Cooperative Republic of Guyana

1st REDD+ Technical Annex

Submitted to the 1st Biennial Update Report, which includes the REDD+ results achieved from Reducing Emissions from Deforestation and Forest Degradation for REDD+ Results-based payment for the period 2013-2022

ONE PEOPLE ONE NATION ONE DESTINY

2024

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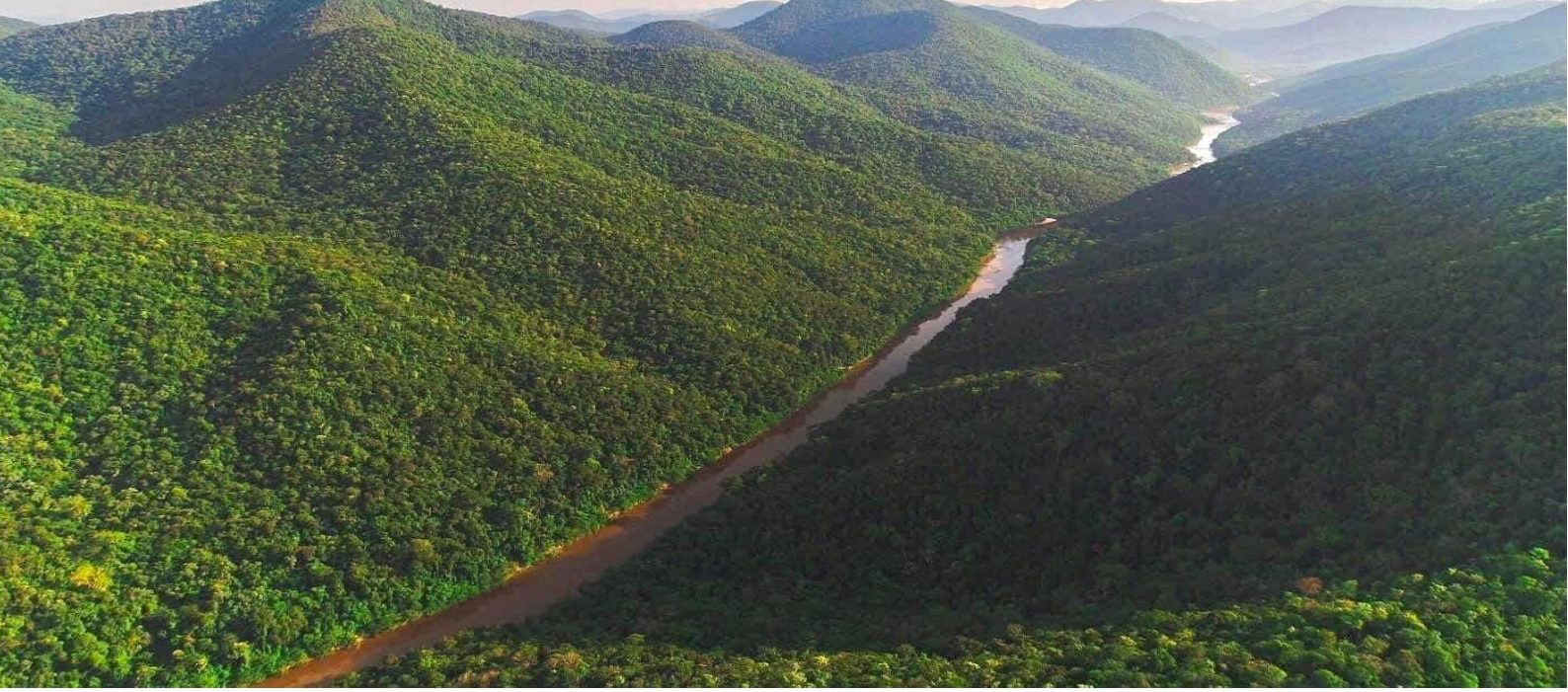
Acronyms

ART	Architecture for REDD+ Transactions
AT	Assessment Team
COP	Conference of the Parties
FREL	Forest Reference and Emissions Level
GFC	Guyana Forestry Commissions
GHG	Greenhouse Gas
GoG	Government of Guyana
HFLD	High Forest Cover/Low Deforestation
IPCC	Intergovernmental Panel on Climate Change
LCDS	Low Carbon Development Strategy
MRV	Measurement/Monitoring Reporting and Verification
NDC	Nationally Determined Contribution
NFMS	National Forest Monitoring System
REDD+	Reducing Emissions from Deforestation and Forest Degradation
TA	Technical Analysis
TREES	The REDD+ Environmental Excellence Standard
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market



INTRODUCTION

This Technical Annex provides additional information to Guyana's first Biennial Update Report of results achieved from Reducing Emissions from Deforestation and Forest Degradation REDD+. This annex has been developed per Decision 14/CP.19 (2013), requiring developing country Parties that wish to receive REDD+ results-based payments to submit their estimated calculation of GHG emissions reduction and removal enhancements related to forests to the United Nations Framework Convention on Climate Change (UNFCCC) as a technical annex to the BURs. This technical annex provides the information and data as requested in the Annex to Decision 14/CP.19, which provides guidance on the elements to be included in the technical annex as per paragraph 7 of Decision 14/CP.19, including six following contents: (1) Overview of FREL/FRL, (2) GHG emission reduction results, (3) consistency in methodology between REDD+ results calculation and FREL/FRL construction, (4) National forest monitoring system and responsibilities of relevant authorities, (5) Necessary information to allow for the reconstruction of the results, and (6) Compliance with paragraphs 1 (c)5 and 1 (d)6 of Decision 4/CP.15.

The Conference of the Parties encourages developing countries, such as Guyana, to contribute to mitigation actions in the forest sector by undertaking REDD+ activities: reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks (decision 1/CP.16, paragraph 70). The activities are intended to contribute to the achievement of Article 2 of the convention, which aims at strengthening the global response to climate change within the context of sustainable development and fulfilling commitments made in the National Determined Contributions proposed by the Party in fulfillment of the obligations set out in Article 4, paragraph 3.

Countries participating in REDD+ are encouraged to develop national strategies or action plans outlining their approach to reducing emissions from deforestation and forest degradation, the conservation and sustainable management of forests, as well as the enhancement of forest carbon stocks. Establishing a forest reference level (FREL) is a crucial aspect of REDD+. The FREL serves as the benchmark against which emission reductions can be measured. One of the key aims of REDD+ is to provide financial incentives for developing countries to reduce emissions from deforestation and forest degradation. It also emphasizes the importance of implementing robust and transparent forest monitoring systems to track changes in forest carbon stocks. This requires the building of institutional and human capacity to effectively implement REDD+ activities, including systems for monitoring,

reporting, and verification (MRV) and building the capacity of relevant stakeholders to ensure transparency and accountability in the implementation of the national REDD+ program.

Guyana is considered a member of the Small Island Developing States (SIDS) and is therefore granted flexibility (Decision 18/CMA.1 , 2018) in fulfilling its commitment to the Paris Agreement (PA) (PA, 2015). Guyana has taken advantage of Article 5.2 of the PA where REDD+ was recognized, by taking action to implement and support, including through results-based payments, the existing framework for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. However, despite the capacity and resource challenges, Guyana, in its effort to improve transparency, accountability, and consistency of its obligation to the PA, is submitting this Technical Annex, which outlines the efforts made by the country in safeguarding its environmental integrity and promoting sustainable use of its forest resources to leverage the promotion of sustainable development along a low carbon pathway following national priorities and international obligations.

As such, Guyana is honored to present this first REDD+ Technical Annex to its first Biennial Update Report, where the results achieved by the country are reported for the period 2013 to 2022. This is following the successful submission of the FREL in 2015, which covers a historic period ending in 2012. This reporting period (2013-2022) was selected to facilitate information consistency and adherence to reporting requirements, aligning with the updated GHG Inventory and reporting periods of the BUR, to which this REDD+ Technical Annex is attached.

This submission presents the results achieved following the jurisdictional approach since 2009 to establish the robust MRV system that generates consistent and accurate information with improvement over time to estimate Guyana's anthropogenic forest-related emissions by source and removals by sinks, forest carbon stocks and forest area changes following the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines.

National Circumstances

Guyana has the second highest percentage of forest cover on earth (85%), storing approximately 19.5 billion tons of CO2 e, and one of four countries in the world verified to have a sustained High Forest Low Deforestation (HFLD) state, containing high levels of biological diversity and endemism (LCDS, 2022). It is home to a variety of known animal species, including the iconic Amazonian species: jaguar, giant river otter, harpy eagle, tapir, giant anteater, and giant armadillo. From the earlier FREL submission, Guyana has refined its mapping of agriculture areas, including potential areas for shifting agriculture, and this has been excluded from the forest cover map in keeping with Guyana's forest definition. Additionally, the forest carbon stock inventory was finalized to cover all areas of Guyana, resulting in an updated stock inventory. The country is also home to large numbers of plant species and natural savannahs, giving Guyana exceptionally high levels of endemism, according to the IUCN[1]. Guyana's ocean area, which is more than half of Guyana's terrestrial area, offers a new frontier for sustainable development through the expansion of the Ocean/Blue Economy. These ecosystems support diverse species to the extent that as of 2010, Guyana's species status was estimated at 8,000 plant species; 467 fishes; 130 amphibians; 179 reptiles; 814 birds; 225 mammals; 1,673 arthropods; over 1,200 fungi; 33 bacteria; 13 nematode; 44 algae; 17 molluscs; and, an estimated 30 viruses (EPA, 2014) According to the FAO[2] , Guyana has 1,182 native tree species. Guyana's biodiversity provides an essential basis for climate regulation, poverty reduction, provisioning of freshwater, economic growth and development in areas such as agriculture, forestry, and fisheries, payment for forest climate services, and community-based economies, particularly in hinterland communities. Loss of biodiversity and any disruption in the provision of ecosystem services would negatively impact the economy and, more particularly, the quality of life of the people of Guyana.

[1] IUNC: https://www.iucn.org/about-iucn

[2] FAO, Global Forest Resources Assessment, 2005. http://www.fao.org/forestry/country/20807/en/guy/.

Guyana has approximately 18 million hectares of forest and has continuously worked with partners to sustain 99.5% of its forest while building the foundation of and developing a low carbon economy. Guyana's deforestation rates are among the lowest in the world, reported at 0.036% for 2022 (GFC, 2023). It is one of four countries forming the Guiana Shield, one of the most pristine rainforest landscapes in the world, comprising around 18% of the world's tropical forest carbon and 20% of the world's freshwater (LCDS, 2022).

Guyana's forest plays an essential role in addressing the global problem of climate change and its effects. At the same time, recognizing that these forest resources are a valuable natural asset for obtaining revenue for growth and development, in 2009, Guyana launched the first Low-Carbon Development Strategy (LCDS), which sets out a vision for inclusive, sustainable development while maintaining the country's forests, about 85% of the country's territory, to help meet some of the world's most urgent challenges. This commitment has not changed over the years and is further strengthened with the now-extended LCDS 2030, finalized in 2022.

The original LCDS 2009 set out a three-phase plan for accessing financing for forest climate services. This commenced with results-based payments under the Guyana-Norway Agreement (Phase 1), and in 2022, this transitioned to access to the voluntary and compliance markets (Phase 2) with a plan to transition to a fully-fledged UNFCCC market mechanism once this has been operationalized (Phase 3).

During Phase 1, the Guyana-Norway Agreement saw Guyana receive over US$220 million for its REDD+ performance during the period 2009-2015. Phase 2 saw payments from the voluntary carbon markets received for performance from 2016 onwards, albeit the first payments were received in 2022. To date in Phase 2, Guyana has earned US$187.5 million from sales in the voluntary carbon market (for results in the period 2016-2020), with a further US$100 million to come for the remainder of the period covered in this Technical Annex (2021 and 2022).

Building from these positive foundations, the expected opportunity to access carbon financing for forest climate services and other ecosystem services will continue to enable Guyana to participate in emissions reduction while, at the same time, growing its economy five-fold over 20 years, keeping energy emissions flat, investing in its people, both indigenous in the hinterland communities and the vast majority living along the coast, from climate change; create jobs; and integrate Guyana's economy with its neighbours (LCDS, 2022). Guyana

Guyana stayed true to the vision in 2009 to create a model low-carbon economy for the world and submitted its reference level for REDD+ to the UNFCCC in 2015. Based on Guyana’s performance, incentivised by results-based payments and then access to the voluntary carbon market, the country maintained an average annual low deforestation rate below 0.06% in the last ten years, with the latest being 0.036% in 2022.

Guyana is preparing to submit its revised FREL in 2024.

Chapter 1: OVERVIEW OF GUYANA'S FREL/FRL

Guyana submitted its national proposed forest reference emission level (FREL) on December 8, 2014, in accordance with decisions 12/CP.17 and 13/CP.19. Following the process contained in the guidelines and procedures of the same, a draft version of the technical analysis (TA) report was communicated to the Government of Guyana, during which the facilitative exchange between the assessment team (AT) and Guyana enables the country to provide clarifications and information considered by the AT. Guyana resubmitted a modified version of its FREL on April 27, 2015, which took into consideration the technical input by the AT, and it is on the revised FREL that the technical assessment was conducted. The technical assessment report was published on October 13, 2015 (FCCC/TAR, 2015).

Guyana's FREL is based on a "combined reference level approach," which provides incentives for all categories of forest countries and encompasses REDD+ in its entirety. A full explanation of the background was set out in Guyana's initial submission in section 6.2 (page 44) but its rationale was summarized in the Eliasch Review[3], which was produced for the Government of the United Kingdom: "The combined [reference level] has the potential to be sufficiently comprehensive to attract countries at all stages of the deforestation process over both the short and long term. Countries with high historical rates of deforestation receive strong and realistic incentives to reduce forest emissions. At the same time, countries with standing forests and a track record of avoided deforestation would receive incentives to keep deforestation rates low, zero or negative (if, for example, rates of ARR are high). This rewards countries with a history of responsible forest policies while reducing the risk of international leakage of deforestation to these countries."

The FREL uses a global forest carbon emissions loss of 0.435%, the historical annual forest carbon emissions percentage of Guyana for the period 2001–2012 (0.049%), resulting in the FREL being 0.242% which is the average of the two. Guyana includes emissions from deforestation and forest degradation due to timber

[3] Eliasch Review - GOV.UK (www.gov.uk)

harvesting practices in its FREL. At that time, it excluded removals from carbon stock enhancements, though it should be noted that more than 80% of the national territory is forested. Historically, there have been few activities related to enhancing forest carbon stocks, for which the reference level was developed, covering the period 2001-2012. The FREL considers national circumstances and Guyana's ongoing development in creating new economic and social incentives, which can significantly impact rates of forest cover. Table 1 lists the main features of Guyana's FREL (FCCC/TAR, 2015).

Table 1 Summary of the Main Features of Guyana's FREL

Features of the FREL		Description
Proposed FREL (t CO_2 e yr^{-1})	46 301 251	Calculated from the estimated combined Guyana and global reference emissions percentage of 0.242%. The reference level is represented as the number of emissions.
Type and duration of FREL	Combined reference level approach	Guyana's historical period of 2001–2012 is considered and adjusted for national circumstances combined with the global average reference level approach.
National/subnational	National	Guyana's FREL is of national coverage.
Gases included	CO_2	Only CO_2 gases are included in the combined FREL.
Carbon pools included	Aboveground biomass, belowground biomass, Deadwood	All five carbon pools were considered for Guyana, but owing to limitations in the global data used to construct the combined FREL, only three pools were used.
Activities included	Deforestation Forest degradation	Includes the gross emissions from deforestation (excluding regrowth from deforestation and forest degradation), including all types of land conversion to non-forest land, and the gross emissions from selective logging under forest degradation.
Forest definition	Included	Minimum tree canopy cover of 30 per cent, minimum land area of 1 ha, and minimum tree height of 5 m in situ
Relationship with the latest GHG inventory	Methods used for FREL differ from the latest GHG inventory (2012)	The difference in methods is due to the use of updated data and the 2006 IPCC Guidelines used in the FREL as compared to 1996 used in compiling the GHG inventory reported in the Second National Communication.
Adjustment for national circumstances	Yes	The global emission levels were used for adjustments as Guyana's historical emission trend is unlikely to predict future emissions accurately.
Description of relevant policies and plans	Included	Included in section 6.1 of the FREL submission
Description of assumptions on future changes in policies	Included	The national circumstances and future perspective describe ongoing policy frameworks and planned new policies and measures.
Future improvements identified	Yes	Some technical improvements are identified, and their submission is planned.

Source: (FCCC/TAR, 2015), Annex

1.1 Information on Forest Definition and Land Tenure

In Guyana, the forest is defined as having "*a minimum area of land of 1 ha with tree crown cover of more than 30% with the potential to reach a minimum height of 5 m at maturity in situ*" (GFC, 2010). This definition is guided by the Marrakech Accords (UNFCCC 2001[4]) and the components suggested by the FAO. Guyana's forests are categorized as tropical rainforests, including high-density forests, secondary forests, mangroves, etc. Approximately 50% of Guyana's State Forest Estate is unallocated, while the remaining 50% is subject to sustainable utilization for commercial operation, whereby extraction levels are strictly monitored based on approved guidelines. These extractions result in deforestation and forest degradation.

Forests in Guyana are managed and administered under the Guyana Forestry Commission Act 2007 and the Forest Act 2009. There are four main forest tenure classifications in Guyana distributed across the national territory of 21.1 million hectares spanning from 2 to 8° N and 57 to 61° W, with a coastline running along the Atlantic Ocean of approximately 16km wide and 459 km long.

- **State Forest Area** - According to the Forest Act Section 3, Chapter 61:01, it is defined as "an area of State Land that is designated as a State Forest" as per the gazette.
- **Titled Amerindian Lands** - The Amerindian Act 2006 provides for areas that are titled Amerindian villages. It includes lands initially titled and the extensions for which titles are issued.
- **Protected Areas -** These are areas that fall under the scope of the Protected Areas Act. To date, Iwokrama, Shell Beach, Kanuku Mountains, and Kaieteur National Park, which account for a total of 1.1 million ha, have been designated as Protected Areas (see Figure 1).
- **State Lands** - State Lands are identified as areas that are not included as part of the State Forest Area that is under the mandate of the State. This category predominantly includes State Lands, with isolated pockets of privately owned land, excluding titled Amerindian lands.

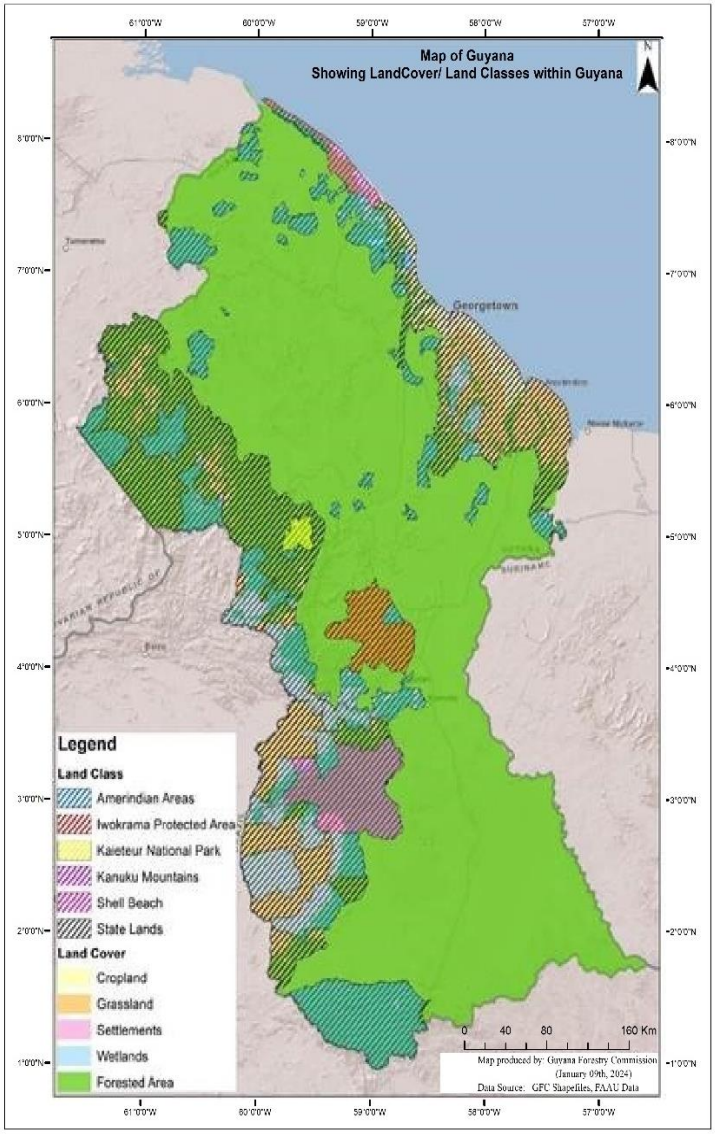


Figure 1 Guyana's Land Use Classes

[4] Marrakech Accords (2001): https://unfccc.int/cop7/documents/accords_draft.pdf

1.2 Setting the FREL

Guyana's FREL is set at the national scale in compliance with the various UNFCCC requirements and is based on the detailed and robust analysis of historic emissions from deforestation and forest degradation for the period 2001 to 2012. Table 2 lists the multiple variables and attributes used in developing Guyana's FREL in compliance with the UNFCCC modalities and the various Decisions.

Table 2 UNFCCC Modalities Relevant to Guyana's National FREL

Guidelines	Description	Guyana's FREL
Decision 12/CP.17 Paragraph 10	Allows for a stepwise approach	FREL is at a national scale and includes all drivers of deforestation and forest degradation due to selective logging only.
Decision 12/CP.17 Annex, paragraph (c)	Pools and gases included	**Pools:** • Aboveground and belowground biomass • Deadwood is included in degradation from timber harvest only. **Gases:** CO_2
	REDD+ Activities: deforestation and forest degradation	**Deforestation Drivers:** Agriculture, mining, forestry infrastructure, and other infrastructure. **Forest Degradation** from timber harvesting only
Decision 12/CP.17 Annex, paragraph (d)	The definition of forest used is the same as that used in the national GHG inventory.	Minimum tree cover: 30% Minimum height: 5 m Minimum area: 1 ha
Decision 12/CP.17 Annex	IPCC guidelines and Guidelines used	IPCC 2003 and 2006 guidelines.
Decision 12/CP.17 II. Paragraph 9	To submit information and rationale on the development of forest RLs/RELs, including details of national circumstances and how the national circumstances were considered.	Guyana is an HFLD country (having over 87% forest cover and an average deforestation rate of below 0.06%). The FREL uses a holistic methodology that includes countries like Guyana, as well as other categories of forest countries and therefore avoids perverse incentives so as to act as an incentive against leakage and in support of additionality and permanence in countries like Guyana.

1.3 Construction of the FREL

Guyana's proposal for a Reference Level for REDD+ illustrated in Figure 2 is based on the Combined Reference Level Approach, in which a global forest carbon emissions loss ((Baccini, et al., 2012) was used, along with Guyana's historic emissions level for the same pools and period 2001 to 2012. The FREL was derived by averaging the global percentage of forest carbon emissions of 0.435% and Guyana's historical annual average of 0.049%, resulting in Guyana's proposed FREL being set at 0.242%, which is equal to 46,301,251 t CO_2 e yr^{-1}.

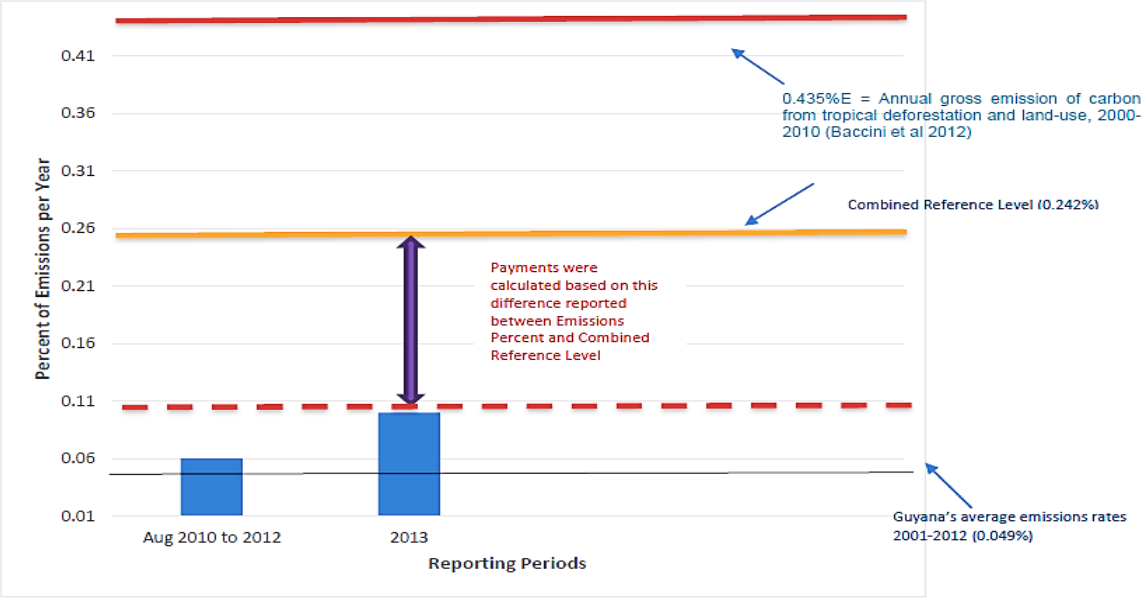


Figure 2 Guyana's for Reference Level for REDD. Source: (GoG, 2015) Fig. 8

1.4 Emissions Drivers Considered in the FREL

Emissions are calculated for each driver considered in Guyana's FREL and projected impacts. These drivers include forestry, mining, agriculture, infrastructure, and other developments. Table 3 lists the projected allocation of emissions each driver will contribute to the reference level. While the FREL is built on historical data, it is understood that adjustments will be made over time as existing and new policies are implemented, new data becomes available, methodology evolves, and national circumstances change.

Table 3 Guyana's FREL by Drivers

Drivers of Projected Emissions Level	Policies	Percentage of Contribution to Reference Level	Total Emissions attributed to driver (thousand tCO_2)
Forestry	EU FLEGT, Reduced Impact Logging and SFM, National Log Tracking and Chain of Custody Management.	20	9,260
Mining	EITI, Codes of Practice, Reduced Use of Mercury, More Efficient Technologies.	49	22,688
Infrastructure, including Brazil/Guyana Road	Scoping of Development, Environmental and Social Impact Assessment (ESIA).	9	4,167

Agriculture	Scoping of Development, ESIA.	4	1,852
Other Developments, such as in Alternative Energy	Scoping of Development, ESIA.	18	8,334
TOTAL			**46,301**

Source: (GoG, 2015) Table 13b

1.5 Annual REDD+ Performance Based on Reference Level

Annual Reported Emissions per cent under the FREL is computed by dividing the annual reported forest carbon emissions loss by the total forest carbon stock of Guyana that is concluded following measurement and verification, inclusive of the establishment of accuracy levels, which is then subtracted from the Combined Average of 0.242%. The Total carbon stocks in life biomass (aboveground and belowground pools) for Guyana is 5,218 million t C (area weighted average is 283 t C ha^{-1}), and the total emissions are 2.55 million t C yr^{-1}, giving an average rate of loss of 0.049%/year (GoG, 2015). These average carbon emissions of 46,301,251 t CO_2e yr^{-1} or 0.242% are used as the baseline for computing and reporting on Guyana's REDD+ activities. The Annual performance is measured against the proposed emissions by the drivers listed in Table 3.

1.6 Technical Evaluation of FREL/FRL

The UNFCCC Technical Assessment Report (TAR) of Guyana's proposed FREL/FRL recognized that the information used in its construction for reducing emissions from deforestation and reducing emissions from forest degradation is transparent and complete and is in overall accordance with the guidelines for submissions of information on FRELs (as contained in the annexe to decision 12/CP.17) (FCCC/TAR, 2015).

As a result of the facilitative interactions with the assessment team (AT) during the technical assessment (TA) session, Guyana submitted a modified submission considering the technical input by the AT, resulting in improvement in the transparency and completeness of the information, an effort the AT noted as commendable. The AT notes that the data used in the construction of the FREL are considered accurate. Guyana was encouraged to continually build on GhG datasets in the preparation of subsequent GHG inventory on forest-related emissions report submissions.

Guyana was commended for the information provided on its ongoing work in the development of FRELs to improve the accuracy and coverage of the estimations by the assessment team. The TAR also acknowledges that Guyana included in the FREL the most significant activity and pools in terms of emissions from forests and that the FREL covers the entire national territory of Guyana, complying with decision 1/CP.16, paragraph 70, on activities undertaken, paragraph 71(b), and decision 12/CP.17, paragraph 10, on implementing a stepwise approach.

The TAR acknowledged that the combined reference level approach used by Guyana in its submission was developed in 2009 before any of the relevant COP decisions were adopted. The AT concludes that the combined reference level approach applied by Guyana is appropriate as an interim approach.

A partnership between Guyana and Norway was agreed to and detailed in a joint concept note outlining the basis of Guyana receives results-based payments in accordance with agreed performance measures - with one of the main measures being the annual deforestation rate, measured against Guyana's FREL.

The intention expressed by Guyana to continue monitoring forest and its related emissions, continued efforts to estimate emissions from other drivers of forest degradation in addition to selective logging, which had not been quantified at that time, efforts to estimate removals due to regrowth, which has also not been quantified at that time; carrying out research and gathering information in order to improve the transparency and accuracy of the approach used to estimate its FREL; and efforts to prevent any double counting between deforestation and forest degradation in its future monitoring system, was commended by the TA in the TAR. Future technical improvements include improving the way effects of national circumstances, policies and programs are quantified and reflected in the FREL, assessing pools and gases included in the FREL, and considering non-CO_2 gas emissions when additional sources of emissions are included in the FREL was reported by Guyana.

Chapter 2: GHG EMISSION REDUCTIONS AND REDD+ RESULTS

Guyana's unique position as a country with vast forests and diverse ecosystems provides significant opportunities for REDD+. Guyana balances its economic development goals with sustainability and takes a proactive approach to addressing emissions to mitigate the impacts of climate change. For consistency, transparency, and comparability purposes, this submission will only consider REDD+ covering the period 2013 to 2022. As such, the results present herein will reflect this period. Notably, there have been improvements since the submission of the FREL in 2015, which are reflected in the current BUR submission and this technical annex. Some of these differences are reflected in the drivers of deforestation and degradation, as well as the methodology and emissions factors used, which are discussed in the methodology section of this report REDD+ Results.

Guyana developed a framework for a national Monitoring Reporting and Verification System for REDD+ in 2009, outlining progressive steps over three phases to build and implement a complete MRV system, with the first year of reporting being 2010. From this period, the country generated annual REDD+ results, which are tracked and verified by a third party as part of its verification process embedded in its standard operating procedures, adding a layer of transparency to the results published annually. To date, twelve (12) annual MRV reports have been published, for which initial feedback is received and addressed before their finalization and publication. The primary purpose of these reports is to report on the country's annual REDD+ performance on deforestation and degradation and to provide critical information used to inform and shape national policies and strategies.

2.1.1 Annual Emissions from Deforestation and Degradation

In Guyana, forest is defined as "Land exceeding 1 hectare with trees exceeding 5m in height and 30% crown cover but not classified as agriculture, infrastructure or settlements" (GFC, 2017). An area is deemed deforested once the cover falls and remains below the elected crown cover threshold of 30%, which is guided by the GOFC-GOLD, 2010[5] definition of "the long-term or permanent conversion of land from forest use to other non-forest uses."

[5] GOFC-GOLD (2010): https://redd.unfccc.int/uploads/63_33_redd_20120509_gofc-gold.pdf

Figure 3 presents Guyana's annual REDD+ performance by deforestation and forest degradation for the accounting period 2013-2022. Despite having information for all five IPCC-recommended carbon pools available, Figure 3 only includes emissions for the aboveground and belowground carbon pools to ensure alignment with the FREL as much as possible. Despite measuring additional drivers since the submission of the FREL, to ensure consistency in reporting against the FREL, only those drivers listed in the FREL are presented in Figure 3. In contrast, for completeness purposes, Figure 4 offers the emissions for all currently measured drivers.

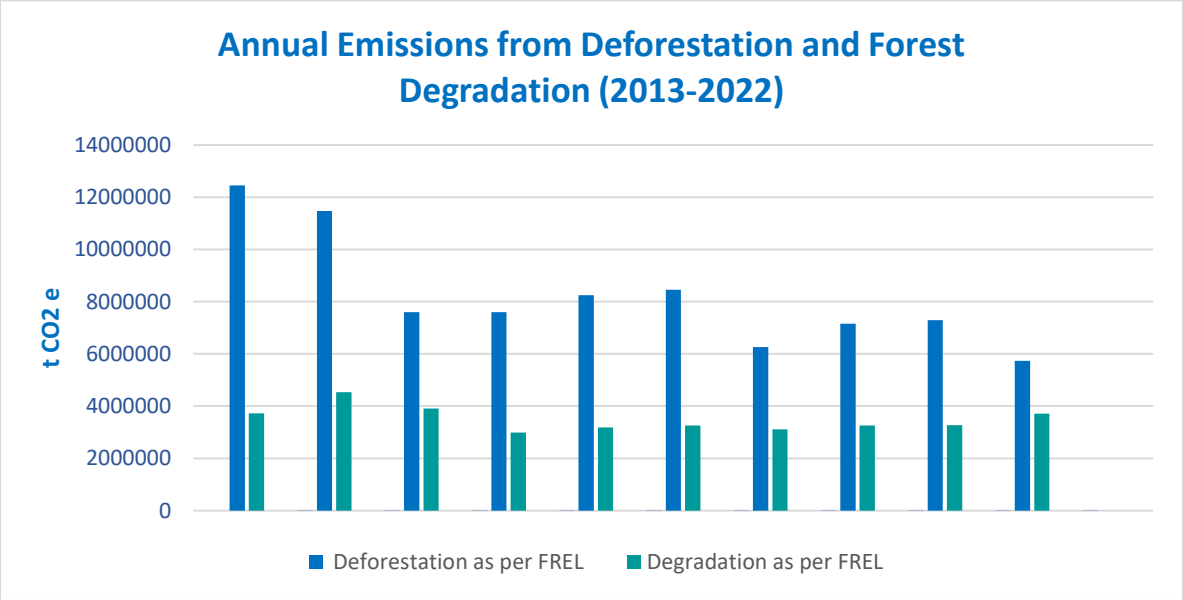


Figure 3 Annual Emissions from Deforestation and Forest Degradation as per FREL

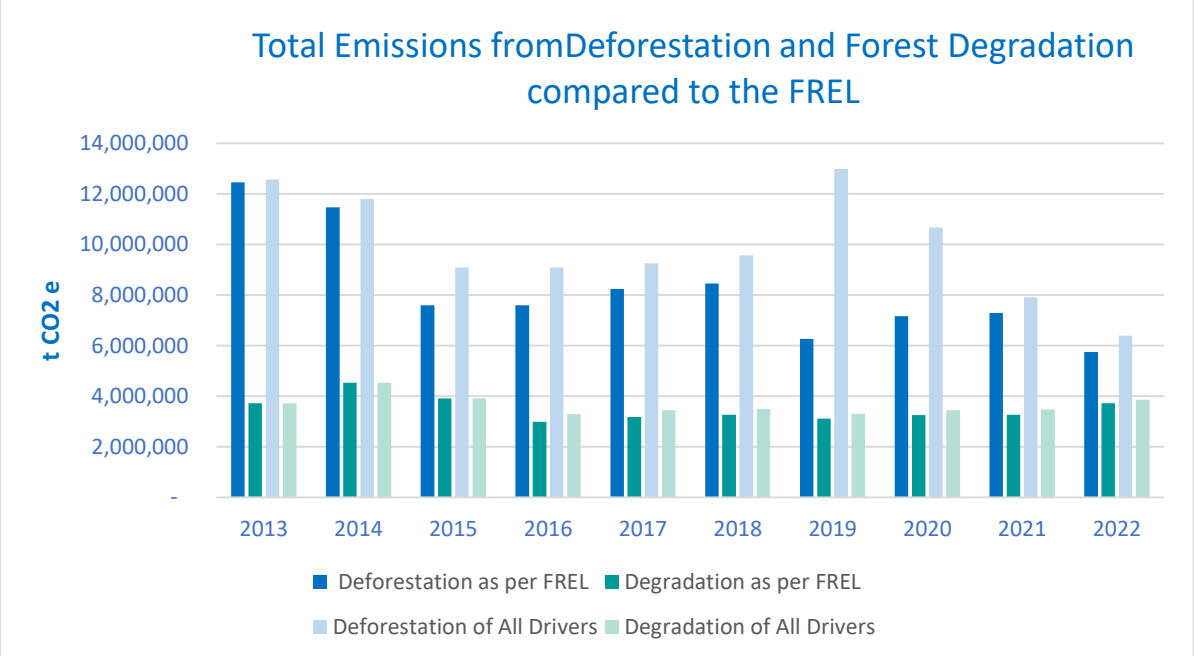
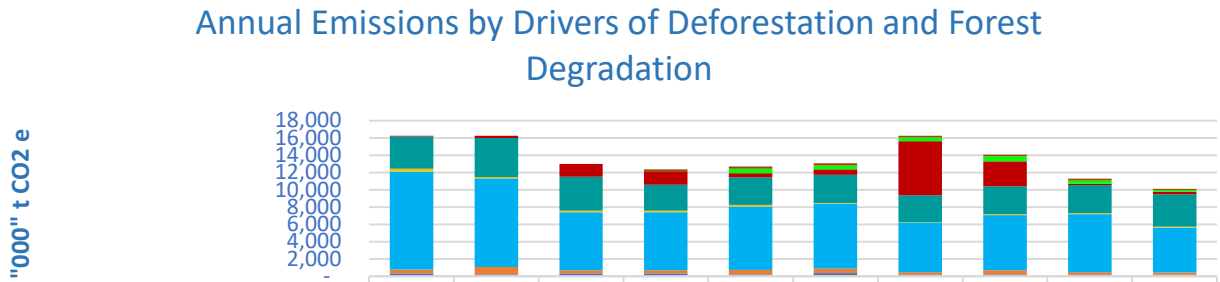


Figure 4 Actual Emissions from Deforestation and Foret Degradation compared to FREL

Over the reporting period, emissions resulting from forest degradation have remained largely consistent. However, deforestation fluctuates, mainly due to mining, which remains the major driver in Guyana, as seen in Figure 3 and Figure 4. The drivers of deforestation and forest degradation contributing to the annual emissions

are presented in Figure 5. While emissions from forest degradation remain almost constant over the reporting period, those from deforestation fluctuate. While fire as a driver is not included in the FREL, it is being tracked as part of the current MRV system.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mining and Infrastructure Deg.	-	-	-	296	257	227	186	184	215	149
Shifting Cultivation	-	-	-	-	511	451	446	574	386	153
Fire	94	254	1,482	1,482	493	649	6,257	2,880	137	328
Logging	3,725	4,533	3,910	2,988	3,181	3,259	3,110	3,254	3,267	3,715
Infrastructure	337	139	214	214	192	66	51	101	115	109
Mining (medium and large scale)	11,343	10,275	6,679	6,679	7,329	7,508	5,733	6,354	6,721	5,184
Agriculture	443	853	396	396	498	534	257	510	225	294
Forestry infrastructure	325	201	308	308	224	351	223	193	225	153

Figure 5 Annual emissions by drivers of deforestation and forest degradation

It should be noted that the emissions from deforestation and forest degradation for these years presented in this REDD+ TA will not align completely with those reported in the greenhouse gas inventory chapter attached to the BUR, as the BUR includes the methodological advancements made since 2015 and revisions made to the crediting baseline. Since submitting the FREL, Guyana has improved its data collection and expanded the drivers, carbon pools, and gases covered to enhance the completeness and accurate reporting of the country's REDD+ Performance to enhance transparency. The new drivers that are included in the country's GHG inventory for deforestation are settlements and biomass burning, and degradation resulting from mining infrastructure, which are reflected in the national GHG inventory. Special studies were done on shifting agriculture which was previously presented as part of Agriculture. Shifting agriculture occurs in the hinterland areas of Guyana, and was separated out from agriculture. The mapping signature is unique as compared to other forms of agriculture, thereby avoiding double counting. Guyana's Standard Operating Procedures for Mapping, provides details on this. A revised FREL to be submitted will reflect the new national circumstances and include these updates.

2.2 REDD+ Results Relative to FREL

For the reporting period 2013 to 2022, Guyana's average annual emissions, as per the FREL, is 13,576,274 t CO_2e, while the average yearly reduction is 32,724,977 t CO_2e. These emissions vary over the years, as illustrated in Figure 6, with an almost consistent decrease in the country's emissions. From the results generated, Guyana is well below its FREL baseline, and considering the evolving national circumstances and data availability, the FREL is being revised. Table 4 lists the annual emissions by drivers reported in the FREL.

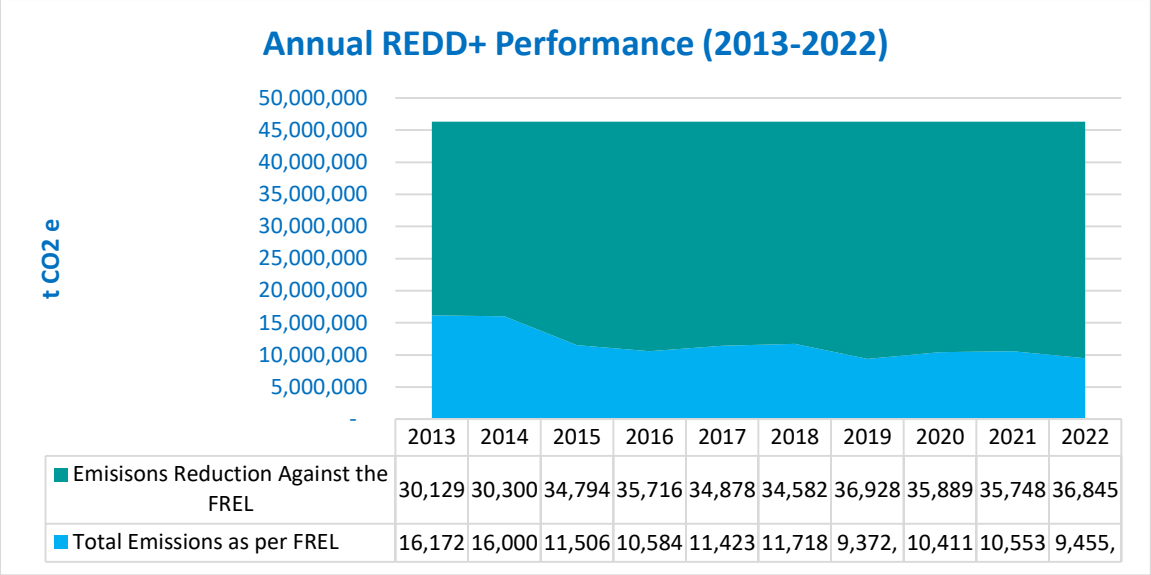


Figure 6 Annual REDD+ Performance in Relation to the FREL Baseline

Table 4 Annual Emissions by Drivers reported in the FREL

Drivers	Deforestation (t CO_2 e)				Forest Degradation (t CO_2 e)
	Forestry Infrastructure	Agriculture	Mining	Infrastructure	Logging
2013	324,987	442,603	11,343,021	336,804	3,724,737
2014	200,901	852,847	10,275,489	138,858	4,532,569
2015	308,245	395,629	6,678,969	213,703	3,910,404
2016	308,245	395,629	6,678,969	213,703	2,987,896
2017	223,551	497,929	7,328,943	192,038	3,180,717
2018	350,592	534,465	7,508,178	65,982	3,259,093
2019	222,567	256,793	5,732,569	51,210	3,109,512
2020	192,518	510,417	6,354,080	100,927	3,253,797
2021	224,536	225,477	6,721,316	115,223	3,266,693
2022	153,202	293,978	5,184,289	108,879	3,714,932

2.3 REDD+ Results-based Finance Received

Guyana's performance to date in relation to the baseline sent in the FREL, illustrates its performance well below that set, which has resulted in the country's being rewarded with carbon financing to date. For the period 2009-2015, Guyana received carbon financing based on results-based payments. One of the key considerations in Guyana's FREL for REDD+ was the integration of a financial incentives baseline with payment computation, which Guyana has successfully done to date. In the mechanism used in the bilateral agreement between Guyana and Norway, a sliding scale was integrated as part of the incentive mechanism. The performance generated by Guyana's forests was monitored, reported, and verified under the national-scale Monitoring, Reporting and Verification System (MRVS) put in place by the Guyana Forestry Commission (GFC). In expressing Guyana's commitment to REDD+ and prioritizing this commitment while developing, the 0.056% deforestation cap ceiling for emissions levels for the agreement period was established on which payments were made. In the years that Guyana exceeds this 0.056 % rate, the payments are reduced on a sliding scale up to the rate of 0.1 per cent, at

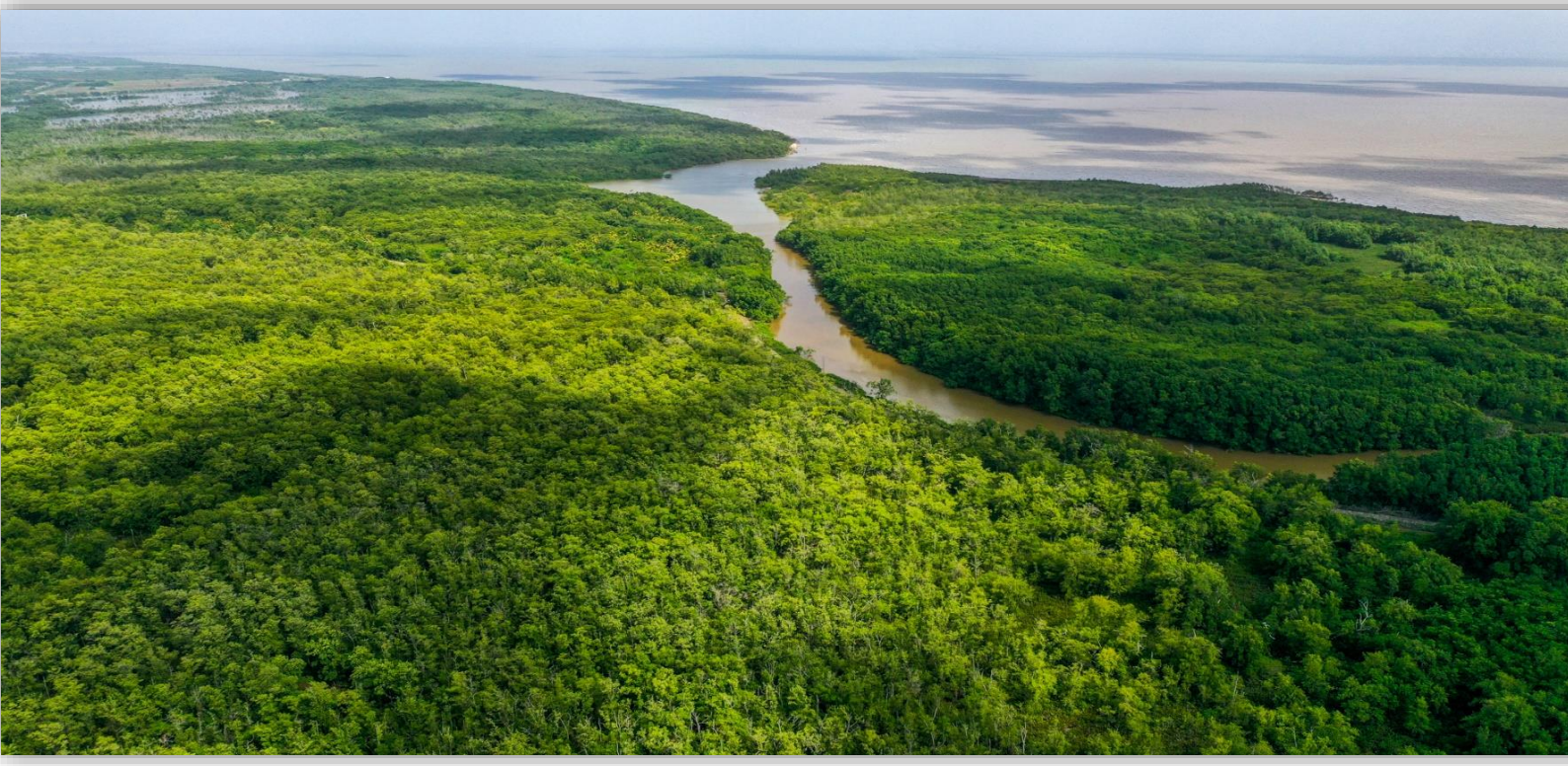
which point, there are no payments made. On the signing of this agreement in 2009, the first climate finance payment was made. While the payments received and country performance stands outside of this reporting period for emissions covered in this report, they are included for clarity and completeness purposes. From this partnership, Guyana received a total of USD 220,800,000 for the performance period 2010 to 2015 (LCDS, 2022).

Table 5 Performance-based Carbon Finance

Year	Channel of Disbursement	Results-based payment
2009 Performance Payment	GRIF	30,355,594
2010 Performance Payment	GRIF	39,474,415
2011 & 2012 Performance Payment	IDB	80,034,965
2013 Performance Payment	GRIF	43,886,657
Direct Disbursement for Capacity Building and EU-FLEGT Projects	CI	14,815,886
Direct Disbursement for Village Sustainable Plans	CI	4,000,000
TOTAL RECEIVED FROM NORWAY		**212,597,518**
Investment Income – GRIF (World Bank Trustee Account)	-	**3,200,000**
Investment Income – IDB Renewable Energy Account	-	**5,100,000**
TOTAL REDD+ FINANCE		**220,800,000**

Source (LCDS, 2022)

While no other finance was generated under this agreement outside of those listed in Table 5 Performance-based Carbon Finance, Guyana maintained its MRV system to ensure permanence, which continues to generate results. This system has allowed Guyana to access the voluntary carbon market in 2022 – and to sell carbon credits for the period 2016-2030, including the period covered by this TA, for which it has successfully received USD187,500,000 to date, with a further US$100 million to come for the period covered in this TA. Guyana intends to continue to improve its system and pursue additional avenues for generating carbon financing while simultaneously fulfilling its obligation under the Paris Agreement of the UNFCCC.



Chapter 3: CONSISTENCY OF METHODOLOGIES BETWEEN THE REDD+ RESULTS AND THE ESTABLISH FREL

The method used to generate the REDD+ results is consistent with the FREL. Both methods use the same forest definition and land use classification and share the same REDD+ activities, maintaining the same carbon pools, gases, and national scales. However, a few improvements can be found in the development of the activity data and emissions factors, owing to the availability of updated national data. These were as a direct follow up to the recommendations made by the Technical Review. This chapter presents the information necessary to allow for the reconstruction of the results and the methodologies used for their generation.

3.1 Use of the Most Recent IPCC Guidance and Guidelines

Both the FREL and this REDD+ Technical Annex (REDD+TA) used the 2006 IPCC Guidelines (IPCC, 2006); however, the emissions factors reflect improvements as more information, studies, and methodologies have resulted in changing approaches since the submission of the FREL. Table 6 summarises the use and consistency of methods used in the FREL and the REDD+ TA to enable reconstructions of the estimate's calculations.

Table 6 Comparison of FREL and REDD+TA for reconstruction of calculation

Parameters	FREL	REDD+TA
IPCC Guidelines	2006 IPCC Guidelines	2006 IPCC Guidelines
REDD+ Activities	Reduction from deforestation and forest degradation	Reduction from deforestation and forest degradation
Forest Definition	30% canopy cover, >1ha, >5m in situ	30% canopy cover, >1ha, >5m in situ
Carbon Pools	-Aboveground -Belowground biomass -Deadwood included in degradation from timber harvest only.	- Aboveground biomass -Belowground biomass -Deadwood included in degradation from timber harvest only.
Gas	CO_2	CO_2

Deforestation Drivers	-Forestry infrastructure -Agriculture -Mining (medium and large scale) -Infrastructure	-Forestry infrastructure -Agriculture -Mining (medium and large scale) -Infrastructure
Degradation Drivers	-Logging volume harvested	-Logging volume harvested
Forest Stratification	High Potential for Change More Accessible Area High Potential for Change Less Accessible Area Medium Potential for Change More Accessible Area Medium Potential for Change Less Accessible Area High Potential for Change More Accessible Area Low Potential for Change Less Accessible Area	Combined Single Stratum. The methods applied across all strata remain unchanged. Additional data was collected and added to the data sets.
Activity Data	Disaggregated by deforestation and forest degradation drivers by stratum	Disaggregated by deforestation and forest degradation drivers
Spatial Mapping	1ha minimum mapping unit	1ha minimum mapping unit
Emissions Factor	Developed by stratum (Tier 2).	Combine emissions factor (Tier 2).
Data Source	GFC Annual MRV Reports	-GFC Annual MRV Reports -Verification Reports

3.2 Methodology for Deriving the Activity Data

Guyana developed its activity data for deforestation and forest degradation using spatial and non-spatial methods. The spatial method is applied for tracking deforestation and some degradation depending on the area size against the forest definition. In contrast, the non-spatial method is applied to forest degradation resulting from logging. The activities developed and tracked in the GIS systems and databases are summarised and listed in Table 7 (GFC, 2023).

Table 7 Activities by Drivers of Deforestation and Degradation captured in the Activity Data

	Activity	Driver	Criteria	Supporting Info	Spatially Mapped
Deforestation	Roads	Infrastructure	Roads > 10m	Mapped layers, satellite imagery	Yes
	Mining	Infrastructure	Roads >10 m	Existing road network, satellite imagery	Yes
	Agriculture	Deforestation	Deforestation sites >1 ha, including shifting cultivation occurring outside the village buffer extent	Registered agricultural leases, satellite imagery	Yes

Forest Degradation	Forestry	SFM	Harvested timber volumes and illegal logging totals.	Annual harvest plans, GIS extent of timber concessions	No

For synergy and ease of reporting under the IPCC, the land use changes from forests are now being classified as transitioning to one of the other five land use classes (croplands, grassland, wetlands, settlement, and other lands). Natural events considered non-anthropogenic change are excluded from the deforestation or degradation estimates, which are typically non-uniform in shape and have no evidence of anthropogenic activity nearby. These are mapped in the GIS for completeness.

3.2.1 Methodology for Deriving the Spatial Activity Data for Deforestation

The datasets used for deriving the activity data from the change analysis have evolved as more tools and methods become available. Initially, the historical change analysis from 1990-2009 was conducted using Landsat imagery. In 2010, a combination of DMC and Landsat, 2011 onwards, was superseded with high-resolution images, including Rapid Eye and Sentinel. For 2015 and 2016, a combination of Landsat and Sentinel data was used, which is the preferred combination in the future to ensure sustainability and consistency in generating the activity data. During the reporting period, the forest/non-forest boundaries were improved, but the forest area also changed, particularly at two points in time, 2012 and 2014. While the data sets have changed in terms of the satellite image utilized, the methodology for change detection remains the same.

Guyana developed a process that enabled the tracking of changes in areas of more than 1 ha spatially over time and by drivers. The system is primarily built to track forest area changes in keeping with international best practices. The method utilizes a wall-to-wall approach that enables complete, consistent, and transparent monitoring of land use and land-use changes across the forest over time. The technique used allows for land cover change greater than one hectare in size to be tracked through time and attributed by its driver (i.e. mining, agriculture, infrastructure, or fire). The approach employed is to divide the country into a series of regularly spaced 24 x 24 km tiles. The mapping process involves a systematic manual review of each 24 x 24 km tile, divided into 1 km x 1 km tiles at a resolution of 1:8000. If a cloud is present, multiple images over that location are reviewed.

Guyana's GIS-based monitoring system is designed to map change events in the year of their occurrence and then monitor any changes over the area each year. If an area remains constant, the land-use class and change driver are updated to stay consistent with the previous analysis. However, where change is detected, this is recorded using the appropriate driver. Each change is attributed to the acquisition date of the pre- and post-change image, the driver of the change event, and the resultant land-use class. Upon completion of the change detection per tile, they undergo a quality assurance quality control process, after which they are stitched together. After stitching, the total area per driver is generated, and this total undergoes the final level of quality assurance.

The mapping criteria are set and dictated by a set of mapping rules on how each event is classified and recorded in the GIS under a standard operating procedure guideline developed as part of the MRV system. The input process is standardized using a customized GIS tool, which provides a series of pre-set selections that are saved as feature classes. The mapping process is divided into mapping and QC. The QC team operates independently of the mapping team and is responsible for reviewing each tile as it is completed. Additional GIS layers are also included in the decision-making process to reduce uncertainty. The decision-based rules are outlined in the mapping guidance documentation or Standard Operating Procedures (SOPs).

In 2018, the forest area was revised to remove areas of historic shifting cultivation that surrounded settlements. This change was made based on a study that concluded that these areas should be considered non-forest, which aligns with Guyana's forest definition (GFC W. I., 2019b).

All mapped results are subject to an Independent Accuracy Assessment. These Reports are published as part of the MRVS Reports and conclude that the reported nationally mapped results compare closely to the independent findings.

3.2.2 Methodology for Deriving Non-Spatial Activity Data for Degradation

The primary sources of degradation are those associated with logging, including forest management-related losses, selective harvesting of timber, logging damage and illegal harvesting. This information is non-spatial and is extracted from a database being administered and managed by the Guyana Forestry Commission (GFC).

3.2.2.1 Forest Management and Production Data

Forest management includes selective logging activities in primary or semi-primary forests. The requirement is that areas under sustainable forest management (SFM) be rigorously monitored and activities documented, including harvest production data, which are used to estimate degradation. By applying the gain-loss method of the 2006 IPCC Guidelines, the production data is used in combination with default expansion factors to account for the loss.

Production volumes are recorded on declaration/removal permits issued by the GFC to forest concession and private property holders. Upon declaration, the harvested produce is verified, and permits are collected, checked, and sent to the GFC's Head Office, followed by data input into the central database. The permits include details on the product, species, volume, log tracking tag number used, removal and transportation information, and, in the case of large timber concessions, more specific information on the location of the harvesting. Production reports are generated by various categories, including total volume, submitted to multiple stakeholder groups and used in national reporting.

Following receipt of removal permits and production registers, monthly submissions are made to the GFC's Management Information System section, where the data collection, recording, and quality control are performed. Data is entered in SQL databases custom-designed for production totals. This database has built-in programmatic QA/QC controls that allow automatic validation and red flagging of tags. These checks include tags being used by unauthorized operators or permits being incorrectly, incompletely or otherwise misused. The system also allows cross-checking of basic entry issues, including levels of production conversion rates, etc. The production data are disaggregated by types and declared volumes of primary products, including logs, lumber (chainsaw lumber), roundwood (piles, poles, posts, spars), splitwood (shingles, staves), and fuelwood (charcoal, firewood). These production data by type are then used to estimate the degradation emissions. Accounting for the impact of selective logging on carbon stocks involves the estimation of several different components:

- Biomass removed in the commercial tree felled – emission.
- Incidental dead wood created as a result of tree felling – emission.
- Damage from logging skid trails – emission.
- Carbon stored in wood products from extracted timber by product class – removal.
- Regrowth resulting from gaps created by tree felling - removal.

3.2.2.2 Illegal Logging

Though there is a robust system in place, the monitoring approach provides for continuous improvements – to capture illegal logging that may occur though the risk of this is quite low. To account for this possibility, areas and processes of illegal logging are monitored and documented as far as practicable. The measurement of these activity data is done by assessing the volumes of illegally harvested wood. In 2020, the rate of illegal logging was informed by a custom-designed database updated monthly and subject to routine internal audits. This database records infractions of unlawful logging in Guyana in all areas.

Reporting on illegal logging activities is done via the GFC's 36 forest stations located strategically countrywide and by field monitoring and audit teams through the execution of both routine and random monitoring exercises. The application of standard GFC procedures determines illegal logging activities. The infractions are recorded, verified and audited at several levels. All infractions are summarised in the illegal logging database and result in a total volume being reported as illegal logging annually.

3.3 Methodology in Deriving the Emission Factor

Guyana has, over the years, developed a number of country-specific emissions factors under the national REDD+ MRV system. These include emission factors associated with both deforestation and degradation. The emission factors related to deforestation are applied to the various drivers. In contrast, those associated with degradation are applied to those drivers, which include those developed for logging damage.

3.3.1 Emission Factors for Deforestation

The development of country-specific emissions factors for deforestation in Guyana was done through a combination of spatial data and those collected in the fields (Petrova, Goslee, Harris, & Brown, 2013). In 2010, methodologies were tested to determine the most appropriate emissions factor that allows for a confident estimation of Guyan's carbon stock, which ultimately contributed to the development of its emissions factors. Guyana's Forest Carbon Monitoring System (FCMS) for REDD+ activities developed by Winrock international provide the methodology used in developing the emissions factors by applying the following:

1. Stratification of the Country forest
2. Designing the sampling approach within the strata
3. Collecting and analyzing the data to achieve a set level of confidence

The emission factor for deforestation used by Guyana in Equation 1 is the sum of all carbon stocks from all live and dead biomass pools minus the post-deforestation carbon stocks and the change in stock for the soil carbon pool. Guyana applied the stratified sampling approach to assess the various carbon pools.

Equation 1 Emissions Factor for Deforestation

$$EF_{deforestation} = \{C_{AGB} + C_{BGB} + CWD + CLT + C_{sap} - C_{post} + [C_{Soil} * F_{LU} * F_{MG} * F_I]\} * \frac{44}{12}$$

Where:

$EF_{deforestation}$ = Emission factor for deforestation; t CO2 ha-1
CAGB = Carbon stock in aboveground biomass pool; t C ha-1
CBGB = Carbon stock in belowground biomass pool; t C ha-1
CDW = Carbon stock in dead wood pools (standing and lying); t C ha-1
CLT = Carbon stock in the litter pool; t C ha-1
Csap = Carbon stock in saplings; t C ha-1
Cpost = Biomass carbon stocks following deforestation; t C ha-1
Csoil = Carbon stock in soil organic matter pool (to 30 cm); t C ha-1
FLU = Stock change factor for land-use systems for a particular land-use, dimensionless
FMG = Stock change factor for management regime, dimensionless
FI = Stock change factor for the input of organic matter, dimensionless

3.3.1.1 Stratification of the Country Forest

Guyana's forested area was stratified using a Tier 2 approach, the method that was reported in the FREL. The first stratification stratified the country into high, medium and low potential for change. These potentials for change were driven by indicators that are driving changes in Guyana (see Figure 7). The indicators were the historical drivers of deforestation, such as roads, settlements, rivers, land under different management practices, elevation, etc., using heuristic and empirical approaches in a spatial modelling framework design. Using the heuristic approach, areas close to the factor feature were ranked with higher values for change than areas further away from the factor feature.

All maps of deforestation factors created using both approaches were evaluated against historical deforestation for the periods 2000-2005 and 2005-2009, using the statistic of Relative Operating Characteristic (ROC). ROC is a method that assesses how well a factor map portrays the location of forest change for both periods without estimating the exact quantity of the change. Factor maps that show high ROC statistics were combined in different combinations to create a Potential for Change (PC) map. The Potential for Future Change (PFC) map was created following the combination of identified factors from the historical analysis.

The idea is that areas close to factor features (roads, settlements, rivers, etc.) have a higher potential for future deforestation or forest degradation due to accessibility than areas further away from these factor features. This resulted in the second stratification of more accessible and less accessible, as illustrated in Figure 7. A large portion of Guyana's forestland is less accessible, and the purpose of the sampling stratification is to overcome this operational constraint while maintaining robust sampling results. As such, the factor of accessibility was introduced in the sampling stratification methodology to provide a forest carbon sampling framework that allows for the efficient collection of carbon sampling data. The more accessible stratum is defined as a 5 km straight distance from roads, a distance which will enable a field team to travel to the sampling point, establish the plots and return to the road within one day. The less accessible stratum is defined as all forestland outside the 5 km road buffer and will require additional travel that may entail camping or air travel for drop-off.

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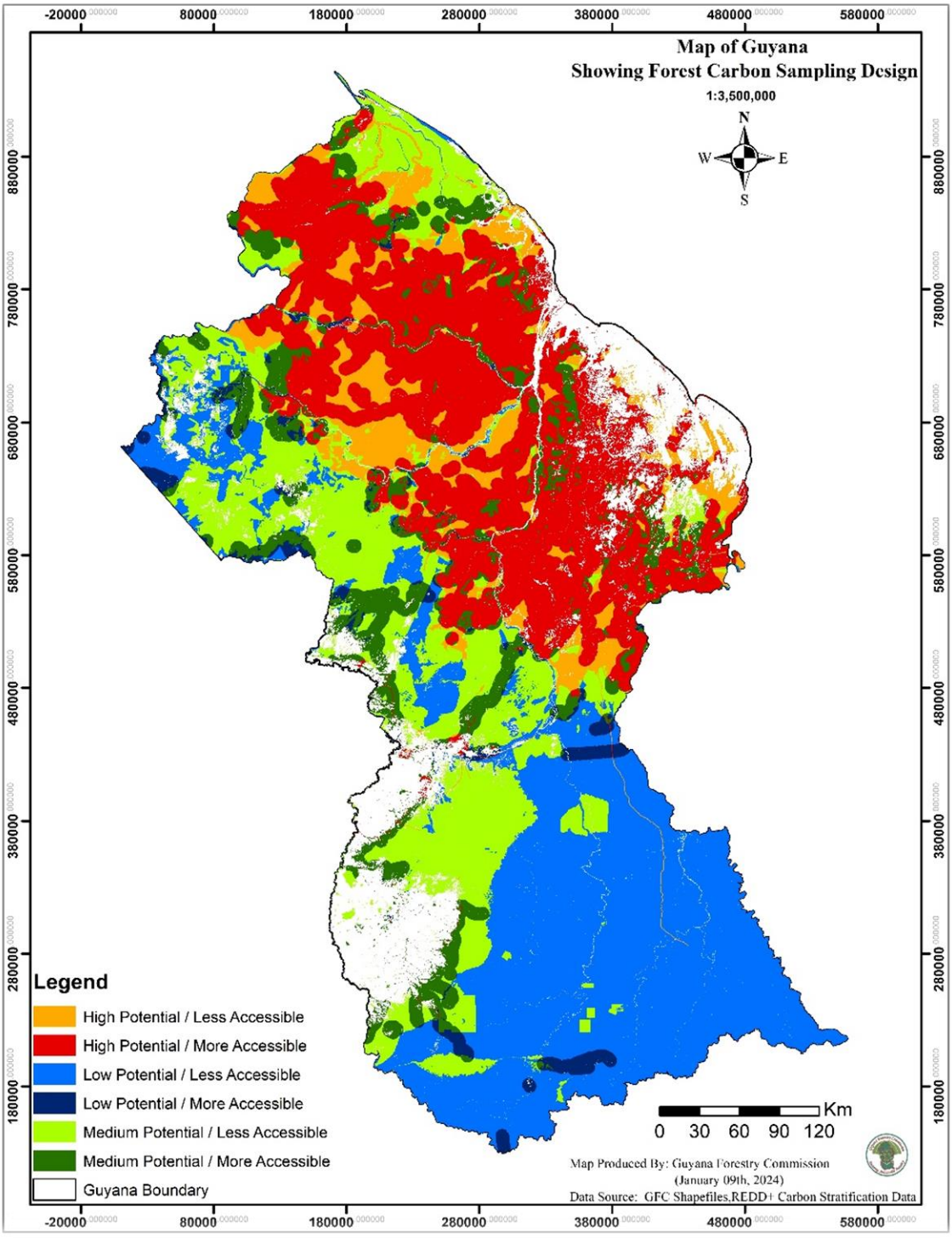

Figure 7 Guyana Forest Stratification Map

3.3.1.2 Designing the Sampling Approach Within the Stratum

Guyana's FCMS uses a stratified two-stage list sampling design with clustered plots for carbon stock assessment. Having established the six strata across the forested areas, subsets of primary sampling units (PSUs) are designed in which clustered plots of secondary sampling units (SSUs) are established. This allows field teams to achieve higher sample sizes at a relatively low cost. The number of PSUs to be sampled varies by stratum, with a greater sampling intensity (two-thirds) implemented in the more accessible strata and a lower sampling intensity (one-third) implemented in the less accessible strata. This follows the rational that areas with high accessibility have a higher chance of changing and should be sampled first.

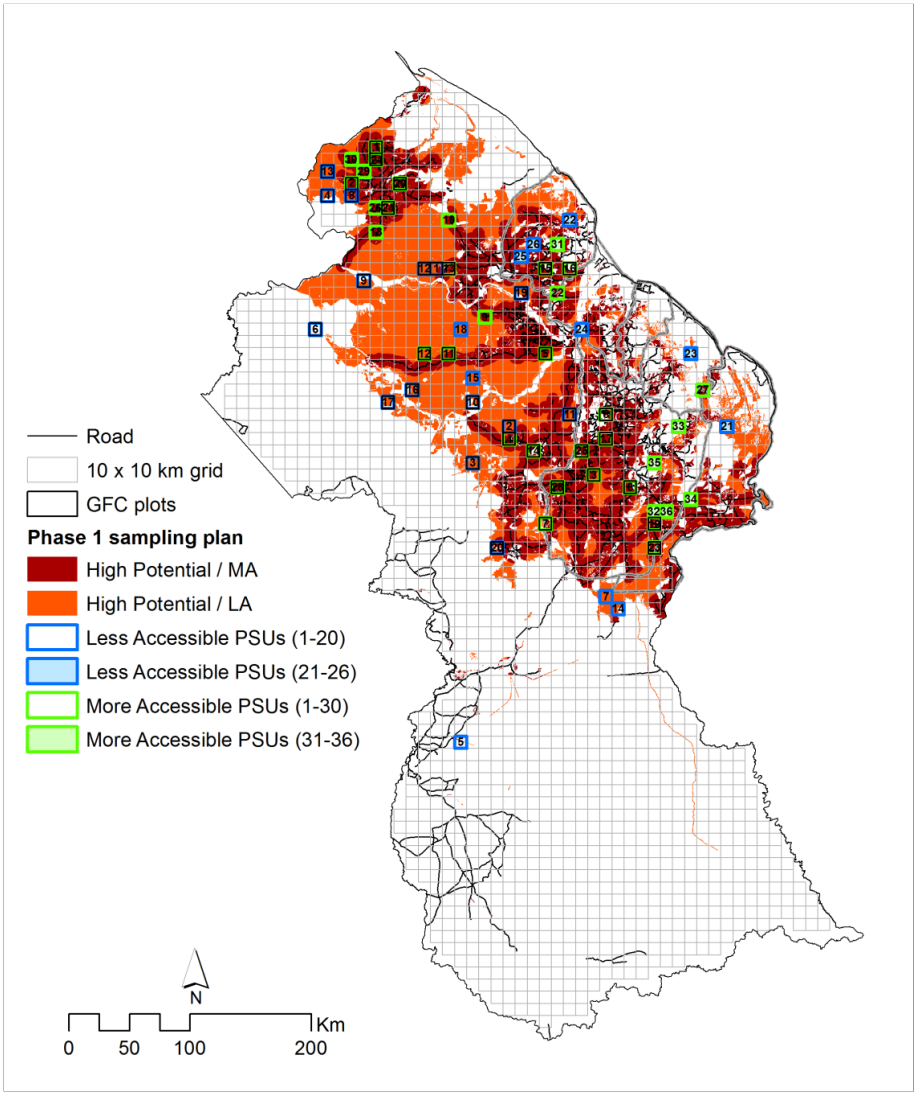

Figure 8 Guyana PSUs and SSUs by Two-tier Stratification

The PSUs are determined by laying a 10x10km grid across a map of Guyana, as illustrated in Figure 8 and identifying those grid cells which fall on the stratum of interest (for example, if data is being collected in the medium potential for change, then only those cells in orange and red will be targeted). Grid cells allow for the clustering of plots to aid in access and efficiency of data collection while focusing on the area of interest. The PSUs to be sampled are randomly selected with probability proportional to the area of a stratum of interest. The grid design of PSUs allows for systematic distribution of SSUs.

Secondary Sampling Units (SSU) are randomly located within each selected PSU with a minimum distance of 1 km from each other. By establishing three locations per SSU, the likelihood is increased that one of the SSU locations can be reached and data can be collected. The three SSU points are randomly numbered 1-3, and the field team collects data at point 1 first, failing that, point 2, and finally, point 3 if the other two are not reachable. SSU consists of a cluster of four (4) subplots established in an "L" shape intended to capture landscape variability, as shown in Figure 9. SSUs can be composed of fewer than four subplots in cases of safety concerns, or the subplot center is located in a different stratum than other subplots within SSU, in which case the subplot in different stratum shall also be sampled. Still, data from SSU will be disaggregated during the analysis. Each subplot of this SSU is further divided into nested plots from where different tree diameters are measured. This approach provides an efficient inventory distributed across the landscape.

3.3.1.3 Estimating the Biomass Carbon Stocks

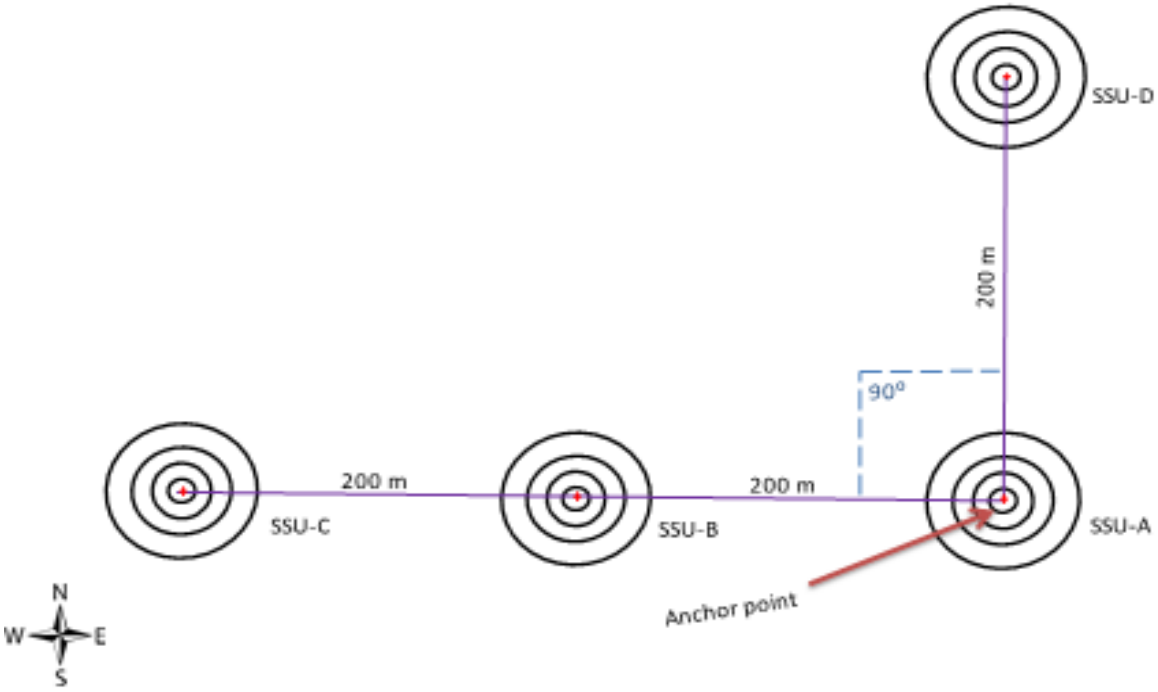

Figure 9 A Single SSU for Field Data Collection

Guyana estimated its forest carbon stocks to inform its national emissions factors for all five carbon pools (aboveground, belowground, deadwood, litter, and soils). Some of these estimates were done using field-tested allometric models (Chave, et al., 2005), others using IPCC-approved methods (Mokany, Raison, & Prokushkin, 2006), and field-collected data.

Aboveground Biomass Carbon Stock

When calculations are done, data and analyses at the plot level are extrapolated to the area of a whole hectare to produce carbon stock estimates. Extrapolation is done by the use of scaling factors that are calculated as the proportion of a hectare (10,000 m^2) that is occupied by a given nested plot by applying Equation 2. Under the methodology developed, Guyana collected information for all five carbon pools (ABG, BGB, Litter, Deadwood, and Soils).

Equation 2 Scaling Factor to Extrapolate to a hectare

$$Scaling\_factor = \frac{10{,}000m^2}{Area\_of\_nest\_(m^2)}$$

Chave et al. 2005 Equation 3 for tropical moist forest stands using diameter at breast height and wood density was used to estimate the aboveground carbon pool in Guyana (Chave, et al., 2005), as such data required for the application of this equation was collected, compiled and generated.

Equation 3 Chave et al. 2005 Tropical Moist Forest

$$AGB_{est} = \rho \times \exp(-1.499 + 2.1481 \ln(D) + 0.207(\ln(D))2 - 0.0281(\ln(D))3)$$

Where:

AGB_{est} = aboveground biomass

ρ= species-specific wood density (when not available, an average value of 0.65 g/cm3 is used)

D = diameter at breast height

Belowground Biomass Carbon Stock

Belowground is one of the most challenging carbon pools to measure. It is even more complex and impractical to measure belowground biomass in tropical forests on a routine basis, making it complicated to develop country-specific allometric equations for root biomass. Instead, belowground biomass is estimated from a well-accepted ratio, an approach Guyana has taken to determine its belowground biomass for tropical moist forests, developed by Mokany (Mokany, Raison, & Prokushkin, 2006) and accepted by the 2006 IPCC Guidelines, which reliably estimates root biomass based on live aboveground biomass Equation 4.

Equation 4 Belowground Biomass Estimation

$$BGB = 0.235 * AGB \text{ if } AGB > 62.5 \text{ t C/ha}$$

$$BGB = 0.205 * AGB \text{ if } AGB \leq 62.5 \text{ t C/ha}$$

Where:

BGB = belowground biomass carbon

AGB = aboveground biomass carbon

Deadwood Biomass Carbon Stock

The estimation of the carbon stocks in dead wood, both lying and standing, is detailed in the Standard Operating Procedures (SOPs) for Guyana's forest carbon monitoring system (FCMS). The primary methods are:

(1) **For standing dead wood** - the volume of the main stem is estimated from measurements of base diameter and height, which is then multiplied by the density of the species.

(2) **For lying dead wood** - measurements are taken to estimate the volume and its density class (sound, intermediate, and rotten) according to the FCMS SOPs.

Biomass Carbon Stock from Sapling

Sapling data is also collected under Guyana's REDD+ MRV system in a 2 m radius plot in the centre of the nested plots. Saplings are defined as trees <5 cm DBH and >1.3 m tall. The number of samplings is multiplied by the average dry weight per sapling to derive the carbon stock.

Biomass Carbon Stock from Litter

Guyana defines the litter layer as all dead organic surface material on top of the mineral soil, including recognizable dead leaves, twigs, dead grasses, small branches and some unidentifiable decomposed fragments of organic material (fruits, flowers, and seeds). The dead wood with a diameter of less than 10 cm is included in the litter layer. Complete samples are weighed in "clip" plots of $1m^2$, from which samples are taken to determine the dry weight, which is then extrapolated to estimate this carbon pool.

Biomass Carbon Stock from Soil

To account for changes to soil carbon, Guyana applied the stock change methods prescribed by the IPCC Guidelines (IPCC, 2006). The change in carbon stocks in the top 30 cm of soil is calculated as the difference between the soil carbon stocks before conversion and the soil carbon stocks after conversion. Soil carbon stocks after conversion were estimated based on land use, management, and input factors as derived from IPCC Guidelines. For simplicity in accounting, Guyana assumes the total emission of soil carbon in the year of clearing rather than spreading the emissions over 20 years (the default period suggested by IPCC 2006). This conservative approach was adopted by Guyana, owing to carbon stocks being highly variable, as shown by the high uncertainty. Soil carbon pool is not impacted equally or at all across all drivers of deforestation and degradation; as such, only those drivers in which this pool is affected include emissions from soils.

The methods described for estimating the carbon stock per carbon pools that inform the country-specific emissions factors are the same methods used for calculating the emissions by drivers in the FREL. However, not all emission factors developed by Guyana are used since in the FREL, only aboveground, belowground carbon and deadwood carbon pools are used.

Since the submission of the FREL in 2015, which is based on information up to 2012, a lot of significant improvements have been made. The most important improvement is the merging of the six strata presented in the FREL into a single national stratum. The time of the FREL submission, Guyana was still in the initial phase of collecting field data. It was working on the assumption that the biomass carbon stock varied significantly by forest type, the potential of an area for change and accessibility. The data used to inform the reference level in Guyana's FREL, therefore, were generated under this assumption, and only 66 plots of data were used to inform this assumption. After the submission of the FREL and as more information became available collected across all carbon pools spanning the six strata in which the country's national territory is divided, it was found that the initial assumption used to inform the FREL was incorrect. From 108 nested plots established across all the strata, when combined, it was found that no significant differences exist between them, and the overall uncertainty was reduced when combined (GFC W. I., 2019a). As such, Guyana, considering the increased accuracy of this based on verified data, chose to apply the single emission factor retroactively to ensure consistency in its reporting.

It was always Guyana's intention to submit a revised FREL in light of the many new developments and result-driven findings. The new FREL will be submitted before the first half of 2024 and will commence from reporting year 2022.

The emission factors presented in this REDD+ TA align with that of the latest GHG inventory, which applies the same emissions factors, thereby ensuring consistency in reporting. The final country-wide forest carbon stocks across all pools in Guyana are now estimated at 270.6 t C ha^{-1}. The findings of this study and the contribution of carbon pools are summarised in Table 8, which shows the single forest carbon stocks for the five carbon pools at a 95% confidence interval and the resulting sampling errors. These are the values that are used in estimating the various emissions across the drivers of deforestation. However, for comparability to the FREL and consistency, only carbon stocks from the aboveground and below-ground carbon pools are used in estimating the emissions in this report.

Table 8 Country-wide Forest Carbon Stocks by Pool for all Forests in Guyana.

AG Tree (t C/ha)	BG Tree (t C/ha)	Saplings (t C/ha)	Standing Dead Wood (t C/ha)		Lying Dead Wood (t C/ha)	Litter (t C/ha)	Sum Carbon Pools (t C/ha)	Number of plots	95% CI as a % of mean
205.8	48.3	3.7	2.6		8.6	1.6	270.6	118	5.1%

Source: (GFC W. I., 2019a)

3.3.2 Emissions Factors for Degradation Associated with Logging Damage

Guyana developed country-specific emissions factors for degradation resulting from logging. Forest degradation in Guyana is primarily attributed to timber harvest, which was the only degrading activity accounted for in Guyana's FREL; however, since the submission of the FREL, Guyana has developed emissions factors for its infrastructure drivers that are also contributing to forest degradation.

To estimate emissions from logging, Guyana uses the approach that is based on estimating emissions per volume of timber harvested, including the timber tree, incidental tree damage, and development of skid trails needed for harvesting. The emission factors were developed to correlate the total biomass damaged (collateral damage and extraction infrastructure-skid trails) to the volume of timber extracted. This relationship allows for the estimation of the total emissions generated by selective logging for different concession sizes across Guyana. Selective logging clears forest for roads and decks, which are primarily large areas that can be identified spatially; hence, they are captured spatially, and their emissions are calculated through the stock-change method based on estimates of area deforested by logging infrastructure determined in the land cover change monitoring, provided that the area is more than 1ha. The emissions factor includes accounting for the impact of selective logging on carbon stocks, including the estimation of both emissions and removal components associated as following:

- Biomass removed in the commercial tree felled – emission.
- Incidental dead wood created as a result of tree felling – emission.
- Damage from logging skid trails – emission.
- Carbon stored in wood products from extracted timber by product class – removal.
- Regrowth resulting from gaps created by tree felling - removal.

The total emissions from selective logging are estimated using Equation 5, which incorporates the various emissions sources associated with log extraction.

Equation 5 Total Emissions from Selective Logging

$$Emissions = \{[Vol * WD * CF * (1 - LTP)] + [Vol * LDF] + [Lng * LIF]\} * 3.67$$

Where:
Emissions =Total emissions from Selective logging (t CO_2 Yr^{-1})
Vol = volume of timber over bark extracted (m^3)
WD = wood density (t/m^3)
CF = carbon fraction
LTP = proportion of extracted wood in long-term products still in use after 100 years (dimensionless)
LDF = logging damage factor—dead biomass left behind in the gap from the felled tree and incidental damage (t C/m^3 extracted)
Lng = total length of skid trails constructed to extract Vol (km)
LIF = logging infrastructure factor—dead biomass caused by construction of infrastructure (t C/km of skid trail to remove the Vol)
3.67 = conversion factor for t carbon to t carbon dioxide Wood in long-term products

Not all carbon is released at once since logs are converted into various items and put to different uses. Therefore, not all the carbon in harvested timber gets emitted into the atmosphere because a proportion of the wood removed may be stored in long-term wood products and must be accounted for. Total carbon stored in long-term wood products is estimated using Equation 6.

Equation 6 Carbon Stores in Long-term Wood Products

$$LTP = C * (1 - WW) * (1 - SLF) * (1 - OF)$$

Where:
LTP: = Carbon stock in long-term wood products pool (stock remaining in wood products after 100 years and assumed to be permanent); t C ha^{-1}
C = Mean stock of extracted biomass carbon by class of wood product; t C ha^{-1}
WW= Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product.
SLF = Fraction of wood products with a short life that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product.
OF = Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product.

3.4 Calculation of Combined Uncertainties

Guyana's approach to calculating uncertainties reported in the FREL was the application of the error propagation method. The methods used follow the recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level and rate of deforestation and the amount of degraded forest area in Guyana. This uncertainty estimate reported in the FREL is based on the application of the error propagation equation in Ch.5 of the IPCC GPG (2003), which was applied to each stratum.

This change has been impacted by the updating of data analysis using the 2006 IPCC Guidelines and the evidence-based merging of the stratification. Like the situation that affected the stratification and the application of emission factors, the method for estimating uncertainty has also been updated after the submission of the FREL. Guyana has transitioned from using the error propagation method of the IPCC GPG (2003) to using the more advanced Monte Carlo simulation to estimate its uncertainty across all its data. This occurred because of the continued advancement in enhancing the assessment of all factors that affect the uncertainty level of reported results.

3.4.1 Activity Data Uncertainties

The uncertainties associated with the spatially generated activity data are catered to in the QA/QC mapping procedures that are outlined in the SOP, which provides strict mapping rules and is still guided by the IPCC Guidelines. The QC team operates independently of the mapping team and is responsible for reviewing each tile as it is completed. In addition to the QA/QC process performed by GFC, an independent accuracy assessment is carried out by the University of Durham by applying sampling techniques using higher-resolution imagery to assess the reporting accuracy. The assessment generates independent deforestation and degradation numbers using a stratified random sampling approach, which is reported in the country's annual MRV reports.

3.4.2 Emissions Factors Uncertainties

To estimate uncertainties associated with the various emissions factors developed, Guyana considers the multiple sources and applies the Monte Carlo analysis (Hagen, Goslee, Pearson, & Brown, 2017). Sources of uncertainty include measurement, allometric model parameterization, allometric model structure, factor, and sampling. The simulation is designed so that sources of uncertainty can be turned off or on as needed, enabling estimates of the contribution to total uncertainty from each source.

A Monte Carlo simulation, or stochastic simulation, uses repeated sampling to determine the properties of a modeled system and is often used to estimate uncertainty. An implementation of a randomized Monte Carlo resampling technique can reduce the reliance on incorrect assumptions about the distribution of the underlying data sets while combining the individual uncertainties from many different sources. The uncertainty generation involves the construction of a large number of scenarios, each generated from randomized alternative data sets and each providing a realistic set of parameters for each model component.

A variant of the residual bootstrap sampling algorithm was applied to estimate uncertainty in the model parameters. With this algorithm, uncertainty in model coefficients is estimated by a) sampling the residuals generated from the model fit (e.g. Chave et al. 2005), with replacement, b) adding these "bootstrapped" residuals to the model estimates to generate a pseudo sample, c) fitting the model to the pseudo sample, d) saving these fit parameters to a file, and e) repeating steps (a) through (d) 10,000 times. The Monte Carlo analysis for emission factors is a distribution of total change in carbon stocks in each stratum and from each activity type. By including large numbers of runs (~10,000), the results generated from the Monte Carlo simulation are statistically robust.

Guyana developed a comprehensive accounting of uncertainty, represented by 95% uncertainty limits. The results represent the following: if the entire stratum was destructively sampled and the actual carbon in each pool measured, including the separate effects from conversion to agriculture, mining, and roads, there is a 95% chance that the value measured would fall between the upper and lower limits if the assumptions about component level uncertainty are realistic. Table 9 lists the emission factors by deforestation drivers and their respective uncertainties, which are applied to the combined stratum covering all of Guyana's forest. In Table 9, the emissions per driver for aboveground and belowground carbon are presented, with an uncertainty of 4.9%. In contrast, when compared to the increased emissions when all carbon pools are included in the estimation, the uncertainty decreased to 4.8%.

Table 9 Uncertainty for EF of Deforestation Drivers

Stratum	Drivers	Emissions Factors ABG and BGB (t CO_2e ha^{-1})	Uncertainty ABG and BGB (IPCC approach 1)	Emissions Factors all C pools (t CO_2e ha^{-1})	Uncertainty all C pools (IPCC approach 1)
Combined Stratum	Forestry infrastructure	**984.8**	**4.9%**	1,051.3	4.8%
	Agriculture	**1,043.9**	**4.9%**	1,110.4*	4.8%
	Mining (medium and large scale)	**984.8**	**4.9%**	1,051.3	4.8%
	Infrastructure	**984.8**	**4.9%**	1,051.3	4.8%

* Includes an additional 30.53 t C/ha for soils accounting for the change in carbon stocks owing to the conversion to permanent agriculture.

The same Monte Carlo approach was used to estimate the uncertainties for the data associated with the selective logging listed in

Table 10, where all parameters were used, including the allometric model, measurement, structure, and factor.

Table 10 Logging Emissions Factors

Logging Emission Factors							
Component	Unit	Factor (tC)	*Std Dev (tC)*	*90% CI (tC)*	t CO2	*Std Dev (tCO2)*	*90% CI (tCO2)*
LDF	per m^3	1.05	*0.68*	*0.08*	3.85	*2.49*	*0.29*
Wood Density of timber harvested	per m^3	0.40	*0.03*	*0.00*	1.47	*0.11*	*0.01*
LIF (Skid Trails)	per km	46.87	*8.08*	*1.60*	171.84	*29.63*	*5.87*

3.4.3 Combined Uncertainties

The combined uncertainties for the REDD+ results are calculated using the Monte Carlo Simulation, combining all activity data and emissions facts to generate the emissions estimates and reduction results for Guyana. This is done via the SimVoi add-in, which is applied to the emission factors and the activity data. This approach was taken as a necessary improvement measure because the uncertainty calculations performed did not capture all sources of uncertainty and thus underestimates the total uncertainty. As the MRVS further developed in Guyana, this step was possible and Monte Carlo analysis was integrated into the MRVS reporting.

Chapter 4: DESCRIPTION OF THE NATIONAL FOREST MONITORING SYSTEM AND INSTITUTIONAL ROLES AND RESPONSIBILITIES FOR MRV RESULTS

The national forest monitoring system is being implemented by the Guyana Forestry Commission (GFC). In 2009, Guyana and Norway collaborated on emission reduction goals under UNFCCC-REDD+, leading to the development of a Measurement Reporting Verification (REDD+ MRV) system for assessing forest area change. The system used satellite data, which at the time was slowed owing to capacity and technological constraints. Since then, GFC has made incremental gains by including new sources of satellite data and refining mapping and reporting processes while building its capacity to manage and monitor its forest, boosting its reporting capability and enhancing accuracy. Simultaneously, field data was being collected to establish verified emissions factors.

4.1 National Forest Monitoring System (NFMS)

The building block of Guyana's national forest monitoring system (NFMS) used for REDD+ is built on spatial and temporal change, including satellite imagery and a way to process the satellite imagery to provide layers of change over time. Additionally, data collected from the field allows for the verification of spatial information as well as monitoring of forest activities. A combination of spatial information and field-based monitoring data provides the annual snapshot of forest change and production data.

Central to the system are satellite data and the datasets provided by Guyana's agencies. GFC's Forest Area Assessment Unit interprets and analyses these data and generates maps and associated spatial layers required to meet annual reporting requirements. Two external audits are included in the process, as illustrated in Figure 10, which provides an overview of Guyana's REDD+ MRV system. The first is the accuracy assessment; since inception, this analysis has been conducted externally by a team from Durham University and external auditors who review and verify methods and analytical processes that meet specified reporting requirements.

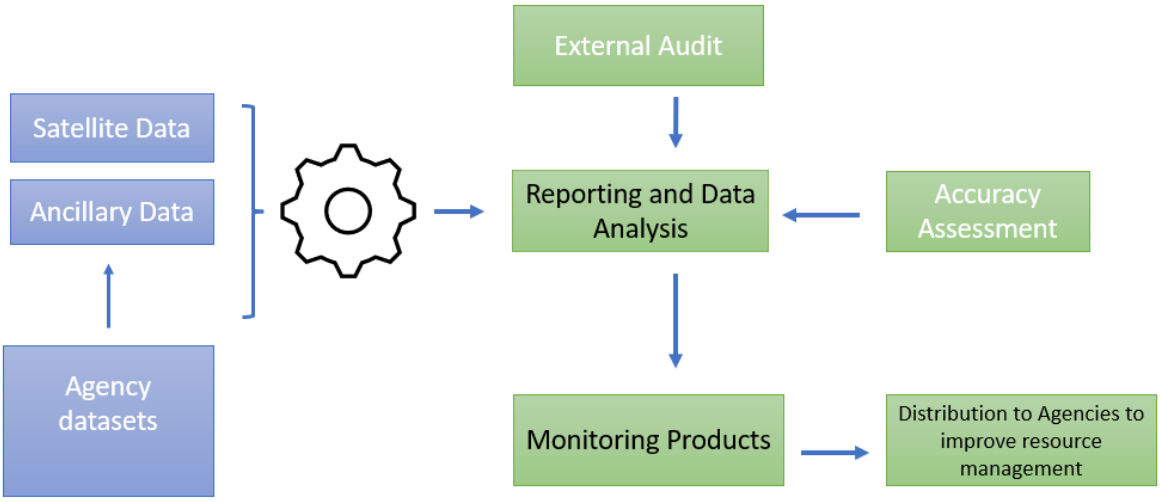

Figure 10 Overview of Guyana REDD+ MRV System within the GFC. Source, (GFC, 2023)

The schematic in Figure 11 shows the various departments/units within the Government of Guyana that provide the data used in measuring, estimating, and reporting for various purposes and the reporting flow. The data generated are used to inform national policies and strategies, access carbon finance, and for international reporting purposes such as to the UNFCCC. As such, information flows from the GFC to other government departments, depending on their use upon request.

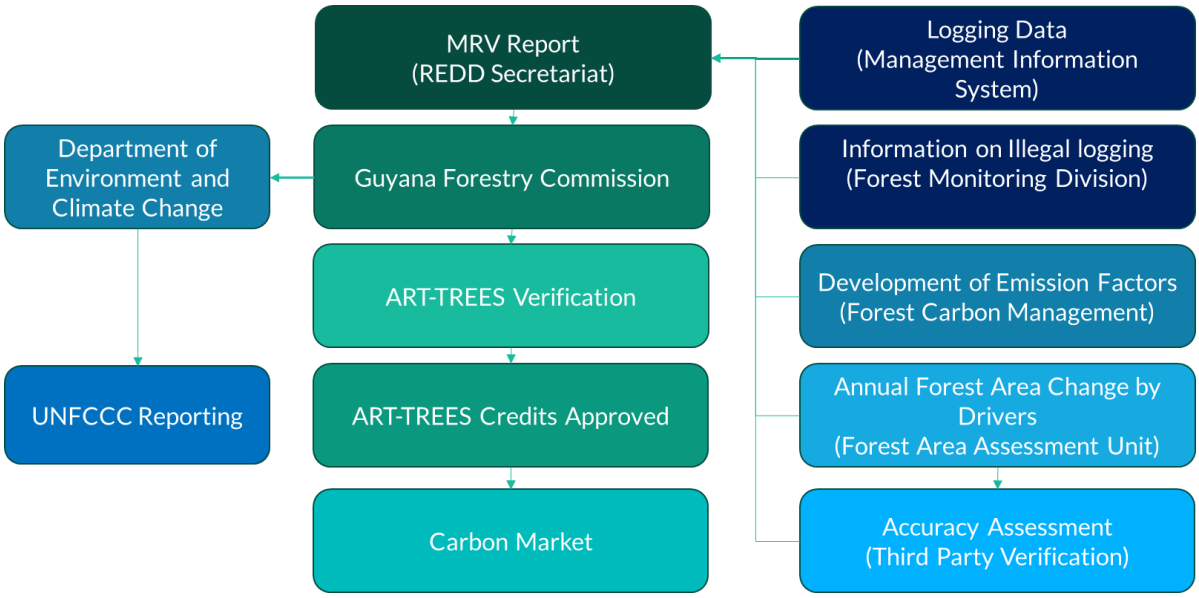

Figure 11 Guyana National REDD+ MRV System

Data storage is an integral part of the national MRV system. All data generated is stored on the Network Attached Storage (NAS) at GFC and is managed by the IT team, who routinely backed it up and stored it off-site. The relevant datasets that are used during the analyses are documented and archived. This includes metadata on the dataset, its location on the network and anticipated/or update frequency. Several datasets are actively used and reside on the GFC's Forest Resource Information Unit (FRIU) network drives. The FAAU (Forest Area Assessment Unit) undertakes the mapping and has access to these drives as well. Additionally, the data gathered and analyzed

by the GFC includes some collected from various government agencies that have different roles and responsibilities, as illustrated in Figure 11.

In 2018, the GFC facilitated consultations with several agencies to identify options for further use of MRVS data beyond the use for forest monitoring and management, thereby establishing the Continuous Resource Monitoring System (CRMS), a prototype system designed to allow more frequent monitoring of Guyana's natural resources and reducing reliance on commercial satellite imagery and software. The system aims to streamline existing image processing workflows by recording them for use within the Google Earth Engine (GEE) platform, which provides access to cloud processing capability, satellite images, and other open-source datasets. The CRMS design incorporates low-cost satellite data and generates monitoring products that support compliance processes, awareness promotion, improved information flows between agencies, enforcement policies, and regulations (GFC, 2020).

4.2 Role and responsibilities

In Guyana, several government agencies are involved in managing and allocating land resources that also contribute data to the national REDD+ MRV systems and national forest management system. The Ministry of Public Works is overseeing the development of the Amalia Hydropower Project. This planned hydroelectric project includes road construction and site clearance. A newly established Protected Areas Commission (PAC) holds spatial representations of all protected areas. Each of the agencies has its data management systems and only provides relevant requested information to the GFC for the compilation of annual reports.

4.2.1 Guyana Forestry Commission (GFC)

The GFC[6] is responsible for advising the subject Minister on issues relating to forest policy, forestry laws and regulations, guided by the Forests Act 2009 and the Guyana Forestry Commission Act 2007. Under these Acts, the GFC is responsible for administrating and managing all State Forest land, and the work is guided by Guyana's National Forest Plan and the National Forest Policy of 2018, among various other regulations put in place by the Commission. The Commission develops and monitors standards for forest sector operations, implements forest protection and conservation strategies, oversees forest research and provides support and guidance to forest education and training. The agency is currently responsible for implementing the National REDD+ MRV through the REDD Secretariat.

The REDD Secretariat was formed in 2009 and, housed within the GFC, is responsible for developing the national REDD+ MRV systems to generate the results and report on the country's REDD+ performance. This secretariat produces the annual MRV reports, which comprise the data for the FOLU sector in Guyana, generated by the spatial mapping developed by the Forest Area Assessment Unit and the Forest Carbon Monitoring Unit. Additionally, the secretariat and the GFC are responsible for contracting independent verifiers to verify the results reported by the country independently, enhancing reporting transparency.

The Forest Monitoring Division of the GFC is responsible for the enforcement of forest laws and regulations, monitoring and controlling the environmental and social impact of operations within the state forest, and collecting revenue in accordance with the various actions and regulations in place. This division is also responsible for processing export documents (with forest produce), quality control and promoting forest products, reviewing and assisting in inquiries in relation to lumber and logs, and therefore recording the annual

[6] GFC: Guyana Forestry Commission – Ensuring Sustainable Forestry

forest productions by product types. Additionally, this department reports on illegal logging and provides this information to the REDD Secretariat to generate the results for the yearly MRV report.

The Management Information Systems of the GFC is responsible for improved data communication between both internal and external stakeholders and ensuring that technological advancements are captured. The main function of this unit is to maintain reliability, security and availability of information that is accessed throughout GFC. It also overlooks the data accuracy, productivity and processing speed/capabilities as it is responsible for developing end-user reporting on the GFC activities data, which are shared with the REDD Secretariat to generate the results for the annual MRV report.

The Forest Resource Management Division of the GFC is responsible for data collection on national forest resources, conducting surveys and inventories, researching and making recommendations on forest dynamics and silviculture, planning and recommending the allocation of concession areas, preparing operational guidelines for forest management planning, evaluating management and operational plans, prescribing standards for forest management and providing support for forestry extensions. This division is also responsible for building a GIS capacity, developing a database of digital geographical data and providing a service to both external & internal stakeholders. This division is currently conducting the national forest inventory.

4.2.2 Guyana Geology and Mines Commission (GGMC)

The Guyana Geology and Mines Commission (GGMC[7]) was created in 1979. It was previously the Department of Geological Surveys and Mines and is guided by the Mining Act 1989. It has in place various regulations that guide the work of the commission, including its own MRV system for its operation. The GGMC's mission is to promote, facilitate, monitor, and regulate the sustainable utilization of Guyana's mineral resources (including petroleum) and to provide effective stewardship of Guyana's mineral resources through deploying competent human resources employing innovative tools and methods, research, and analysis. The GGMC collaborates with the GFC in providing information affecting the forests, which it monitors on the ground and spatially. Together, the GGMC and the GFC provide enhanced ground verification for the various drivers of deforestation and forest degradation in Guyana. Additionally, the GGMC is responsible for piloting the reforestation of mined-out areas in collaboration with the GFC.

4.2.3 Guyana Lands and Survey Commission (GL&SC)

The Guyana Lands and Surveys Commission (GL&SC[8]), which falls under the Office of the President, is responsible for the overall management of the national territory. The work of the GL&SC is guided by the Guyana Lands and Survey Commission Act 1999, Lands Department Act 1903, State Lands Act 1903, Land and Surveyors Act 1891, and various other regulations. The GL&SC's mandate includes providing land policy recommendations and drafting land use plans to ensure orderly and efficient utilization of public land resources, advice on land surveying matters, and effective and efficient land administration. This is the agency that provides land-use zoning and allocations of titles and lease lands. Most of the information collected by this agency is reported under land use, for example, the area allocated for mining, agriculture, settlement, infrastructure development such as Hydroelectric projects, and title Amerindian areas. This agency provides the various land use changes to the GFC used to generate and report data for the FOLU sector.

[7] GGMC: Who We Are | Guyana Geology and Mines Commission (ggmc.gov.gy)

[8] GL&SC: GLSC – Administer Land. Promoting Development

4.2.4 Protected Areas Commission

The Protected Area Commission (PAC[9]) is a government agency under the Office of the President mandated to manage Guyana's National Protected Areas, guided by the Protected Area Act 2011. This Act provided for the establishment, management, maintenance, promotion and expansion of the protected area system in Guyana. The main objectives of the PA Act are to assist in combating climate change, assist the state in meeting international obligations, recognize the value of biological diversity, conserve biodiversity, and conserve ecosystem services and ecosystems representative of Guyana's natural land and seascapes. Additionally, guiding the work of the PAC are the Iwokrama Act 1996, the Kaieteur National Park Act 1929 and amended Act 2002, and other regulations put in place by the PAC.

Prior to becoming a commission, there was a national Protected Area System that was in existence for over 90 years and under which the Kaieteur National Park (KNP) was established in 1929, the first national park created in the Amazon region and only one of three countries in South America to have a protected area. Guyana has taken a measured approach to the development of protected areas, with the country's second protected area, The Iwokrama Rainforest Reserve, being formally established in 1996. Two new protected areas, the Kanuku Mountains Protected Area (KMPA) and Shell Beach Protected Area (SBPA), were declared following decades of preparatory work with local communities and other stakeholders in 2011. The largest and first-ever indigenous-owned PA, Kanashen Amerindian Protected Area (KAPA), was added to the NPAS in 2017. Also included in the system are four urban parks: the Botanical Gardens, Zoological Park, National Park, and Joe Vieira Park. The PAs, together with the urban parks, account for approximately 8.4% of the country's land area. The PAC provides this information to the GFC to be included in the annual MRV reports as these land use types impact the forest uses and, consequently, the emissions.

4.2.5 Department of Environment and Climate Change

The Department of Environment and Climate Change (DECC) was formed by merging the Office of Climate Change and The Department of Environment in 2020. This department is the National Focal Point of the UNFCCC on climate change issues and is responsible for coordinating Guyana's reporting requirements and other international agreements. The role of the DECC continues to evolve as it advises government partners to participate in international climate negotiations representing Guyana's best interests and leads on national climate actions and policies. It also leads dialogues with multilateral agencies on behalf of the Government of Guyana (GoG) to establish partnerships and facilitate access to technical and financial support for low-carbon initiatives and national development. The DECC activities span policy-level intervention and advisory as well as program and project management and execution, with engagements directly with sectoral GoG partners to provide advice and recommendations to sector-level planning and strategies where they intersect with climate change adaptation and mitigation. Additionally, the DECC is responsible for leading and coordinating national adaptation and mitigation efforts in collaboration with multiple GoG sector agencies and other stakeholders.

Together, these agencies are responsible for the development and testing of methodologies, conducting the data analysis, and reporting under the various conventions and national agencies that require this information for the fulfilment of multiple purposes.

[9] PAC: https://www.pac.gov.gy/

Chapter 5: INFORMATION NECESSARY FOR THE RECONSTRUCTION OF THE RESULTS.

For the reconstructions of the results presented in this REDD+ Technical Annex, information extracted from Guyana's national REDD+ MRV System is presented disaggregated by activity data and emission factors.

5.1 Activity Data for Deforestation and Forest Degradation by Drivers

The average of the various activity data generated and used in deriving the results presented by Guyana in establishing its REDD+ results are listed in Table 11. The results cover the period 2011-2022 and exclude natural events that are considered non-anthropogenic change.

Table 11 Annual Average of Forest and Forest Loss by Deforestation Drivers

Variable	Description	
Coverage	National	
Period	2013-2022	
Satellite Image Resolution (m)	Variations of 5m, 10, and 15 m	
Average Deforestation by Driver (ha)	Forestry Infrastructure	255
	Agriculture	422
	Mining	7,494
	Infrastructure	156
Average Logging extraction (m^{-3})		585,620
Average Logging - skid trail (km yr^{-1}		2,214

While the system initially measured and reported on forest area change in its inception, over the years, it has evolved as more data are collected, and the system's data uses changes to satisfy multiple purposes, including reporting to the UNFCCC. As such, while methods remain largely the same, many improvements occurred to improve estimates' accuracy and reporting transparency. As such, the carbon pools, as per the FREL remain constant for this reporting period. However, new drivers have been added. As such presents, all the drivers associated with the FREL while all currently measured drivers' activity data are listed in Table 12. Of the drivers listed in Table 12, settlements, fire, and shifting cultivation do not form part of the emissions estimates for

reporting, according to the FREL, since these are additional drivers. Still, they are included here for completeness purposes.

Table 12 Area Deforestation by Drivers

	Forestry Infrastructure	Agriculture	Mining	Infrastructure	Settlements	Fire	Shifting Cultivation
	(ha)						
2013	330	424	1,518	342	23	96	-
2014	204	817	10,434	141	71	259	-
2015	313	379	6,782	217	8	1,509	-
2016	313	379	6,782	217	8	1,509	-
2018	356	512	7,624	67	7	661	436
2019	226	246	5,821	52	22	6,371	431
2020	195	489	6,452	102	60	2,933	554
2021	228	216	6,825	117	105	139	393
2022	156	282	5,264	111	169	333	156

5.2 Emission Factors for Deforestation and Forest Degradation

Guyana applied the emission factors listed in Table 9 to generate the REDD+ results by drivers of deforestation and those listed in Table 10 for forest degradation. These country-specific emission factors are used in developing the GHG emissions for the sector reported in the national GHG inventory submitted as part of the country's Biennial Update Report, to which this REDD+ annex is attached. Additionally, emission factors were generated for degradation attributed to mining and infrastructure and logging activities linked to the volume extracted. These are captured in the GHG inventory estimates but are excluded from this report along with emissions from degradation resulting from settlements, biomass burning and shifting cultivation for consistency purposes to the FREL.

5.3 Calculation of Emission Reductions Resulting from REDD+

Guyana's annual emissions and reduction from REDD+ are estimated using the systems outlined in the methodology section of this report, which is guided by the country's national REDD+ MRV system that is compliant with the IPCC Guidelines (IPCC, 2006). Since this REDD+ technical annex covers the period from 2013-2022, Table 13 lists the country's performance in relation to its annual emissions and reductions, only accounting for the drivers and carbon pools covered in the FREL.

Table 13 Annual REDD+ Performance

Year	Total Deforestation (tCO_2e)	Total Degradation (tCO_2e)	Total emission (tCO_2e)	Total emission reductions as per FREL (tCO_2e)
2013	12,447,415	3,724,737	16,172,152	30,129,099
2014	11,468,094	4,532,569	16,000,663	30,300,588
2015	7,596,547	3,910,404	11,506,951	34,794,300
2016	7,596,547	2,987,896	10,584,442	35,716,809
2017	8,242,461	3,180,717	11,423,177	34,878,074

2018	8,459,216	3,259,093	11,718,309	34,582,942
2019	6,263,139	3,109,512	9,372,650	36,928,601
2020	7,157,941	3,253,797	10,411,739	35,889,512
2021	7,286,552	3,266,693	10,553,245	35,748,006
2022	5,740,349	3,714,932	9,455,281	36,845,970

Since submitting the FREL, Guyana has improved its data collection and expanded the drivers covered to enhance the completeness and accurate reporting of the country's REDD+ Performance, which has allowed access to carbon finance. The new drivers that are included in the country's REDD+ performance for deforestation and degradation. Additionally, Guyana developed country-specific emissions factors for additional drivers. These new sources of emissions have been incorporated into the GHG inventory reported in the BUR but excluded from this report. The inclusion of these sources increased the country's emissions, as expected. However, despite the inclusion of these new drivers, the country's emissions have remained well below the reference level of the FREL, as seen in Table 14.

Table 14 Total emissions, including all drivers of deforestation and forest degradation

Year	Total Deforestation (tCO_2e)	Total Degradation (tCO_2e)	Total emission (tCO_2e)	Total emission reductions as per FREL (tCO_2e)
2013	12,564,342	3,724,737	16,289,078	30,012,173
2014	11,792,364	4,532,569	16,324,933	29,976,318
2015	9,086,325	3,910,404	12,996,729	33,304,522
2016	9,086,325	3,283,518	12,369,843	33,931,408
2017	9,253,505	3,438,197	12,691,702	33,609,549
2018	9,566,572	3,486,455	13,053,027	33,248,224
2019	12,987,717	3,295,268	16,282,984	30,018,267
2020	10,671,069	3,437,674	14,108,743	32,192,508
2021	7,912,787	3,481,675	11,394,463	34,906,788
2022	6,387,743	3,863,498	10,251,241	36,050,010

These results generated from the inclusion of the sources of emissions that contributed to an increase in the country's emissions have been used to inform a new baseline that Guyana will be setting in the revised FREL. Additionally, these combined emissions have been used by Guyana to transition from bilateral results-based payments to a voluntary carbon market, which was a first phase towards implementing Article 6 of the Paris Agreement. Even with the additional drivers of emissions being added, Guyana is well below its FREL baseline.

Guyana intends that the submission of its BUR and REDD+ Technical Annex will ensure alignment with implementing the enhanced transparency framework that is the next step of reporting in the form of the upcoming Biennial Transparency Report (BTR) submission.

Chapter 6: DESCRIPTION OF HOW THE ELEMENTS IN 4/CP.15 PARA. 1(C) AND (D) HAVE BEEN TAKEN INTO ACCOUNT

6.1 Use of the most recent IPCC Guidance and Guidelines

In developing this REDD+ technical annex, Guyana utilised the 2006 IPCC Guidelines, as encouraged by the Conference of the Parties, for estimating its anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes. The same guidelines were used to develop the national GHG inventory reported in the BUR and the FREL, which was submitted to the UNFCCC. The changes are reported for both deforestation and forest degradation and are divided into two parts applying different methods as prescribed by the 2006 IPCC Guidelines.

To calculate the net change in carbon stocks resulting from deforestation, Guyana used the Stock-Difference method, which estimates the difference in total carbon stock between two time periods following Equation 2.5, Chapter 2, Volume 4, 2006 IPCC Guidelines. Additionally, the emissions resulting from fire, which is also a driver of deforestation, are estimated using Equation 2.27, Chapter 2, Volume 4, 2006 IPCC Guidelines.

To estimate the emissions from forest degradation attributed to logging activities, the Gain-Loss Method based on estimates of annual change in biomass was used by applying Equation 2.4, Chapter 2, Volume 4, 2006 IPCC Guidelines.

Following the Good Practice Guidance and uncertainty, Guyana applied the Monte Carlo uncertainty simulation. The Monte Carlo estimation of uncertainties was done by source as well as using the techniques to estimate overall uncertainty annually as well as trends.

6.2 Establish, According to National Circumstances and Capabilities, Robust and Transparent National Forest Monitoring System

As stated in Guyana FREL, the forest MRV system in place is at a national scale and will remain as such (described in Chapter 4). Additionally, there is a community MRV system in place, and both systems provide information to

each other. As mentioned in Chapter 3, Guyana employed the use of a combination of remote sensing and ground-based forest carbon inventory approaches for estimating its anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes. The spatial estimates include the use of high-resolution imagery of various types, tested to determine the appropriateness and applicability for the country's needs. The field data used were also tested to ensure its suitability and applicability, including the uncertainty associated with the data collected and analysis.

Since submitting the FREL, Guyana has made significant improvements in sustained capacity building, data collection and analysis, revised country-specific emission factors, and revised its emissions accounting to improve its reporting accuracy. Some of these changes include the revision of the stratification of the country's forest; the addition of three new deforestation drivers: settlement, biomass burning, and shifting cultivation to its monitoring; the addition of a new driver for degradation: mining and infrastructure, the development of additional country-specific emission factors, and the move to a higher more complete form of uncertainty assessments.

Guyana's reporting on its methods and uncertainties demonstrates the openness to transparently reporting on its emissions and removals as far as practical, utilizing its national capacity and capabilities. The rigorous accuracy assessment built into the REDD+ MRV system illustrates the confidence in the accuracy of the estimates generated by the country, which is proven by the various international verifications. Additionally, the generating and publishing of the annual MRV reports is an indication of Guyana's openness and confidence in its transparent system, which is no different to this report being submitted to the UNFCCC, which is also subjected to review, which Guyana welcomes.

Guyana considered its improvements, which resulted in an overall increase in accuracy and consistency, to be a significant milestone achieved and can illustrate the country's commitment to improving its national systems and reporting capabilities

CONCLUSIONS

Guyana intends to continue improving its national REDD+ MRV systems as more information and data become available. The country will continue to build on the existing systems and adopt changes as necessary to ensure its sustainability. One of the key improvements is the planned implementation of the Continuous Resource Monitoring System (CRMS), which is currently being tested and aims to reduce the reliance on commercial satellite imagery and software. Guyana will continue to put systems in place to implement the modalities and procedures required for the ETF implementation with an effort to implement Article 6 of the Paris Agreement. However, in the interim, Guyana intends to pursue the voluntary carbon markets to continue accessing carbon financing for national development and putting in place the necessary systems and institutional arrangements, including capacity-building to fulfil its commitment to the UNFCCC and pledges made under the Paris Agreement.

Since the submission of Guyana's FREL in 2015, many improvements have been made owing to data availability and changing national circumstances. Guyana will be submitting a revised FREL, which will then align with the improved MRV system.

In the future, Guyana will continue to participate in the jurisdiction approach to REDD+ accessing voluntary and compliance markets (and once operational, full UNFCCC mechanisms for REDD+) and has outlined a benefit-sharing mechanism to ensure that the climate finance benefits will be shared in a way that is fair and equitable, recognizing the contribution of stakeholders.

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