifications in the actual mutiplication of AD x EF. Currently no correlations are considered in the calculations. While this may increase the random and systematic errors, it is a conservative approach. QA/QC processes in the preparation of the tool involved several revision processes and consultations in regard to the best PDFs to apply for every component of the simulation. The expected impact from the model (AD x EF) on the overall uncertainty is high (through both systematic and random error) but the QA/QC applied to the AD and EF calculations as described above should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H(bias/random)	YES	NO
Probability Density Functions	S/R	The model followed a parametric MC approach given the unreliability of a bootstrap for those rare cases which are present due to the relatively low sample size of the ground plots. The choice of PDF's may be a source of uncertainties. Most of the variables were fitted as Gaussian distributions and relative canopy cover reduction was fitted with a beta distribution. While ideally both should be truncated to avoid either rare negative numbers or fractions of canopy cover reduction above those permitted by the forest definitions, the lack of within-plot mean and standard error estimates considering truncated distributions makes the task impossible. However, overall these small deviations are likely representing very small errors, probably slightly biasing the overall median result.	H (bias/random)	YES	NO

		Hence the expected impact is likely to be overall low regarding both bias and random error. No residual uncertainty regarding the choice of PDF was included.			
Integration	S	This source of uncertainty is related to the lack of comparability between the transition classes of the AD and those of the EF. AD is estimated through remote-sensing observations, whereas EFs for a specific ecological zone were based on ground-based observations of the ecological zone. These may not be comparable, and it may represent a source of bias. QA/QC involved the fine tuning coordinates alignment of LIDAR transects and field plots (Chen et al. 2015). Furthermore, the assessment of forest degradation is as harmonized as possible since information on relative canopy cover reduction is used to approximate biomass loss. The difference between open and closed forest average biomass contents to approximate the degradation EF is a much poorer estimate since the observed plots show that in many cases of degradation in closed forest, the post-degradation canopy cover is not below 60%. The expected impact from integration on the overall uncertainty is high (through systematic error) but the QA/QC applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H (bias)	YES	NO

The following references are used in above table:

- *Chave, J., Réjou‐Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B., ... & Vieilledent, G. (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology, 20(10), 3177-3190.*
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- *Holdaway, R. J., McNeill, S. J., Mason, N. W., & Carswell, F. E. (2014). Propagating uncertainty in plot-based estimates of forest carbon stock and carbon stock change. Ecosystems, 17(4), 627-640.*
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- *Van Breugel, M., Ransijn, J., Craven, D., Bongers, F., & Hall, J. S. (2011). Estimating carbon stock in secondary forests: decisions and uncertainties associated with allometric biomass models. Forest ecology and management, 262(8), 1648-1657.*
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5.2 Uncertainty of the estimate of Emission Reductions

Parameters and assumptions used in the Monte Carlo method

Monte Carlo simulations were generated using Excel. Including all the parameters highlighted in the section below and the probability density functions justified in the table, 16,000 random values for each parameter were generated. While often MC simulations involve 10,000 values, we forced the number of values to the maximum limit allowed by Excel, to reduce the small deviations coming out from different runs. Although full stability of estimates was still not achieved, final ER uncertainties were seen to deviate with maximum values 0.2% every time random values are refreshed, which was considered precise enough for the uncertainty reporting, given that these deviations are always far from crossing the resulting uncertainty discount threshold for 8%. Following IPCC (2006) chapter 3, Ghana deemed that only two parameters needed non-Gaussian (i.e., non-normal) PDF's (see table below): those regarding root-to-shoot ratios, and those regarding canopy cover reduction for the detection of forest degradation. Since non-normal PDFs are used, the Monte Carlo approach is justified. Correlations in EFs were not considered, due to a lack of within-plot uncertainty data availability. Following the guidelines, the MC approach generated trend estimates through simulation of activity data each year, while maintaining constant EFs due to assumed full correlations of EFs between years.

Parameter included in the model	Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
General factors				
Ratio of molecular weights	3.667	Not applicable	Fixed	
Carbon fraction	0.470	Uncertainty ranges as provided in sources	Normal	IPCC (2006). Chapter 4. Table 4.3. Normality assumption following Chabi et al. (2019)
Days applicable to ER in 2019	203	Not applicable	Fixed	
Biomass measurements				
AGB (tC /ha) Open All forest	27.4	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
AGB (tC /ha) Closed Wet Evergreen	81.3	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
AGB (tC /ha) Closed Moist Evergreen	202.9	Sampling error	Normal	Representative, raw data not available. Normality

				assumption as in Chave et al. (2004)
AGB (tC /ha) Closed Moist Semideciduous SE	100.5	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
AGB (tC /ha) Closed Moist Semideciduous NW	75.9	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
AGB (tC /ha) Closed Upland Evergreen	74.6	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
BGB (tC /ha) Open All forest	10.4	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
BGB (tC /ha) Closed Wet Evergreen	10.5	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
BGB (tC /ha) Closed Moist Evergreen	26.8	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
BGB (tC /ha) Closed Moist Semideciduous SE	25.8	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
BGB (tC /ha) Closed Moist Semideciduous NW	19.0	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
BGB (tC /ha) Closed Upland Evergreen	24.1	Sampling error	Normal	Representative, raw data not available. Normality assumption from the multiplication of a constant root:shoot ratio times AGB
DW (tC /ha) Open All forest	20.5	Sampling error	Normal	Representative, raw data not available. Normality

				assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
DW (tC /ha) Closed Wet Evergreen	29.0	Sampling error	Normal	Representative, raw data not available. Normality assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
DW (tC /ha) Closed Moist Evergreen	18.3	Sampling error	Normal	Representative, raw data not available. Normality assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
DW (tC /ha) Closed Moist Semideciduous SE	65.8	Sampling error	Normal	Representative, raw data not available. Normality assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
DW (tC /ha) Closed Moist Semideciduous NW	38.6	Sampling error	Normal	Representative, raw data not available. Normality assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
DW (tC /ha) Closed Upland Evergreen	41.9	Sampling error	Normal	Representative, raw data not available. Normality assumption from the mean estimator of independent line transects, as in Affleck et al. (2005)
L (tC /ha) Open All forest	2.6	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Tuomi et al. (2009)
L (tC /ha) Closed Wet Evergreen	3.0	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Tuomi et al. (2009)
L (tC /ha) Closed Moist Evergreen	3.3	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Tuomi et al. (2009)
L (tC /ha) Closed Moist Semideciduous SE	2.9	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Tuomi et al. (2009)
L (tC /ha) Closed Moist Semideciduous NW	2.4	Sampling error	Normal	Representative, raw data not available. Normality

				assumption as in Tuomi et al. (2009)
L (tC /ha) Closed Upland Evergreen	1.4	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Tuomi et al. (2009)
SOC (tC /ha) Open All forest	9.9	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
SOC (tC /ha) Closed Wet Evergreen	16.0	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
SOC (tC /ha) Closed Moist Evergreen	17.0	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
SOC (tC /ha) Closed Moist Semideciduous SE	7.6	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
SOC (tC /ha) Closed Moist Semideciduous NW	12.7	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
SOC (tC /ha) Closed Upland Evergreen	15.1	Sampling error	Normal	Representative, raw data not available. Normality assumption as in the IPCC EF database (https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php)
post-Def LU (tC /ha) Open All forest (simplified average)	15.1	Sampling error	Normal	Representative, raw data not available. Normality assumption from error

				propagation between two random normal variables.
post-Def LU (tC /ha) Closed Wet Evergreen	15.2	Sampling error	Normal	Representative, raw data not available. Normality assumption from error propagation between two random normal variables
post-Def LU (tC /ha) Closed Moist Evergreen	14.1	Sampling error	Normal	Representative, raw data not available. Normality assumption from error propagation between two random normal variables
post-Def LU (tC /ha) Closed Moist Semideciduous SE	14.8	Sampling error	Normal	Representative, raw data not available. Normality assumption from error propagation between two random normal variables
post-Def LU (tC /ha) Closed Moist Semideciduous NW	17.2	Sampling error	Normal	Representative, raw data not available. Normality assumption from error propagation between two random normal variables
post-Def LU (tC /ha) Closed Upland Evergreen	14.0	Sampling error	Normal	Representative, raw data not available. Normality assumption from error propagation between two random normal variables
Monitored values deforestation 2005-2014				
AD (ha /yr) Open All forest	4,756	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Wet Evergreen	304	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	1,728	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous SE	1,078	Sampling error	Normal	Representative, raw data available . Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous NW	1,171	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Upland Evergreen	160	Sampling error	Normal	Representative, raw data available . Central limit theorem: binomial approaches normal.

Monitored values deforestation 2019				
AD (ha /yr) Open All forest	1,924	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Wet Evergreen	0	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	0	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous SE	0	Sampling error	Normal	Representative, raw data available . Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous NW	619	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Upland Evergreen	0	Sampling error	Normal	Representative, raw data available . Central limit theorem: binomial approaches normal.
Planting (net areas, discounted for annual survival rates)				
Area established (ha) teak 2005 (ha)	1,419	Not applicable	Fixed	
Area established (ha) teak 2006 (ha)	1,419	Not applicable	Fixed	
Area established (ha) teak 2007 (ha)	1,422	Not applicable	Fixed	
Area established (ha) teak 2008 (ha)	1,422	Not applicable	Fixed	
Area established (ha) teak 2009 (ha)	1,422	Not applicable	Fixed	
Area established (ha) teak 2010 (ha)	1,388	Not applicable	Fixed	
Area established (ha) teak 2011 (ha)	1,589	Not applicable	Fixed	
Area established (ha) teak 2012 (ha)	1,534	Not applicable	Fixed	
Area established (ha) teak 2013 (ha)	1,185	Not applicable	Fixed	
Area established (ha) teak 2014 (ha)	602	Not applicable	Fixed	
Area established (ha) non teak 2005 (ha)	608	Not applicable	Fixed	
Area established (ha) non teak 2006 (ha)	608	Not applicable	Fixed	

Area established (ha) non teak 2007 (ha)	609	Not applicable	Fixed	
Area established (ha) non teak 2008 (ha)	609	Not applicable	Fixed	
Area established (ha) non teak 2009 (ha)	609	Not applicable	Fixed	
Area established (ha) non teak 2010 (ha)	595	Not applicable	Fixed	
Area established (ha) non teak 2011 (ha)	681	Not applicable	Fixed	
Area established (ha) non teak 2012 (ha)	658	Not applicable	Fixed	
Area established (ha) non teak 2013 (ha)	508	Not applicable	Fixed	
Area established (ha) non teak 2014 (ha)	258	Not applicable	Fixed	
Removal factors				
Average stock AGB+BGB (tC /ha) teak	97.690	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
Growth period (years) teak	25	Not applicable	Fixed	
Average stock AGB (t d.m. /ha) non teak	173.300	Sampling error	Normal	Representative, raw data not available. Normality assumption as in Chave et al. (2004)
RSR non teak	0.240	Uncertainty ranges as provided in sources	Lognormal	Representative, raw data not available. Log-normality assumption as in Mokany et al. (2006)
Growth period (years) non teak	40	Not applicable	Fixed	
Removals from planting 2018-2019				
Area planted (ha) teak 2018 (ha)	7749.35	Not applicable	Fixed	
Area planted (ha) teak 2019 (ha)	9504.614	Not applicable	Fixed	
Area planted (ha) non teak 2018 (ha)	3321.15	Not applicable	Fixed	
Area planted (ha) non teak 2019 (ha)	4073.406	Not applicable	Fixed	
EF forest degradation				
Relative canopy cover reduction Open	0.480	Sampling error	Beta	Representative, raw data available. Beta distribution as in Ferrari & Cribari-Neto

				(2004) and Korhonen et al. (2007)
Relative canopy cover reduction Closed	0.299	Sampling error	Beta	Representative, raw data available. Beta distribution as in Ferrari & Cribari-Neto (2004) and Korhonen et al. (2007)
Monitored values degradation 2005-2014				
AD (ha /yr) Open All forest	375	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Wet Evergreen	304	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	1,153	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous SE	1,270	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous NW	1,354	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Upland Evergreen	80	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
Monitored values degradation 2019				
AD (ha /yr) Open All forest	0	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Wet Evergreen	607	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	1,282	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous SE	4,426	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous NW	3,095	Sampling error	Normal	Representative, raw data available. Central limit

				theorem: binomial approaches normal.
AD (ha /yr) Closed Upland Evergreen	0	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.

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The following summarizes the selection of PDF through testing the goodness of fit:

- *Deforestation area: Deforestation area is measured through binary observations of deforestation / no-deforestation over a large number of sample plots. The total deforestation area corresponds to the counts of deforestation observations multiplied with an area factor. Such binary observations are, evidently, binomially distributed, a formal goodness-of-fit test is not necessary. The probability of deforestation is then calculated from several thousand such binary distributions. Since it is the sum of a large number of random variables, it is normally distributed. The simulation of the deforestation area can therefore employ a normal distribution with the sample mean and its standard error as coefficients.*
- *Root-to-shoot ratio for removal factors in non-teak: Root-to-shoot ratios tend to follow lognormal distributions. The mean value was taken from the refined IPCC (2019) default tables, which take them from Mokany et al. (2006). The IPCC tables take a SE value with asymmetric extreme values due to the lognormality of residuals stated by Mokany et al. (2006). Both mean and SE are used to calculate the lognormal distribution, after which values are back-transformed to natural (antilog) scales.*
- *Relative canopy cover reduction: The relative canopy cover reduction upon forest degradation was measured for 137 sample locations. A sample mean and sample standard deviation could be estimated. In a first step, five statistical distributions were tested for their goodness of fit (normal, exponential, Poisson, uniform and beta), with the beta distribution having the best chi-squared statistic. It was therefore chosen to most accurate represent the distribution of relative canopy cover reduction. In a second step, the fitted beta distribution was employed to simulate the means over 137 sample locations for 1000 iterations. In a third step, the resulting statistical distribution of 1000 sample means was again fitted to the beta distribution, which could be used for the Monte Carlo model.*
- *Forest degradation area: The same reasoning applies as for the deforestation area as the same measurement approach was used.*

Quantification of the uncertainty of the estimate of Emission Reductions

In below table the emission reduction estimates in the first column include forest degradation. The values in the second column on forest degradation have been reported for information only. For the uncertainty discount, the value of the aggregate estimate in the first column has been used.

		Total Emission Reductions*
A	**Median**	1,523,255
B	**Upper bound 90% CI** (Percentile 0.95)	2,380,459
C	**Lower bound 90% CI** (Percentile 0.05)	715,333
D	**Half Width Confidence Interval at 90% (B – C / 2)**	832,563
E	**Relative margin (D / A)**	55%
F	**Uncertainty discount**	8%

*Remove forest degradation if forest degradation has been estimated with proxy data.

5.3 Sensitivity analysis and identification of areas of improvement of MRV system

Referring to criterion 7 and indicators 9.2 and 9.3 of the Methodological Framework and the Guideline on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions, a sensitivity analysis was undertaken to identify the relative contribution of each parameter to the overall uncertainty of Emission Reductions. The sensitivity analysis was conducted by "switching off" the sources of uncertainty one at a time and assessing the impact on the overall uncertainty of emission reductions.

The results of the sensitivity analysis were the following:

Scenario	ER Uncertainty 90%	Difference to ER Uncertainty 90% of all parameters
All parameters	55%	0%
No Deforestation	34%	-21%
No Forest degradation	44%	-11%
No Enhancement	55%	0%
No EF	49%	-6%
No AD	22%	-33%
No Deforestation AD	38%	-17%
No Deforestation EF	51%	-4%
No Forest degradation AD	43%	-12%
No Forest degradation EF	55%	0%

No Enhancement AD	55%	0%
No Enhancement EF	55.%	0%

The difference in the uncertainty of emissions reductions (right column in the table) with respect to the uncertainty in the reference level where all parameters are considered clearly shows a possible hierarchy of parameter importance when it comes to consideration of important error sources open for improvement in monitoring. Improvements in AD estimation have, for example, the potential to reduce the current ER uncertainty by 33% (overall ER uncertainty for all parameters being 55% vs. overall ER uncertainty when AD presents no errors being 22%). Given this prioritization, several overall improvements can be perceived.

Improved monitoring of activity data is likely to largely contribute to uncertainty decreases in emission reductions. Possible future actions may include larger sampling efforts in conjunction with the use of higher-resolution imagery that will likely be available for future years. Currently Ghana has built Standard Operating Procedures for area estimation that will reinforce the training of interpreters to minimize both systematic and random errors in area estimation:

1. *Given that deforestation is the reported activity currently providing a larger sensitivity in activity data monitoring (17%), special efforts should be put into improved detection of deforestation. It is assumed that the future use of post-stratification over dense systematic grids (part of the larger sampling effort) will significantly contribute to overall decreases in uncertainty of ER.*
2. *Forest degradation in AD monitoring shows slightly less sensitivity (12%). However, it is expected that the uncertainty due to forest degradation should also diminish with the improvements from high resolution imagery, which will allow to finely detect changes in canopy cover.*

6 TRANSFER OF TITLE TO ERS

6.1 Ability to transfer title

>>>> The ability of the Forestry commission (FC) to transfer title of Emission Reductions is clear and there is no contesting party to that effect. Evidence demonstrating the FC's ability to transfer title has already been submitted to the Carbon Fund via letter referenced FC/A.10/sf.21/v.6/139 dated 3rd February 2020 (attached as appendix 3)

6.2 Implementation and operation of Program and Projects Data Management System

>>>> Currently in Ghana, no entity has the right to claim ownership of title to ERs. Therefore, there is no threat of multiple claim to an ER title. The Forestry Commission working in close collaboration with the Ghana Cocoa Board is authorized by the Government of Ghana through the Minister of Finance to implement the Program. Subsequently,

The FC has subsequently developed a Ghana REDD+ Data Hub (www.ghanaredddatahub.org) that provides information on the Program including details on the geographic boundaries of the program, the carbon pools, and the reference level. The reference level has subsequently been amended. The data hub would display the amount of ERs that would be transferred to the Carbon Fund with the associated reversal and uncertainty buffer accounts. This would ensure transparency of the process.

Details of the amendment are attached in annex 4

6.3 Implementation and operation of ER transaction registry

>> The Government of Ghana through the FC has communicated to the Carbon Fund to use the FCPF's ER Transaction Registry so the responsibilities of the Registry Administration and buffer management will fall on the trustee of the Carbon fund.

6.4 ERs transferred to other entities or other schemes

Intentionally left blank

7 REVERSALS

7.1 Occurrence of major events or changes in ER Program circumstances that might have led to the Reversals during the Reporting Period compared to the previous Reporting Period(s)

Intentionally left blank

7.2 Quantification of Reversals during the Reporting Period

Intentionally left blank

7.3 Reversal risk assessment

The reversal risk assessment using the CF Buffer Guidelines has not changed since the preparation of the revised final ERPD.

Risk Factor	Risk indicators	Default Reversal Risk Set-Aside Percentage	Discount	Resulting reversal risk set-aside percentage
Default risk	*N/A*	**10%**	*N/A*	*10%*
Lack of broad and sustained stakeholder support	There is low stakeholder risk as the programme has clearly identified its main stakeholders and a high degree of formal and informal consultations were undertaken during the design phase (reference ERPD Section 5 pgs 70-81). Extensive further engagements /consultations/capacity building on specific issues (Benefit Sharing, Safeguards, governance) have continued across the HIAs (https://reddsis.fcghana.org/documents.php)	**10%**	*Reversal risk is considered low 10%-10%=0% discount*	*0%*

	In line with the program design, the in-depth participation of cocoa farmers, their rural communities, women, and the private sector and farmer associations, and the HIA-Consortium structure ensures a high degree of buy-in. This is evident in the signing of the first framework agreement with the Juaboso/Bia HMB (appendix 4) There was a risk that broad support would not be provided during the early phase of implementation, this risk was mitigated early in the project cycle through official launch of the programme by the President of Ghana[7], broad community consultation involving all stakeholders, especially traditional authorities, community elders, and other key persons. The consultation process served to manage community expectations, increase ownership, inclusiveness, and ensure sustainability while garnering broad community support (refer to table 1 which gives further details of work in the various HIAs). These activities were buttressed by the implementation of safeguards and grievance redress mechanisms under the programme (details of safeguards and grievance redress mechanisms in annexes 1 &2). In addition the existence of the following mitigates this risk: • Benefit Sharing Plan, which is being operationalized • Existence of Process Framework Document • Signing of Memorandum of Understanding with partner institutions[8]			
Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination	The risks associated with institutional capacity for implementation and sustainability are listed as medium. At the start of REDD+ and the GCFRP in Ghana, institutional capacity was relatively low, however, capacity is being strengthened through numerous trainings and workshops (https://reddsis.fcghana.org/documents.php) at the National and landscape levels, and Ghana's capacity to implement this programme has further improved.	**10%**	Reversal risk is considered Medium: 10% - 5% = 5% discount	*5%*

[7] https://www.ghanaweb.com/GhanaHomePage/business/Ghana-signs-agreement-with-cocoa-and-chocolate-companies-to-protect-and-restore-forests-1234705

[8] https://www.confectionerynews.com/Article/2021/04/15/Cocoa-companies-forge-new-partnership-with-Ghana-to-protect-and-restore-forests

	For example, in the past, there was weak cross-sectoral coordination amongst the lead institutions, the Forestry Commission and the Ghana Cocoa Board. This has now changed as evidenced by the coordination required to design and implement this programme as well as the Forest Investment Program (FIP). Moreover, The CEOs of the FC and Cocobod sign the framework agreements with the HMBs (refer to appendix 4) Another evidence is the key roles played by the various stakeholders to produce Ghana's first monitoring report (section 9.2) The complexity of the institutional and implementation arrangements for coordinating, verifying, receiving and disbursing ER payments at a programmatic scale of this size is a challenge for the GCFRP. This is being mitigated with the procurement of the consultancy to develop fund flow mechanism in line with the Benefit Sharing Plan (ToR of consultancy in Annex 6 of BSP). By the consultancy end date, the HIA accounts will have been set up for at least four HIAs (Juabeso/Bia, Kakum, Asutifi-Asunafo, Sefwi-Wiawso) with significant progress on Governance structures also completed within same timeframe. Again, as indicated in the BSP, by the end of year 2021, Hotspot Implementation Committees would have been formed in at least four HIAs mentioned. This would enhance implementation at the HIA level. Overall, the coordination across natural resource-related agencies (environment, forestry, agriculture, cocoa, water, minerals, and energy) at the local and national levels combined with: (i) the complexity of monitoring requirements for performance-based carbon finance; and (ii) the complexity of orchestrating hundreds of thousands of land-users to act toward common goals of forest conservation and climate-smart cocoa agriculture is acknowledged to be a medium risk. Since the GCFRP began, Ghana continues to identify interventions[9]/initiatives (cocoa & forest Initiative), which enhance annual work planning and budgeting across sectors and projects operating within the GCFRP. In addition, the program has sought to enhance safeguards implementation (annex 1 of this			

[9] http://reddsis.fcghana.org/projects.php?id=4 ,

	report) and has ensured delivery of operational and coordination requirements. Finally, the programs strategy focusses on interventions in decentralized deforestation hotspots (table 1), which given the emissions reductions reported in this document highlights that the program has successfully mitigated the risk associated with institutional capacity. In addition, the following also mitigate this risk • Forestry Commission and Ghana cocoa Board Regional and District Offices are located in all the programme areas and thus have the requisite staff to execute the programme and coordinate activities at the landscape level • FC has lots of experiences in the implementation of projects that involve other agencies in Ghana. The projects include the Forest Investment Programme, Natural resources Environment Programme, Sustainable Land and water Management Project) • Existence of the GCFRP Implementation Committee with membership from FC, Cocobod and World Cocoa Foundation to guide operational activities			
Lack of long term effectiveness in addressing underlying drivers	The programme interventions have directly focused efforts on two of the main drivers and agents of deforestation and degradation in the region (cocoa/subsistence farming and unsustainable logging). The risks from cocoa farming and subsistence agriculture have been mitigated through the direct engagement of agents in programme interventions through the formation of the HMBs and signing of framework agreements (table 1) These agents are also unlikely to migrate within or outside the program area and thus the risk of displacement is low. This is because Cocoa production mainly thrives in the Programme area in Ghana[10] Risks associated with illegal logging was considered low. As indicated in the ERPD, the risk of illegal logging is mitigated by both hard and soft	**5%**	Reversal risk is considered Medium: 5% - 3% = 2% discount	*2%*

[10] Ghana Cocoa Board Research and Monitoring Department.

	approaches. The FC has increased its law enforcement role by deploying the Rapid Response Unit to augment the roles of Resource Guards in flash points where there are constant reports of illegal logging. As part of the VPA FLEGT process, there has been a reform in the regulation of timber utilization in Ghana, thus there is a new legislative Instrument to regulate the utilization of timber resources (http://www.fao.org/faolex/results/details/en/c/LEX-FAOC173919/). Through this process, there is a legal assurance for timber production and utilization in Ghana. Ghana looks forward to issuing the first FLEGT License by end of first quarter 2022. Also, as part of the by-laws of HMBs, they assist in the protection of the forest resources The risk from illegal small-scale mining was also considered medium. Landowners were not considered migratory, though some of the agents were. Increased income from climate-smart agriculture and other benefits is helping to mitigate the opportunity cost. Again, Government has also introduced community mining schemes[11] to guide community level mining in sustainable manner. In addition, lessons learnt from the successful implementation of the FIP which is a pilot to the GCFRP are being used to address the underlying drivers (provision of Alternative/ additional livelihood options, key legislative reforms). The REDD+ strategy and the ERPD give a clear direction (at least 20 years) on the implementation of the program beyond the ERPA period. The program primarily targets sustainable cocoa productions and this commodity is a high exchange earner for Ghana. Therefore, governments always pay attention to this sector and hence the programme would persist the ERPA period.			
Exposure and vulnerability to natural disturbances	This risk associated with natural disturbances remains low. The main natural risk in the GCFRP accounting area is forest fires. Generally, the occurrence of uncontrolled forest fires may happen as a result of illegal practices related to , land	**5%**	*Reversal risk is considered Low*	*0%*

[11] https://presidency.gov.gh/index.php/briefing-room/news-style-2/1653-new-community-mining-schemes-to-create-12-000-jobs-at-aboso-gwira-akango-president-akufo-addo

	clearing, charcoal production, and as a result of dry years (El Nino events). The programme has mitigated the risk of forest fires by strengthening fire management and control units at the Forestry Commission, district assemblies, and fire volunteers etc. The FC also implemented the Wild Fire Management Project (2000-2008) and has therefore gained lots of experience in the management of wildfires in Ghana. A Manual of Procedure to guide FC staff in the management of fires has also been produced. This is currently being reviewed and may be ready by end of March, 2022. Better land use planning with the development and operationalization of HIA management plans would ensure forests remain healthy and less susceptible to fires. The HIA management plans for both Juaboso/Bia and Asutifi/Asunafo HIAs would be ready by end of year 2021. Again, the promotion of Climate Smart Cocoa practices is one of the pillars of this programme and this would mitigate the effect of climate change on cocoa production systems (ERPD page 55).		*5% - 5% =0%*	
		Total reversal risk set-aside percentage		*17%*
		Total reversal risk set-aside percentage from ER-PD or previous monitoring report (whichever is more recent)		*17%*

8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

A.	**Emission Reductions during the Reporting period (tCO_2-e)**	*from section 4.3*	1,530,111
B.	**If applicable, number of Emission Reductions from reducing forest degradation that have been estimated using proxy-based estimation approaches (use zero if not applicable)**		N.A.
C.	**Number of Emission Reductions estimated using measurement approaches (A-B)**		1,530,111
D.	**Conservativeness Factor to reflect the level of uncertainty from non-proxy based approaches associated with the estimation of ERs during the Crediting Period**	*from section 5.2*	8%
E.	**Calculate (0.15 * B) + (C * D)**		122,409
F.	**Emission Reductions after uncertainty set-aside (A – E)**		1,407,702
G.	**Number of ERs for which the ability to transfer Title to ERs is still unclear or contested at the time of transfer of ERs**	*from section 6.1*	
H.	**ERs sold, assigned or otherwise used by any other entity for sale, public relations, compliance or any other purpose including ERs that have been set-aside to meet Reversal management requirements under other GHG accounting schemes**	*From section 6.4*	
I.	**Potential ERs that can be transferred to the Carbon Fund before reversal risk set-aside (F – G – H))**		1,407,702
J.	**Total reversal risk set-aside percentage applied to the ER program**	*From section 7.3*	17%
K.	**Quantity of ERs to allocated to the Reversal Buffer and the Pooled Reversal Buffer (multiply I and J)**		239,309
L.	**Number of FCPF ERs (I – L).**		1,168,393

ANNEX 1: INFORMATION ON THE IMPLEMENTATION OF THE SAFEGUARDS PLANS

I. *Requirements of FCPF on Managing the Environmental and Social Aspects of ER Programs*

SAFEGUARDS

A Strategic Environmental and Social Assessment (SESA) [12] was conducted in 2014 and updated in 2016 to better understand the social and environmental issues within the Ghana Cocoa Forest REDD+ Programme (GCFRP) area. The SESA process went through a wide stakeholder consultative process from sub-national consultations to national validation workshops. At least, 600 key stakeholders were consulted during the SESA process. Out of this number, 260 were females and 340 were males. The list of the key stakeholders consulted are indicated in Table 7 below.

Table 7 List of key stakeholders consulted during the SESA process

WESTERN REGION

Contact person	Location	Position	Contact number	Date
Mrs Lydia Opoku	Kumasi	Regional Manager		18-26/03/2014
Emmanuel Yeboah		Assistant Regional Manager	0200373979	
Samuel Agyei-Kusi			0270454066	
Augustine Gyedu		Assistant Regional Manager	0208170822	
S. A. Nyantakyi		Assistant District Manager	0243102830	
Felix Nani		Acting Manager	0206289085	
Ezekiel Bannyemanyea		Community Affairs	0207601311/0245852247	
Bismark Ackah		Registry	0206770907	
Bona Kyiire		Assistant Wildlife Officer	0244505192	
Papa Kwao Quansah		Tourism Officer	0205957949	
Mr. Fosu Lawrence		FSD, District Manager	0244581957	
Mr. Okyere Darko		OASL, District Officer	0244241034	
Mr. Oduro Boampong		Aowin District Assembly-DPO	0244830698	
Mr. Yaw Adu		MOFA, District Director	0249105224	
Mr. Felix Appiah		District Cocoa Officer CSSVD/Extension	0203733102	

[12] Link to SESA report - https://reddsis.fcghana.org/admin/controller/publications/SESA%20Final%20Report-Safeguard-Final%20SESA%20Report-Dec%202017.docx

Contact person	Location	Position	Contact number	Date
Mr. Samuel Obosu		SWMA-MPO	0244433031	
Mr. Andrew Ackah		OASL-Municipal Officer	0243684078	
Mr. Issah Alhassan		CHRAJ-Municipal Officer	0240195541	
Mr. Samuel Amponsah		COCOBOD-Regional CSD Head	0244560785	
Mr. George Dery		FSD-District Manager	0244684857	
Mr. Justice Niyuo		FSD Assistant District Manager	0242171767	
Dr. Benjamin Donkor		Executive Director	0203893725	
Mr. Yaw Kumi		Contracts & Permits Manager	0244503857	
Mr. Faakye Collins		Timber Grading & Inspection Manager	0208135037	
Mr. Peter Zomelo		Trade & Industry Development Manager	0244376246	

Jomoro District
Amokwah CREMA

Contact person	Position	Contact number	Date
Paul Kodjo	Chairman,	0208412085	21-03-2014
Barima Moro	Executive member	0209167883	
Ama Foriwaa	Executive member	0209874607	

Nsuano Community

No.	Name	Position/Designation	Age	Occupation	Date
Men					21-03-2014
1	John Amponsah	CEC Secretary	58	Farmer	
2	Nana Mbala	Chief of Nsuano		Farmer	
3	Samuel Akowa	Chief-Tenant farmers		Farmer	
4	Francis Amo	Youth Leader		Farmer	
5	Lolonyo			Farmer	
6	Kofi Kusase			Farmer	
7	Agyemang Nketia	Elder/Opinion Leader		Farmer	
8	Ewoku Ndele	Linguist		Farmer	
9	Nuro James		37	Farmer	
10	Collins Coffie		22	Farmer	
11	Sampson Kombate		32	Farmer	
12	Issa Alhassan		41	Business man	
13	Kwabena Peter		34	Farmer	
14	Yaw Abanga		31	Farmer	
15	Appiah Josh		34	Farmer	
16	Ohene George		33	Farmer	
17	Zufura Seidu		43	Farmer	
18	Musah Anbela		48	Farmer	
19	Opanin Samuel Obuobi		60	Farmer	
20	Kwame Manu		38	Farmer	

21	Nana Yaw	Ahohohene	59	Farmer	
22	Robert Gyimah		46	Farmer	
23	Augustine Tawiah		34	Farmer	
Women					
1	Beatrice Afrifa		28	Trader	
2	Patricia Amedi		22	Trader	
3	Grace Anamba		42	Farmer	
4	Charlotte Amponsah		33	Business woman	
5	Irene Amedi		26	Business woman	
6	Diana Nyuenmawor		25	Farmer	
7	Ama Musah		42	Farmer	
8	Christina Ehimaa		35	Farmer	
9	Vida Nyarko		45	Farmer	
10	Faustina Anaaba		24	Farmer	
11	Margaret Fosuaa		32	Farmer	
12	Akua Abulaih		24	Farmer	
13	Faustina Ohenewaa		39	Farmer	
14	Rashalutu Alhassan		45	Farmer	
15	Hawa Groma		65	Farmer	
16	Faustina Afia Nyamekye	CEC Treasurer	53	Farmer/Business woman	
17	Sophia Ackah		51	Farmer/Business woman	

Sefwi Wiawso District
Akurafo Community

No.	Name	Position/Designation	Age	Occupation	Date
Men					22-03-2014
1	Atta Kofi		48	Suhuma Timber Co	
2	Nana Yaw Fosu	Nkosohene	40	Farmer	
3	Yaw Gyabeng		60	Farmer	
4	Joseph Boakye		45	Storekeeper	
5	David Nsowah		85	Farmer	
6	Osumanu Mohammed		35	Farmer	
7	Seidu Patron		49	Farmer	
8	Opong Frimpong		35	SPU-Cocobod	
9	Isaac Sampa	Assemblyman	35	SPU-Cocobod	
10	Joseph Sarkodie		40	Farmer	
11	Osuman K. Oppong		73	Farmer	
12	Thomas Sampa		25	Farmer	
13	Kofi Abudu		48	Farmer	
14	Kwame Sumaila		35	SPU-Cocobod	
15	E. A. Sampah		72	Farmer	
16	Nicholas Armah		68	Farmer	
17	Samuel K. Baah		60	Farmer	
18	Gidi Kwesi		29	Farmer	
19	Kwame Owusu		45	CSSCD	
20	L. B. Kuranteng		64	Farmer	
21	Emmanuel Abusale		45	Farmer	
22	Sapato Ocloo		51	Agriculturalist	
23	Asuntaaba Atingah		35	Farmer	

24	Inusah Mohammed		54	Agriculturalist	
25	Edward Mensah		16	Pupil	
26	Sampa Daniel		18	Mechanic	
27	Emmanuel Tuona		20	Mechanic	
28	Abdela Mohammed		18	Pupil	
29	Kofi Gyamfi		31	Farmer	
30	Ebenezer Coffie		26	Farmer	
Women					
1	Christiana Owusu		54	SPU-Cocobod	
2	Hannah Mesumekyere		70	Farmer	
3	Ama Konadu		67	Farmer	
4	Lardi Adu		60	Farmer	
5	Yaa Mary		31	Farmer	
6	Felicia Nsowah		36	Farmer	
7	Adama Asante		82	Farmer	
8	Mary Armah		70	Farmer	
9	Amina Attah		106	Farmer	

Kunuma community

No.	Name	Position/Designation	Age	Occupation	Phone contact	Date
Men						
1	Bona Isaac		39	Teacher	0242541653	24-03-2014
2	Kyere Dacosta		26	Farmer	0248994346	
3	Opoku Antwi		27	Farmer	0549260706	
4	Freeman Dollar		54	Farmer	0246519040	
5	Nana Boamah	Reagent	70	Farmer		
6	Abu Sulam	Assemblyman	46	Farmer	0240849350	
7	Osei George	Unit Committee member	40	Farmer	0241988330	
8	Boamah Stephen		30	Farmer	0242072936	
9	Mammud Moro		38	Farmer	0240170484	
10	Kwasi Badu		64	Farmer		
11	John Azubi		53	Farmer	0543648473	
12	Philip Gyabeng		42	Farmer	0243753771	
13	Kwasi Ninkyin		35	Farmer	0246559443	
14	Appiah Isaac		41	Farmer	0540560701	
15	Charles Yaw		37	Farmer		
16	Michael Nkuah		60	Farmer	0247113896	
17	Jacob Ackaah		46	Farmer	0548789780	
18	Ibrahim Alhassan		39	Farmer	0242549346	
19	George Opoku Mensah		47	Driver		
20	Amoah Johnson (K.O)		47	Farmer		
21	Adu Frimpong		50	Farmer		
22	Opanyin Kwame owusu		89	Farmer		
23	John Boadu		59	Farmer		
24	Paul Yeboah		47	Farmer		
25	Kwadwo Nyarko		56	Farmer		
26	Anthony Osei		27	Farmer		
27	Joseph Alhassan		32	Farmer		

28	Elder Asiedu		64	Farmer	0249233768	
29	Kwabena Kra		42	Farmer	0541784659	
30	Kwadwo Fodwo		70	Farmer		
31	Vincent Kwarteng		29	Farmer	0246831047	
32	Gyabeng Daniel		31	Farmer		
33	Attah Kofi		45	Farmer		
34	Thomas Baidu		57	Farmer		
35	Teacher Attah		55	Teacher/Farmer		
36	Kwabena Prah		39	Farmer		
37	Teacher Amoah		54	Teacher/Farmer	0248694596	
38	Kofi Oduro		31	Farmer	0248907968	
39	Kwabena Abokye		39	Farmer	0209285024	
40	Asumang Adu Benedict		26	Farmer	0240877735	
41	Sulley Mbugre		42	Farmer	0245128446	
42	Asante Richmond		29	Farmer	0244562794	
43	Musah Gjaro		70	Farmer		
Women						
1	Naomi Appiah		30	Farmer	0249091093	
2	Agatha Kwesi		67	Farmer		
3	Ama Antobam		67	Farmer		
4	Rebecca Kyei		35	Farmer	0274386626	
5	Cecilia Mensah		42	Farmer		
6	Charity Afful		25	Farmer		
7	Grace Brun		45	Farmer		
8	Agnes Asoh		45	Farmer		
9	Alimatu Gjaro		27	Farmer		
10	Akosua Boatema		45	Farmer		
11	Mercy Oduro		26	Farmer		
12	Akosua Vivian		30	Farmer		
13	Adwoa Broni		55	Farmer		
14	Gloria Fosuah		36	Farmer		
15	Cynthia Yeboah		29	Farmer		
16	Theresa Nsiah		40	Farmer		
17	Vivian Owusu		43	Farmer		
18	Abena Gyaako		32	Farmer		
19	Margaret Opoku		52	Farmer		
20	Nana Ama		33	Farmer		
21	Akyaa Nyame		45	Farmer		
22	Zinabu Lareba		40	Farmer		
23	Abena Badu		29	Farmer		
24	Georgina Mensah		30	Farmer		
25	Charlotte Asante		22	Farmer	0540827119	
26	Yaa Tano		25	Farmer	0548757849	
27	Serwaah Mokuah		38	Farmer		
28	Faustina Opoku		37	Farmer	0242262780	
29	Mary Nkrumah		55	Farmer		
30	Grace Mensah		30	Farmer		
31	Dede Faustina		30	Farmer		
32	Ama Nyame		70	Farmer		

33	Mary Agyeman		26	Farmer		

CENTRAL REGION

Contact person	Position	Contact number	Date
Assin Fosu District			
Mr. Kyei Samuel	FSD-District Manager	0248991337	25-03-2014
Mr. Nifaa Boyir Chrisantus	FSD-Assistant District Manager	0208988256	
Rose Adjei Okyere	FSD-Technical Officer/Ranger		
Mr. Jonathan McCarthy	MOFA-Extension Officer	0242211477	
Mr. Samuel Bawah	MOFA Crops Officer	0244946406	
Mr. Samuel Kwakye	Project Coordinator-Oasis Foundation International	0264057217	
Mr. Yaw Ansah	Chairperson-Artisanal Sawn Mill Association	0247101421	
Mallam Yahaya	Member/Truck Driver-Artisanal Sawn Mill Association	0540583786	
S. K. Boafo	Member- Artisanal Sawn Mill Association		
Cape Coast			
Mr. Asiedu Okrah	FSD-District Manager		
Mr. Daniel Adjei	FSD-Asst district manager		
Ms Eunice Ompon Peprah	FSD-District Range supervisor	0272847785	
Ms Christie Ofoe Tsatsu	FSD-District Ranger supervisor	0244590475	
Mr. Solomon Bagasel	FSD-District Customer service	0208291000	
Mr. Alex Oduro Barnie	FSD-Regional Manager		

ASHANTI REGION

Contact person	Position	Contact number	Date
FSD, RMSC, TIDD Kumasi			
Isaac Noble Eshun	Assistant FSD Regional Manager	0243556188	09-11/04/2014
Alexander Boamah Asare	Manager, Collaborative Forest Management, CRMD-RMSC	0208149194	
Isaac Buckman	TIDD, Contract & Permit Officer	0242312630	
Antony Amamoo	TIDD, Regional Manager	0208142192	
FORIG, Kumasi			
Dr. Emmanuel Marfo	Senior Research Scientist- Policy & Governance	0244627274/ 0264627274	

Contact person	Position	Contact number	Date
Tropenbos International (TBI)-NGO			
Bernice Agyekwena	Communication Officer	0276478083	
K. S. Nketia	Project Director	0208150148	
OASL, Kumasi			
Nana Nsuase Poku Agyeman III	Regional Stool Lands Officer/ Otumfuo's Akyeamehene/ Chief Linguist	0244461057	
Land Commission, Kumasi			
Afia Abrefa	Senior Lands Officer-PVLMD	03220-26402	
Benjamin Nti	Lands Officer- PVLMD		
A. Karikari	Divisional Head-Land Registration Division, Ashanti Reg	02033221111	
Institute of Renewable Natural Resources - KNUST			
Dr. Emmanuel Acheampong	Senior Lecturer		
Form Ghana			
Marius Krijt	Operations Manager	0544441441	
Mariam Awuni	HR & Development Manager	0266374047	

BRONG AHAFO REGION

Contact person	Position	Contact number	Date
Goaso			
Joseph Bempah	FSD District Manager	0244804624	12-16/04/2014
Edward Nyamaah	Forester/ Range Supervisor	0243462897	
Kintampo			
Edward Opoku Antwi	FSD District Manager	0244043657	
Samuel Abisgo	DPO-Kintampo South D. A.	0208288577	
Sunyani			
Mariam Awuni	Form Ghana - HR & Development Manager	0266374047	
Isaac Kwaku Abebrese	Dean-School of Natural Resources-University of Energy & Natural Resources	0200863738/ 0277825094	
Dr (Mrs) Mercy A. A. Derkyi	Lecturer (NRM governance, policy and conflict management-Dept. of Forest Science, University of Energy & Natural Resources	0242186155	
Clement Amo Omari	FSD Assistant Regional Manager	0244549463	
Geoffrey Osafo-Osei	OASL-Regional Stool Lands Officer	0243536375	
Daniel Acheampong	OASL-Assistant Regional Officer	0246375788	
Nat Opoku Tandoh	OASL- Accountant	0209153153	
I.K.A Baffor Anane	Department of Community Development - Regional Director	0208162334	

Boadikrom settlement, Ayum Forest Reserve, Goaso Forest District

No.	Name	Position/Designation	Occupation	Date
1	Abdulai Alhassan	-	Farmer	12-04-2014
2	Kobina Mensah	-	Farmer	
3	Kwame Matthew	-	Farmer	
4	Sika Sanvia	-	Farmer	
5	Daniel Boadi	Odikro/ 0205253201	Farmer	

Akwaboa No. 2 Community, Ayum Forest Reserve, Goaso Forest District

No.	Name	Position/Designation	Age	Occupation	Date
Men					
1	Yaw Amoah		58	Marketing clerk	12-04-2014
2	Abu Samual		29	Farmer	
3	Kwasi Basare		61	Farmer	
4	Adams Fuseini		21	Student	
5	Akwasi Addai		35	Farmer	
6	Nii Ogye		50	Farmer	
7	Isaac Tetteh		10	Student	
8	Kwame Amagro		40	Farmer	
9	Dogo Busanga		85	Farmer	
10	Nana Beng		75	Farmer	
11	Yakubu Adams	Chief's spokesman	40	Farmer	
12	Emmanuel Tetteh		60	Farmer	
13	Osei Tutu Kontre	Opinion Leader	54	Farmer (0203737205)	
14	Nana Akwasi Badu	Chief		Farmer	
15	Akwasi Agoda		38	Farmer	
16	Mohammed Lamini		34	Farmer	
17	S. B. Emini		57	Teacher	
18	Osei Prince		24	Student	
19	Boateng		20	Student	
20	Ali Mohammed		23	Student	
21	Kwame owusu		14	Student	
Women					
1	Charlotte Atawiah		22	Farmer	
2	Alberta Adampaka		20	Farmer	
3	Mary Forkua		24	Farmer	
4	Adams Ramatu		20	Farmer/hairdresser	
5	Mary Serwah		32	Farmer	
6	Ruth Lamisi		37	Farmer/hairdresser	
7	Afia Wusuwah		35	Farmer/hairdresser	
8	Grace Mansah		52	Farmer/Trader	
9	Akua Cecilia		38	Farmer	
10	Comfort Asieduwaa		22	Farmer	
11	Naomi Odartey		40	Farmer	
12	Yaa Comfort		31	Farmer	
13	Gladys Brago		32	Farmer	
14	Maame Mali		50	Farmer	
15	Rita Kondadu	Queen mother	44	Trader	
16	Esther Amadu		23	Farmer	
17	Abena Leyoma		30	Farmer	
18	Janet Yaye		35	Farmer/Trader	

Bosomoa Forest reserve, Kintampo Forest District
Nante Community

No.	Name	Position/Designation	Age	Occupation	Date
Men					
1	Kofi Asante	-	40	Farmer	14-04-2014
2	Kwaku Taapen		28	Farmer	
3	Pena Daniel		45	Farmer	
4	Idrisu Salemana		25	Farmer	
5	Adamu Ibrahim		45	Farmer	
6	Abukari Sudisu		25	Farmer	
7	Yakubu Atteh		21	Farmer	
8	Issaka Adam		20	Driver's mate	
9	Alhaji Sofo Alhassan	Imam/CFC chairperson	57	Farmer	
10	Atta Kofi	Roman Catechist	50	Farmer	
11	Kofi Yamawule		30	Farmer	
12	Abubakari Bibioboto		28	Driver	
13	Yakubu Isahaku		35	Farmer	
14	Abubakari Abdul Rahamadu		28	Farmer	
15	Abdul Razak Yaya		20	Student	
16	K. Asuman		31	Storekeeper/trader	
17	Osei Prince		18	Mason Apprentice	
18	Rashid Adoku		19	Carpentry apprentice	
19	Kwabena Badu		46	Farmer	
20	Ibrahim Nuhu		36	Machine operator	
21	Gyan Kwame		32	Carpenter	
22	Kwaku Gyamfi		25	Driver	
23	Kojo Asante		29	Farmer	
24	Kojo Damoah		31	Carpenter	
25	Tassil Kwabena		27	Bar owner	
26	Adu Amponsah	Youth leader	38	Farmer	
27	Yaw Apaw		52	Farmer	
28	Hon Cpl Gyiwaa		53	Farmer	
Women					
1	Helena Anane		46	Trader/business woman	
2	Naomi Pokua		45	Farmer	
3	Akosua Kesewa		41	Farmer	
4	Mary Jato		28	Dressmaker	
5	Ramatu Mohammed		39	Waakye seller	
6	Salamatu Zawe		30	Dressmaker	
7	Akua Agness		22	Trader	
8	Saah Florence		22	Farmer	
9	Georgina Akolowa		40	Yam seller	
10	Zamabu Seidu		45	Trader	
11	Margaret Adobea		48	Farmer	
12	Comfort Dusie		34	Farmer	
13	Asin Forsa		40	Farmer	
14	Asanjia Doko		40	Farmer	
15	Akua Kandusi		38	Farmer	
16	Rahinatu Issaku		30	Farmer	
17	Tada Benedicta		22	Student	

18	Tukusama Rose		20	Dressmaker	
19	Akose Churepo		33	Farmer	
20	Komeol Akose		28	Farmer	
21	Yaa Appiah		40	Farmer	
22	Gyasi Emelia		40	Yam seller	
23	Afia Angelina		30	Farmer	
24	Afia Gyamea		48	Farmer/Trader/Queen Mother	
25	Rafatu Muhammed		38	Trader	

Krabonso Dagombaline – Kintampos Forest District
Forest reserve - Bosome

No.	Name	Age	Occupation	Date
Men				
1	Potuo Bilaba	65	Farmer	14-04-2014
2	Latif Alhassan	18	Farmer	
3	Azizu Alhassan	20	Farmer	
4	Yaw Sangi	20	Farmer	
5	Mohammed	35	Farmer	
6	Abduli	35	Farmer	
7	Hadi Adama	20	Farmer	
8	Yaw Bawuu	30	Farmer	
9	Kari Wagi	23	Farmer	
10	Dassaan Isaac	20	Farmer	
11	Yaawuloza Mohammed	20	Farmer	
12	Felimon Nubolanaa	20	Farmer	
13	Kwabena Dassaan	30	Farmer	
14	Bawuloma Nubosie	40	Farmer	
15	Alahassan Iddrissu	25	Farmer	
16	Ibrahim Iddrissu	30	Farmer	
17	Zakari Osman	31	Farmer	
18	Soribo Alfred	70	Farmer	
19	Fusena Iddrissu	80	Farmer	
20	Abdulai Tanko	40	Driver	
21	Wuudo Ada	55	Farmer	
22	Abduliman Ibrahim	56	Farmer	
23	Isaah Tayii	20	Farmer	
24	Yakubu Idrissu	32	Farmer	
25	Abdulai Razak	28	Farmer	
26	Amentus Karpiyie	65	Farmer	
27	Siedu Ibrahim	39	Farmer	
28	Latif Alhassan	42	Farmer	
29	Jato Dassaan	45	Farmer	
30	Alidu Karih	32	Farmer	
31	Nbuli Dassaan	40	Farmer	
32	Imoro Mohammed	32	Teacher	
33	Isahaku Amadu	25	Farmer	
34	Tayii Isaaku	33	Farmer	
35	Yamusa Awudu	53	Teacher	
36	Bawa Jannaa	75	Farmer	
Women				

1	Tikayi Bawa	60	Farmer	
2	Lukaya Amidu	40	Farmer	
3	Afukyetu Abdulai	40	Farmer	
4	Naapo Yeyereku	35	Farmer	
5	Alociyo Cynthia	41	Farmer	
6	Polina Kando	34	Farmer	
7	Faalinbon Akosua	42	Farmer	
8	Moolesia Mathew	38	Farmer	
9	Kambrenya Selina	39	Farmer	
10	Ayesetu Yakubu	44	Farmer	
11	Tanpo Daana	38	Farmer	
12	Akosua Deri	46	Farmer	
13	Afua Abdulai	38	Farmer	
14	Latif Ibrahim	39	Farmer	
15	Alishetu Mohammed	40	Farmer/NPP Women organiser	
16	Ama Ankomah	22	Farmer	
17	Janet Dorzea	23	Farmer	
18	Sakinatu Alidu	30	Farmer	
19	Abiba Mohammed	32	Farmer	
20	Asana Mohammed	36	Farmer	
21	Felicia Akua	45	Farmer	
22	Faati Martha	42	Farmer	
23	Afua Gyinapo	48	Farmer	
24	Adwoa footi	35	Farmer	
25	Akosua Juliet	36	Farmer	
26	Grace Tan	37	Farmer	
27	Akosua Nyobea	42	Farmer	
28	Akua Dordaa	44	Farmer	
29	Rahina Alhassan	39	Farmer	
30	Mariama Tuahilu	50	Farmer	
31	Ama Wajuli	60	Farmer	
32	Philomena Soo	42	farmer/NDC women organiser	

NORTHERN REGION
Zakaryili community

No.	Name	Age/ description	Occupation	Date
Men				
1	Alhassan Adu	Elderly	Farmer	01-05-2014
2	Sherasu Alhassan	Youth	Farmer	
3	Mohammed Abdul –Latif	Youth	Farmer	
4	Alhassan Iddrisu	Youth	Farmer	
5	Yakubu Iddrisu	Youth	Farmer	
6	Alhassan Mohammed	Youth	Farmer	
7	Fuseini Rashid	Youth	Farmer	
8	Fuseini Abdulai	Youth	Farmer	
9	Yakubu Wambei	Elderly	Farmer	
10	Baba Alhassan	Elderly	Farmer	
11	Abdul Rahiman	Elderly	Farmer	
12	Yakubu Bawa	Elderly	Farmer	
13	Alhassan Iddrisu	Elderly	Farmer	

14	Sualisu Yusif	Youth	Farmer	
15	Iddrisu Amin	Youth	Farmer	
16	Iddrisu Abdulai	Youth	Farmer	
Women				
1	Abiba Alhassan	Elderly	Farmer	
2	Amina Fuseini	Youth	Farmer	
3	Amina Yakubu	Elderly	Farmer	
4	Fatimata Baba	Elderly	Farmer	
5	Abiba Mohammed	Elderly	Farmer	
6	Adisa Abdul-Rahman	Youth	Farmer	
7	Abibatu Yusif	Youth	Farmer	
8	Zulaiha Yakubu	Youth	Farmer	
9	Sumayatu Yakubu	Youth	Farmer	
10	Arishitu Alhassan	Youth	Farmer	
11	Sanatu Alhassan	Youth	Farmer	
12	Fatimata Latifu	Youth	Farmer	
13	Mohammed Sahada	Youth	Farmer	
14	Ayi Yakubu	Youth	Farmer	
15	Rabi Sherazu	Youth	Farmer	
16	Senatu Iddrisu	Youth	Farmer	
17	Fuseina Yakubu	Youth	Farmer	
18	Arahimatu Iddrisu	Youth	Farmer	
19	Filila Alhassan	Youth	Farmer	
20	Samatu Mohammed	Elderly	Farmer	
21	Arishitu Baba	Youth	Farmer	
22	Mariama Yakubu	Youth	Farmer	
23	Abiba Sherazu	Elderly	Farmer	
24	Abibata Alhassan	Youth		

Elderly: >45 years **Youth: >18 and <45 years**

Moya community

No.	Name	Age	Occupation	Date
Men				
1	Abukari Danna (Chief)	75	Farmer	01-05-2014
2	Issahaku Azuma	50	Farmer	
3	Abukari Mohammed	40	Farmer	
4	Yakubu Abukari	30	Farmer	
5	Baba Fuseini	40	Farmer	
6	Karim Nina	40	Farmer	
7	Sulemanna Azindo	38	Farmer	
8	Zakariya Fuseini	35	Farmer	
9	Alhassan Abubakari	50	Farmer	
10	Ibrahim Mamudu	40	Farmer	
11	Alhassan Yusif	42	Farmer	
12	Alhassan Azindo	20	Farmer	
13	Iddrisu Azima	40	Farmer	
14	Abubakari Mansuru	20	Farmer	
15	Abdulai Fuseini	30	Farmer	
16	Shaibu Nina	43	Farmer	
17	Sualisu Nina	45	Farmer	
18	Amadu Majid	35	Farmer	

19	Zakari Abukari	40	Farmer	
20	Alhassan Bawa	45	Farmer	
21	Abubakari Shaibu	70	Farmer	
Women				
1	Sanatu Azuma	50	Farmer	
2	Alimatu Zakariya	40	Farmer	
3	Awabu Mahamatu	35	Farmer	
4	Mariama Baba	29	Farmer	
5	Zinabu Alhassan	30	Farmer	
6	Mariama Alhassan	60	Farmer	
7	Sakina Zakari	23	Farmer	
8	Filila Alhassan	35	Farmer	
9	Rahimatu Ibrahim	35	Farmer	
10	Sulaya Iddrisu	28	Farmer	
11	Azara Damba	60	Farmer	
12	Mamunatu Abdul-Nasiri	18	Farmer	
13	Mariam Majeed	32	Farmer	
14	Sikina Shaibu	50	Farmer	
15	Fati Alhassan	52	Farmer	
16	Awabu Sulemana	18	Farmer	
17	Abana Rashid	23	Farmer	
18	Sanatu Azima	53	Farmer	
19	Nima Alhassan	18	Farmer	
20	Ashitu Abubakari	50	Farmer	
21	Anatu Karim	38	Farmer	
22	Fatima Sulemana	28	Farmer	
23	Martha Bawa	60	Farmer	
24	Fatimata Adam	40	Trader/Farmer	
25	Adamu Moro	34	Trader	
26	Fatimatu Osman	20	Farmer	
27	Fati Fuseini	30	Farmer	
28	Awabu Yussif	35	Farmer	
29	Adamu Issah	60	Farmer	
30	Hawa Fuseini	60	Farmer	
31	Sanatu Yahaya	62	Farmer	
32	Asana Abdulai	25	Farmer	
33	Fushina Abukari	38	Trader	
34	Larbi Issahaku	29	Trader	

Kenikeni Forest Reserve and Mole National Park
Grupe Community

No.	Name	Age	Occupation	Date
Men				
1	Dari Naatida	30	Farmer	02-05-2014
2	Kwaku Bayowo	30	Farmer	
3	Awule Donkoyiri	52	Farmer	
4	Dare Tan	28	Farmer	
5	Simon Bugla	53	Farmer	
6	Lamin Abdulai	20	Farmer	
7	Kipo Simole	23	Farmer	
8	Disuri Berviley	31	Farmer	

9	Attah Zinkoni	50	Farmer	
10	Pentu Aliasu	20	Farmer	
11	Kular Yirikubayele	45	Farmer	
12	Kipo Musah	23	Student/Farmer	
13	Denyi Beyinar	30	Farmer	
14	Kwame Beyinor	25	Farmer	
15	Tinwah Dasaah	35	Farmer	
16	Gbiale Gbentuota	30	Farmer	
17	Yanyele Yawkrah	55	Farmer	
18	Kpibari Vinn	45	Farmer	
19	Dramani Salisu	21	Student	
20	Dramani Saaka	50	Farmer	
21	Sunwale Kpankpori	45	Farmer	
22	Adams Gbolosu	27	Farmer	
Women				
1	Jemi Aness	20	Farmer	
2	Hawa Seidu	45	Farmer	
3	Kpandzana Duntze	45	Farmer	
4	Magazia Zinatuna	50	Farmer	
5	Bamba Barah	20	Farmer	
6	Wiagu Diana	45	Farmer	
7	Alberta Tinnah	40	Farmer	
8	Attah Fiah	29	Farmer	
9	Yaa Jang	32	Farmer	
10	Beyiwor	45	Farmer	
11	Akua Dari	30	Farmer	
12	Kwame Tanpogo	35	Farmer	
13	Kulpor Anawa	35	Farmer	
14	Attah Kipo	45	Farmer	
15	Zinatornor Bawizia	50	Farmer	
16	Kipo Abutu	40	Farmer	
17	Yao Akosua	30	Farmer	
18	Abiba Seidu	28	Farmer	
19	Kulpor Ados	30	Farmer	
20	Tampor Porlina	30	Farmer	
21	Asata Mumuni	30	Farmer	
22	Afisah Dari	35	Farmer	
23	Adwoa Zore	45	Farmer	
24	Fati Dramani	40	Farmer	
25	Vorsana Dramani	25	Farmer	

Kenikeni Forest Reserve and Mole National Park
Nasoyiri Community

No.	Name	Age	Occupation	Date
Men				
1	Nasoyiri Wura	-	Farmer	02-05-2014
2	Sey Nalotey	-	Farmer	
3	Sansan Bidintey	50	Farmer	
4	Bisen Kontome	35	Farmer	
5	Ollo Sonyitey	43	Farmer	
6	Nyolina Taba	30	Farmer	

7	Bitoyiri	22	Farmer	
8	Andrew Selli	23	Farmer	
9	Dokobo Ditey	25	Farmer	
10	Jacob Bale	35	Farmer	
11	Bashiru Fornule	40	Farmer	
12	Fotey Lifatey	45	Farmer	
13	Soletey Sansa	50	Farmer	
14	Dale Kpoku	30	Farmer	
15	Bitoyiri	56	Farmer	
16	Sekentey	60	Farmer	
17	Adam Natorma	46	Farmer	
18	Tensare Selle	58	Farmer	
19	Banala Kani	48	Student	
20	Botwo Sontey	47	Farmer	
21	Kyilentey Chichutey	56	Farmer	
22	Dare Bola	54	Farmer	
23	Maalyir	23	Farmer	
24	Glikoli Gariba	54	Farmer	
25	Yasotey	45	Farmer	
Women				
1	Bugula	43	Farmer	
2	Nowenuma	35	Farmer	
3	Sawala	58	Farmer	
4	Juliana Akosua	20	Farmer	
5	Gbollo	35	Farmer	
6	Parreh	33	Farmer	
7	Zanabu	34	Farmer	
8	Phillipa Amoh	21	Farmer	
9	Joana Turema	19	Farmer	
10	Yaa Brafi	42	Trader	
11	Sahaana	51	Farmer	
12	Nayorli Limah	32	Farmer	
13	Mabel Dawo	23	Farmer	
14	Yaatel Dawo	30	Farmer	
15	Yiri Binana	48	Farmer	
16	Yaa Nebina	45	Farmer	
17	Grace Temale	35	Farmer	
18	Rita Ayulo	41	Farmer	
19	Victoria Alamina	42	Farmer	
20	Bena Yare	40	Farmer	
21	Wamuni	33	Farmer	
22	Dusama	35	Farmer	
23	Sudiri	40	Farmer	
24	Rophina	30	Farmer	
25	Sentey Chabb	31	Farmer	
26	Hanna Mopu	42	Farmer	
27	Yiley	37	Farmer	
28	Adams Gyikye	35	Farmer	
29	Adams Nafisa	32	Farmer	
30	Janet Solomey	40	Farmer	

31	Manno Dare	55	Farmer	
32	Nkaayene Sankuma	35	Farmer	
33	Adwoa Tireh	35	Farmer	
34	Sofaa Yiri	22	Farmer	
35	Comfort Tire	30	Farmer	
36	Maa Adwoa	37	Farmer	
37	Afua Mumuni	27	Farmer	
38	Yaa Angelina	22	Farmer	

Contact person	**Position**	**Contact number**	**Date**
FSD, Tamale, Bole			
Ebenezer Djabletey	Regional FSD Manager	0244639643	30-04-2014 / 01-05-2014
Emmanuel Okrah	Tamale District FSD Manager	0243716352	30-04-2014
Nii Kwei	Tamale Assist. Dist. Manager	0200122333	30-04-2014 / 01-05-2014
Paul Hinneh	Bole Assist Dist. FSD Manager	0244934324	02-05-2014
Joseph Akuoko	Bole-TO/Range Supervisor	0242108943	
Saviour Attu	Bole – TO/Range supervisor	0243141630	
Lands Commission, Tamale			
Samuel Anini	Head- LVD	0244618902	05-07/05/2014
Osei Owusu	Head- PVLMD	0244633902	
Yaw Aboagye	Regional Lands Officer/ Head-Survey & Mapping	0244798808	
Tree Aid Ghana - NGO			
Andrew Dokurugu	Country Director	0208882226 andrew.dokurugu@treeaid.org.uk	
OASL, Tamale			
Franklin Oppong Obiri	Regional Stool Lands Officer	0207339887/ 0244496668	
EPA, Tamale			
Musa Adam Jafaru	Programme Officer	0244445831/ 0501301601	
Jimah Louly	Programme Officer	0543315665/ 0501301600	
Abu Iddrisu	Regional Director		
GNFS, Tamale			
Douglas Koyiri	Regional Fire Commander	0208284332	
Department of Community Development			
Williams Alagma	Regional Director	0244845045/0206277359 alagwillie@yahoo.com	
MOFA, Tamale			
William Boakye Acheampong	Regional Director	0244216918	

Contact person	Position	Contact number	Date
RCC, Tamale			
Alhassan Issehaku	RCD	0208236483	
Care International-NGO			
Francis Avura	Local Governance & Advocacy Officer	0208137503	
Nuhu Suleimana	Livelihood and Disaster Risk Reduction Officer	0248406305	
Association of Church-Based Development NGOs (Acdep)			
Pealore Zachary	ECCRING Project Manager	0206151928/ razackpealore@acdep.org	
Michael Pervarah	Project Manager	0244777442	

UPPER EAST REGION

Contact person	Position	Contact number	Date
FSD - Bolga, Navrongo			
James K. Ware	Regional FSD Manager	0207142090	07-09/05/2014
Robert Deri	Bolga District FSD Manager	0208158736	
Kobina Baiden	Bolga Assist. Dist. Manager	0208316214	
Awuah Oteng	Navrongo Dist. FSD Manager	0243373059	
Agbontor Raymond	Navrongo ADM	0209161881	
Wildlife Division			
John Naada Majam	Regional Wildlife Div. Manager	0244167419	
Lands Commission, Bolga			
Alhassan B. Zakariah	Head- LVD	0209123550	
Eric Mwim	Head- PVLMD	0202857941	
Seidu Zakari Abu	Ag. Regional Lands Officer/ Head-Survey & Mapping	0209656296	
Office of the Administrator of Stool Lands (OASL), Bolga			
Larri John Kwame	Regional Stool Lands Officer	0246361631	
EPA, Bolga			
Hamidu Abdulai	Assist. Programme Officer	0268861474	
Agbenyeka Godfred		0249990930	
Benedict Agamah		0242342376	
Freda Amizia		0203217602	
GNFS, Bolga			
Albert A. Ayamga	Regional Fire Commander	0208240499/0242569152	
Albert Adongo Ayamga	Rural Fire Department-Officer	0208384171/0245914619	
FORIG, Bolga			
Stephen Akpalu	Research Scientist	0207392105	

Contact person	Position	Contact number	Date
Gloria Adeyiga	Research Scientist	0207327391	
MOFA, Bolga			
Zimri Alhassan	Assist. Regional Ext. Officer	0240399482	
Ben Issah	Reg. Extension Officer	0244838789	
WRC- Volta Basin, Bolga			
Aaron Aduna	Volta Basin Officer	0242074137/0208234442 aaronaduna@yahoo.com aaronaduna@gmail.com	
NADMO, Bolga			
Paul Wooma	Deputy Chief Disaster Control Officer	0206381927	
RCC, Bolga			
Paul K. Abdul Korah	RCD/Chief Director	0244632151	

Energy Commission-Accra			
Julius Nyarko	Senior Programme Officer	0546995989	16-05-2014
SNV, Accra			
Quirin Laumans	Country Sector Leader – Agriculture	0546 487 855 / qiaumans@snvworld.org	7-4-2014
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Table 8 Attendance list of the National SESA validation workshop – 18th September, 2014

NAME	DESIGNATION	CONTACT
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The SESA was undertaken with the aim of mainstreaming sustainable development principles into the REDD+ strategy options. The following World Bank Operational Policies (OPs) were triggered during the SESA process;

- **OP 4.01 Environmental Assessment;** improve decision making to ensure that project options are sound and sustainable and adverse effects are mitigated;
- **OP 4.04 Natural Habitats;** promote environmentally sustainable development by supporting the rehabilitation of natural habitats;
- **OP 4.36 Forests;** Ensure that forest restoration projects maintain or enhance biodiversity and ecosystem functionality;
- **OP 4.09 Pest Management;** Support integrated approaches to pest management
- **OPN 11.03 Physical Cultural Resources;** Inventory of potential cultural resources likely to be affected;
- **OP 4.12 Involuntary Resettlement;** Assist displaced persons in their effort to improve or at least restore their standards of living;

As a result of the SESA process, the following safeguards instruments were produced:

i. *Environmental and Social Management Framework (ESMF);*
ii. *Resettlement Policy Framework (RPF);*

These safeguards instruments have been disclosed in national dailies and on the SIS web platform[13].

Environmental and Social Management Framework (ESMF)
Ghana's Environmental and Social Management Framework (ESMF) clearly specifies appropriate roles and responsibilities, and outlines the necessary reporting procedures, for managing and monitoring environmental and social concerns related to project interventions.

The ESMF is being executed by FC in collaboration with other partners such as Ghana Cocoa Board (Cocobod), Environmental Protection Agency (EPA), Ministry of Lands and Natural Resources (MLNR), Ministry of Food and Agriculture (MoFA), Ministries, Departments and Agencies (MDAs), Metropolitan Municipal and District Assemblies (MMDAs), Private sector partners, NGOs/CSOs. The FC is the lead government institution implementing REDD+. The National REDD+ Secretariat led by the Director Climate Change at FC is responsible for coordinating all REDD+ activities.

[13] Link to the safeguards instruments- https://reddsis.fcghana.org/admin/controller/publications/ESMF%20GCFRP%20Clean%20for%20RSA%20cleared-Safeguard-ESMF%20GCFRP%20Clean%20for%20RSA%20cleared%20and%20for%20disclosure.doc
https://reddsis.fcghana.org/admin/controller/publications/Resettlement%20Policy%20Framework%20(RPF)%20for%20GCFRP-Safeguard-RPF%20GCFRP%20RPF%20November%202018%20Final.docx

There is a REDD+ National safeguards Focal Person whose roles and responsibilities include:

- Coordinating environmental and social safeguards across all projects and programmes;
- Working closely with regional and district Safeguards Focal Persons for the implementation of safeguards;
- Providing guidance and project level information and tools on safeguards for all stakeholders;
- Coordinating all safeguard activities with donors, implementing agencies and other potential investors;
- Overseeing all environmental and social safeguard training and capacity building.

There is also a functional REDD+ Safeguards Sub-Working Group (SSWG) which is a multi-stakeholder technical and advisory forum created to provide guidance and supervision for the effective implementation of REDD+ Safeguards in Ghana. The SSWG is made up of government (FC, COCOBOD, EPA, Minerals Commission), NGOs/CSOs and private sector.

The specific role of the SSWG is to facilitate, promote and supervise the development and effective implementation of REDD+ safeguards instruments in a transparent, inclusive and participatory manner. The SSWG constitutes one of the robust arms in the institutional arrangements set up during Readiness and they have been very instrumental in ensuring the full and active participation of relevant stakeholders on all consultations regarding REDD+ generally and also specifically to the program. Their meetings are as frequent as need be however, they meet at least once a quarter.

Resettlement Policy Framework (RPF)

The Resettlement Policy Framework (RPF) provides guidance on how resettlement issues should be dealt with and how project affected persons should be compensated. In the end, such persons should not be "*worse-off if not better off*" after the resettlement.

The RPF was produced in response to the triggered WB OP 4.12 on involuntary resettlement. It is designed for projects that may entail involuntary resettlement, acquisition of land, impact on livelihood, or restricted access to natural resources. It provides guidance on how to address compensation issues as related to affected properties/livelihoods including land and income generation activities during Project implementation.
The FC does not anticipate any involuntary resettlement during the ERPA period.

For the GCFRP, a 10-year period has been given in the RPF to resettle affected illegal farmers. However, during the governance development processes in the Juabeso and Kakum HIAs, some farmers have indicated that, they may want to voluntarily move out of encroached portions of forest reserves. A draft roadmap to guide such voluntary relocation has been developed.

There were two (2) other SESA documents produced under the Forest Investment Programme (FIP). The FIP is a pilot of programme under the GCFRP that seeks to address the underlying drivers of deforestation and catalyze transformational change by providing upfront investment to support the implementation of the REDD+ Strategy, and generate information and experience for policy and regulatory changes with the ultimate aim of reducing the emissions of Green House Gas (GHG) within the Land Use, Land Use Change and Forestry (LULUCF) sector in Ghana.

The documents are:

I. Process Framework (PF)-

The PF establishes a process by which potentially affected communities are engaged in the design of project components, determination of measures necessary to achieve resettlement policy objectives and implementation as well as monitoring of relevant project activities

II. Pest Management Plan (PMP)

The PMP promotes the use of biological and environmental control methods for pest management and reduce the use of synthetic pesticides to ensure the health and environmental hazards associated with pesticides are minimized.

Project proponents are expected to screen projects for likely social and environmental risks and then develop Safeguards Action Plans (SAP). The SAP adopts actions in these instruments as mitigation measures to address triggered safeguards. These instruments are the guiding documents and proponents are required to use them to guide implementation of safeguards.

Specifically, the procedures and steps in the PF guide inclusive and transparent stakeholder consultations as well as collective decision making by all stakeholders. The principles on appropriate pest management approaches and chemical pesticide thresholds and applications are also used to prevent pollution to near-by water bodies as a result of run-off.

REDD+ Safeguards Implementation Arrangements

There are REDD+ Safeguards Focal Persons (SFPs) from the Forestry Commission District Offices from all 7 administrative regions and 23 forest districts and 2 National Parks within the programme area who have been selected and trained to support the implementation of safeguards. The SFPs have been trained in the application (both theory and practical) of the WB Safeguards instruments, Cancun safeguards and national safeguards during program implementation. Four (4) major trainings were held for SFPs table 9 provides modules, objectives, location and periods in which the trainings were undertaken. In addition, safeguards teams (comprising institutions other than the FC to enhance transparency and inclusivity) are also set up at the District levels to assist the District Safeguards Focal Person (DSFP) to undertake safeguards implementation and monitoring.

Table 9 Capacity building programs held for SFPs

PROGRAM	MODULES	OBJECTIVES	LOCATION/ VENUE	DATE

Training on safeguards for REDD+ regional and district focal persons	• *Ghana's REDD+ Safeguards instruments* • *Country Approach to REDD+ Safeguards* • *Modalities for Feedback and Grievance Redress Mechanism (FGRM) under REDD+* • *REDD+ Safeguards Monitoring and reporting*	• Training on REDD+ Safeguards (WB Safeguards Instruments, Cancun Safeguards etc) for the SFPs • To train SFPs on the application of Principles Criteria and Indicators (PCIs) developed for GCFRP Safeguards monitoring • To train SFPs on operationalizing the GCFRP FGRM at the landscape level • To guide SFPs on how to conduct REDD+ Safeguards monitoring and reporting. • *To train SFPs on the development and application of Safeguards Action Plans, monitoring and reporting*	Anita Hotel, Kumasi	7th, 8th & 22nd February 2018
Refresher training on safeguards for safeguards focal person (and team) in the Juaboso-Bia HIA under the 3PRCL Project	• *Ghana's REDD+ Safeguards instruments* • Principles Criteria and Indicators • Development of Safeguards Action Plans • *REDD+ Safeguards Information System (SIS)* • *REDD+ Safeguards Monitoring and reporting* • REDD+ Feedback and Grievance Redress Mechanism (FGRM) operationalisation	• Training on safeguards and sensitization on the PCIs • Training on safeguards data collection • Sensitization on the SIS web platform • Training on gender responsive activity planning • Sensitization and operationalization of the FGRM	Juabeso-Bia	21st – 23rd May, 2019
Training on the functions of Ghana's SIS web platform and FGRM	• *REDD+ Safeguards Information System (SIS)* • *REDD+ Safeguards Monitoring and reporting* • *REDD+ Feedback and Grievance Redress Mechanism (FGRM) operationalisation*	• Training on the functions of the SIS web platform • To guide SFPs on how to conduct REDD+ Safeguards monitoring and reporting. • To train SFPs on operationalizing the GCFRP FGRM at the landscape level	Forestry Commission Training Centre (FCTC), Akyawkrom	19th - 20th June, 2019

Refresher training on safeguards for redd+ regional and district safeguards focal persons across the GCFRP area	• Overview of REDD+/ GCFRP • Safeguards Instruments/ REDD+ & Gender • Principles Criteria and Indicators • Overview of GCFRP Benefit Sharing Plan • Ghana Environmental Regulation • Undertaking Safeguards Monitoring & Reporting / FGRM Modalities • Practical guidance- Safeguards Monitoring & reporting (field Work)	• To conduct a refresher training on REDD+ Safeguards (WB Safeguards Instruments, Cancun Safeguards etc) for the SFPs • To train SFPs on the application of Principles Criteria and Indicators (PCIs) developed for GCFRP Safeguards monitoring • To train SFPs on operationalizing the GCFRP FGRM at the landscape level • To guide SFPs on how to conduct REDD+ Safeguards monitoring and reporting. • *To train SFPs on the development and application of Safeguards Action Plans*	Golden Bean Hotel, Kumasi	3rd - 5th March, 2020

Below are steps involved in setting up a safeguard team:

- *Conduct stakeholder mapping to identify relevant stakeholders/institutions in the HIA*
- *Letters are sent from the Forestry Commission's District Office to the institutions (identified) to nominate an individual to form part of the team;*
- *The institutions then submit names of nominees (women are strongly encouraged to be nominated);*
- *A meeting is scheduled by the District Safeguards Focal Person to meet all nominated persons and officially set up the team;*
- *These members are then introduced to the Regional Safeguards Focal Person;*
- *A follow up meeting is scheduled to undertake refresher training for the safeguards team with support from the National REDD+ Secretariat (NRS).*

In 2019, the first safeguards team was formed in the Juabeso/Bia HIA. The team comprises one member each from EPA, Juabeso District Assembly, COCOBOD, Ministry of Food and Agriculture, Ghana Police Service, Ghana Fire Service and three members of the Hotspot Intervention Area Management Board.

Implementing Safeguards

By the design of the Emission Reductions Programme (ERP), lots of projects/sub-projects are expected to be undertaken, and as such Safeguards Action Plans (SAP) are to be developed to guide the effective implementation of each sub-project under the REDD+ programme. The SAP guides project implementers in screening project activities for their likely social and environmental impacts and propose mitigation measures to address those risks.

Partnership for Production, Protection and Resilience in Cocoa Landscapes (3PRCL) is a sub-project under the GCFRP that aims at addressing the drivers of deforestation and forest degradation in the Juabeso-Bia HIA. The project is being implemented with consortium partners consisting of FC, Cocobod, Touton, NCRC, SNV and Tropenbos Ghana.

Subsequently, a SAP[14]. for the 3PRCL project has been developed and being implemented. The first safeguards monitoring for the 3PRCL SAP was undertaken in December 2019 together with the safeguards team in Juabeso-Bia. The Safeguards Monitoring template included institutions implementing actions in the SAP, activities, questions and responses from communities and institutions, means of verification and a comment section.

Key findings from the monitoring exercise revealed that there is close collaboration amongst partner institutions however, community engagements needed to be enhanced.

Some recommendations during the monitoring were: the need to share Safeguards monitoring template with partner institutions to populate before undertaking field verification and monitoring, the need to increase support to enhance safeguards monitoring.

The SAP for the 3PRCL was developed as an activity line under the total Safeguards budget for the project. At the time, this represented a huge achievement in engagements with Cocoa private sector as the issue of safeguards other than health and safety had not been in their core scope for consideration. The SAP was developed through consultations with a consortium made up of Forestry Commission, Cocobod, Touton SE, Agro-Eco, SNV Netherlands and Nature Conservation Research Centre (NCRC), the Juabeso/Bia HMB. The SSWG provided technical guidance duration the preparation of the SAP.

Table 10 Some key risks, opportunities and benefits identified during the Screening and the development of the Safeguards Action Plan for the 3PRCL

RISK	Opportunities	Benefits	Mitigation measures
Lack of or inadequate alternative livelihood for farmers during lean season	Existence of projects/programs in the landscapes that seek to build the capacities of farmers on alternative livelihoods	Improved community livelihoods	Provisions have been made for alternative livelihoods in the Upfront Advance Payment Activities
Gender consideration not likely to be incorporated in partners project activities	Existence of REDD+ Gender Action plan	Increased gender consideration in project design and implementation	Conscious effort was made to have women representation in the Juabeso/Bia HMB. There are 6 women out of the 13 member Board members
Absence of full and effective participation of relevant stakeholders	FGRM is available to resolve grievances on participation and gender inclusiveness	Increased participation and inclusiveness	Design guidelines for developing constitution of HIAs which ensures effective participation
Absence of a Pest Management Plan for the project	The use of pest management plan (PMP) to ensure that health and environmental hazards associated with pest are minimized	Minimised health and environmental hazards related to pests	Set up of rural service center in the landscape to give guidance on PMP. One has been set up in Juaboso HIA.

[14] SAP- https://reddsis.fcghana.org/admin/controller/publications/Safeguard%20Action%20Plan%20for%203PRCL-Safeguard%20Action%20Plan-Safeguards%20Action%20Plan%20(3PRCL).docx

II. Monitoring and Reporting Requirements

1. ***Entities that are responsible for implementing the Safeguards Plans are adequately resourced to carry out their assigned duties and responsibilities as defined in the Safeguards Plans.***

1.1 Key institutional arrangements required under the Safeguards Plans.

The NRS has conducted a number of training programmes as well as refresher trainings for all SFPs[15]. The relevance of the refresher training is to equip focal persons with the needed knowledge to easily ensure the programme is safeguarded. Their capacity has been built to the extent that they are able to lead landscape level capacity building programmes (refer to Table 9 for details) where they sensitize and engage relevant MDAs as well as MMDAs and local communities who would be involved in the implementation of REDD+. The SFPs are leading in the formation of safeguards teams at their various districts for safeguards monitoring and reporting purposes. The NRS attends such training programmes to provide technical backstopping.

STEPS IN SAFEGUARDS MONITORING & REPORTING

1. *The District SFP together with the Safeguards team (FC, Cocobod, Private sector, District Assembly/communities etc.) collects safeguards data and information*
2. *Data collected is reviewed by the safeguards team(s) before it is sent to the Regional SFP for verification.*
3. *The Regional SFP upon verification of the data subsequently submits verified data to the PMU Safeguards Specialist.*
4. *The PMU Safeguards Specialist review reports to verify information submitted before forwarding the data to the National Safeguards Specialist for preliminary verification and validation, with the knowledge of the Director for Climate Change.*
5. *The Director Climate Change then gives final validation of safeguards information and then trigger reporting to the World Bank, Environmental Protection Agency (EPA) for the UNFCCC (national communication) and enable web-based publication and updates into the SIS for relevant stakeholders and the general public.*

[15] Table 9 above has information on the capacity building held for SFPs

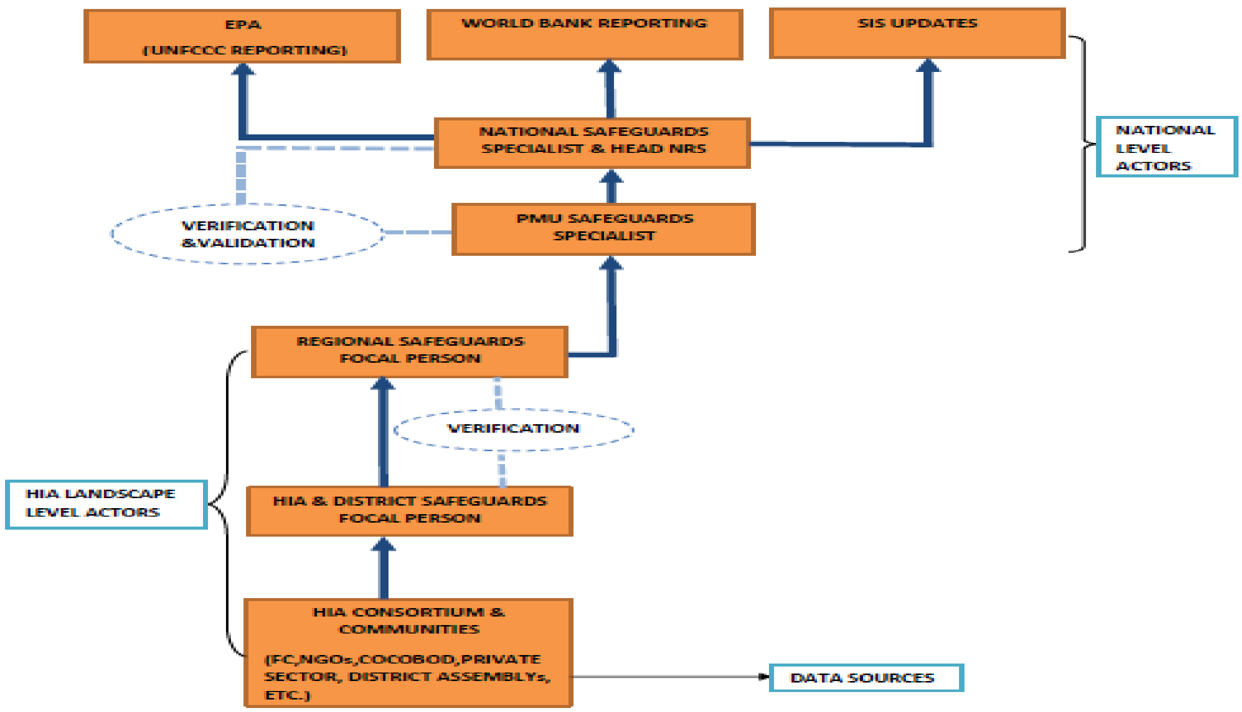

Figure 12 REDD+ Safeguards Reporting Structure

The FC through its medium term workplans make budgetary provisions for Safeguards implementation. Therefore, as and when needed, funds are made available to undertake Safegurads activities. Table 11 below indicates the provisions made by FC for Safeguards implementation. This is in addition to the Program's budgetary support

Table 11 Budgetary Provisions for Safeguards Implementation by FC

Year	Amount ($)
2019	483, 000
2020	486, 000
2021	417, 000

However in 2019, the the actual expenditure by FC on Safeguards implementation was GH¢ 60,659.00, whilst GH¢30,050 was the actual released in 2020 for Safeguards implemtation.

This notwithstanding, the support from the private sector has been encouraging as they understand the need to comply with safeguards requirement for sustainability of the REDD+ programme. For instance, Tropenbos Ghana support the development of Safeguards Training Manual in 2020 for an amount of GH¢ 65,000. As part of the 3PRCL project, an amount of GH¢ 87,505 was expended for Safeguards implementation in 2019.

Further more, Eight (8) capacity building programmes were conducted on safeguards for the private sector actors, district assemblies, MMDAs, etc. within the GCFRP and hence they are well informed on REDD+ Safeguards and how to undertake monitoring of their activities.

1.2 Confirmation of institutional arrangements in place.

All institutional arrangements needed to operationalize the Safeguards plans have been put in place and functional. The roles and responsibilities of persons within the structure are well known in the execution and implementation of the REDD+ safeguards. They have undergone extensive capacity building trainings on REDD+ Safeguards.

1.3 Implementing entities and stakeholders understand their respective roles and responsibilities with adequate human and financial resources.

The consortium partners and other key stakeholders including Safeguards Focal Persons and Safeguards Teams have undergone extensive capacity building on safeguards (details for SFPs in table 9 above) and have the requisite technical capacity to execute their roles and responsibilities and in ensuring safeguards compliance as stated above. In all of this, inclusive participation of relevant stakeholders in the REDD+ decision making and its activities has been a top priority throughout the REDD+ programme implementation. This is far advanced in the Juabeso-Bia and Kakum HIA and expected to be replicated in the other HIAs.

Table 12 Capacity building for stakeholders[16]

PROGRAM	OBJECTIVES	LOCATION	DATE
REDD+ Safeguards Training	• *To build the capacities of participants on REDD+ Safeguards and Safeguard Information System (SIS).* • *To build capacity on mainstreaming Gender consideration into the REDD+ Process.* • *To introduce the FGRM in addressing REDD+ conflicts in project implementation*	Goaso	10th and 11th April, 2018
REDD+ Safeguards Training	• *To build the capacities of participants on REDD+ Safeguards, Safeguard Information System (SIS), gender responsiveness and the Feedback and Grievance Redress Mechanism (FGRM).* • *To introduce the FGRM in addressing REDD+ conflict that may arise in project implementation.*	Nyinahin	11th - 12th April, 2018
REDD+ Safeguards Training	• *To build the capacities of participants on REDD+ Safeguards*	Begoro	17th - 18th April, 2018

[16] Capacity building trainings specifically for SFPs have been given in Table 9 above

	and Safeguard Information System (SIS). • *To build capacity on mainstreaming Gender consideration into the REDD+ Process.* • *To introduce the FGRM in addressing REDD+ conflicts in project implementation*		
REDD+ Safeguards Training	• *To build the capacities of participants on REDD+ Safeguards and Safeguard Information System (SIS).* • *To introduce the FGRM in addressing REDD+ conflict that may arise in project implementation.* •	Juaboso	24th - 25th April 2018
REDD+ Safeguards Training	• *To build the capacities of participants on REDD+ Safeguards and Safeguard Information System (SIS).* • *To introduce the FGRM in addressing REDD+ conflict that may arise in project implementation.*	Kakum	3rd - 4th July, 2018
Safeguards Training Workshop for the Partnership for Production, Protection and Resilience in Cocoa Landscapes (3PRCL) Project	• *To build the capacities of participants on REDD+ Safeguards and Safeguard Information System (SIS).* • *To build capacity on mainstreaming Gender consideration into the REDD+ Process.* • *To introduce the FGRM in addressing REDD+ conflicts in project implementation.*	Juabeso-Bia	21st - 23rd May, 2019
Training Of Landscape Management Board Members In Sefwi Wiawso On REDD+ Safeguards Under The Olam-RA Project Partnership For Livelihoods And Forest Landscape Management	• *To build the capacities of participants on REDD+ Safeguards, Safeguard Information System (SIS), gender responsiveness and the Feedback and Grievance Redress Mechanism (FGRM).* • *To introduce the FGRM in addressing REDD+ conflict that*	Sefwi Wiawso	12th -14th February, 2020

	may arise in project implementation.		

The PMU develops annual workplans for activities including Safeguards activities. Financial resources are made available through an approved work plan. Therefore, through FC and/or private sector budget, funds are made available to undertake trainings to build the capacities of key stakeholders including their roles and responsibilities in Safeguards operationalization.

1.4 Extent to which specific capacity building measures have been carried out.

Annually, the FC requires its staff to indicate their training needs for the year and budgets subsequently allocated for such trainings. The FC is poised on increasing the capacity of all staff at all levels in order to increase performance to meet the overall mission and vision of the organization and the programme.

Currently, the FC is sponsoring three (3) staff of the PMU staff to undertake a professional course in Environmental Management with the Institute of Environmental Assessment (IoEA). Other staff have also undergone short courses in climate change to enhance their work performance. Which include Climate Change and Development.

In some instances, the services of specific expertise required are procured to build the capacity of SFPs. For example, experts from the EPA are procured to train SFPs on how to screen projects, and the requirements of an Environmental Impact Assessment when needed.

In addition, the NRS also periodically conducts refresher trainings for all SFPs to bring them up to speed on developments as REDD+ is evolving with new information on a regular basis.

2. ***ER Program activities are implemented in accordance with management and mitigation measures specified in the Safeguards Plans.***

2.1.
Confirmation that Environmental and Social documents prepared are based on Safeguards plans

All documents prepared during programme implementation such as the Safeguards Principles, Criteria and Indicators (PCI) and the Safeguards Action Plan for the 3PRCL Project are based on World Bank OPs.

For example, the SAP developed for the 3PRCL is consistent with the World Bank's OPs, National Safeguards and other safeguards and Procedures to guide project implementers in screening project activities for their likely social and environmental impacts and outline mitigation measures to address those risks as well as monitor safeguards compliance.

As at the time of preparing this MR which is beyond the reporting period for this MR, three (3) sub-projects namely 3PRCL, Kakum Cocoa Agroforestry Project and restoration component under the Mondelez Cocoa Life

Programme had been screened for their likely risks, and mitigation measures identified and subsequently a SAP developed for monitoring. The projects are located in the Juabeso Bia, Kakum and Asunafo HIAs respectively. The NRS has prepared SAP for the 3PRCL project

Table 13 Some Key Risks, Opportunities, Benefits and Mitigation Actions for the Three Sub-Projects Screened

RISK	Opportunities	Benefits	Mitigation measures
Inadequate alternative livelihoods for farmers during lean season	Existence of projects/programs in the landscapes that seek to build the capacities of farmers on alternative livelihoods	Improved community livelihoods	Capacity buiding on alternative livelihoods for farmers
Exclusion of stakeholders in planning and implementation of restoration activities	FGRM is available to resolve grievances on participation and gender inclusiveness	Increased participation and inclusiveness	Undertake stakeholder mapping to identify all relevant stakeholder and involve them in the planning and implementation of project activities Where there are grievances on participation and gender inclusiveness use the FGRM to resolve such grievances
Over reliance and use of agro chemicals and impact on food crops, water and soil	Existence of a pest management plan which tables out recommended agro chemicals to be used in their right quantities and also recommends the practice of integrated pest management	Increased food production with minimal impact on soil and water	Promote the use of biological and environmental control methods for pest management Reduce the use of synthetic chemical pesticides. Use the pest management plan to ensure that health and environmental hazards associated with pest are minimized
Gender consideration not likely to be incorporated in partners project activities	Existence of REDD+ Gender Action plan	Increased gender consideration in project design and implementation	Conscious effort made to have women representation and participation in project activities

The Safeguards plans were prepared in a transparent, all-inclusive and timely manner with over 300 people consulted and was subsequently disclosed in the national dailies and on the FC's website in January 2019.

2.2 Entities responsible for implementing the Safeguards Plans maintain consistent and comprehensive records of ER Program activities.

Documentation of every step in the Safeguards process is key in ensuring a transparent and participatory process. Records on all stakeholder engagements, meetings, framework Agreement, Finalized Benefit Sharing Plan, FGRM forms, training reports, etc. are kept online (www.reddsis.fc.org) these records include total number of participants to ensure gender balance. All reports are then uploaded onto the REDD+ SIS web platform for the general public for transparency and accountability.

The SFPs also double as Feedback and Grievance Redress Officers and they are responsible for receiving and addressing conflicts related to REDD+ implementation. They have been trained on how to receive and address any feedback or grievance to do with implementation of the programme.

For FGRM implementation, the SFPs will receive complaints by completing the FGRM form and issue a receipt to the disputing persons.

- Broadly, the FGRM will be operationalized in four steps.
- Parties seeking to have any REDD+ dispute resolved would file their complaint at the district FGRM office within the ER project area where it will be received, and processed before it is communicated to the National FGRM coordinator:

1. If the parties are unable or unwilling to resolve their dispute through negotiation, fact-finding or inquiry a mediator chosen with the consent of both parties would be assigned to assist the Parties to reach a settlement.
2. Where the mediation is successful, the terms of the settlement shall be recorded in writing, signed by the mediator and the parties to the dispute and lodged at the FGRM registry. The terms of the settlement will be binding on all parties.
3. If the mediation is unsuccessful, the Parties will be required to submit their dispute for compulsory arbitration, by a panel of 5 arbitrators, selected from a national roster of experts.
4. The awards of the arbitration panel will be binding on the Parties and can only be appealed to the Court of Appeal. All cases of legality would be referred to the High Court.

The FGRM process is duly documented and ensures all feedback and/or grievance is duly addressed and in a timely manner to avoid any undue delays as seen in the court system. Stakeholders also have the opportunity to provide feedback or grievance using the REDD+ Safeguards Information System (SIS). There are also FGRM hotlines within the HIAs and at the National level for receiving and addressing conflict.

The ER programme is yet to receive any report related to grievances. However, it is anticipated that grievances to do with benefit sharing, participation, etc. may be received as the programme progresses as this was the anticipated case during consultations on possible grievances which informed the design of a functional FGRM for Ghana's REDD+ process. However, more awareness raising about the existence of an operational FGRM. This should be a continuous process in all HIAs and for stakeholders to be well informed about the FGRM.

2.3 Extent to which environmental and social management measures set out in the Safeguards Plans and any subsequent plans prepared during Program implementation are implemented in practice, the quality of stakeholder engagement, as well as field monitoring and supervision arrangements in place.

The safeguards plans are key in the programme's implementation. The ESMF is the blueprint for the environmental and social screening of projects and sub-projects, and where necessary an appropriate level of environmental assessment carried out for the sub-project to guide implementation. Screening is conducted to determine the impact of projects on the environment and people.
Stakeholder engagements are held at all levels and targets various stakeholder groups. This has enhanced awareness on the GCFRP. There is high level buy in at the national level where the President of the Republic officially launched the GCFRP on October, 4th 2019. This has also helped in securing more private sector support for the smooth implementation of the programme.

Formation of CREMAs, Sub HIAs and HIA Management Board (HMB) are examples of how stakeholders are engaged at the landscape level.

The capacity of SFPs have also been built on WB Ops, REDD+ Safeguards architecture for the Program and in undertaking field monitoring and supervision of safeguards compliance. Special attention is paid to gender in capacity building programmes to ensure gender mainstreaming in the REDD+ process. Report of engagement can be assessed on the SIS web platform

Engagement Principles has also been developed to guide partners on how to engage on the GCFRP. Resource persons are engaged to lead on safeguards capacity building workshops as and when needed.

2.4 Functionality status of the FGRM

The FGRM is operational and the FGRM form captures all the steps in the FGRM process. For now, no feedback and or grievance has been recorded using the FGRM form. All key stakeholders have been fully sensitized on the FGRM Operational Modalities and they are aware of where to lodge a complaint (nearest FC office or using the Safeguards Information System).

FGRM awareness creation materials (flyer and posters) have been disseminated to the Juabeso-Bia HIA. Different channels of communication have also been adopted for sensitization purposes such as conducting workshops, radio shows, radio jingles and community center announcements. FGRM fliers and forms attached accordingly.

3. The objectives and expected outcomes in the Safeguards Plans have been achieved.

3.1 Overall effectiveness of the management and mitigation measures set out in the Safeguards Plans.

Generally, the Safeguards Plans have provided guidance in the rolling out of safeguards actions which has contributed to the overall smooth implementation of safeguards.

- *The SAP enables programme implementers to identify and reduce risks, outline mitigation measures to address the risks and enhance benefits.*
- *The mitigation measures outlined in the ESMF are clear and concise and have guided the overall compliance with safeguards measures to enable the programme meet the requirement for receiving results-based payment under REDD+.*
- *SFPs helps with ease of access and early detection at the district level*

- *The Safeguards teams comprising of different institutions ensures transparency and Inclusiveness in contributing to the management and mitigation measures in the safeguards plans.*

3.2 Arrangements for quality assurance, monitoring, and supervision for identifying and correcting shortcomings in cases when ER Program activities are not implemented in accordance with the Safeguards Plans.

Special focus is placed on quality assurance and this is applied in terms of our reporting structure. The District SFP gathers data together with the safeguards team and submit their report to the regional SFP.

In terms of quality assurance, the Safeguards team undertakes verification of primary safeguards data collected. This eliminates bias on the side of the FC in the Safeguards reporting arrangement.

The regional SFP then verifies (quality assurance) the submitted document and ensures that whatever has been captured in the report is a true reflection of what happened in the landscape. Once this data is verified by the regional SFP the report is submitted to the PMU who also conducts quality checks before onward submission to the national level for final approval by the Director of Climate Change.

Therefore, at each channel of reporting, quality assurance of the information is guaranteed.

3.3 Description and effectiveness of supervision and oversight arrangements to ensure that the Safeguards Plans and, if any, subsequent environmental and social documents prepared during Program implementation are implemented.

Per the architecture of reporting, Safeguards reporting starts at the district level through the regional to the national. The Regional SFP supervises the work of the DFP. When satisfactorily verified, the RSFP forwards the report to the PMU who does the national reporting. At the PMU, the overall verification is done by the Director, Climate Change who after reporting to the WB post same on the website for the general public to also comment as appropriate

4 Program activities present emerging environmental and social risks and impacts not identified or anticipated in the Safeguard Plans prepared prior to ERPA signature.

4.1 Continuous Relevance of potential risks and impacts identified during the SESA process to ER Program activities

Table 14 Summarized Risks and Mitigation Measures Identified During the SESA Process

Environmental and socioeconomic Issues	**Risks**	**Mitigation Measures**
Natural resource	• Soil and water quality concerns from increasing agrochemical usage	Development of buffer zones around key rivers/water bodies
Economic	• Equity issues (benefit sharing);	Farmers to participate in decisions for benefits/compensation arrangements

	• Limited financial resources (hampering effective forest management)	Access to credit/funding facility towards forest management
Socio-cultural	• Food security • Admitted and illegal farms/settlements in forest reserves (moving beyond their original boundaries)	Adoption of Modified Taungya System (MTS) Re-demarcation of admitted farm boundaries
Institutional	Lack of a Land use Plan for Ghana	Development and implementation of a land use plan.

4.2 Risks and impacts not previously identified in Safeguards Plans.

As mentioned earlier, no additional risks/impacts have been identified. The NRS undertakes periodic field monitoring and reporting and documents such activities therefore in any case where additional risks are identified, mitigation measures will be identified to address such risks.

5. Corrective actions and improvements needed to enhance the effectiveness of the Safeguards Plans.

5.1 Self-assessment of the overall implementation of the Safeguards Plans

Specifically, the Safeguards plans developed during the SESA process provide a better understanding of the environmental, social, economic issues within the GCFRP area. This positioned Ghana to easily identify the risks, come up with mitigation measures and ways of enhancing benefits from the programme. This was conducted in a transparent and all-inclusive manner with all key stakeholders consulted. This has enabled the smooth safeguards compliance monitoring to ensure that Ghana is able to receive results-based payment under REDD+.

Implementation of Safeguards is being mainstreamed into the operations of the FC in which SFPs lead on the implementation of safeguards from the district through regional to national level. Again, there is continuous capacity building of key stakeholders on safeguards.

5.2 Corrective actions and areas for improvements.

N/A
Currently, no corrective measures have been identified. Once this is identified, it will be reported in subsequent MR.

5.3 Timeline to carry out the corrective actions and improves identified above.

N/A
Since no corrective actions have been identified there exist no time

ANNEX 2: INFORMATION ON THE IMPLEMENTATION OF THE BENEFIT-SHARING PLAN

I. Requirements of FCPF on Benefit Sharing Plans

II. Monitoring and Reporting Requirements

1. Benefit Sharing Plan Readiness

1.1 Disclosure of BSP

After extensive stakeholder consultations, validations, comments and iterations, the BSP was certified as finalized in March, 2020. The ERP pays special focus and attention to women, aged, disabled, marginalized communities, etc. as their views and input are important during implementation. Thus, and they were not left out during the stakeholder engagements on the BSP.

The BSP was subsequently disclosed in the national dailies (copies attached) and the FC's website in March, 2020[17]. Beneficiaries have access to the disclosed BSP. The disclosed BSP is in English which is Ghana's national language and represents the most appropriate language for such a national document as it is widely spoken and read. The use of local dialects for written documents of such nature have not been found to be so useful in the execution of past projects as reading of same is difficult. However, in the use of English language, school children can even help to interpret the contents to their parents, guardians and communities as English is both written and spoken in all Ghanaian schools. The BSP was one of the conditions of effectiveness for the ERPA. After finalizing the BSP, the World Bank has subsequently communicated the effectiveness of the ERPA. The BSP is wholly accepted by all stakeholders.

1.2
Completed and outstanding capacity building measures to ensure system effectiveness of the program.

In line with the BSP design process where stakeholders at both national and sub-national were consulted, the capacity building of stakeholders on the BSP follows similar format. A number of sensitizations programmes have been undertaken on the BSP and Upfront Advance Payment (UAP) for the GCFRP at national and landscape level and therefore institutional roles and responsibilities are clear in implementing the BSP.

Box 1: Use of UAP

> The UAP was not used to fund BSP awareness. What the statement is communicating is that the BSP awareness creation also involved education on the UAP; its purpose, mode of administration and institutional mandate for management. This is necessary as the funds will be deducted from first ER payment against the benefits accruing to FC though the activities under UAP are not just for FC mandate.

At the national level, the capacity of representatives from key institutions are continually built on the BSP during workshops/training programmes. This is to enable them fully understand the content of the finalized BSP. In some instances, institutional specific capacity building workshops have been organized for strategic national stakeholders, example is the Ministry of Finance (World Bank unit). During all Safeguards capacity building workshops, there are special sessions dedicated solely for BSP, and this involves both national and sub-national stakeholders. Trainings, workshops and capacity building initiatives have been held in the appropriate language

[17] BSP - https://www.oldwebsite.fcghana.org/library_info.php?doc=121&publication:Final%20Benefit%20Sharing%20Plan%20-%20Ghana%20Cocoa%20Forest%20REDD+%20Programme&id=23

for the responsible beneficiary or stakeholder groups. As trainings are delivered in spoken languages, the use of local dialects is adopted where relevant.

Table 15 below shows all national and sub-national level stakeholder workshops, trainings and engagements organized specifically for sensitization on the approved BSP and also includes specific presentations and sessions on the BSP. In addition to events, the table shows the date and location of each engagement, the stakeholders consulted, and the main comments or learning from the event. Kindly note that, before its approval, the BSP had been widely consulted on and after approval it had been a feature in every landscape level engagement before prior to and after the specific ones.

DATE	ACTIVITY	LOCATION	PURPOSE OF ENGAGEMENT	STAKEHOLDERS	SUMMARY OF DISCUSSION	COMMENTS/NEXT STEPS
23rd September, 2020	Kakum HIA consortium meeting	Assin Fosu	To update and sensitize key stakeholders on the benefit sharing arrangements including the Upfront advance payment for the Ghana Cocoa Forest REDD+ Programme	• NCRC • SHEC • District Assembly • FC • Olam • COCOBOD • ECOM	• Finalization and disclosure of the GCFRP BSP • Types of benefits (Carbon and non-carbon) • Beneficiaries (HIA landscape stakeholders, Government, Private sector) • Distribution of ERPA proceeds • Flow of funds and governance • Activity plan for the UAP.	• *undertake stakeholder engagement on the BSP and UAP from 2nd -20th November, 2020* • *There should be continuous stakeholder engagement on the BSP at the HIA slevel.*
2nd – 3rd November, 2020	National stakeholder engagement on the benefit sharing plan and upfront advance payment[18]	National, Accra	To sensitize and update key stakeholders on the benefit sharing arrangements including the Upfront advance payment for the Ghana Cocoa Forest REDD+ Programme and discuss implementation plan for the GCFRP.	1) National REDD+ working group (MLNR, COCOBOD, CSIR-FORIG, FC, MoF, National House of Chiefs, Ministry of Local Government and Rural development, National Forest Forum) 2) Safeguards and Gender sub working group (IUCN, Tropenbos Ghana, A Rocha, FC, SNV,)	The discussion focused on the following; • Purpose of the BSP • Design process (stakeholder consultations, extensive field study) • Beneficiaries (HIA landscape stakeholders, Government, Private sector)	• *There should be continuous stakeholder engagement on the BSP* • There is the need to have an effective communication strategy to assist all levels of stakeholders understand and appreciate the BSP monitoring reports.

[18] Refer to Box 1

				3) MRV Sub-working Group (EPA, FORIG, FC, RMSC, CERSGIS, KNUST) 4) Policy Sub-working Group (MLNR, FC, Energy Commission, MESTI,) 5) M&E Sub-working Group 6) Private sector, CSOs and NGOs actors	• Types of benefits (Carbon and non-carbon) • Distribution of ERPA proceeds including UAP an its use. • ER payment and performance scenarios • Flow of funds and governance • Monitoring of the BSP	• There should be a comprehensive budget for the preparation of the BSP monitoring reports.
12th – 13th November, 2020	Kakum	Assin Fosu	To sensitize key stakeholders on the benefit sharing arrangements including the Upfront advance payment for the Ghana Cocoa Forest REDD+ Programme	• NCRC • SHEC • District Assembly • FC • Olam • COCOBOD	The discussion focused on the following; • Purpose of the BSP • Design process (stakeholder consultations, extensive field study) • Beneficiaries (HIA landscape stakeholders, Government, Private sector) • Types of benefits (Carbon and non-carbon) • Distribution of ERPA proceeds including UAP and its use.	• There should be continuous stakeholder engagement on the BSP at the HIA level. • Allocation should be made for more portions of the benefits to be used to support the forestry teams on the ground, especially the monitoring teams

					• ER payment and performance scenarios • Flow of funds and governance Monitoring of the BSP	
17th – 18th November, 2020	Sefwi Wiawso/Bibiani	Sefwi Wiawso	To sensitize and update key stakeholders on the benefit sharing arrangements including the Upfront advance payment for the Ghana Cocoa Forest REDD+ Programme	• LMB • District Assembly • FC • Rainforest Alliance • Olam • COCOBOD • Traditional Authority	• Finalization and disclosure of the GCFRP BSP • Types of benefits (Carbon and non-carbon) • Beneficiaries (HIA landscape stakeholders, Government, Private sector) • Distribution of ERPA proceeds • Flow of funds and governance	• There should be a collaborative effort among stakeholders in the registration of farmers to benefit from the BSP as beneficiaries under the GCFRP
19th – 20th November, 2020	HIA/Community Juabeso-Bia HIA	Juabeso	To sensitize key stakeholders on the benefit sharing arrangements including the Upfront advance payment for the Ghana Cocoa Forest REDD+ Programme	• HIA executive members • FC • COCOBOD • Police • Fire Service • District Assembly • Agro Eco • Touton • Tropenbos Ghana • Department of Agric • MTS farmers	• Purpose of the BSP • Design process (stakeholder consultations, extensive field study) • Beneficiaries (HIA landscape stakeholders, Government, Private sector)	• *There should be continuous stakeholder engagement on the BSP at the HIA level.*

					• Types of benefits (Carbon and non-carbon) • Distribution of ERPA proceeds including UAP and its use. • ER payment and performance scenarios • Flow of funds and governance • *Monitoring of the BSP*	

At the HIA and community level, engagements on the BSP focused on sensitizing HIA leaders and community members on their roles and benefits outlined in the BSP. This is to manage expectations from stakeholders and for them to understand that the GCFRP is results- based and emission reductions needs to be proved and verified before any payments can be made. In 2020, work primarily focused on the Juabeso-Bia, Kakum and Sefwi HIAs.

The NRS plans to hold the following additional capacity building events on the BSP before the end of 2021 for four HIAs. The other two HIAs (Ahafo-Ano and Atewa) will benefit from same capacity building workshops likely towards the last quarter of 2021, however it is inconclusive now as the development of governance structures has not progressed much for Ahafo-Ano it is yet to begin entirely for Atewa HIA. Aligning BSP capacity building initiatives with the set-up of governance structures is very prudent as it targets the relevant stakeholders who will have responsibilities towards the achievement of ERs. Therefore it is possible such engagements might shift into first quarter 2022, and they are not included in the table below. At the national level, this will focus on specific institutional roles and responsibilities under the BSP, type of benefits, distribution of ERPA proceeds, flow of funds and governance arrangements. At the HIA level, there will be continuous sensitization on the types of beneficiaries, roles and responsibilities, flow of funds and governance.

Table 16 Planned Capacity Building exercise on the BSP

Date	**Activity**	**Targeted Stakeholders/institutions**	**National/Sub-national**
3RD & 4th quarter, 2021	• Capacity building of landscape actors on roles and responsibilities regarding the framework Agreements/ Benefit Sharing/ Fund Flow Mechanism • Landscape wide sensitization and awareness creation on the BSP	• HMB • HIC • Sub-HIA Executives • CEC Executives • FC District Officers • COCOBOD District Officers • District Assembly Officers • CSOs • Private Sector • Traditional Authorities • Department of Agric • WCF	Kakum HIA

2nd, 3RD & 4th quarter, 2021	• Capacity building of landscape actors on roles and responsibilities regarding the framework Agreements/ Benefit Sharing/ Fund Flow Mechanism • Landscape wide sensitization and awareness creation on BSP	• HMB • HIC • Sub-HIA Executives • CEC Executives • FC District Officers • COCOBOD District Officers • District Assembly Officers • CSOs • Private Sector • Traditional Authorities • Department of Agric • WCF	Juaboso HIA
2nd, 3RD & 4th quarter, 2021	• Capacity building of landscape actors on roles and responsibilities regarding the framework Agreements/ Benefit Sharing/ Fund Flow Mechanism • Landscape wide sensitization and awareness creation on BSP	• HMB • HIC • Sub-HIA Executives • CEC Executives • FC District Officers • COCOBOD District Officers • District Assembly Officers • CSOs • Private Sector • Traditional Authorities • Department of Agric • WCF	Sefwi-Wiawso-Bibiani HIA
2nd, 3RD & 4th quarter, 2021	• Capacity building of landscape actors on roles and responsibilities regarding the framework Agreements/ Benefit Sharing/ Fund Flow Mechanism • Landscape wide sensitization and awareness creation on BSP	• HMB • HIC • Sub-HIA Executives • CEC Executives • FC District Officers • COCOBOD District Officers • District Assembly Officers • CSOs • Private Sector • Traditional Authorities • Department of Agric • WCF	Asutifi-Asunafo HIA

A Fund Flow Mechanism (FFM) through which Carbon Fund payments will be disbursed to beneficiaries and actors, in accordance with the agreed BSP is being developed. A consultancy is ongoing to develop the FFM and is due to be completed by October, 2021. By the consultancy end date, the HIA accounts will have been set up for at least four HIAs (Juabeso/Bia, Kakum, Asutifi-Asunafo, Sefwi-Wiawso) with significant progress on Governance structures also completed within same timeframe.

The consultant has made good progress in detailing the operational modalities for the FFM, in specifying the selection criteria and process for RDA Board of trustees, in drafting a terms of reference for the Board, and articulating the rules of procedure for the RDA Board. The RDA Board is due to be set up by October, 2021. Even-though Ghana is confident of having in place the RDA Board and other FFM structures by October, 2021 and in time for the receipt of the ERPA payments, the transfer of ERPA payments if expected to occur before this date should nonetheless not be impeded as the central point of receipt being the REDD+ Dedicated Fund has already been set-up and is same as received the UAP. However, disbursement will not occur until complete FFM structures are in place.

1.3 Confirmation of whether any agreed changes to the benefit sharing arrangement identified during the previous reporting period have been completed.

N/A.
This is the first monitoring report for the first reporting period under Ghana's ERPA, therefore no such information exists to be reported on.

2. Institutional Arrangements

2.1 Agreed institutional arrangements under the BSP and appropriate resources for implementing entities to carry out their respective responsibilities in place.

The key outstanding institutional arrangement for the implementation of the BSP is the setting up of the RDA Board. As indicated in 1.2 above, a consultancy has been procured to assist with the setup of the Board. The RDA Board when set up shall be adequately resourced to carry out their roles and responsibilities smoothly. However, beneficiaries under the GCFRP are known and clearly stated in the final BSP. Furtherance to that, an HIA Implementation Committee (HIC) comprising three members of the HMB, one member each from government, private sector and NGOs/CSOs shall be set up to provide overall coordination and guidance at the HIA level. The on-going consultancy to develop the guiding principles and rules of procedure for the structures in the BSP FFM is also accompanied by regular consultations which provide relevant inputs in the design of the FFM and its multi-tiered governance. It is important to note that the key institutional arrangements for REDD+ established during readiness and presented in Ghana's approved R-package are functional and still hold. The development of the FFM structures only produce another layer of governance arrangement solely for the BSP to avoid any third-party interference and elite capture in the distribution of benefits.

There will be no fundamental changes to the BSP which was widely consulted, validated with stakeholders. Only very specific changes necessary where there is inconsistency for operationalization of the BSP will be considered. All revisions to the agreed BSP will be consulted with, and agreed with key stakeholders. As part of the operationalization of the Fund Flow Mechanism. Changes being foreseen are as follows: RDA Board of Trustees role as signatories to the account will need to be changed per report from the FFM Consultancy currently underway.

2.2 Regulatory or administrative approvals required for implementing the BSP

The signing of the ERPA by both the Minister of Finance and the Chief Executive of the Forestry Commission signals government's approval of the BSP. There were a number of stakeholder consultations and validation on the document as well for stakeholder buy-in and acceptance. At the Sub-national level, the Hotspot Implementation committee will provide administrative approvals and endorsement for implementing the BSP when RBPs are received during the program implementation.

2.3 Assessment of BSP stakeholders (beneficiaries and administrators) understanding of their obligations, roles and responsibilities.

Based on the set up of the HIA governance structure, Community Resources Management Committees (CRMCs) are formed at the community level to assist directly with broad based farmer-level engagements including information dissemination. Through collaborative efforts with CRMCs, HIC, HIA executive members (HMB, SHEC & CEC) and Traditional Authorities, under the coordination of NRS and its partners, targeted farmers (beneficiaries) at the community level will be sensitized on the BSP through community durbars, community information centers and any other workable community-based information sharing platforms. This makes it possible to reach the direct beneficiaries. On the flip side, general concerns from beneficiaries are reported through the CRMCs at the community level and such concerns are relayed through the upward communication channel to reach various levels of the governance processes depending on the appropriateness of the authority to attend to them. Though the existing arrangements have feedback loops from representatives on these governance structures to their constituents, the program monitoring framework also allows for random sampling of communities to verify how these feedback loops are communicating key decisions and also relaying key concerns to the decision-making table.

In line with the above, extensive stakeholder capacity building workshops have been undertaken in four HIAs (Kakum, Asunafo-Asutifi, Juabeso-Bia and Sefwi Wiaso-Bibiani) as stated in section 1.2. This was to enable all beneficiaries (including other key stakeholders) present to gain deeper understanding of their eligibility, roles and responsibilities serving as prerequisite to receiving any benefits (carbon or non-carbon). The participants also served as trainer-of-trainers to assist with the promotion and enhancement of community level sensitization and awareness creation on the final BSP and its modalities to targeted beneficiaries. There were in-depth discussions during all sessions to clear any doubts or concerns and for key stakeholders to have better understanding of the BSP.

The next step will be to strengthen community level sensitization and awareness creation through a joint effort of all relevant stakeholders in the four HIAs. A roadmap to guide this process will be developed before receipt of first payment at the HIA level. This is to ensure that all key stakeholders fully understand their roles and responsibilities in the BSP and also representatives relay information to other beneficiaries and report back as appropriate.

Moreover, the consultancy procured to work on the Fund Flow Mechanism would also enhance beneficiaries' understanding of their obligations, roles and responsibilities. The development of the FFM structures entail national and sub-national level field activities specially to collect data on best practices to set up the RDA Board of Trustees and HIA account opening procedures. This process will produce its best outputs through the inputs of beneficiaries as they also enhance their understanding on how their roles and responsibilities set out or to be set out in the framework agreements translate into their active participation in a functional FFM.

2.4 A system in place for recording the distribution of benefits and associated obligations to eligible beneficiaries.

REDD+ Dedicated Account has been set up and functional for ER payments receipt, tracking, distribution and monitoring. It is through this account the UAP was received in country. HIA accounts are however yet to be set up and as already indicated, will be set up by October, 2021

The consultant engaged on operationalization of the Fund Flow Mechanism, will provide further guidance on the opening of the HIA level accounts.

2.5 Accountability mechanisms in place and functional

The REDD+ programme as part of respecting and addressing safeguards, ensures the full and effective participation of stakeholders in all REDD+ interventions. This is to ensure that the views of all stakeholders are considered in the programme design and delivery. To ensure transparency, all documents or reports that are produced are disclosed on the FC website for the general public. There will be third party verification of our anticipated emission reductions to prove actual ERs before receipt of payment. There are also yearly audits of activities of programmes being implemented at the FC by independent auditors. As mentioned earlier, there is a functional Feedback and Grievance Redress Mechanism (FGRM) for receiving and addressing conflicts to do with implementation of the programme. The draft monitoring report has not been disclosed on the FC website as yet. Once this report is finalized and approved, stakeholders will be informed about it and subsequently disclosed on the website for the general public, however the team working on the monitoring report represent a significant cross-section of the relevant stakeholders so its outdooring is not expected to be entirely new

2.6 Functionality of the FGRM.

The FGRM is operational as mentioned above. There is readiness to receive and address complaints as focal persons have knowledge and understanding of how to receive and address feedback and/or grievances. There are hotlines available where complainants can call and lodge a complaint. All key stakeholders and partners within the programme area also are aware of the modalities for the FGRM. Some grievances were recorded and some addressed under the FIP which is a pilot project under the GCFRP. Notable among the complaints were lack of presence of field or extension officers to provide guidance on planting technologies and the request for additional tree seedlings to plant on their farms.

There have been trainings on the FGRM operational modalities for Safeguards Focal Persons, Safeguards team for the Juabeso-Bia HIA, Consortium partners, HMB and SHEC members for the Juabeso/Bia HIA within the GCFRP area. The SFPs are expected to track information on grievances received and addressed. The SIS web platform has also been designed to receive grievances for redress. Though there has been a number of sensitization and training workshops on the FGRM there is the need to extend it to the other HIAs and continuously engage stakeholders on it.

At all Safeguards capacity building workshops and stakeholder engagements, specific sessions are dedicated to FGRM, however the table below presents ONLY FGRM tailored capacity building and sensitization workshops held in Juabeso and Kakum HIAs. As part of UAP activities, FGRM sensitization is being undertaken and will be undertaken throughout 2021 for all HIAs as the full set-up of governance structures is not needed before FGRM sensitization. The FGRM also provides for grievances of non-inclusion in consultations to be addressed therefore it is a useful vehicle to identify marginalized stakeholders who might have been inadvertently omitted in stakeholder mapping exercises.

Table 17 Summary of specific sensitization events held on the FGRM

Date	Activity	Stakeholders	Summary of Discussions
21st May to Thursday 23rd May, 2019	Sensitization and operationalization of the Feedback and Grievance Redress Mechanism (FGRM) in the Juabeso-Bia HIA	the Forestry Commission, COCOBOD, Touton, NCRC, Agro-Eco, SNV and Tropenbos Ghana including MMDA, CSOs, Traditional Authority, Local communities, Sub-HIA Executive Committee (SHEC)	Potential conflict sources that can result from REDD+ implementation (resource use and access; land and tree tenure; benefit sharing; participation and inclusiveness, among others.) FGRM operational modalities
3rd March, 2020	Sensitization on the FGRM Operational Modalities	Safeguards Focal Persons across the GCFRP area	

Table 18 FGRM planned activities for 2021

9 PLANNED ACTIVITY	10 LEAD	11 COLLABORATOR	12 LOGISTICS	13 INDICATOR	PERIOD	14 HIA	15 REPORTS
Continuous sensitization of Communities on FGRM Operational Modalities (workshops, radio jingles, community centres announcement etc)	**NRS**	FSD WD HIA Consortium	Logistics for workshops, planned messages for jingle recordings and announcements	Jingles produced and aired, Announcement transmission certificates	2nd – 4th quarter	ALL HIAs	Workshop reports Recorded messages, jingles, etc.
Print FGRM awareness creation Materials (Posters, Fliers, banners etc) and display at vantage points	**NRS**	FSD/HIA Consortium/WD/ Communities/ NGOs/ General Public			2nd quarter	ALL HIAs	Displayed FGRM Materials
Support Focal persons to address grievances (mediation, data purchase, mediation process, etc)	**NRS**	FSD WD (SFPs)	Logistics to organize meetings and Panel sittings	Short report on complaints and planned support actions	1st – 4th quarter	ALL HIAs	Notes/reports of meetings held--grievance redress report for monitoring report FGRM Reports; to include Notes or reports of meetings held, Support given and

							how, outcomes.

2.7 Adequate human and financial resources allocated or maintained for implementing the BSP.

Yes, adequate human and financial resources have been allocated to ensure the successful implementation of the BSP. Capacities of key stakeholders have been built on the BSP. There are funds allocated to enable the smooth implementation of the BSP for the programme as part of PMU fixed costs which includes the recruitment of a permanent BSP officer or specialist in the second reporting period. The BSP specialist when recruited will lead sensitization and awareness creation on the BSP and its implications under performance or non-performance scenarios. The 36 SFPs within the regional and the district levels in the GCFRP implementation areas would support sensitization programmes on the BSP.

The RDA Board of Trustees (BoT) and the HIA Implementation Committees are the designated human resources at the program level and HIA level respectively.

The RDA Board in collaboration with beneficiaries and other key stakeholders will perform an assessment of the setups, systems and processes of beneficiaries of the ER payments to ensure that beneficiaries are duly set up or established along the governance guidelines in the final BSP. Specifically, the RDA Board will undertake the following activities;

a) Evaluating the Farmer Groups and HIAs towards making sure they are properly setup in accordance with the Final BSP
b) Ensuring that the HIAs governance structures are properly setup in accordance with the Final BSP (i.e. gender balance, leadership make-up and bank signatories).
c) Ensuring that beneficiary Traditional Authorities have properly registered HIAs and Farmer Groups in their jurisdiction.

d) That the bank accounts of beneficiaries, particularly the HIAs and Traditional Authorities are well setup with the registered name and particulars of the beneficiary entity and with the proper authorized signatories

e) Receive and verify addresses and contact information of all beneficiaries

f) The Board will also at this stage define the mode(s) for communicating with the Beneficiaries and stakeholders (E-mail, Phone, Mail etc.) and will share this information with them

The consultancy for the development of the FFM as stated in 1.2 above is developing the necessary processes and documents for the formation of the RDA BoT. An HIA Implementation Committee has been established in Juabeso HIA. Governance structures for the other HIAs are being developed for the eventual set up of the respective HICs. Therefore, direct responsibility to coordinate the sharing of benefits from CF payments, and therefore, the BSP itself with associated monitoring and reporting, is the responsibility of the RDA Board of Trustees at the program level, and the HIA Implementation Committees at the HIA level.

3. Status of Benefit Distribution

3.1 Distribution of all monetary and non-monetary benefits during the reporting period.

The GCFRP is yet to make any benefits distribution. As at the first reporting period, the country has only received an Upfront Advance Payment (UAP), which is to be used for the operations of the PMU and implementation of some key programme activities.

3.2 Number and type of beneficiaries who received benefits during the reporting period

N/A.
As this is the first monitoring report based on which the first ER payments will be received, as such no benefits have been distributed yet. Therefore, there is no record on the actual numbers and type of beneficiaries. This information will be adequately provided in the preparation of subsequent ER MRs.

3.3 Adequate implementation support of beneficiaries to assist in the management and use of benefits distributed to them?

N/A.
The same scenario above applies and is actually the case for the entire section 3 as it relates to status of benefit distribution which is yet to materialize as this is the first monitoring report communicating ERs for verification. However, adequate arrangements have been made which will be 'tested' with the receipt of the first ER payments.

3.4 Description and assessment of the effectiveness of the mechanisms for ensuring transparency and accountability during the implementation of the BSP.

N/A.
The mechanisms in place for transparent and accountable benefits distribution are considered very effective since they are built to incorporate protocols of independent verification and monitoring by non-program beneficiaries from national level to sub-national level with the relevant safeguards protocols. However, as this is the first monitoring report, these mechanisms are yet to be 'tested' in this learning curve. However, the receipt of the first ER payments will provide this opportunity for adequate reporting in the subsequent ER MRs.

3.5 Continued Relevancy of Benefit Sharing distributions to core objectives and legitimacy of the ER Program objectives

N/A.
The full or partial scope of this assessment will most likely be beyond the receipt of two ER payments, that is midway through program implementation to understand the impact of benefits distribution to ER achievements. However, as Ghana is even yet to receive any ER payments, it is impossible to indicate now.

3.6 Description of the mechanisms in place to verify how benefits are used and whether those payments provide sufficient incentive or compensation to participate in program activities to change land use or reduce carbon emissions.

N/A.
Socio-economic parameters to measure program performance particularly on farmer yield enhancements, farmer livelihood enhancements and re-investment of benefits to improve climate smart farming practices will serve as key indicators for verification.

3.7 Understanding of beneficiaries of their continued obligations

N/A.
Obligations, roles and responsibilities are the key elements in the Framework Agreements, HMB constitutions, CREMA bye-laws and constitutions. As the process for setting up governance structures progresses, there is evidence of understanding of these obligations, roles and responsibilities with the needed capacity building. However, as ER payments are received eventually, they will provide another layer to assess the understanding and priorities assigned to these obligations, roles and responsibilities.

4. Implementation of the Environmental and Social Management Measures for the BSP

4.1 Extent to which the measures for managing the environmental and social aspects of BSP activities have been implemented.

In the finalized BSP, the environmental (referred in the BSP as ERs indicators) and social indicators have been proposed to guide the relative assessment and performance of the HIAs. The social indicators are functions of the environmental indicators

Currently, through a consultancy and key consultations, an options paper for assessing the environmental aspects of the BSP has been developed. For the key next step, the options paper would be taken through a review and comments process by both national and landscape actors to agree on the best option. Consultations, review, amendments and validation of the Options Paper is currently on-going and is expected to be completed by August, 2021.

The draft recommended options from the consultancy which are going through key consultations are indicated below. The outcome of the consultations would help finalize the options.

1) *The baseline period to be used for identifying change in the HIA's deforestation should be the same as the larger programme's reference period: Jan 2005 to Dec 2014. The assessment period should be the results-reporting periods of the whole programme: 2019, 2020-2021, 2022-2023 and 2024.*

2) *The HIA indicators should be operationalized only based on deforestation, since this is what was decided when the benefit-sharing plan was drawn up. Efforts to reduce forest degradation and enhance tree planting should not be considered for the emission reduction indicator (but are considered through social performance indicators).*

3) *A minimum threshold for the amount of observed change in deforestation area should be introduced, such that a very small change below the threshold would be considered insignificant. The minimum threshold could be set at 30% for significant change of deforestation in HIAs, corresponding to the target precision of the deforestation measurement for the HIAs.*

4) *The emission reduction indicators should be based on the measurement of deforestation areas (and not emissions).*

A similar process is planned for the social indicators as well. A roadmap to guide this process shall be developed and rolled subsequent to the appropriate dialogues and consultations. The roadmap is expected to be developed by end of 3rd quarter in 2021.

5. Recommendations for BSP Improvement or Modifications.

5.1 Specific recommendations for modifying the procedural or substantive content of the BSP.

There are plans to modify one procedural content of the BSP. In the finalized BSP, the RDA Board of Trustees (specifically the Co-Chairs) are to be signatories to the RDA. However, after consultations with the Ministry of Finance on how this would practically be operationalized, it has come out clearly from the preliminary report of the technical assistance on the FFM that, as a statutory recognized body and per Financial Management of the Country, the Forestry Commission would have to sign cheques for the release of funds to beneficiaries through the HIA accounts.

However, the RDA Board would have to give a notification of consent before the FC may sign any cheques for the release of funds to beneficiaries.

Going forward, beneficiaries and stakeholders shall be consulted and informed on outputs of the consultancy in general and specifically on this modification.

5.2 Procedural or administrative obstacles to timely distribution of benefits.

N/A as there are no benefits to distribute yet

5.3 Evidence of other emerging risks that may affect the sustainability or effectiveness of the BSP.

N/A as no emerging risks have been identified

5.4 Suggested timeline and an outline of administrative arrangements to introduce any recommended changes.

The suggested procedural change is expected to be effected once Ghana receives the first ER payment after verification. Hence this is tied to the period of receipt of the first payment.

ANNEX 3: INFORMATION ON THE GENERATION AND/OR ENHANCEMENT OF PRIORITY NON-CARBON BENEFITS

Priority Non-Carbon benefits

1. Identified set of priority Non-Carbon benefits

The priority non-carbon benefits which are deemed to be critical to incentivizing the behavioral changes which will produce ERs within the GCFRP area are listed in table 19 below. These non-carbon benefits are same as were identified during the ERPD formulation:

Table 19 Priority Non- Carbon Benefits

Priority Non-Carbon Benefit	• ***Details on activities for generation and enhancement*** ○ ***Approach (as defined in ERPD including relevant indicators)***	• ***REMARKS***
• *Increased yields via Climate Smart Cocoa (CSC) practices*	Farmer engagement package that gives farmers access to improved planting materials, access to inputs, access to technical extension, access to business extension, and access to financial and risk products will enable increases in yields and incomes. Ensuring transparency in cocoa purchases will further increase income for cocoa farmers;	The ERPD estimates an average farm yield of 400kg/ha. This is expected to double over the Programme period. Currently due to interventions, The Ghana Cocoa Board Reports an average of 500kg/ha[19] The Ghana Cocoa Board has a policy to develop irrigations to support Cocoa Production as part of productivity enhancement as an adaption for uncertainty in rainfall distribution patterns. In 2019, 2,261,247 tree seedlings were supplied to farmers by various groups (Cocobod, FC,CSos, Private Sector)[20] (details in Table 12 , page 30 of the 2019 Forest Plantation Strategy report) (link already indicated in main report) In 2019, 224,500 farmers were trained in Climate Smart Cocoa Practices. In 2020, under the Upfront Advance Payment, out of the 251 farmers who benefitted, 162 were males while 89 were females. ACHIEVEMENT

[19] Communication with the Monitoring and Research Department of the Ghana Cocoa board

	Indicators • *Average yield per hectare over the programme period* • *Number of tree seedlings supplied to farmers* • *Hectares of cocoa farms benefiting from hand pollination* • *Number of farmers trained on CSC practices* • *Number of irrigation systems for cocoa production set up* • *Number of farmers trained in Farmer Business School (FBS)*	500Kg/ha is the currently reported average cocoa yield per hectare 2,261,247 tree seedlings were distributed to farmers for planting on farm 57,600 ha pollinated as at end of 2020 224,500 farmers were trained in 2019 (at least 30% of them were women) 52 irrigations fully set up as at end of 2020 224,500 farmers were trained in Climate Smart Cocoa Practices (at least 30% were females
• *Tree tenure reform and resource use rights improved for farmers, land users*	Indicators	There have been a number of stakeholder consultations on tree tenure rights /benefits. Through these engagements, farmers now really appreciate the fact, 'once one plants a tree, the tree belongs to her/him'. The demand for shade trees from farmers to plant on farms has increased over the period. Currently what remains inconclusive is the naturally occurring trees which have been/ are being nurtured by farmers. By law all such trees are invested in the President (the State) for communal benefit. As the discussions continue, farmers are being supported to register their trees. By this process farmers can make claim to both user and benefit rights and clearly distinguish planted trees from naturally occurring ones.

	Number of farmers supported to register trees on farm	105,400 farmers supported to register Trees on Farm
• *Improved law enforcement*	Strengthened collaboration with HIA communities on monitoring and enforcement of local by-laws and national laws; Indicators • *Number of Hotpot Intervention Areas (HMBs) Management Boards MBs set up* • *Number of CREMA Executive Committees (CECs) set up* • *Number of Sub-HIA Executive Committees (SHECs) set up*	The setting up community frameworks (governance structures) to efficiently assist with monitoring has been the initial focus. As indicated above, the governance structures for the various HIAs are currently at various stages of being set up. The HIAs enact by-laws to include forest protection, and this makes it obligatory for local communities to support FC's forest protection mandate. 1 HMB set up as at the time of reporting in Juabeso - Bia HIA. 16 CECs have been set up in Juaboso-Bia, Asutifi-Asunafo and Kakum HIAs. 12 SHECshave been set up in Juaboso-Bia, Asutifi-Asunafo and Kakum HIAs.
• *Improved landscape management and planning*	The adoption of a landscape management approach to natural resource management under the GCFRP through coordinated efforts and support by stakeholders will lead to improved	The framework agreement is signed between the Forestry Commission, Ghana Cocoa Board and the Hotspot I Management Board who represent the communities/the HIA.

in the HIA landscapes	landscape management and planning in HIA landscapes Indicators • *Number of framework agreements signed* • *No of women elected unto the HMB* • *Number of HMB and Landscape Management Board (LMB) in place.*	There are six HIAs, and the expectation is to sign 6 framework agreements. So far, one framework agreement has been signed, which is with the Jauboso/Bia HIA. Subsequently, six Private Sector entities/NGOs/CSOs have signed an addendum to the framework agreement. Work is far advanced to sign two more framework agreements by the end of August 2021 with the both the Asutifi and Ahafo Ano HIAs In Juabeso/Bia HIA where the framework agreement has been signed, the HMB is made up of 13members out of which 6 are females. The contact details of the women are as follows: Hawa Asraa: +233556509596 Nallice Afrakomah Adjei: +233549983118 Sheila Addo Boah: +233245299126 Mary Arthur: +233245490244 Christiana Adusei: +233542823628 Nana Akua Tawiah : +233559829316 Achievement 1 Framework Agreement Signed 6 *women elected unto the Juabeso/Bia HMB* 1 HMB has been established
• *Improved watershed management*	As a result of HIA landscape management planning and monitoring water bodies are being protected and effectively managed. Indicators	434.5 ha of degraded watershed was restored in 2019.

	• *Area of degraded watershed restored*	

Other Non-Carbon benefits and additional information as linked to Monitoring and Evaluation Framework

2. Any other (non-priority identified) Non-Carbon benefits*:*

Livelihood enhancement and sustainability

2.1. Testing ways to sustain and enhance livelihoods under the CF program.

Per the design of the GCFRP, provision of additional/alternative livelihood options for community members is a key objective to ensure successful programme implementation. In the administration of the UAP for instance, there would be a market analysis of selected alternative/ additional livelihood options to ensure efficient implementation.

To ensure sustainability and enhance livelihoods of local actors within the GCFRP area, the NRS as part of its safeguards capacity building workshops, sensitize stakeholders on alternative/additional livelihoods options. The NRS also encourages private sector in particular to integrate in their workplans alternative/additional livelihoods for local actors as part of GCFRP implementation

Biodiversity

2.2. Testing ways to conserve biodiversity under the CF program.

Generally, the GCFRP does not primarily target biodiversity. However, when trees on farm are increased, it contributes to the improvement of biodiversity within the off-Forest Reserve areas.

Specifically, the Kakum HIA is highly considered for biodiversity conservation under the GCFRP. The focus is to create a rich buffer zone to minimize the threat on the Kakum National park. Seasonal patterns/changes are also monitored to check elephant and other large mammal distribution and abundance.

Currently In the Kakum HIA, a pilot monitoring on biodiversity is being undertaken. Bird survey is ongoing where a bird expert is employed to identify hornbills as a keystone species threatened by habitat loss, hunting or international trade.

In the Bia National Park, wildlife corridors have been established to enhance movement of the wild animals.

Protected/conserved areas

2.3. Amount (in ha) of protected or conserved areas included in your CF program area

There are three main protected and conservation areas in the GCFRP area as follows:

Conservation Area	Extent (ha)
Kakum National park	20,918
Bia National Park	31,401
Assin-Atandanso Game Production Reserve	15,802

These are areas under conservation and as such have not increased nor decreased in the last year.

Re/afforestation and restoration

2.4. Total forest area re/afforested or restored through program

Over 1.27 million ha (21%) of the programme area is gazetted as forest reserves and national parks, both of which are managed by the FC and commonly referred to as the "On-Reserve and Protected Areas". The majority of the forests within the accounting area are located within the on-reserve. In contrast, the "off reserve" (all land outside of protected areas) covers approximately 4.65 million ha and is made up of settlements and infrastructure, agricultural lands (including tree crops), fallow lands, and forest patches or high biomass agroforests.

In 2019, a total of 18,443.55 ha was reforested in the programme area.

The table below outlines regional breakdown of restoration activities within the ecological zones

Table 20 Restoration activities within the ecological zones

ECOLOGICAL ZONES (Total HA Planted 2019)									
Regions	**Moist semi deciduous (north west subtype)**	**Areas planted**	**Moist semi deciduous (south east subtype)**	**Areas planted**	**Moist evergreen**	**Areas planted**	**Wet evergreen**	**Areas planted**	**Totals**
Western Region	Sefwi Wiawso	2,574.36			Takoradi	321.0	Tarkwa	29.50	2,895.36
	Bibiani	738.35					Asankragwa	310.64	1048.99
	Juaboso	910.21					Enchi	7.95	918.16
	Sub Total								**4,862.51**
Ashanti Region	Nkawie	1,221.88	Bekwai	485					1,706.88
	Mankranso	832.44	Juaso	660.43					1492.87
	Offinso	2,170.36	New Edubiase	270					2,440.36
	Kumawu	337.08							337.08
	Sub Total								**5,977.19**
Bono Region	Dormaa Ahenkro	1,201							1,201
	Bechem	511.76							511.76
	Sunyani	3,242.78							3,242.78
	Sub Total								**5,344**
Ahafo	**Goaso**	**388.39**							388.39
Central Region					Assin Fosu	916.71			916.71
					Dunkwa	304.31			304.31
	Sub Total								1221.02
Eastern Region			Akim Oda	259.87					256.87
			Kade	421.36					421.36
			Begoro	267.35					267.35
			Somanya	93.32					93.32
	Sub Total								**1038.9**
Totals									**18,443.55**

Finance and Private Sector partnerships

2.5. Update on CF program budget (as originally presented in ERPD), with updated detail on secured (i.e. fully committed) finance, in US$

Funding for the implementation of the GCFRP will be from a mix of sources: ER Payments (21.1%), private sector investment (51.3%), Government of Ghana, including Cocoa Board and FC investment (22.7), and donor grants (4.9%).

Ghana estimates that the total cost of setting up and operating the GCFRP over its first five years is US $ 236,727,250. Out of this, it is anticipated that the programme will generate approximately US$50 Million in revenue from emission reductions.

Table 21 Summary of funding sources for the GCFRP (2019-2020)

Summary of Funding Sources	Projections	Receipts
REDD+ Funding	$ 49,990,400	$1.3m (UAP)
Private Sector	$ 121,360,000	
Grants	$ 11,718,800	
Government	$ 53,658,050	$151,533
TOTAL	**$ $236,727,250**	

2.5.1. Amount of finance received (including ER payments) in support of development and delivery of your CF program.

Amount (US$)	**Source** (e.g. FCPF, FIP, name of gov't department)	**Date committed** (MM/YY)	**Public or private finance?** (Delete as appropriate)	**ERP, grant, loan, equity or other?** (Delete as appropriate)
$1,300,000	FCPF	September, 2020	Public	ERP Payment

2.5.2. The value of REDD+ ER payments that the CF projects and the county have received overall not including ER payments from the FCPF Carbon Fund.

	Total REDD+ ER payments received to date ($US)
Carbon Fund project/s (i.e. ER payments from sources other than the Carbon Fund)	$
All other national REDD+ projects	$

Number of formal partnerships established between the CF program and private sector entities.

The GCFRP has engaged a number of private sector/CSO/NGOs and subsequently signed MoUs with them and some of which are

Partnerships between CF Program and Private sector entities

Partner institutions	***Partner Institutions with MoU***
Tropenbos Ghana	*Tropenbos Ghana*
International Union for Conservation of Nature	*Proforest Africa*
Solidaridad	*Solidaridad West Africa*
Mondelez International Ghana	**Mondelez International*
Center for International Forestry Research (CIFOR)	*CIFOR*
World Cocoa Foundation	*World Cocoa Foundation*
Touton SA	**Touton SA*
Proforest Africa	**NCRC*
Hershey	**SNV*
KASA Initiative Ghana	**Agro Eco*
A ROCHA	*Nyonkopa (Subsidiary of Barry Callebaut Ghana)*
SNV Netherlands Development Organisation (SNV)	
Rainforest Alliance	
OLAM Ghana Ltd	
ECOM Agroindustrial Corp. Ltd	
Nature Conservation Research Centre (NCRC)	
***Agro Eco-Louis Bolk Institute** (Agro Eco)*	
Nyonkopa (Subsidiary of Barry Callebaut Ghana)	

** FC have individual and/or joint MoU with those entities*

	Established in the last year *(Jul-Jun 2019)*	***Total to date***
Number of private sector partnerships involving financial exchange	*1*	*3*
Number of private sector partnerships involving non-financial exchange	*1*	*1*

3. Other Non-Carbon benefits and additional information

Other Non-Carbon Benefits in addition to the priority non-carbon benefits stated earlier are:

- *Trainings and planting materials*
- *Improved supply chain efficiency through the adoption of CSC practices*

<u>Policy development</u>

3.1. CF program involvement in the development, reform and/or implementation of policies to help institutions/people/systems/sectors.

The FIP which is a pilot programme under the GCFRP has advanced a policy reform process on tree tenure and benefits especially on naturally occurring trees in off reserves.

<u>Capacity building</u>

1.1. Training, education or capacity building opportunities to increase the capacity of institutions/people/systems for the CF program.

The GCFRP has undertaken a number of capacity building programmes on REDD+, Safeguards, Gender, FGRM at the National, Regional, District and landscape level.
The approach has always been to enhance the capacity of stakeholders when the need arise or upon formal request from the respective partners/stakeholders to train their landscape actors. The NRS upon request by Tropenbos and Rainforest Alliance-Olam built the capacities of Landscape actors on REDD+ Safeguards at Sefwi Wiawso and Kintampo respectively. Another training workshop on safeguards and gender was conducted for Consortium partners for the Juabeso-Bia HIA. Sex disaggregated dated was highly considered as an indicator in the reports. The various training, capacity/sensitization reports are on the SIS web platform

<u>Other</u>

3.2. Non-carbon benefits not already covered in this annex of the CF program

N/A
All non-carbon benefits are covered under the Annex

Appendix 1

LETTER FOR SAFEGUARDS TEAM NOMINATION AND TOR FOR TEAM

FORESTRY COMMISSION
(FOREST SERVICES DIVISION)

P. O. BOX 3
JUABOSO - B/A
TEL:

26/09/ 2019

KINDLY REFER TO DISTRIBUTION

Dear Sir/Madam,

NORMINATION TO SERVE ON THE SAFEGUARDS TEAM FOR THE JUABESO BIA HIA LANDSCAPE

One of the flagship programs in Ghana's REDD+ Strategy is the Ghana Cocoa Forest REDD+ Programme (GCFRP), which aims to halt further expansion of cocoa production into forest areas while adopting climate smart practices to increase cocoa yield.

For the purpose of landscape governance, the GCFRP has been designed to adapt a model called Hotspot Intervention Areas (HIA) which is an aggregation of political districts and a multitiered governance structure for the people in the landscape.

The Juabeso Bia HIA is one of the six (6) Hotspot Intervention Areas (HIAs) selected for implementation of the Ghana Cocoa Forest REDD+ Programme. As part of efforts to implement REDD+ safeguards activities within the Juabeso Bia HIA, there is the need to set up a safeguards team to monitor and report on REDD+ safeguards within the landscape.

As a key stakeholder, you are kindly requested to nominate one person from your institution/governance structure as a member of the Juabeso Bia safeguards team to execute the attached ToRs. The nominee should contact **Mr. Tweneboah on 0248590510** for the next line of actions by **3rd of October, 2019.**

We count on your valued cooperation.

Yours faithfully,

MARK AIDOO GYAMFI
DISTRICT MANAGER
JUABOSO/BIA DISTRICT

Cc: Director, Climate Change Director

Regional Manager, FSD Western Region.

Regional Manager, WD Western Region

VISION: To leave future generations and their communities with richer, better, more valuable forestry and wildlife endowments than we inherited.

Appendix 2

DISCLOSED BSP IN NATIONAL DAILIES

Ministry of Lands & Natural Resources

FORESTRY COMMISSION

Forestry Commission

PUBLIC DISCLOSURE NOTICE

DISCLOSURE OF FINAL BENEFIT SHARING PLAN (BSP) FOR THE GHANA COCOA FOREST REDD+ PROGRAMME (GCFRP)

Ghana led by the Forestry Commission (FC) in partnership with the Forest Carbon Partnership Facility (FCPF) of the World Bank implemented the Readiness phase of the Global Climate Change Mitigation Mechanism; Reducing Emissions from Deforestation and Forest Degradation (REDD+) since 2008.

After a decade of REDD+ Readiness Activities, Ghana has developed its premier Emission Reductions Program dubbed the Ghana Cocoa Forest REDD+ Program (GCFRP), which has been accepted into the Carbon Fund of the FCPF for potential results-based payments. The Forestry Commission (FC) and Ghana Cocoa Board (Cocobod) jointly coordinate this Programme with the support of private sector and local communities.

The goal of the GCFRP is to significantly reduce deforestation and forest degradation in the High Forest Zone by promoting restoration of degraded landscapes, enrichment planting in forest reserves, climate-smart cocoa production, landscape level land-use planning, strategic policy reforms, integrated coordination and monitoring, law enforcement as well as risk reduction efforts within priority Hotspot Intervention Area (HIA) landscapes.

Subsequently, an Emission Reductions Payment Agreement (ERPA) which establishes the conditions of sale and purchase of any Emission reductions (ERs) from the GCFRP was signed between the Government of Ghana (GoG) and the World Bank as a trustee for the Carbon Fund in June 2019 for a period of six years.

A key condition for signing the ERPA is for Ghana to finalise its Benefit Sharing Plan towards full execution of the programme and eventual receipt of payments against demonstrated ERs as a mandatory Safeguards tool.

This notice therefore is to inform the public that the BSP document, which has been designed and developed through extensive stakeholder consultations as an equitable benefit sharing mechanism intended to distribute ERs payments transparently and accountably as articulated by the Programme Document is fully completed and endorsed by the Carbon Fund (CF). It describes the various beneficiaries, their eligibility, roles and responsibilities while specifying the scale and modalities for distribution. Additionally, the BSP describes the type of benefits to be transferred to beneficiaries, the timing of the distribution, and the conditions to be satisfied for the payment of the benefits. It also details the appropriate indicators for monitoring, measuring and verifying compliance with modalities for distributing benefits to beneficiaries.

The completion of the BSP represents a very significant milestone in the lifetime of the GCFRP and the Forestry Commission (FC) is appreciative of all national and sub-national stakeholder efforts for this achievement.

Further details relating to the Final BSP for the GCFRP could be accessed via the Forestry Commission website http://fcghana.org/library.php and http://reddsis.fcghana.org/admin/controller/publications/Final%20BSP_Ghana_%20March%202020.pdf

For further enquiries or clarifications on this disclosure, kindly contact us through the following email addresses and telephone numbers:

Email: info.hq@fcghana.org, radjei.hq@fcghana.org

Tel. numbers: +233 302 401210, 401227, 401216

ISSUED BY

THE FORESTRY COMMISSION

P. O. Box MB 434

ACCRA-GHANA

Appendix 3

FORESTRY COMMISSION
(CORPORATE HEADQUARTERS)
P. O. BOX MB 434, ACCRA - GHANA
TEL: (233-302) 401210 / 401216 / 401227
Fax: (233-302) 401197
E-mail: info.hq@fcghana.org
Website: www.fcghana.org

Forestry Commission

Our Ref: FC/A.10/SF.21/V.6/139

Your Ref:.................................

3rd February, 2020

The Coordinator
The Carbon Fund of the Forest Carbon Partnership Facility
1818 H Street, N.W.
Washington, D.C. 20433
United States of America

EVIDENCE DEMONSTRATING PROGRAM ENTITY'S ABILITY TO TRANSFER TITLE TO EMISSION REDUCTIONS

Reference is made to the Emission Reductions Payment Agreement (ERPA) signed between the International Bank for Reconstruction and Development (IBRD) acting as Trustee to the Carbon Fund and the Government of Ghana (Represented by the Ministry of Finance and Forestry Commission) for the Ghana Cocoa Forest REDD+ Program (GCFRP).

We write with reference to the third condition of effectiveness in the ERPA which is to submit evidence demonstrating the Program Entity's ability to transfer Title to ERs free of any interest, Encumbrance or claim of a Third Party. This declaration has already been made by the Attorney-General and Minister of Justice for Ghana on the 6th May, 2019 and same was forwarded to the Trustee on same date. This declaration by the Attorney-General and Minister for Justice was made based on a comprehensive legal assessment led by Messrs Atlas Environmental Law Advisory together with national legal experts (Copy attached).

The Forestry Commission subsequently submits this letter together with the above mentioned documents as proof of its legal status to transfer Title to ERs free of any interest, Encumbrance or claim of a Third Party on behalf of all stakeholders regarding the sale and purchase of ERs from the Ghana Cocoa Forest REDD+ Program. This legal status to transfer Title to ERs in no way translates into ownership of ERs by the Forestry Commission as the program design does not permit one entity to own ERs but has a comprehensive Benefit Sharing Plan developed through extensive stakeholder consultations involving all actors and beneficiaries.

Yours faithfully,

KWADWO OWUSU AFRIYIE
CHIEF EXECUTIVE

VISION: To leave future generations and their communities with richer, better, more valuable forestry and wildlife endowments than we inherited.

Appendix 4

FRAMEWORK AGREEMENT FOR IMPLEMENTATION OF THE GHANA COCOA FOREST REDD+ PROGRAM IN THE JUABESO/BIA HOTSPOT INTERVENTION AREA

FREEDOM AND JUSTICE

GHANA

Forestry Commission

Ghana Cocoa Board

GhREDD+

FRAMEWORK AGREEMENT FOR IMPLEMENTATION OF THE GHANA COCOA FOREST REDD+ PROGRAM IN THE JUABESO/BIA HOTSPOT INTERVENTION AREA

1. Preamble

After almost a decade of REDD+ Readiness Activities, Ghana has developed its premier Emission Reductions Program as outlined in Ghana's REDD+ Strategy; the Ghana Cocoa Forest REDD+ Program (GCFRP). As part of its goals, the GCFRP seeks to significantly improve livelihood opportunities for farmers and forest users, and has established an implementation framework through which the government, private sector, civil society, traditional authorities and local communities can collaborate. It is against this background that the parties of this agreement are collaborating to contribute to the attainment of the goals of the GCFRP. This collaborative effort is in recognition of the importance of cocoa and forestry sectors to Ghana's economic development and poverty alleviation.

The GCFRP aligns with key policy documents such as the Forest and Wildlife Policy (2012) and the Ghana Climate Change Policy (2012) amongst others.

In addition to the above, under the auspices of the Cocoa & Forests Initiative (CFI), the Government of Ghana through the World Cocoa Foundation signed a joint framework of action with 28 global cocoa companies and chocolate producers in 2017. They jointly agreed to transform the cocoa sector from a major driver of deforestation to one that is leading the protection and re-forestation of the high forest zone, as well as the sustainable production of cocoa at a landscape scale.

The CFI has thus enhanced existing engagements with the cocoa private sector and cocoa farmers.

2. Parties to the Framework Agreement

This framework agreement has been reached amongst the Forestry Commission, Ghana Cocoa Board ; the Juabeso Hotspot Intervention area (HIA) , as represented by the HIA Management Board; and other consortium partners who have agreed to the goal of the Ghana Cocoa Forest REDD+ Program (GCFRP).

The other consortium partners may be Private Sector/ Civil Society Organisations/ Non Governmental Organisation and/or other government agencies who are undertaking specific projects in line with the GCFRP.

3. Background to the Parties

The Forestry Commission and the Ghana Cocoa Board as the proponents of the GCFRP are the lead consortium partners.

The Forestry Commission of Ghana is an agency of state established by the Forestry Commission Act of 1999 (Act 571) of the Parliament of the Republic of Ghana with the mandate to effectively and sustainably manage the forest estates of Ghana in a manner that ensures socio-economic development and environmental integrity for the benefit of all segments of the Ghanaian society. Forestry Commission shall collaborate with Ghana Cocoa Board to coordinate projects implementation in the Bia-Juabeso Landscape. For this agreement, Forestry Commission (hereinafter referred to as "FC" or "party") is represented by **Kwadwo Owusu Afriyie**, Chief Executive, FC Ghana

And

"HIA" means the Hotspot Intervention Area as described in the GCFRP documents and is applied in this agreement to mean the xxxxx HIA, asrepresented by the HIA management board

"HIA-ConsortiumFramework Agreement" means anagreement between the lead Consortiumpartners and the Juabeso/Bia Landscape Management Board and other consortium partners of the HIAclearly stipulating all the terms in this collaboration.

5. Guiding Principles

The Parties agree to operate on a constructive and collaborative basis within the HIA landscape.

The Parties agree to establish a climate-smart cocoa sub-landscape with the intention to transform cocoa farming methods and landscape conservation measures for the purpose of creating positive and sustainable environmental practices as outlined in the Ghana Cocoa Forests REDD+ Programme.

The Parties envisage the cocoa farms of the HIA will have greater capacity to adapt to changes in rainfall patterns and increases in temperature. Encroachment into forest reserves will cease and the off-reserve landscape will retain significant patches of secondary forest, old forest fallows and relic cocoa agro-forests due to the implementation of a land-use planning process.

6. Parties Jointly Recognize

The Parties jointly recognize the following:

- The private sector membersoperate proven business models focused on commodity (cocoa, timber, oil palm etc.) sourcing from the HIA landscape for international markets.
- The private sector faces growing international pressure to demonstrate sustainable and climate smart and deforestation free sourcing of their commodities.
- The Civil Society members operate long-term efforts to demonstrate pathways to enhanced sustainability and climate resilience for commodities (cocoa, timber, oil palm, etc) and Non Timber Forest Products (NTFPs) from the landscape.
- The HIA membership have undertaken to manage their agriculture and forest landscape in a more sustainable manner than previously done to ensure enhanced capacity to withstand climate change impacts.
- All Parties agree to develop a fundraising mechanism to manage forest governance and monitoring in the landscape.
- All Parties agree to develop a fund management and financial sustainability mechanism to support the HIA's operational sustainability.
- All Parties agree to contribute to the HIA Annual Work Plan, derived from the overarching Landscape Management Plan, in alignment with their individual CFI action plans.
- All Parties agree that only members of this agreement shall have rights to claim deforestation-free value chains in the HIA landscape.
- All certificates, reports, maps, images and outputs produced by the Parties within the HIA will remain the property of that individual Party – including copyright where appropriate. Members will share such documents to the maximum extent possible without compromising confidential business operations.
- All Parties agrees to implement activities and practices that are in alignment with the safeguard and grievance redress mechanism of the GCFRP.

7. <u>Parties Jointly Agree</u>

The Parties jointly agree to the following:

- The Agreement will focus on the sustainable production of commodities (cocoa, timber, oilpalmetc) and NTFPs in the Juabeso/Bia HIA in the Western North Region of Ghana.
- The Agreement will allow continuous research, monitoring and learning from the HIA landscape for the purpose of documentation and exchange with other HIA locations.
- The Parties will communicate freely with each other, keeping the other Parties informed of the status of activities and projects, while also respecting confidentiality that each Party may have with other organizations, companies and individuals.
- A formal review meeting shall be held periodically to assess progress of planned activities.
- Juabeso/Bia HIA and other partners shall implement anySub-Project/ER Program Measures (as specified in the GCFRP Programme Document (PD) in accordance with the terms of the GCFRP .
- For the avoidance of doubt, the parties authorize the government (Forestry Commission) to transfer any ERs generated from such Sub-Project/ ER Program Measures to the FCPF Carbon Fund free of any third party interest or encumbrance.
- Juabeso/Bia HIA and other partners shall inform the Government Forestry Commission immediately after becoming aware of the occurrence of a Reversal Event under any Sub- Project/ER Program Measure.
- Juabeso/Bia HIA and other partners will operate and implement its Sub-Project/ER Program Measures in compliance with the World Bank Operational Policies and any Safeguards Plans provided for under the Emission Reduction Payment Agreement (ERPA).
- Juabeso/Bia HIA and other partners will maintain and prepare any Sub-Project/ER Program Measures to allow for Verification.
- Juabeso/Bia HIA and other partners will satisfy any obligations in respect of applications for all licenses, permits, consents and authorizations required to implement the Sub-Project/ ER Program Measures
- Forestry Commission shall provide the parties with the ERPD, the ER Monitoring Plan (if needed), the Safeguards Plans and any other information relevant to the implementation of any Sub-Project/ER Program Measures (including relevant communication between the Trustee and the Program Entity in relation to the ERPA).
- Forestry Commission shall collect from parties, and, if necessary, confirm the accuracy of, all information required to be collected under the Monitoring Plan and the applicable Safeguards Plans.

8. <u>Members Roles and Responsibilities</u>

Juabeso/Bia HIA Management Board roles and responsibilities:

- The Management Board commits to implement 'CREMA-type' landscape planning and management processes
- The Management Boardcommits to building local governance institution to manage the cocoa landscape
- The Management Board commits to support farmers in the adoption of climate-smart cocoa practices, with attention to gender and youth
- The Management Boardcommits to participate in identification of cocoa farms in the landscape, including on-reserve
- The Management Board commits to contribute to the development and implementation of agreements for farmer resettlement
- The Management Board commits to lead in the drafting and implementation of by-laws that support sustainable, climate-smart cocoa farming, forest protection, and

7. Parties Jointly Agree

The Parties jointly agree to the following:

- The Agreement will focus on the sustainable production of commodities (cocoa, timber, oilpalmetc) and NTFPs in the Juabeso/Bia HIA in the Western North Region of Ghana.
- The Agreement will allow continuous research, monitoring and learning from the HIA landscape for the purpose of documentation and exchange with other HIA locations.
- The Parties will communicate freely with each other, keeping the other Parties informed of the status of activities and projects, while also respecting confidentiality that each Party may have with other organizations, companies and individuals.
- A formal review meeting shall be held periodically to assess progress of planned activities.
- Juabeso/Bia HIA and other partners shall implement anySub-Project/ER Program Measures (as specified in the GCFRP Programme Document (PD) in accordance with the terms of the GCFRP .
- For the avoidance of doubt, the parties authorize the government (Forestry Commission) to transfer any ERs generated from such Sub-Project/ ER Program Measures to the FCPF Carbon Fund free of any third party interest or encumbrance.
- Juabeso/Bia HIA and other partners shall inform the Government Forestry Commission immediately after becoming aware of the occurrence of a Reversal Event under any Sub- Project/ER Program Measure.
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- The Management Board commits to lead in the drafting and implementation of by-laws that support sustainable, climate-smart cocoa farming, forest protection, and

tree tenure reforms towards on-farm planting of shade trees and farmer assisted natural regeneration

- he Management Boardcommits to participate in of GCFRP activities within the landscape

Forestry Commission roles and responsibilities:

- Forestry Commission commits to provide program coordination and monitoring on social and environmental issues, including safeguards,FGRM, and benefit sharing
- Forestry Commission commits to monitoring and reporting on landscape level sustainability outcomes
- Forestry Commission commits to implement tree tenure policy reforms and create an enabling environment for the program
- Forestry Commission commits to identification of cocoa farms located on-reserve
- Forestry Commission commits to support HIAs in landscape management planning, by aligning forest management plans
- Forestry Commissioncommits to strengthen forest law enforcement and monitoring, with collaboration from HIAs
- Forestry Commission commits to enhanced public-private collaborations in HIAs
- Forestry Commission commits to providing oversight over the implementation of all Safeguards plans

Cocobod Roles and Responsibilities

- Cocobod commits to promote investment in HIAs and support farmers with Climate Smart Cocoa (CSC) inputs and extension packages towards long-term productivity of high-quality cocoa
- Cocobod commits to support mapping of cocoa farms towards supply chain traceability
- Cocobod commits to support efforts to prevent malpractices in the purchase of cocoa beans.
- Cocobod commits to support efforts to provide geographical location of all cocoa farms to enable Forestry Commission to identify cocoa farms located on-reserve
- Cocobod commits to enhanced public-private collaborations in Hotspot Intervention Areas (HIAs)

Civil society/ NGOs roles and responsibilities:

- NGOs commit to share information and hold consultations with HIAs (farmers, communities, leaders) on all key aspects of the program
- NGOs commit to the design and implementation of landscape standards in cocoa and forest landscapes
- NGOscommit to support the development of HIA governance structures and processes
- NGOs commit to support the establishment and management of HIA fundraising and financial sustainability mechanisms
- NGOs commit to support the development of innovative cocoa farming models and income diversification strategies that are compatible with CSC / cocoa agroforestry, and are gender and youth inclusive
- NGOs commits to advocacy and public awareness creation about the program activities

Private sector roles and responsibilities:

- Private sector commits to inform all farmers about CSC packages
- Private sector commits to enroll all willing farmers (including women and youth) into CSC programs/activities and development of a national register of farmers and farms
- Private sector commits to support farmers with CSC inputs and extension packages
- Private sector supports HIAs in management planning and the implementation of management plans, with particular emphasis on forest protection and cocoa intensification

- Private sector commits to mobilize new sources of funding to support program coordination, sustainable financing mechanisms for HIA, and to enhanced public-private collaborations in HIAs
- Private sector commits to support the development of innovative cocoa farming models and income diversification strategies that are compatible with CSC / cocoa agroforestry, and are gender and youth inclusive
- Private sector commits to support improved transparency in the purchase of cocoa beans

9. Benefits to Parties

HIA benefits:

- HIA farmers benefit from increased yields
- HIA farmers benefit from income diversification
- HIA farmers benefit from increased climate resilience
- HIA farmers benefit from crop insurance coverage
- HIA Management Board and Sub-HIAs benefit from development of long-term financial sustainability
- HIAs benefit from improved protection of the forest
- **HIA farmers, communities and Traditional Authority benefit from Carbon Fund Benefit Sharing packages (conditional on performance)**
- *Forestry Commission Benefits* Reinvesting of Carbon Fund Benefit Sharing Packages
- Social and Environmental safeguards supported and monitored by GCFRP
- Decreased deforestation rates monitored by GCFRP
- Reinvesting of Carbon Fund Benefit Sharing Packages

Cocobod Benefits

- Increased local production of quality climate smart cocoa beans
- Improved aggregation of farmers and platform for engaging farmers
- Diversified livelihood activities support for farming communities
- Reinvesting of Carbon Fund Benefit Sharing Packages

Other Partners benefits:

- Increased local production of quality climate smart cocoa beans
- Improved aggregation of farmers and platform for engaging farmers
- Diversified livelihood activities support for farming communities
- Learning platform supported and operational.

10. Review

This Agreement may be amended if the Parties consider that prevailing circumstances require such.

11. Duration and Termination

This Agreementshall be valid for a period of 6 years (representing the duration of the Emissions Reduction Payment Agreement) commencing from the date of execution hereof .

This Agreement may be terminated by mutual agreement by the Parties upon the expiration of the Emission Reductions Payment Agreement (ERPA). In case of unforeseen circumstances, this Agreement may be suspended with by a party 3 months' notice in writing to the other Parties. In such circumstances, if attempts to resolved outstanding disagreements are unsuccessful, then each of the Parties agrees to provide the other Parties with 12 months formal written notice of intention to terminate this Agreement.

This Agreement shall be terminated immediately upon the signing of a definitive successor agreement unless its renewal is agreed upon by the Parties.

12. Amendments and Variations

Amendments or variations to this Agreement will be in writing and will be signed by officers authorized to execute such amendments as may be agreed amongst the parties.

13. Force Majeure

No Party shall be liable for damages for any delay or default in performing hereunder if such delay or default is caused by conditions beyond its control including, but not limited to natural disasters, wars, insurrections, accidents, industrial disputes and/or any other cause beyond the reasonable control of the party whose performance is affected.

14. Assignability

No party shall have the right to assign or transfer any of its rights or obligations under this Agreement to any third party without first obtaining consent in writing from the other parties.

15. Governing Law

This Framework Agreement and the relationship of the parties in connection with the subject matter of this Agreement and each other shall be governed and construed in accordance with the laws of the Republic of Ghana.

16. Resolution of Disputes

Any differences or disputes which may arise between the Parties relating to any matter under this Framework Agreement will be settled amicably by consultation and negotiations between the Parties, or failing that, through mediation by a mutually agreed third party.

17. Execution by the Parties

The Lead consortium partners (FC and Cocobod) formalise their collaboration in the signing of this agreement with the Juabeso/Bia Landscape Management Board and develop a long-term partnership that will serve the objectives of the Parties. The other consortium partners having agreed to the provisions of this agreement shall communicate their specific roles, actions and activities by signing as an annex to this agreement.

The signing of this framework agreement by the initial parties to the agreement does not limit any other entity besides the initial parties of this framework agreement from joining the consortium by signing an addendum to this agreement and/or undertaking complementary activities within the Juabeso/Bia HIA

This Agreement shall take effect on the date of the signatures to the agreement.

Prepared in Accra, Ghana on 4th October 2019, in three copies.

Signed on behalf of

Juabeso BiaHIA Management Board

Name: BEN KOFI ANTHONY

Signature:

Date: 5-12-2019

Signed on behalf of

Forestry Commission

Name: KWADWO OWUSU AFRIYIE

Signature:

Date: 7.10.2019

Signed on behalf of

Ghana Cocoa Board

Name: HON JOSEPH BOAHEN AIDOO

Signature:

Date: 21/11/2019

ANNEX 4: CARBON ACCOUNTING - ADDENDUM TO THE ERPD

Technical corrections

In June 2017 Ghana's Emission Reductions Program Document (ERPD) was included in the FCPF portfolio under the condition that the accuracy of activity data on deforestation, forest degradation and enhancement of forest carbon stocks in the reference period is improved. Subsequently, in June 2019 Emission Reduction Payment Agreements (ERPA) were signed with Tranche A and B of the FCPF Carbon Fund. Both agreements, in section 7.01 (b), contain a covenant to further improve the accuracy of the activity data on deforestation, forest degradation and enhancement of forest carbon stocks in the reference period.

This annex describes the methodology applied and data used to make the requested improvements. The document also provides the new estimate of the Reference Level for the Ghana Cocoa Forest REDD+ Program, which the program proposes to use in the future to report its emission reductions.

Summary of technical corrections

The improvements have been made considering the issues raised in FMT Note CF-2018-6 and the requirements of the guidelines on technical corrections to GHG emissions and removals reported in the reference level (Guidance Document on the Methodological Framework, No. 2). In summary, the following improvements have been made:

- *When the Ghana ERPD was included in the FCPF portfolio, one of the Conditions of Effectiveness requested Ghana to submit an updated accuracy assessment of change detection for deforestation and uncertainty analysis of the activity data for deforestation. FMT Note CF-2018-6 concluded that Ghana had provided a comprehensive report on an accuracy assessment conducted on change detection and area estimation. However, additional improvements were identified in the same note related to the response design.*

  In response, the program carefully analyzed available data and products, including the maps used for the previous estimates. It was decided to apply an improved approach where the collection of the activity data for both deforestation and forest degradation uses a systematic sampling approach instead of the previous maps. In conjunction with this improved approach, a new sampling design and response design was implemented. The accuracy assessment of change detection for deforestation and the uncertainty analysis of the activity data for deforestation were updated according to this improved approach.
- *The second and third Conditions of Effectiveness pertained to the estimates of emissions from forest degradation. In order to address these Conditions, the program had proposed a new methodology for estimating emissions from forest degradation based on remote sensing methods using the LandTrendR algorithm. FMT Note CF-2018-6 found that this methodology is promising, but some clarification was still needed on the definition of forest degradation, the reported estimates and the integration of the forest degradation methodology with that used for deforestation.*

  As already explained above, under the improved approach the program will collect activity data for both deforestation and forest degradation using a systematic sampling approach. This replaces the approach based on the LandTrendR algorithm. The new response design associated with this approach addresses the issue raised in FMT Note CF-2018-6 on the definition of degradation and the integration of the forest degradation methodology with that used for deforestation. Furthermore, the improved approach also addresses identified issues with the trends observed in the LandTrendR product.
- *The Emission Factors were also improved, please see this annex for details. No new data was collected but rather the same data source was used as the one used for the Emission Factors in the ERPD (i.e. the inventory measurements performed under the Forest Preservation Programme).*

7. CARBON POOLS, SOURCES AND SINKS

7.1 Description of Sources and Sinks selected

Sources/Sinks	Included?	Justification/Explanation
Emissions from deforestation	*Yes*	The ER Programme will account for emissions from deforestation. Deforestation was identified as the most significant source of emissions based on the first order emissions estimates using the FCPF Decision Support Tool.
Emissions from forest degradation	*Yes*	The ER programme will account for emission from four sources of forest degradation which are considered significant
Removals from carbon stock enhancements	*Yes*	The ER programme will account for removals from forest plantations that have been planted both on- and off-reserve as part of the National Forest Plantation Development Programme (NFPDP). Although considered as insignificant (i.e. below the 10% threshold (in absolute terms) in terms of its contributions to net emissions), removals from carbon stocks enhancement was nonetheless included in the FRL. Ghana has developed an ambitious National Forest Plantation Strategy which is closely aligned with the programmatic objectives of the ERP. The Forest Plantation Strategy will serve as the blueprint for the NFPDP. The Strategy seeks to, amongst others, facilitate the incorporation of trees within 3.75 million hectares of agricultural landscapes in the country over a 25-year period, commencing from 2016. Inclusion of the forest plantations to be established under the NFPDP will therefore enable Ghana to access the requisite data to track/ monitor removals associated with the implementation of the NFPDP in the GCFRP area and also ensure that the GCFRP is well aligned with this important national initiative.
Sustainable Management of Forest	*No*	Sustainable Forest Management (SFM) was not included as an activity for the ER programme based on expert advice from Ghana's REDD+ MRV sub-working group. The key reasons advanced to support this decision are outlined below: *1. Generally, carbon fluxes associated with sustainable forest management over a period tends to be at equilibrium – losses associated with harvesting and other disturbances may be offset in the long term by natural and assisted regeneration. Thus, any emissions or removals may not be significant to warrant the cost and need for development of a complex model/ approach for the activity (i.e. SFM); and* *2. Emissions resulting from logging in 'managed' forests in Ghana have been incorporated in the assessment of emissions for degradation. In reality, logging in Ghana's forests leads to degradation rather than sustainable forest management since management plans are usually not fully enforced. Inclusion of SFM as an additional activity could therefore lead to 'double counting' of emissions*
Conservation	*No*	Conservation was also not included as an activity for the ER programme based on expert advice from Ghana's REDD+ MRV sub-working group. A fully conserved forest will have very limited emissions or removals whereas any changes in the conservation status will be captured under deforestation and degradation analyses.

7.2 Description of carbon pools and greenhouse gases selected

Carbon Pools	Selected?	Justification/Explanation
Above Ground Biomass (AGB)	*Yes*	The aboveground biomass pool is the most significant pool for forests in Ghana
Below Ground Biomass (BGB)	*Yes*	The belowground biomass pool is a significant pool.
Dead Wood	*Yes*	For completeness, deadwood is included
Litter	*Yes*	For completeness, litter is included
Soil Organic Carbon (SOC)	*Yes*	The soil carbon pool is a significant pool.

GHG	Selected?	Justification/Explanation
CO_2	*Yes*	The ER Program shall always account for CO_2 emissions and removals
CH_4	*No*	Non-CO_2 emissions occur with burning of forest, which in the ERPD was included only for deforestation. The ERPD estimated non-CO_2 emissions from fire to amount to 0.023% of total emissions from deforestation, or 0.15% as percentage of the new deforestation estimate. Non-CO_2 emissions are omitted as they are not significant.
N_2O	*No*	

8 REFERENCE LEVEL

8.1 Reference Period

The reference period for the construction of the reference level is from 2005-2014, which is the Reference Period in the final ERPD from April 2017.

8.2 Forest definition used in the construction of the Reference Level

Following Ghana's National REDD+ Strategy, the definition used for Ghana's ER-PD is a minimum of 15% canopy cover, minimum height of 5 meters, and minimum area of 1 hectare, based on thresholds set by the IPCC for these structural parameters and the Marrakesh Accord.

Tree crops, including cocoa, citrus, oil palm (in smallholder or estate plantations), and rubber are not considered to be forest trees. Timber tree plantations are considered forest under the national forest definition.

Agreement on this definition was reached following an intense consultative process in which three options were debated and discussed amongst a broad group of stakeholders. Consensus was reached on the definition stated above based on the strength of arguments adduced, however, it is important to note that not all participants in the process agreed with the outcome as they felt that the canopy cover and height parameters would exclude much of northern Ghana from participating in REDD+. It is noted that the UNFCCC will accept only a single forest definition for each country, and there is no option to provide different forest definitions for different ecological zones. However in completing the national FRL, it is clear the forest definition does not exclude the North as significant patches of forests were captured in the national land use maps that have been developed.

8.3 Average annual historical emissions over the Reference Period

Description of method used for calculating the average annual historical emissions over the Reference Period

Activity data and emission factors used for calculating the average annual historical emissions over the Reference Period

Activity data deforestation and forest degradation

The previous version of the ERPD included deforestation estimates following a stratified area estimate approach. The maps used for the stratified area estimate concern three change maps (2000-2010; 2010-2012; 2012-2015) created through post-classification (i.e. change is assessed by comparing independently created classifications for different dates). These forest area (change) maps of the Ghana Cocoa Forest REDD+ Programme (GCFRP) landscape show some irregularities, for example large areas in the North-West of the landscape appear as deforestation (forest land to other land) in 2000-2010 would be expected to show as Other Land in 2010-2012, instead they show again as Forest Land in 2010-2012 (Figure 13). Likewise, large areas that show as Other Land to Forest Land (OL-FL) in 2000-2010 would be expected to appear as Forest Land in 2010-2012 but instead show as Other Land, and areas that appear as other land in the 2010-2012 map appear as deforestation in 2012-2015.

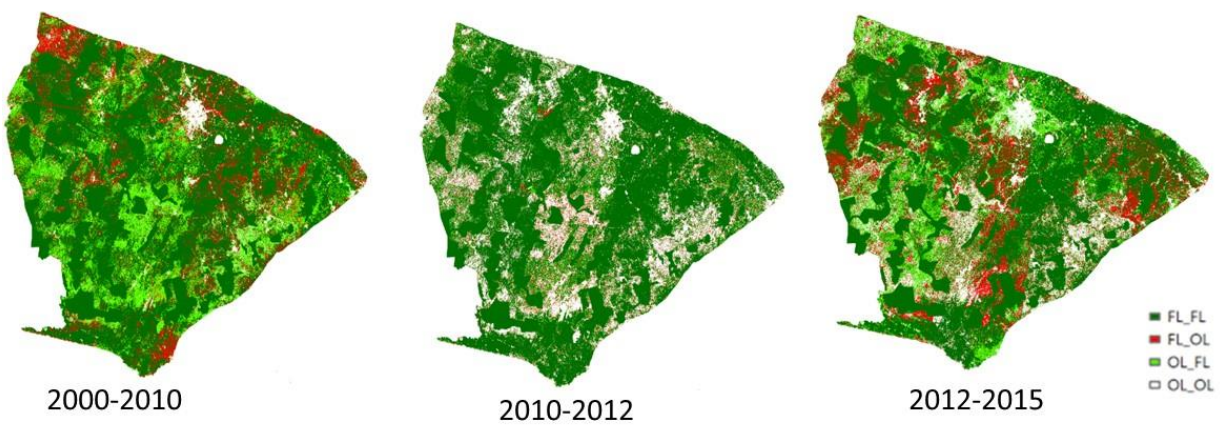

Figure 13 Forest area (change) maps for GCFRP. FL_FL is stable forest, FL_OL is deforestation, OL_FL is afforestation/reforestation and OL_OL is stable non-forest. The maps show some irregularities where the final land classification of maps for earlier periods do not always correspond to the begin land classification of maps for subsequent periods

In addition to these irregularities, change classes in these maps (i.e. FL_OL and OL_FL) were assessed through post-classification ("map subtraction"). Post-classification of change is the comparison of two independently created map classifications. These tend to assess large amounts of false change especially for open forest areas that may be have a cover near the threshold and could easily be classified as either open forest or grassland. By comparing separate classifications, large areas may be classified as open forest in time one, and as other land in time two maybe due to the images corresponding to a slightly different season, or different meteorological conditions affecting the spectral signal. Assessing change through a direct comparison of such classifications accordingly results in large areas of false change (see Figure 14). It is therefore to be expected that an accurate assessment of deforestation will be much lower as change tends to be a relatively rare event, even in very dynamic landscapes.

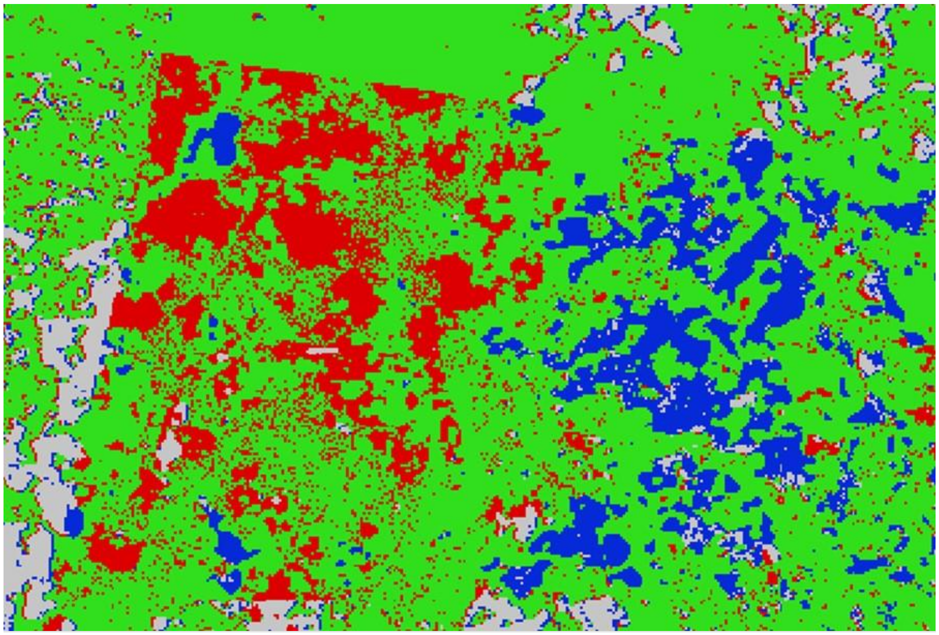

Figure 14 Zoomed-in detail of the forest area (change) maps for the GCFRP landscape. In the center-left we see the shape of the Landsat tile with large areas of false change detected (forest loss in red, forest gain in blue). On the extreme left and upper right we see "the 3d effect" where minor shifts in the projection of both maps results in lines of loss pixels on the right and gain pixels on the left of forest polygons.

After careful revision of the available data, products and estimates, it was therefore decided to create an improved change map and use this map as stratifier for an efficient sample distribution (i.e. generate a stratified area estimate). The change map would assess both deforestation and forest degradation. The intention was to build on existing products, i.e. Ghana's forest mask for the GCFRP landscape and combine these products with a direct change assessment.

Different algorithms were explored for performing the direct change assessment, such as the Global Forest Change (GFC) product[21] which provides a tree cover loss assessment on Landsat pixel basis. This product was reclassified with a decision tree applying the thresholds in Ghana's forest definition. Other products reviewed included the LandTrendR map prepared by the University of Oklahoma in 2018 and a new change map using the BFAST algorithm[22] which is similar to LandTrendR in the sense that it also performed a dense time series analysis, filtering out seasonal changes from trends.

The available products were visually inspected with Ghana Remote Sensing experts at a workshop in Ghana in October/November 2019. None of the available products was assessed to perform well enough to form the basis of a stratified area estimate analysis. Table 22 shows the overall deforestation assessed by the individual products. The cumulative deforestation of all these products combined (so not double counting areas assessed as deforestation by more than one product) is 1,106,053 ha, while adding these areas without considering any overlap would give an area (1,192,419 ha) that is only 7% larger meaning there is very little agreement on the locations of deforestation between the products.

Table 22 Deforestation areas found with different products in the GCFRP over the reference period

[21] https://earthenginepartners.appspot.com/science-2013-global-forest

[22] http://bfast.r-forge.r-project.org/

	Deforestation (in pixels)	Percentage of deforestation area where both other products also assess deforestation
GFC	215,893	2.6 %
BFAST	118,720	4.8 %
LandTrendR (2019)	857,806	0.7 %
Cumulative on map	1,106,053	

Table 23 Overlap of deforestation between the different products (i.e. areas where products agree on deforestation)

Overlap deforestation found in different products (in pixels)			
BFAST & GFC	BFAST & LandTrendR (2019)	GFC & LandTrendR (2019)	BFAST & GFC & LandTrendR (2019)
31,377	7,847	47,147	5,655

The change product map classifications were compared against a 4 x 4 km grid with sample plots, revealing the GFC product was performing best at assessing deforestation correctly. However, comparing the sample-based assessment of deforestation of the 4 x 4 km grid against the GFC loss estimate, revealed that the GFC loss estimate was 6 times higher than the sample-based estimate. To filter out tree crop dynamics and false losses, the GFC map was filtered by the Ghana forest mask where only loss inside the forest mask was considered as deforestation. Subsequently, a stratified area estimate was created by post-stratifying the 4 x 4 km sample with the GFC map filtered by the Ghana forest mask. This gives an indicative estimate only since some of the strata will not have a sufficient sample size according to Olofsson et al. (2014)[23] equations.

The results of this exercise are displayed in Figure 15 and Table 24. The deforestation area estimates differ only 0.05% with or without post-stratification and the user and producer accuracy of forest loss in the map is very low, with 3 and 4 % respectively. Figure 15 shows in addition that the confidence interval of the post-stratified reference data is similar (±24%) to the confidence interval without applying any stratification (±24%). We conclude from this that the GFC map is an inefficient stratifier and subsequently it was decided not to use a change map for stratification at this stage.

[23] Olofsson, P.; Foody, G.M.; Herold, M.; Stehman, S.V.; Woodcock, C.E.; Wulder, M.A. Good practices for estimating area and assessing accuracy of land change. Remote Sens. Environ. 2014, 148, 42–57.

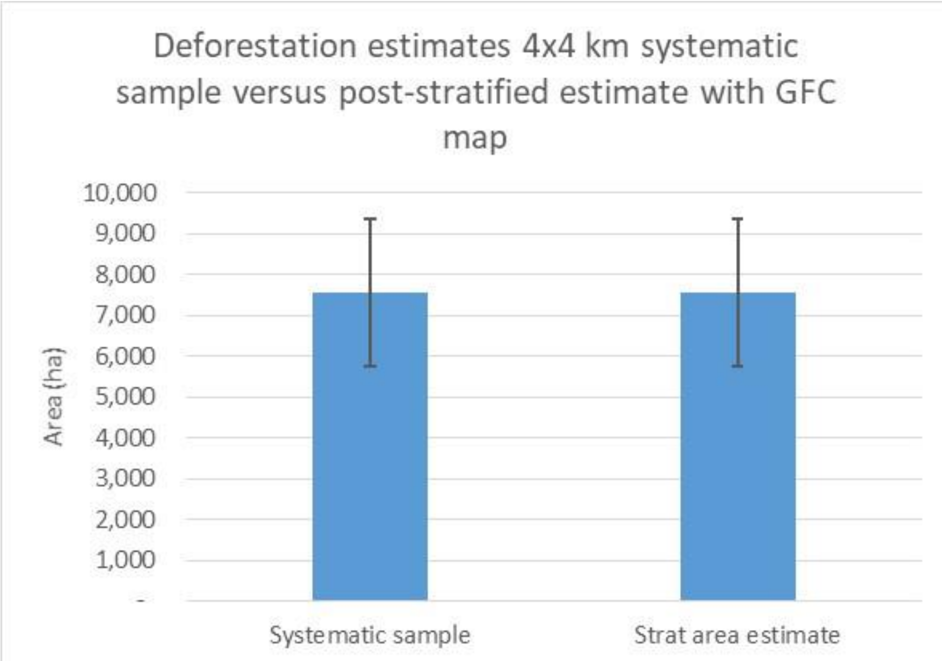

Figure 15 Two deforestation estimates based on a 4 x 4 km systematic sample and post-stratifying the 4 x 4 km systematic sample (n = 3 609) with a stable forest, stable non-forest and forest loss map derived from GFC data (n = 3 601)

Table 24 Error matrix of accuracy assessment of GFC map filtered with Ghana's forest mask

2005-2014		Reference data			**Total sample units in map class**	User's accuracy
		Forest loss	Stable Forest	Stable non-forest		
Map data	Forest loss	**2**	19	38	**59**	3%
	Stable Forest	29	**1045**	1328	**2402**	44%
	Stable non-Forest	15	237	**888**	**1140**	78%
Total reference sample units per class		**46**	**1301**	**2254**	**3601**	
Producer's accuracy		4%	80%	39%		**Overall accuracy: 54%**

In May 2019, Ghana with the support of FAO-CBC collected an 8 x 8 km systematic national sample as part of the project "National Land Monitoring and Information System for a transparent NDC reporting". The sampling unit or sample plot size was 0.5 ha. Following the earlier decision not to use the change map for stratification, it was decided to build further on this existing effort and estimate both deforestation and forest degradation using a systematic sampling approach.

SAMPLING DESIGN

A total target sample size is calculated based on the information available from the 8 x 8 km systematic sample. Given the confidence level (i.e., 90%), the *significance level* is $\alpha = 1 - confidence\ level$.

Equation 1 Approximate estimated total sample size n:

$$n \approx \frac{z^2_{\alpha/2} \cdot \hat{O} \cdot (1-\hat{O})}{d^2} \qquad (1)$$

where

- Ô *is an expected* overall feature area *expressed as a proportion.*
- z *is a percentile from the* **standard normal distribution** *(*z *= 1.645 for a 90% confidence interval),*
- *d* is the ***allowable margin of error***. This is the maximum half-width of the confidence interval we aim towards in our estimate. It is given as area proportion, not as percentage. It should be the precision level, taken as a confidence interval, required for the feature to be measured.

From the 8 x 8 km systematic sample, it was assessed that deforestation between 2005-2014 concerned an area of 88,840 ha. The total GCFRP landscape has an area of 5.9 mln ha. Therefore, in the above formula Ô, the expected overall feature area as a proportion is $\hat{O} = \frac{88\,840}{5\,914\,425} = 0.015$. This "deforestation proportion" can also be explained as the probability of the feature occurring in a randomly selected plot or point. It should not be confused with a deforestation rate, since the deforestation rate would be calculated as a proportion of the forest in the landscape, not as a proportion of the entire landscape.

In the above formula, d is calculated as Ô multiplied by the % precision, or the confidence interval expressed as % around the deforestation estimate. Using different confidence intervals gives us the correlation between the sample size and precision as displayed in Figure 16.

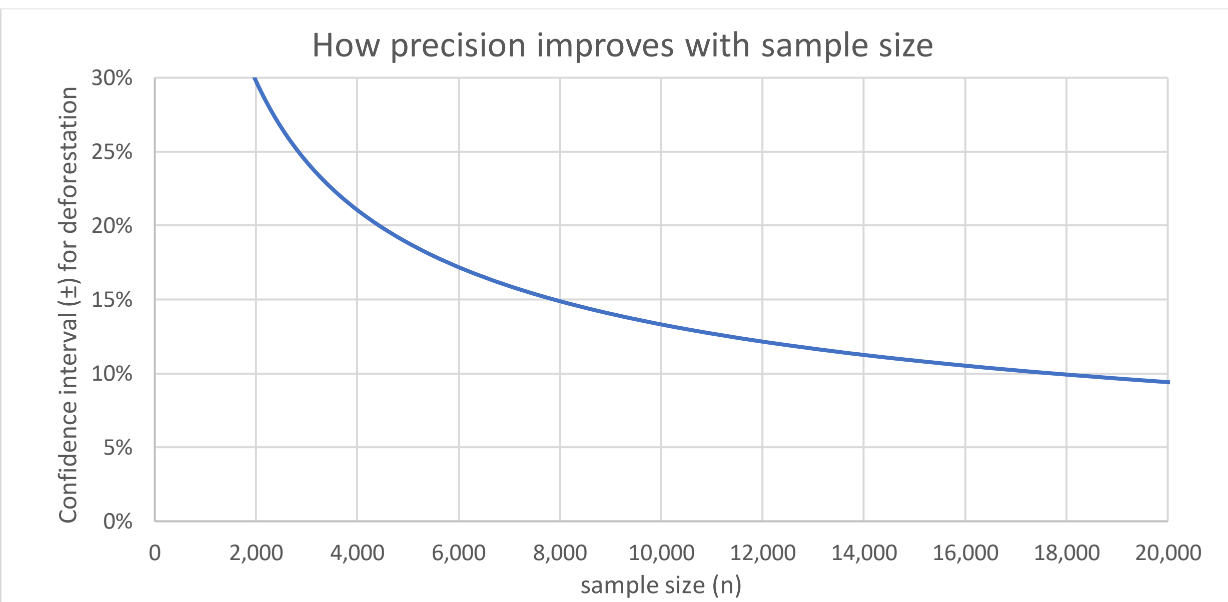

Figure 16 Relation between sample size and half-width confidence interval around the deforestation estimate for the reference period.

As Figure 16 illustrates, increasing the sample size initially results in major improvements in precision but this curve flattens rather quickly. For example, improving precision from 30% to 20% requires the sample size to increase with 2,461 sample plots, but increasing precision from 20% to 10% requires the sample size to increase with 13,290 sample plots. Having a very large sample size may result in a reduction of interpretation quality and makes quality assurance and quality control more challenging. Considering this trade-off, the target precision was selected between 15-16%. This suggests a target overall sample size n of 6,922 – 7,886.

This 8 x 8 km systematic grid was intensified for the GCFRP landscape to a 4 x 4 km grid making the 8 x 8 km grid a sample of the overall 4 x 4 km systematic grid. After this, it was decided to further intensify data collection placing a 2 x 2 km grid on the forest mask and a 1 x 1 km grid on the rare ecozone “Upland evergreen” to ensure sufficient sample size in each stratum for which estimates are produced. Since the number of sample plots increases exponentially with each intensification it was decided to make a random selection of plots in the 2 x 2 km and the 1 x 1 km intensified layers. The result is a nested grid with different sampling intensities and random gaps in the grid.

The forest mask used for the intensification of sampling inside the GCFRP landscape is a “potential” forest mask, combining all FL_FL classes in the three available maps produced by Ghana’s Forestry Commission. It is visualized in Figure17. As explained earlier in this document, there are some accuracy issues with the maps. Though these issues are mostly with the change assessment, the forest mask may equally be subject to accuracy issues. However, since the forest mask is only used for intensified sampling it doesn’t matter that it is imperfect as long as it makes the sampling more effective, i.e. as long as it is more likely for forest to be present inside the forest mask it helps the sampling efficiency.

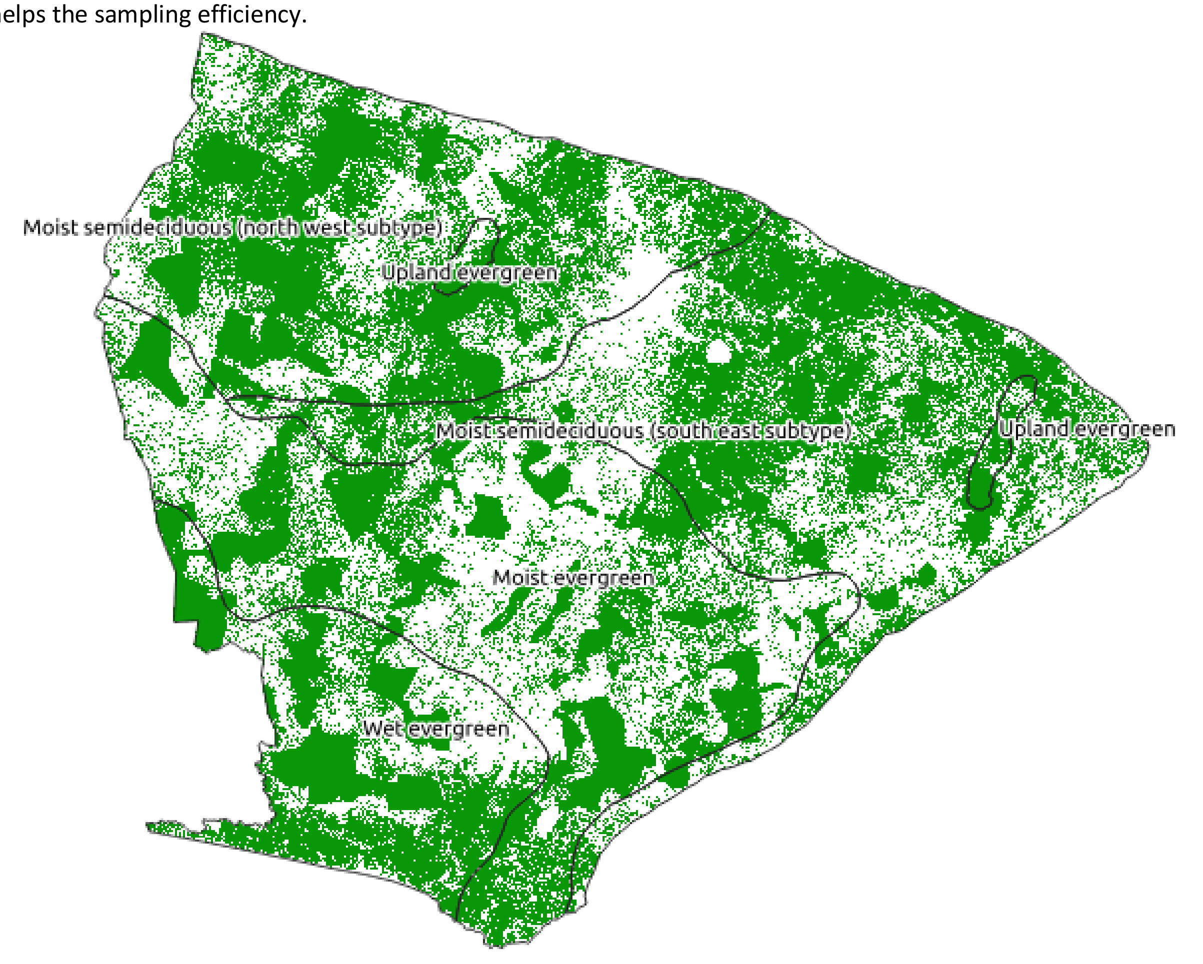

Figure 17 Forest mask for the GCFRP landscape used for sample intensification and based on the existing Forestry Commission maps

The number of sample plots collected per stratum is provided in Table 25 and Figure 18 shows the final sample distribution.

Table 25 Sample plot size and distribution in GCFRP

	# plots	Area (ha)	Proportion of area
Outside forest mask (4 x 4 km grid)	2 063	2 555 905	0.4321
On forest mask (2 x 2 km grid)	5 234	3 295 919	0.5573
In upland evergreen ecozone (1 x 1 km grid)	392	62 601	0.0106
Total	**7 689**	**5 914 425**	**1.0000**

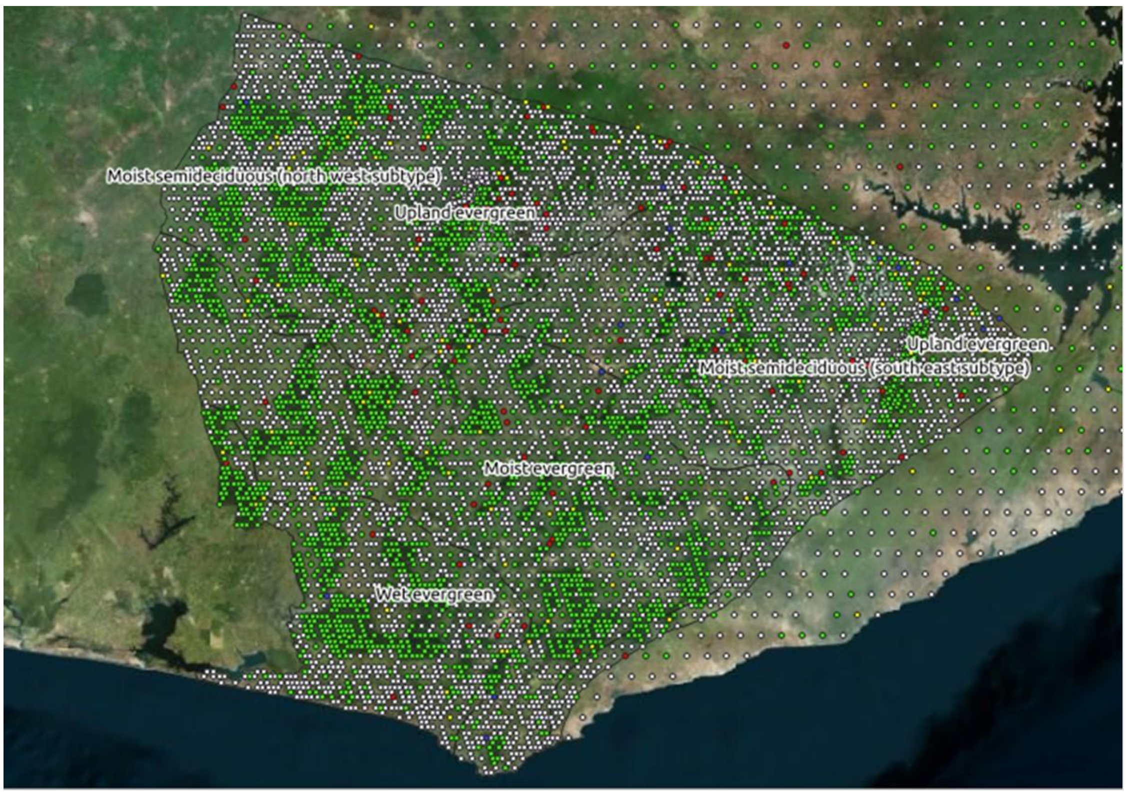

Figure 18 Final sample plot distribution

Table 26 All strata considered in the calculations of deforestation and degradation areas, the associated sample unit weights and the number of deforestation and degradation sample units per stratum over the reference period

Vegetation zones, e *Post-strata, with the exception of upland evergreen*	Number of sample units per vegetation zone	Grid spacing on the forest mask, outside the forest mask an in upland evergreen (km), stratum i *Sampling strata*	Area per stratum (ha), $A_{e,i}$	Number of sample units per stratum, $n_{e,i}$	Expansion factor (ha/plot), $A_{e,i}/ n_{e,i}$	Number of deforestation plots (2005-2014), $n_{v,e,i}$	Number of degradation plots (2005-2014), $n_{v,e,i}$
Moist evergreen	2,123	2x2	886,983	1,384	641	7	12
		4x4	945,406	739	1,279	16	4
Moist SemiD NW	2,045	2x2	962,079	1,554	619	31	17
		4x4	595,511	491	1,213	9	4
Moist SemiD SE	2,148	2x2	989,659	1,543	641	32	17
		4x4	737,423	605	1,219	8	2
Wet evergreen	981	2x2	457,198	753	607	4	3
		4x4	277,565	228	1,217	2	1
Upland evergreen	392	1x1	62,601	392	160	11	5

The equation applied to calculate the deforestation and area by vegetation zone is provided in Equation 2 for the vegetation zones Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East and Moist Semi-Deciduous North-West. For the vegetation zone Upland Evergreen the same equation is applied only it has one single grid spacing (1 x 1 km).

Equation 2 The area of variable v in vegetation zone e:

$$A_{v,e} = \sum_{i=1,2} p_{v,e,i} \times A_{e,i} \quad (2)$$

where

- $p_{v,e,i} = n_{v,e,i}/n_{e,i}$ *is the estimated probability of variable* v *in vegetation zone e falling in stratum* i,
- $n_{v,e,i}$ *is the number of sample plots of variable* v *in vegetation zone* e *falling in stratum* i,
- $n_{e,i}$ *is the number of sample plots in vegetation zone* e *falling in stratum i,*
- $A_{e,i}$ *is the area of stratum* i *in vegetation zone* e.

The deforestation estimate for the 8 x 8 km grid was considered too coarse to provide estimates at vegetation zone level, therefore the formula applied to calculate the deforestation area was as Equation 2 but replacing vegetation zone e by the full GCFRP landscape (and with a single grid spacing of 8 x 8 km).

The single phase, stratified special case of the Horvitz-Thompson estimator (the generalized estimator for unequal probability sampling) was used for estimating the associated uncertainty. The half-width 90% confidence interval around the areas of variable v in vegetation zone e and stratum i is as follows.

Equation 3 The half-width 90% confidence interval (CI) around the area of variable v in vegetation zone e and stratum i:

$$CI\ (\pm)\ of\ A_{v,e,i} = 1.64 \times \sqrt{\frac{p_{v,e,i} \times (1 - p_{v,e,i})}{(n_{e,i} - 1)}} \times A_{e,i} \tag{3}$$

- *Where $p_{v,e,i}$ is the estimated probability of variable v in vegetation zone e, calculated as $n_{v,e,i}/n_{e,i}$*
- *$n_{e,i}$ is the total number of sample plots in vegetation zone e falling in stratum i,*
- *$A_{e,i}$ is the total area of stratum i in vegetation zone e*

The formula for the stratified standard error estimator in equation 3 has a theoretical basis in a "conditioning" argument that is explained in section 10.4 of Särndal *et al* (1992)[24].

To obtain the CI around the deforestation and degradation areas per vegetation zone ($A_{v,e}$) and for the entire GCFRP landscape (A_v), the errors are propagated using equation 4 (which is the equivalent of equation 3.2 of IPCC 2019):

Equation 4 Propagation of errors for summation

$$U_{total} = \sqrt{(U_1)^2 + \ldots + (U_n)^2} \tag{4}$$

where

- U_{total} *is the absolute uncertainty in the sum of the quantities (half the 90 percent confidence interval), e.g.* CI (±) of $A_{v,e}$ *or* CI (±) of A_v
- U_n *is the absolute uncertainty associated with each of the quantities, e.g.* CI (±) of $A_{v,e,I}$

As the sample was intensified, the evolution of the assessed deforestation estimate for the period 2005-2014 in the GCFRP was monitored (Figure 19). This exercise showed that the estimate remained relatively stable with the intensification, and the confidence interval was reduced from ±49% (8 x 8 km sample), to ±24% (4 x 4 km sample), to ±15% (intensified sample). This result is characteristic of using an unbiased estimator of area. The sample based estimates are expected to be more precise as the sampling intensity increases (as reflected by decreased estimated standard errors).

[24] Särndal, C. E., Swensson, B., and Wretman, J. (1992), Model-Assisted Survey Sampling. Springer-Verlag, New York

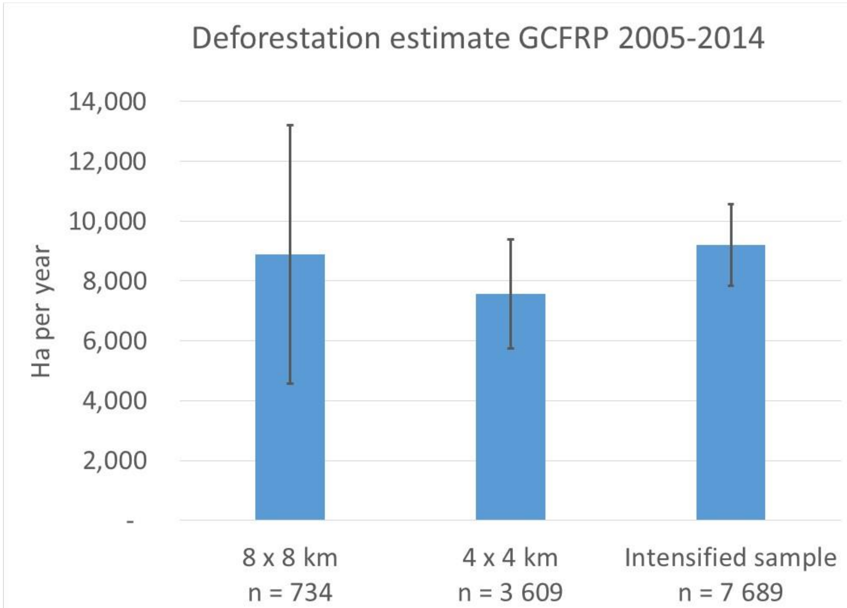

Figure 19 Evolution of deforestation estimate for the GCFRP: the estimate remains fairly stable and the confidence interval is reduced to ±15%

Figure 19 in tabular values	Deforestation (ha/yr)	90% CI ± (in ha/yr)	90% CI ± (in percentage)	Sample size (n)
8 x 8 km	8,884	4,326	48.7%	734
4 x 4 km	7,556	1,821	24.1%	3,609
Intensified sample	9,196	1,496	16.3%	7,689

As the data collection proceeded, a more precise estimate was obtained for the "deforestation proportion" or overall feature area Ô in Equation 1. The deforestation proportion was slightly larger than what the 8 x 8 km sample suggested, therefore $\hat{O} = \frac{91\,958}{5\,914\,425} = 0.0156$. In case our sample would have been simple random without intensification in the forest mask, the precision of the deforestation, forest degradation and forest area estimates would have been 14.9%, 21.3% and 2.8% respectively. Instead, the precision of the deforestation, forest degradation and forest area estimates is 15.1%, 21.6% and 2.9% respectively, suggesting the use of the forest mask as a stratifier to intensify sampling has not increased the efficiency of the sample. This finding underscores the importance of continued efforts to create a more accurate forest (change) map which could increase the efficiency (through post-stratification) in the future.

RESPONSE DESIGN

The response design refers to what rules have been applied when interpreting the sample plot, i.e. what were the labelling protocols.
Ghana adopted the use of IPCC hierarchy classification as a benchmark in the interpretation of plots:

- *Settlement = 20%*
- *Cropland = 20%*
- *Forest = 20%*
- *Grassland = 20%*
- *Wetland = 20%*
- *Otherland = 20%*

This is to infer that all plots interpreted, had 20 % of land use classes which preceded over the other at any point in time following the order in which the land uses are listed above. E.g. if any plot has 20% settlement and 80% forest, it will be labeled as “settlement”. Inside the plot is a 7 x 7 grid with 49 control points (see Figure 21) which help to estimate percentage coverages within the plot. The control points were used as guide to give a precise interpretation in line with the classification hierarchy.

Ghana’s forest definition stating, minimum of 15% canopy cover, minimum height of 5 meters, and minimum area of 1 hectare, is consistent with the definition used in the most recent National Greenhouse Inventory. These structural parameters are within the ranges provided by the Marrakesh Accord for Annex I countries. This definition informed the used of the appropriate parameters for the entire process. In the response design, a plot is assessed as ‘forest degradation’ when it is forest land remaining forest land but for which there is visual evidence of one of the disturbances indicated in Figure 20. A plot was assessed as deforested if there was clear visual evidence of a conversion from forest land to another landuse. The year of the deforestation and degradation event is collected, as well as the landuse replacing forest land in case of deforestation.

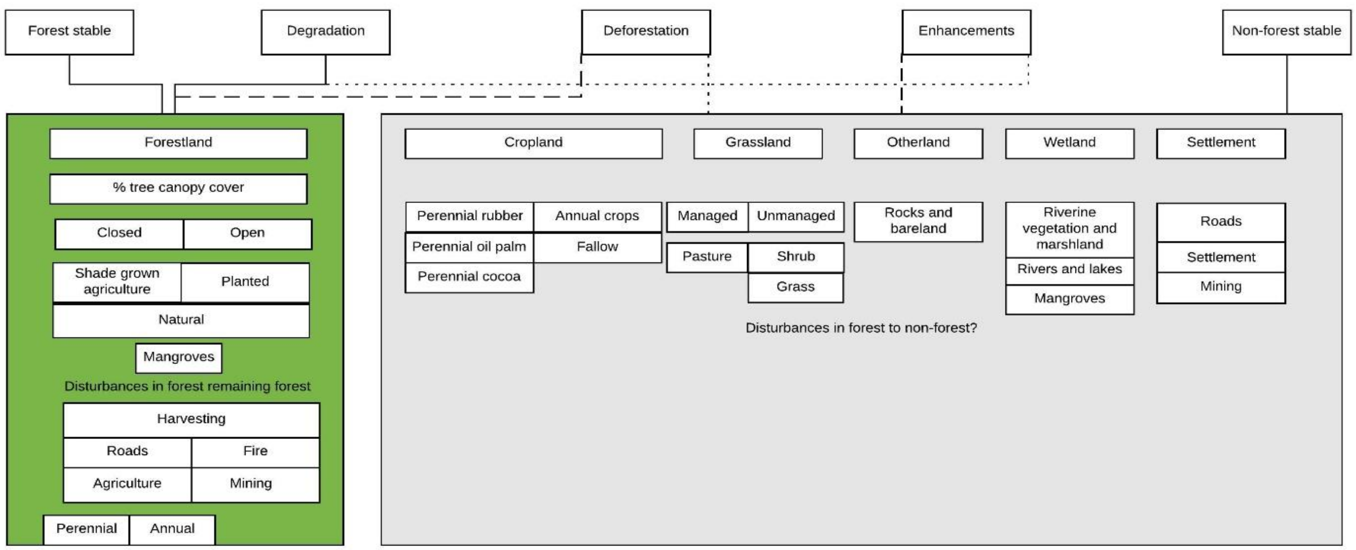

Figure 20 Classification system applied for the sample plot interpretation

In the response design, Ghana also collected information on the canopy cover before a deforestation event took place and the canopy cover before and after a forest degradation event took place. This information was used to determine whether deforestation and forest degradation was happening in open (20 – 59% canopy cover) or closed (60 – 100% canopy cover) forest. In the case of degradation, the canopy cover before and after the event was collected in the sample units, allowing the calculation of the average canopy cover reduction (both in forest that was closed at the time it was affected by a degradation event and in forest that was open at the time it was affected by a degradation event). The information on average canopy cover reduction is used to approximate the average carbon stock loss of forest that undergoes degradation.

Sample plot data were collected by experienced remote sensing experts with knowledge of the ground situation. The experts were using Collect Earth (Figure 21) for the sample plot data collection. Information on vegetation zone was not collected by the remote sensing experts, this information was directly calculated using the location of the sample unit and the corresponding vegetation zone from the vegetation zone map.

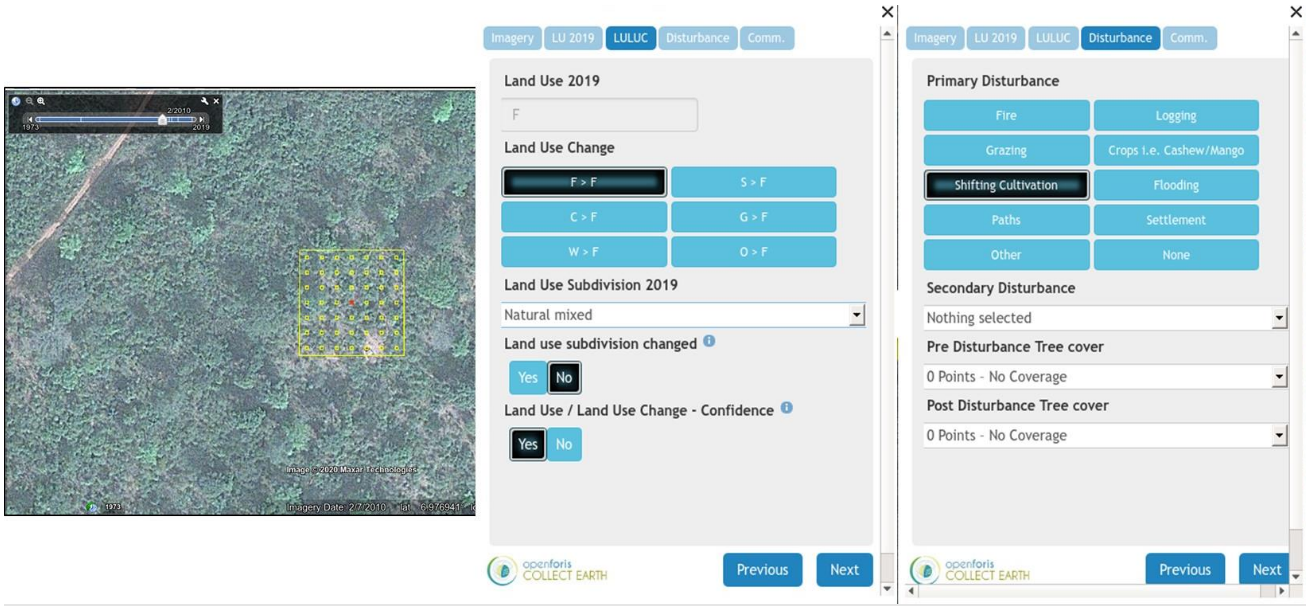

Figure 21 Collect Earth interface for Ghana's data collection

In the Collect Earth platform the interpreters used all available information for each plot, such as high resolution imagery from Google Earth or Bing maps, Landsat time series and Modis, Landsat and Sentinel NDVI indices (Figure 22). In addition, as of December 2019 Ghana had access to Planet data providing a consistent and full coverage additional data set. The challenge faced is with the interpretation of earlier dates and changes that happened in the past since for dates pre-2014 high quality images are scarcer.

Figure 22 Examples of available imagery and auxiliary data the remote sensing experts could use for the sample plot interpretation. High resolution imagery is not available for all locations in Google Earth or Bing maps, for those locations specifically Planet data can add value.

Of the detailed information collected through the sample unit assessment, the proportion of post-deforestation land-use (annual cropland, perennial cropland, grassland, settlement) is used to calculate the weighted post-deforestation carbon contents (see “Emission factors deforestation and forest degradation” below).

QUALITY MANAGEMENT

It is good practice to implement Quality Assurance / Quality Control (QA/QC) procedures in the phases of design, implementation and analysis. QA/QC procedures contribute to improve transparency, consistency, comparability, and accuracy (IPCC, 2006). Before the data collection started, experts jointly revised the classification hierarchy and reviewed a number of sampling plots together to enhance internal consistency (Figure 23).

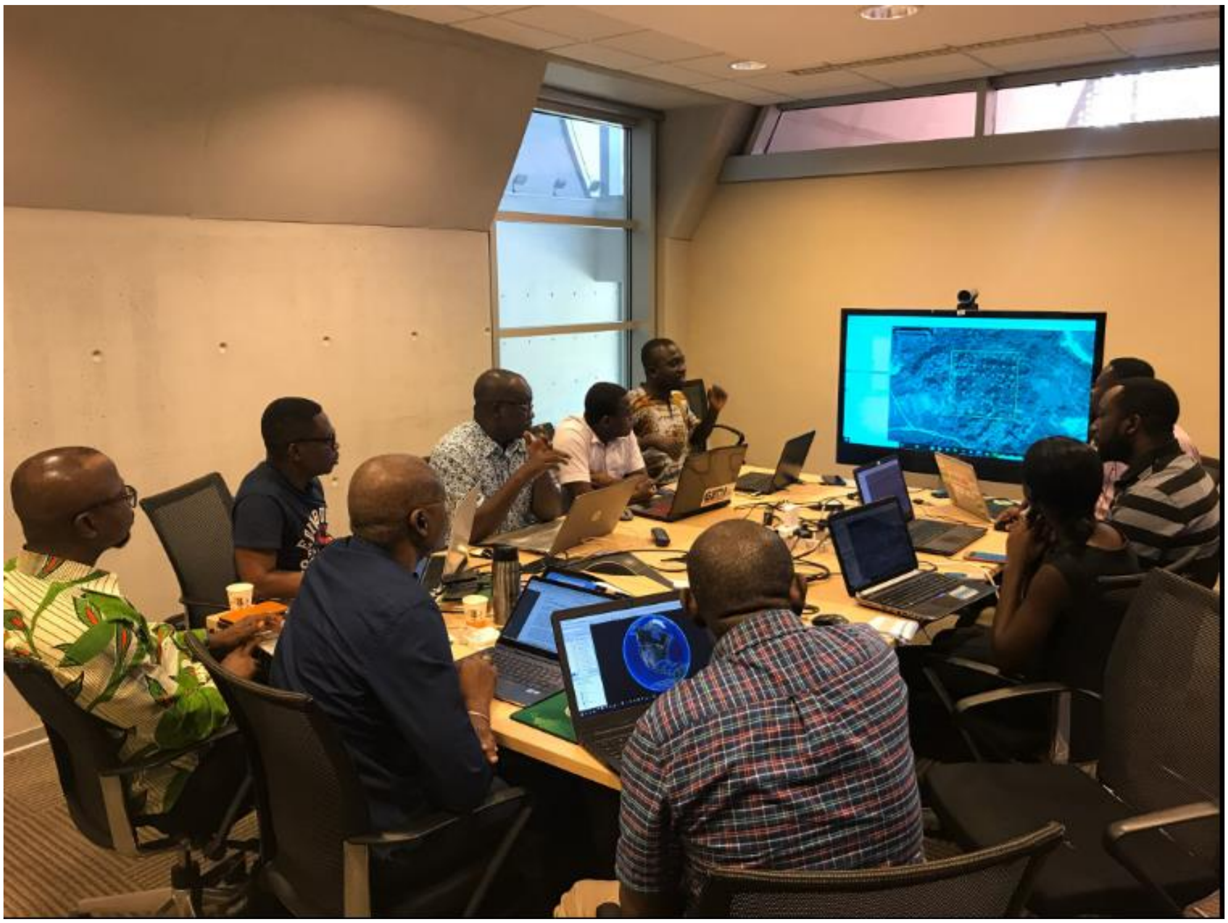

Figure 23 Several sampling plots were discussed among the remote sensing experts to improve consistency in interpretation

To assess the level of interpreter agreement, 598 sample plots were blindly re-assessed by a different interpreter. This corresponds to approximately 8% of the entire sample. The exercise resulted in an interpreter agreement of 82%, which in comparison to interpreter agreement assessments in other countries is a fair level of agreement.

To improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as “low confidence” were re-assessed and all forest or deforestation sample plots assessed in June 2019 were re-assessed since at that time the interpreters did not have access to Planet data.

Emission Factors deforestation and forest degradation

FOREST CARBON STOCKS: AGC, BGC, DEAD WOOD AND LITTER

Forest carbon stocks used for the calculation of emission factors in the ERPD are derived from inventory measurements performed under the Forest Preservation Programme (FPP), under a Japanese Aid Grant and with technical support from Arbonaut. The field measurements were undertaken in 2012 and cover both forest and non-forest landuses. This study performed field measurements in 252 plots, and of this sample, 168 plots fall into the GCFRP landscape.

The plot level carbon estimates per pool form an interim step in the calculation of the EFs, which are included as fixed parameters. The plot level carbon estimates were obtained as follows:

Above ground carbon

The tree-level allometric aboveground biomass models were generated during the project based on the destructive sampling of trees across the nine ecological zones. A variety of models were considered and the best models for each zone were selected based on a statistical review of model quality by comparing their properties using statistical measures of model performance (R-squared value, root mean squared error (RMSE) and bias). In addition the risk for height measurement errors had to be considered in model selection. Table 27 provides an overview of the model parameters for both the Moist and Wet vegetation zones.

Table 27 Tree level allometric models selected for the calculation of AGC

		a	b	R^2	RMSE
Dry Zone • Savannah, • Dry Semideciduous • Southern Margin	Trees with measured height and height below 25 meters: $Y=a*(Ht*D^2)^b$	0.0139	1.0379	0.81803	615.8164
	Trees without measured height or with height above 25 meters : $Y=a(D^2)^b$	0.6494	0.9817	0.7517	719.339
Moist Zone • Moist-Semideciduous SE • Moist-Semideciduous NW • Upland Evergreen	Trees with measured height: $Y=a*(Ht*D^2)^b$	0.00153	1.2078	0.9724	933.37
	Trees without measured height: $Y=a(D^2)^b$	0.00388	1.6063	0.9498	1258.82
Wet Zone • Evergreen • Moist Evergreen	Trees with measured height and with height below 25 meters: $Y=a*(Ht*D^2)^b$	0.00153	1.2078	0.9724	933.37
	Trees without measured height or with height above 25 meters: $Y=a(D^2)^b$	0.2471	1.1783	0.9595	1128

(dry zone is outside GCFRP landscape)

The allometric models convert the plot-level field measurements of tree diameter at breast height (D) and tree height (Ht) into tC/ha estimates at the plot level. The resulting plot-level tC/ha estimates are an input for the average tC/ha estimates per vegetation zone and forest structure (open/closed).

The average AGC value for open forest is 27.4 tC/ha, while the IPCC 2019 default AGC value for secondary forest <20 years in African tropical rainforest is 25 tC/ha. The average AGC values for closed forest in the different vegetation zones range between 74.6 – 202.9 tC/ha, while the IPCC 2019 default AGC values for secondary forest >20 years and primary African tropical rainforest is 102-194 tC/ha. Final biomass values used for the calculation of emissions factors can be found in Annex 4.

Below ground carbon

Similar to AGC, tree-level allometric below-ground biomass models were generated during the project based on the destructive sampling of trees. The selected models for BGC are provided in Table 28.

Table 28 Tree level allometric models selected for the calculation of BGC

		a	b	R^2	RMSE
Dry Zone • Savannah, • Dry Semideciduous • Southern Margin	Trees with measured height $Y=a*(Ht*D^2)^b$	1.3928	0.3664	0.358587	7.946294
	Trees without measured height: $Y=a(D^2)^b$	1.0442	0.5797	0.31492	8.212331
	(dry zone is outside GCFRP landscape)				
Moist Zone • Moist-Semideciduous SE • Moist-Semideciduous NW • Upland Evergreen	Trees with measured height: $Y=a*(Ht*D^2)^b$	0.5746	0.5091	0.489865	36.47425
	Trees without measured height: $Y=a(D^2)^b$	2.3174	0.5322	0.427698	38.63283
Wet Zone • Evergreen • Moist Evergreen	Trees with measured height: $Y=a*(Ht*D^2)^b$	0.0057	0.9598	0.94663	39.215087
	Trees without measured height: $Y=a(D^2)^b$	0.0167	1.255	0.925694	46.271627

The allometric models convert the plot-level field measurements of tree diameter at breast height (D) and tree height (Ht) into tC/ha estimates at the plot level. The resulting plot-level tC/ha estimates are an input for the average tC/ha estimates per vegetation zone and forest structure (open/closed).

BGC was calculated at plot level but looking at average values per vegetation zone and forest structure, we note that the average root-to-shoot ratios for closed forest in different vegetation zones vary between 0.13 – 0.32, while the average root-to-shoot ratio for open forest is 0.38. The IPCC 2019 default root-to-shoot ratios vary between 0.23 – 0.83.

<u>*Dead wood*</u>

The average deadwood (standing and downed) carbon is calculated at plot level. For all downed dead trees both the base and tip diameter are measured in the field. The tree volume is calculated using a frusto-conical formula.
Standing deadwood is classified into 4 different classes based on the tree decomposition level. The different levels are:

1. tree with branches and twigs and resembles a live tree (except for leaves),
2. tree with no twig, but with persistent small and large branches,
3. tree with large branches only and
4. bole (trunk) only, no branches.

These different classes use different models to calculate the carbon contents in deadwood, which are described in Manual 2-4 Computing C-stock and developing look up table values (2013). Two decomposition coefficients were calculated from the destructive sampling data based on the portions of stem, branches and leaves. The look-up table values for deadwood were averaged using the inverse cluster weights for each plot inside the ecological zone and land use class categories.

The FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013) indicated the following issue with the collected DW data: "*Deadwood in large quantities was discovered in moist evergreen plots, most likely due to trees felled on the cocoa farms admitted to expand into the forest reserves and pruning residues of palm trees in off-reserve areas.*" As a result, the ERPD suggested to use of default values from IPCC 2003 but IPCC 2006 adjusted the information provided in IPCC 2003 and noted it was not possible to provide default values for deadwood due to the large variations and the lack of regionally representative measurements. IPCC 2019 does provide default values and a default range, but DW plot measurements in the GCFRP landscape should in theory provide more representative estimates. To remove the above-mentioned bias in the plot assessment, outliers in the plot level assessments were removed, by omitting plots containing a DW assessment exceeding the upper limit of the range provided in IPCC 2019. The resulting DW measurements per vegetation zone and forest structure range between 18 – 66 tC/ha.

The weighted average DW contents per hectare of deforestation in the assessment is 28.4 tC/ha, which is above the IPCC 2019 default value of 17.7 tC/ha for broadleaf tropical rainforest, but within the range provided by IPCC 2019 going from 0.9 – 218.9 tC/ha and well below its upper limit.

<u>Litter</u>

The average litter carbon is also calculated at plot level. Litter, non-tree and soil sample physical and chemical properties were analyzed in the laboratory. Based on the analyses majority of the plots have average litter and non-tree biomass values. On top of that carbon fraction coefficients were analyzed for both litter and non-tree samples. The litter and non-tree carbon density is computed as follows:

Equation 12 Litter and non-tree carbon density

$$Carbon\left(\frac{Mg}{ha}\right) = CC \times \left(\frac{W_{DrySample}}{W_{FreshSample} \times W_{PlotTotal}}\right) \times 0.01 \tag{1}$$

where

CC	=	Carbon contents of the sample (ratio)
$Weight_{DrySample}$	=	Dry sample weight of a sample (in grams) analysed in the laboratory
$Weight_{FreshSample}$	=	Fresh sample weight of a sample (in grams) analysed in the laboratory
$Weight_{PlotTotal}$	=	Total litter weight (in grams) per 1 m^2 –plot

The look-up table values for litter, non-tree and soil were averaged using the inverse cluster weights for each plot inside the ecological zone and land use class categories. Equation 1 converts samples weights into estimates of tC/ha for the litter pool.

The resulting litter values for forests in the GCFRP landscape range between 1.4 – 3.3 tC/ha for the different forest structures/vegetation zones. IPCC 2019 provides a default value for litter of 2.5 tC/ha for tropical rainforest.

<u>Soil organic carbon</u>
Soil samples were measured for three different soil layers: 0-10 cm, 10-20 cm and 20-30 cm. A total soil carbon value was calculated as the sum of the separate layer values. Based on the laboratory analyses the soil carbon can be derived for each soil layer sample using the following formula:

Equation 13 Soil carbon density

$$Carbon\left(\frac{Mg}{ha}\right) = BD \times OC \qquad (2)$$

where

BD	=	Bulk density (g/cm3)
OC	=	Organic carbon contents (%)

The aggregated carbon density for the soil layer 0-30 cm was achieved by summing up the values for each individual 10-cm layer. Equation 2 converts soil sample measurements into plot level tC/ha values. The SOC values per forest structure/vegetation zone are obtained by the average of plot measurements in the different forest structure and vegetation zone combinations.

The resulting SOC values for forests in the GCFRP landscape ranges between 40.9 – 91.2 tC/ha for the different forest structures/vegetation zones. The range of IPCC 2019 default values for all soil types in the tropical wet climate zone is 46 – 77 tC/ha.

Table 16 in the ERPD of April 2017 includes results from this study but reveals some unlikely values, e.g. the AGB and BGB for wet evergreen closed forest suggest a root-to-shoot ratio of 0.06 (which is a factor 6 below the IPCC default value). Furthermore, the excel file with the original numbers revealed further discrepancies, e.g. the wet evergreen open forest value with confidence interval is based on zero plot measurements and uncertainties for AGC range between 0.2 – 1.4% which is unlikely low for a heterogeneous forest and the estimates being based in multiple instances on <10 plot measurements. As the original calculations were not available and one should be able to share these at the stage of verification of results and since furthermore plot level estimates are needed to perform a Monte Carlo analysis, it was decided to re-analyse the plot level carbon estimates.

The plot level data contains estimates of above ground carbon (AGC), below ground carbon (BGC), dead wood (DW), litter (L) and soil organic carbon (SOC). Information on land use and land cover was collected in the field but not consistently, as such field observations were available for 91 of the 168 plots only. For those plots that were missing information on landuse and landcover, this information was collected from a 2012 LULC map. However, this information is considered of poorer accuracy than the field observation and therefore an additional quality control was applied in which plots that according to the map were closed forest but had a carbon contents <15tC/ha were removed from the analysis since this was considered to be impossible. This resulted in the removal of 10 plots.

Of the remaining 158 plot measurements, 97 plot measurements were in forest land[25]. Of these, 69 plots were in closed forest and 28 plots were in open forest. Since there is a relatively low number of plot measurements available in the open forest and the carbon contents in open forest does not seem to vary much per vegetation zone (this ranges between average values of 17-28 tC/ha for the different vegetation zones[26]), all open forest plot measurements have been combined for a single average value for open forest. Since open forests represent stands of different age and structure, combining all measurements in all vegetation zones is expected to give a more robust result, especially since 4 of the 5 vegetation zones had only 3 or less measurements in open forest.

Figure 24 provides the carbon stock of above ground biomass or above ground carbon (AGC) for closed forest in the different vegetation zones and open forest for all vegetation zones combined.

[25] 97 observations were available for AGC, 80 for BGC, 88 for DW, 89 for litter and 96 for SOC
[26] with an outlier of 60 tC/ha for the Wet Evergreen vegetation zone but this is based on a single measurement so may not be representative

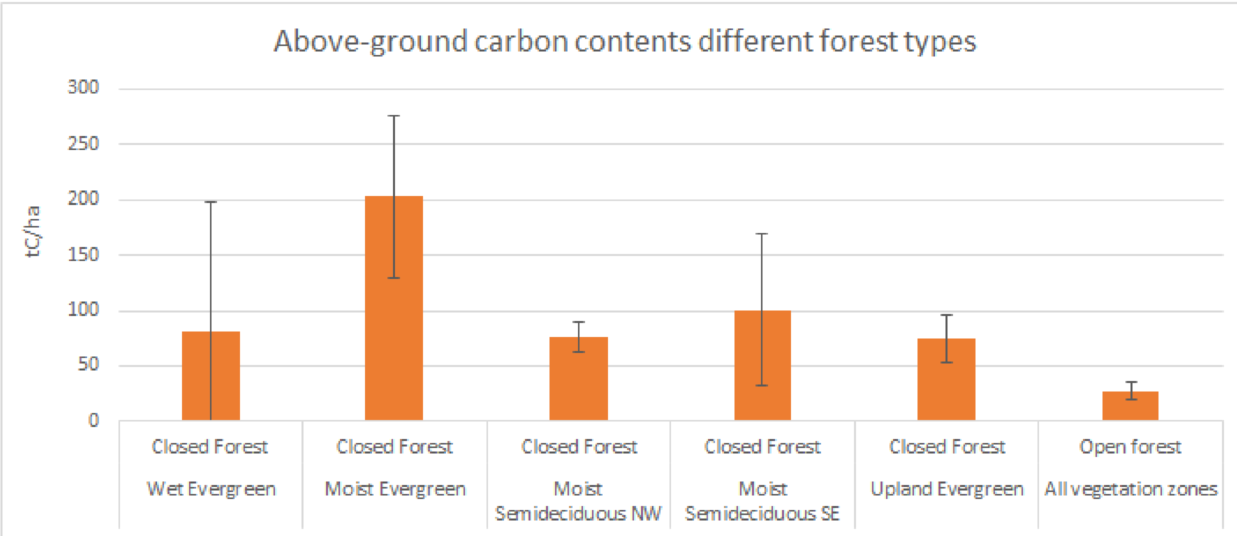

Figure 24 Above-ground carbon per forest type

Table 27 provides the average carbon stocks in the pools AGC, BGC, DW and L with their associated 90% confidence intervals.

Table 29 Carbon stocks with associated half-width 90% confidence intervals for four pools

		AGC			BGC			DW			L		
		tC/ha	±CI (tC/ha)	±CI (in perc)	tC/ha	±CI (tC/ha)	±CI (in perc)	tC/ha	±CI (tC/ha)	±CI (in perc)	tC/ha	±CI (tC/ha)	±CI (in perc)
Closed forest	Wet Evergreen	81.3	115.9	143%	10.5	17.4	166%	29.0	66.2	228%	3.0	1.4	47%
	Moist Evergreen	202.9	73.3	36%	26.8	9.9	37%	18.3	14.9	81%	3.3	2.4	71%
	Moist Semi-deciduous NW	75.9	13.6	18%	19.0	1.7	9%	38.6	12.8	33%	2.4	0.6	24%
	Moist Semi-deciduous SE	100.5	68.5	68%	25.8	5.3	21%	65.8	49.7	75%	2.9	1.1	38%
	Upland Evergreen	74.6	21.7	29%	24.1	1.8	8%	41.9	29.3	70%	1.4	0.3	32%
Open forest	All vegetation zones	27.4	8.0	29%	10.4	2.8	27%	20.5	8.1	40%	2.6	0.75	29%

SOIL EMISSIONS FROM DEFORESTATION

Soil emissions are estimated using GCFRP specific values for soil carbon in forest land (i.e. SOC_{REF} in IPCC equation 2.25 is provided through the FPP inventory) applying to this the IPCC equation and Tier 1 stock change factors. Tier 1 assumes zero soil emissions in case of forest degradation (IPCC 2019: vol 4, chapter 4). For mineral soil emissions from deforestation, IPCC equation 2.25 is applied (IPCC 2019: vol 4 chapter 2). The land-use, management and input factors are obtained by expert judgement selected from Table 5.10 for cropland (IPCC 2019) and following indications under the respective chapter for grassland and settlements (IPCC 2019: vol 4, chapter 6 and 8). For annual cropland the following values were proposed in the ERPD:

F_{LU}: Long-term cultivated Tropical moist =0.48
F_{MG}: reduced tropical moist/wet = 1.15
F_I: Medium, dry and moist/wet = 1.0

For perennial cropland, the product of F_{LU} x F_{MG} x F_I is assumed to be 1. On average, 42% of post-deforestation cropland is annual crops and 58% perennial crops. Therefore, the stock change factor applied for cropland is (0.48 x 1.15 x 1.0) x 0.42 + 1.0 x 0.58 = 0.81.

For grassland, a value of 1.00 was applied, for settlement 0.8 and for other lands 0.55. Settlements and other land are combined and therefore the stock change factor applied to settlements/other land is (0.8 + 0.55)/2 = 0.68.

These factors (Table 30) are applied for the different post-deforestation land-uses for which data was collected.

Table 30 Stock change factors for change in organic carbon in mineral soils

	Cropland	Grassland	Settlements
F_{LU} x F_{MG} x F_I	0.81	1.00	0.68

Table 31 provides the soil organic carbon (SOC) stock in the different forest types from the FPP inventory and the associated SOC emissions applying IPCC equation 2.25. Soil emissions are calculated as the difference of soil organic carbon in forest land and soil organic carbon in the replacing landuse after 20 years as suggested by IPCC. Ghana accounts for committed emissions, meaning the SOC emissions are not projected over 20 years but accounted as emission in the year of deforestation for the sake of transparency.

Table 31 Soil organic carbon stock in different forest types with associated half-width 90% confidence intervals, and soil emissions

		SOC-REF		**SOC emissions**		
		tC/ha	**±90% CI (tC/ha)**	**tCO2/ha**	**±90% CI (tCO_2/ha)**	**±90% CI (in percentage)**
Closed Forest	Wet Evergreen	85.5	49.4	69.3	57.7	83%
	Moist Evergreen	91.2	30.2	69.0	47.5	69%
	Moist Semi-deciduous NW	67.8	6.3	45.9	29.3	64%
	Moist Semi-deciduous SE	40.9	13.5	25.7	16.9	66%
	Upland Evergreen	80.8	29.4	65.1	33.1	51%
Open Forest	All vegetation zones	55.1	8.9	40.5	20.7	51%

POST-DEFORESTATION CARBON STOCK

The EF for deforestation is established as the average forest carbon stock in the respective ecozone minus the average carbon stock in the land-use replacing forest after a deforestation event. The data on the replacing land-use is collected through sample plot interpretation by the remote sensing experts. The results of this assessment are displayed in Table 32. The proportions in Table 30 should be interpreted as follows: for all deforestation of wetland evergreen forest, on average 25% is converted into annual cropland, 50% into perennial cropland and 25% into settlement.

Table 32 Proportion of post-deforestation land-use assessed in the GCFRP per vegetation zone for the period 2005-2014 (total n = 120). The associated uncertainties are calculated using equation 6. For the calculation in the reference level the confidence intervals as shown here will be doubled to be conservative.

		Annual cropland	Perennial cropland	Grassland	Settlement	Sample size (n)
Wet Evergreen	proportion	0.25	0.50	0.00	0.25	6
	±90% CI abs.	0.39	0.45	0.00	0.39	
	±90% CI perc.	156%	90%	-	156%	
Moist Evergreen	proportion	0.36	0.44	0.03	0.18	23
	±90% CI abs.	0.18	0.18	0.06	0.14	
	±90% CI perc.	49%	42%	225%	78%	
Moist Semideciduous NW	proportion	0.37	0.55	0.04	0.04	40
	±90% CI abs.	0.13	0.13	0.05	0.05	
	±90% CI perc.	36%	24%	132%	130%	
Moist Semideciduous SE	proportion	0.33	0.44	0.14	0.08	40
	±90% CI abs.	0.13	0.13	0.09	0.08	
	±90% CI perc.	38%	31%	66%	89%	
Upland Evergreen	proportion	0.09	0.45	0.09	0.36	11
	±90% CI abs.	0.16	0.29	0.16	0.28	
	±90% CI perc.	181%	63%	181%	76%	

The carbon stock values applied to the assessed post-deforestation land-uses are based on average values from FPP inventory measurements as displayed in Table 33. Only FPP plot measurements have been included with field observations indicating the use was annual cropland, perennial cropland, settlement or grassland.

Table 33 Average carbon contents (AGC + BGC) applied to post-deforestation landuses

	Biomass (tC/ha)	±90% CI (tC/ha)	±90% CI (in percentage)	n (number of field measurements)	Source
Annual cropland	5.0	1.9	38%	11	FPP inventory
Perennial cropland	27.3	8.7	32%	34	FPP inventory

Grassland	7.3	8.1	111%	3	FPP inventory
Settlement	1.3	4.2	324%	2	FPP inventory

Equation 5 Equation used for the weighted post-deforestation carbon contents ($Bafter_e$)

$$Bafter_e = \sum_{lu=1,4} \left(\frac{Adef_{lu,e}}{Adef_e} \times Bafter_{lu} \right) \quad (5)$$

where

$Adef_{lu,e}$	=	the total area of deforestation with post-deforestation landuse *lu* (either annual cropland, perennial cropland, grassland or settlement) in vegetation zone *e*
$Adef_e$	=	the total area of deforestation in vegetation zone *e*
$Bafter_{lu}$	=	biomass in the landuse replacing forest (either annual cropland, perennial cropland, grassland or settlement)

Equation 6 provides the half-width 90% confidence interval (CI) for the post-deforestation ratios included in equation 5. It concerns a simplification since the correct calculation of the confidence interval should consider the stratification. However, this resulted in a highly complicated calculation for a detail (proportion of post-deforestation landuse) that has a relatively small importance and impact on the calculation of the reference level. As such, Ghana has opted to maintain the simplified equation 6 but double the resulting confidence interval to be conservative. The sensitivity of the aggregate uncertainty of the reference level to the confidence interval of this proportion calculation is tested, doubling the CI around the proportion increased the aggregate uncertainty around the reference level value with 0.50%. Ghana therefore concludes the impact is small enough to allow for this simplification and the CI around the proportion is multiplied by two to be conservative.

Equation 6 Equation used to calculate the half-width 90% confidence interval of the proportions (included in equation 5)

$$CI\ of\ p_{lu,e} = t_{0.05} \times \sqrt{\frac{\frac{ndef_{lu,e}}{ndef_e} \times \left(1 - \frac{ndef_{lu,e}}{ndef_e}\right)}{(ndef_e - 1)}} \quad (8)$$

where

$p_{lu,e}$	=	the proportion of the area of post-deforestation landuse *lu* as proportion of the total area of deforestation in vegetation zone *e*
$t_{0.05}$	=	the t-value for the 90% confidence level; given the relatively small sample size for some of the strata this value is calculated instead of using the value 1.64
$ndef_{lu,e}$	=	the number of deforestation plots with post-deforestation landuse *lu* in vegetation zone *e*
$ndef_e$	=	the total number of samples of variable v in vegetation zone e

The post-deforestation carbon contents expressed in tCO_2/ha is provided in Table 34 with their associated uncertainties. The weighted average carbon contents per vegetation zone ranges between 51.3 and 63.2 tCO_2/ha.

Table 34 Weighted per ha post-deforestation carbon contents (in tCO_2/ha) per vegetation zone

	Wet Evergreen	**Moist Evergreen**	**Moist Semideciduous NW**	**Moist Semideciduous SE**	**Upland Evergreen**

Post-deforestation C contents (in tCO_2/ha)	55.8	51.7	63.2	54.2	51.3
±90% CI (in tCO_2/ha)	48.5	23.4	22.5	20.3	33.1
±90% CI (in percentage)	87%	45%	36%	37%	64%

The EF for deforestation was calculated as the difference between average pre-and post- deforestation carbon contents, with pre deforestation biomass estimates per vegetation type estimated based on data collected as part of the FPP. Post deforestation estimates are based on both data from the FPP as well as data collected by the team undertaking the activity data analyses. Emissions factors have been calculated following guidance provided by the 2006 IPCC guidelines where post deforestation biomass (tC/ha) is subtracted from pre-deforestation biomass estimates. This step is outlined in equation 7 below:

Equation 7 Emissions factor for deforestation for vegetation zone e and forest structure s during the reference period:

$$EF\ deforestation_{e,s} = \left(Bbefore_{e,s} - Bafter_{e} + \delta S_{e}\right) \times \frac{44}{12} \quad (7)$$

where

$B_{before\ ,e,s}$	=	Total carbon of vegetation zone *e* for forest structure s (open or closed) before conversion, which is equal to the sum of AGC, BGC, deadwood and litter. For open forest a single B_{before} value is used for all different vegetation zones.
$B_{after,\ e}$	=	see equation 5, total weighted carbon biomass (AGC + BGC) in land uses after conversion (deforestation) per vegetation zone *e*.
δS_e	=	Change in soil carbon as a result of deforestation, calculated with different soil reference values per vegetation zone *e* from FPP where the change in soil contents after conversion is calculated with IPCC Equation 2.25 (IPCC 2019, volume 4, chapter 2). The Tier 1 stock change factors are provided in Table 28.
44/12	=	Conversion of carbon to carbon dioxide

The uncertainty of the average carbon contents in the individual pools was calculated based on the sampling error (equation 8).

Equation 8 Confidence interval (±) around carbon contents in the different pools

$$CI\ of\ C_{p,e,s} = t_{\ 0.05} \times \sqrt{\frac{StDev\ C_{p,e,s}}{(n_{p,e,s}-1)}} \quad (8)$$

where

$t_{0.05}$	=	the t-value for the 90% confidence level; given the relatively small sample size for some of the plot data this value is calculated
$C_{p,e,s}$	=	the carbon contents in pool *p* (AGB, BGB, DW, L, SOC_{REF}) from plot level FPP data, in vegetation zone *e* for forest structure *s* (*s* being open or closed)

$n_{p,e,s}$	=	the total number of sample plot measurements for pool *p* in vegetation zone *e* and forest structure *s*

For the EF calculation, the errors of the individual pools are aggregated using equation 4 (simple error propagation).

FOREST CARBON STOCK REDUCTION WITH DEGRADATION

To make sure that the estimated amount of CO_2 emitted per hectare forest that is degraded corresponds to the assessed hectares of forest degradation, the remote sensing interpreters assessed the average tree cover prior to and after a degradation event. The underlying assumption is that canopy cover reduction is a good approximation of biomass reduction in a plot. This way, the average canopy cover reduction in open forest and closed forest is assessed.

In the data set, 64 points for which forest degradation was assessed over the years 2005-2014 fall in the GCFRP landscape. For 55% of the forest degradation points the cause of degradation was assessed to be logging.

The average relative canopy cover reduction in closed forest was 29.9 %, while the average relative canopy cover reduction in open forest was 48.0 % (see Table 35).

Table 35 *Average canopy cover reduction in closed and open forest as a result of forest degradation (relative canopy cover reduction gives reduction rates in equation 9)*

	Average pre-disturbance canopy cover (%)	Average post-disturbance canopy cover (%)	Absolute canopy cover reduction (%)	Relative canopy cover reduction (%)	90% CI (rel)	n
Closed forest	85.2	60.0	25.2	29.9	15%	60
Open forest	42.0	22.0	20.0	48.0	59%	5

Emissions factors for forest degradation were derived based on the relative plot level canopy cover reduction captured for degraded plots during the activity data analysis (see equation 5 in section 2.2.2). The remote sensing interpreters assessed the average tree cover prior to and after a degradation event, after which for each plot the relative percentage reduction was calculated. Accordingly, the average relative canopy cover reduction was calculated for open and closed forest for all vegetation zones combined. The relative percentage tree cover reduction was applied to the forest carbon stock (AGC, BGC, DW) to approximate the carbon loss associated with degradation. The pools AGC, BGC and DW were selected in the ERPD as associated with logging. Since this is the largest cause of degradation and since DW is a significant pool, this selection was applied here. The calculation of the EF for degradation is provided in equation 9.

Equation 14 Emissions factor for forest degradation for vegetation zone e during both the reference and monitoring period

$$EF\ degradation_{e,s} = Cbefore_{e,s} \times\ reduction\ rate_s \times \frac{44}{12} \qquad (9)$$

where

$C_{Before,e,s}$	=	The pre-degradation carbon contents (AGC + BGC + DW) in vegetation zone *e* for forest structure *s* (open or closed). For open forest a single Bbefore value is used for all different vegetation zones
Reduction rate $_s$	=	Average relative canopy cover reduction in forest structure *s* (open of closed) as a result of forest degradation, which was identified as part of the activity data analyses
44/12	=	Conversion of carbon to carbon dioxide

Enhancement of forest carbon stocks

The measurement approach relies on national statistics on areas planted and applies removal factors representing the growth of planted trees. Ghana-specific numbers are included for teak but IPCC defaults are applied for other species. Only accumulation in above and belowground tree biomass is included. All other pools are insignificant and given the increase in sequestration in the implementation case versus the reference level, any exclusion of pools is conservative.

The National Forest Plantation Development Programme (NFPDP) has engaged in a range of tree planting activities including a range of species (*Tectona grandis*, *Terminalia superba*, *Triplochiton scleroxylon*, *Mansonia altissima*, *Khaya anthotheca*, *Terminalia ivorensis*, *Pycnanthus angolensis*). Teak is the dominant species planted in the GCFRP Accounting Area, so activity data and removal factors for enhancement are categorized into two sub activities:

1. *Establishment of teak species*
2. *Establishment of other broadleaf species*

As plantation activities are subject to failure due to management or natural causes, a plantation failure rate derived from NFPDP data, was applied to discount activity data accordingly.

REMOVAL FACTORS

Teak: The study conducted by Adu-Bredu S., et al. 2008[27] assessing tree carbon stocks in teak stands in Moist Evergreen forest in Ghana was used to develop removal factors for teak stands in the GCFRP Accounting Area. The value of 97.69 Mg C ha^{-1} included both above and belowground tree carbon stocks. A removal factor in t CO_2/ha was calculated by applying the molecular weight ratio of carbon dioxide to carbon, of 44/12 to get 358 t CO_2/ha. To derive annual removals over the lifetime of the plantation, the removal factor was divided by a typical rotation length of 25 years in Ghana, to get a final removal factor of 14t CO_2ha^{-1} yr^{-1}.

Non-teak broadleaf species: Due to a lack of data available on carbon stocks in tree plantations in Ghana, IPCC AFOLU Vol. 4 default values from table 4.8 reflecting aboveground biomass in forest plantations were applied. Values for ‘Africa broadleaf >20 years’ for three ecological zones in the GCFRP Accounting Area (tropical rain forest, tropical moist deciduous forest, and tropical dry forest) were averaged to get 173.3 t d.m. ha^{-1} , which was converted to t C/ha by applying a factor of 0.47 to get 81 t C/ha. The belowground biomass value was then generated by applying a root-to-shoot ratio of 0.24 for tropical/subtropical moist forest/plantations >125 Mg ha^{-1} (Mokany et al.2006[28]), to get 20 t C/ha. The total aboveground biomass in non-teak broadleaf species was thus estimated to be the sum of below and above-ground biomass stocks: 101 t C/ha.

[27] Adu-Bredu S., et al. (2008). Carbon Stock under Four Land-Use Systems in Three Varied Ecological Zones in Ghana. Proceedings of the Open Science Conference on Africa and Carbon Cycle: the CarboAfrica project, Accra, Ghana, 25-27 November 2008. Available at http://www.fao.org/3/a-I2240.pdf

[28] Mokany K, Raison R.J, Prokushkin A.S 2006 Critical analysis of root : shoot ratios in terrestrial biomes. Global Change Biol. 12, 84–96. doi:10.1111/j.1365-2486.2005.001043.x.

A removal factor in t CO2 ha^{-1} was calculated by applying the molecular weight ratio of carbon dioxide to carbon, of 44/12 to get 370 t CO_2/ha. To derive annual removals over the lifetime of the plantation, the removal factor was divided by the typical rotation length of 40 years for indigenous species in Ghana, to get a final removal factor of 9t CO_2 ha^{-1} yr^{-1}.

The values and sources used to estimate for both removal factors are summarized below:

Table 36 Summary of Removal Factors for Teak and Non-Teak Broadleaf

Species		**Value**	**Unit**	**Source**
Teak	AGB & BGB	98	t C ha^{-1}	Adu-Bredu S, et al. 2008
	Final RF	14	t CO2 ha^{-1} yr^{-1}	*Calculation: Annual growth over 25 years*
Non-teak broadleaf)	AGB	81	t C ha^{-1}	IPCC AFOLU Vol. 4 table 4.8 above-ground biomass in forest plantations.
	BGB	20	t C ha^{-1}	Mokany et al.2006
	Final RF	9	t $CO_2$$ha^{-1}$ yr^{-1}	*Calculation: Annual growth over 40 years*

For on-reserve plantations, the NFPDP had tabular records of planting activity for all years in the historical reference period. For MTS, CFMP, GPDP, and Model programmes, the total area planted in the GCFRP Accounting Area forest reserves up to 2009 was divided across the years the programme was in operation. Off-reserve plantations under the NFPDP began in 2010 and continued through to 2012. The calculated activity data, as well as the applied failure rates and dates of NFPDP programmes are summarized below.

Table 37 GCFRP Activity Data for Enhancements

	OFF RESERVE		ON RESERVE					
Source	NFPDP data		NFPDP data					
Year	Off-reserve planted area (ha)	Survival Rate	GPDP planted area (ha)	MTS planted area (ha)	CFMP planted area (ha)	Model planted area (ha)	Expanded Program	Survival Rate
2005			948.25	2428.85	303.22	0.00	0.00	55.1%
2006			948.25	2428.85	303.22	0.00	0.00	55.1%
2007			948.25	2428.85	303.22	6.67	0.00	55.1%
2008			948.25	2428.85	303.22	6.67	0.00	55.1%
2009			948.25	2428.85	303.22	6.67	0.00	55.1%
2010	1614.59	62%	0.00	0.00	0.00	0.00	1304.11	75.4%
2011	218.79	57%	0.00	0.00	0.00	0.00	2843.50	75.4%
2012	67.41	64%	0.00	0.00	0.00	0.00	2849.09	75.4%
2013			0.00	0.00	0.00	0.00	1692.49	100.0%
2014			0.00	0.00	0.00	0.00	859.50	100.0%

On-Reserve Success Rates:

- *2005-2009: Derived from the reported failure rate of 44.9% (Source: survey and mapping of government plantation sites established between 2004 to 2009 in some forest reserves of Ghana)*
- *2010-2015: Derived from the average survival rate reported (Source: NFPDP dataset '2013 Final Verification Nationwide'.) As actual estimates for rates of survival per forest reserve were available in this dataset for the year 2013 and 2014, those rates were applied to activity data for 2013 and 2014.*

Off-Reserve Success Rates:

- *2010-2012: The off-reserve survival rates are the averages of the individual small holder plantations within the GCFRP for a particular year as reported in the handing over notes of the NFPDP by Ecotech and Zoil Services limited*

GCFRP Reference Level

The AD and EF values for deforestation and forest degradation are integrated following IPCC guidance. Removals instead are calculated following recommendations from FMT Note CF-2020-5. The resulting reference level calculation is outlined in equation 10.

Equation 10 Reference level for the GCFRP landscape (tCO_2/year)

$$RL_{GCFRP} = \sum_{e=1,5} \sum_{v=1,2} \sum_{s=1,2} \frac{(A_{v,e,s} \times EF_{v,e,s})}{t} + removals \quad (10)$$

where

RL_{GCFRP}	=	Annual reference level emissions/removals for the Ghana Cocoa Forest REDD+ Program area
$A_{v,e}$	=	Area of variable *v*, in vegetation zone *e*, in forest structure *s*
$EF_{v,e}$	=	Emissions factor for variable *v* for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
t	=	Number of years in the reference period
removals	=	This is the reference level value for removals calculated as the projected annual removals from the average planted area over the period 2005-2014

Activity data and emission factors used for calculating the average annual historical emissions over the Reference Period

Activity data

<table>
<tr><td>Parameter:</td><td>Average deforestation area in open- and closed forest per vegetation zone (2005-2014)</td></tr>
<tr><td>Description:</td><td>Area of forest converted to non-forest.</td></tr>
<tr><td>Data unit:</td><td>Hectares per annum</td></tr>
<tr><td>Source of data and description of measurement/calculation methods and procedures applied:</td><td>Activity data estimates reflecting deforestation were derived from sample-point interpretation. The sample point data set consisted of 7689 samples points systematically located across the GCFRP region on a nested, multi-scale grid with random gaps. Deforestation was estimated per vegetation zone. For each sample unit labeled as deforestation, the pre-deforestation canopy cover has been assessed. If the pre-deforestation canopy cover was 60% or higher it means closed forest was deforested. If instead, the canopy cover was between 15-59% it means open forest was deforested.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th></th><th colspan="3">Deforestation open forest</th><th colspan="3">Deforestation closed forest</th></tr>
<tr><th></th><th>in ha/yr</th><th>±90% CI (ha/yr)</th><th>±90% CI (perc.)</th><th>in ha/yr</th><th>±90% CI (ha/yr)</th><th>±90% CI (perc.)</th></tr>
<tr><td>Wet evergreen</td><td>182</td><td>223</td><td>122%</td><td>304</td><td>264</td><td>87%</td></tr>
<tr><td>Moist evergreen</td><td>768</td><td>491</td><td>64%</td><td>1728</td><td>730</td><td>42%</td></tr>
<tr><td>Moist Semideciduous NW</td><td>1840</td><td>661</td><td>36%</td><td>1171</td><td>482</td><td>41%</td></tr>
<tr><td>Moist Semideciduous SE</td><td>1950</td><td>667</td><td>34%</td><td>1078</td><td>472</td><td>44%</td></tr>
<tr><td>Upland evergreen</td><td>16</td><td>26</td><td>164%</td><td>160</td><td>82</td><td>51%</td></tr>
<tr><td></td><td>4,756</td><td>1,083</td><td>23%</td><td>4,440</td><td>1,031</td><td>23%</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures applied:</td><td>It is good practice to implement Quality Assurance / Quality Control (QA/QC) procedures in the phases of design, implementation and analysis. QA/QC procedures contribute to improve transparency, consistency, comparability, and accuracy (IPCC, 2006). Before the data collection started, experts jointly revised the classification hierarchy and reviewed a number of sampling plots together to enhance internal consistency.

To assess the level of interpreter agreement, 598 sample plots were blindly re-assessed by a different interpreter. This corresponds to approximately 8% of the entire sample. The exercise resulted in an interpreter agreement of 82%, which in comparison to interpreter agreement assessments in other countries is a fair level of agreement.

To improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as “low confidence” were re-assessed and all forest or deforestation sample plots assessed in June 2019 were re-assessed in 2020 since June 2019 the interpreters did</td></tr>
</table>

	not have access to Planet data and they could not have assessed deforestation events in the second half of 2019.
Uncertainty for this parameter:	The single phase, stratified special case of the Horvitz-Thompson estimator (the generalized estimator for unequal probability sampling) was used for estimating the associated uncertainty, and where areas were added. The half-width 90% confidence interval around the areas of variable *deforestation* was calculated using equations 3 and 4 mentioned above under the header sampling design.
Any comment:	

Parameter:	Average forest degradation area in open and closed forest per vegetation zone (2005-2014)
Description:	Area of forest experiencing forest degradation (forest land remaining forest land)
Data unit:	Hectares per annum
Source of data and description of measurement/calculation methods and procedures applied:	Activity data estimates reflecting forest degradation were derived from sample-point interpretation. The sample point data set consisted of 7689 samples points systematically located across the GCFRP region on a nested, multi-scale grid with random gaps. Degradation was estimated per vegetation zone. For each sample unit labeled as degradation, the pre-and post-degradation canopy cover has been assessed. If the pre-degradation canopy cover was 60% or higher it means closed forest was degraded. If instead, the canopy cover was between 15-59% it means open forest was degraded. The pre- and post-degradation canopy cover was converted into relative canopy cover reduction, used to approximate the degradation EF.
Value applied	(see table below)
QA/QC procedures applied:	It is good practice to implement Quality Assurance / Quality Control (QA/QC) procedures in the phases of design, implementation and analysis. QA/QC procedures contribute to improve transparency, consistency, comparability, and accuracy (IPCC, 2006). Before the data collection started, experts jointly revised the classification hierarchy and reviewed a number of sampling plots together to enhance internal consistency.

	Degradation open forest			**Degradation closed forest**		
	in ha/yr	±90% CI (ha/yr)	±90% CI (perc.)	in ha/yr	±90% CI (ha/yr)	±90% CI (perc.)
Wet evergreen	0	-		304	264	87%
Moist evergreen	128	210	164%	1,153	513	45%
Moist Semideciduous NW	245	245	100%	1,293	521	40%
Moist Semideciduous SE	64	105	164%	1,270	505	40%
Upland evergreen	0	0		80	58	73%
	437	**339**	**78%**	**4,099**	**929**	**23%**

	To assess the level of interpreter agreement, 598 sample plots were blindly re-assessed by a different interpreter. This corresponds to approximately 8% of the entire sample. The exercise resulted in an interpreter agreement of 82%, which in comparison to interpreter agreement assessments in other countries is a fair level of agreement. To improve the quality of the plot interpretation, all sample plots that were labeled by the interpreter as “low confidence” were re-assessed and all forest or deforestation sample plots assessed in June 2019 were re-assessed since at that time the interpreters did not have access to Planet data.
Uncertainty for this parameter:	The single phase, stratified special case of the Horvitz-Thompson estimator (the generalized estimator for unequal probability sampling) was used for estimating the associated uncertainty, and where areas were added. The half-width 90% confidence interval around the areas of variable *degradation* was calculated using equations 3 and 4 mentioned above under the header sampling design.
Any comment:	

Parameter:	Average annual area of forests planted between 2005-2014, discounted by plantation failure rates
Description:	Carbon stock enhancements.
Data unit:	Hectares planted/yr
Source of data and description of measurement/calculation methods and procedures applied:	National Forest Plantation Development Programme official statistics. The NFPDP collects data on on-reserve and off-reserve tree establishment across Ghana, and include a number of programmes that took place along different time frames between 2002-2015 Government Plantation Development Programme (GPDP), Modified Taungya System (MTS), Community Forestry Management Project (CFMP), Model plantations, and other on-and off-reserve planting programmes. While spatial data were not available on area planted, historical tabular data are organized into hectares planted per forest reserve. For the development of historical removals within the GCFRP Accounting Area, it was necessary to isolate how many hectares were planted in forest reserves located within the ER-Programme area (GCFRP Accounting Area). Shapefiles of forest reserve boundaries were used to delineate which forest reserves were located within GCFRP Accounting Area boundaries, and only those inside the GCFRP Accounting Area were included. For plantings in forest reserves that fell both within and outside the GCFRP Accounting Area boundary, the proportion of the forest reserve inside and outside the boundary was calculated, and the only proportion of planted area within GCFRP Accounting Area boundary was applied. To account for plantation failure, the recorded annual area planted within the GCFRP Accounting Area was discounted based on official statistics from the NFPDP. These official

	statistics reflect the two distinct periods of activities that the NFPDP undertook, whereby the 2001-2009 period reflected plantation activities in forest reserves largely led by the public sector. Starting in 2010, activities shifted toward issuing private sector companies leases to establish plantations within forest reserves. This shift in activities and management appears to have resulted in significantly different plantation failure rates: **On-Reserve**: • *2005-2009: "Survey and Mapping of Government Plantation Sites Established between 2004 and 2009 in some forest reserves of Ghana" stated that 44.9% of the planted area was estimated to have failed during this time period.* • *2010-2014: The NFPDP 2013 Dataset on Final Verification Nationwide included estimates of survival percentage per forest reserve. The average survival percentage for 2013 was reported as 75.43%, and thus a failure rate of 24.6% was applied. For the year 2013, actual survival rates per forest reserve were used rather than the average* **Off-Reserve**: • *The NFPDP 2010-2012 handing over reports by Ecotech and Zoil services limited figures reported for off-reserve plantation within the GCFRP were used. These were smallholder plantations with different survival rates for each plantation. The average survival rate of all the plantations for each year was applied. The average survival rates are 61.84,%, 57% and 63.85 % for 2010, 2011 and 2012 respectively* The adjusted annual estimates for area planted were then divided according to species composition, so that appropriate removal factors could be applied. The total estimated area of successful plantations was assumed to comprise 70% teak species and 30% other broadleaf species. This assumption about species composition was made based on expert opinion as well as a review of NFPDP data.
Value applied	Teak: 1,340.23 ha/yr Non-teak: 574.38 ha/yr These are net values, after application of the survival rate.
QA/QC procedures applied:	The activity data used for the estimation of removals was derived from national census data, reported by the National Forest Plantation Development Programme.
Uncertainty for this parameter:	No uncertainty is assumed around national census data and assessed survival rates.
Any comment:	

Emission factors

Parameter:	*Emission factors for deforestation*
Description:	Ghana uses 10 different emissions factors for deforestation. These emission factors do not change between the reference period and monitoring period assessments. The different EFs are as follows: Deforestation in open forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones. Deforestation in closed forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones Though the above mentioned 10 EFs for deforestation remain fixed, the average EF per deforested hectare over the reference and monitoring period will differ since deforestation may target forest structure (open or closed) and vegetation zones differently over both periods (see area of deforestation monitoring below). The EFs in open forest are calculated using the same forest carbon contents per vegetation zone but different post-deforestation carbon contents per vegetation zone resulting in factors that differ slightly.
Data unit:	tons of CO_2 equivalent per ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	The emission factor for deforestation considers emissions from all five carbon pools. The gross EF is calculated as the sum of above-ground carbon (AGC), below-ground carbon (BGC), dead wood (DW), litter (L) and emissions from soil organic carbon (SOC). The net EF is obtained by subtracting from the gross EF the carbon stock in the post-deforestation land-use (See additional fixed data parameters). The carbon contents in the replacing landuses are also obtained from plot measurements and a single weighted value is established per vegetation zone (so the same post-deforestation carbon contents are applied to open and closed forest), which varies between 51.3 – 63.2 tCO_2/ha (depending on the vegetation zone). Soil emissions are estimated using GCFRP specific values for soil carbon in forest land (i.e., SOC_{REF} in IPCC equation 2.25 is provided through the FPP inventory) applying to this the IPCC equation and Tier 1 stock change factors. The assumptions and values used are elaborated in above section “Soil emissions from deforestation”. Ghana accounts for committed emissions, meaning the SOC emissions are not projected over 20 years but accounted as emission in the year of deforestation for the sake of transparency. Average carbon contents per pool in the different strata were derived from inventory measurements as described above under “EFs deforestation and forest degradation” in this Annex (section 8.3). The number of plot measurements underlying the average estimates of the carbon contents of the different pools were as follows: ➢ *97 plot measurements were available for AGC,* ➢ *80 plot measurements were available for BGC,* ➢ *88 plot measurements were available for DW,* ➢ *89 plot measurements were available for litter,* ➢ *96 plot measurements were available for SOC.*

	For post-deforestation carbon contents, the number of measurements available were as follows: ➢ *11 plot measurements were available for annual cropland,* ➢ *34 plot measurements were available for perennial cropland,* ➢ *3 plot measurements were available for grassland,* ➢ *2 plot measurements were available for settlements.*
Value applied:	(see table below)

Emission Factors deforestation

		tCO_2/ha	±90% CI (tCO_2/ha)	±90% CI (in percentage)
Closed Forest	*Wet Evergreen*	*467.2*	*505.6*	*108%*
	Moist Evergreen	*938.6*	*283.8*	*30%*
	Moist Semi-deciduous NW	*481.1*	*81.7*	*17%*
	Moist Semi-deciduous SE	*686.7*	*313.0*	*46%*
	Upland Evergreen	*534.5*	*150.4*	*28%*
Open Forest	*Wet Evergreen*	*207.8*	*104.5*	*50%*
	Moist Evergreen	*211.9*	*62.3*	*29%*
	Moist Semi-deciduous NW	*200.4*	*58.0*	*29%*
	Moist Semi-deciduous SE	*209.4*	*57.3*	*27%*
	Upland Evergreen	*212.3*	*77.1*	*36%*

QA/QC procedures applied	Forest carbon stock data are taken from the FPP project. Generally, the FPP plot-based mean values are generated with a small number of field plots for each of the ecological zone, and this leads to relatively high uncertainty
Uncertainty associated with this parameter:	The table above provides the 90% confidence interval for all fixed variables reported. The confidence intervals around the individual pools were calculated using the following equation:

$$CI\ of\ C_{p,e,s} = t_{0.05} \times \sqrt{\frac{StDev\ C_{p,e,s}}{(n_{p,e,s}-1)}}$$

where

$t_{0.05}$	=	the t-value for the 90% confidence level; given the relatively small sample size for some of the plot data this value is calculated
$C_{p,e,s}$	=	the carbon contents in pool *p* (AGB, BGB, DW, L, SOC_{REF}) from plot level FPP data, in vegetation zone *e* for forest structure *s* (*s* being open or closed)
$n_{p,e,s}$	=	the total number of sample plot measurements for pool *p* in vegetation zone *e* and forest structure *s*

	For the additions and subtractions of carbon pools for the final net EF simple error propagation was applied.
Any comment:	Since the calculation of post-deforestation carbon contents is based on the AD observations of the LU replacing forest over the 2005-2014 period, this value could either remain fixed or change with each assessment. Post-deforestation carbon contents is discussed in the following parameter box.

Parameter:	*Post-deforestation carbon content (interim in EF calculation)*
Description:	This is the average weighted carbon contents in the landuse replacing forest in case of deforestation. This value is subtracted from the forest carbon stock to get the net per hectare emission factor associated with deforestation. The post-deforestation carbon contents is averaged at the vegetation zone level and the same average value is used when open- or closed forest is deforested.
Data unit:	*tons of CO_2 equivalent per ha*
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	This information is a combination of the SLMS and FPP. In the sample unit assessment of the SLMS, for each deforestation plot the land-use after deforestation is assessed. Accordingly, the proportion of post-deforestation land-use (annual cropland, perennial cropland, grassland, settlement) is calculated, and these proportions are used to calculate the weighted post-deforestation carbon contents. In analysing the FPP inventory data, the value of perennial and annual cropland is recalculated using only plots for which field observations were available. The analysis suggests an average carbon contents of 5 tC/ha for annual cropland and 27.3 tC/ha for perennial cropland.
Value applied:	(see table below)
QA/QC procedures applied	Data are taken from the FPP project
Uncertainty associated with this parameter:	The tables above provide the 90% confidence interval for all fixed variables reported. The confidence intervals around the individual pools were calculated using the following equation: $CI\ of\ C_{p,e,s} = t_{0.05} \times \sqrt{\frac{StDev\ C_{p,e,s}}{(n_{p,e,s}-1)}}$ where

Value applied:

	Wet Evergreen	Moist Evergreen	Moist Semideciduous NW	Moist Semideciduous SE	Upland Evergreen
Post-deforestation C contents	55.8	51.7	63.2	54.2	51.3
(in tCO2/ha)	48.5	23.4	22.5	20.3	33.1
±90% CI	87%	45%	36%	37%	64%

	$t_{0.05}$ = the t-value for the 90% confidence level; given the relatively small sample size for some of the plot data this value is calculated $C_{p,e,s}$ = the carbon contents in pool *p* (AGB, BGB, DW, L, SOC_{REF}) from plot level FPP data, in vegetation zone *e* for forest structure *s* (*s* being open or closed) $n_{p,e,s}$ = the total number of sample plot measurements for pool *p* in vegetation zone *e* and forest structure *s* For the additions of carbon pools for the weighted post-deforestation carbon contents simple error propagation was applied.
Any comment:	In the April 2017 ERPD, many different values are proposed for the post-deforestation carbon contents, originating from a mix of the FPP inventory, Kongsager et al 2013 and IPCC. The cropland estimates from the FPP inventory range between 30-51 tC/ha. The new analysis of the FPP inventory discussed above finds an average for open forest carbon stock in biomass at 37,7 tC/ha. Considering the description of cropland in the ERPD being "herbaceous and slash-and-burn", the values between 30-51 tC/ha seem therefore too high. The newly calculated weighted average post deforestation carbon contents ranges between 51.3 – 63.2 tCO_2/ha for the five different vegetation zones, or a weighted average of 56.5 tCO_2/ha for all vegetation zones combined. There is however a lot of uncertainty in the determination of the post-deforestation landuse, especially for the more recent years where a time series of the post-deforestation landuse it not yet available and it may be challenging to distinguish between annual and perennial cropland. Also, for annual or biennial estimates (monitoring period) the uncertainty is much larger than for 10-year estimates (reference period) since the observations will be much fewer. Given the high uncertainties around the estimation of post-deforestation landuse over the monitoring period, it was opted to keep this variable stable such that it will not impact the ER calculation. Nonetheless, Ghana did calculate how the post-deforestation carbon contents would have impacted the ERs by recalculating the post-deforestation carbon contents based on the observations of post-deforestation landuse in the 2018-2019 deforested plots. The different is displayed in below Table, showing there was less conversion into settlements and more conversion into annual croplands. (see table below) The average weighted post-deforestation carbon contents for 2005-2014 was 56.5 tCO_2/ha while the average weighted post-deforestation carbon contents for 2018-2019 was 58.5 tCO_2/ha, meaning if the EF would not be fixed it would have been slightly smaller for the monitoring period compared to the reference period, meaning it would have contributed to (slightly) more emission reductions. As such, it appears the choice of keeping the post-deforestation carbon contents fixed is conservative. However, the impact on emission reductions for the year 2019 would have been 0.2% only, which is not very significant.

	Weighted average 2005-2014	Weighted average 2018-2019
Annual cropland	34%	48%
Perennial cropland	48%	49%
Grassland	7%	3%
Settlement	11%	0%

<table>
<tr><td>Parameter:</td><td>Emission factors for forest degradation</td></tr>
<tr><td>Description:</td><td>Ghana uses 6 different emission factors for forest degradation. These emission factors will not change between the reference period and monitoring period assessments

The different EFs are as follows:
Different EFs for degradation in closed forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones, and one EF for degradation in open forest (all vegetation zones)</td></tr>
<tr><td>Data unit:</td><td>tons of CO_2 equivalent per ha</td></tr>
<tr><td>Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):</td><td>This information is a combination of the SLMS and FPP.
Emissions factors were derived from inventory measurements multiplied by the relative percentage canopy cover reduction observed in all degradation plots over the reference period. Total forest carbon stock by vegetation zone for open and closed forest was collected under the Forest Preservation Programme (FPP), as explained in detail in the parameter description of EF for deforestation (see section “Forest carbon stock reduction with degradation” above for more detail).
The average relative canopy cover reduction in closed forest was 29.9 %, while the average relative canopy cover reduction in open forest was 48.0 %. The carbon pools affected by forest degradation according are AGC, BGC and DW. The EFs are approximated by multiplying the percentage reductions assessed with the average carbon contents in AGC, BGC and DW.</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th colspan="5">Emission Factors forest degradation</th></tr>
<tr><th colspan="2"></th><th>tCO_2/ha</th><th>±90% CI (tCO_2/ha)</th><th>±90% CI (in percentage)</th></tr>
<tr><td rowspan="5">Closed Forest</td><td>Wet Evergreen</td><td>132.3</td><td>203.0</td><td>153%</td></tr>
<tr><td>Moist Evergreen</td><td>271.7</td><td>107.6</td><td>40%</td></tr>
<tr><td>Moist Semi-deciduous NW</td><td>146.3</td><td>36.2</td><td>25%</td></tr>
<tr><td>Moist Semi-deciduous SE</td><td>210.6</td><td>133.5</td><td>63%</td></tr>
<tr><td>Upland Evergreen</td><td>154.1</td><td>60.3</td><td>39%</td></tr>
<tr><td>Open Forest</td><td>All vegetation zones</td><td>102.5</td><td>66.8</td><td>65%</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures applied</td><td>Data are taken from the FPP project and SLMS. See QA/QC description under degradation area for the QA/QC applied for the SLMS.</td></tr>
</table>

Uncertainty associated with this parameter:	The table above provides the 90% confidence interval for all fixed variables reported. The confidence interval is a result of the error propagation of the error values in Table 6 and Table 12 in section "EFs deforestation and forest degradation"
Any comment:	The share of degradation happening in open and closed forest is not fixed (degradation area assessment) but the relative canopy cover deduction is fixed.

Parameter:	Removal factor for teak
Description:	Calculated removal factor for carbon stock enhancement through plantation of teak in forest reserves (AGB and BGB)
Data unit:	t CO_2 ha^{-1} yr^{-1}
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Published literature (Adu-Bredu S., et al. 2008) on total tree carbon stocks in teak stands in Moist Evergreen forest in Ghana (98 Mg C/ ha) (included both aboveground and belowground carbon stocks). 98 Mg C/ ha = 358 t CO_2/ha Annual removals: 358 t CO_2ha^{-1} / 25 yr =14 t CO_2ha^{-1} yr^{-1}
Value applied:	14 t CO_2 ha^{-1} yr^{-1}
QA/QC procedures applied	N/A
Uncertainty associated with this parameter:	Adu-Bredu et al. (2008) was completed using temporary sample plots following standard operating procedures for the measurement of terrestrial carbon. While only the total tree carbon stocks were used for the development of removal factors, an estimation of statistical accuracy was offered in the form of the mean, minimum, and maximum carbon values for the total carbon stocks of the teak stands studied in the Moist Evergreen Forest strata, as well as the standard deviation: Mean: 138 Minimum: 133 Maximum: 144 Based on these values, uncertainty could be 6% of the mean. However, to be more conservative, uncertainties in the removal factors are approximated using an average standard error value for teak from Bombelli and Valentini 2011[29] and a standard error value from IPCC 2019[30] for the root-to-shoot ratio.
Any comment:	

[29] Bombelli A., Valentini R. (Eds.), 2011. Africa and Carbon Cycle. World Soil Resources Reports No. 105. FAO, Rome. http://www.fao.org/3/i2240e/i2240e.pdf#page=108

[30] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf#page=26

Parameter:	Removal factor for other broadleaf species
Description:	Calculated removal factor for carbon stock enhancement through plantation of trees (non-teak) in forest reserves (AGB and BGB)
Data unit:	t CO_2 ha^{-1} yr^{-1}
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	IPCC AFOLU Vol. 4 table 4.8 above-ground biomass in forest plantations. Values for 'Africa broadleaf >20 years' for three ecological zones in the GCFRP Accounting Area (tropical rain forest, tropical moist deciduous forest, and tropical dry forest) were averaged, and converted to carbon (81 t C/ha) using a carbon-to-biomass ratio of 0.47. The belowground biomass value was generated by applying a root-to-shoot ratio of 0.24 for tropical/subtropical moist forest/plantations >125 Mg ha^{-1} (Mokany et al.2006). This rendered a total stock of 101 t C/ha. 101 Mg C ha^{-1}= 370 t CO_2 ha^{-1} Annual removals: 370 t CO_2 ha^{-1} / 40 yr =9 t CO_2 ha^{-1} yr^{-1}
Value applied:	9 t CO_2 ha^{-1} yr^{-1}
QA/QC procedures applied	N/A
Uncertainty associated with this parameter:	For the development of this parameter, IPCC defaults for aboveground biomass in forest plantations in Africa were applied. Given they are continental averages for all broadleaf species, uncertainty can be assumed to be high. Belowground biomass stocks are produced using a root-to-shoot ratio (Mokany et al., 2006), and therefore values are tied to the estimates for aboveground biomass Uncertainties are approximated using a standard error value from IPCC 2019[31] for the biomass values and root-to-shoot ratios.
Any comment:	

[31] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf#page=26

8.4 Estimated Reference Level

ER Program Reference level

Crediting Period year *t*	**Average annual historical emissions from deforestation over the Reference Period (tCO_{2-e}/yr)**	**If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO_{2-e}/yr)**	**If applicable, average annual historical removals by sinks over the Reference Period (tCO_{2-e}/yr)**	**Adjustment, if applicable (tCO_{2-e}/yr)**	**Reference level (tCO_{2-e}/yr)**
2019	4,133,146	867,069	-49,041		4,951,174
2020	4,133,146	867,069	-73,561		4,926,654
2021	4,133,146	867,069	-98,082		4,902,133
2022	4,133,146	867,069	-122,602		4,877,613
2023	4,133,146	867,069	-147,122		4,853,093

Calculation of the removals from the Reference Period

The ERPD estimated average removals over the period 2005-2014 at -139,172 tCO_2/year. However, for each year subsequent to the start year of the reference period (2005), delayed removals from the preceding years are included from the growing plantations. So, in year 2005 only growth in plantations established in 2005 are accounted for. In 2006, growth in plantations established in 2006 and growth in plantations established in 2005 are accounted for, etc. As such, the historical average removal value of -139,172 tCO_2/year includes on average $\frac{(1+2+3+4+5+6+7+8+9+10)}{10} = 5.5$ years of growth. If removals occurring over the 2018-2019 monitoring period would be accounted as including only growth in plantations established these two years without considering delayed growth from the preceding years this would mean the average years of growth included in the monitoring period would be $\frac{(1+2)}{2} = 1.5$ years. As such, Ghana makes reference to FMT Note CF-2020-5 dating 29 January 2021 and is suggesting to follow the FMT recommendation. All information for the annual assessment of removals over the reference period remains unaltered.

Table 38 Projected removals (removals in case the planted area does not change)

Reference level		**Average ha/year**	**2018**	**2019**
Reference level projected reforestation in 2018	Teak	1,340	-19,203	-19,203
	Non-teak	574	-5,318	-5,318
Reference level projected reforestation in 2019	Teak	1,340		-19,203
	Non-Teak	574		-5,318
Total carbon stocks (tCO_2)			**-24,520**	**-49,041**

Calculation of the average annual historical emissions over the Reference Period

Emissions for deforestation and forest degradation are calculated by multiplying AD with EF.

The average annual emissions and associated 90% confidence intervals over the reference period for deforestation are provided in Table 39. The average annual emissions and associated 90% confidence intervals over the reference period for forest degradation are provided in Table 40.

Table 39 Average annual emissions from deforestation in GCFRP (2005-2014)

	Wet Evergreen	**Moist Evergreen**	**Moist Semi-deciduous NW**	**Moist Semi-deciduous SE**	**Upland Evergreen**	**Total**
	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	**tCO_2/year** ±CI (tCO_2) **±CI (%)**
Open Forest	37,916 50,129 132%	162,699 114,478 70%	368,556 170,096 46%	408,321 178,930 44%	3,390 5,694 168%	**980,881** 276,766 **28%**
Closed Forest	141,971 196,935 139%	1,621,512 842,383 52%	563,454 250,776 45%	739,975 467,601 63%	85,354 49,914 58%	**3,152,265** 1,016,082 **32%**
Total	**179,886** 203,215 **113%**	**1,784,211** 850,126 **48%**	**932,010** 303,020 **33%**	**1,148,295** 500,666 **44%**	**88,744** 50,238 **57%**	**4,133,146** 1,053,101 **25%**

Table 40 Average annual emissions from forest degradation in GCFRP (2005-2014)

	Wet Evergreen	**Moist Evergreen**	**Moist Semi-deciduous NW**	**Moist Semi-deciduous SE**	**Upland Evergreen**	**Total**
	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	tCO_2/year ±CI (tCO_2) ±CI (%)	**tCO_2/year** ±CI (tCO_2) **±CI (%)**
Open Forest	- - 0%	13,110 23,136 176%	25,118 29,997 119%	6,573 11,599 176%	- - 0%	**44,801** 39,618 **88%**
Closed Forest	40,211 70,865 176%	313,223 186,626 60%	189,123 89,415 47%	267,405 200,093 75%	12,305 10,189 83%	**822,268** 296,627 **36%**
Total	**40,211** 70,865 **176%**	**326,333** 188,055 **58%**	**214,241** 94,312 **44%**	**273,978** 200,429 **73%**	**12,305** 10,189 **83%**	**867,069** 299,261 **35%**

The total average emissions from deforestation (2005-2014) are 4 133 146 tCO_2/year ± 25% and the total average emissions from forest degradation (2005-2014) are 867 069 tCO_2/year ± 35%.
The annual average removals from afforestation through plantation establishment on non-forest land over the reference period and projected for the years 2018 and 2019 are -24 520 tCO_2/year and -49 041 tCO_2/year for 2018 and 2019 respectively.

Therefore the reference level for the GCFRP landscape is **4 975 695 tCO_2/year ± 22.0%** for **2018** and **4 951 174 tCO_2/year ± 22.1%** for **2019**.

8.5 Upward or downward adjustments to the average annual historical emissions over the Reference Period (if applicable)

Explanation and justification of proposed upward or downward adjustment to the average annual historical emissions over the Reference Period

Not applicable to Ghana

Quantification of the proposed upward or downward adjustment to the average annual historical emissions over the Reference Period

Not applicable to Ghana

8.6 Relation between the Reference Level, the development of a FREL/FRL for the UNFCCC and the country's existing or emerging greenhouse gas inventory

The original reference level developed for the ER-Programme in April 2017 served as the framework for the national FRL submitted to the UNFCCC in January, 2017.

Similarly, the methodology for an updated FREL that was submitted to the UNFCCC in January 2021 was based on the data used in this updated reference level for the ER-Programme.

9 APPROACH FOR MEASUREMENT, MONITORING AND REPORTING

9.1 Measurement, monitoring and reporting approach for estimating emissions occurring under the ER Program within the Accounting Area

The measurement, monitoring and reporting approach used by Ghana to develop its reference level is the exact same approach used for quantifying the emissions reductions reported (see section 2.2 of the Monitoring Report and section 8.3 of this Annex for a full description).

The following line diagrams provide a systematic representation of the different steps in the process. Figure 425 provides the line diagram of the forest inventory preparation, data collection and analysis. This work was undertaken in 2012 and forms the basis for the derivation of Emissions Factors used for both the Reference Level and the Monitoring Report. The available dataset used contained per hectare average aboveground carbon (AGC), belowground carbon (BGC), deadwood (standing and downed) carbon (DW), and litter (L), non-tree and soil carbon (SOC) at plot level Figure 26 provides and overview of all different steps, while figure 27 to 31 provide a systematic representation of each step in greater detail.

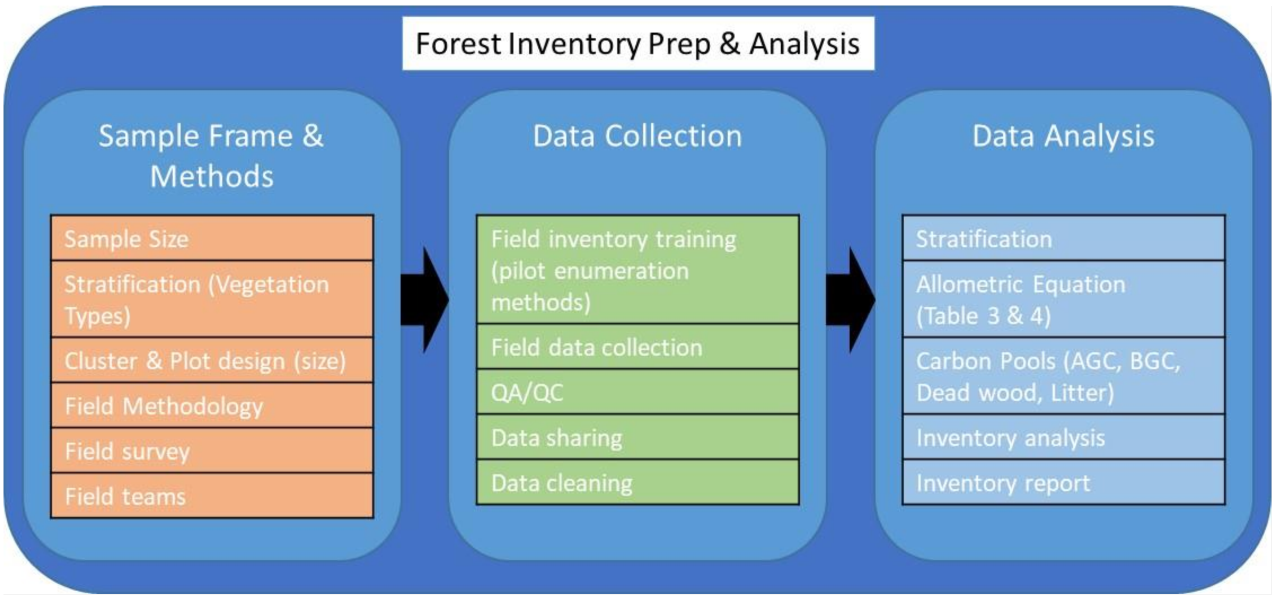

Figure 25 NFI field data collection and analysis

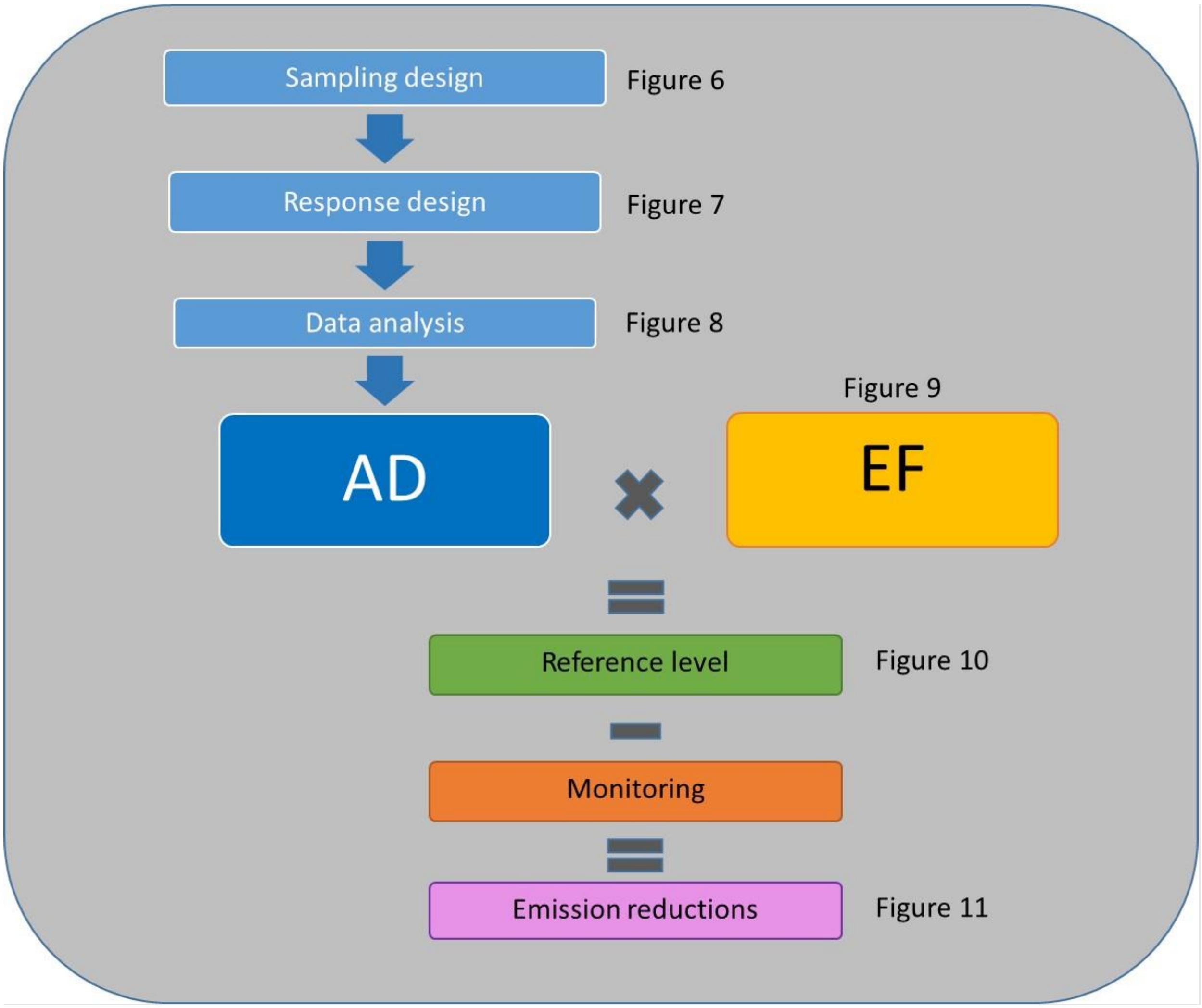

Figure 26 Overview of different steps

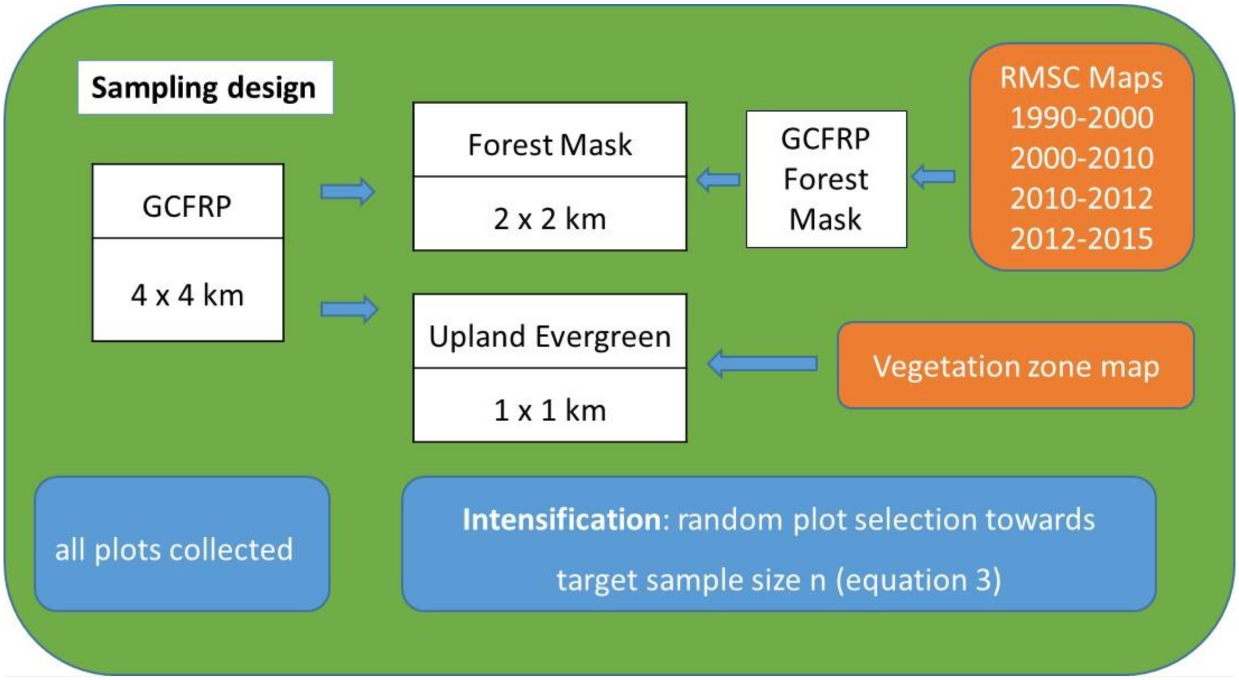

Figure 27 Sampling design

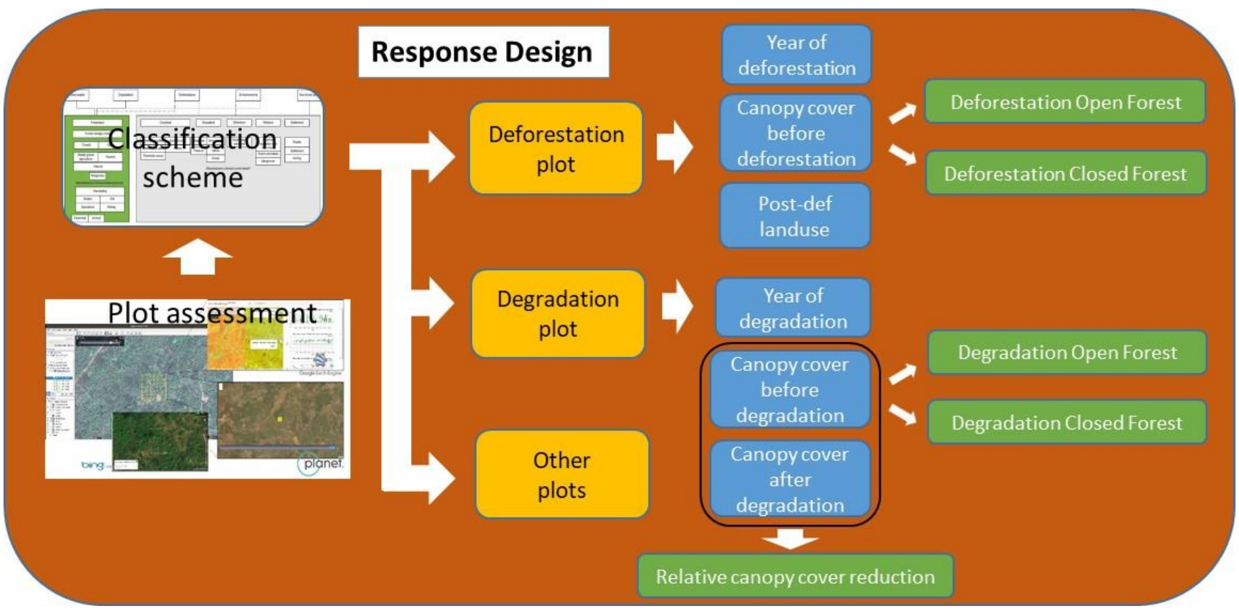

Figure 28 Response Design

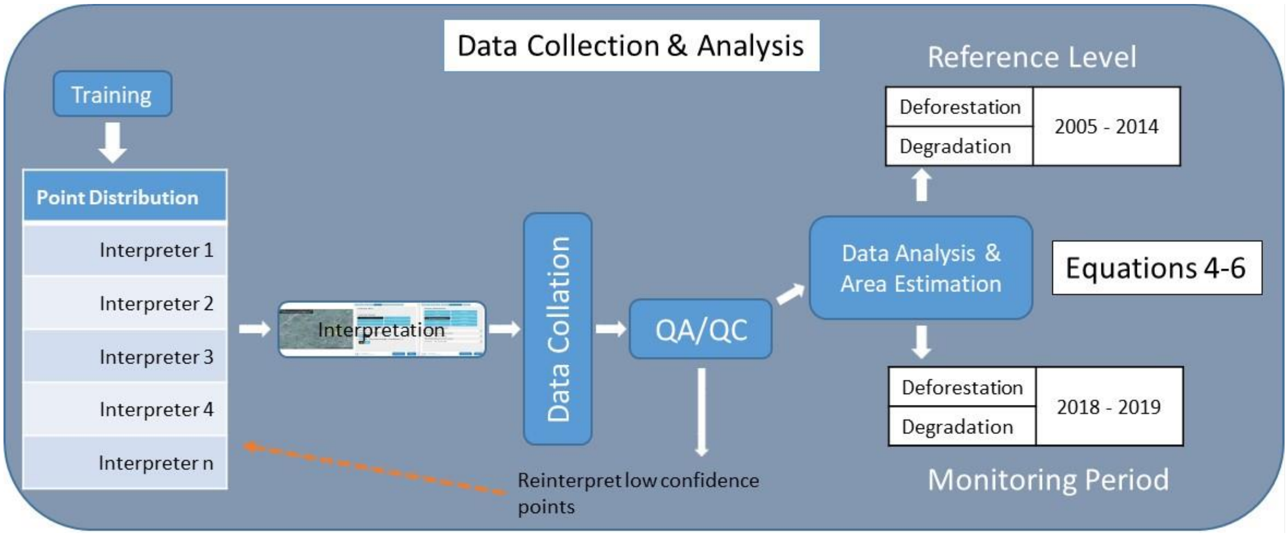

Figure 29 Data collection & analysis

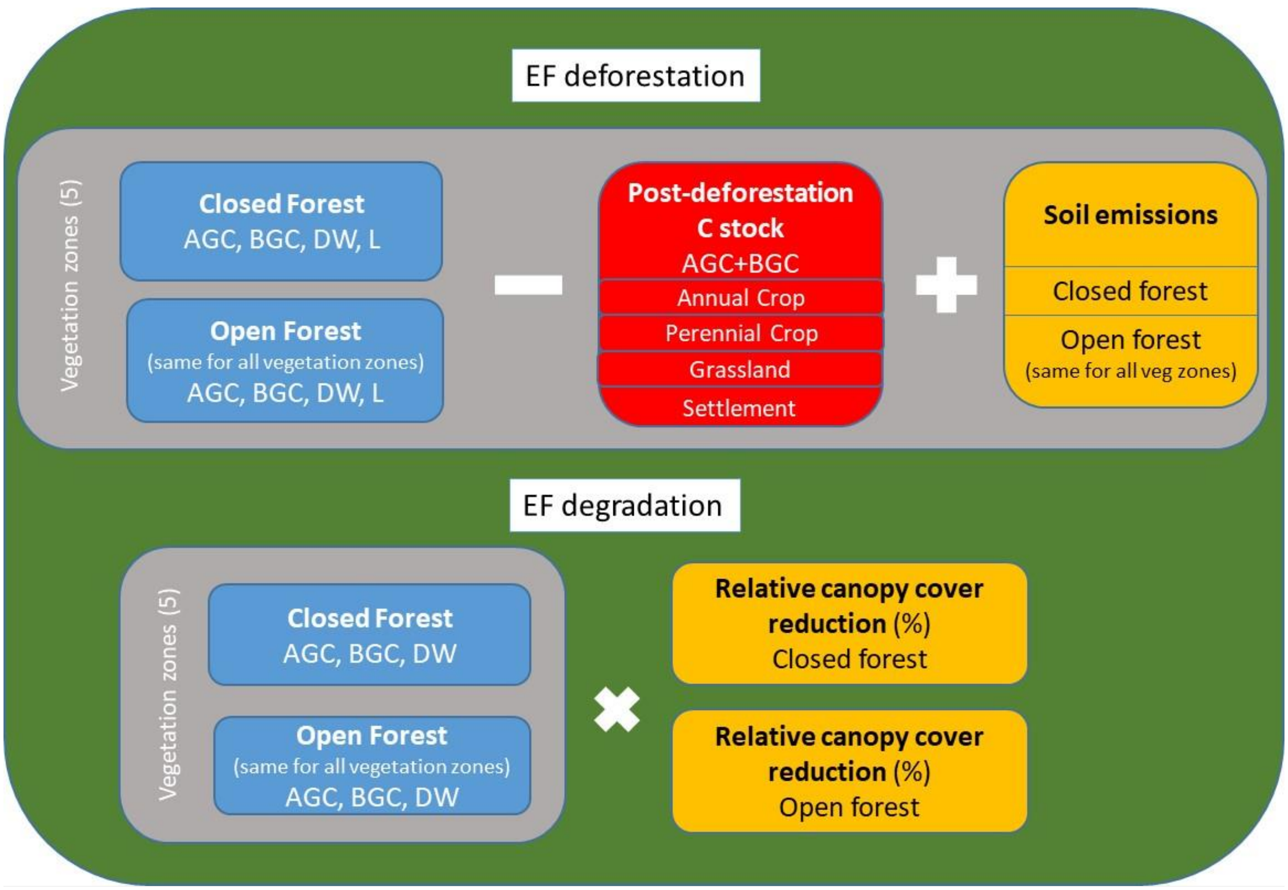

Figure 30 GCFRP Emissions *Factors for deforestation and forest degradation*

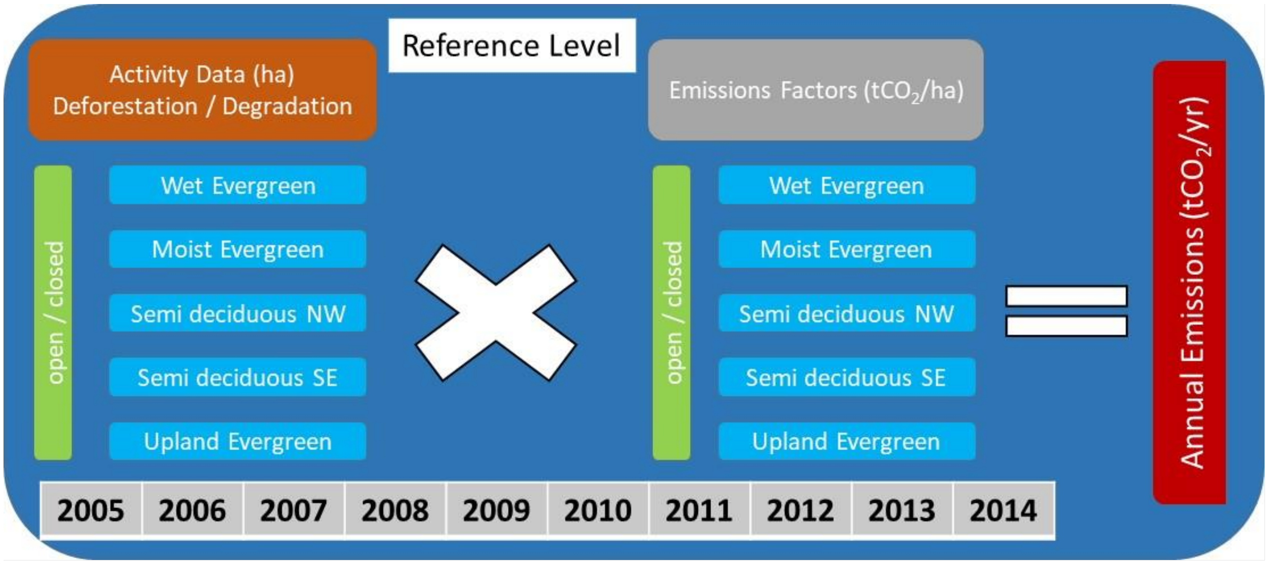

Figure 31 Ghana GCFRP Reference Level

Parameters to be monitored

Parameter:	Area of Deforestation & Forest Degradation
Description:	Area of forest converted to non-forest and area of forest experiencing forest degradation.
Data unit:	Hectares per annum.
Source of data or measurement/calculation methods and procedures to be applied, including the spatial level of the data (local, regional, national, international) and if and how the data or methods will be approved during the Term of the ERPA	Sample-point interpretation of the ER Program area using the approach described above.
Frequency of monitoring/recording:	annual
QA/QC procedures applied:	Before the data collection started, experts will jointly revise the classification hierarchy and reviewed a number of sampling plots together to enhance internal consistency.

	To assess the level of interpreter agreement, between 7 and 10% of sample plots will be blindly re-assessed by a different interpreter. Based on this an interpreter agreement will be determined. To improve the quality of the plot interpretation, all sample plots that will be labeled by the interpreter as "low confidence" will be re-assessed.
Uncertainty for this parameter:	The single phase, stratified special case of the Horvitz-Thompson estimator (the generalized estimator for unequal probability sampling) will be used for estimating the associated uncertainty. The half-width 90% confidence interval around the areas of variable v (deforestation and degradation) in vegetation zone e and stratum i is calculated using equation 3 in section 8.3 of Annex 4 of this document. The formula for the stratified standard error estimator in equation 3 has a theoretical basis in a "conditioning" argument that is explained in section 10.4 of Särndal et al (1992). To obtain the CI around the deforestation and degradation areas per vegetation zone (Av,e) and for the entire GCFRP landscape (Av), the errors are propagated using equation 4 in section 8.3 of Annex 4 of this document (which is the equivalent of equation 3.2 of IPCC 2019).
Any comment:	

Parameter:	Area of forests planted, discounted by plantation failure rates
Description:	Carbon stock enhancements.
Data unit:	Hectares planted/yr and survival in percentage
Source of data or measurement/calculation methods and procedures to be applied, including the spatial level of the data (local, regional, national, international) and if and how the data or methods will be approved during the Term of the ERPA	National Forest Plantation Development Programme official statistics. The NFPDP collects data on on-reserve and off-reserve tree establishment across Ghana. The Plantation's Department of the Forestry Commission undertakes an annual survival survey of all planted sites from which failure rates/survival rates are obtained.
Frequency of monitoring/recording:	Annual

QA/QC procedures applied:	The activity data used for the estimation of removals was derived from national census data, reported by the National Forest Plantation Development Programme.
Uncertainty for this parameter:	No uncertainty is assumed around national census data and assessed survival rates.
Any comment:	

9.2 Organizational structure for measurement, monitoring and reporting

Ghana's National Forest Monitoring System (NFMS) falls under the responsibility of the Forestry Commission. The NFMS has several data collection components as indicated here below:

- *Satellite land monitoring system (SLMS) (providing AD on deforestation and forest degradation)*
- *Field inventory data from the Forest Preservation Programme (providing EF for deforestation and forest degradation through a field inventory exercise with data collected in 2012)*
- *National Forest Plantation Development Programme (providing statistics on planted areas, including details on species and whether planting was in- or outside reserve areas. Removals factors for enhancement through the conversion of non-forest land into forest land through plantation establishment are obtained from IPCC)*

For Ghana's measuring, monitoring and reporting system, the following institutions will be directly involved:

- *The Forestry Commission's Climate Change Unit (CCU) / NRS*
- *Ghana Cocoa Board*
- *The Forestry Commission's Resource Management Support Center (RMSC)*
- *The Forestry Commission's Forest Services Division (FSD)*
- *ICT Department of the Forestry Commission*
- *The Environmental Protection Agency (EPA)*
- *Private Sector, NGOs and Research Institutions*
- *HIA Consortium/ Governance Body*
- *Academia*

Many of these institutions have clear mandates that will effectively allow them to undertake their specified roles during MMR of programme performance. The specialized departments and units of the Forestry Commission including RMSC, FSD, ICT and the NRS will play significant roles in the collection, analysis and storage of data during the MMR phase. These tasks form an integral component of their expected operational activities. The Forestry Commission and its parent ministry, Ministry of Lands and Natural Resources will also ensure that dedicated funds are set aside to support all the activities envisaged under the MMR and the procurement of relevant software and hardware.

Additionally, the FC has entered into MOUs with the Environmental Protection Agency (EPA) (both the IPCC and UNFCCC focal points) for information exchange and technical assistance on forest monitoring and national greenhouse gas inventory processes.

In formalizing the MMR institutional framework, adequate attention will also be invested towards strengthening the capacity of the identified institutions through targeted training programmes and procurement of required hardware and software. The NRS will identify experts that will serve as resource persons for the training programme.

The rest of this section describes institutional roles and responsibilities and outlines the MMR timeline.

National REDD+ Secretariat
The NRS in collaboration with the PMU is responsible for the overall coordination of the programme's MRV system. All data collected from the institutions listed above will be submitted to the NRS and integrated into the programme's overall data management system. NRS will ensure quality assurance and quality control of the data collected and will also have responsibility for uploading data to the REDD+ Information Database.

As the focal point for REDD+ in Ghana, the NRS will have responsibility for Ghana's reporting obligations on the implementation of the MRV system to the Carbon Fund of the World Bank as well as provide requisite information to the Environmental Protection Agency to support Ghana's communication to the UNFCCC.

Environmental Protection Agency
The EPA houses the National Climate Change Data Hub. The NRS will submit GHG emission estimates from the forestry sector to the EPA for national reporting to the UNFCCC. The EPA reports to the Ministry of Environment, Science, Technology and Innovation.

Resource Management Support Center
RMSC will play an overarching role in data collection and design for all forest related parameters in close collaboration with district and regional offices of the Forest Services Division (FSD). All raw data will be handled, stored and backed up by RMSC.

The specific responsibilities of RMSC during the Measurement, Monitoring and Reporting (MMR) phase of the programme include the following:

- ***generation of spatial activity data**. These processes will facilitate the generation of activity data for assessment of deforestation trends and their associated emissions. RMSC will work closely with the Forest Services Division for the collection of field data for training and accuracy assessment of the classification. In addition*
- ***Possible refinement of emission factors** should a strong justifiable reason emerge for revision of the carbon stocks, RMSC will play a leading role in collecting data from Sample plots for generating revised carbon stock estimates.*

Forest Services Division (FSD)
FSD's Plantations Department will track the activity data needed for emission removals from enhancement activities. The department, along with RMSC's plantation department, has developed Excel-based tools to track data outlined in the enhancement section above.

ICT Department of the Forestry Commission
The ICT Department will provide a supporting role in storing all data, providing backups of data and advising on the procurement of any ICT software and equipment.

Private Sector
The private sector particularly those involved in the cocoa value chain and leading HIA Consortiums will be a good source of data from their programmematic interventions. These data may include spatial/ ground data on enhancement activities being undertaken in cocoa plantations, mapping of cocoa farms, and data on illegal activities.

NGOs
NGOs will play an essential role in the MMR process by sharing any valuable data from their engagement in HIA Consortiums and implementation of programme activities with the NRS. They can also provide support in the dissemination of results from the measurement and monitoring to key local stakeholders including the Governance Bodies leading the HIA landscapes and associated communities.

The MRV sub-working group

The multi-stakeholder MRV sub-working group (one of the thematic REDD+ technical working groups) will support the NRS to undertake assessment of outputs received from the various institutions whilst supporting efforts towards information sharing with relevant agencies. The working group has representation from the following institutions in Ghana: The Forestry Research Institute of Ghana (Chair), The national REDD+ secretariat, The Resource Management Support Center (technical Wing of Ghana's Forestry commission), The Environmental Protection Agency, The Center for Remote Sensing and Geographic Information Services of the University of Ghana, Forest Services Division of Ghana's Forestry Commission, Kwame Nkrumah University of Science and Technology.

9.3 Relation and consistency with the National Forest Monitoring System

Under the Forestry Commission, the data necessary to estimate emission and removals from enhancements, deforestation and degradation are collected at the national level and are continuously being improved on a step-wise basis. These data serve as the basis of Ghana's National Forest Monitoring System (NFMS), which is consistent with IPCC guidelines for forest monitoring, and were used to estimate the reference level for the ER Programme. These methods will be followed in data collection for the measurement and reporting of Ghana's emissions as well. The ER-programme is consistent with the NFMS.

12 UNCERTAINTIES OF THE CALCULATION OF EMISSION REDUCTIONS

12.1Identification and assessment of sources of uncertainty

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
Activity Data					
Measurement	S/R	Source of error still being subject of academic research. It is potentially subject to both bias and random error and may also potentially contribute significantly to overall	H (bias/random)	YES	NO

		uncertainty. It was addressed through QA/QC protocols by : 4. Developing specific manuals and through several capacity building workshops[32]. *Note: the workshop on Monte Carlo Analysis would be conducted in third quarter 2021* 5. Dubiously identified sampling plots were discussed through consensus among interpreters. 6. Use of high resolution imagery (through different sources) that minimizes possible interpretation errors Other measurement errors may potentially be applicable, such as those associated to remote sensors and their spectral and spatial resolutions. However these are almost never applied beyond some academic exercises. The contribution of measurement error to the overall uncertainty is potentially high (both through random and systematic error) but the QA/QC (refer to points 1 -3 above) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.			
Representativeness	S	The sampling design followed strict procedures through the use of systematic grids (refer to SOPs) aiming to produce proper allocation according to strata. As such, only possible errors in the definition of strata from satellite imagery seem plausible in regards to producing potential biases. However the sampling methodology within the strata was robust. The expected impact from representativeness on the overall uncertainty is low (through systematic error) but the QA/QC applied within the strata should have minimized the remaining error inasmuch as practicable. No residual uncertainty is included in the estimate.	L (bias)	YES	NO
Sampling	S/R	The choice of estimator was based on a ratio-based approach, which is in principle tend to provide higher biases, but the high number of samples in the stratified scheme is expected to minimize that bias. Random error has been shown to be lower than with the use of purely regression-based estimators or simple means. Yet, sampling errors in AD are in practical large-scale applications always high overall. QA/QC procedures[33] led to intensification and an increase in sampling size to minimize sampling errors, including revision of sample allocation through the strata.	H(bias/random)	YES	YES

[32] http://www.ghanaredddatahub.org/settings/uploadreports/

[33] http://www.ghanaredddatahub.org/settings/uploadreports/

		The contribution of sampling error to the overall uncertainty is high (both through random and systematic error) but the QA/QC applied should have minimized this as much as practicable. Residual uncertainty is included in the estimate.			
Extrapolation	S	This source of error has been minimized due to the alignment between forest types as reporting domains with strata in the design. Hence, for example deforestation is calculated independently for each stratum that is also a certain forest type reported. The expected impact from extrapolation on the overall uncertainty is low (through systematic error) but the QA/QC applied within the strata should have minimized the remaining error this as much as practicable. No residual uncertainty is included in the estimate.	L(bias)	YES	NO
Approach 3		The approach taken is a sampling approach that allows land-use conversions to be tracked on a spatially explicit basis			
Emission factor					
DBH measurement error	R	Absence of tree-level data . Errors in DBH measurements are usually small (Picard 2015) and considered to cancel out when aggregation from tree to plots take place (Yanai et al. 2010, Holdaway et al. 2014). The expected impact from DBH measurment on the overall uncertainty is low (through random error). QA/QC (SOP 1.1 and 1.2 precribes the use of combining uncertainties) has been applied and should have minimized the remaining error as much as practicable. No residual uncertainty is included in the estimate.	L(random)	YES	NO
H measurement error	S/R	Absence of tree-level data. Tree height tends to present lower precisions, and it is highly variable and site-dependent. Clinometer-measured heights have also shown to present consistent biases of approx. 1 m. for trees > 20 m. As a consequence per ha. scale, it has been reported to give AGB uncertainties of 5-6% that can also present high biases. Although precision is reduced when aggregating at large scales due to cancelling out random errors, biases do propagate, in some cases reportedly showing 4% overestimation in AGB (Hunter et al. 2013). Field trainings took places with Arbonaut, linked to LIDAR measurements. (Refer to manuals 5.1.2, 5.3 and 5.4, link same as above) This linkage implicitly helps quality assurance through contrasting tree height measurements with those from LIDAR. As an add-on, risk for height measurement errors was already taken into account in the AGB model selection, minimizing even more this source of error. The expected impact from H measurment on the overall uncertainty is high where this concerns systematic error	H (bias) & L(random)	YES	NO

		and low where this concerns random error. QA/QC has been applied and should have minimized the errors as much as practicable. No residual uncertainty is included in the estimate.			
Plot delinea tion	S/R	No analysis took place regarding plot delineation, which can also be considered a measurement error on its own. Systematic bias can be expected because crews in the field might aim to avoid large obstacles and deviate slightly from the originally designed plot boundaries. The expected impact from plot delineation on the overall uncertainty is low (through random and systematic error). As part of QA/QC, Systematic plots of 3 plots per cluster with 500 m distance among plots and 1,000 m between clusters. Within an inventory team there was navigational team and field measurement team. The two teams woked together but were independent. The navigational team extract the center coordinate of each plot from the LIDAR strip in Arcmap, uploaded to handheld GPS and use that to locate the field plot. This was to ensure that the location of the plot remained unchanged. However, inaccessible plots such as flooded areas, mangroves were abandoned. Furthermore, when a plot laid the GNSS was used to pick the center coordinate and the four corners of the plot. The essence was to crosscheck the coordinates from the field and the ones extracted from the LIDAR image. Ground control points (GCP) with their associated coordinates were supplied by the Survey and Mapping Division. These were used to coordinate the survey of the plots. . No residual uncertainty is included in the estimate.	L(bias/ra ndom)	NO	NO
Wood density measur ement error	S/R	Wood density was not considered for live trees, since AGB models developed did not take it into account. However it had to be used to estimate AGB of dead standing trees. For that, species identity is needed. Lacking tree-level data, this source can not currently be used in this exercise. However it is known that taxonomies were used (hence QA/QC was ensured), although average WD estimates per plot were produced. This may have masked some of the taxon WD variability, which can often be high. However, because deadwood carbon is very low compared live carbon, very low errors would be expected from WD. (The expected impact from wood density estimation on the overall uncertainty is low (through random and systematic error). Information on QA/QC is found in manual 5.3 and 5.4. (*all manuals in link provided above*) No residual uncertainty is included in the estimate.	L(bias/ra ndom)	YES	NO
Biomas s allomet	S/R	The absence of tree-level data makes extremely difficult to provide a quantitative estimation of the level of uncertainty at plot-scale due to this source of	L(bias), H/L	YES (local models)	NO

ric model		uncertainty. While RMSE exists for all models used, there is presently no information of the abundance of the different species in a plot. Hence the tree-based biomass model uncertainties can not be properly propagated at plot level. Thus, neither the model choice error nor the model coefficients uncertainty can be used. As a counterargument and possible justification, the use of local BGB models like the ones used for this report has been shown to reduce possible biases as opposed to pantropical models (van Breugel et al. 2011), although pantropical models, such as Chave (2014) can significantly reduce precision. Thus we expect this source of uncertainty to have a low contribution to bias but possibly high to random error in a static estimation. In the case of emission reductions, the full correlation assumption will point to minimal effects of this source of error. The expected impact from the biomass allometric models (AGB and BGB) on the overall uncertainty is low (for systematic error) to medium (for random and systematic error) but the QA/QC (manuals 5.3 and 5.4) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	(random)		
Sampli ng	S/R	Plots were distributed along LIDAR transects and randomly located along the lines, stratified by vegetation types. Estimators were SRS (over a systematic configuration of plots along LIDAR transects, by ecological zone) within each stratum, and carbon stock was expanded to a per ha. basis. The plots can be considered as a quasi-transect sample of the forests. The field plots have a square shape of 40 m by 40 m (Chen et al. 2015[34]) Sampling could result in both systematic and random errors. Information is missing on the QA/QC applied. No residual uncertainty is included in the estimate. The within plot uncertainty should be low, the between plot uncertainty should be high.	L (bias/ran dom)	NO	YES
Carbon fraction	S/R	Value taken from the literature. Hence, it could lead to both random and systematic errors. The random error is usually considered to be low but the aggregated effect might be high. Different carbon fractions were applied to different parts of the tree in the plot measurements for the different pools so the expectation is that the aggregated value is as representative as possible. The carbon fraction could result in both systematic and random errors but by using different fractions for	H (bias/ran dom)	NO	NO

[34] *Chen, Q., Laurin, G. V., & Valentini, R. (2015). Uncertainty of remotely sensed aboveground biomass over an African tropical forest: Propagating errors from trees to plots to pixels. Remote Sensing of Environment, 160, 134-143*

		different pool components this error is expected to have been minimized. No residual uncertainty is included in the estimate.			
Decomposition values	S/R	Uncertainty from decomposition values is assumed to have a low contribution because of the very small fraction of deadwood usually present in the forest. However in the specific case of this study some doubts were raised because of extremely high values of deadwood in some cocoa areas. This was raised during the QA/QC revision and alternative default values were instead used. Yet we cannot calculate quantitatively the uncertainty because of the absence of within-plot data. The expected impact from the decomposition value on the overall uncertainty is medium (through random error) but the QA/QC applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H/L(random)	YES	NO
Removal aboveground biomass	S/R	Plantation AGB estimates are obtained from local documentation (for teak plantations) or IPCC default values (for other species) and are subject to random variation whose origins are difficult to identify and were given as a range. As such, they may increase total uncertainty. However, they are going to represent a small fraction of the overall uncertainty. The expected impact from the removal aboveground biomass estimates on the overall uncertainty is low (through both random and systematic error). No QA/QC was applied since these values were taken from literature and IPCC.	L (bias/random)	NO	YES
Root-to-shoot for removal factors	R	Root-to-shoot ratios tend to follow lognormal distributions. The mean value was taken from the refined IPCC (2019) default tables, which take them from Mokany et al. (2006). The IPCC tables take a SE value with asymmetric extreme values due to the lognormality of residuals stated by Mokany et al. (2006). Both mean and SE are used to calculate the lognormal distribution, after which values are back-transformed to natural (antilog) scales. Given the low contribution of removals overall to final emission reductions, they represent a very small contribution to overall uncertainty. The expected impact from the root-to-shoot values on the overall uncertainty is low (through random error). No QA/QC was applied since these values were taken from IPCC. No residual uncertainty is included in the estimate.	L (random)	NO	YES
Relative canopy cover reduction for	S/R	Degradation is based on detected canopy cover reduction in a very small set of plots where it was detected. The variation is likely to be due mostly from sampling error over rare events. Since it is such a rare event, its contribution to overall uncertainty is small.	L(random/bias)	NO	YES

degradation		The expected impact from the relative canopy cover reduction estimates on the overall uncertainty is low (through both random and systematic error) but the QA/QC applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.			
Representativeness error	S	LIDAR transects lines were parallel. Hence, a systematic approach relies over the overlapping of plots on these transect lines. As such we expect the possible bias due to representativeness to be minimized. Out of at total area of 15,153 km^2 of the study area, LiDAR scanning was required for only 770 km^2 (sampling intensity being 5.1%) (Sah et al. 2012) The expected impact from representativeness on the overall uncertainty is low (through systematic error). Information is missing on the QA/QC applied. No residual uncertainty is included in the estimate.	L (bias)	YES	NO
Integration					
Model	S/R	Integration of AD and EF through Monte Carlo can present potential biases and the random errors are naturally propagated. The combination of AD & EF does not necessarily need to result in additional uncertainty. Usually, sources of both random and systematic error are the calculations themselves and model errors in integration may arise because of the implicit simplifications in the actual mutiplication of AD x EF. Currently no correlations are considered in the calculations. While this may increase the random and systematic errors, it is a conservative approach. QA/QC processes in the preparation of the tool involved several revision processes and consultations in regard to the best PDFs to apply for every component of the simulation. The expected impact from the model (AD x EF) on the overall uncertainty is high (through both systematic and random error) but the QA/QC applied to the AD and EF calculations as described above should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H(bias/random)	YES	NO
Probability Density Functions	S/R	The model followed a parametric MC approach given the unreliability of a bootstrap for those rare cases which are present due to the relatively low sample size of the ground plots. The choice of PDF's may be a source of uncertainties. Most of the variables were fitted as Gaussian distributions and relative canopy cover reduction was fitted with a beta distribution. While ideally both should be truncated to avoid either rare negative numbers or fractions of canopy cover reduction above those permitted by the forest definitions, the lack of within-plot mean and standard error estimates	H (bias/random)	YES	NO

		considering truncated distributions makes the task impossible. However, overall these small deviations are likely representing very small errors, probably slightly biasing the overall median result. Hence the expected impact is likely to be overall low regarding both bias and random error. No residual uncertainty regarding the choice of PDF was included.			
Integration	S	This source of uncertainty is related to the lack of comparability between the transition classes of the AD and those of the EF. AD is estimated through remote-sensing observations, whereas EFs for a specific ecological zone were based on ground-based observations of the ecological zone. These may not be comparable, and it may represent a source of bias. QA/QC involved the fine tuning coordinates alignment of LIDAR transects and field plots (Chen et al. 2015). Furthermore, the assessment of forest degradation is as harmonized as possible since information on relative canopy cover reduction is used to approximate biomass loss. The difference between open and closed forest average biomass contents to approximate the degradation EF is a much poorer estimate since the observed plots show that in many cases of degradation in closed forest, the post-degradation canopy cover is not below 60%. The expected impact from integration on the overall uncertainty is high (through systematic error) but the QA/QC applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H(bias)	YES	NO

The following references are used in above table:

- *Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B., ... & Vieilledent, G. (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology, 20(10), 3177-3190.*
- *Chen, Q., Laurin, G. V., & Valentini, R. (2015). Uncertainty of remotely sensed aboveground biomass over an African tropical forest: Propagating errors from trees to plots to pixels. Remote Sensing of Environment, 160, 134-143*
- *Holdaway, R. J., McNeill, S. J., Mason, N. W., & Carswell, F. E. (2014). Propagating uncertainty in plot-based estimates of forest carbon stock and carbon stock change. Ecosystems, 17(4), 627-640.*
- *Hunter, M. O., Keller, M., Victoria, D., and Morton, D. C..(2013) Tree height and tropical forest biomass estimation, Biogeosciences, 10, 8385–8399, https://doi.org/10.5194/bg-10-8385-2013, 2013.*
- *Picard, N., Bosela, F. B., & Rossi, V. (2015). Reducing the error in biomass estimates strongly depends on model selection. Annals of forest Science, 72(6), 811-823.*
- *Sah, B. P., Hämäläinen, J. M., Sah, A. K., Honji, K., Foli, E. G., & Awudi, C. (2012). The use of satellite imagery to guide field plot sampling scheme for biomass estimation in Ghanaian forest. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 4, 221.*

- *Van Breugel, M., Ransijn, J., Craven, D., Bongers, F., & Hall, J. S. (2011). Estimating carbon stock in secondary forests: decisions and uncertainties associated with allometric biomass models. Forest ecology and management, 262(8), 1648-1657.*
- *Yanai, R. D., Battles, J. J., Richardson, A. D., Blodgett, C. A., Wood, D. M., & Rastetter, E. B. (2010). Estimating uncertainty in ecosystem budget calculations. Ecosystems, 13(2), 239-248*

12.2Quantification of uncertainty in Reference Level Setting

Parameters and assumptions used in the Monte Carlo method

Parameter included in the model	Parameter values	Standard deviation (±)	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function
General factors				
Ratio of molecular weights	3.667	0	Not applicable	Fixed
Carbon fraction	0.470	0.013	Uncertainty ranges as provided in sources	Normal
Days applicable to ER in 2019	203	0	Not applicable	Fixed
Biomass measurements				
AGB (tC /ha) Open All forest	27.4	5.4	Sampling error	Normal
AGB (tC /ha) Closed Wet Evergreen	81.3	49.9	Sampling error	Normal
AGB (tC /ha) Closed Moist Evergreen	202.9	43.7	Sampling error	Normal
AGB (tC /ha) Closed Moist Semideciduous SE	100.5	37.5	Sampling error	Normal
AGB (tC /ha) Closed Moist Semideciduous NW	75.9	11.1	Sampling error	Normal
AGB (tC /ha) Closed Upland Evergreen	74.6	14.3	Sampling error	Normal
BGB (tC /ha) Open All forest	10.4	1.9	Sampling error	Normal
BGB (tC /ha) Closed Wet Evergreen	10.5	6.1	Sampling error	Normal
BGB (tC /ha) Closed Moist Evergreen	26.8	5.9	Sampling error	Normal
BGB (tC /ha) Closed Moist Semideciduous SE	25.8	3.8	Sampling error	Normal
BGB (tC /ha) Closed Moist Semideciduous NW	19.0	2.1	Sampling error	Normal
BGB (tC /ha) Closed Upland Evergreen	24.1	2.6	Sampling error	Normal
DW (tC /ha) Open All forest	20.5	5.1	Sampling error	Normal
DW (tC /ha) Closed Wet Evergreen	29.0	28.1	Sampling error	Normal
DW (tC /ha) Closed Moist Evergreen	18.3	7.7	Sampling error	Normal

DW (tC /ha) Closed Moist Semideciduous SE	65.8	26.2	Sampling error	Normal
DW (tC /ha) Closed Moist Semideciduous NW	38.6	7.5	Sampling error	Normal
DW (tC /ha) Closed Upland Evergreen	41.9	16.3	Sampling error	Normal
L (tC /ha) Open All forest	2.6	0.4	Sampling error	Normal
L (tC /ha) Closed Wet Evergreen	3.0	0.5	Sampling error	Normal
L (tC /ha) Closed Moist Evergreen	3.3	1.2	Sampling error	Normal
L (tC /ha) Closed Moist Semideciduous SE	2.9	0.5	Sampling error	Normal
L (tC /ha) Closed Moist Semideciduous NW	2.4	0.3	Sampling error	Normal
L (tC /ha) Closed Upland Evergreen	1.4	0.3	Sampling error	Normal
SOC (tC /ha) Open All forest	9.9	0.9	Sampling error	Normal
SOC (tC /ha) Closed Wet Evergreen	16.0	4.2	Sampling error	Normal
SOC (tC /ha) Closed Moist Evergreen	17.0	2.8	Sampling error	Normal
SOC (tC /ha) Closed Moist Semideciduous SE	7.6	1.2	Sampling error	Normal
SOC (tC /ha) Closed Moist Semideciduous NW	12.7	0.6	Sampling error	Normal
SOC (tC /ha) Closed Upland Evergreen	15.1	2.8	Sampling error	Normal
post-Def LU (tC /ha) Open All forest (simplified average)	15.1	7.0	Sampling error	Normal
post-Def LU (tC /ha) Closed Wet Evergreen	15.2	7.0	Sampling error	Normal
post-Def LU (tC /ha) Closed Moist Evergreen	14.1	4.0	Sampling error	Normal
post-Def LU (tC /ha) Closed Moist Semideciduous SE	14.8	4.9	Sampling error	Normal
post-Def LU (tC /ha) Closed Moist Semideciduous NW	17.2	5.8	Sampling error	Normal
post-Def LU (tC /ha) Closed Upland Evergreen	14.0	3.4	Sampling error	Normal
Monitored values deforestation 2005-2014				
AD (ha /yr) Open All forest	4,756	661	Sampling error	Normal
AD (ha /yr) Closed Wet Evergreen	304	161	Sampling error	Normal
AD (ha /yr) Closed Moist Evergreen	1,728	445	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous SE	1,078	288	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous NW	1,171	294	Sampling error	Normal
AD (ha /yr) Closed Upland Evergreen	160	50	Sampling error	Normal
Monitored values deforestation 2019				
AD (ha /yr) Open All forest	1,924	1,110	Sampling error	Normal
AD (ha /yr) Closed Wet Evergreen	0	0	Sampling error	Normal
AD (ha /yr) Closed Moist Evergreen	0	0	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous SE	0	0	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous NW	619	619	Sampling error	Normal

AD (ha /yr) Closed Upland Evergreen	0	0	Sampling error	Normal
Planting (net areas, discounted for annual survival rates)				
Area established (ha) teak 2005	1,419	0	Not applicable	Fixed
Area established (ha) teak 2006	1,419	0	Not applicable	Fixed
Area established (ha) teak 2007	1,422	0	Not applicable	Fixed
Area established (ha) teak 2008	1,422	0	Not applicable	Fixed
Area established (ha) teak 2009	1,422	0	Not applicable	Fixed
Area established (ha) teak 2010	1,388	0	Not applicable	Fixed
Area established (ha) teak 2011	1,589	0	Not applicable	Fixed
Area established (ha) teak 2012	1,534	0	Not applicable	Fixed
Area established (ha) teak 2013	1,185	0	Not applicable	Fixed
Area established (ha) teak 2014	602	0	Not applicable	Fixed
Area established (ha) non teak 2005	608	0	Not applicable	Fixed
Area established (ha) non teak 2006	608	0	Not applicable	Fixed
Area established (ha) non teak 2007	609	0	Not applicable	Fixed
Area established (ha) non teak 2008	609	0	Not applicable	Fixed
Area established (ha) non teak 2009	609	0	Not applicable	Fixed
Area established (ha) non teak 2010	595	0	Not applicable	Fixed
Area established (ha) non teak 2011	681	0	Not applicable	Fixed
Area established (ha) non teak 2012	658	0	Not applicable	Fixed
Area established (ha) non teak 2013	508	0	Not applicable	Fixed
Area established (ha) non teak 2014	258	0	Not applicable	Fixed
Removal factors				
Average stock AGB+BGB (tC /ha) teak	97.690	7.350	Sampling error	Normal
Growth period (years) teak	25	0	Not applicable	Fixed
Average stock AGB (t d.m. /ha) non teak	173.300	79.577	Sampling error	Normal
RSR non teak	0.240	0.110	Uncertainty ranges as provided in sources	Normal
Growth period (years) non teak	40	0	Not applicable	Fixed
Removals from planting 2018-2019				
Area planted (ha) teak 2018	7749.35	0	Sampling error	Fixed
Area planted (ha) teak 2019	9504.614	0	Sampling error	Fixed
Area planted (ha) non teak 2018	3321.15	0	Sampling error	Fixed
Area planted (ha) non teak 2019	4073.406	0	Sampling error	Fixed
EF forest degradation				
Relative canopy cover redux Open	0.480	0.073	Sampling error	Beta
Relative canopy cover redux Closed	0.299	0.026	Sampling error	Beta
Monitored values degradation 2005-2014				
AD (ha /yr) Open All forest	375	198	Sampling error	Normal
AD (ha /yr) Closed Wet Evergreen	304	161	Sampling error	Normal
AD (ha /yr) Closed Moist Evergreen	1,153	313	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous SE	1,270	308	Sampling error	Normal

AD (ha /yr) Closed Moist Semideciduous NW	1,354	324	Sampling error	Normal
AD (ha /yr) Closed Upland Evergreen	80	36	Sampling error	Normal
Monitored values degradation 2019				
AD (ha /yr) Open All forest	0	0	Sampling error	Normal
AD (ha /yr) Closed Wet Evergreen	607	607	Sampling error	Normal
AD (ha /yr) Closed Moist Evergreen	1,282	906	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous SE	4,426	1,881	Sampling error	Normal
AD (ha /yr) Closed Moist Semideciduous NW	3,095	1,383	Sampling error	Normal
AD (ha /yr) Closed Upland Evergreen	0	0	Sampling error	Normal

Quantification of the uncertainty of the estimate of the Reference level

Uncertainty of the Reference Level at the 90% confidence level is reported according to criterion 7, indicators 9.2 and 9.3, and criterion 22 of the Methodological Framework and summarized in below table.

		Deforestation	Forest degradation	Enhancement of carbon stocks
A	**Median**	4,088,748	856,871	2018: -24,526 2019: -48,998
B	**Upper bound 90% CI** (Percentile 0.95)	5,190,167	1,162,262	2018: -19,754 2019: -44,231
C	**Lower bound 90% CI** (Percentile 0.05)	3,090,976	611,640	2018: -29,320 2019: -53,793
D	**Half Width Confidence Interval at 90% (B – C / 2)**	1,049,595	275,311	2018: 4,783 2019: 4,781
E	**Relative margin (D / A)**	25.7%	32.1%	2018: -19.5% 2019: -9.8%
F	**Uncertainty discount**	4%	8%	2018: 4% 2019: 0%

Sensitivity analysis and identification of areas of improvement of MRV system

Making reference to criterion 7 and indicators 9.2 and 9.3 of the Methodological Framework and the *Guideline on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions*, a sensitivity analysis was undertaken to identify the relative contribution of each parameter to the overall uncertainty of Emission Reductions. The sensitivity analysis was conducted by “switching off” the sources of uncertainty one at a time and assessing the impact on the overall uncertainty of emission reductions.

The results of the sensitivity analysis were the following:

Scenario	ER Uncertainty 90%	Difference to ER Uncertainty 90% of all parameters
All parameters	55%	0%
No Deforestation	34%	-21%
No Forest degradation	44%	-11%
No Enhancement	55%	0%
No EF	51%	-4%
No AD	22%	-33%
No Deforestation AD	39%	-16%
No Deforestation EF	51%	-4%
No Forest degradation AD	44%	-11%
No Forest degradation EF	55%	0%
No Enhancement AD	55%	0%
No Enhancement EF	55.%	0%

As above table shows, the AD contributes much more to the ER uncertainty than the EFs. The uncertainty in the AD is relatively high because the feature of interest is relatively rare. If Ghana would manage to reduce deforestation and forest degradation in the future, it is likely that the uncertainty would increase because the features of interest (deforestation and degradation) would become even rarer. As described in Annex IV, Ghana already made efforts to reduce the uncertainty of the estimates by increasing the sampling intensity. The current sample size is 7,689 plots. If Ghana would increase this with 50% (which would require substantial resources), the expected gain in precision would be merely 3% if the areas of the feature of interest would remain similar. Furthermore, for future assessments it would be beneficial to use 'permanent plots' rather than changing the plots and sample size.

Document history

Version	Date	Description
2.1	November 2020	Aspects on uncertainty analysis were revised based on the guidelines on uncertainty analysis.
2	June 2020	Version approved virtually by Carbon Fund Participants. Changes made: • *Update to consider the changes made to the Methodological Framework (Version 3.0) and Buffer Guidelines (Version 2.0)* • *Update to consider the changes made to the Validation and Verification Guidelines*
1	January 2019	The initial version approved by Carbon Fund Participants during a three-week non-objection period.