Forest Carbon Partnership Facility (FCPF)
Carbon Fund

ER Monitoring Report (ER-MR)

ER Program Name and Country:	Ghana Cocoa Forest REDD+ Programme (GCFRP)
Reporting Period covered in this report:	01-01-2022 to 31-12-2023
Number of FCPF ERs:	3,708,704
Quantity of ERs allocated to the Uncertainty Buffer:	581,302
Quantity of ERs to allocated to the Pooled Reversal Buffer:	213,144
Number of FCPF ERs from enhanced removals through afforestation/ reforestation	
Date of Submission:	25/11/2024
Version	3.1.1

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List of Acronyms

ACRONYM	MEANING
AD	Activity Data
AFOLU	Agriculture, Forestry and Other Land Uses
AGC	Above Ground Carbon
ASM	Artisanal Small-scale Mining
BGC	Below Ground Carbon
BUR	Biennial Update Report
CEA	Community Extension Agents
CFI	Cocoa and Forest Initiative
CIFOR	Centre for International Forestry Research
COCOBOD	Ghana Cocoa Board
CREMA	Community Resource Management Support Area
CSC	Climate Smart Cocoa
DBH	Diameter at Breast Height
DW	Dead Wood
EF	Emission Factor
EPA	Environmental Protection Agency
ER	Emission Reduction
ER-PD	Emission Reduction Program Document
ESMF	Environmental and Social Management Framework
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FC	Forestry Commission
FCPF	Forest Carbon Partnership Facility
FPP	Forest Preservation Programme
FREL	Forest Reference Emissions Level
FSD	Forest Services Division
GCFRP	Ghana Cocoa Forest REDD+ Program
GFOI	Global Forest Observation Initiative
GHG	Greenhouse gas
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HIA	Hotspot Intervention Area
HMB	HIA Management Board
ICT	Information Communication Technology
IPCC	Intergovernmental Panel on Climate Change
L	Litter
LIDAR	Light Detection and Ranging
LMB	Landscape Management Board
MC	Monte Carlo
MMR	Measuring, Monitoring and Reporting
MRV	Measurement, Reporting and Verification
MTS	Modified Taungya System
NCRC	Nature Conservation Research Centre
NDC	Nationally Determined Contributions

NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NFPDP	National Forest Plantation Development Programme
NRS	National REDD+ Secretariat
NW	NorthWest
PMU	Project Management Unit
QA/QC	Quality Assurance/Quality Control
RDA	REDD+ Dedicated Account
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus the role of conservation, sustainable management and enhancement of forest carbon stocks
RMSC	Resource Management Support Centre
RPF	Resettlement and Policy Framework
SE	South East
SESA	Strategic Environmental and Social Assessment
SLMS	Satellite and Land Monitoring System
SOC	Soil Organic Carbon
SOP	Standard Operating Procedure
tCO2-e/yr	Tons of Carbon Dioxide equivalent per year
UNDP	United Nations Development Programme
USD	United States Dollar
WD	Wildlife Division

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 the Ghana Cocoa Board (Cocobod). The FC is responsible for regulating the utilization of forest and wildlife resources, the conservation and management of those resources, and the coordination of related policies, while Cocobod's mission is to regulate the production, processing, and marketing of good quality cocoa.

The GCFRP is centered on developing a sustainable commodity supply chain that hinges upon the non-carbon benefits that will be channelled to farmers due to 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 collaborate 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.

Background

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 effectiveness conditions to the ERPAs fulfilled. Subsequently, 1.3 million USD as Upfront Advance Payment as negotiated under the ERPAs was released on September 3, 2020, to support Program implementation. The Benefit Sharing Plan, which guides the sharing of Carbon Benefits generated under the GCFRP, has been finalized and disclosed. The REDD+ Dedicated Account (RDA) has been opened to receive all the Carbon Payments. The RDA Steering Committee, which provides transparency by backstopping the disbursement of carbon payments, has been set up in line with the Benefit Sharing Plan. The RDA has been very instrumental in the disbursement of funds for the first carbon payment, they review proposals, approve authorization forms and the advice on the use of funds by beneficiaries. The GCFRP has also developed the right Safeguard architecture to tackle and report on all social and environmental safeguards issues (details in annex 1).

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 agreed to transform the Cocoa sector from a major driver of deforestation to one that enhances the protection and reforestation of the High Forest Zone and 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 engagement, and companies see GCFRP as the main program and vehicle to achieve their commitments.

Subsequently, in 2023, and in line with the Emission Reductions Payment Agreement (EPA) with the World Bank, Ghana received an amount of USD 4,862,280 (less the upfront advance) after a successful validation and verification of the 2019 Emission Reductions/Removals of 972,456 ERs. This made Ghana the second country in Africa (after Mozambique) to have received results-based payments from the FCPF. Again, after successfully validating and verifying the second monitoring report, Ghana received USD 16,895,805 after validating and verifying 3,379,161 ERs in June 2024. For the first Carbon payment (MR 2019) , Ghana has disbursed all to the various beneficiaries in line with the Benefit Sharing Plan[1] for the ER Program. Ghana has yet to disburse the MR 2020/2021 payments. Therefore, this report will cover disbursements made for the first Carbon Payments and present plans for disbursing the second carbon payment.

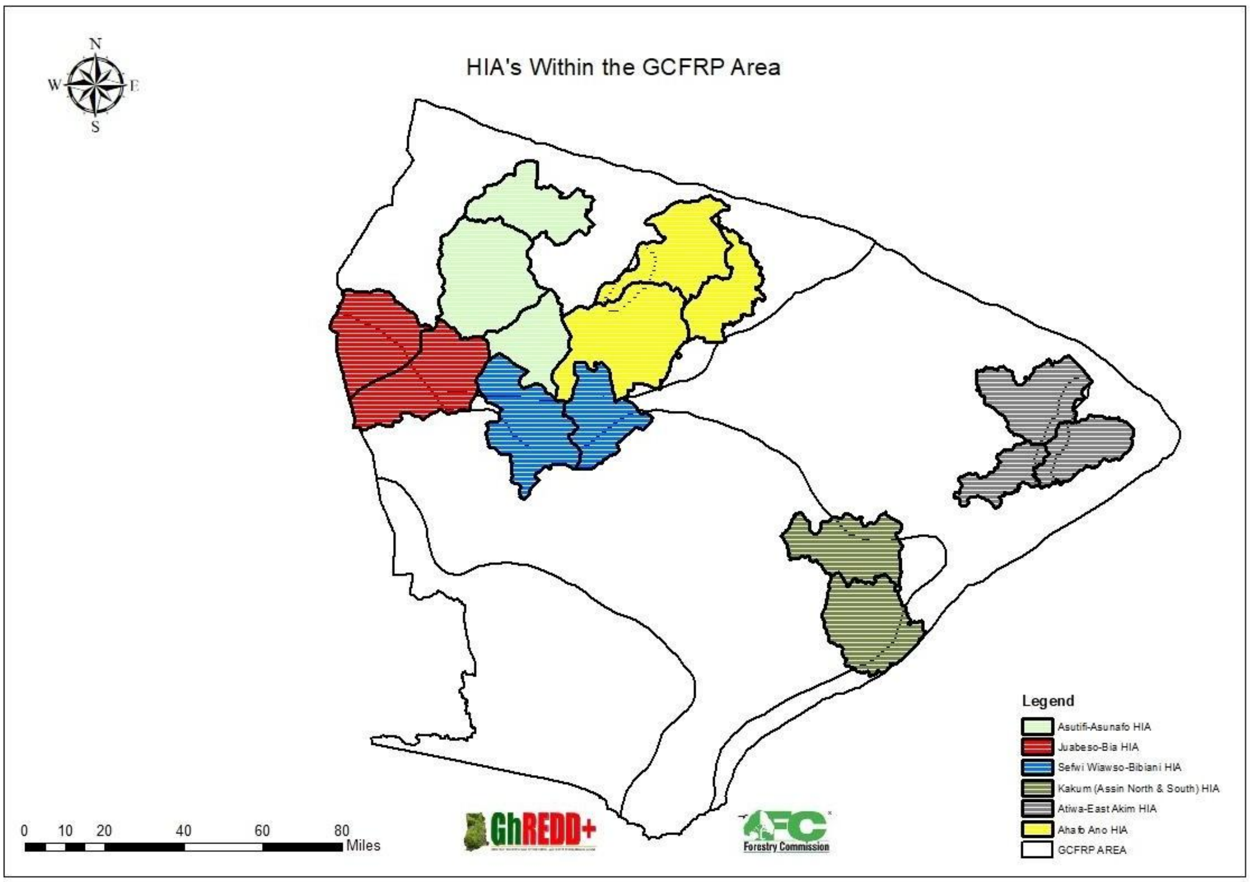

Figure 1: Map of GCFRP with target HIA

Progress and key achievements

[1] http://documents.worldbank.org/curated/en/631901587993144858/

- Established a REDD+ Dedicated Account Steering Committee with the Chair as the Ministry of Finance

- The disbursement of first Carbon Payment due the beneficiaries can be found here: https://reddsis.fcghana.org/admin/controller/publications/SHARES%20OF%20BENEFICIARIES%20FROM%20FIRST%20ER%20PAYMENTS.xlsx

- Solidaridad West Africa (with support from the WB) was engaged to train the functional units of the governance structures on the Benefit Sharing Plan so that they could better understand their roles and responsibilities.

- Bi-annual safeguards monitoring reports were undertaken in the six HIAs, and reports were submitted to the World Bank accordingly. The World Bank subsequently considered the reports satisfactorily and passed them off. The reports are published on Ghana's SIS: https://reddsis.fcghana.org/documents.php

- Following the completion of the second verification process, in April 2024, Ghana received an ER payment of $16,895,805 for the verified and transferred 3,379,161 ERs. This was after the third-party verifier SCS Global Services verified[2] the 2020/2021 Monitoring Report, who undertook a field visit from September 26-29, 2023.

- In 2022, under the advance payment, the National REDD+ Secretariat, in collaboration with selected CSOs, provided farmers with additional livelihood support. The livelihood types included beekeeping, snail farming, and vegetable farming. In all, 218 people benefited. Kindly find the details in Table 1 below

- In 2023, the Asunafo-Asutifi HIA received support under the CFI for restoration, on-farm tree planting, and strengthening of governance structures, among other things. This was made possible by the existing platform established by the GCFRP.

- The World Bank, through the AccelREDD+ Project, procured a Consultancy service to support the Forestry Commission in developing an M&E Framework and results-based monitoring system

- Development of Atewa ESMP to help monitor REDD+ safeguards

Table 1: Additional livelihood options

HIA	**Livelihood Type**	**Beneficiaries**
Sefwi Wiawso Bibiani	Bee Keeping and Snail Farming	21 (beekeeping; 14 males and 7 females) 10 (snail farming; 8 males and 2 females)
Juaboso Bia	Bee-Keeping and Snail	18 (beekeeping; 17 males and 1 female) 10 (snail farming; 4 males and 6 females)
Asunafo-Asutifi	Bee-Keeping, ginger farming and Snail	18 (beekeeping; 11 males and 7 females) 9 (snail farming; 6 males and 3 females)

[2] https://www.forestcarbonpartnership.org/sites/default/files/documents/wb_fcpf_ghana_ver2_report_v1-3_030124.pdf

		10 (Ginger; 7 males and 3 females)
Kakum	Bee-Keeping, Vegetable farming and snail farming	10 (beekeeping; 9 males and 1 female) 15 (snail farming; 10 males and 5 females) 15 (Vegetable farming; 8 males and 7 females)
Atewa	Mushroom, snail farming, bee-keeping	14 (beekeeping; 8 males and 6 females) 26 (snail farming; 11 males and 15 females) 6 (mushroom; 4 males and 2 females)
Ahafo Ano South	Aquaculture, vegetable farming, snail farming and beekeeping	3 (beekeeping; 2 males and 1 female) 11 (snail farming; 6 males and 5 females) 5 (aquaculture; 5 males) 1 (vegetable farming; 1 male)
Total		**202**

The detailed reports, which have been shared with the World Bank, can be found here https://docs.google.com/document/d/1DWgHzSGmcCup722hy1IDrBCL-ouPr80_/edit?usp=sharing&ouid=102450896921355209838&rtpof=true&sd=true

Furthermore, the link below gives further details on restoration activities by the Government of Ghana in 2022 and 2023 within the regions where the HIAs are found (ANNUAL REPORT 2022 – GHANA FOREST PLANTATION STRATEGY—Forestry Commission, ANNUAL REPORT 2023 – GHANA FOREST PLANTATION STRATEGY—Forestry Commission).

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

Cocoa Farming	
Risk of displacement	Low
Progress of the strategy in Place	First, Cocoa production in Ghana is central to the GCFRP landscape. Therefore, recalling from the ERPD (pg 161), 'agents are not migrating out of the activity area to plant cocoa in other localities due to ecological limitations of cocoa trees, which do not do well outside the programme's boundaries. The threat from a changing climate and its impacts on cocoa production outside the recommended growing areas further reduces the likelihood of displacement. In addition, given that cocoa farmers and farming communities will be directly engaged in the programme interventions and receiving associated benefits, there should be little incentive to move outside the programme'. Since cocoa farmers have been the main beneficiaries of the Carbon Payment, they have seen the ERPD benefit their livelihood (details of beneficiaries in annex II). Again, with the development of the governance structures and the signing of the Framework Agreement, farmers have identified their roles and responsibilities to the ERPD, which include the adoption of climate-smart cocoa practices. Again, cocoa production is limited or nonexistent outside the ERPD landscape, with some minimal production within the transition zone. That notwithstanding, capacity building, training, and extension services by both FC and COCOBOD have extend to the Transition areas to ensure that farmers implement CSC practices. For instance, FC, through the NRS is implementing a project in collaboration with FAO dubbed 'Forest and Farm Facility Phase II' within the Forest, Transition and Savannah Zones, which aims to help forest farm producer organizations become stronger, amplify their potential and connect with each other whilst helping to promote sustainable development through management of farmland and forests that produce food, livelihoods, medicine. In 2022, training workshops on Climate Change Mitigation and Adaptation and Access to Finance were organized for 46 farmers in the transition zone. Additionally, the government of Ghana has signed an Emission Reductions Payment Agreement with Tullow Oil Plc regarding developing a carbon offset project in the Transition zone. This has led to the implementation of REDD+ actions in the transition zone, further reducing the risk of displacement Generally, the strategy 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 farms 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 of decreases cocoa yield. As at 2020, 4199 hectares had been rehabilitated. In addition to this, other 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, including Touton, SNV Netherlands, NCRC, Forestry Commission (FC), and Ghana Cocoa Board (COCOBOD), has signed an addendum to the Juaboso Bia Framework Agreement. The project has established landscape governance and forest protection mechanisms and enhanced Cocoa productivity at the farm level while also providing farmers incentives and income diversification options as conditions for forest protection and sustainable land management. In the Asutifi/Asunafo HIA, the Environmental Sustainability project (Public and Private Partnership; Mondelez, United Nations Development Program (UNDP), FC, COCOBOD) 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, Mondelez has reforested a total area of 167.5 ha using the Modified Taungya System approach. The first of its kind by any Chocolate Brand in Ghana. COCOBOD continues to train farmers on the Climate Smart Cocoa (CSC) Standard, which administers on-farm best practices to Cocoa Farmers. For instance, under the Carbon Payment received by Cocobod from the first Carbon Payment, 650 cocoa farmers, comprising 426 males and 224 females, have been trained on CSC.
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 subsistence agricultural fields adjacent to their cocoa trees and 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. These incentives include the provision of additional livelihood for the farmers, using the MTS approach to reforest degraded forest reserves, where farmers have access to additional lands to cultivate their food crops, provision of free extension services for cocoa farmers, the supply of tree seedlings for planting on farm, provision of farm inputs and farm services as well as protective clothing etc. Farmers are now less likely to engage in clearing forested environments as specific mechanisms are established to identify and sanction those engaging in clearing activities. In 2023, 3,509 ha of forest was reforested through MTS. In addition to the above, community governance structures have been developed for the six HIAs. The Framework Agreements, which indicate the roles and responsibilities of farmers have also been signed with the HIA Management Boards (HMBs). The roles of farmers/communities include the protection of the forests and undertaking sustainable agriculture practices. Through series of engagements and

	capacity building programs, and the announcement of the receipt of the first ER payment by Ghana, farmers are more encouraged to undertake their roles in the Framework Agreements. The Ghana Cocoa Board has established the Cocoa Management System in anticipation of implementing several new, farmer-focused initiatives, including pension schemes; this system would help provide tailor-made extension services to farmers. Progress of CMS so far The first phase, which involves mapping farms, enumerating farmers, and linking the farm's geospatial data to the farmer, has been completed in all the cocoa-growing regions, which comprise seventy (70) districts. This involved mapping 1,239,169 farms covering 1,373,756 hectares of farmland belonging to 792,954 farmers. Mop-up and validation are currently ongoing and expected to be completed by the end of January 2025.
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 described below: Improved landscape governance and planning (HIA governance structures development) along with enhanced skills mainly through sensitization on monitoring allow both communities and government entities to collaboratively respond to identified acts of illegal logging. 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 ERPD) 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 the Ghana Wood Tracking System systems to control, verify and license legal timber. In line with this, a new legislative Instrument (LI 2254) has been developed to guide the value chain of timber from the forest gate to processing. All Timber Permits need to be ratified by Parliament. So far, the first batch of 19 have been laid before Parliament for ratification. The Forestry Commission has been undertaking forest protection, including forest reserve patrol, to detect and apprehend illegal offences, including illegal logging, farming, mining sand/gravel mining, charcoal production, hunting, cattle grazing, carving of canoes, setting of forest fires and infrastructure development. This exercise is undertaken by staff of FC at National, Regional and District levels with the support of the Rapid Response Unit. Ghana has consistently strived to enhance forest protection and sustainability. Since signing unto the Voluntary Partnership Agreement in 2009, the country has put in place robust structures that will curb illegal logging and is set to deliver its first consignment of FLEGT licensed timber to the European Union(https://fcghana.org/ghana-set-to-deliver-flegt-licensed-timber-to-the-eu/). This was announced during the 12th session of the Ghana-EU Joint Monitoring and

	Review Mechanism (JMRM) of the Voluntary Partnership Agreement in November 2024. Consequently, the JMRM concluded with the signing of an Aid Memoire, a working document between Ghana and the EU that captures major action points for the technical interaction. The Aid Memoire encapsulates the key outcomes of the discussions and serves as a roadmap for future actions, underscoring both parties' commitment to enhancing transparency, accountability, and sustainable forest resource management in Ghana. The Minister for Lands and Natural Resources signed on behalf of the Republic of Ghana, while the EU Ambassador signed on behalf of the EU. From the agreement's inception, Ghana received grant funding to develop the Ghana Wood Tracking System (GWTS), engage stakeholders and train forest auditors. This has not only enhanced the country's alignment with the international agreement but is also addressing the trade of illegal timber in the domestic market. This system will track timber trade that involves both supplier and traders, such that a proof of legality will be strictly adhered to in the chain of custody. Furthermore, the "black market" for illegal timber will collapse thus encouraging only legally sourced timber which is sustainable. Arrested culprits are arraigned before court of Law and punitive measures are meted against them to serve as deterrent for others. The table below provides details of forest related number of prosecutions for 2022 and 2023. Year Prosecutions 2022 28 2023 17 Total 45
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 regarding mitigating this risk. In 2017, the government launched a new program (artisanal mining) to enforce the law by putting up measures to stop the menace. This helped to reduce the menace. Some reports do indicate that the practice has returned, however, in the project landscape. In response, Government has introduced some policies to help mitigate illegal mining. These include the following: • All eighty-three (83) Small Scale Mining Committees in the various mining districts, in accordance with section 92 of the Minerals and Mining Act, 2006 (Act 703), to assist the District Offices of the Minerals Commission to effectively monitor, promote and develop mining operations in their jurisdictions. This is the first time, since the passage of Act 703, that Small Scale Mining Committees have been established in all mining districts in the country. Under the Ghana Landscape Restoration and Small-Scale Mining

	Project, members of these Committees to build their capacity efficiently perform their functions. • Establish community mining schemes, which allow mining to be undertaken in a sustainable manner. • Implement the National Alternative Livelihood Program (NALEP) to fulfil its mandate. Launched on 25 October 2021, this program aims to create jobs as an alternative to illegal mining. Since its launch, the program has engaged about 80,000 youth in re-afforestation activities in five endemic illegal mining communities. Also, in partnership with AngloGold, NALEP has trained 115 youth in Obuasi as part of its 10-year livelihood enhancement program. This initiative fosters long-term solutions to unemployment, marking a critical step toward sustainable economic development in Obuasi. In addition to the above, additional livelihood schemes are provided for farmers through the Forest Investment Programme and GCFRP to increase their income levels. Again, the logic of intensifying good farm practices and other climate-smart interventions is to help increase cocoa yields. This motivates farmers not to give up their cocoa farms to illegal mining. Notwithstanding the above, illegal mining activities have escalated since the previous monitoring period. In response, the Forestry Commission has enhanced its protective role in the forest reserves by training additional Rapid Response Personnel. Furthermore, to boost mobility and ensure a swift response to reports of illegal mining activities, the Forestry Commission has utilised its share of the second carbon payments to purchase 17 pick-ups and distribute them across the forest districts within the Programme area. The FC would continue to work with key institutions such as the Minerals Commission to reverse this trend. In the light of this, we have maintained the 'medium' risk categorization for 'illegal mining'.

1.1.1 Effectiveness of the organizational arrangements and involvement of partner agencies

The successful implementation of the ER Program is dependent on effective organizational arrangements, especially at the Programs Management Unit (PMU). In Ghana, for instance, many institutions are involved in the implementation process. Therefore, key stakeholder engagements were undertaken in 2022 and 2023. The key milestones achieved are:

- Continued working of the RDA Steering Committee to ensure the transparency of the disbursement of Carbon Payment
- Orientation for the RDA Steering Committee to ensure their understanding of the process
- Disbursement of Carbon Payments to beneficiaries in 5 HIAs
- Receipt of second carbon payment after successful verification by SCS Global Services
- The development of the Atewa HIA Governance structures to ensure that the beneficiaries receive the benefits due them
- Training of the functional units of the HIA governance arrangements to ensure the comprehensive understanding and implementation of the Program activities

- Recruitment of a Benefit Sharing Officer at the NRS to coordinate the disbursement of the Carbon funds
- Successful World Bank Missions during the 2022/2023 monitoring years
- Successful submission of bi-annual safeguards reports

1.1.2 Updates on the assumptions in the financial plan and any changes in circumstances that positively or negatively affect the financial plan and the implementation of the ER Program.

On page 85 of the ERPD submitted to the Carbon Fund, Ghana indicated that the program's funding will come from REDD+ Funding (Carbon Payments), the Private Sector, Grants, and the Government. This assumption has not changed over the Monitoring period. This is evident from the program's ability to report Emission reductions for three successive monitoring Periods, which are even more than the target in the ERPA with the World Bank.

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

Deforestation and forest degradation drivers 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.

During the monitoring period of 2022 and 2023, land use disturbances and land use changes replacing forests were recorded, providing insights into the drivers of deforestation and degradation. The primary deforestation driver was mining, accounting for 70% of the deforested area, followed by 20% converted to grassland and 10% to cropland. Degradation, on the other hand, was entirely due to human impacts, such as logging.

It is noteworthy that Ghana identified mining as a driver of deforestation during the 2020/2021 monitoring period, and this has increased in the current period, largely due to widespread illegal mining activities. The Forestry Commission's commitment to reversing this trend has been unwavering. The Commission has allocated funds from its share of the second payment to purchase vehicles and motorbikes to enhance forest protection and minimize illegal mining activities. In line with the Emission Reductions Program Document (ERPD), the Forestry Commission has also deployed the Rapid Response team to areas with high levels of illegal logging to support efforts against illegal loggers.

1.3 Methodological Deviation

Ghana is not proposing a methodological deviation in this Monitoring Report.

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

2.1 Forest Monitoring System

Ghana's Forestry Commission manages GHG-related data and information, with data collected through the National Forest Monitoring System (NFMS). The data necessary to estimate emissions and removals from enhancements, deforestation, and degradation are collected at the national level and continuously improved stepwise. 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.

In line with the NFMS, and specifically, for Ghana's Measuring, Monitoring and Reporting (MMR) system, the following institutions are 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 structure
- Academia

Many of these institutions have clear mandates that effectively allow them to undertake their specified roles during MMR of programme performance. For instance, RMSC, FSD, ICT and the NRS play significant roles in data collection, analysis, and storage during the MMR phase. The institutions' detailed roles are described in Ghana's first monitoring report. To ensure proper coordination of the institutional activities, the MRV sub-working group has been formed, to include the institutions listed above. The MRV sub-working group primarily undertake assessment of outputs received from the various institutions whilst supporting efforts towards information sharing with relevant agencies.

Ghana produced Standard Operating Procedures (SOPs) in 2014 to guide the production of Emission Factors, Activity Data, Quality Control and Quality Assurance. However, to reflect the amendment in the Reference Level as proposed, updated SOPs were also developed, (details of the first and updated SOPs are found here.

The SOPs covered the following areas

NO	NAME
1	Sampling Design
2	Response Design
3	Data Collection
4	Training
5	Data Analysis

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)

The responsibility of reporting the GHG data and information are divided between Forestry Commission Environmental Protection Agency (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

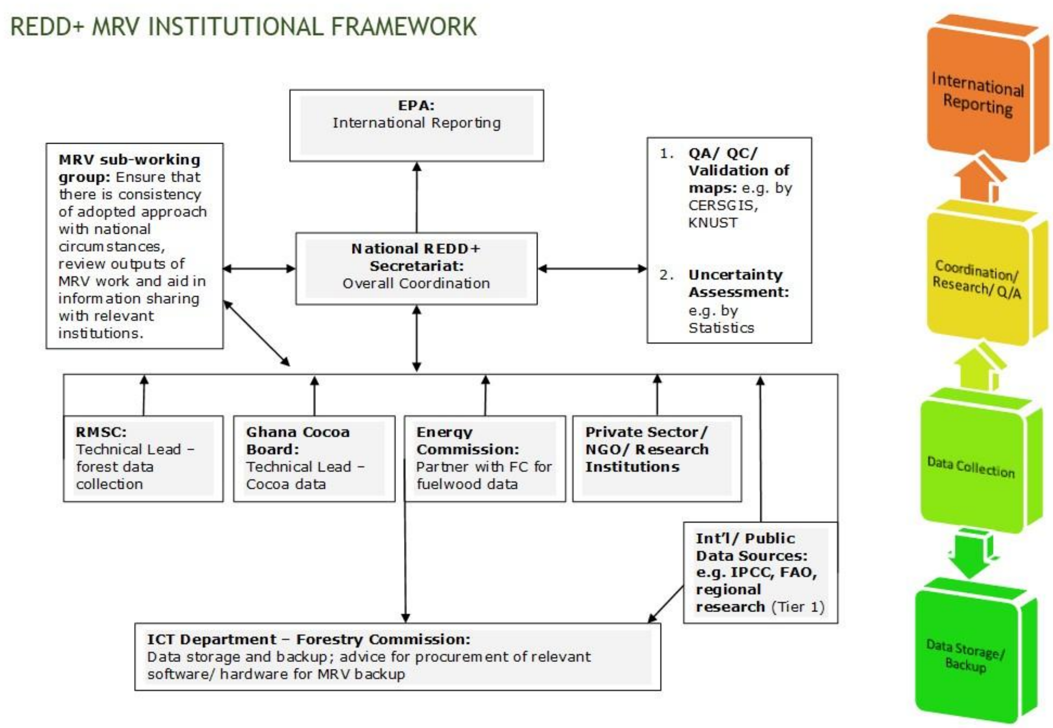

Figure 2 Overall Institutional Framework for FMS

Table 3: Institutions involved in Ghana's Forest Monitoring System

MMR Institutions	Main Roles and Responsibilities
Ministry of Lands and Natural Resources (MLNR)	The sector ministry to which the Forestry Commission reports. Responsible for Ghana's Forest Investment Programme(FIP) and will serve as the programme's Coordination and Management Committee to ensure integration with FIP projects and related activities. The MLNR will also provide financial support for operationalizing the MRV
Forestry Commission (FC)	Allocate funding to support monitoring activities
Districts and Regions of the Forest Services Division FSD, of the FC)	Provide data on on-reserve CSE activities and legal timber harvest to RMSC. Support RMSC to collect field data for classification and accuracy assessment.
National REDD+ Secretariat	Overall coordination of the MMR processes - Reports to the Carbon Fund - Reports to the EPA
Resource Management Support Centre (RMSC, ofthe FC)	Technical lead for collection of field data and analysis of spatial data to generate emissions estimates
Forestry Research Institute of Ghana (FORIG)	Support with collection of data on illegally harvested timber. Develop/ refine allometric equations for carbon stocks estimation in various strata/ forest types
Soil Research Institute (SRI)	Estimation of forest carbon
Center for Remote Sensing & Geographic Information Services (CERSGIS), University of Ghana	QA/ QC of maps
Environmental Protection Agency (EPA, underMESTI)	The National Focal Point for Climate Change and is responsible for the National Communications to the UNFCCC
Ghana Energy Commission (under MOE)	Collection of woodfuel data
Ghana Cocoa Board (COCOBOD)	Provide relevant data on CSC activities being undertaken in cocoa farms
HIA Consortium/ Governance structure	The HIA Consortium/ Governance structures support data collection.

Table 4 The following GHG related data and information is selected

GHG flux	Gases included	Parameter	Elements included	Source	Responsible Institutions

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	NRS,FSD, RMSC, National REDD+ Working Group, FAO
			Post-deforestation carbon (measurements at plot level)	NFMS: FPP	RMSC, NRS, FAO
		Activity data deforestation	Deforestation assessments at plot level	NFMS: SLMS	FSD, RMSC, NRS, CERSGIS, MRV Sub Working Group
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	NRS, FAO, RMSC, MRV Sub Working Group
		Activity data degradation	Canopy cover reduction assessments at plot level	NFMS: SLMS	NRS, FAO, RMSC, MRV Sub Working Group
	CO_2	AD enhancement	Planted area assessment	NFMS: NFPDP	NRS, FSD

Net removals from enhancement (afforestation/reforestation)			Survival rate assessment		FSD
		Removal factor enhancement	Teak	Adu-Bredu et al. (2008)	Publication
			Other broadleaf species	IPCC 2006 (Vol 4, Chapter 4, Table 4.8)	

Forest Monitoring for the ER Program

The above institutional arrangement is adapted concerning 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, which houses the Program Management Unit (PMU) with technical support led by RMSC. The PMU is responsible for the activities at both national and programme(s) levels. 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 maintaining 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 PMU, with support from the WB, has developed and operationalized an M&E framework. The NRS submits reports during World Bank Missions based on the M&E Framework.

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. In the development of this report, however, Food and Agriculture Organisation (FAO), provided quality assurance for all the data collected, and the corresponding analysis of data.

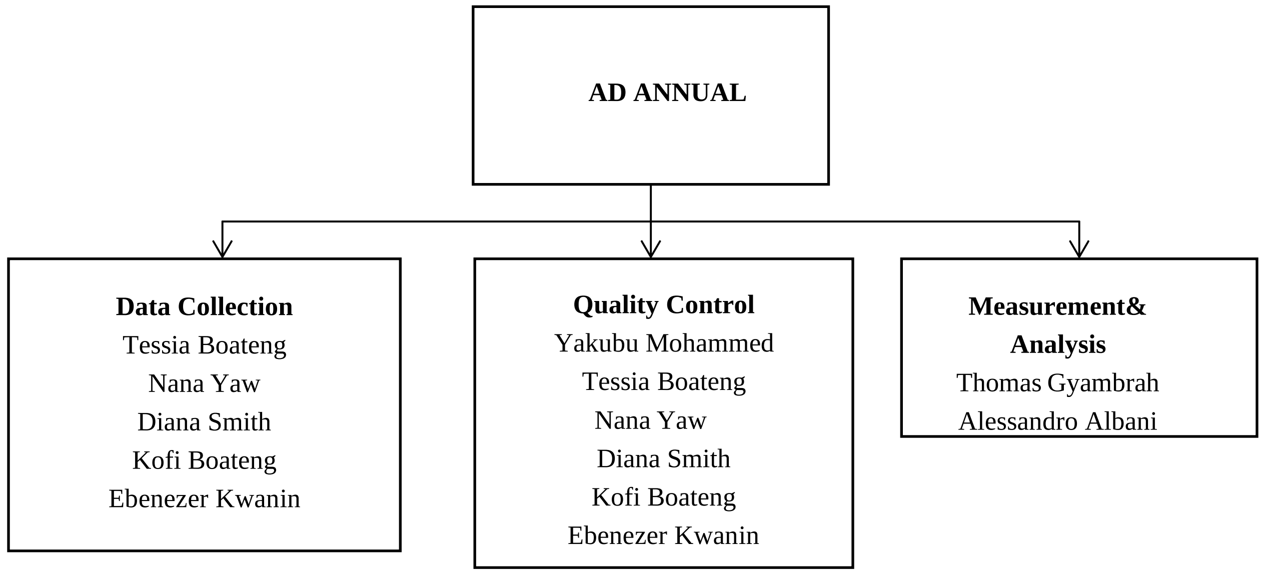

Figure 3 Organizational structure for Activity Data for monitoring period (2022/2023)

In 2012/3, Ghana implemented the Forest Preservation Programme (FPP). The objective of this programme was to map forest cover and estimate carbon stocks for all the ecological zones in the country. The emission factors developed for deforestation analyses under the FPP incorporated all the carbon pools including those that were identified as significant based on the IPCC recommended thresholds (i.e. the aboveground, belowground and soil carbon) and the other pools (litter, deadwood and herbaceous). The emission factors for deforestation analyses under the ER programme were sourced from the FPP and consequently included all the carbon pools.

In summary, for the estimation of emission factors, as described in the first monitoring report, 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 regularly is extremely costly.

For the estimation of activity data, 7692[3] spatial plots have been assessed in 2024 by a team of remote sensing experts. The spatial design used was based on several quality assessment exercises. The first monitoring report describes the spatial design, response design, and quality management aspects. 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.

Ghana changed its sample plot size from 0.5ha used in calculating the reference level and the first monitoring period to 1ha in order to align with in country definition of forest (minimum area of 1ha, minimum crown cover of 15% and a minimum height of 5m)

Therefore, to assess the impact of the plot size change, the forest land use change samples from the reference level assessment were assessed for any changes between a plot size of 0.5 ha and 1 ha. A total of 257 sample were assessed, 255 out of 257 or 99.2% of the samples were assessed to have the same classification for the 0.5 plot size and 1 ha plot size. Which leads us to the conclusion that changing the plot size from 0.5 ha to 1 ha does not have a significant impact on the sample interpretation.

[3] The number of samples are different from the previous monitoring reports because, the experts did not have satellite images for some of the plots and hence did not interpret.

This screen shot shows an example of the 0.5 ha plot area outlined in red and the 1 ha plot area outlined in yellow. Effectively the difference between the 0.5 ha plot and the 1 ha plot is a 15meter buffer around the original plot.

Figure 4 Plot showing a 0.5ha (red shaped) and 1ha(yellow shaped) on Google Earth

Systems and processes that ensure the accuracy of the data and information are described in detail in Annex 4 of the Emission Reductions-Monitoring Report of first reporting period. 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. A random selection of plots was re-assessed.

Systems and processes that supports the Forest Monitoring System, including Standard Operating Procedures and QA/QC procedures

The developed SOPs are:

- Sample Design – SOP 1
- Response Design – SOP 2
- Data Collection/QA/QC – SOP 3
- Data Analysis – SOP 4

2.2 Updates to the monitoring approach

To address conditions the Carbon Fund participants raised in 2017, Ghana applied technical corrections to the reference level (see Annex 4 of the first monitoring report). Ghana's measurement, monitoring, and reporting approach to developing the corrected reference level is the same approach used for quantifying the emissions reductions reported. There have been no further changes to the monitoring approach.

2.3 Measurement, monitoring and reporting approach

2.3.1 *Line Diagram*

This section visualises the overview of the different steps that lead up to the Emission Reductions

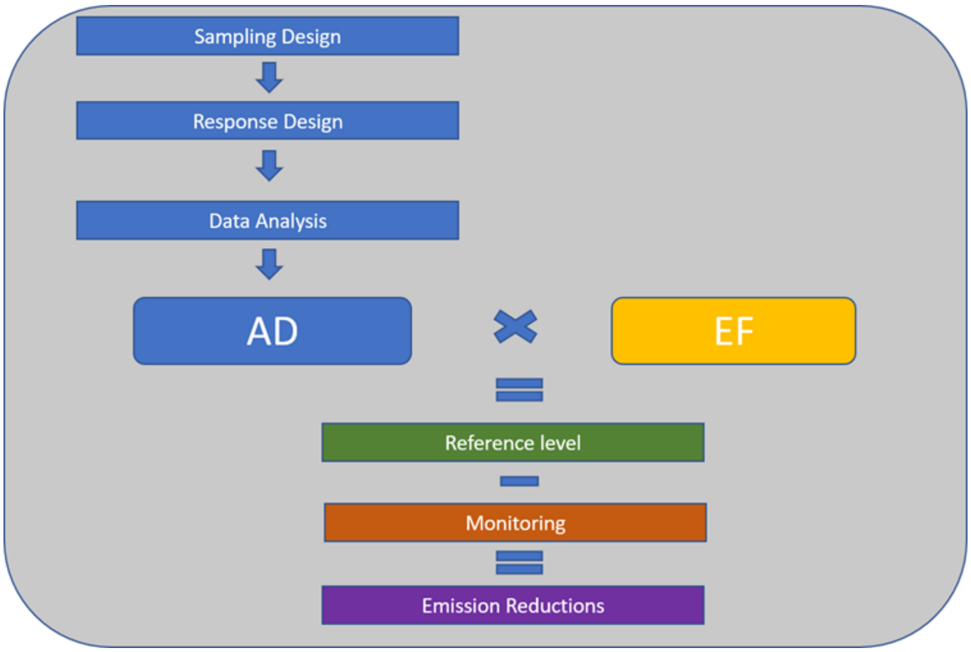

Figure 5 Overview of different steps

Activity Data

The SLMS is a sub-system of the National Forest Monitoring system and is used to produce activity data (Figures 6) 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 the Forestry Commission of Ghana.

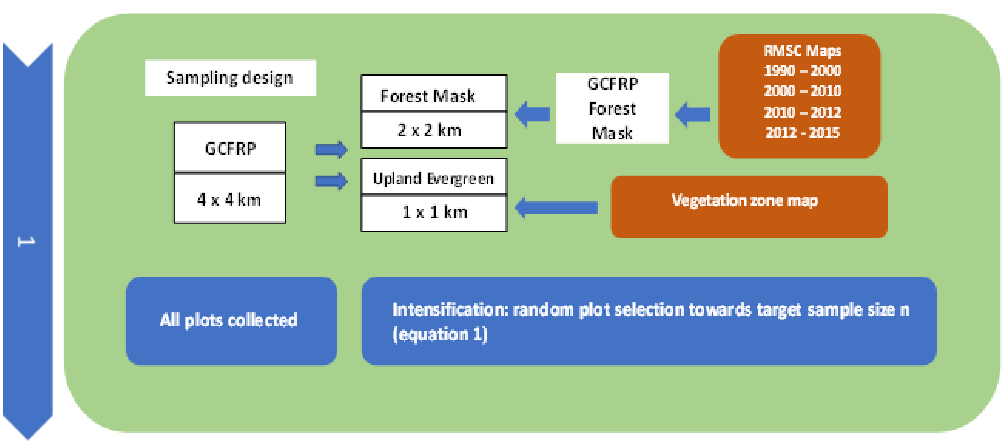

Figure 6 Sampling design

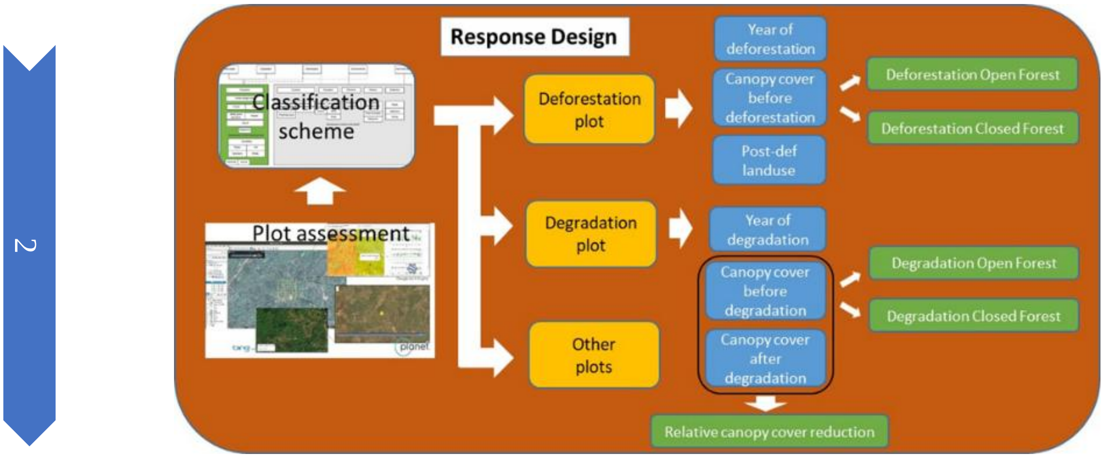

Figure 7 Response Design

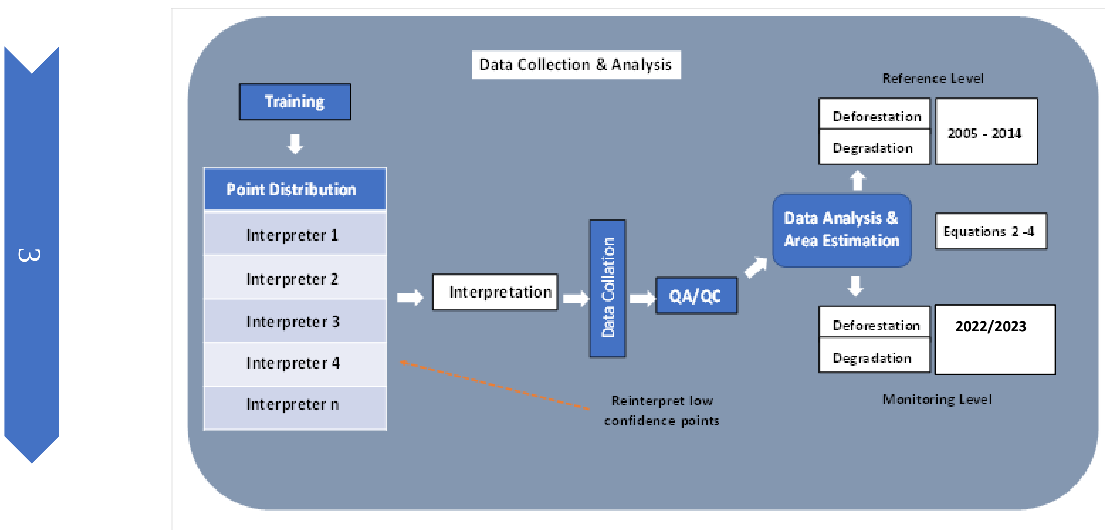

Figure 8 Data Collection & Analysis

Emission factors

The Forestry Inventory has not been revised from the first monitoring report.

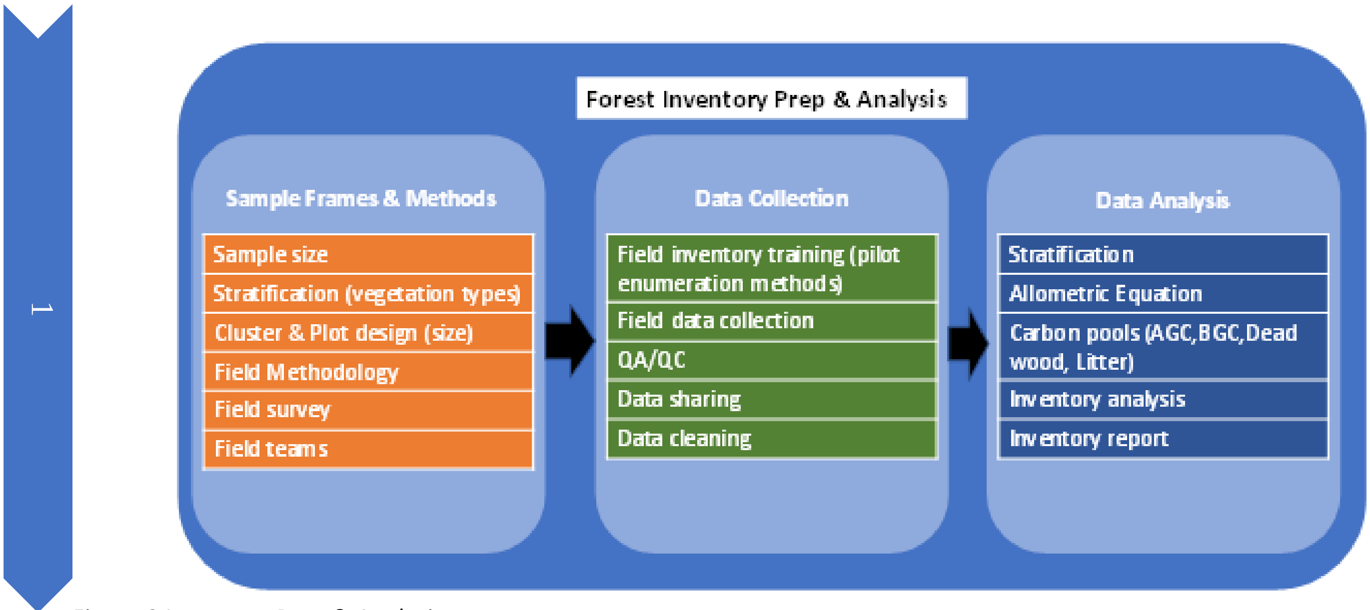

Figure 9 Inventory Prep & Analysis

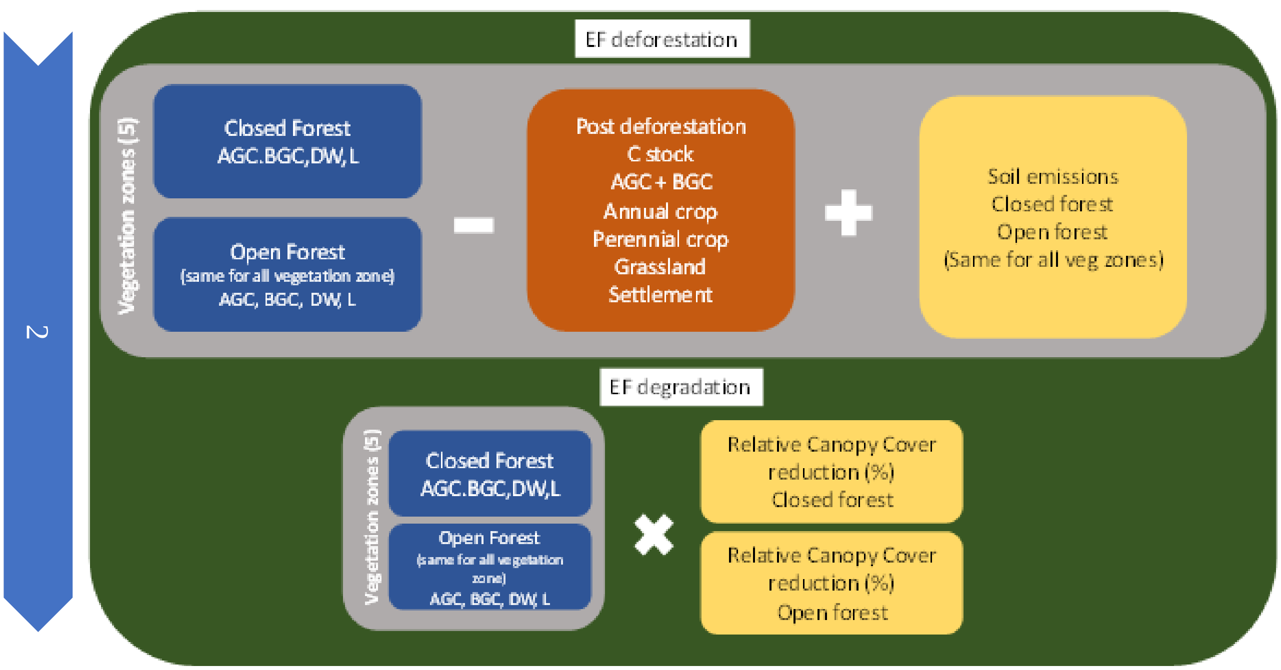

Figure 10 EF Deforestation

The following line diagrams (Figures below) provide a systematic representation of the different steps in the analysis after the AD and EFs were derived.

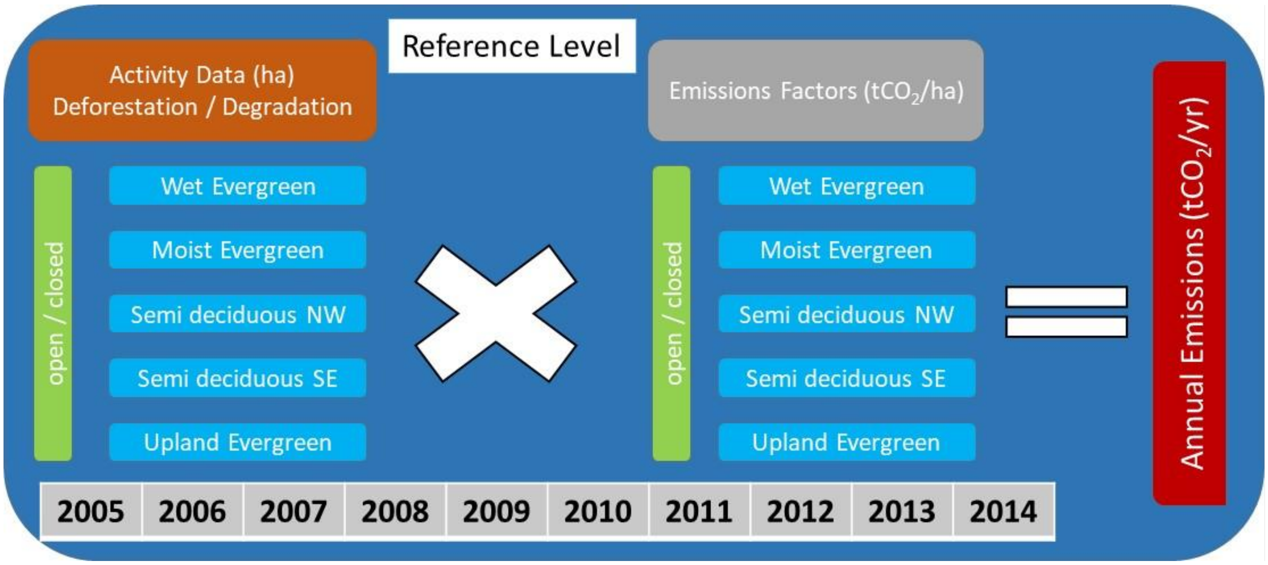

Figure 11 Reference level

2.3.2 Calculation

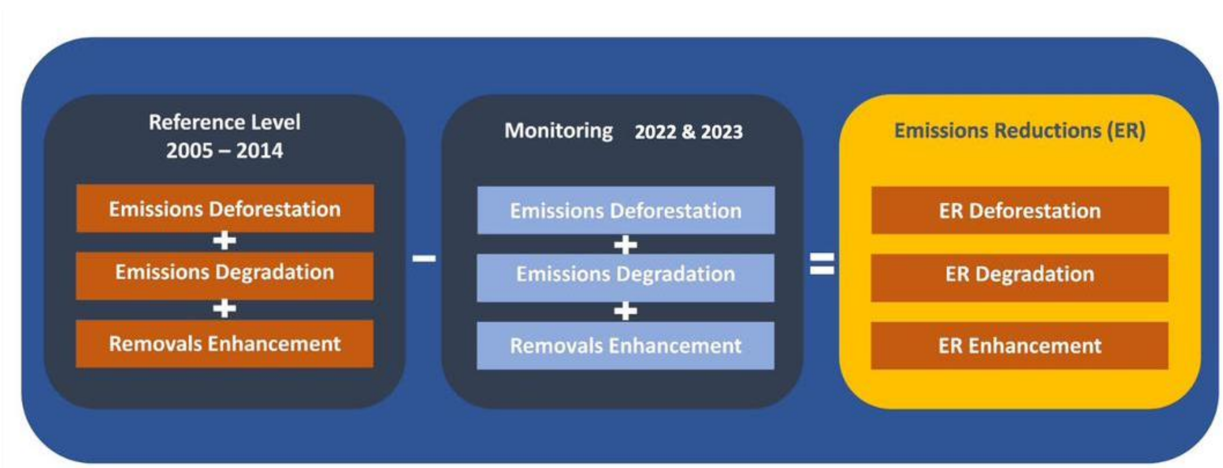

Figure 12 Calculation of ERs

GCFRP emission reductions
Figure 12 presents the final line diagram describing the methods used for calculating the final emissions reduction for the monitoring period. Both the Reference Level and the Monitoring period use 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 1 below. The equation calculates emission reductions by deducting

monitored emissions from historical average emissions over the reference period. Emissions reductions are calculated for the GCFRP landscape only.

Equation 1 Equation for emission reductions in years 2022 and 2023

$$ER_{GCFRP,t} = RL_{GCFRP} - GHG_{GCFRP,t} \quad (1)$$

where:

$ER_{GCFRP,\,t}$	=	Emissions Reductions under the ER program in year t ; $tCO_2e*year^{-1}$
RL_{GCFRP}	=	Annual reference level emissions for the Ghana Cocoa Forest REDD+ Program area; $tCO_2e*year^{-1}$
$GHG_{GCFRP,\,t}$		GHG emissions over monitoring period for the Ghana Cocoa Forest REDD+ Program area ; $tCO_2e*year^{-1}$
t	=	Number of years in the monitoring period

Equation 2 Annual Reference level emissions for the GCFRP landscape (tCO_2/year)

$$RL_{GCFRP} = \sum_{e=1,5} \frac{(A_{def,e,s}(rp) \times EF_{def,e,s} + A_{degr,e,s(rp)} \times EF_{degr,e,s})}{t} + removals_{RL} \quad (2)$$

where

$A_{def,e,s}$	=	Area of deforestation, in vegetation zone *e*, in forest structure *s during the reference period*
$EF_{def,e,s}$	=	Emissions factor for deforestation for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
$A_{degr,e,s}$	=	Area of degradation, in vegetation zone *e*, in forest structure *s during the reference epriod*
$EF_{degr,e,s}$	=	Emissions factor for degradation for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
t	=	Reference period, year 2005-2014
$removals_{RL}$	=	This is the reference level value for removals calculated as the projected annual removals during the monitoring period from the average planted area over the period 2005-2014 (Annex 4 First Monitoring report)

Equation 3 Monitored GHG emissions for the GCFRP landscape (tCO_2/year)

$$GHG_{GCFRP} = \sum_{e=1,5} \sum_{s=1,2} \frac{(A_{def,e,s(mp)} \times EF_{def,e,s} + A_{degr,e,s(mp)} \times EF_{degr,e,s})}{t} + removals_{MP} \quad (3)$$

where

$A_{def,e,s}$	=	Area of deforestation, in vegetation zone *e*, in forest structure *s during monitoring period*
$EF_{def,e,s}$	=	Emissions factor for deforestation for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
$A_{degr,e,s}$	=	Area of degradation, in vegetation zone *e*, in forest structure *s during monitoring period*
$EF_{degr,e,s}$	=	Emissions factor for degradation for vegetation zone *e* for forest structure *s* during both the reference and monitoring period
t	=	Years in the monitoring period, 2022, 2023
$Removals_{MP}$	=	This is the monitored value for removals calculated as the actual removals from the crediting period occurring during the monitoring period 2022-2023 (Annex 4 First Monitoring report)

<u>Area of Deforestation and degradation</u>

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 equations 4 and 5.

The area of deforestation, in vegetation zone *e*, in forest structure *s* is calculated as follows:

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

where

$P_{def,e,s,i}$	=	the estimated probability of deforestation in vegetation zone *e* , forest structure s, falling in stratum *i,* calculated as $n_{v,e,s,i}/n_{e,s,i}$ where $n_{v,e,s,i}$ is the number of sample plots of deforestation in vegetation zone *e,* forest structure *s*, falling in stratum *i* and $n_{e,s,i}$ is the number of sample plots in vegetation zone *e*, forest structure *s*, falling in stratum *i*
$A_{e,s,i}$	=	the area of stratum *i* in vegetation zone *e* and forest structure *s*

The area of degradation, in vegetation zone *e*, in forest structure *s* is calculated as follows:

$$A_{degr,e,s} = \sum_{i=1,2} p_{degr,e,s,i} \times A_{e,s,i} \tag{5}$$

where

$P_{def,e,s,i}$	=	the estimated probability of degradation in vegetation zone *e* forest structure *s* falling in stratum *i,* calculated as $n_{v,e,s,i}/n_{e,s,i}$ where $n_{v,e,s,i}$ is the number of sample plots of degradation in vegetation zone *e* forest structure *s* falling in stratum *i* and $n_{e,s,i}$ is the number of sample plots in vegetation zone *e* forest structure *s* falling in stratum *i*

$A_{e,s,i}$ = the area of stratum *i* in vegetation zone *e* and forest structure *s*

Equations 4 and 5 perform area-based weighting. This means that each plot receives the same weight for the stratum where it belongs, and the weight is calculated by dividing the area per stratum by the total number of plots in the stratum. This is the equivalent of equation 8 in Olofsson et al (2014)[4]. Equations 4 and 5 are applied for the forest types 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.

For deforestation (Equation 4) the following conversions are possible:

- *Wet Evergreen closed forest to Non Forest type;*
- *Moist Evergreen closed forest to Non forest type;*
- *Moist Semi Deciduous North East closed forest to Non Forest type;*
- *Moist Semi Deciduous South West closed forest to non forest type ;*
- *Upland Evergreen closed forest to Non-forest type; and*
- *Open forest to Non-forest type*

For degradation (Equation 5) the following subpopulations are possible:

- *Degradation in Wet Evergreen closed forest;*
- *Degradation in Moist Evergreen closed forest;*
- *Degradation in Moist Semi Deciduous North East closed forest;*
- *Degradation in Moist Semi Deciduous South West closed forest;*
- *Degradation in Upland Evergreen closed forest; and*
- *Degradation in Open forest*

<u>Emission factors for deforestation and forest degradation</u>

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[5] where post deforestation biomass (tC/ha) is subtracted from pre deforestation biomass estimates. This step is outlined in equation 7 below. This equation approximates emissions per hectare deforestation as the difference between the carbon (AGC, BGC, DW, L) in the forest before the deforestation event and the average carbon (AGB, BGB) in the land use following deforestation, plus the change in the soil carbon pool (where the change in soil carbon is calculated with equation 2.25 in IPCC, 2019).

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[4] 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.
[5] Intergovernmental Panel on Climate Change (IPCC) (2006).IPCC Guidelines for National Greenhouse Gas Inventories. Volume 1: General Guidance and Reporting. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Hayama, Japan

Equation 6 Emissions factor for deforestation for vegetation zone e and forest structure s during both the reference and monitoring period:

$$EF\ deforestation_{e,s} = (Bbefore_{e,s} - Bafter_e + \delta S_e/20) \times \frac{44}{12} \quad (6)$$

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 7, total weighted carbon biomass (AGC + BGC) in land uses after conversion (deforestation) per vegetation zone *e*.
$\delta S_e/20$	=	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). Accordingly, the emissions are projected over 20 years following the FCPF Guidance Note on accounting of legacy emissions/removals, v1 (2021).
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

Equation 7 Equation used for the weighted post-deforestation carbon contents ($Bafter_e$)

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

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)

<u>Calculation EF forest degradation</u>

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 Figure 7 in section 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 of canopy cover 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. Reduction in canopy cover can be taken as a proxy for degradation according to FAO (2000)[6].

Equation 8 Emissions factor for forest degradation for vegetation zone e during both the reference and monitoring period

$$EF\ degradation_{e,s} = \ Cbefore_{e,s} \times \ \ reduction\ rate_{s} \times \frac{44}{12} \qquad (8)$$

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 B before 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

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 8 shows how the weighted post-deforestation carbon contents is calculated: Post-deforestation biomass is estimated from weighted post-deforestation land use per vegetation class, where the biomass in the post-deforestation land use is assessed through field measurements from the FPP. The principle of estimating emissions from each land use change stratum as the difference between the forest carbon stocks per unit area before conversion and the forest carbon stocks per unit area for the new land use after conversion is in line with GFOI (2016, page 59)[7] and IPCC (2003)[8]. The same weighted post-deforestation carbon content is applied to deforestation in open and closed forest.

Equation 9. Removals associated with average net area planted over the reference period projected over the crediting period

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[6] FAO (2000). FRA 2000 – On definitions of forest and forest cover change. FRA programme, Working paper 33, Rome, Italy.
[7] GFOI (2016) Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative, Edition 2.0, Food and Agriculture Organization, Rome.
[8] Intergovernmental Panel on Climate Change (IPCC) (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., and Wagner F (Eds). IPCC/IGES, Hayama, Japan.

$$Removals_{RL} = \left(A_{RL,teak,on/off} \times RF_{teak} + A_{RL,nteak,on/off} \times RF_{nteak}\right) \times t_1 + \left(A_{RL,teak,on/off} \times RF_{teak} + A_{RL,nteak,on/off} \times RF_{nteak}\right) \times (t_1 + t_2) + \left(A_{RL,teak,on/off} \times RF_{teak} + A_{RL,nteak,on/off} \times RF_{nteak}\right) \times (t_1 + t_2 + \cdots)$$

Where:

$A_{RL,teak,on/off}$	=	*Average net annual area teak planted (ha/year) on- and off-reserve during the reference period, where net means the area has been discounted with the assessed survival rate*
RF_{teak}	=	*Removal factor teak, mean annual increment of teak plantations (tCO2/ha/year)*
$A_{RL,teak,on/of}$	=	*Average net annual area non-teak planted (ha/year) on- and off-reserve during the reference period, where net means the area has been discounted with the assessed survival rate*
RF_{nteak}	=	*Removal factor non teak, mean annual increment of non-teak plantations (tCO2/ha/year)*
t_1, t_2, …	=	*Year 1 of the crediting period, year 2 of the crediting period, etc.*

Equation 10. Removals associated with average net area planted over the reference period projected over the crediting period

$$Removals_{MP} = \left(A_{t1,teak,on/off} \times RF_{teak} + A_{t1,nteak,on/off} \times RF_{nteak}\right) + \left[\left(A_{t1,teak,on/off} \times RF_{teak} + A_{t1,nteak,on/off} \times RF_{nteak}\right) + \left(A_{t2,teak,on/off} \times RF_{teak} + A_{t2,nteak,on/off} \times RF_{nteak}\right)\right] + \cdots$$

Where:

$A_{t1,teak,on/off}$	=	*Net annual area teak planted (ha/year) on- and off-reserve during year 1 of the crediting period, where net means the area has been discounted with the assessed survival rate*
$A_{t2,teak,on/off}$	=	*Net annual area teak planted (ha/year) on- and off-reserve during year 2 of the crediting period, where net means the area has been discounted with the assessed survival rate*
RF_{teak}	=	*Removal factor teak, mean annual increment of teak plantations (tCO2/ha/year)*
$A_{t1,nteak,on/off}$	=	*Average net annual area non-teak planted (ha/year) on- and off-reserve during year 1 of the crediting period, where net means the area has been discounted with the assessed survival rate*
$A_{t2,nteak,on/off}$	=	*Average net annual area non-teak planted (ha/year) on- and off-reserve during year 2 of the crediting period, where net means the area has been discounted with the assessed survival rate*
RF_{nteak}	=	*Removal factor non-teak, mean annual increment of non-teak plantations (tCO2/ha/year)*
….	=	*Continued cumulative removals for subsequent years following the same calculation*

UNCERTAINTY PROPAGATION

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)[9].

Equation 11 Propagation of errors for summation

$$U_{total} = \sqrt{(U_1)^2 + \ldots + (U_n)^2} \quad (11)$$

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 $A_{v,e,i}$

<u>*Uncertainty calculation EF*</u>

The uncertainty of the average carbon contents in the individual pools was calculated based on the sampling error (Snedecor and Cochran 1989).

Equation 12 Confidence interval (±) around carbon contents in the different pools

$$CI\ of\ C_{p,e,s} = t_{\ 0.05} \times \sqrt{\frac{StDev\ C_{p,e,s}}{(n_{p,e,s}-1)}} \quad (12)$$

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)

[9] IPCC 2019, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

3 DATA AND PARAMETERS

3.1 Fixed Data and Parameters

Parameter:	*Emissions factor for deforestation for vegetation zone e and forest structure s, EF_def,e,s*
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*[11] *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 10 EFs for deforestation mentioned above remain fixed, the average EF per deforested hectare over the reference and monitoring periods 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 (see Baftere in next parameter description) per vegetation zone resulting in factors that differ slightly.*
Data unit:	tons of CO2 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 forest inventory data is used for the EF calculation. Forest inventory data was collected as part of the Forest Preservation Programme (FPP) in Ghana, under a Japanese Aid Grant and with technical support from Arbonaut. Therefore, this is a countrylevel data. This study performed field measurements in 252 plots in the year 2012, of this sample, 168 plots fell within the GCFRP landscape. Full inventory details are available in the FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013)[12]. Annex 4 of the first monitoring report provides additional details on processing the forest inventory plot level data. Figure 5,6 & 7 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 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. 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. The carbon contents in the replacing land uses 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 29.0 – 64.6 tCO2/ha (depending on the vegetation zone *details found in 'ADxEF -MR2-clean-harmonised;'sheet postDef C-content cells B2toF2).* Soil emissions are estimated using GCFRP-specific values for soil carbon in forest land (i.e., SOCREF 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 the above section, "Soil emissions from deforestation." Ghana accounts for committed emissions, meaning the SOC emissions are not projected over 20 years but accounted for as emissions in the year of deforestation for the sake of transparency. *Average carbon contents per pool in the different strata were derived from inventory measurements (Refer to "EFs deforestation and forest degradation" in the Annex 4 of the first monitoring report.*
Value applied:	*Net Emission Factors deforestation*

		tCO_2/ha	±90% CI (tCO_2/ha)	±90% CI (in percentage)
Closed Forest	Wet Evergreen	401.3	502.3	125%
	Moist Evergreen	862.3	280	32%
	Moist Semi-deciduous NW	435.9	76.3	18%
	Moist Semi-deciduous SE	665.7	312.4	47%

	Upland Evergreen	494.9	141.8	29%	
Open Forest	Wet Evergreen	169.3	102.4	61%	
	Moist Evergreen	162.8	59.8	37%	
	Moist Semi-deciduous NW	160.3	54.3	34%	
	Moist Semi-deciduous SE	174.3	52.9	30%	
	Upland Evergreen	196	64	33%	

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

		AGC			BGC			DW			
		tC/ha	±CI (tC/ha)	±CI(in %)	tC/ha	±CI (tC/ha)	±CI(in %)	tC/ha	±CI (tC/ha)	±CI(in %)	
Closed Forest	Wet Evergreen	81.3	115.9	143%	10.5	17.44	166%	29	66.15	228%	
	Moist Evergreen	202.9	73.3	36%	26.8	9.86	37%	18.3	14.90	81%	
	Moist Semi-deciduous NW	75.9	13.6	18%	19	1.67	9%	38.6	12.75	33%	
	Moist Semi-deciduous SE	100.5	68.5	68%	25.8	5.31	21%	65.8	49.66	75%	
	Upland Evergreen	74.6	21.7	29%	24.1	1.81	8%	41.9	29.25	70%	
Open Forest	All vegetation zones	27.4	8.0	29%	10.4	2.8	27%	20.5	8.15	40%	2.6 0.75

Single year legacy emissions soil organic carbon (tC/ha) with associated half-width 90% confidence intervals

		SOC (Single year legacy)		
		tC/ha	±CI (tC/ha)	±CI(in %)
Closed Forest	Wet Evergreen	0.90	0.59	66%
	Moist Evergreen	0.59	0.34	58%

		Moist Semi-deciduous NW	0.33	0.20	61%
		Moist Semi-deciduous SE	0.86	0.43	49%
		Upland Evergreen	0.91	0.73	80%
	Open Forest	All vegetation zones	0.53	0.24	46%
	NB: This table presents the values for a single-year SOC legacy. Ghana followed the FCPF Guidance Note on accounting of legacy emissions/removals (2021).				
QA/QC procedures applied	The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were selected as quality control plots. However, 12 out of these plots were visited in the field for quality control, representing 4.1 per cents of the plots with measured data, details in Section 4 of FPP Report 2013. The average differences between the original and quality control measurements are found statistically insignificant (t-test); the maximum average diameter and height differences are up to 11.5 cm and 8.5 meters based on the field measurements excluding the outlier plots. For 75percent of the plots AGC and BGC values deviate less than 30 percent between two measurements 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.				
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 11 (see section 2.2.2), and the uncertainties are aggregated through simple error propagation				
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:	Weighted post-deforestation carbon contents*, Bafter $_{e}$ (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. The same values are used for the reference and monitoring periods (see Comment below)*
Data unit:	*tons of CO2 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 is a country level data. This information is a combination of the SLMS and FPP. In the SLMS's sample unit assessment, the land use after deforestation is assessed for each plot. 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.

Value applied:

Parameter:	Weighted post-deforestation carbon contents, Baftere (interim in EF calculation)				
	Wet Evergreen	Moist Evergreen	Moist Semi-deciduous NW	Moist Semi-deciduous SE	Upland Evergreen
Post-deforestation contents (tCO_2/ha)	55.7	62.2	64.6	50.7	29.0
(Cl in Tco_2/ha)	92.9	41.3	33	30.6	47.3
±90% CI (in percentage)	167%	66%	51%	60%	163%

NB

CI's in the table are actual CI's, in the calculations this values is doubled (see comment under uncertainty associated with the parameter)

QA/QC procedures applied	The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were selected as quality control plots. However, 12 out of these plots were visited in the field for quality control, representing 4.1 per cents of the plots with measured data, details in Section 4 of FPP Report 2013. . 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)
Uncertainty associated with this parameter:	The tables above provide the 90% confidence interval for all fixed variables reported. However, the confidence interval calculation is simplified as it does not consider the proper weights of the different strata. To avoid underestimating the uncertainty through this simplification, the confidence interval is doubled, and its impact is assessed and evaluated as insignificant.
Any comment:	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 29.0-64.6 tCO_2/ha for the five different vegetation zones for the period 2005-2014. There is however a lot of uncertainty in the determination of the post- deforestation land use, especially for the more recent years where a time series of the post-deforestation land use 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 land use over the monitoring period, it was opted to keep this variable stable such that it will not impact the ER calculation.

Parameter:	*Emissions factor for forest degradation for vegetation zone e, forest structure s* $EF\_degr_{e,s}$
Description:	Ghana uses 6 different emission factors for forest degradation. These emission factors will not change between the reference period and monitoring period assessments.

<table>
<tr><td></td><td>Different EFs have been used 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 is a country level data.

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.

To make sure that the estimated amount of CO2 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%).

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 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.</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><td colspan="5">Emissions Factors Forest degradation</td></tr>
<tr><td colspan="2"></td><td>tCO_2/ha</td><td>±90% CI (tCO2/ha)</td><td>±90% CI (in percentage)</td></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 SLMS and FPP project. See the FPP Report on Mapping of Forest Cover and Carbon Stock in Ghana (2013), section 4.1.4</td></tr>
</table>

	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 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 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 SOP14 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, 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, 1052 plots (14%) were blindly re-assessed by a different interpreter. The overall agreement of this double-blind assessment was 87%, i.e. an improvement compared to the 2020 assessment, which saw an overall agreement of 82%. FPP project: The inventory data management workflow includes Quality Assurance and Quality Control procedures. 15 randomly selected plots were selected as quality control plots. However, 12 out of these plots were visited in the field for quality control, representing 4.1 per cent of the plots with measured data, details in Section 4 of FPP Report 2013. The average differences between the original and quality control measurements are found to be 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 measurements. 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.
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 of the first monitoring report, section 8.3).
Any comment:	

Parameter:	*Area of deforestation, in vegetation zone e, in forest structure s, $A_{def,e,s\ (rp)}$*

Description:	Area of forest converted to non-forest and area of forest experiencing deforestation during the reference period
Data unit:	Hectares per annum
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	This is a program area specific data. 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. Details can be found in section 2.22 of Ghana's first MR.
Value applied:	(see table below)

	Deforestation open forest			Deforestation closed forest		
	in ha/yr	±90% CI (ha/yr)	±90% CI (perc.)	in ha/yr	±90% CI (ha/yr)	±90% CI (perc.)
Wet evergreen	182	223	122%	304	264	87%
Moist evergreen	768	491	64%	1 728	730	42%
Moist Semideciduous NW	1 840	661	36%	1 171	482	41%
Moist Semideciduous SE	1 950	667	34%	1 078	472	44%
Upland evergreen	16	26	164%	160	82	51%
	4 756	1 083	23%	4 440	1 031	23%

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.

	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 not have access to Planet data and they could not have assessed deforestation events in the second half of 2019.
Uncertainty associated with 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 in section 2.2.2 of the first MR
Any comment:	

<table>
<tr><td>Parameter:</td><td>Area of degradation, in vegetation zone e, in forest structure s, $A_{degr,e,s\ (rp)}$</td></tr>
<tr><td>Description:</td><td>Area of forest converted to non-forest and area of forest experiencing forest degradation during the reference period</td></tr>
<tr><td>Data unit:</td><td>Hectares per annum</td></tr>
<tr><td>Source of data or description of measurement/ calculation methods and procedures applied:</td><td>This is a program area specific data.

Activity data estimates reflecting forest degradation were derived from sample-point interpretation. The sample point data set consisted of 7692 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.</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><td></td><td colspan="3">Deforestation open forest</td><td colspan="3">Deforestation closed forest</td></tr>
<tr><td></td><td>in ha/yr</td><td>±90% CI (ha/yr)</td><td>±90% CI (perc.)</td><td>in ha/yr</td><td>±90% CI (ha/yr)</td><td>±90% CI (perc.)</td></tr>
<tr><td>Wet evergreen</td><td>0</td><td>-</td><td></td><td>304</td><td>264</td><td>87%</td></tr>
</table>
</td></tr>
</table>

	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%
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. 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 associated with 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:	Removal factor for teak (RF_{teak}) – for the Reference Level
Description:	Calculated removal factor for carbon stock enhancement through plantation of teak in forest reserves (AGB and BGB)
Data unit:	t CO2 ha^{-1} yr^{-1}
Source of data or description of the method	This is a country level data

for developing the data including the spatial level of the data (local, regional, national, international):	Published literature (Adu-Bredu S., et al. 2008 , https://doi.org/10.1016/j.foreco.2007.12.052) 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 CO2/ha Annual removals: 358 t CO2ha-1 / 25 yr =14 t $CO2ha^{-1}$ yr^{-1}
Value applied:	14 t CO2 ha^{-1} yr^{-1}
QA/QC procedures applied	N/A
Uncertainty associated with this parameter:	Adu-Bredu et al. (2008) completed the study using temporary sample plots and following standard operating procedures for measuring 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 201115 and a standard error value from IPCC 201916 for the root-to-shoot ratio.
Any comment:	

Parameter:	Removal factor for other broadleaf species (RF_{nteak}) – for the reference level
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	Country-specific data was not available, therefore, IPCC AFOLU Vol. 4 table 4.8 above-ground biomass in forest plantations was used. 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.

the data (local, regional, national, international):	101 Mg C ha^{-1}= 370 t CO2 ha^{-1} Annual removals: 370 t CO2 ha^{-1} / 40 yr =9 t CO2 ha^{-1} yr^{-1}
Value applied:	9 t CO2 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 201917 for the biomass values and root-to-shoot ratios.
Any comment:	

3.2 Monitored Data and Parameters

Parameter:	Area of deforestation, in vegetation zone e, in forest structure s, $A_{def,e,smp}$ Area of degradation, in vegetation zone e, in forest structure s, $A_{degr,e,smp}$
Description:	Area of forest converted to non-forest and area of forest experiencing forest degradation during the monitoring period respectively
Data unit:	Hectares per annum
Value monitored during this Monitoring / Reporting Period:	*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. 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 1 (Cochran 1977[18]).

Equation 1 Formula to determine overall sample size:

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

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 in1.64 is used in the simple error propagation)

d = the allowable margin of error. This is the maximum half-width of the confidence towards in our estimate. It is given as area fraction, not as percentage. It should be th 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 1 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.

Table 6: Sample plot size and distribution in GCFRP

	# plots	**Area (ha)**	**Proportion of area**
Outside forest mask (4 x 4 km grid)	2,066	2,555,905	0.43214767
On forest mask (2 x 2 km grid)	5,233	3,295,919	0.55726787
In upland evergreen ecozone (1 x 1 km grid)	393	62,601	0.01058446
Total	7,692	5,914,425	1

This sampling intensity will also be used for future monitoring period (2024).

Response design

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

	Open Forest		Closed Forest	
Deforestation	2022 Def(ha/yr)	2022 CI (ha)	2022 Def(ha/yr)	2022 CI (ha)
Wet Evergreen				
Moist Evergreen			1,281	1485
Moist Semideciduous NW			619	1015
Moist Semideciduous SE				
Upland Evergreen				

	Open Forest		Closed Forest	
Deforestation	2023 Def(ha/yr)	2023 CI (ha)	2023 Def(ha/yr)	2023 CI (ha)
Wet Evergreen			610	1000
Moist Evergreen			4,478	2,800
Moist Semideciduous NW				
Moist Semideciduous SE				
Upland Evergreen				

Degradation	Open Forest		Closed Forest	
	2022 Deg(ha/yr)	2022 CI (ha)	2022 Deg(ha/yr)	2022 CI (ha)
Wet Evergreen				
Moist Evergreen				
Moist Semideciduous NW			619	1015
Moist Semideciduous SE				
Upland Evergreen				

Degradation	Open Forest		Closed Forest	
	2023 Deg(ha/yr)	2023 CI (ha)	2023 Deg(ha/yr)	2023 CI (ha)
Wet Evergreen			610	1000
Moist Evergreen			1281	1484
Moist Semideciduous NW				
Moist Semideciduous SE			641	1,218
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 7692 samples points systematically located across the GCFRP region on a nested, multi-scale grid with random gaps. While preparing the ERPD and the amendment to the ERPD, Ghana explored using 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. Section 2.2 and Annex 4 of the first monitoring report (section 8.3) provide a detailed description of the establishment of the sample size, sample design, and response design.
QA/QC procedures applied:	Ghana has consistently strived to increase the accuracy of its data and as such puts in place robust QA/QC procedures regarding Activity data generation. Before data collection, a refresher training is

	held to enhance internal consistency amongst interpreters. During data collection, the following are included as well; 1. Supporting images from Bing maps and GEE are used to augment images from Google Earth 2. A blind recheck of plots is interpreted, thus random plots are selected from the initial round 1 collection and reassessed by interpreters for confidence checks. After the initial data collection, an initial analysis is conducted to tease out all "low confidence" plots for a careful recheck by expert interpreters. 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, 1525 plots (20%) were blindly re-assessed by a different interpreter. The overall agreement of this double-blind assessment was 77%, which further solidifies the certainty of interpreted 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:	The data collection efforts were conducted in a group setting, where experts gathered and interpreted the sample data in the same room and resolved sub-tile differences in the landuse and associated changes. If an expert had any doubt about the sample classification, the plot was displayed on a projector and all experts intervened to accurately classify the sample.

Parameter:	Teak and broadleaf areas of on- and off-reserve planting for the reference level and monitoring period, discounted with failure rate ($A_{RL,teak,on}$, $A_{RL,teak,off}$, $A_{RL,nteak,on}$, $A_{RL,nteak,off}$, $A_{MP,teak,on}$, $A_{MP,teak,off}$, $A_{MP,nteak,on}$, $A_{MP,nteak,off}$)
Description:	Area of non-forest converted to forest area (enhancement)
Data unit:	Hectares per annum
Value monitored during this Monitoring / Reporting Period:	see table below
Source of data and description	National Forest Plantation Development Programme official statistics.

	NFPDP data			
	Off-reserve planted area (ha)	Survival Rate	On-reserve planted area (ha)	Survival Rate
2022	14,313	55%	19,037	55%
2023	225	81%	3,878	81%

of measurement/ calculation methods and 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. Plantation's Department of Forestry Commission undertakes an annual survival survey of all planted sites from which the survival rates were derived. In 2019, the survival rate was estimated to be 55%. Ghana has used this conservative figure for the subsequent years since the actual were not being undertaken. In 2023, survival was undertaken, check page 11 of the 2023 annual plantation report (copy here : 2023 plantation annual report). The percentage is 81.9. Therefore, Ghana used this figure (81%) for only the 2023 survival, whilst we maintained the conservative figure for 2022. Normally, the sampling intensity for survival surveys is 20%. This is done systematically by selecting every fifth row to ensure that the survival survey is representative enough.
QA/QC procedures applied:	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: 2022 plantation annual report 2023 plantation annual report
Uncertainty for this parameter:	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
Any comment:	

4 QUANTIFICATION OF EMISSION REDUCTIONS

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

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)
2022	3,778,367	867,069	-98,082		4,547,353
2023	3,798,642	867,069	-122,602		4,543,109
Total	7,577,009	1,734,138	-220,684		9,090,462

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

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)
2022	1,386,956	90,530	-938,360	539,126
2023	4,124,371	563,708	-980,923	3,707,156
Total	5,511,327	654,238	-1,919,283	4,246,282

4.3 Calculation of emission reductions

	Deforestation	If applicable, forest degradation	If applicable, enhanced removals from afforestation/ reforestation (A/R)	Total (tCO_{2-e})
Emission or removals in the Reference Level (tCO_{2-e})	7,577,009	1,734,137	-220,684	9,090,462
Emission or removals under the ER Program during the Reporting Period (tCO_{2-e})	5,511,327	654,238	-1,919,283	4,246,282
Emission Reductions during the Reporting Period (tCO_2-e)	2,065,682	1,079,899	1,698,599	4,844,180

Emission reductions from enhanced removals from afforestation/reforestation as a percentage of the total FCPF ERs (%)	n/a

5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

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)
- Representativeness

- Integration:
  - Model
  - Integration

These sources of uncertainty were considered as follows.

- Activity data sampling uncertainty was considered 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 considered 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 considered (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[10] 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, (Ferrari, S. & Cribari-Neto, F. 2004) ; https://doi.org/10.1080/0266476042000214501

- [10] Ferrari, S. & Cribari-Neto, F. 2004; https://doi.org/10.1080/0266476042000214501

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 (SOPs) and through several capacity building workshops. These materials were used as guidance for refresher training for data collectors. 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 4. Data collectors have gained experience in interpretations due to consistency in the personeel who collect the data 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 -4 above) applied should have minimized this as much as practicable. No residual uncertainty is included in the estimate.	H (bias/random)	YES	NO
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 regard 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 in as much 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	H (bias/random)	YES	YES

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		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 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.			
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	H (bias) & L(random)	YES	NO

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		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.			
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;	L(bias/random)	NO	NO

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		details in FPP Report: section 2.5[11] . 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.			
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 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	L(bias), H/L (random)	YES (local models)	NO

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https://www.dropbox.com/scl/fi/3eyco56j1dc7cf1jwvgjo/Ghana_Final_Report_Main.pdf?rlkey=1jly1975007qvis5dotfoonrk&e=2&st=9f1g0p1h&dl=0

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		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 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	H/L(random)	YES	NO

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		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
Representativ	S	LIDAR transects lines were parallel. Hence, a systematic approach relies over the overlapping of plots on these	L (bias)	YES	NO

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
eness error		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.			
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

Sources of uncertainty	Systematic/ Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Address through QA/QC	Residual uncertainty estimated?
		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:

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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 12%. 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)
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 (20-year total)	10.6	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 Wet Evergreen (20-year total)	18.2	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 (20-year total)	18.0	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 (20-year total)	6.6	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 (20-year total)	11.8	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 (20-year total)	17.2	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)	14.3	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	17.0	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	13.8	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	17.6	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	7.9	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 2022 and 2023				
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	610	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	5,759	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)	688	Not applicable	Fixed	

Area established (ha) teak 2011 (ha)	1,501	Not applicable	Fixed	
Area established (ha) teak 2012 (ha)	1,504	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)	295	Not applicable	Fixed	
Area established (ha) non teak 2011 (ha)	643	Not applicable	Fixed	
Area established (ha) non teak 2012 (ha)	644	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 2022 and 2023				
Area planted (ha) teak 2022 & 2023 (ha)	14,420	Not applicable	Fixed	
Area planted (ha) non teak 2022 & 2023 (ha)	6,180	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	0.30	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	437	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	1,293	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 2022 & 2023				
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	610	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Evergreen	1281	Sampling error	Normal	Representative, raw data available. Central limit theorem: binomial approaches normal.
AD (ha /yr) Closed Moist Semideciduous SE	641	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.

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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 the table below the emission reduction estimates in the first column include forest degradation. For the uncertainty discount, the value of the aggregate estimate in the first column has been used.

		Reporting Period	Crediting Period
		Total Emission Reductions*	**Total Emission Reductions***
A	**Median**	5,419,252	12,061,461
B	**Upper bound 90% CI** (Percentile 0.95)	10,507,923	19,504,161
C	**Lower bound 90% CI** (Percentile 0.05)	65,321	4,963,014
D	**Half Width Confidence Interval at 90% (B – C)/ 2**	5,221,301	7,270,573
E	**Relative margin (D / A)**	96%	60%
F	**Uncertainty discount**	12%	8%

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:

Sensitivity analysis. 2022+2023 Iterations:		**16,000**
Scenario	ER Uncertainty 90%	Difference to ER Uncertainty 90% of all parameters
All parameters	96.3%	0.0%
No Defor	14.3%	-82.1%
No Degrad	68.0%	-28.4%
No Enhance	96.3%	0.0%
No EF	66.6%	-29.8%
No AD	20.2%	-76.1%
No Def AD	24.3%	-72.1%
No Def EF	66.0%	-30.4%
No Degr AD	68.8%	-27.6%
No Degr EF	69.9%	-26.4%
No Enhanc AD	96.3%	0.0%
No Enhanc EF	96.3%	0.0%

The difference in the uncertainty of emissions reductions (right column in the table) concerning the uncertainty in the reference level, where all parameters are considered, shows a possible hierarchy of parameter importance when considering important error sources open for improvement in monitoring. For example, AD estimation improvements can potentially reduce the current ER uncertainty by 76 % (overall ER uncertainty for all parameters being 96% vs. overall ER uncertainty when AD presents no errors being 20.2%). Given this prioritization, several overall improvements can be perceived.
Improved monitoring of activity data will likely contribute to uncertainty and vast decreases in emission reductions; higher-resolution imagery will likely be available in future years. Again, Ghana's current Standard Operating Procedures for area estimation reinforce the training of interpreters to minimize both systematic and random errors in area estimation:

6 TRANSFER OF TITLE TO ERS

6.1 Ability to transfer title

Ghana does not have legislation covering ER title transfer. The government procured a legal opinion from an international legal expert, Mortiz von Unger, dated 16 April 2019, which considers that the structure envisioned in the ERPD, based on the BSP supported by sub agreements, would be capable in principle to allow transfer of ER title. The Forestry Commission submitted a letter dated 3 February 2020 (attached as an Appendix 1) to the WB, which informs that, considering the legal opinion, and in the absence of specific legislation, the ability to transfer title is demonstrated based on sub-agreements with program participants and the BSP. The letter also confirmed the ability of the Forestry Commission to transfer the title. Further to affirm these claims, the Attorney General provided a letter dated 06 May 2019 (attached as Appendix 2)

Subsequently, Framework Agreements (FAs) were signed between the Forestry Commission, The Ghana Cocoa Board (proponents of the ERP), and the HIAs that are part of the ERP. In these FAs, sections are restating and confirming that the Forest Commission can transfer any ERs from the ERP to the FCPF, and that HIAs and partners are recognized as beneficiaries in the BSP. These FAs are with the following HIAs:

- Juabeso / BIA: signed in October 2019; further, 5 sub-agreements under the FA were signed with project partners that implement activities (mix of Ghanaian NGOs and international partners);
- Asunafo-Asutifi: September 2021;
- Ahafo Ano South – Atwima Nwabiagya-Atwima Mponua: September 2021;
- Kakum: December 2022.
  Sefwi Wiawso – Bibiani: December 2022.
- Atiwa-East Akim: June 2024

Subsquently,the FC has transferred the verified and validated Emission Reductions (ERs) for both the first and second monitoring reports under the Emission Reductions Payment Agreement with the Carbon Fund through the International Bank for Reconstruction and Development (IBRD).

6.2 Implementation and operation of Program and Projects Data Management System

Currently, in Ghana, no entity has the right to claim[12] ownership of the title to ERs. Therefore, there is no threat of multiple claims to an ER title. The Forestry Commission, working closely with the Ghana Cocoa Board, is authorized by the Government of Ghana through the Minister of Finance to implement the Program. However, there are currently three VCS-registered projects whose status is described in the table below.

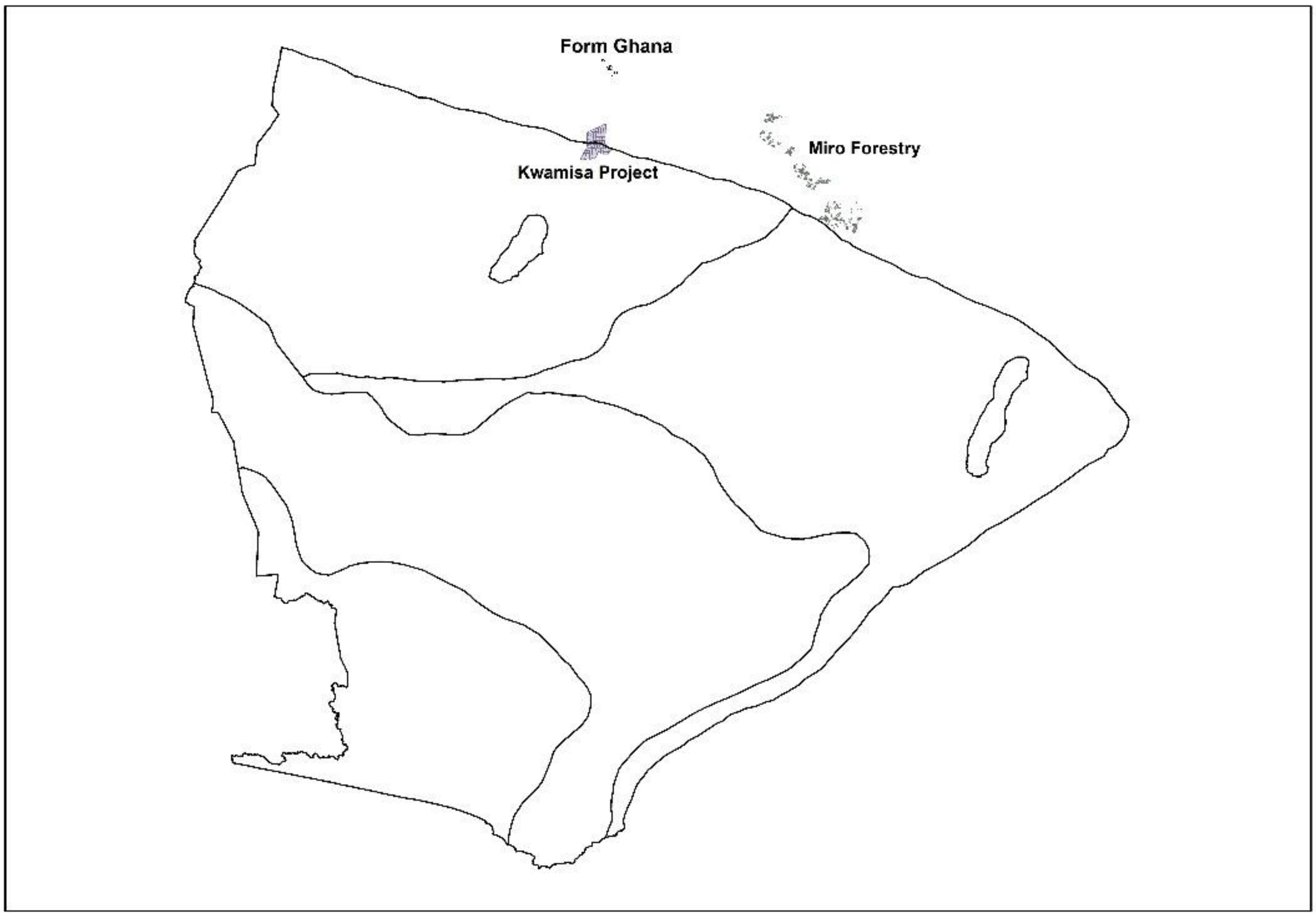
No.	VERRA ID	NAME	REGION	STATUS OF ISSUANCE	DOUBLE COUNTING STATUS
1	3425	Kwamisa/Other reserves community forest Project	Ashanti	No issuance yet.	Portion of the Kwamisa Reserve falls in the GCFRP Area. Issuance of credits has not started.

[12] Three registered ARR Projects exist by Form Ghana, Miro Ghana (outside the GCFRP Area) and ClimeTrek, which have a portion in the GCFRP area. This project seeks to issue carbon credit beyond the Crediting Program for the ERPA. Ghana has also developed the Article 6 registry to track future Carbon Credit transactions and issuance.

3	2410	Reforestation of Degraded forest reserve areas in Ghana, West Africa Miro Forestry	Ashanti	Issued Verified Carbon Units	Outside GCFRP Area
4	987	Reforestation of Degraded forest reserves in Ghana Form Ghana	Ashanti	Issued Verified Carbon Units	Outside GCFRP Area

From the table above, it is clear that the only project that falls in the GCFRP area has not issued any credits yet and shall not issue credit during the monitoring period; thus, Ghana is not double-counting any credits.

The FC has developed a Ghana REDD+ Data Hub (www.ghanaredddatahub.org[13]) that provides information on the program, including its geographic boundaries, carbon pools, and reference level. Subsequently, the reference level has been amended. The data hub would display the amount of ERs transferred to the Carbon Fund with the associated reversal and uncertainty buffer accounts, ensuring transparency of the process.
Below is a map of the areas of the VCS-registered projects
Figure 13: Map of area of VCS registered projects



[13] Currently undergoing upgrade

6.3 Implementation and operation of ER transaction registry

The Government of Ghana, through the Forestry Commission (FC), has formally communicated with the Carbon Fund regarding the adoption of the Forest Carbon Partnership Facility's (FCPF) Emission Reduction (ER) Transaction Registry. This decision designates the Carbon Fund trustee as responsible for Registry Administration and buffer management.
As of the current time frame, no active carbon projects within the program area are generating Carbon Credits. However, it is essential to note that Verra has issued carbon credits to two projects located outside the program area. Ghana actively monitors these issuances by referencing the Verra Registry to assess and quantify the credits allocated to these projects.

In addition, the Forestry Commission maintains a comprehensive plantation database that records the established hectares of both public and private plantations. While Verified Carbon Standard (VCS) projects are not accounted for under the Ghana Cocoa Forest REDD+ Program (GCFRP), they are integrated into the National Plantation database, managed by the Forestry Commission. This database encompasses plantation requests and supervises projects located both on-reserve and off-reserve. Notably, the VCS projects are situated within Forest Reserves and adjoining areas, with documentation held by landowners and verified by the Forestry Commission.

The Environmental Protection Agency (EPA), serving as the UNFCCC Focal Point in Ghana, has recently developed a registry (https://gcr.epa.gov.gh) for collecting and tracking transactions from mitigation activities at the sector, city and corporate levels. The FC would engage the EPA on registering programs/projects from the forest sector.

Additionally, the REDD Data Hub (accessible at www.ghanaredddatahub.org) has been established to gather information on projects within the GCFRP area.

At the time of the Emission Reductions Payment Agreement (ERPA) signing, Ghana had no existing projects within the program area, nor had any projects been recorded. Continued engagement on the GCFRP has ensured that potential project proponents are fully informed that no carbon credit can be issued within the program area during the World Bank ERPA period.
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6.4 ERs transferred to other entities or other schemes

No ERs have been transferred to a third party. After the verification and Validation of this Monitoring Report (MR), all the volume will be transferred on a 100% basis in line with the ERPA. No ERs will be transferred to third parties until the contractual ERs under the ERPA are met.

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)

There have not been any major events or changes in ER Program circumstances that have led to the Reversals during the Reporting Period

7.2 Quantification of Reversals during the Reporting Period

Intentionally left blank

7.3 Quantification of pooled reversal buffer replenishments

Intentionally left blank, as there are no reversals have occurred during the previous reporting periods.

7.4 Reversal risk assessment

The reversal risk assessment using the CF buffer guidelines remains 13% (compared to last monitoring period) since the preparation of the revised final ERPD. The change is due to the risks associated with institutional capacity for implementation and sustainability. The risk was reduced due to several implementations that strengthen the institutional capacity for implementation as outlined in the table below:

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	*Ghana has precise and participatory procedures for consultations with key stakeholders (local communities and cocoa farmers, Government agencies and ministries, NGOs, private sector and international partners) affected (or to be affected) by the ER program, with considerations of proportional engagement. The consultation process involves workshops, focus group discussions, town hall meetings, and diverse representation from women, youth, and marginalized communities, providing platforms for stakeholders to voice concerns and suggestions. The consultation process is transparent by providing clear information about the program's objectives, activities, and potential impacts, and regularly updating stakeholders on the progress and outcomes. All engagement reports and relevant documents have been disclosed on the SIS sub-site, (https://www.reddsis.fcghana.org/)* *All reports include lists of participants and other details, which are also included in Annex 1.* *Ghana has developed and disclosed its benefit sharing plan, and the governance arrangements for operationalizing the BSP have been communicated to the bank. Ghana has received the first and second carbon payments, and the whole first carbon payments have been disbursed. The National REDD+ Secretariat conducted a citizen satisfaction survey in five out of the six HIAs that received the first payment, resulting in high levels of satisfaction among 1629 farmers engaged in 124 communities. The survey also highlighted improvements made to the BSP, indicating Ghana's commitment to promoting climate resilience. Kindly refer to Annexes I and II.*	**10%**	*Reversal risk is considered low* *10% - 10% = 0% discount*	*0%*

	Ghana has implemented operational modalities for its Feedback and Grievance Redress Mechanism (https://www.reddsis.fcghana.org/modality.php) and has reported on feedback and grievances received during the Monitoring Period in Annexes I, II, and III.			
Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination	*The GCFRP is implemented by the Forestry Commission and the Ghana Cocoa Board. The Forestry Commission regulates the utilization of forest and wildlife resources, manages them, and coordinates policies. Established in 1999, it comprises agencies for protection, management, and regulation of forest and wildlife resources. The Cocoa Board, established in 1947, regulates and manages the cocoa sector in Ghana. Both institutions play crucial roles in ensuring sustainable development. The Forest Commission (FC) and Cocoa Board of Ghana have partnered to implement the Forest Investment Program, with grant support from the Climate Investment Fund. The FIP served as the pilot for GCFRP, a program with over 50 years of experience in forest management and conservation, including the REDD+ Strategy, the Ghana Forest Plantation Strategy and the Forestry Development Master Plan.* *Ghana Cocoa Board has been operational for over 60 years, focusing on regulating and promoting the cocoa industry.* *Since its inception, the Forest Investment Program has been a collaboration between FC and COCOBOD, laying the foundation for the GCFRP Carbon Fund. The FC has adapted the CREMA model for landscape governance, transforming it into the Hotspot Intervention Areas. COCOBOD has also promoted climate-smart cocoa practices to enhance sustainability and productivity.* *In operationalizing the Benefit Sharing Plan, the REDD+ Dedicated Account steering committee was formed to guarantee transparency in distributing carbon benefits. They have overseen the disbursement of all of the first carbon payments with the second one currently ongoing. It is chaired by Ghana's Ministry of Finance and includes representatives from Office of the Administrator of Stool Lands, the World Cocoa Foundation and three representatives from NGOs working in the forest sector. Kindly refer to Annex II of the 2nd and 3rd Monitoring reports.*	**10%**	*Reversal risk is considered low* *10% - 10% = 0% discount*	*0%*
Lack of long term effectiveness in addressing	*The ex-ante risk assessment evaluates key institutions' programs, policies, or regulations that have successfully decoupled deforestation and degradation from economic outputs for at least five consecutive years in the last 15*	**5%**	*Reversal risk is considered Medium*	*3%*

underlying drivers	*years. Key institutions include the Forestry Commission and Ghana Cocoa Board, which have collaborated on the Forest Investment Program, implemented the CREMA model for landscape governance, and promoted climate-smart cocoa practices.* *The GCFRP has demonstrated decoupling from deforestation and degradation in Hotspot Intervention Areas (HIAs) for at least four consecutive years, indicating effective long-term strategies and interventions by key institutions, resulting in sustainable economic growth and environmental conservation. This evidence supports the program's success in reducing deforestation and degradation.* *The legal and regulatory environment in Ghana supports REDD+ objectives, as documented in the ERPD. The Forest and Wildlife Policy (2012), Forestry Development Master Plan (FDMP) 2016-2036, and Ghana Forest Plantation Strategy 2016-2040 are key policies. These policies are coherent through a chain of legal authority and obligation originating from the constitution, which created the Forestry Commission. The REDD+ Strategy launched in 2016 is designed to meet the requirements of the Warsaw Framework on REDD+ strategy, paying significant attention to national circumstances and developmental aspirations. Other enabling laws include the Timber Resources Management Regulation 2002 (L. I 1649) and the Timber Resources Management (Amendment) Regulation 2003 (L.I 1721), which include provisions for sustainable management of timber resources.* *The ex-post assessment reveals that Ghana's legal and regulatory framework continues to promote REDD+ objectives. The country has enacted the Timber Resource Management and Legality Licensing Regulations, 2017, and the Wildlife Resources Management Act, 2024 (Act 1115), which align with existing policies and international conventions on wildlife. Enforcement remains strong, with ongoing monitoring and reporting mechanisms in place. The first two monitoring reports have led to payments of 21,758,085 million dollars, indicating a Low-Risk score for the legal and regulatory framework. Overall, the existing legal and regulatory framework effectively promotes REDD+ objectives.* *Notwithstanding the successes mentioned above that have yielded a low-risk score, illegal mining activities have escalated since the previous monitoring period. In response, the Forestry Commission has enhanced its protective role in the forest reserves by training additional Rapid Response Personnel. Furthermore, to boost mobility and ensure a swift response to reports of illegal mining*		*5% - 2% = 3% discount*	

	activities, the Forestry Commission has utilised its share of the second carbon payments to purchase 17 pick-ups and distribute them across the forest districts within the Programme area.			
Exposure and vulnerability to natural disturbances	*The Ghana Cocoa landscape is not susceptible to natural disasters like fire, storms, or drought, but due to anthropogenic causes, fires may occur. Community forest governance arrangements have been set up in places (HIAs) and communities are sensitized and awareness is raised about the dangers of anthropogenic fires. The GCFRP Framework Agreement mandates community fire management, with fire volunteers promoting awareness and education to mitigate fire incidents. They also provide hands-on support to farmers using fire in farm management. The community's efforts are backed by key institutions like the Ghana Fire Service, District Assembly, and Forestry Commission, contributing to the permanence of fire management in the program area.* *Low*	**10%**	*Reversal risk is considered Low* *10% - 10% = 0% discount*	*0%*
		Total reversal risk set-aside percentage		*13%*
		Total reversal risk set-aside percentage from ER-PD or previous monitoring report (whichever is more recent)		*13%*

8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

A.	Emission Reductions during the Reporting period (tCO_2-e)	*from section 4.3*	4,844,180
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)		0
C.	Number of Emission Reductions estimated using measurement approaches (A-B)		4,844,180
D.	Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested	*from section 6.1*	100%
E.	ERs sold, assigned or otherwise used by any other entity for sale, public relations, compliance or any other purpose including ERs accounted separately under other GHG accounting schemes or ERs that have been set-aside to meet Reversal management requirements under other GHG accounting schemes	*from section 6.4*	0
	If applicable, any buffer replenishments	*section 7.3 P*	0
F.	Total ERs [(B+C)*D-E] minus, if applicable, any replenishments as per section 7.3, Q		4,844,180
G.	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*	12%
H.	Quantity of ERs to be allocated to the Uncertainty Reversal Buffer (0.15*B/A*F)+(G*C/A*F)		581,302

I.	**Total reversal risk set-aside percentage applied to the ER program**	*from section 7.4*	13%
J.	**Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*I**		213,144
K.	**Number of FCPF ERs (F- H – J)**		3,708,704
L.	**Percentage of Emission reductions from enhanced removals from afforestation/reforestation as a percentage of the total removals [Optional if the country wishes to generate enhanced removals]**	*From section 4.3*	
M	**Number of FCPF ERs from enhanced removals from afforestation/reforestation (L * K) [Optional if the country wishes to generate enhanced removals]**		

ANNEX 5: DETAILED DESCRIPTION OF THE APPLICATION OF THE REVERSAL RISK ASSESSMENT TOOL

9 APPENDIX 1

Forestry Commission

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

Our Ref: FC/A.16/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.

10 APPENDIX 2

In case of Reply the number and date of this letter should be quoted

Our Ref No. D23/54.64
Your Ref No.
FAX No. 667609

Tel No: 665051

REPUBLIC OF GHANA

OFFICE OF THE ATTORNEY-GENERAL
& MINISTRY OF JUSTICE
P. O. BOX MB 60
ACCRA

6th May, 2019

THE COORDINATOR
FOREST CARBON PARTNERSHIP
FACILITY OF THE WORLD BANK
WASHINGTON DC

TRANSFER OF TITLE TO EMISSION REDUCTIONS FROM THE GHANA COCOA FOREST REDD+ PROGRAMM BY THE GOVERNMENT OF GHANA TO THE CARBON FUND

In my capacity as the Attorney General and Minister for Justice of the Republic of Ghana, I declare to the addressee the following:

i. The Independent Declaration by Atlas Law Advisory of Germany has been reviewed by my office;

ii. The relevant laws of Ghana have been considered by the independent reviewer; and

iii. Based on the above and my own legal opinion of the Ghanaian laws, I hereby confirm and declare that the Government of Ghana through the Forestry Commission has the power to transfer title to Emission Reductions from the Ghana Cocoa REDD+ Program to the Carbon Fund.

GAAkuffo

GLORIA AFUA AKUFFO (MISS)
ATTORNEY-GENERAL
& MINISTER FOR JUSTICE

N/A