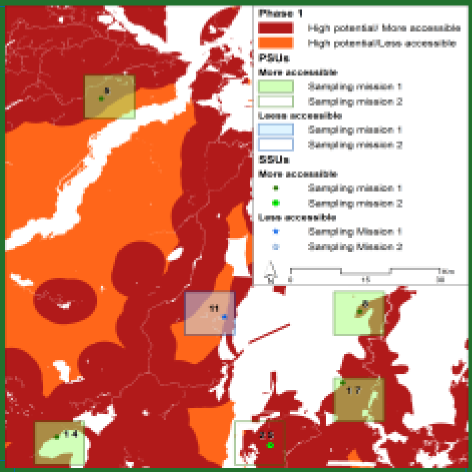
Government of the Cooperative
Republic of Guyana

September 2015

The Reference Level for Guyana's REDD+ Program



Contents

ACRONYMS

AD	Activity Data
A/R	Afforestation/reforestation
AFOLU	Agriculture, Forestry, and Other Land Use
BAU	Business as Usual
CO_2	Carbon dioxide
COP	Conference of Parties
DNRE	Department of Natural Resources and the Environment
EF	Emission Factor
EPA	Environmental Protection Agency
EVN	Economic Value to the Nation
FCMS	Forest Carbon Monitoring System
FCPF	Forest Carbon Partnership Facility
FPA	Forest Producers Association
GHG	Greenhouse Gas
GFC	Guyana Forestry Commission
GGDMA	Guyana Gold & Diamond Miners Association
GGMC	Guyana Geology & Mines Commission
GIM	Geospatial Information Management Unit
GoG	Government of Guyana
GoN	Government of Norway
GPG	Good Practice Guidance
GRIF	Guyana REDD+ Investment Fund
HFLD	High-forest, low deforestation
IPCC	Intergovernmental Panel on Climate Change
LCDS	Low Carbon Development Strategy
LULUCF	Land use, land-use change, and forestry
MoU	Memorandum of Understanding
MRV	Monitoring, reporting, and verification
NAREI	National Agricultural Research & Extension Institute
OCC	Office of Climate Change
REDD+	Reducing emissions from deforestation and forest degradation, and the role of conservation of forest carbon stocks, sustainable management of forests and enhancement of carbon stocks
RL/REL	Reference Level/ Reference Emissions Level
UG	University of Guyana
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

This document presents Guyana's revised submission of its reference level (RL) for deforestation, and forest degradation due to timber harvesting practices for results-based payments for REDD+ under the UNFCCC. In this document, and accompanying technical reports, Guyana has submitted detailed information on its historic emissions and projected emissions that are:

- transparent, with full documentation and highly sufficient for experts to assess the extent to which good practice requirements have been met;
- complete, whereby all relevant emissions categories are estimated and reported;
- consistent, whereby the methodologies used over the historic period are the same and use the same implementers so the differences from year to year are real and not an artifact of change in methodology; and
- accurate and with low uncertainty so that results are neither under or over-estimated.

The long term historical deforestation in Guyana has been very low over the whole country – and is one of the lowest in the world. Guyana has presented a rationale for why the forest RL should take into account national circumstances as the likely future emissions are not well captured by historical ones. The key reason for this is that Guyana's ongoing development is creating new economic and social incentives which can significantly impact rates of forest cover. By contrast, standing forest has historically not generated any economic value to the nation. Therefore, a programme of REDD+ based on prevailing good practice methods must generate sufficient economic incentives to reflect the global benefits provided by Guyana's efforts in maintaining standing forests, and create new economic alternatives to deforestation that will limit any future increase in emissions.

The RL for Guyana, developed at the National scale, is based on the detailed and robust analysis of historic emissions from deforestation from all causes and from degradation due to timber harvesting, and includes the following:

- The key drivers of deforestation, including conversion to agriculture, mineral extraction, and infrastructure expansion (mining and logging roads);
- Degradation from timber production, representing a source of emissions;
- Forest are defined as having a minimum area of land of 1 ha with tree crown cover (or equivalent stocking level) of more than 30% with the potential to reach a minimum height of 5 m at maturity in situ;
- Only the aboveground and belowground biomass out of the five recognized carbon pools are included[1] and the key GHG selected is CO_2;
- The historic period selected is from 2001 to 2012, a total of 12 years;
- The collection and analysis of activity data (AD) and field data on forest carbon stocks are consistent with good practice in that they neither over- nor under-estimate as far as can be judged; and

[1] For this interim RL only these two pools are included so as to be consistent with the global data used in "Combined Reference Level Approach" described in Section 6 of this report. See Annex 1 for more details on the historic emissions based on including all five pools and non-CO2 gases.

- And all data are at Tier 2 and 3 levels for the following reasons:
    - Wall-to-wall coverage of satellite imagery is used to obtain the AD related to conversion of forest lands to other uses and such data are combined and co-registered with other key spatial data bases in a GIS such as roads, rivers, settlements, vegetation class, location of logging concessions, location of mining concessions, and topography.
    - A comprehensive, peer-reviewed, field sampling system was designed and implemented to attain a required precision target of a 95% confidence interval of <+/-15% of the mean sum of aboveground and belowground carbon stock of forests.

Having established the historic emission for Guyana, with specific reference to the results summarized in Table 13(a), Table 7a and b and Section 5.3, Guyana has developed its Proposal for Reference Level for REDD+.

Guyana's proposal for Reference Level for REDD+ is based on the Combined Reference Level Approach, in which a global forest carbon emissions loss of 0.435%, as concluded by Baccini et. al. 2012 is used, along with Guyana's historic emissions level for the same pools and period 2001 to 2012, as established in this Proposal.

The use of the combined reference level is determined to be the most appropriate method for Guyana and one which allows for the broadly accepted objective within the UNFCCC negotiations to be fulfilled. This objective expresses general agreement that a REDD+ mechanism must provide genuine incentives for forest conservation in low deforestation countries, as well as ensure global additionality.

This approach involves two main steps, and is summarized below:

- **Setting the Reference Level:**

    Using a global percent of forest carbon emissions of 0.435%, as the global level, and
    - establishing the historic annual average emissions percent level for Guyana (2001-2012) by dividing this average annual emissions by the average total carbon stock of Guyana (based on the average forest area during the 2001-2012 period), resulting in 9,366,891 tCO_2 divided by total stock of 19,134,623,287 tCO_2 = 0.049%
    - deriving the Combined Average of the global and historic annual average emissions percent by: 0.435% + 0.049% divided by 2 = 0.242%.

- **Computing Annual REDD+ Performance based on Reference Level:**
    - Annual Reported Emissions percent (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 establishment of accuracy levels, is then subtracted from the Combined Average of 0.242%.

Guyana's Proposed Reference Level for its REDD+ Programme, calculated by multiplying the combined average of 0.242% by the average carbon stock, is 46,301,251 t CO_2.

One of the key considerations in Guyana's Proposal for Reference Level for REDD+ is the integration of a financial incentives baseline and sliding scale mechanism within the payment computation. This will provide Guyana's commitment to ensuring that its REDD+ programme aims at assuring environmental integrity whilst advancing a low carbon pathway. One example of this model is currently in use in the bilateral agreement between Guyana and Norway. Further, key consideration is also extended in ensuring congruence with existing internationally accepted methods, such as those established for the FCPF Carbon Fund which allows for 0.1% of total carbon stock, as adjustments to emissions over the historic level.

1.0 BACKGROUND

In accordance with decision 12/CP.17 paragraph 13[2], Guyana has deemed it appropriate to submit and is submitting on a voluntary basis for consideration by the UNFCCC its initial proposal for developing the forest reference level (RL). There are two main components of the RL: (a) establishment of Guyana's historical emissions profile from the forestry sector and (b) the development of the proposed reference level. Here we include an overview of the data and methodologies used to estimate the historical emissions profile as well as details of how national circumstances are considered for developing a RL. The information presented is intended to be transparent, complete, consistent with UNFCCC guidance, accurate and guided by the most recent IPCC guidance and guidelines. We request the Secretariat to make this information available on the UNFCCC REDD web platform and hereby request a technical assessment of Guyana's initial proposal.

2.0 THE GUYANA CONTEXT

In global assessment reports, the Guiana Shield has been identified as one of the largest remaining blocks of primary tropical forest on earth, and has the potential to play an important role in mitigating climate change. The region has been reported to contain both the highest percentage of forest cover (over 90% is intact tropical forest) and the lowest human population density of any major tropical forested area.

Historical deforestation in Guyana has been very low (0.02% to 0.079% yr^{-1} over the past 22 years), but this trend may change in the future as deforestation increases to meet growing demands for agriculture, timber, minerals, and human settlements. Guyana is therefore considered to be a high forest cover low emission/deforestation rate (HFLE/D) country, with forests covering approximately 85% of the country (forest area of 18.4 million hectares) and containing an estimated 20.4 billion tons (or Gt) of CO_2 in live and dead biomass pools. In addition to being one of Guyana's most valuable natural assets, these forests are suitable for logging and agriculture, and are underlain with significant mineral deposits. Mining has been the primary driver of deforestation in Guyana[3], accounting for approximately 60% of all deforestation between 1990 and 2009 and more than 90% of deforestation between 2009 and 2012. Other drivers include forestry infrastructure, agriculture, and other infrastructure.

This submission is made based on best available data, policies, and assessments available at this time. It is intended that as the drivers continue to be monitored, and more data become available for additional forest assessment including but not limited to by economic models, spatial platforms, and other available methods, that Guyana will be updating its submission. In any case, an updated submission is planned at the very latest within the next 5 years, given additional data on drivers, forest carbon, and econometric modeling for future projections. This submission should therefore be viewed in this context.

[2] Decision by the Conference of Parties (COP).

[3] Decision 4, CP.15 paragraph 1(a) requests developing country Parties to identify drivers of deforestation and forest degradation resulting in emissions.

3.0 APPLICATION OF UNFCCC MODALITIES TO GUYANA'S RL

Within the context of the United Nations Framework Convention on Climate Change (UNFCCC or Convention), REDD+ REL/RLs serve two purposes[4]. First, RLs establish a business-as-usual (BAU) baseline against which actual emissions are compared, whereby emission reductions are estimated as the difference between RLs and actual emissions. In this sense, RLs depict what the emissions scenario would be in the absence of REDD+ implementation, and thus provides the basis for measuring its success. Second, RLs are needed to determine the eligibility of UNFCCC Parties for international, results-based support for REDD+, and to calculate that support on the basis of measured, reported, and verified emission reductions.

The creation of forest RLs as benchmarks for assessing performance are guided by modalities contained in UNFCCC Conference of Parties (COP) decisions, most notably decision 12/CP.17 and its Annex. These modalities state that when establishing forest RLs, Parties should do so transparently taking into account historic data and adjusting for national circumstances in accordance with relevant decisions[5]. Forest RLs can be developed sub-nationally as an interim measure while transitioning to a national scale, but Guyana has chosen from the outset to develop its RL at a national scale. A step-wise approach is allowed that enables Parties to improve the forest RL by incorporating better data, improved methodologies and, where appropriate, additional pools. Forest RLs are expressed in units of tons of CO_2 equivalent per year and must maintain consistency with a country's greenhouse gas inventory (according to 12/CP.17, Paragraph 8). In response to the guidelines for submissions of information on RLs provided in decision 12/CP.17, a summary of Guyana's decisions on these modalities is given in Table 1.

[4] Meridian Institute. 2011. "Modalities for REDD+ Reference Levels: Technical and Procedural Issues." Prepared for the Government of Norway, by Arild Angelsen, Doug Boucher, Sandra Brown, Valérie Merckx, Charlotte Streck, and Daniel Zarin. Available at: http://www.REDD-OAR.org.

[5] Decision 4/CP.15, paragraph 7.

Table 1. UNFCCC modalities relevant for Guyana's national RL.

Reference to Guideline	Description	Guyana's Proposal for Interim Report
Decision 12/CP.17 Paragraph 10	Allows for a step-wise approach	• RL is at national scale, and includes all drivers of deforestation, forest degradation due to selective logging only, but not removals or C stock enhancements at this stage.
Decision 12/CP.17 Annex, paragraph (c)	Pools and gases included	• Pools: (activity specific)[6] - Aboveground and belowground biomass - Dead wood included in degradation from timber harvest only - • Gases: - Include CO_2 only
Decision 12/CP.17 Annex, paragraph (c)	Activities included	• Include deforestation caused by agriculture, mining, forestry infrastructure, and other infrastructure • Include forest degradation from timber harvesting only
Decision 12/CP.17 Annex, paragraph (d)	Definition of forest used is same as that used in national GHG inventory	• Minimum tree cover: 30% • Minimum height: 5 m • Minimum area: 1 ha[7]
Decision 12/CP.17 Annex	The information should be guided by the most recent IPCC guidance and guidelines,	• All data are gathered using best practices and integrated to estimate emissions using IPCC 2003 and 2006 guidelines[8]
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 on how the national circumstances were considered	• Being a high forest cover and low deforestation country, Guyana proposes to make adjustments to allow for national circumstances likely future emissions are not well captured by historical ones.

In Guyana's National Communications, the definition of forest that was used was more descriptive in nature and is not based on the parameters as described above. Guyana's first and second national communications predated the implementation of the main results of the national MRVS - which have informed the forest definition used in

[6] Data for all 5 IPCC pools have been collected as described in Annex 1

[7] Based on the Marrakech Accords.

[8] The two IPCC reports used are the IPCC 2003 Good Practice Guidance for the LULUCF sector (IPCC 2003 GPG) and the IPCC 2006 Guidelines for National GHG Inventories, Volume 4 AFOLU (IPCC 2006 AFOLU)

this RL Submission. Future national communication will use this definition, and will therefore allow for consistency in Guyana's various submissions.

Many of the critical elements of REDD+ and establishing a RL do not have strict guidance from the UNFCCC, leaving the analysis and final decision-making up to the country. At the UNFCCC COP meeting in 2013, additional guidelines and procedures were discussed regarding technical assessment of RL submissions. Such additional guidance provides more clarity regarding how to proceed with submission of a Reference Level. The text that Guyana has followed closely was developed at the 2013 COP and is available at http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf#page=16

3.1 Rationale and Justification of Guyana's Decisions for the RL

Guyana's process of developing the Reference Level which is based on an ***agreed "Roadmap" to building a national MRV system***. The Roadmap was created in consultation with stakeholders and includes: a national implementation strategy, status of current activities and capacities, requirements for the MRV system, a capacity gap assessment, and a roadmap including an institutional framework for implementation. In March of 2014, a phase 2 Roadmap was developed that assesses the achievement of the Phase 1 period, and identified next steps.[9]

3.1.1 Scope of Activities

Guyana has chosen to include emissions from deforestation and forest degradation in its RL but not removals from carbon stock enhancements at the initial stage. This recommendation is made given that more than 80% of Guyana is forested, and historically there have been few activities related to enhancing forest carbon stocks from which a reference level could be developed.

Deforestation

There are several drivers of deforestation, including conversion to agriculture, mineral extraction, and infrastructure expansion, and Guyana intends to include deforestation as a REDD+ activity.

Forest Degradation

There are several sources of forest degradation in Guyana, each of which should be considered separately to determine whether potential emissions are significant to include in the RL, whether they can be included at reasonable cost, and whether it is likely that interventions can be implemented to reduce such emissions.

Potential causes of forest degradation in Guyana include:

1. Selective logging
2. Human-induced fires
3. Small scale land-use change (e.g., mining that does not qualify as a deforestation event)
4. Degradation of the forest in the 100 m buffer zones around mining sites and infrastructure

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[9] Guyana Forestry Commission, "Terms of Reference for Developing Capacities for a national Monitoring, Reporting, and Verification System to support REDD+ participation of Guyana: September, 2014.

5. Expanding shifting cultivation and/or shortened fallow periods

Selective Logging

Because the timber industry is active in Guyana and emissions from this form of degradation represent a significant proportion of emissions, degradation from selective logging is included in the RL.

Fires, Small-Scale Mining, Buffer Zones, and Shifting Cultivation

Emissions from other sources of forest degradation have not yet been quantified, though additional studies are being conducted on the impact of shifting cultivation and on the impact of degradation in the 100 m buffer around large to medium scale mining sites and infrastructure. After preliminary data are evaluated, a method will be developed so that these sources of forest degradation can be included in the RL.

Establishing a reliable and robust business-as-usual scenario for carbon impacts of degradation from human-induced fires is generally difficult. However, the results from remote sensing analysis indicated that about 600 ha were degraded by fire and none were deforested. Given these results, Guyana therefore excludes degradation and deforestation from fire in its RL due to the insignificance of fire as an emission source in Guyana.

Small scale mining that affects a smaller land area, often less than one hectare is classed as degradation. This practice is likely to result in fewer trees being cleared per unit area than medium or large scale mining. Therefore, the immediate impact of such activities would be classified as degradation due to the definition of a forest as having a minimum area of one hectare. However, small scale mining operations often coalesce, resulting in what appears to be a medium scale mine. Small-scale mining operations will be tracked using very high resolution satellite imagery in post 2010 work by GFC.

Regeneration (gain) could occur over time on previously logged areas and small clearings when abandoned but at this stage no assumptions as to what this value might be has been made. Further work is planned to include this in the next phase of work.

3.1.2 Forest Definition

Guyana plans to implement REDD+ at the national scale, so it is appropriate to maintain one consistent forest definition rather than giving subnational jurisdictions the option to use a different definition. Guyana chose to use the thresholds of crown cover, height and area to develop a forest definition because this has been the overwhelming precedent set by the Clean Development Mechanism for Afforestation/Reforestation projects.

Guyana has chosen to define forest following the definition as outlined in the Marrakech Accords (UNFCCC 2001). Under this agreement forest is defined as having a minimum area of land of 0.05 – 1 ha with tree crown cover (or equivalent stocking level) of more than 10-30% with the potential to reach a minimum height of 2-5 m at maturity in situ. Guyana has elected to classify land as forest if it meets the following criteria:

- Tree cover of minimum 30%
- Minimum height of 5 m
- Minimum area of 1 ha

It was recommended that based on Guyana's forest characteristics, where there is largely undisturbed primary forest and the remaining being sustainably managed forests, where trees are predominantly 5 m in height, the minimum threshold for this variable is recommended to be 5m. From a monitoring perspective. The use of the upper limit (5m) would require the lowest transaction cost with no added value of going down to 2m.

Approximately 50% of Guyana's State Forest Estate is unallocated for commercial utilization. The remaining 50% is subject to sustainable utilization whereby extraction levels are strictly monitored based on approved guidelines. Additionally, in logging activities selective harvesting is practiced, and it is highly unlikely that the crown cover would diminish to below 30%. An assessment of Guyana's forest land showed that 85% of the forest land has a crown cover of 30% and greater. It is envisaged that the majority of future planned land use development activities may involve clearing of areas that are of 10% to 30% canopy cover. In order to adequately provide for this in Guyana's forest definition, an appropriate range for this variable is required to be taken into account. As such, it is recommended for Guyana to adopt a 30% crown cover threshold in the definition of forest. Guyana's national greenhouse gas inventory is being aligned to also use this definition.

Guyana's forest management system builds from one (1) hectare area size, to one block (100) hectare to compartments. In this context, the minimum monitoring unit for Guyana is therefore 1 ha. Guyana considered the relative sizes of the resolution of the imagery to be used in monitoring forest area change, (the minimum mapping unit, MMU), and the specified minimum area to be defined as forest. One (1) hectare was thought to be the most ideal size to allow for effective monitoring of forest area change. It is also intended that deforestation be assessed using medium/high resolution image on a routine (annual or biennial) basis. Detecting area change that is 0.05ha to 0.5ha becomes difficult, costly and possibly imprecise at this resolution. In considering the selection of a MMU, it is important to note that the MMU is closely connected with a country's forest definition. It is also important to note that Remote Sensing data analyses become more difficult and more expensive with smaller MMU as this requires an increase in mapping efforts, which usually results in a decrease in mapping accuracy. In keeping with Guyana's consideration of 1 ha for measurement of land area under its forest definition, the MMU should also be 1 ha. This is also appropriate as the optimal option because it will allow for the consistency in application of the forest definition and the MMU.

3.1.3 Scale

Guyana has opted to develop its RL at the national scale rather than developing subnational RLs due to its relatively small size and relatively centralized government structure. The advantage of a national approach is that the integration of separate subnational RLs and MRV systems is not necessary. Therefore, the process of developing a RL is simplified and can happen more quickly than if common standards and agreements had to be developed for subnational jurisdictions to use.

3.1.4 Pools/Gases

Pools for Guyana were selected separately for each activity included in the RL (Table 2[10]). The selection of pools was based on the expected magnitude of the change in stock in a given pool as a result of deforestation as well as the resources required to collect accurate and precise data. For degradation caused by timber harvesting, the

[10] All field work and data collection for estimating emission factors included all five IPCC pools, but here in the RL report they are not included. This is because Guyana's proposal for Reference Level for REDD+ is based on the Combined Reference Level Approach using a study that reported the historic global emissions, which included above and below ground biomass only. The results for the other pools are presented in Annex 1 to this report.

dead wood pool was included as logging operations create a large increase in this pool when trees are felled and extracted. The selection of greenhouse gases for Guyana includes CO_2 only.

Table 2. Carbon pools selected to include in the RL according to activity[11].

Activity	AG Biomass	BG Biomass	Dead Wood
Deforestation	x	x	
Degradation from Timber Harvesting	x	x	x

3.1.5 Historic Time Period

Guyana has established the time period for historic emissions to be from 2001 to 2012, a total of 12 years. This period was selected because robust and credible activity data are available for both deforestation and for degradation from timber harvest for this whole period. Furthermore, there were very few data on forest carbon stocks from which to build on and all carbon data used to estimate emission factors for Guyana's forests have been collected during the period late 2010 to early 2014, and extending these data to represent carbon stocks of pre 2000 forests is a weak assumption. We recognize that the MOU with Government of Norway established a benchmark period of 1990 to 2009, with subsequent monitoring through 2012. However, as REDD+ programmes are in development, with the funds received from Norway to date being used to build local capacity, to develop and implement a monitoring system, and generally prepare Guyana for a REDD+ mechanism, it is expected that programmes in development will impact emission reductions in the period following 2012. The period 2001-2012 was therefore identified as the benchmark rather than 1990-2009, for the following reasons:

1. Activity data pre-2000 are available in large blocks (10 year and 5 year periods).). E.g. we have analysed activity data for 1990 to 2000 as one block. This is owing to lack of sufficient cloud free data to conduct analysis annually.
2. Annual activity data commenced from 2010 and now is available for 3 years as presented in the Proposal, with the fourth and fifth years both to be completed by end of 2015. If Guyana were to use the period ending 2009, then this would not have benefitted from the annual, which presents a more precise capture of activity data, activity data assessment of 2010, 2011, and 2012.
3. Extending data collected on carbon stock during 2010 to 2014, to represent carbon stocks of pre 2000 forests is a weak assumption.
4. With initial date of the MoU with the Government of Norway commencing in 2009, actual flow of funds and implementation of REDD+ activities commenced until after 2012, thereby making the period 2010 to 2012 more aligned with the benchmark period.
5. Activity data for estimating emissions from degradation by logging are only available post 2001.

The forest area as at end of 2012, is being used to denote the historic period. This was done so as to take advantage of the full development of the mapping of forest areas in Guyana that evolved over the period 2010 to 2012. Activity data and base maps for sample design for emissions computations, and remote sensing analysis

[11] Results for all C pools are given in Annex 1 to this report.

are congruent. Moreover, the 2012 forest cover map will be used as the benchmark for future monitoring of deforestation to track CO_2 emissions.

3.1.6 IPCC Guidance

The IPCC 2003 IPCC Good Practice Guidance for Land Use, Land-use Change, and Forestry (GPG-LULUCF) and the IPCC 2006 Guidelines for National Greenhouse Gas Inventories Agriculture, Forestry and Other Land use (AFOLU)[12] were developed for use in preparing a national greenhouse gas inventory. No guidance has been made with respect to preparing and reporting on REDD+ related activities although in 2011 the UNFCCC Conference of Parties agreed[13] that the Biennial Update Reports for non-Annex 1 Parties (i.e. developing countries) should be based on the 2003 GPG including the Tables in Annex 3.A.2.However, Decision 12/CP.17 Annex states that information used to develop a RL should be guided by the most recent IPCC guidance and guidelines; thus Guyana refers to both IPCC reports (GPG and AFOLU).

Key concepts that the IPCC recommends countries address with respect to estimating emissions and removals, and how Guyana applies these concepts in developing their RL are described below:

- **Good Practice**: Inventories consistent with good practice are those that contain neither over- nor under-estimates as far as can be judged, and in which uncertainties are reduced as far as practicable. These requirements are intended to ensure that estimates of emissions by sources and removals by sinks, even if uncertain, are bona fide estimates, in the sense of not containing any biases that could have been identified and eliminated. Good practice entails the following five principles: 1) transparency—that documentation is sufficient for reviewers to assess the extent to which good practice requirements have been met; 2) completeness—all relevant emissions and removal categories are estimated and reported; 3) consistency—differences in emissions and removals between years are real and not an artifact of changes in methodology or data; 4) comparability—so that inventory estimates can be compared among countries; and 5) accuracy—methods used are designed to produce neither under or over estimate. Guyana has applied good practice to all its data collection and analyses efforts by:
    - Building local capacity in all aspects of data collection and analyses
    - Developing and implementing a QA/QC plan, including steps for checking internal self-consistency, checking against other independent estimates, standard operating procedures (SOPs) for field data collection, data analysis, processing remote sensing imagery, and data archiving
    - Establishing and achieving accuracy targets for interpretation of remote sensing imagery used to estimate rates of forest loss (activity data--AD)
    - Establishing and achieving accuracy and precision targets for field data collection and analyses for estimating emission factors (EFs).
    - All documents and data bases are available for inspection

- **Tiers**: A system of tiers has been developed by the IPCC to represent different levels of methodological complexity. Tier 1 is the basic method, Tier 2 is intermediate and Tier 3 is the most demanding in terms of complexity and data requirements.

[12] Available at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html. And http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html
[13] See Annex III to Decision 2/CP.17.

The higher order Tier 3 include models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national level. Such systems may include comprehensive field sampling repeated at regular time intervals and/or GIS-based systems of age, class/production data, soils data, and land-use and management activity data, integrating several types of monitoring. Parcels of land where a land-use change occurs can usually be tracked over time, at least statistically. All models should undergo quality checks, audits, and validations and be thoroughly documented. Guyana is operating at Tier 2 to 3 levels for the following reasons:

- Wall-to-wall coverage of satellite imagery is used to obtain the AD related to conversion of forest lands to other uses. For the period 1990 to 2010 Guyana used primarily Landsat imagery with a variety of other sensors. Post-2010 AD is based on practically wall to wall monitoring using high resolution RapidEye imagery. See Figure 1 (a) for examples of forest area and forest area change mapping.
- All AD are disaggregated by the strata used for the field sampling design for EF estimation (e.g. threat for land use change, accessibility), and by the drivers (e.g. mining, infrastructure, converted to cropland, converted to settlements,).
- All AD data are combined and co-registered with other key spatial data bases in a GIS such as roads, rivers, settlements, vegetation class, location of logging concessions, location of mining concessions, topography, etc.
- A comprehensive, peer-reviewed, field sampling system was designed to attain a required precision target (95% confidence interval of <+/-15% of the mean carbon stock of forests) and implemented. The location of each sample plot was selected statistically through a series of steps in a GIS[14].
- A field sampling plan has been designed for long-term, repeated measurements of the forest carbon stocks and ongoing monitoring of forest cover change.
- The allometric model of Chave et al.[15] was validated for use in Guyana forests.

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[14]Brown, S., K. Goslee, F. Casarim, N. L. Harris, and S. Petrova. 2014. Sampling Design and Implementation Plan for Guyana's REDD+ Forest Carbon Monitoring System (FCMS): Version 2. Submitted by Winrock International to the Guyana Forestry Commission.

[15]Chave, J, C. Andalo, S. Brown, M.A. Cairns, J.Q. Chambers, D. Eamus, H. Folster, F. Fromard, N. Higuchi, T. Kira, J.P. Lescure, B.W. Nelson, H. Ogawa, H. Puig, B. Riera, T. Yamakura. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145:87-99.

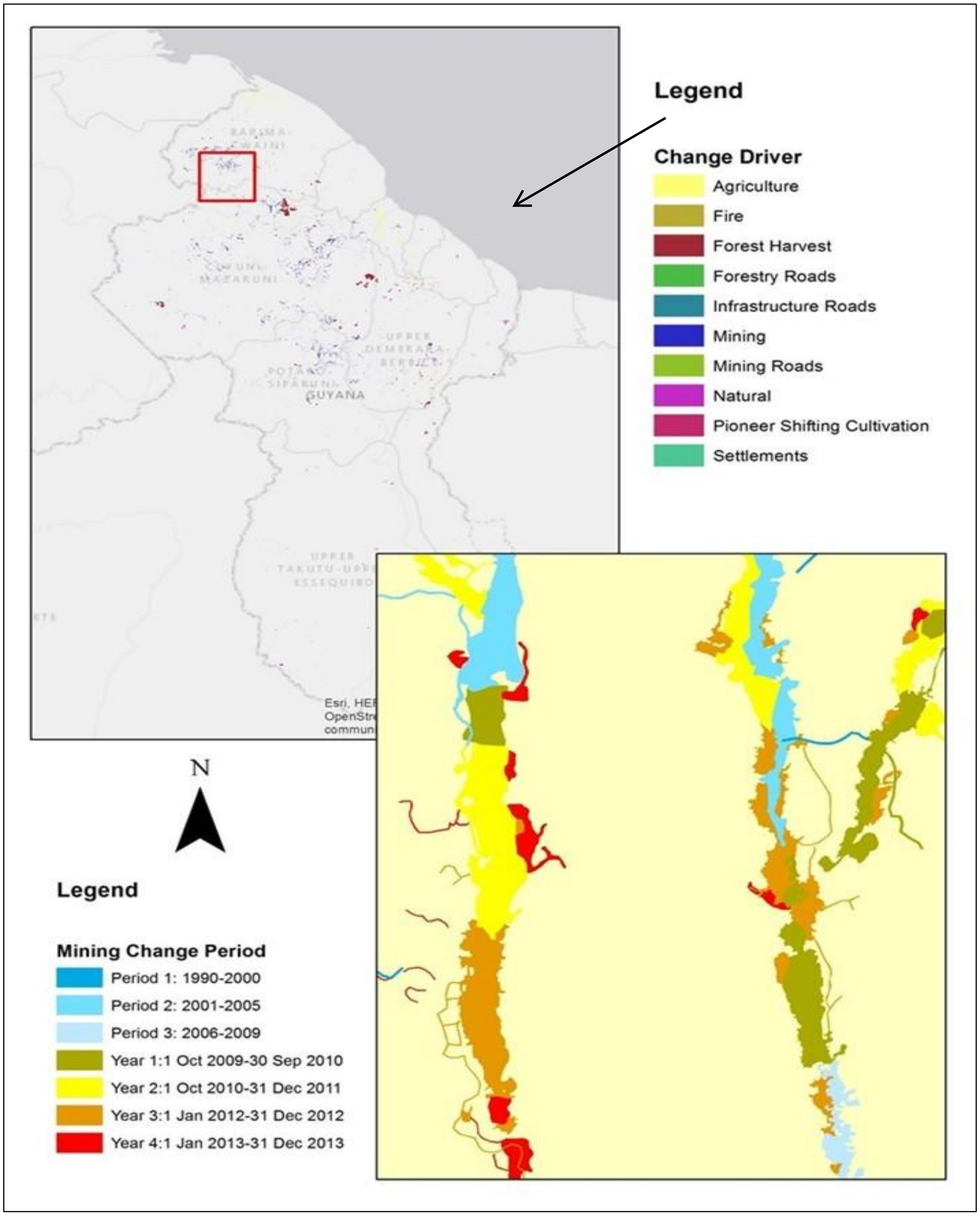

Figure 1 (a). Example of Forest Change Mapping illustrating the linear pattern of deforestation caused by mining and how it expands over time.

3.1.7 Adjust for National Circumstances

According to Decision 12/CP.17 II. Paragraph 9, countries can submit information and rationale on the development of forest RLs, including details of national circumstances and if adjusted include details on how the national circumstances were considered. Being a country with high forest cover and low deforestation, Guyana proposes to make adjustments to allow for national circumstances to take into account:

- Likely future emissions are not well captured by historical ones.
- Mining is a major driver of deforestation and rising mineral prices could create incentives that significantly impact rates of forest cover change caused by this driver.
- Logging is a cause of forest degradation and changes in timber demand and prices could create incentives that significantly impact emissions caused by this driver.
- Need for broad participation by Parties and to assure equity across countries.

4.0 ESTABLISHMENT OF GUYANA'S NATIONAL FOREST MONITORING SYSTEM

UNFCCC decisions[16] requests developing country Parties to establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems (NFMS) and, if appropriate, sub-national systems as part of national monitoring systems that:

- Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related GHG emissions by sources and removals by sinks, forest carbon stocks and forest area changes
- Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities
- Are transparent and their results are available and suitable for review as agreed by the COP

Guyana's NFMS (referred to within Guyana as the Monitoring, Reporting, and Verification System –MRVS), which is composed of the Forest Area Assessment System and the Forest Carbon Monitoring System(FCMS), has been developed for data and information collection, such as information on historical forest cover changes and emission factors, to inform the assessment of national forest RLs. In this way, the MRVS forms the link between historical assessments and current/future assessments, enabling consistency in the data and information to support the implementation of REDD+ activities. The MRVS details the methods required to quantify the changes in forest cover and changes in forest carbon stocks in Guyana, develop driver-specific emission factors by forest strata, and monitor emissions from land cover/land use change over time based on a variety of management activities.

The activity data and emission factors generated from the MRVS for key categories are combined to estimate total CO_2 emissions by source or driver under Guyana's REDD+ programme. Table 3 provides an overview of

[16] Decision 4/CP.15 paragraph 1d and Decision 1/CP.16 paragraph 71(c)

each key category addressed by Guyana, including the associated drivers and the pools included in each IPCC required category.

Monitoring deforestation and forest degradation at national scale has been identified as a national priority under Guyana's REDD+ Programme. Based on Guyana's MRVS System Roadmap developed in 2009, Guyana sought to establish a comprehensive, national system to monitor, report and verify forest carbon emissions resulting from deforestation and forest degradation in Guyana. To date, four national annual assessments have been conducted: 2010, 2011, 2012 and 2013, supported by a historic assessment from 1990, resulting in a 24 period being covered. The annual assessment for 2014 is currently underway and will be completed by September 2015, with independent third party verification, and accuracy assessment completed by December 2015. The forest definition was adopted is based on 30% crown cover, minimum height of 5 m and minimum mapping unit of 1 ha. The 1990 forest area was determined using Landsat imagery and also consultation of aerial imagery from the 1960/70's to determine if areas met the minimum specifications. A Normalised Difference Vegetation Index (NDVI) was generated and this was field checked and flown to confirm the vegetation meet the definition set. In 2011 the forest area was reviewed using RapidEye 5 m imagery and the edges and boundaries refined. The accuracy of this layer has been independently evaluated by the accuracy assessors (University of Durham). The forest/ non-forest map has a quoted accuracy of 99%.

Table 3. Overview of the IPCC categories, drivers, and pools used to estimate emission factors for each key category included in this RL report.

IPCC Category	Driver(s) as defined in MRVS	Pools included		
		Biomass	Dead organic matter	Soil
Forest Land Remaining Forest Land	Degradation caused by logging	AG & BG tree	Dead wood caused by logging	Not included
Forest Land Converted to Cropland	Agriculture	AG & BG tree, saplings	Not included	Not included
Forest Land Converted to Settlements	Infrastructure including mining roads and forestry Infrastructure	AG & BG tree, saplings	Not included	Not included
Forest Land Converted to Other Land	Mining (bare soil)	AG & BG tree, saplings	Not included	Not included
Biomass Burning in Forest Lands	Fire-Biomass burning	AG, saplings	Not included	Not included

Monitoring of forest change in 2010 was completed with medium resolution imagery, mainly Landsat 5. In 2011, assessment was conducted using a combination of Landsat (5 and 7) and for the first time, 5m high resolution imagery, with RapidEye coverage for approximately half of Guyana where majority of land use changes were taking place. Forest change in 2013 was determined using high resolution imagery for the whole of Guyana. The current method is an automated-assisted process of careful systematic manual interpretation of satellite imagery to identify deforestation based on different drivers of change. The minimum mapping unit (MMU) for deforestation is 1 ha (Guyana's forest definition) and a country-specific definition of 0.25 ha for degradation. This allows for every polygon to be mapped and for the status of each polygon to be traced through time (at least for the past 24 years) for change of any kind, for clear distinguishing to be made between deforestation and forest degradation, and for direct attribution to change to drivers, specific to the time period within which they have taken place. In addition to reporting on drivers of forest change, from the assessment year 2013, activity data is also report by IPCC categories based on IPCC categorization for forest to non-forest, and forest remaining forest.

The total forested area of Guyana is estimated as 18.4 million hectares (ha). In 2012 as planned, Guyana's forest area was re- evaluated using RapidEye 5 m imagery. Deforestation in 2013 was estimated at 12 733 ha which equates to a total deforestation rate of 0.068%. Significant progress was made in 2012 and 2013, in mapping forest degradation. The area of forest degradation as measured by interpretation of 5m RapidEye satellite imagery in 2013 was 4,352 ha.

All results are subject to accuracy assessment and independent, third party verification and this has been competed for four annual reporting periods competed by Guyana. All Reporting on MRVS, Accuracy Assessment Reports, and Independent Third Party Verification Reports, are available on the GFC's website: www.forestry.gov.gy

These remote sensing and forest monitoring system described below, allow for a clear distinction between deforestation area and temporally un-stocked areas, as well as the exclusion of deforestation area from forest degradation estimates.

Guyana has put in place a national forest monitoring system, which has enforcement of forest legality amongst one of its main objectives. The forest legality procedures and mechanisms are a direct result of years of experience and are governed by a series of guiding documents and legislation, mainly the country's Forest Act, the National Forest Policy and Plan, and the Guyana Forestry Commissions' Work Plan. The monitoring division of the GFC consists of a staff of 205, spread out over the head office personnel in Georgetown, 4 divisional stations, 39 field stations, and 10 mobile stations.

The forest monitoring system has four main components that are used to enforce forest legality:

- Forest Concession Monitoring: This part of the monitoring system consists of the monitoring of the concessions from a legal point of view (i.e., permitting, payment of royalties, etc.) and the compliance level of forest management activities performed by the concessionaires;

- Monitoring of forest produce in transit: This is the Chain of Custody (CoC) system that has been implemented in Guyana since the year 2000. This CoC system, of which the Log Tracking System is a main part, has as the main objective to verify the origin of raw material and to control the level of harvesting within State Forests;

- Sawmills and Lumberyards monitoring: This component consists of the verification of the legality of sawmills and Lumberyards and their operation;

- Exports: This component of the monitoring system seeks to control all exportations and to check the legality of the produce to be exported.

The existing CoC system provides detectable evidence on the legitimacy, location and magnitude of forest operations in Guyana, and is currently applied to all forestry operations, including state forests, Amerindian reservations, as well as private properties. The system is based on the traceability of forest produce through the use of log tracking tags, which are assigned to all concessionaires and private forest holders who are involved in commercial logging operations in a given year. Log tagging is done at the stump, where half of the tag is affixed to the stump at the time of felling, and the other part of the tag bearing the same sequence of numbers as recorded on the stump tag is affixed to the produce being removed and transported. This procedure is carried out for all types of forest produce, including logs, lumber piles, poles, and posts. The unique identification code on each unit of produce will indicate who the concessionary operator is, and can therefore help indicate the geographic origin of the forest produce. In addition, the tagging systems is linked to a quota system, where information is gathered in order to control the volume of produce being harvested from a given area, and which is calculated based on the assigned sustainable yield of the forest area in question and which also considers variables such as felling cycles, felling distances, and minimum girth requirements.

The link between the tagging system and the produce information (e.g. origin, destination, volume, type of produce) is done through volume declarations, which are included within the removal permit records issued by the GFC.

The monitoring process of the extracted volumes varies depending on whether the operation:

- Takes place in a State Forest lands and is not a procedural breach;
- Takes place in the private properties / Amerindian lands and is not a procedural breach;
- It is a procedural breach (i.e. State Forest lands or private properties / Amerindian lands);
- It is illegal logging.

The forest monitoring has written procedures which are in place for each of the above areas. Guyana’s SFM system and reporting on forest harvest and illegal logging levels have been subject to annual audits for the past 4 years. The results of these independent, third party verification exercises have verified that the GFC’s system as robust and appropriate for forest management in Guyana and for the practice of sustainable forest management.

4.1 Estimating Activity Data

4.1.1 Deforestation

Activity data (AD) are developed by estimating the extent of forest change measured by area in the case of deforestation. In the case of degradation, where it can often be difficult to accurately relate changes in carbon to changes in area, activity data will employ, as needed, units other than area.

Forest area change has been estimated for forests converted to other lands (deforestation) for all drivers, based on IPCC Approach 3 (e.g., Figure 1 (a)). The Guyana Forestry Commission, with the services of Pöyry and Indufor, has completed an historical assessment of forest area change—from forest to non-forest—for six periods: 1990-2000, 2001-2005, 2006-September 2009, October 2009- September 2010, October 2010- December 2011, and January to December 2012. The analyses for these six periods were done by the same team of people using consistent methods. For the first four periods Landsat imagery was used, for the fifth period it was a combination of Landsat and Rapideye, and for the sixth reporting year wall-to-wall high resolution Rapideye imagery was used[17]. The use of higher resolution imagery in the most recent time frame allowed for higher accuracy of interpretation in this period and for a re-evaluation of the total forest area for the previous years. All remote sensing products have been assessed for accuracy (accuracy on forest area of >97%) and verified independently by a 3rd party and all steps certified by an external auditors.

For each of time period up to September 2010, 30 meter resolution satellite imagery was used to quantify deforestation resulting from various drivers including mining (mined areas and roads), agriculture, forestry infrastructure (roads and log decks only), road infrastructure, and fire. For the October 2010 to December 2011 period, 5 meter resolution RapidEye imagery was also used for half of Guyana's land area with the 30 m imagery, and full wall-to-wall coverage with RapidEye for 2012. GFC will conduct future monitoring of deforestation with medium/high resolution imagery and a product that gives similar quality and detail in functionality.

The MRVS does not currently address other lands converted to forest (reforestation), though this may be included in the future. Activities used to determine forest area and area change and the findings are described in complete detail in reports by GFC and Pöyry (2011) and GFC and Indufor (2012, 2013)[18].

4.1.2 Degradation

One driver of forest degradation, selective logging, is included in the MRVS at present, whilst work is ongoing to collate data for the other drivers of forest degradation. These activity data were estimated from two sources: (1) the areas cleared for forestry infrastructure (roads and log decks) from the analysis of remote sensing imagery and (2) the volume of timber removed during commercial logging and the length of skid trails, based on records available from GFC. During the historical period, no timber was extracted and recorded from the forests prior to deforestation and thus there is no risk in this period for double counting of carbon[19].

The additional activity data for selective logging were obtained from records from the GFC—this includes legal and illegal timber production. The GFC reports on volume of timber extracted, by the primary product class (Table

[17] GFC and Indufor 2013, Guyana REDD+ Monitoring Reporting & Verification System (MRVS); Year 3 Interim Measures Report 01 January 2012 – 31 December 2012.

[18] GFC and Indufor 2013, Guyana REDD+ Monitoring Reporting & Verification System (MRVS); Year 3 Interim Measures Report 01 January 2012 – 31 December 2012. Available from the GFC. Indufor, 2012. Guyana Forestry Commission Guyana REDD+ Monitoring Reporting & Verification System (MRVS) Interim Measures Report, 01 October 2010 – 31 December 2011. Joint report between Indufor and the Guyana Forestry Commission. Pöyry Management Consulting Ltd (Pöyry).2011.Guyana Forestry Commission REDD+ Measurement Reporting Verification System (MRVS) Interim Measures report. Joint report between Pöyry and the Guyana Forestry Commission (GFC).

[19] Since 2013, new regulations have been initiated by GFC that require commercial timber species be extracted prior to deforestation—this will be tracked so that during future monitoring, adjustments to the EF for deforestation will be made so as to prevent any double accounting

4) from its concessions and the length of the skid trails planned to extract the timber to the logging decks[20]. All timber data are converted to cubic meters over bark using a variety of factors, and summed to give a total timber production for each year.

Table 4. Primary product classes tracked by GFC and their conversion factors to obtain true volume under-bark in cubic meters. All volumes were converted to over-bark by multiplying under-bark by 1.12 (from IPCC 2006AFOLU).

Product		Description
Logs 1000 m^3/yr	Production	Log is a main product produced and is not a subset of any category. This volume that is declared is the hoppus volume that discounts a part of the log to provide for the taper factor. To determine the true volume of logs, it is recommended to multiply this by 1.278%.
Sawnwood 1000 m^3/yr*	Production	This category of production is a stand along category and is in addition to Logs. That is, it is not a sub set of the Logs category. This is the case since, Guyana's Forest Act allows for forest concessionaires to declare harvested timber in logs as well as Primary Lumber which is largely Chainsawn Lumber or Portable Mill produced lumber. To derive a total harvested volume quantity, this has to be ADDED to Logs harvested. Note that the conversion rate of Logs to Lumber of 50% therefore, to derive this total of production, it would have taken twice as much of log volume.
Roundwood (Piles, Poles, Posts, Spars) 1000 m^3/yr	Production	This is a separate category. Not a subset of Logs or Primary Lumber. Needs to be added to Logs and Primary Lumber to generate a total of harvested timber.
Splitwood (Staves, Shingles 1000 m^3/yr)	Production	This is a separate category and only includes non factory manufactured splitwood. Not a subset of Logs or Primary Lumber. Needs to be added to Logs, Primary Lumber and Roundwood to generate a total of harvested timber.

4.2 Estimating emission factors

4.2.1 Deforestation

Field data have been collected to estimate forest carbon stocks and for use in estimating emission factors for all drivers of deforestation and for degradation resulting from selective logging. Carbon stocks are estimated for the pools given in Table 2, using country-specific data and conversion factors, and an allometric equation[21] verified through destructive sampling of four large trees. The field data were used to estimate emission factors that meet IPCC's requirements for Tier 3. All field data were collected and validated using the Standard Operating Procedures (SOP) manual developed for this work.

[20] See section 9.7 in GFC and Indufor 2013, cited above in footnote 12, for more details.
[21] Chave, J, C. Andalo, S. Brown, M.A. Cairns, J.Q. Chambers, D. Eamus, H. Folster, F. Fromard, N. Higuchi, T. Kira, J.P. Lescure, B.W. Nelson, H. Ogawa, H. Puig, B. Riera, T. Yamakura. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145:87-99.

Stratification of Guyana's forest lands is a key step for developing a cost effective sampling plan and increasing the accuracy and precision of the resulting emission factors for deforestation. Estimating GHG emissions across Guyana as a whole is not possible without consideration of how carbon stocks are distributed across the country with respect to specific drivers or agents of forest land cover/use change and other physiognomic features of the landscape (i.e., forest type, elevation, soils composition, etc.). Often forest carbon stocks vary based on forest type, and because Guyana has diverse forests, initial attempts at stratification incorporated forest type. However, estimates of carbon stocks for different forest types based on measurements collected from preliminary plots were not significantly different across the multiple forest types in Guyana[22]. Differences in drivers of forest cover change, however, do result in differences in changes in carbon stocks and thus emission factors. In addition, different land-use histories as a result of accessibility such as proximity to roads and population centers can also lead to different forest carbon stocks and resulting emission factors.

A key first step in estimating emissions factors for deforestation was to use a stratified sampling design applied to the forests of Guyana. A stratified sampling design allows for maximum flexibility in designing a sampling protocol within each stratum that is tailored to the desired level of precision—for Guyana the target is a 95% confidence interval of ±<15% of mean--as well as the time and resources available to collect the data. Stratification criteria for the FCMS include both *ecological considerations* that affect how much carbon is contained within in a given area of land as well as *human pressure considerations* related to how the land is being used (and how it will be used in the future). For example, it is desirable to group all lands of similar carbon stocks together that are under similarly high pressure of future deforestation into one stratum, and other lands that are of similar carbon stocks but under little to no pressure into a separate stratum. In this way, resources can be optimized so that sampling intensity is greater (thus precision is higher) in the areas most likely to undergo change in the future.

An overarching spatial analysis framework, operating in a Geographical Information System (GIS) was used to create a Potential for Future Change (PFC) stratification system that developed a relationship between the historical deforestation pattern and the spatially represented factors of deforestation. This method of stratification aims to understand which forest change factors, or combinations of factors, contribute most significantly to the historical pattern of deforestation. Humans tend to deforest areas that are close to roads and settlements (accessible for clearing), clearly demarcating some areas as having high potential for future change and others low potential. Two recent historical periods, 2000-2005 and 2005-2009, were considered for defining the pattern of forest change. The PFC spatial analysis framework and the specific techniques are discussed in the spatial techniques report[23].This PFC framework resulted in the identification of three strata based on their potential for future change—high (HPfC), medium (MPfC), and low (LPfC) potential for change (Figure 1 (b)).

In addition to stratifying by potential for change, the forests were also stratified by accessibility. A large portion of Guyana's forestland is not easily accessible and the purpose of the sampling stratification is to overcome some operational constraints while maintaining robust sampling results. Therefore, the factor of accessibility was introduced in the sampling stratification methodology to provide a forest carbon sampling framework that allows for efficient collection of data. The accessibility strata were also included, because, given the long history of

[22] Section 3.7.5 in Brown, S., K. Goslee, F. Casarim, N. L. Harris, and S. Petrova. 2014. Sampling Design and Implementation Plan for Guyana's REDD+ Forest Carbon Monitoring System (FCMS): Version 2. Submitted by Winrock International to the Guyana Forestry Commission.

[23] Petrova S., K. Goslee, N. Harris, and S. Brown. 2013 Spatial Analysis for Forest Carbon Stratification and Sample Design for Guyana's FCMS: Version 2. Submitted by Winrock International to the Guyana Forestry Commission.

logging in Guyana, our initial working assumption was that areas near roads would have been disturbed and have lower carbon stocks than those areas far from roads. The more accessible (MA) stratum is defined as 5 km straight-line distance from both sides of roads for a total of 10 km, a distance which allows a field team of 4 or 5 people to travel to the sampling point and return to the road within one day. The less accessible (LA) stratum is defined as all forestland outside the 5 km road buffer were likely little disturbed (Figure 1 (b)).

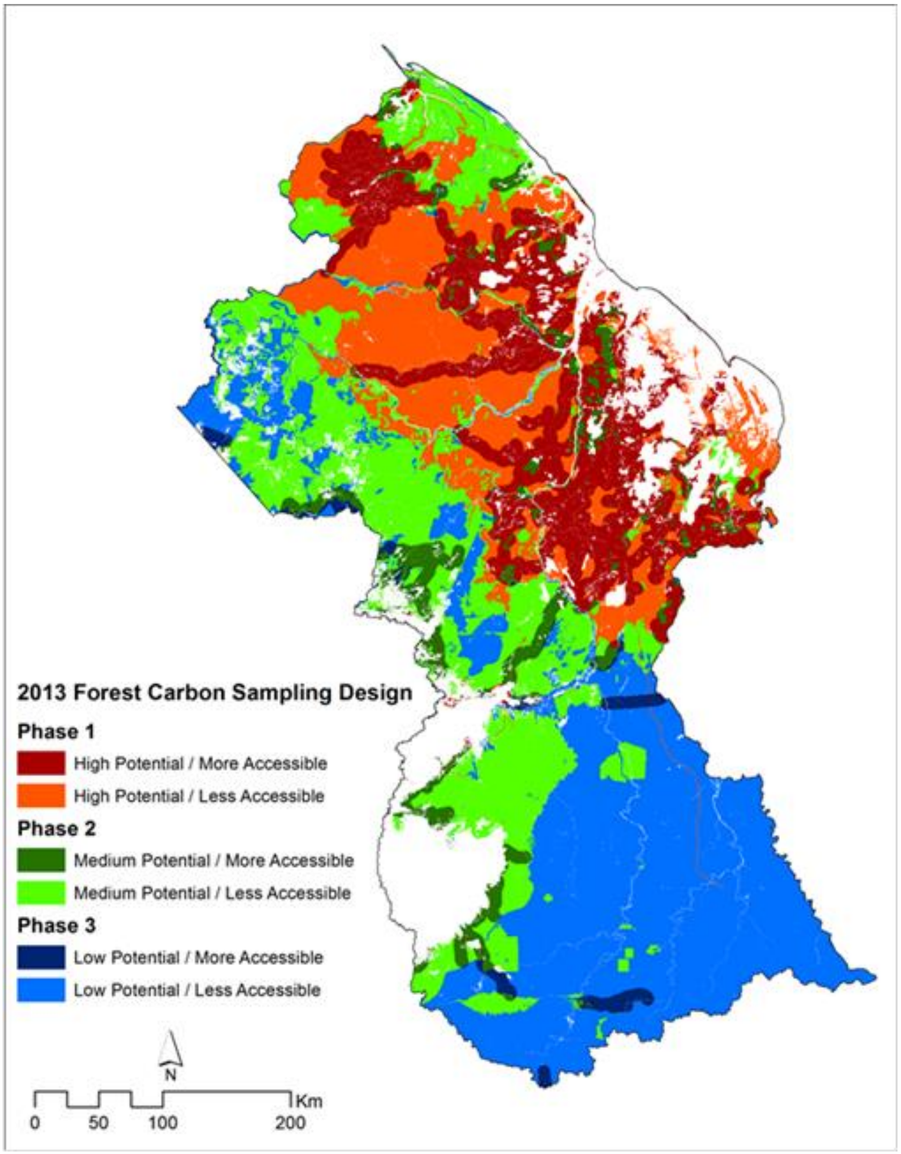

Figure 1 (b).Stratification of Guyana's forest area by deforestation threat, or potential for future change.

The number of sampling plots and the design of the plots was determined by a preliminary sampling process that randomly located plots across various forest types identified in the Guyana vegetation map, and across a latitude and longitude gradient. Different sampling methods were tested aiming at the optimum design, balancing data collection with precision, robustness, efficiency and scientific integrity. Single plots and cluster plots (a cluster of four plots) were tested during preliminary data collection. Results from the preliminary field work, indicated that cluster plots were most appropriate because when compared to single plots, results showed improvement in precision across plots, reduction of variability within plots, and reduction in travel time in sampling for reaching the precision target. The results also showed that there were no significant differences in carbon stocks among the main forest types and that stratification by forest type was not necessary[24].

Sampling Design

For Guyana's carbon stock assessment, a stratified two-stage list sampling design with clustered plots was used. In this approach, the country is divided into 10 km x 10 km blocks (primary sampling units-PSUs). The PSUs within each stratum are selected using stratified two-stage list sampling design for carbon measurement—referred to as Stage 1 (Figure 2). Secondary sampling units (SSUs) designed as L-shaped cluster of four subplots are established within each PSU and carbon measurements are obtained (Figure 3). Stage 2 is the random selection of SSUs within the PSUs. This design allows for the selection of a subset of primary sampling units (PSUs) in which clustered plots (SSUs) can be established. This allows field crews to achieve higher sample sizes at relatively low cost. This approach provides an efficient inventory that is well distributed across the landscape[25]. To implement a stratified approach each stratum should be considered separately and the number of PSUs to be sampled varied by stratum.

Based on the preliminary field data of carbon stock measurements, it was estimated that 35 SSU cluster plots in the HPfC stratum should be measured to attain the selected precision target (95% confidence interval of <15% of the mean). However, a total of 36 PSU/SSUs were pre-selected for the MA and 26 for the LA in case the carbon stocks were more variable than originally estimated in the preliminary sampling. These steps were repeated for the MPfC MA and LA strata. No PSUs/SSUs have been sampled for the LPfC stratum at this time but work is underway in 2015. Further details are given in Brown et al. 2014. (cf footnote 24).

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[24]Brown, S., K. Goslee, F. Casarim, N. L. Harris, and S. Petrova. 2014. Sampling Design and Implementation Plan for Guyana's REDD+ Forest Carbon Monitoring System (FCMS): Version 2. Submitted by Winrock International to the Guyana Forestry Commission.

[25]Tomppo, E. and M. Katila. 2008. Comparing alternative sampling designs for national and regional forest monitoring. Appendix 4 in Tomppo, E. and K. Andersson, Technical review of FAO's approach and methods for national forest monitoring and assessment (NFMA), NFMA Working Paper No. 38, Rome, 2008.

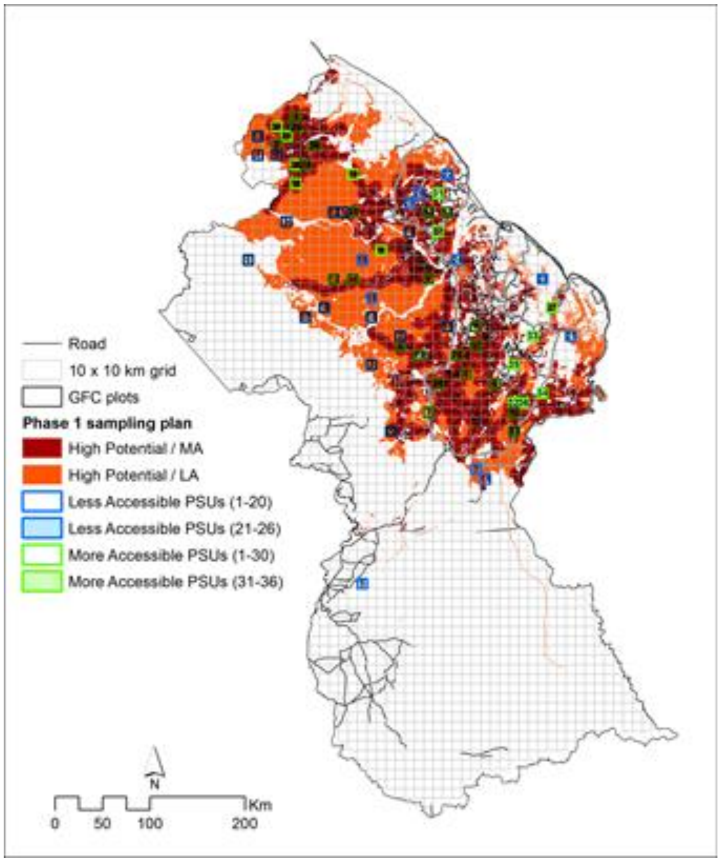

Figure 2. The stratified two-stage list sampling design with plot location for the High Potential for Change More Accessible (MA) and Less Accessible (LA) strata.

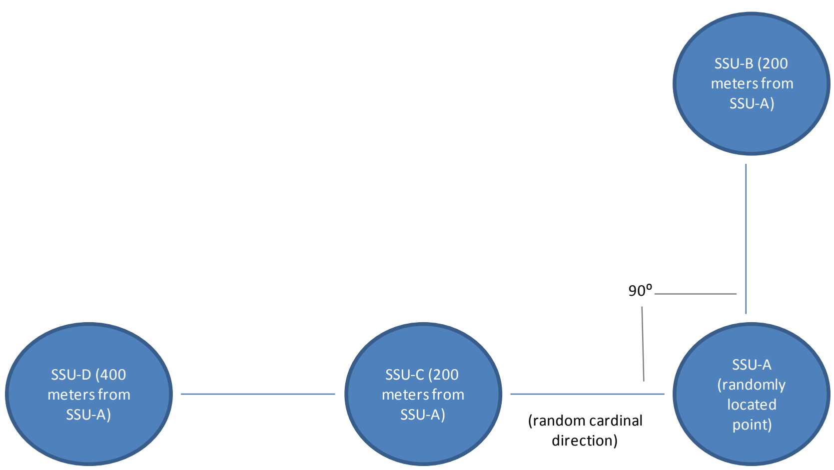

Figure 3. Layout of the four subplots that comprises a Secondary Sampling Unit (SSU). Each subplot consists of 4 nested plots ranging in size of 2 m radius for saplings, 6 m radius for trees 5-25 cm DBH, 14 m radius for trees 25-50 cm DBH, and 20 m radius for trees >50 cm DBH.

The area of each stratum and number of cluster sample plots actually measured is given in Table 5. Based on this stratification system, data collection efforts were divided into three phases: the HPfC stratum first (Phase 1), followed by the MPfC stratum (Phase 2), and then the low priority LPfC (Phase 3) (Figure 1(b)). To date all field work has been completed for Phase 1 and 2.

Table 5.Average area of each sampling strata for the period 2001-2012.

Forest Carbon Sampling strata		Area (ha)	Number of sample plots
High potential for change	**More accessible**	3,526,665	26
HPfC	**Less accessible**	3,160,253	16
Total HPfC		**6,686,917**	**42**
Medium potential for change	**More accessible**	1,116,669	11
MPfC	**Less accessible**	4,389,557	13
Total MPfC		**5,506,226**	**24**
Low potential for change	**More accessible**	271,416	Sampling in Progress
LPfC	**Less accessible**	5,963,066	
Total LPfC		**6,234,482**	
Total all strata		**18,427,626**	

A complete description of the methods used for data collection is available in Brown et al. (2014) and the field data used to estimate emission factors are described in Goslee et al (2014)[26].

4.2.2 Degradation

Emissions due to degradation from selective logging were estimated through the development of emission factors related to the volume of timber extracted (in m^3 over bark). Sampling was conducted on active concessions across Guyana to determine the loss of carbon stocks through harvesting and collateral damage in the gaps and skid trails. Losses were assessed with data collected from "logging plots" and skid trails.

The carbon emissions from logging in Guyana can vary as a function of different logging intensities and practices, defined by stand re-entry, extraction rates, and reduced impact logging practices. These differences are captured in the types of concessions, classed as large, medium, and small scale concessions. The main difference between these different concessions is related to the amount of timber extracted per hectare and the re-entry period.

[26]Goslee, K., S. Brown, and F. Casarim, 2014. Forest Carbon Monitoring System: Emission Factors and their Uncertainties, Version 2. Submitted by Winrock International to the Guyana Forestry Commission.

The goal of this component was to develop emission factors relating total biomass carbon damaged, and thus carbon emissions, to the volume of timber extracted and based on the method in Pearson et al[27]. This method allows for the estimation of the total emissions generated by selective logging for different concession sizes across the entirety of Guyana, and was implemented by:

1. Measuring, on a sample of logging gaps (183 plots across four large scale commercial concessions), the extracted volume and carbon in the timber tree and the incidental carbon damage to surrounding trees;
2. Estimating the carbon impact caused by construction of skid trails. (Although selective logging clears forest for roads and decks, their emissions will be estimated under the deforestation component.)

The results of a preliminary analysis for Guyana's timber production, based on a simple approach[28], indicated that the amount going into storage of HWP was insignificant, representing about 0.1% of the annual emissions from logging. Given the insignificant storage of carbon in wood products Guyana decided report it as zero and not include it in the analysis of emissions following the advice of the IPCC AFOLU Ch Vol4-12.

Estimating the total impact of selective logging on carbon stocks involves quantifying a number of different components:

- Volume and biomass removed in the commercial tree felled – emission;
- Dead wood created as a result of tree felling – emission;
- Damage from logging infrastructure – emission;

Carbon loss or change in live and dead biomass between the "before-logging" and "after-logging" scenario is a result of the felling of the timber tree, extraction of timber volume, the damage caused to residual trees from the logging activities, and the extraction of trees due to construction of skid trails. This is expressed in equation forms as follows

$$\textbf{Emissions, t C/yr} = \underbrace{[Vol \times WD \times CF]}_{(1)} + \underbrace{[Vol \times LDF]}_{(2)} + \underbrace{[Vol \times LIF]}_{(3)} \qquad \text{(Eq.1)}$$

Where:

Vol = volume timber over bark extracted ($m^3 yr^{-1}$)

WD = wood density ($t\ m^{-3}$)

CF = carbon fraction, the proportion of biomass that is carbon - 0.5 (IPCC 2003 GPG and 2006 AFOLU)

LDF = logging damage factor—dead biomass left behind in gap from felled tree and collateral damage ($t\ C\ m^{-3}$)

LIF = logging infrastructure factor—dead biomass caused by construction of skid trails ($t\ C\ m^{-3}$)

Field measurements are collected from logging plots to quantify components (1) and (2) in Eq. 1 above. To quantify the biomass carbon that is damaged and dead as a result of constructing the skid trails (component (3)

[27] Pearson, TRH, S Brown, and FM Casarim. 2014. Carbon emissions from tropical forest degradation caused by logging. Environ, Res. Lett 9 034017 (11 pp) doi:10.1088/1748-9326/9/3/034017

[28] Described in Winjum, J. K., S. Brown, and B. Schlamadinger. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. Forest Science 44:272-284.

in above equation), measurements of the average width of skid trails and the forest carbon stocks damaged during the construction of trails are made.

Because of the need to collect data at plots located exactly where a tree has been felled, it is not possible to establish completely random plots across Guyana. Rather, plots are located at sites of recently felled trees in concessions, and the volume and biomass removed in commercial logs is determined. In addition, for the measurement of damage that results from tree felling, it is not possible to establish a set plot size. Instead, one or more felled trees that create one gap define a "logging plot", and it is necessary to identify and measure all of the surrounding trees damaged during the felling in a given gap. In this way, it is possible to calculate carbon emissions per unit of volume extracted in commercial trees[29].

5.0 HISTORICAL EMISSIONS

5.1 Deforestation

5.1.1 Activity Data

Total deforestation over the historic period is estimated to be 69.5 thousand ha. It is clear that most of the past deforestation has occurred in the HPfC stratum where about 61.5 thousand ha have been cleared compared to 6.5 thousand ha in the MPfC stratum, and only 1.5 thousand ha in the LPfC stratum during the same time period (Table 6). Moreover, annual amounts of clearing have generally been increasing over the same time period.

For the HPfC stratum about twice as much deforestation occurred in the MA stratum than in the LA (40 thousand ha vs 22 thousand ha). However, in the MPfC stratum, about three times more deforestation occurred in the LA area than in the MA area, and this is mostly due to mining activities.

[29]Further details of all field measurements and analyses are given in are given in SOPs 17-22 in Casarim FM, K Goslee, S Petrova, S Brown, H Sukhdeo, and C Bhojedat. 2014 Standard Operating Procedures for the Forest Carbon Monitoring System of Guyana. Winrock International; and Casarim F., K. Goslee, and S. Brown, 2014. User Manual for Calculating Emission Factors with Guyana's Selective Logging Tool. Submitted by Winrock International to the Guyana Forestry Commission.

Table 6. Historical activity data for deforestation by driver and stratum

Stratum	Drivers	Area of forest change (ha)				
		2001-2005	2006-2009	2009-2010	Oct 1 2010 - Dec 31 2011	Jan 1 2012 - Dec 31 2012
HPFC-MA	Forestry infrastructure	1,187	2,041	117	182	200
	Agriculture	60	2,902	255	140	257
	Mining (medium and large scale)	5,573	8,512	3,645	4,319	6,663
	Mining infrastructure	120	1,328	373	636	476
	Infrastructure	642	262	3	129	25
HPFC-LA	Forestry infrastructure	9	180	2	30	142
	Agriculture	308	2,948	23	89	176
	Mining (medium and large scale)	740	3,948	2,237	3,503	4,523
	Mining infrastructure	8	515	239	822	708
	Infrastructure	52	46	-	204	32
Total	**Forestry infrastruture**	**1,196**	**2,220**	**118**	**212**	**342**
	Agriculture	**368**	**5,850**	**278**	**229**	**434**
	Mining (medium and large scale)	**6,313**	**12,460**	**5,882**	**7,822**	**11,186**
	Mining infrastructure	**128**	**1,844**	**612**	**1,458**	**1,184**
	Infrastructure	**694**	**307**	**3**	**333**	**56**
Total across drivers		8,699	22,681	6,893	10,053	13,202
Total Annual Average		1,740	4,725	6,893	8,043	13,202
MPFC-MA	Forestry infrastructure	13	182	0	12	3
	Agriculture	-	98	23	2	1
	Mining (medium and large scale)	274	467	85	123	193
	Mining infrastructure	11	38	14	17	21
	Infrastructure	1	54	1	22	27
MPFC-LA	Forestry infrastructure	-	34	-	10	8
	Agriculture	34	515	0	10	15
	Mining (medium and large scale)	309	775	750	587	1,128
	Mining infrastructure	-	31	59	130	177
	Infrastructure	52	77	44	34	51
Total	**Forestry infrastruture**	**13**	**216**	**0**	**21**	**11**
	Agriculture	**34**	**613**	**23**	**12**	**16**
	Mining (medium and large scale)	**583**	**1,242**	**835**	**709**	**1,321**
	Mining infrastructure	**11**	**69**	**73**	**147**	**198**
	Infrastructure	**53**	**131**	**44**	**56**	**78**
Total across drivers		693	2,271	977	946	1,624
Annual Average		139	473	977	757	1,624
LPFC-MA	Forestry infrastructure	0	1	-	0	-
	Agriculture	-	-	0	-	0
	Mining (medium and large scale)	63	29	37	4	39
	Mining infrastructure	7	0	-	-	0
	Infrastructure	-	1	-	-	-
LPFC-LA	Forestry infrastructure	-	64	2	7	0
	Agriculture	-	25	9	-	2
	Mining (medium and large scale)	85	419	167	221	177
	Mining infrastructure	0	14	3	14	3
	Infrastructure	52	1	-	5	41
Total	**Forestry infrastruture**	**0**	**65**	**2**	**7**	**-**
	Agriculture	**-**	**25**	**10**	**-**	**2**
	Mining (medium and large scale)	**148**	**449**	**204**	**225**	**216**
	Mining infrastructure	**7**	**14**	**3**	**14**	**4**
	Infrastructure	**52**	**3**	**-**	**5**	**41**
Total across drivers		208	555	219	250	262
Annual Average		42	116	219	200	262

5.1.2 Emission Factors

The emission factors for deforestation were calculated as:

$$EF_{deforestaton} = \{C_{AGB} + C_{BGB}]\} \times \frac{44}{12} \qquad \text{(Eq.2)}$$

Where:

$EF_{deforestation}$ = gross emission factor for deforestation; t C ha^{-1}

C_{AGB} = Carbon stock in aboveground biomass pool; t C ha^{-1}

C_{BGB} = Carbon stock in belowground biomass pool; t C ha^{-1}

The carbon stock of the aboveground and belowground pools of Guyana's forests is high in comparison to many other tropical forests around the world, averaging about 284 t C/ha (Table 7(a)), with more than 80% in the aboveground biomass. The reason for the high C stocks in Guyana, particularly the HPfC-LA and MPfC-MA&LA strata, is due to the large proportion of trees with DBH >60 cm (about 12% of the live trees), the high proportion of trees with wood density >0.8 (36-58% of live trees), and the lack of human disturbance in the HPfC-LA and MPfC-LA&MA strata. Forests in the MA stratum of the HPfC had the lowest stock, and the LA stratum forests of the HPfC contained the highest stock. There was no statistical difference in forests C stocks between the MA and LA of the MPfC stratum, thus the two were combined (Table 7(a)). No field data have been collected for the LPfC stratum and thus the C stocks for the MPfC stratum will be used for this area at this time.

The targeted 95% confidence interval was <+/-15% of the mean total carbon stock. The target was achieved in all strata.

Table 7(a). Carbon stocks in the selected pools in Guyana's forests in the high (HPfC) and medium (MPfC) potential for change forests. MA=more accessible stratum and LA=less accessible stratum. The values in parentheses are the 95% Confidence Interval expressed as a percent of the mean

Carbon Pool	HPfC		MPfC
	MA	LA	MA&LA
	Carbon Stocks (t C ha^{-1})		
Aboveground Tree	193.6	267.6	229.7
Belowground Tree	45.5	62.9	54.0
Total	239.1 (10.3%)	330.5 (13.1%)	283.7 (10.1%)

The total carbon stocks in Guyana's forests (aboveground and below ground biomass) were estimated based on the average area for each stratum (average for the period 2001-2012 in Table 5) and the carbon stocks in Table 7(a). The total C stock of Guyana forests is 5.22 billion t C (Table 7(b)). The carbon stock in the forests is relatively uniformly distributed among the three potential for change strata.

Table 7(b). Total Forest Carbon Stock in Guyana's Forest based on average area for the period 2001-2012, the carbon stock data in Table 7 (a), and assume the LPfC strata are the same as the MPfC strata.

Forest Carbon Sampling strata		Area (ha)	Total C stock (million t C)
High potential for change	**More accessible**	3,526,665	843.3
HPfC	**Less accessible**	3,160,253	1,044.4
Total HPfC		**6,686,917**	**1,887.7**
Medium potential for change	**More accessible**	1,116,669	316.8
MPfC	**Less accessible**	4,389,557	1,245.3
Total MPfC		**5,506,226**	**1,562.1**
Low potential for change	**More accessible**	271,416	77.0
LPfC	**Less accessible**	5,963,066	1,691.7
Total LPfC		**6,234,482**	**1,769.7**
Total all strata		**18,427,626**	**5,218.5**

The emission factors resulting from the application of Equation 2 (Table 8) are based on the assumption that all of the biomass carbon is emitted in the year of the event—commonly referred to as committed emissions.

Table 8. Emission factors for deforestation by driver and stratum. HPfC=High potential for change, MPfC=medium potential for change, MA=more accessible, and LA=less accessible.

Stratum	Driver	Emission factor (t CO_{2e} ha^{-1})
HPfC-MA	Forestry infrastructure	876.8
	Agriculture	876.8
	Mining (medium and large scale)	876.8
	Mining infrastructure	876.8
	Infrastructure	876.8
HPfC-LA	Forestry infrastructure	1,211.7
	Agriculture	1,211.7
	Mining (medium and large scale)	1,211.7
	Mining infrastructure	1,211.7
	Infrastructure	1,211.7
MPfC-MA and LA	Forestry infrastructure	1,040.2
	Agriculture	1,040.2
	Mining (medium and large scale)	1,040.2
	Mining infrastructure	1,040.2
	Infrastructure	1,040.2

5.1.3 Historical Emissions

The activity data and emission factors for deforestation were combined to provide estimates of the historical emissions for the period 2001-2012 (Table 9). The total emissions from deforestation between 2001-2012 were **69.47 million t CO_2**. The average annual CO_2 emissions from deforestation over the whole period were **5.79 million t CO_2 yr^{-1}**. To provide estimates of annual emissions for each year, the total emission for 2006-2009 were divided by 4 yr instead of the 4.8 yr covered by the remote sensing data and the emissions for 2010-2011 were divided by 1 yr instead of 1.25 yr covered by the remote sensing data, resulting in a total emission period of 12 yr. About 88% of the total emissions were from deforestation in the HPfC stratum, with 10% occurring in the MPfC and about2% in the LPfC strata. Emissions from medium and large scale mining and mining infrastructure accounted for 79.7% of the total emissions, followed by agriculture (11.8%); forestry infrastructure (5.8%), and infrastructure (2.6%).

Table 9. Total emissions for historical period 2001-2012, by driver and stratum.

Stratum	Drivers	Emissions (t CO_2)				
		2001-2005	2006-2009	2009-2010	2010-2011	2012
HPfC-MA	Forestry infrastructure	1,040,398	1,789,136	102,446	159,533	174,944
	Agriculture	52,673	2,544,509	223,429	122,734	225,406
	Mining (medium and large)	4,886,758	7,463,631	3,196,144	3,786,894	5,841,871
	Mining infrastructure	104,939	1,164,796	327,167	557,770	417,305
	Infrastructure	562,565	229,482	2,677	112,980	21,622
MA TOTAL		6,647,334	13,191,553	3,851,862	4,739,911	6,681,147
HPfC-LA	Forestry infrastructure	10,807	217,696	1,951	36,162	172,650
	Agriculture	372,976	3,571,792	27,571	107,368	213,862
	Mining (medium and large)	896,601	4,783,832	2,710,508	4,245,280	5,480,825
	Mining infrastructure	9,948	624,098	289,783	995,844	858,106
	Infrastructure	63,346	55,345	-	246,802	38,309
LA TOTAL		1,353,678	9,252,763	3,029,814	5,631,457	6,763,752
HPfC TOTAL		8,001,012	22,444,316	6,881,676	10,371,368	13,444,900
MPfC-MA&LA	Forestry infrastructure	13,801	224,945	274	22,299	11,619
	Agriculture	35,451	637,942	24,441	12,523	16,544
	Mining (medium & large)	605,945	1,291,771	868,902	738,007	1,373,839
	Mining infrastructure	10,934	71,574	76,294	153,223	206,312
	Infrastructure	54,986	136,142	45,924	57,857	81,294
MPfC TOTAL		721,117	2,362,374	1,015,834	983,909	1,689,609
MPfC Annual		144,223	492,161	1,015,834	787,127	1,689,609
LPfC-MA&LA	Forestry infrastructure	363	67,411	2,019	7,116	0
	Agriculture	0	26,411	9,937	0	1,883
	Mining (medium & large)	153,756	466,575	212,490	233,596	224,443
	Mining infrastructure	7,639	14,121	3,365	14,420	3,670
	Infrastructure	54,380	3,035	0	4,940	42,279
LPfC TOTAL		216,138	577,553	227,810	260,072	272,275
LPfC Annual		43,228	120,324	227,810	208,058	272,275
ALL	Forestry infrastructure	1,065,370	2,299,189	106,689	225,110	359,214
	Agriculture	461,100	6,780,653	285,378	242,626	457,695
	Mining (medium & large)	6,543,060	14,005,809	6,988,043	9,003,776	12,920,979
	Mining infrastructure	133,460	1,874,589	696,608	1,721,257	1,485,393
	Infrastructure	735,277	424,004	48,602	422,579	183,504
TOTAL		**8,938,267**	**25,384,244**	**8,125,320**	**11,615,348**	**15,406,784**
ALL	Forestry infrastructure	213,074	574,797	106,689	225,110	359,214
	Agriculture	92,220	1,695,163	285,378	242,626	457,695
	Mining (medium & large)	1,308,612	3,501,452	6,988,043	9,003,776	12,920,979
	Mining infrastructure	26,692	468,647	696,608	1,721,257	1,485,393
	Infrastructure	147,055	106,001	48,602	422,579	183,504
ANNUAL TOTAL		**1,787,653**	**6,346,061**	**8,125,320**	**11,615,348**	**15,406,784**

Average annual emissions have increased over the period 2001-2012 at a rate of approximately 0.96 million t CO_2 per year (the slope of the line in Fig. 4). The upward trend is statistically significant but is limited and is driven by the large increase in mining activity after the unprecedented increase in the price of gold following the global financial crisis. No significant upward pressure was exerted by other drivers, for example by agriculture or large scale infrastructure development – despite the existence of opportunities to permit these drivers.

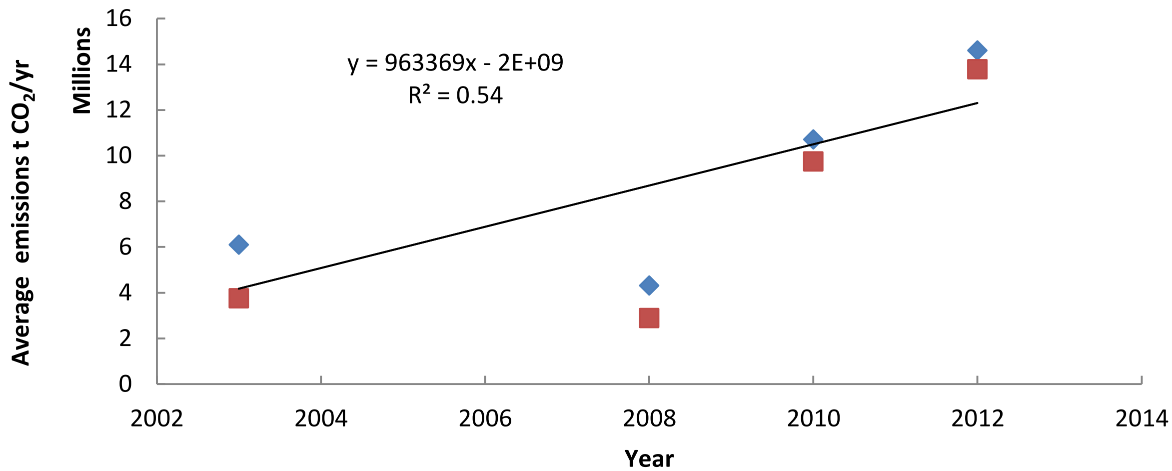

Figure 4. Average annual CO_2 emissions for the period 2001-2012 caused by deforestation. The midpoint of 2001-2005 was assumed to be 2003, and the midpoint of 2006-2009 was assumed to be 2008. The blue symbols =total emissions; red symbols =emissions from mining & mining infrastructure.

5.1.4 Uncertainty in deforestation emissions

The remote sensing products produced by Pöyry, Indufor and GFC team were verified and their accuracy assessed [30] Based on the verification of the remote sensing products, the estimated accuracy was >97% or a conservative uncertainty of 3%.

The uncertainty of the total emissions for deforestation is **a 95% confidence interval of ±11.7%**.This is based on application of the error propagation equation in Ch.5 of the IPCC GPG (2003) applied to each stratum (see the Uncertainty tab and Total Emissions tab in the Excel file:REV Historic emission tool_only AG+BG pools).

5.2 Degradation

5.2.1 Activity Data

As mentioned above, selective logging is the only driver of degradation that is included in the assessment of historical emissions. Robust activity data are available from 2001 to 2012. Selective logging, unlike deforestation, has a number of different data sources used to estimate emission factors and activity data.

These activity data include the volume of wood products and the length of skid trails (Table 10).

[30] GFC and Indufor 2013, Guyana REDD+ Monitoring Reporting & Verification System (MRVS); Year 3 Interim Measures Report 01 January 2012 – 31 December 2012.

Table 10. Activity data for timber harvesting used for developing historic emissions. The volume of logs is reported in Hoppus volume underbark that has been converted to true volume overbark[31].

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total true volume overbark logs m^3/yr	536,377	513,190	443,591	628,262	618,626	738,004	664,069	565,861	567,575	654,298	608,730	585,108

The length of skid trails was estimated based on two factors: for 2003 a factor of 4.31 km of skid trails per 1,000 m^3 of timber extracted and for 2009 a factor of 3.78 km per 1,000m^3 extracted. The 2003 factor was used for the period 2001 to 2008 and the 2009 factor was used for the period 2009-2012. For each year the appropriate factor was multiplied by the total timber over-bark harvested, resulting in the total length of skid trails constructed.

5.2.2 Emission Factors

To estimate carbon impact from readily available indicators, factors were created linking extracted volume with non-merchantable biomass of the felled tree (top and stump), collateral damage, and damage from skid trails left as dead wood in the forest. A total of 183 logging plots were installed across four large scale commercial forest concessions operating on a 25 year cutting cycle. The summary of results is given in Table 11.

Table 11. Extracted volume and estimated emission factors from selective logging on large concessions based on field data from 183 logging plots. LDF=logging damage factor and LIF=logging infrastructure factor

	Extracted Volume (m3 gap^{-1})	Average wood density (t C m^{-3})	Top & stump of Felled Tree (t C m^{-3})	Collateral Damage per Vol. Extracted (t C m^{-3})	LDF Total Carbon Damage per Vol. Extracted (t C m^{-3})	LIF Carbon Damage from Skid Trail (t C/km)
Mean	3.47	0.40	0.57	0.48	1.05	46.87
Std.Dev	2.19	0.03	0.30	0.56	0.68	8.08
95% CI	0.32	0.00	0.04	0.08	0.10	1.91
Uncertainty (CI as % of mean)	9.2%	1.0%	7.5%	16.9%	9.4%	4.1%

The data in Table 11 were used to estimate emission factors for selective logging to be used with the activity data on annual timber harvested and length of skid trails constructed (Table 12)

[31] True volume = 1.278*Hoppus volume; and volume overbark = 1.12*true volume underbark (from IPCC AFOLU 2006). See the Excel Historic Emissions tool for more details.

Table 12. Emission factors for selective logging. LDF=logging damage factor and the LIF=logging infrastructure damage from skid trails.

Driver	Emission Factors	
	Unit	t CO2
LDF	per m3	3.85
Wood density	per m3	1.47
LIF	per km	171.84

5.2.3 Historical Emissions

Combing the activity data in Table 10 with the emission factors in Table 12 results in an estimated total emissions from logging during the historical period of **42.93 million t CO_2**. The annual average emissions are **3.58 million t CO_2** and vary between 2.68 and 4.47 million t (Figure 5). More than 64% of the emissions are due to the logging damage factor (LDF), 12% are due to the construction of skid trails, and 24% from the harvested logs.

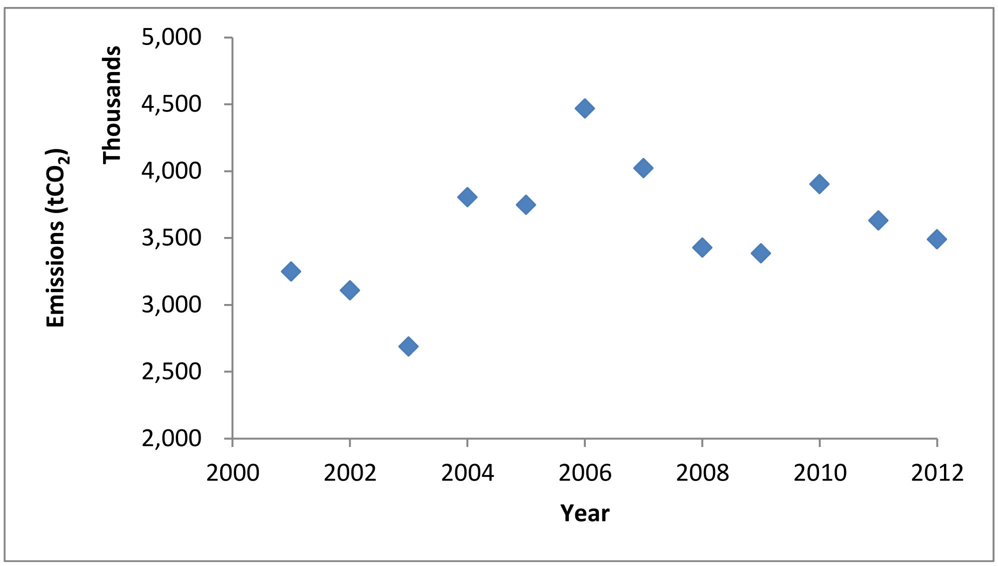

Figure 5. Annual emissions from selective logging between 2001 to 2012

5.2.4 Uncertainty in degradation emissions

The uncertainty in the timber production data is assumed to be zero as these data are well tracked by the GFC and monitored at four main levels: forest concession monitoring, monitoring through the transportation network, monitoring of sawmills and lumberyards, and monitoring ports of export.

The uncertainty of the total emissions for logging is a **95% confidence interval of ±6.6% of the mean**. This is based on application of the error propagation equation in Ch.5 of the IPCC GPG (2003) and includes the uncertainty of the LDF (95% CI of ±9.4% of the mean), the uncertainty in mean volume * wood density of species logged (95% CI of ±10.1% of the mean), and the uncertainty in the measurements of the width and C stock of damaged trees for skid trails (95% CI of ±14.6% of the mean). Details of all calculations are given in the Uncertainty Tab of the Excel file REV Historic emission tool).

5.3 Total Historic Emissions

Combining the historical emissions from deforestation with those from degradation from timber harvest gives a total emission estimate of **112.40 million t CO_2** for the period 2001-2012, and an annual average of **9.37 million t CO_2** (Table 13). Using the error propagation method proposed by IPCC (2003 GPG), the **95% CI is ±8.63 million t CO_2 or ±7.7% of the mean** (see Total Emissions Tab in the Excel File REV Historic emission tool for more details).

Table 13 (a). Total historic emissions from deforestation and timber harvesting between 2001 and 2012.

Drivers	2001-2012	
	t CO_2e	% of total
Forestry infrastructure	4,055,572	4%
Agriculture	8,227,452	7%
Mining (medium and large scale)	49,461,667	44%
Mining infrastructure	5,911,307	5%
Infrastructure	1,813,965	2%
Timber harvesting	42,932,724	38%
Total	**112,402,687**	**100%**
Annualized	**9,366,891**	

It is clear that mining, and associated roads, is the largest emission source during the period 2001 to 2012, accounting for 49% of the total emissions, followed by timber harvesting activities (if infrastructure created to allow for forestry operations, such as roads and decks are taken into account), accounting for another 42% of the total. Thus, mining and timber harvesting together account for 91% of the total emissions. Conversion to agriculture and other infrastructure account for about 9% of the total.

It should be noted that the total impact of timber harvesting is spread over a large area of utilization, that is, on an annual period approximately 2 million hectare. This results in a very low impact per hectare as compared to other Drivers, such as mining, which impacts more significantly on a given hectare that is used. The impact per hectare is therefore significantly lower in forest harvest areas than in mining areas.

The annual emissions appear to vary only slightly for the first 9 years, but this is an artefact of the way the deforestation data were collected—over about a 4 to 5 year period—thus the annual rate is averaged over the period in question (Figure 6). In the last 3 years there was a large increase in emissions, but at present there is no way to know if this occurred only in the last 3 years or was preceded by larger emissions in the previous year (e.g. 2008 and 2009).

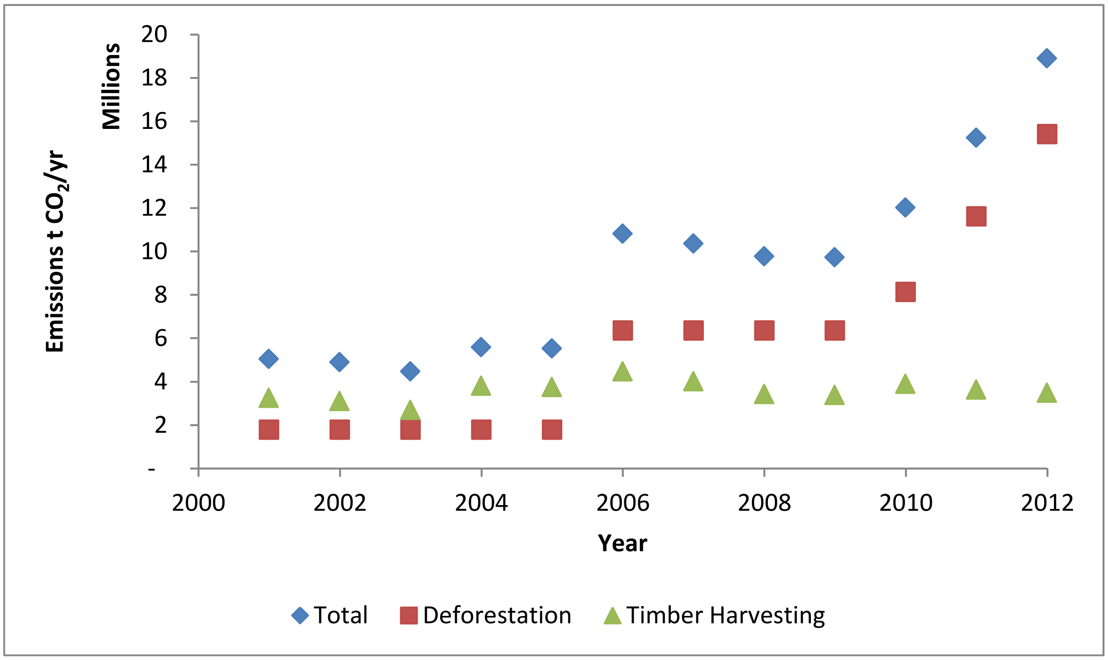

Figure 6. Annual emissions of CO_2 from deforestation and degradation from timber harvesting during the historic period 2001-2012.

6.0 GUYANA'S PROPOSAL FOR REFERENCE LEVEL FOR REDD+

6.1 Background

In 2008, Guyana set out the broad parameters of what he described as its willingness to create a globally replicable model for REDD+. Guyana stated that: "Avoiding a business-as-usual development model will require shifts in economic calculations to make the forests worth more alive than dead. Because of the global benefits from climate and other ecosystem services, those who benefit internationally need to contribute towards paying for these services".

To start competing with the pressures on Guyana's forests, the Government proposed that an Interim REDD+ mechanism would be set up whereby Guyana would receive interim payments modelled on a potential future REDD+ mechanism under the UNFCCC. This Interim REDD+ mechanism would be tied to a global goal to halve deforestation by 2020 and eliminate net deforestation by 2030, and it would create significant new economic incentives which could support low/reduced impact from drivers of deforestation, while at the same time generating financing flows to invest in a new low carbon development trajectory for the entire country.

In November 2009, the Governments of Guyana and Norway agreed an interim payment-for-carbon partnership, which the Government of Guyana classifies as "payment for climate services". Norway pays Guyana US$5/t based on the reference level methodology described below. To date, Guyana has earned in excess of US$200 million under this partnership, to create opportunities for other partners to join. This in turn has funded Guyana's Low Carbon Development Strategy and is catalysing in excess of US$1billion in private sector investment, mostly for the energy sector.

Based on Guyana's experience with the Guyana-Norway partnership, this section describes Guyana's proposed UNFCCC reference level. It covers:

- The existing pressures on Guyana's forest resources and potential to be created from extractive activities
- The Guyana-Norway partnership and the establishment of a small but significant payment for services model under REDD+
- How payment for services from REDD+ is enabling investment in Guyana's Low Carbon Development Strategy and non-extractive economic alternatives

6.1.1 Existing Pressures on Guyana's Forest Resources

Guyana's forests cover approximately 85% of the country, contain an estimated 20.5 billion ton of CO_2 in all biomass pools, and cover an estimated 18.5 million hectares (Guyana Forestry Commission, 2013.) In addition to being one of Guyana's most valuable natural assets, these forests are suitable for logging and conversion to agriculture, and have significant mineral deposits.

Guyana's economy is dominated by its natural resource sector; with agriculture, fishing and forestry sectors accounting for 20%, and mining and quarrying for 11% of GDP in the first half of 2014. Gold plays a central role, accounting for 9.6% of GDP, 24% of exports, and 78% of the mineral production values of the country in 2013. Between 2015 and 2020, the government is potentially looking at an average of US$53 million per annum in natural resource revenues[32].

Should Guyana choose to pursue a development pathway that would lead to increased deforestation from mining, logging and agriculture, there would be significant negative consequences for the world, as the critical ecosystem services that Guyana's forests currently provide both locally and globally – such as biodiversity, water regulation and carbon sequestration – would be lost. If an effectively designed and appropriately resourced Reducing Emissions from Deforestation and Degradation (REDD+) mechanism is agreed by the Parties to the UNFCCC, Guyana will be able to decide whether to place its forest under long-term protection by establishing an agreed level of forest based greenhouse gas emissions.

However, no trading markets exist for these environmental services – and as a consequence, individuals and companies in rainforest countries face powerful incentives to deforest. In turn, the Government is faced with economic and social pressures to use the forest for economic and employment benefit. Reconciling this tension between protecting rainforests and pursuing economically rational development is the core challenge that must be addressed to make forests worth more alive than dead.

There has been increasing global recognition of the fact that protecting forests is essential to the fight against climate change – deforestation and forest degradation contribute a significant percent of global greenhouse gas emissions. As a consequence, the conditions under which long-term forest protection might align Guyana's interests with global needs to combat climate change have become clearer. If a properly designed and resourced Reduced Emissions from Deforestation and Degradation (REDD+) mechanism is agreed by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), Guyana will be able to decide whether to

[32] Ministry of Natural Resources & the Environment of Guyana, 2015

place its forest under long-term protection by establishing a voluntary cap on forest based greenhouse gas emissions.

Guyana faces many of the challenges and opportunities that must be addressed by all forested countries to reduce deforestation and forest degradation. The country has a strong track record in sustainable forestry practices, with national MRVS statistics demonstrating a very low rate of deforestation over the past 23 years. However, economic pressures to increase value from forest resources in Guyana are growing. The great majority of Guyana's forests are suitable for timber extraction, there are large sub-surface mineral deposits within the forest, and rising agricultural commodity prices increase the potential returns to alternative forms of land use, all increasing the opportunity cost of leaving the forest alone. These challenges will intensify as infrastructure links between Northern Brazil and Guyana advance, increasing development opportunities in the interior of Guyana. The best approach will require incentives to reward both the preservation of existing forests, and support to restoration of forests that have been removed. To not do so would result in economic leakages across borders in the Amazon region and elsewhere – deforestation activities would migrate from countries rewarded for slowing down deforestation to countries where deforestation was not previously taking place. The incentives therefore need to appeal to the broad spectrum of forest countries.

Guyana also faces potentially massive climate change adaptation costs given the need to protect low-lying areas from the risk of flooding (~90 percent of Guyana's population and all of its economic base lives on a narrow strip of coastal land that lies below sea level, rendering it vulnerable to sea-level rise and inland flooding). Moreover, its citizens expect continuously better social and economic services as the country develops. If long-term economic incentives to protect the forest are weak, future Governments may well find it necessary to meet these needs using revenues from unsustainable resource extraction. These pressures bring into sharp focus the need to create meaningful incentives for forest conservation, and make Guyana an important case study in the economics of deforestation.

To better inform Guyana's national circumstances across the land use sectors and the emissions that may likely results from these, two parallel tracks of assessment were conducted. Discussion were held with the main land use sectors of forestry, mining and agriculture. These were based on looking at the historic trend of emissions, current and planned developments, and projected future emission levels. The projections of emissions below, have been informed by these discussions. The second track of assessment looked at the infrastructure drivers through the spatial platform available at the GFC as part of the MRVS. Based on the likely spatial impacts for investment in alternative energy (including hydro power), and expanding national infrastructure systems (e.g. the Guyana Brazil road), computations were conducted on likely emissions impacts.

6.2 National Circumstances

a. Mining & Guyana's Forests

Guyana is ranked as the 14th largest gold producer in Latin America and the 34th largest globally in 2013 (SNL, 2014).

The Guyana Geology & Mines Commission (GGMC) reports gold production in Guyana to have increased from 305 thousand ounces in 2009 to 481 thousand ounces in 2013. Guyana is still in the early stages in the development of its mining sector, with bauxite extraction being the only large scale mining activity in the country. Gold and diamond mining are carried out by artisanal, small and medium scale operations, as are sand, loam and crushed rock.

Mining is an important part of the Guyanese economy, with gold playing a central role, accounting for 9.6% of GDP, 24% of exports, and 78% of the mineral production values of the country in 2013.

Over the period 2010 to 2013, mining is estimated to have contributed 93% of total deforestation from Guyana. The emissions due to deforestation occurs as mines expand, as prospectors try to find new deposits, and as roads are built to ship materials into and out of new mining sites.

Guyana's Reference Level takes account of the continued prominent place that gold mining will play in Guyana's economy whilst identifying programmes to ensure that this limits the impact on forests.

Guyana's Mineral Production 2009-2013

	2009	2010	2011	2012	2013
Gold ('000 oz)	305	308	363	439	481
Bauxite ('000 tons)	1,448	1,100	1,827	2,210	1,694
Diamond ('000/carats)	144	50	52	41	56
Quarry stone ('000 tons)	340	506	534	484	655
Sand ('000 tons)	478	652	675	1,478	2,334
Loam ('000 tons)	2	-	12	92	94

Source: Guyana Geology & Mines Commission, 2014

The gold mining sector has been playing an increasingly important role in the national development of Guyana, with production reaching unprecedented levels in 2012. The growth of the industry has resulted in significant job creation and stimulated economic activity in remote communities and across the country. Increased investment in the sector has resulted in innovative technology being utilized to effect more efficient recovery and production. With this in mind, progressive and continuous development and improvement in mining practices are seen as a phased undertakings to be executed through a strategic programme of work in the short to medium term.

Overall in 2012 gold and bauxite exports represented 50% and 10% respectively of total export revenues[33]. Gold export earnings were US$716.9 million, 38.7% higher than the 2011 level, reflecting favourable world prices and the higher volumes exported. The average export price per ounce of gold increased by 6.0% to US$1,575.4 per ounce from US$1,486.5 per ounce in 2011.

Declared gold production of 438,645 ounces was the highest recorded in the entire history of the gold industry (excluding one of the largest producers – Omai's production), and was 20.8% higher in 2012 than 2011. The bauxite industry recorded growth in value added of 12.5%, with production of 2,213,972 tonnes with the highest rate of increase achieved in the production of cement grade bauxite.

The mining industry is also one of the principal contributors for Foreign Direct Investment (FDI) in Guyana, with several large scale investments in the sector. The demonstrated level of investor confidence and anticipated continued high price levels for gold on the world market augur well for the sector. The mining and quarrying industry recorded 14.8% growth in 2012 over 2011.

Guyana's capital account also reflected a surplus in 2012 and this was driven by significant growth in foreign direct investment (FDI), mainly investments in the mining and quarrying, among two other sectors, resulting in

[33]Guyana Bureau of Statistics; Bank of Guyana

total FDI increasing for Guyana by 19% to US$293.7 million in 2012. Net domestic credit by the banking system expanded in 2012 with strong contributions from the mining sector of 51.5%.

In 2011, it was estimated that 13,800 people are directly employed for the small and medium scale mining of gold and diamonds, and 19,000 indirectly employed in mining support industries. For bauxite an estimated 2,070 are directly employed[34]. It was shown that up to 15% of Guyanese citizens are economically dependent on small-scale mining[35].

The mining sector has also contributed to the development of hinterland infrastructure. A large number of mining companies develop infrastructure for areas in which they operate and allow multiple use of these access ways, for not only mining operators but also for forestry activities, as well as other uses. This results in the opening up of previously inaccessible areas for commercial as well as community level utilization.

Foreign direct investments will be the dominant driver for mining in the next two decades. These large scale foreign investments are expected to generate 700-2,000 direct employment opportunities over the next decade. FDI is expected to raise Guyana's profile in international markets, creating scope for more investments in the extractive sector.

There are a number of large scale gold mining activities expected to commence in 2015-2017, that could potentially double the country's gold output. These new mines will be operated by foreign multinationals, bringing in distinctive mining practices, investments and technologies[36].

It is envisaged that the mining sector, which includes all aspects of mining, is projected to account for 49% or 22.69 million tCO_2 of the annual reference level as shown below.

Drivers of Projected Emissions Level	***Policies***	***Percentage of Contribution to Reference Level***	***Total Emissions attributed to Driver (thousand tCO2)***
Mining	EITI, Codes of Practice, Reduced Use of Mercury, More Efficient Technologies.	49	22,687
TOTAL Reference Level			**46,301**

b. Logging & Guyana's Forests

The forest sector has been a strong contributor to Guyana's economy. Over the past 15 years, the forestry sector recorded 403,000m^3 to 537,000m^3 per annum in production of timber, plywood and fuelwood based products. Export value from forest products range between US$32M to US$62M over the past decade and include both

[34] Guyana's Gold & Diamond Mining Sector (2005-2010)_May 2011_ GGMC
[35] Small Scale Mining - World Bank - 2010
[36] Ministry of Natural Resources & the Environment of Guyana, 2015

primary timber exports and added value forest products. Total employment in the forestry sector is estimated at approximately 20,000 persons with the larger majority of these being in interior locations.

State forests administered by the Guyana Forestry Commission (GFC) account for about 12.6 million ha of which 54% had been allocated for timber harvesting. Access for commercial timber removal on State Forests is controlled by the GFC through the allocation of temporary concessions and permits as follows:

1. Timber Sales Agreement (TSA) covers concessions of more than 24,000 hectares and is allocated for a period of more than 20 years.
2. Wood Cutting License (WCL) is issued for 3 to 10 years, and covers forests of between 8,000 and 24,000 hectares.
3. State Forest Permissions (SFP) are given for two years and cover areas of less than 8,000 hectares. SFPs are generally issued to individual small-scale operators and community-based associations.
4. State Forest Exploratory Permits (SFEPs), which is the precursor stage to TSA and WCL.

There has over the past five years, been growing interest in forest concessions for timber harvesting and export of forest products. Whilst this sector has traditionally recorded low rates of deforestation, there continues to be economic and social pressures that may lead to increases to this rate as well as the forest degradation level.

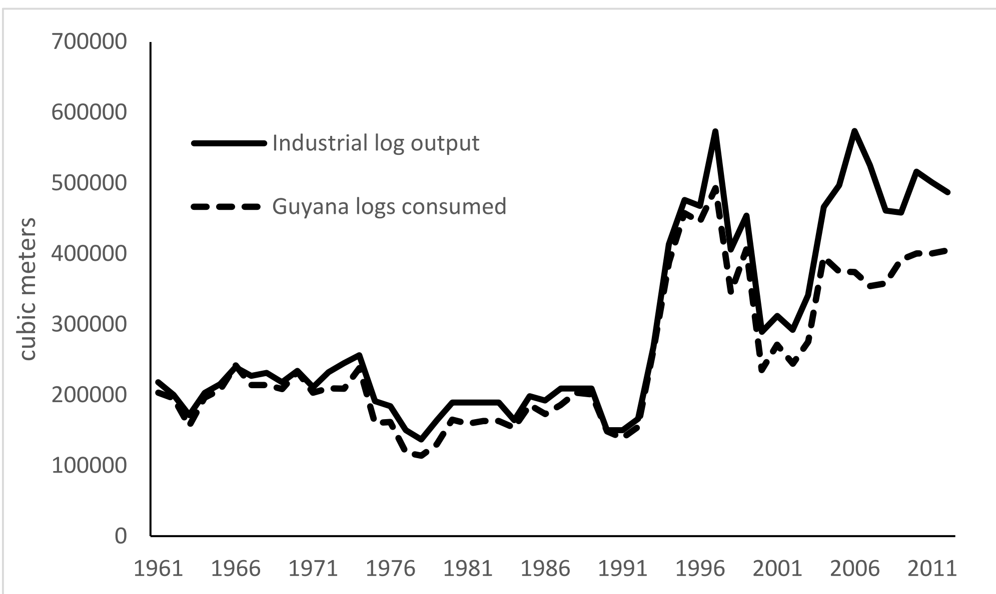

Figure 6 (b): Industrial log production (output) and consumption within Guyana (Data from UN FAO, 2014)

It is envisaged that the forest sector, is projected to account for 20% or 9.26 million tCO_2 of the annual reference level as shown below:

Drivers of Projected Emissions Level	*Policies*	*Percentage of Contribution to Reference Level*	*Total Emissions attributed to Driver (thousand t CO2)*
Forestry	EU FLEGT, Reduced Impact Logging and SFM, National Log Tracking and Chain of Custody Management.	20	9,260
TOTAL Reference Level			**46,301**

c. Infrastructural Development & Guyana's Forests

Alternative Energy

Exploring alternative energy is a key part of Guyana's development and this emphasizes Guyana's priority of decarbonising its energy needs. The country's energy policy, recognizing the importance of clean, reliable, sustainable and affordable energy for development and the improved welfare of its people, is focused on developing and utilizing its own energy sources, improving efficiencies and energy conservation. Over the next five years, Guyana will continue to examine alternative sources of energy – hydro power, wind, and solar.

Guyana has a large hydropower potential of approximately 4.5-7GW. The Guyana Energy Agency (GEA) has compiled an inventory of the hydropower potential in Guyana and has identified 67 potential hydropower sites (GEA 2011) across four major river basins; the Cuyuni, Mazaruni, Potaro and Essequibo basins. The Amaila Falls Hydro Project is a fundamental component of Guyana's Low Carbon Development Strategy, and can potentially, significantly lower the Guyana's carbon footprint while reducing the country's long term energy costs and exposure to imported oil price volatility. It is expected to eliminate over 92% of the country's energy-related emissions, after the emissions associated with its construction are accounted for. The hydro power option is located where the Amaila and Kuribrong rivers meet, and can likely deliver to Guyana's capital, Georgetown, and its second largest town, Linden, by 270 km high voltage electric transmission line. Construction of the hydro facility is currently under review, with plans cleared for advancement in 2015, on the Access Road to the Facility. This involves the building of new roads and the upgrading of existing roads. Construction of access roads began in 2010 and will be completed soon.

Relevant assumptions on future changes in domestic policies have been considered in the development of the RL. Policies and plans for both the mining and forest sectors support existing programmes as outlined in this section and are being implemented in a phased manner. These programmes are intended to bring about a maintained low rate or a lowering of emissions where applicable. Plans for the future development for the main extractive sectors have been considered in the development of the RL.

Georgetown Lethem Road Corridor

The potential for infrastructure development is enormous, and it is GoG policy to develop infrastructure to serve the needs of the people of Guyana. This initial development will concentrate on the Linden-Lethem road, for which both pre-feasibility and feasibility studies have been completed, and the advancing work in the area of alternative energy. This will also bring about likely impact on Guyana's emissions level and it is projected to impact on several drivers of forest area change.

Guyana is collaboration with neighbouring Brazil on a number of large-scale projects, including a hydro-electric facility and paving of the Linden/Lethem road. The Georgetown Lethem Road Corridor project provides the only accessible road access to the south of the country form the coast. It further provides the only link between Georgetown and Brazil's federal highway network in the states of Amazonas and Roraima.

The establishment of the Georgetown Lethem Road Corridor is of high importance to Guyana and its immediate South American neighbours; it is recognised as an essential North-South link in the overall national transportation network. The road is divided into two sections:

- Georgetown to Linden: This road is already paved to accommodate traffic at international standards.

- Linden to Lethem: 450 Km of gravel surfaced road which will require upgrading and will require the replacement of some 80 drainage structures. Two major river crossings are included in the project, including the bridge across the Demerara River at Linden, which is in reasonable condition, but only capable of accommodating one-lane traffic and will require extension, and the Kurupukari river mid-way on the route from Linden to Lethem

As a South American nation Guyana is part of a regional integration infrastructure programme to connect countries across the continent. The South American countries identified a list of projects that would connect the continent and it included the Linden to Georgetown Road. In December 2012 a Memorandum of Understanding was signed between the Guyana and Brazil to establish a working group to look at infrastructural projects including the Linden to Lethem Road. In the budget 2014 presentation, it was noted that "Negotiations have advanced substantially between the Brazilian and Guyanese technical working groups regarding the preparation of a design study for the construction of the Linden to Lethem road. The Governments of Guyana and Brazil are in ongoing discussions on the development of this road.

It is envisaged that the Infrastructure sector, is projected to account for 9% or 4 4.17 million tCO_2 of the annual reference level as shown below; whilst the other main development of projects relating to Alternative Energy generation is projected to account for 18% or 8.33 million tCO_2 of the annual reference level. The Alternative Energy and the Guyana/'Brazil Road projects will be one off, planned infrastructure for socio-economic development and will relate to the annual periods of the development, following which these will not apply:

Drivers of Projected Emissions Level	Policies	Percentage of Contribution to Reference Level	Total Emissions attributed to Driver (thousand t CO2)
Infrastructure, including Brazil/Guyana Road	Scoping of Development, ESIA.	9	4,167
Other Development such as in Alternative Energy	Scoping of Development, ESIA.	18	8,334
TOTAL Reference Level			**46,301**

d. Agriculture & Guyana's Forests

Agriculture is an important sector of the Guyanese economy, accounting for around 13% of the national GDP in 2010 (Bureau of Statistics 2011). The vast majority of agriculture occurs on the coastal plain with rice and sugar the main crops.

Rice is the most productive crop in Guyana with an export value in 2010 of US$155m (Bureau of Statistics 2011), double what it was in 2007 and well above the US$57m a year between 2000 and 2008 (Ministry of Agriculture/Scott Wilson 2011). The growing international demand for rice and the recent export agreement with Venezuela indicate that rice production could well drive expansion of the agricultural sector. There are sugar estates and factories on the coastal plain in Regions 3, 4, 5 and 6 covering about 44,500ha, with recent expansion in Region 6 due to the modernisation of the Skeldon plant (which became operational in 2008) and an increase in area and production coupled with increased power production from burning bagasse as part of the co-generation process

Other crops include ground provisions, coconut, fruit and vegetables which are grown in different locations on the coastal plain. Production of these non-traditional agricultural products were 3.25mkg of Copra, 2.7mkg of Dried Coconut, 111,000kg of coconut water, 529,000kg of pumpkin and 365,000kg of watermelon for 2009 (MoA 2009). A small increase of 3% was seen in the first half of 2011 compared to 2010. There is a potential for development of this sector as set out in the LCDS.

Livestock production in Guyana takes place mainly in the coastal plain and in the Intermediate and Rupununi savannahs in the south. The National Dairy Development Programme estimated a total cattle population of 238,000, the NDS in 1996 estimated a total cattle population for Guyana of 270,000 head and also quoted figures of 300,000 sheep and 150,000 goats. A more recent census for Regions 5 and 6 in 2006 gave a population of 280-300,000 head and based on these figures estimates were made of other regions.

Guyana has identified more than US$1 billion in essential capital projects that can be fully or partially funded through private investment assisted by an in-country infrastructure investment fund built from forest payments. Among other initiatives, these projects will enable future economic growth to be powered predominantly by clean energy (including hydropower), and to make non-forested parts of the country accessible to private investors who can generate low-carbon economic development and employment (largely high-end agriculture and aquaculture).

Guyana has identified six priority low-carbon economic sectors: fruits and vegetables, aquaculture, sustainable forestry and wood processing, business process outsourcing, ecotourism, and possibly bio-ethanol. Guyana plans to focus initially on three sectors: fruits and vegetables, aquaculture, and sustainable forestry. In each of these sectors, long-term market demand exists and Guyana has the essential natural resources to operate at scale. Guyana is well-positioned to expand exports of fruits and vegetables as it has major tracts of non-forested arable land that are potentially suitable for commercial agriculture – and the country is close to major fresh fruit and vegetable import markets in the Caribbean and the United States.

It is envisaged that the agriculture sector, is projected to account for 4% or 1.85 million tCO_2 of the annual reference level as shown below:

Drivers of Projected Emissions Level	***Policies***	***Percentage of Contribution to Reference Level***	***Total Emissions attributed to Driver (thousand tCO2)***
Agriculture	Scoping of Development, ESIA.	4	1,852
TOTAL			**46,301**

Summary of Guyana's Proposal for Reference Level based on Sectors

Policies that are in place to influence projected emissions are foreseen to take effect in limiting emissions in areas where these can be substantially higher in the absence of these policies, or maintain at a low level where these may prevail.

Below is a summary of Guyana's proposal for Reference level based on sectors. It should be noted that the emissions for the Guyana/Brazil Road and Hydro Power projects will be relevant only for those years that development will take place.

Table 13 (b) – Reference Level Emissions by Drivers

Drivers of Projected Emissions Level	***Policies***	***Percentage of Contribution to Reference Level***	***Total Emissions attributed to Driver (thousand tCO2)***
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, ESIA.	9	4,167
Agriculture	Scoping of Development, ESIA.	4	1,852
Other Development such as in Alternative Energy	Scoping of Development, ESIA.	18	8,334
TOTAL			**46,301**

It should be noted that these estimates of emissions by driver is informed by best available data on the various projects and sectors. These percentages are indicative.

6.3 Policies & Programmes

Guyana' Low Carbon Development Strategy

On the 8th of June 2009, the Government of Guyana launched its Low Carbon Development Strategy (LCDS), which outlines Guyana's vision and national trajectory for promoting sustainable economic development, while striking a harmonious balance for combating climate change. Guyana's Low Carbon Development Strategy sets out a vision through which economic development and climate change mitigation will be enabled through the generation of payments for forest services in a mechanism of sustainable utilization and development. The result is intended to be the transformation of Guyana's economy whilst combating climate change. The Strategy has four key dimensions: (1) value of Guyana's forests (mitigation), (2) low carbon development opportunities, (3) adaptation plans, and (4) the involvement and socio-economic development of Guyanese. Through the implementation of the LCDS, Guyana would be able to protect its forest and simultaneously seek a development path that promotes the growth of low-carbon economic sectors and reduces deforestation and high-carbon economic activity.

Guyana's Proposal for Reference Level for REDD+ is a core aspect of the LCDS.

REDD+ Priorities for Guyana

It is expected that mining will continue to be the key driver of the economy, and that growth will be strong (although dependant on international commodity prices).

Accompanying projected developments in the sector is a programme of work that has already started and that will be further advanced in the next few years. These efforts are systemic interventions to improve the REDD+ model. A number of initiatives have been developed to reduce degradation from the mining sector.

The Strategic Framework for the Natural Resources Sector for the period 2013-2018 makes a number of recommendations, including those that relate directly to the mining sector such as activities to improve reclamation of mined out areas, and initiatives to address impacts on deforestation and forest degradation from mining.

The SLUC was established in 2009 to provide recommendations to Cabinet through a cross-sectoral approach to manage land use conflicts and issues, including aspects of land use as they related to degradation from extractive activities. The recommendations from this committee aimed at addressing key mining issues under broad themes including: (1) Enhanced Land Reclamation, (2) Improved Infrastructure in Mining Districts, (3) Sustainable Land Management in the mining and forestry sector, (4) Strengthening of Land-Use Planning and Coordination and (5) Amendments to the Mining Act and Regulation among natural resource agencies.

Additionally, there are a number of activities in various stages of planning and implementation that will contribute to reduced degradation from extractive activities. These activities overlap to varying degrees with the higher level initiatives; they can be divided into four categories (1) Improving reclamation of mined areas (2) Improving compliance (3) Providing technical assistance and raising awareness and (4) Improving technologies.

In 2012, broad stakeholder discussions resulted in the establishment of the Land Reclamation Committee (LRC) to address specific recommendations/issues of the SLUC within the broader environmental management framework. Building on existing initiatives and recommendations, the LRC has the overarching objective of coordinating national level efforts for the reclamation of mined-out land and to provide guidance to the Government and the GGMC.

At the level of the GGMC, work has advanced in developing and implementing Codes of Practice on Mining. The codes include those relating to avoiding environmental degradation from mining. GGMC is currently revising the codes of practice[37], e.g. on the use of mercury and wastewater management. The draft codes of practices have been reviewed. The drafts have also been shared with the mining community, so that they understand future compliance requirements by the GGMC and the Guyana Gold and Diamond Miners Association.

There has been development at the operational end of mining. The improvement of technology and mining practices are very important to (1) shift miners away from the use of mercury and (2) to improve the recovery efficiency of mining operations. New technologies such as centrifuge systems can increase recovery rates in mines from 30% to 80% compared to traditional practices. This means that a mine need only be worked once, after which it can be closed and the forest restored.

The Mining School was established and incorporated in 2012. The School will offer miners short courses (between one and six months) once the draft curriculum has been approved. The curriculum has been developed in consultation with relevant stakeholders, including EPA and GGDMA and will be further developed through a

[37] (Ref. 320; 321;322;323;328;329; 330; 331;332) GGMC Codes of Practice

project with support from the WWF. The School will focus on geology, mining methods, exploration technology, surveying and computer applications for mining operations and mineral explorations.

To facilitate the objective of having readily available and accurate spatial data to inform decision making, a dedicated group of persons from different Agencies were recruited to establish the Geospatial Information Management Unit (GIM). This Unit was convened to provide services and support to all Agencies under the purview of the Department of Natural Resources & the Environment. Additionally, the lessons learnt will be shared with other Government Agencies to create and maintain an online portal that can facilitate the collection, dissemination and integration of spatial data to improve decision making nationally. The Unit utilizes technology innovation, capacity building and training sessions, development of specific applications and decision support systems to achieve its objectives. The GIM comprises staff that have been seconded from the GFC as well as other natural resources management agencies. The physical office of the GIM is hosted by the GFC and shares data amongst the agencies based on agreed protocols.

The National Forest Plan 2011 embodies ideals for enhanced development and wider opportunities for the management of Guyana's forest estate. Programme areas of the Plan cover the Low Carbon Development Strategy (LCDS), increased value-added production, additional guidelines for sustainable forest management (including non-timber forest products), improvements in marketing strategies, meeting training and human resource capacity needs, ensuring community development is satisfied, and forest resources equitably shared; all of which are enshrined in the National Forest Policy Statement 2011.

One of the main programme areas of work of the forest sector is to improve added value activities locally. This will assist in creating a higher potential for carbon storage in long term wood products. This could also potentially reduce the pressure on forest resources as a higher value may result in reduced harvest levels.

Further, a key priority for the forest sector is the implementation of sustainable forest management methods of which Reduce Impact Logging (RIL) is a key aspect. RIL, among other advantages, is intended to lower collateral and incidental damage associated with logging including tree damage from tree felling and logging infrastructure impacts, such as skid trails. Reducing the incidental and collateral damage during tree felling by about 10% and the damage from skid trails by about 35% (avoiding mid-size trees during skidding), could reduce the annual emissions by about 13.5% each year. This translates to a reduction of about 430 thousand t CO_2 per year and can target more predominantly the smaller concession category.

Reducing and even stopping illegal logging, although at low levels, is also a high priority for Guyana. In this regard, the continued implementation of the National Log Tracking System and chain of custody programme, both of which are aspects of Guyana's current negotiation process with the EU on a FLEGT VPA (Forest Law Enforcement Governance and Trade, Voluntary Partnership Agreement), will likely result in the finalization of a bilateral agreement that certified forest legality for exports of forest products.

Management of the Natural Resources Sector

Guyana's Engagement in EU Forest Law Enforcement Governance & Trade (EU FLEGT)

GoG have started formal VPA negotiations with the EU within the planned timeframe. The European Union Forest Law Enforcement, Governance and Trade Action Plan (EU FLEGT) has been part of Guyana's REDD+ Programme, as a REDD+ Enabling Activity (REDD+ Governance) since 2009. Through this process Guyana has sought to draw on synergies between the requirements of the EU FLEGT programme and on-going processes, at both the international and national levels.

Since 2009 GoG has conducted several formal and informal multi stakeholder consultations to determine the key topics that need to be discussed and the potential impacts of the EU FLEGT programme on Guyana. The main aspects of discussion on the Voluntary Partnership Agreements (VPA) include:

- multiple land uses (e.g. agriculture, forestry, and mining),
- the impact on indigenous peoples and their titled lands in regard to commercial and subsistence activities,
- potential cost associated with meeting the requirements of the VPA as a country, and
- potential synergies with existing processes, among others.

Taking into consideration the results and views expressed by stakeholders, GoG and EU, in June 2012, publicly communicated their partnership under the EU FLEGT Action Plan and signalled the intent to commence the formal process of entering into a VPA. Over the reporting period GoG and EU have been working together to review and further refine the interim definition of legality. The next steps identified by the parties are a programme of stakeholder consultations on this draft definition.

It is intended that the VPA drafting will be completed by June 2016, ratified by the EU and Guyana by September 2016 with licences issued from as early as January 2017.

A number of steps have been taken leading up to and following the commencement of formal negotiations, including:

1. the formation of National Technical Working Group (NTWG) and sub-committees, a multi stakeholder steering body to oversee EU FLEGT activities,
2. the development of a Guyana Roadmap for VPA Negotiations, (which includes the drafting of a Forest Legality definition), and
3. the establishment of a VPA Secretariat in Guyana (within GFC).

This programme is expected to impact on reduced or maintained low levels of impact on forest degradation emanating from logging activities.

Guyana's Engagement in Extractive Industries Transparency Initiative (EITI)

Implementing the EITI is a complex undertaking which will bring Guyana in line with international best - practices in terms of financial transparency.

In 2012 the former Ministry of Natural Resources and the Environment (MNRE) (now Department of NRE) assumed the responsibility of the EITI and the EITI International Secretariat was actively re-engaged. A second in-country visit by the Secretariat was arranged to develop a plan for Guyana. In May 2012 a MoU was signed between MNRE and the EITI International Secretariat to jointly pursue realization of the EITI principles and criteria and for EITI to provide support and facilitate contacts with partners as necessary.

A prospective EITI Candidate Country must complete a four step process requirement before filing an application with the EITI Board for candidacy, namely:

- The Government should issue an unambiguous public statement of intent to implement EITI.
- The Government is required to appoint an officer of senior managerial status to lead the implementation of EITI on its behalf.

- The Government is required to commit to working with civil society and businesses and establish a multi-stakeholder group to oversee the implementation of EITI.
- The multi-stakeholder group is required to maintain a current workplan, fully costed and aligned with the reporting and validation deadlines established by the EITI Board.

A study has recently been completed by Moore Stephens International and a report will be submitted to the DNRE in June 2015. The Inter-American Development Bank and the World Bank are providing technical advice to the government of Guyana in its efforts towards EITI candidacy.

It is expected that EITI would strengthen best practice in the mining industry and therefore impact positively on Guyana's REDD+ programme.

6.4 Guyana's Combined Reference Level Proposal

Guyana is a country with high forest cover and low deforestation. However, as illustrated in the previous section, the economic and social incentives to allow significant increases in deforestation are strong and growing. The economic value they create can drive Guyana's poverty alleviation and economic development objectives – however, they could also lead to increased deforestation.

Therefore, Guyana proposes a reference level which enables Guyana to maintain very low levels of deforestation, while at the same time earning money from the global benefits provided by Guyana's forests – and using this money to invest in a new low carbon economy. Guyana proposes the use of the Combined Reference Level Approach that reports on percent of emissions per year. A simplified version of this has been used as part of the Guyana-Norway partnership from 2009-2015.

The "combined reference level" methodology provides incentives for all categories of forest countries, and ensures that emissions from deforestation and forest degradation are reduced cumulatively at a global level. The application of this method takes an advanced step to that which is applied in the Guyana Norway agreement by using a scientifically established historic carbon emissions level, country informed forest carbon stocks and storage ratios, and includes both deforestation and forest degradation impacts. Additionally, the global level to which the national reporting results are proposed to be compared to, is an emissions total rather than a deforestation rate previously utilized.

The use of the combined reference level is determined to be the most appropriate method for Guyana because it allows for the broadly accepted objective within the UNFCCC negotiations to be fulfilled. This objective expresses general agreement that a REDD-mechanism must provide genuine incentives for forest conservation in low deforestation countries, as well as ensure global additionality. To maintain additionality, Strassburg et. al. (2009) proposed a 'combined incentives' mechanism which maintains the sum of national references levels equal to the global reference level through a flexible combination of higher reference levels for countries with historically low deforestation rates and lower reference levels for countries with historically high deforestation rates.

As stated in the Eliasch Review, 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 Guyana-Norway Joint Concept Note emphasizes this point: "For a global REDD+ mechanism to be effective, it must incentivise both (i) reductions in deforestation in countries with high levels of deforestation and (ii) maintenance of low deforestation rates in countries that have maintained their forest cover. If only countries with high deforestation rates are compensated for improving their forest protection under an international climate regime, deforestation pressures will move to countries with currently low deforestation, like Guyana, and the overall emissions reduction effect will be diluted or lost on the other hand. If a global incentive structure does no ensure global additionality, the international community will be paying for "hot air" and there will be no mitigation impact. "

With this method, the following steps are proposed:

- Identify a global benchmark percent of (potential) emissions per year derived by dividing global annual loss of forest carbon stock by total global forest carbon stock.
- Establish a national historic annual average emissions percent level for Guyana (2001-2012) by dividing the average annual emissions for Guyana from 2001-2012 by the total carbon stock of Guyana averaged over same period.
- Derive the Combined Average of the global and historic annual average emissions percent.
- Compare annual measured and verified levels, to combined average.
- The difference from the performance reporting against Guyana's national RL.

6.4.1 Background to Combined Reference Level

Recent studies show that compensating developing countries for even a small portion of the global benefits their forests provide might be sufficient to greatly reduce deforestation (Stern, 2007). An outcome of the eleventh Conference of the Parties (COP 11) in December 2005 was the decision that the scientific board of the UNFCCC should examine the issue of positive incentives to reduce emissions from deforestation in developing countries (UNFCCC, 2005). A group of scientists proposed the concept of ''compensated reductions'' (Santilli et al., 2005). A submission from Brazil became the first official proposal for a REDD mechanism (UNFCCC, 2006). The proposed mechanism would offer incentives to countries to reduce their deforestation in comparison to a national reference level calculated from their deforestation rate in a recent snapshot of time (1990s, or early 2000s). The general formula for a historical national reference level mechanism would be:

$$I_t = (HE - E_t) \times P$$

where I_t is the country incentive in year t; HE is the historical annual emissions from deforestation; E_t is the emissions from deforestation in year t; and P is the incentive payment per avoided t of CO_2.

A country's reference level is equal to its average national emissions from deforestation over a recent historical reference period, as in one variant of the original 'compensated reduction' proposal (Santilli et al 2005). When the sum of national reference levels is greater than the global business as usual emissions rates, there is the possibility that there could be more credits generated than emissions reduced at the global level, compromising additionality. To maintain additionality, Strassburg et al (2009) proposed a 'combined incentives' mechanism that would maintain the sum of national references levels equal to the global reference level through a flexible combination of higher reference levels for countries with historically low deforestation rates and lower reference levels for countries with historically high deforestation rates. This mechanism benefited considerably from the feedback received from two side-events dedicated to it at the meetings of the scientific board of the UNFCCC (Strassburg et al., 2007; Strassburg, 2008;Busch *et al,* 2009)

Some of the key features of the Combined Incentives Mechanism include:

a) Utilises a national level approach- project level REDD mechanisms are extremely vulnerable to subnational leakage, in addition to which most deforestation is either decided or heavily influenced by national governments and are part of the long-term development strategies of each country. Though national level mechanisms are still subject to international leakage, the mechanism is comprehensive and offers incentives capable of inducing the conservation of standing forests in developing countries in every stage of the conversion process, and thereby minimizes this risk.
b) Designed to be comprehensive, by including countries in all stages of the conversion process (i.e. high, low or negative past or projected deforestation rates), while being able to stimulate forest conservation, reforestation and afforestation activities both across countries and time.
c) Offers incentives based on recent deforestation rates, so that high deforesting countries have enough incentive to reduce their deforestation rates. But it also includes an incentive for countries to keep their deforestation rates below the global average, making it attractive to countries that have been conserving their forest in the recent past.
d) Can accommodate any source of funding- either market oriented, where demand for credits is created and can be traded, or fund-oriented, where financing countries provide the resources by taxing specific commodities or income or a combination of the two.

The combined incentives mechanism was designed to receive two kinds of incentives simultaneously. The first is based on the ''compensated reduction'' concept and is an incentive to reduce a country's emissions in comparison with its historical emissions:

$$I1 = (HE - E_t) \times P$$

The second follows the ''expected emissions'' concept that connects the incentive to the ecosystems carbon stock while maintaining global additionality. It is an incentive to emit less than it would emit if it followed an average behaviour given by the global baseline emission rate:

$$I2 = (EE - E_t) \times P$$

All countries receive both incentives at the same time. The key point is the way in which these incentives are combined. By making the weight of each incentive variable, the mechanism is able to be comprehensive enough to include all countries in a single simple formula and flexible enough to combine short-term realities with long-term sustainable goals. It does so by introducing a weighting factor, a, in the sum of both incentives. So the ''combined incentives'' mechanism formula is:

$$CI = \alpha (I1) + (1- \alpha) (I2)$$

Or

$$CI = [\alpha (HE) + (1- \alpha) (EE) - E_t] \times P$$

With a varying value between 0 and 1, where HE = country historic emissions; EE_i = country expected emissions; E_{it} = country emissions in year t; and P = base incentive per avoided tonne of CO_2.

The factor α weights the incentives between historical and stock (or average) incentives by influencing each country's reference level against which their performance will be assessed.

The historical emissions rate of each country is fixed. The global average emissions rate used to calculate each country's EE can be fixed at the relatively constant rate of the last 25 years.

6.4.2 Approach used in Guyana Norway Agreement

Through the Guyana Norway Agreement, a provisional national reference level[38] is being used that guides the amount of payment Norway contributes to the Guyana REDD+ Investment Fund. To date, Norway has made four payments, totalling US$150 million, to the Guyana REDD+ Investment Fund (GRIF) based on verified results as compared to the "combined incentives" reference level described below. In parallel to the use of this approach, Guyana is evaluating deforestation and degradation drivers and how various future scenarios may be developed to establish a future reference level.

If designed for maximum effectiveness and efficiency this reference level methodology could allow for significant variations in individual countries' deforestation rates while still ensuring global additionality. However, in the absence of a global system would imply that Guyana would be eligible for significant payments even if it were to increase its deforestation along a business-as-usual ("no REDD+") trajectory. Therefore, pending the introduction of a global incentive system, Guyana and Norway agreed on the use of a temporary cap - whereby Guyana's emissions are basically capped at the current rate, but payments are made—in a sliding scale—based on a separate "crediting (or payments) baseline". The payments baseline is calculated as midway point between the rate of deforestation in Guyana from 2000-2009 (0.03%) and the average deforestation rate for developing countries between 2005 and 2009 (0.52%), or a payments baseline of 0.275%. The "cap" on emissions was set as the deforestation rate in 2010 (0.056%). If Guyana exceeds this rate in any given year, the payments are reduced on a sliding scale, up to the rate of 0.1%, at which point there are no payments made. This cap would not be needed if an international REDD+ mechanism were in place.

[38] The term "reference level" is used, consistent with the Norway-Guyana Joint Concept Note.

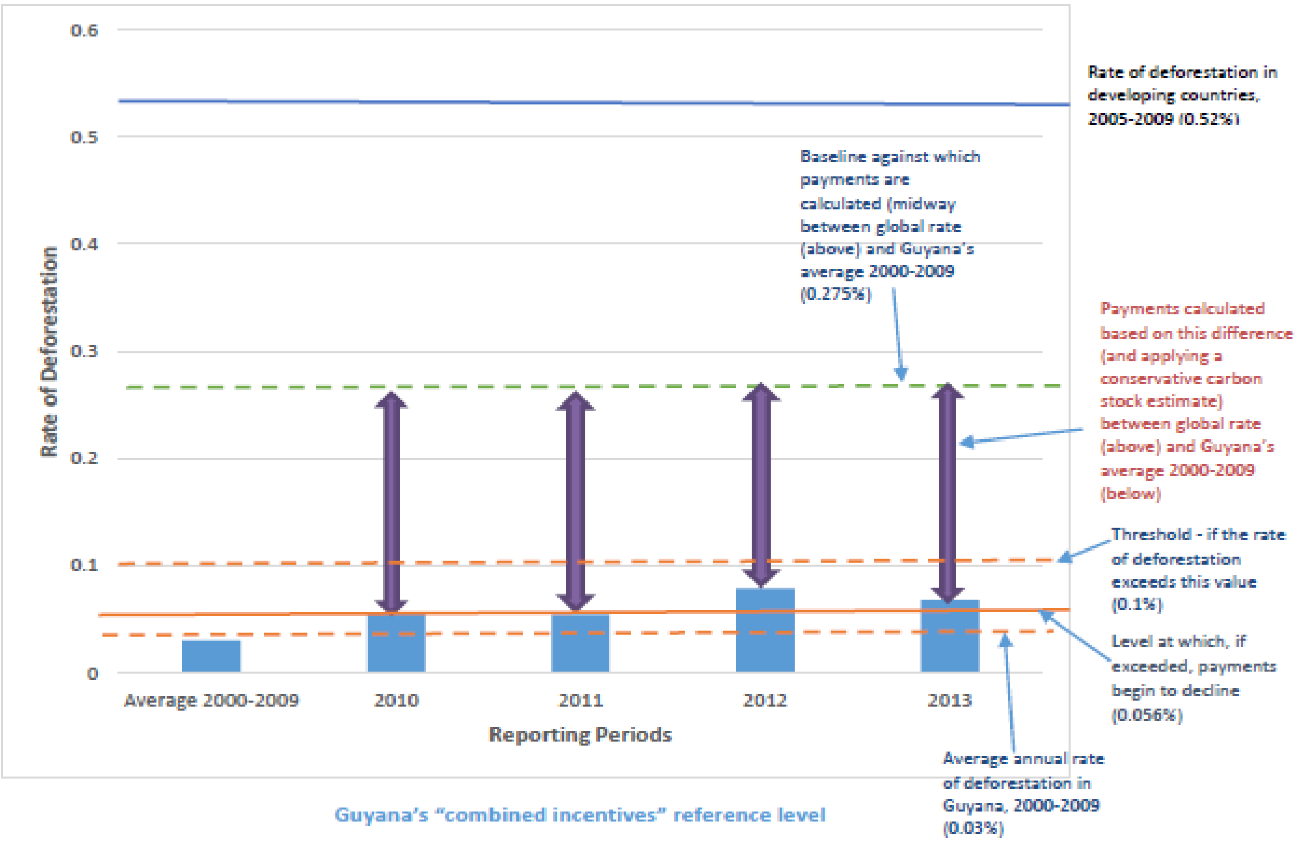

Figure 7 (a) Emerging approaches to Forest Reference Emission Levels and/or Forest Reference Levels for REDD+ Guyana: Combined Incentives reference level in partnership with Norway, Source: UNREDD Programme, October 2014

Main Justification for the Combined Reference Level approach being used by Guyana:

- ***A step-wise and flexible approach*.** The reference level agreed between Guyana and Norway allows for continuous improvement over time, including the addition of degradation (as the MRV system is developed) as well as an adjustment in the reference level approach consistent with UNFCCC decisions.
- ***High degree of transparency***. Annual reporting on performance indicators and MRV progress is made available online, along with the independent assessments or verification reports. To date, Guyana has completed forest area change assessments for 1990–2000; 2001–2005; 2006 to September 2009 (Benchmark); 1 October 2009 to 30 September 2010 (Year 1); 1 October 2010 to 31 December 2011 (Year 2), and January 1-December 31 2012 (Year 3).
  Over the years, there have been improvements in technologies used for conducting the forest area change assessment. One such improvement has been in the use of high level 5 metre resolution imagery- previously, Landsat 30m resolution imagery was used to map and measure forest area change for

Guyana. The improved resolution enabled better identification of change boundaries, drivers of change and areas of forest degradation. In particular, it was revealed that the mapping of forest degradation is more precise when using high resolution imagery rather than medium-resolution imagery.

- ***Provision of incentives for a HFLD country***. The "combined incentives" approach provides an opportunity for Guyana as a historically low deforestation country to receive payments for continued forest conservation.
- ***An interim method to account for degradation***. The use of a proxy measure and conservative accounting (i.e. the use of a discount on payments received) is an innovative way to account for emissions while Guyana improves its ability to measure and monitor degradation more accurately. From the commencement of the Agreement with Norway to 2014, Guyana has undertaken a number of technical studies to inform a scientifically sound methodology to account for forest degradation.

6.5 Establishing the Global Benchmark Percent of Potential Emissions per Year

In determining what an appropriate global rate, Guyana looked toward the available global assessments for tropical counties. There are several scientific papers that have directly calculated a global average emission rate, or more precisely, a global average rate of forest carbon stock loss (global forest carbon stock loss divided by global forest carbon stock).

A summary of the various options are presented in Figure 7 below and addresses the use of global rates of average annual forest loss and emissions loss. In the current version of the RL used by Guyana in the bilateral cooperation agreement with the Government of Norway, the rate of forest loss (based on deforestation) was used. Following the establishment of the system of reporting on emissions, and having established historic emissions for the period 2001 to 2012 as presented in the earlier chapters of this Proposal, Guyana is proposing that is RL now be based on emissions level using the global as well as the national level based on emissions. In this way, the "E's" in Figure 7 below, were found to be particularly relevant to Guyana. This is necessary because if Guyana was to continue using an area based average (deforestation rate or "F's" as termed in Figure 7 below), it will be at the cost of excluding forest degradation which is a core part of Guyana's reporting on emissions, both historic and annual emissions. Further, to use an area based global estimate (likely to include only deforestation) with an emission rate national level (including both deforestation and forest degradation) will be incongruent.

Given the above, among the more applicable proposals to Guyana are Baccini A. et al. 2012 in: "Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps" (published in Nature Climate Change). These findings are a result of combining estimates of aboveground carbon stocks with estimates of regional deforestation rates and timber harvesting. This assessment was done using multi-sensor satellite data to estimate aboveground live woody vegetation carbon density for pan-tropical ecosystems. The goal of Baccini et al. 2012 was to update the record of net emissions from tropical forest land use and land use change. The method used by the Baccini et al. tracks annual per hectare change in carbon stocks when (1) forest area is cleared for cropland, pasture, or shifting agriculture; (2) forests are harvested; (3) plantations are established; and (4) agriculture lands are abandoned and returned to forests.

Among the key reasons for the selection of Baccini et. al 2012 as the global average emissions percent, are those outlined below:

- **Inclusion of Forest Harvest** – Baccini et. al. 2012 includes forest harvest and the sources of emissions emanating from this land use. Guyana's reporting on RL similarly integrates this land use within its historic and routine reporting on emissions.
- **Reporting on Land Use/Drivers** – Baccini et. al. 2012 uses an approach that includes deforestation events to land cover and specific land uses. This is also the method that has been used by Guyana in reporting annually on drivers of deforestation and forest degradation.
- **Gross versus Net Emission** – Baccini et. al. 2012 presents results for gross and net emissions, the latter includes estimates of regrowth after timber harvesting and shifting cultivation. Whilst recognizing that Guyana is reporting on Gross Emissions to date, it is the plan to include removals of carbon as the next development of the national MRVS.
- **Reporting on Global Carbon Stock** – Baccini et. al. 2012 provides estimates for both global average rate of carbon stock loss and global forest carbon stock. The generation of both values by Baccini et. al. 2012, which are necessary for the combined RL for Guyana, also presents another advantage of using this approach. Some studies establish only global average rate of carbon stock loss.
- **Period of Study** - the time period used by Baccini et. al. 2012 covers the period 2001 to 2010, this time series is in close synergy with the historic period used in the Guyana Historic Emissions computations of 2001 to 2012 and therefore makes this method very congruent in this temporal scope, to the Guyana's proposal.
- **Definition of forest cover**- Guyana defines forests as those with a canopy closure of 30% or more. It is not clear in the Baccini et al paper how they define forest given the multiple sources of data they use, but they report in their paper that they include carbon stock data for dense and open forests (with >50% canopy closure and < 50% canopy closure, respectively) among other vegetation types and that they use the activity data from the FAO 2010[39], which defines forests as lands with >10% tree cover. Although these definitions are not the same, the GFC argues that this difference is not critical for using the Baccini et al. results in the combined approach because: Guyana's native forests are practically all dense closed canopy and if they used the FAO forest definition it would not change the total area of forest cover in Guyana—that is, the FAO definition captures all of Guyana's forests as defined by Guyana.

6.5.1 Consistency between Guyana and Global Carbon Emissions Estimates

To use a RL based on Guyana's and the global emission estimates it is important to make both data sets consistent. Here the steps taken to ensure this are described along with the results.

Because the results of gross carbon emissions from tropical deforestation given in Baccini et al. 2012 appeared to be different from those given in Harris et al. 2012a, an analysis of both published papers was made to investigate the source of these apparent differences (Harris et al. 2012b "Progress toward a consensus on carbon emissions from tropical deforestation"). This analysis examined the details of all the components included in each published paper and, as a result, the contribution of each component could be identified and quantified. The gross emissions of the Baccini et al. paper include those from deforestation, industrial logging, fuelwood harvest and shifting cultivation. As a result, it was possible to separate out only those components of the Baccini et al. paper that are the same as those for Guyana—that is deforestation and industrial logging—thus only results for these two components from the Baccini et al. paper will be given here.

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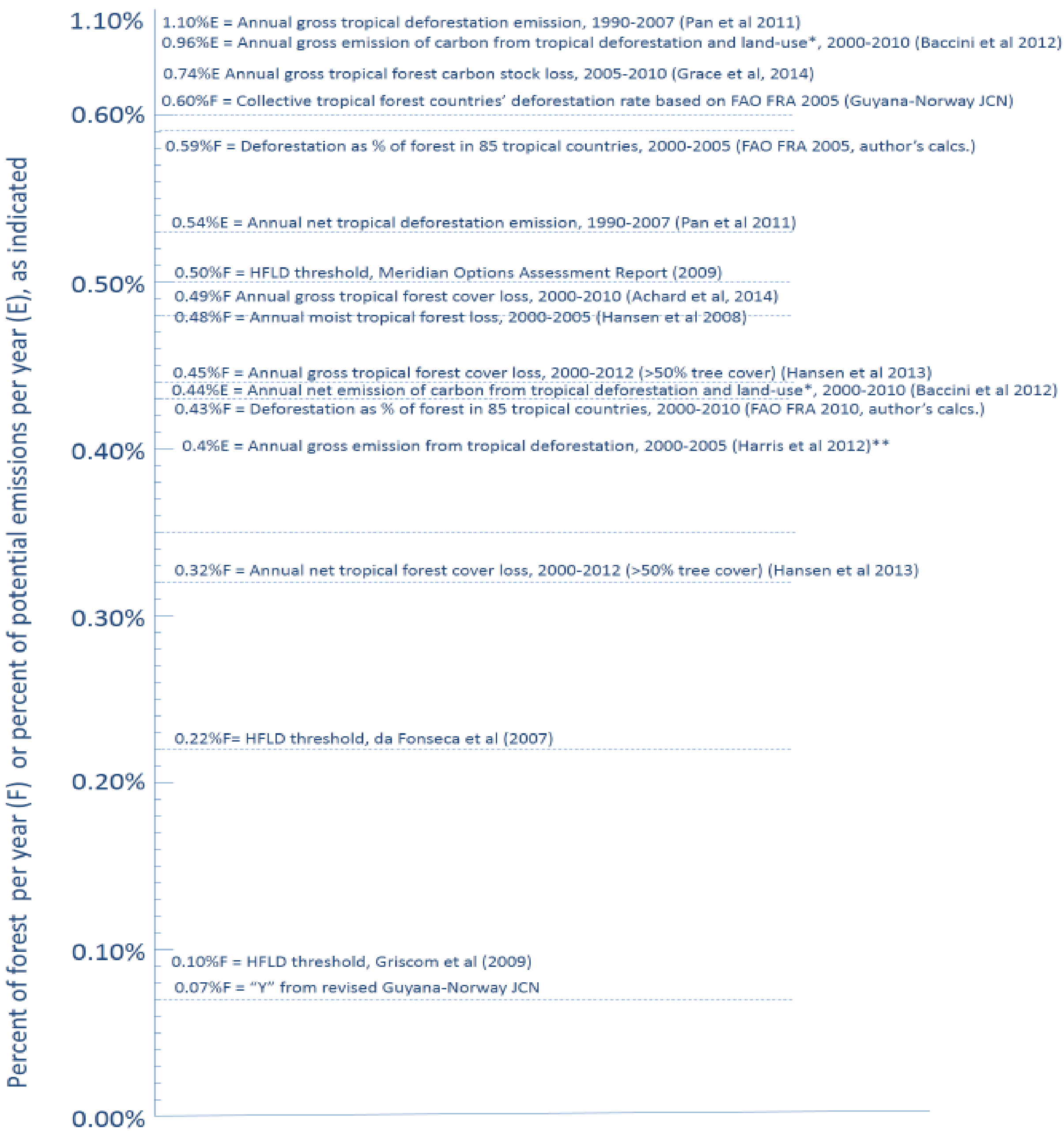
[39] FAO 2010. Global Forest Resources Assessment 2010, FAO forestry Paper 163.

The Baccini paper only included aboveground biomass. To add belowground biomass to the Baccini paper, results from Harris et al (2010) were used in which the below ground biomass was included in their estimates for each country and tropical region. From these results an average ratio of aboveground to belowground biomass for each tropical region was calculated—these ratios were then applied to the Baccini results. To make Guyana's emission estimates comparable to those of Baccini, the emissions estimates for Guyana include only aboveground and below ground biomass (see Annex 1 for details on other pools that have been measured and estimated).

Table 14. Estimates of consistent carbon stocks and emissions for Guyana, (based on average area during 2001-2012, and global tropical area.

Component	Guyana	Global
Aboveground C stock -Million t C	4,225.4	228,700
Belowground C stock -Million t C	993.2	60,623
Total C stock- Million t C	5,218.5	289,323
Deforestation Emissions -Million t C	1.58	810
Logging Emissions –Million t C	0.98	450
Total Emissions –Million t C	2.55	1,260
Emissions/Stock -%	0.049	0.435



*Other land use includes industrial logging, fuelwood harvest, shifting cultivation, soils

**Harris et al 2012a includes deforestation only

Figure 7 (b): Summary of Scientific Papers providing a Global Average Emissions Rate

6.6 Proposed Reference Level for Guyana

Guyana's proposal for Reference Level for REDD+ is the use of the Combined Reference Level Approach, using a global forest carbon emissions loss of 0.435%.

Based on Table 14, the total C stock in aboveground and belowground pools is 5,218 million t C (area weighted average is 283 t C/ha) and the total emissions are 2.55 million t C, giving an average rate of loss of 0.049%/year. These values are used in the setting of the RL for Guyana as shown below.

Setting the Reference Level	
Global average rate of forest carbon stock loss (global stock loss divided by global stock)	0.435%
Guyana's 2001-2012 historic forest carbon stock loss of 2,554,607 t C divided by the average carbon stock over same time period	0.049%
Combined reference level in %	0.242%
Combined reference level in t CO_2	46,301,251 t CO_2

Guyana's proposal is as follows:

- **Setting the Reference Level:**
  - Using a global percent of forest carbon emission loss of 0.435%, as the global level, and
  - Establishing the historic annual average emissions percent level for Guyana (2001-2012) by dividing the average annual emissions for Guyana from 2001-2012 by the total carbon stock of Guyana: = 0.049%,
  - Derive the Combined Average of the global and historic annual average emissions percent by: 0.435% + 0.049% divided by 2 = 0.242%.

- **Computing Annual REDD+ Performance based on Reference Level:**
  - Annual Reported Emissions percent (computed by dividing the annual report forest carbon emissions loss by the total forest carbon stock of Guyana) that is concluded following measurement and verification, inclusive establishment of accuracy levels, is then subtracted from Combined Average of 0.242%, and the last step taken to:

- **Computing Performance Payment:**
  - Compute performance payment based on the price per tCO_2, derived by taking the difference between the annual report emissions percent and the Combined Average, translating this
  - This is presented graphically below, in Figure 8:

Financial Incentives Baseline and the Use of the Sliding Scale for REDD+ Incentives

One of the key considerations in Guyana's Proposal for Reference Level for REDD+ is the integration of a financial incentives baseline within the payment computation. One example of this model is currently in use in the bilateral agreement between Guyana and Norway.

One of the justifications of integrating this baseline is the clear expression of commitment by Guyana that its programme on REDD+ is aimed foremost at ensuring environmental integrity is maintained whilst advancing a low carbon development pathway.

Further key consideration is also extended in ensuring congruence with existing methods, such as those established for the FCPF Carbon Fund which allows for 0.1% of adjustments to emissions over the historic level.

This approach is compatible with the Government of Guyana's declared long-term strategy to maintain the maximum amount of forest cover in Guyana, if an appropriate incentive structure is in place to make Guyana' LCDS viable. This is being done through a balanced mix of maintaining forests under full protection (areas where only small-scale subsistence farming by forest dependent communities is allowed) and sustainable commercial forest management.

This Proposal, at this stage does not indicate final decision on this area, as discussions are still ongoing at the national level on best ways of addressing this matter. As such, thresholds relating to this baseline are not presented in this Proposal.

As part of the application on the financial incentives baseline, Guyana is considering the integration of a sliding scale as part of the incentives mechanism. This may be applied in a similar manner as done in the current Guyana Norway Agreement but with new thresholds and period ranges. The main objective of the use of the sliding scale will be to further elaborate a commitment to ensuring that Guyana's REDD+ programme aims at assuring environmental integrity and in doing so, ensure that emission cannot rise too much from the historical levels before payments are reduced. Through this mechanism, Guyana may only request payment if emissions actually stay low and continue to stay low, whilst still allowing room for development. Further, through this mechanism, Guyana proposes that one-off predictable and controllable deforestation events should be allowed for critical national infrastructure that is part of Guyana's transition to a low carbon development path and not form part of the sliding scale mechanism.

This mechanism will therefore mean:

a) that a ceiling on the level of emissions that can take place within a set period, with incentives still flowing up to that agreed level,

b) the accommodation of limited annual upward variations to ensure that the incentive structure still makes REDD+ a positive development choice for Guyana; and

c) that Guyana is incentivized to maintain over 99% of its forest cover as part of its LCDS and REDD+ commitments.

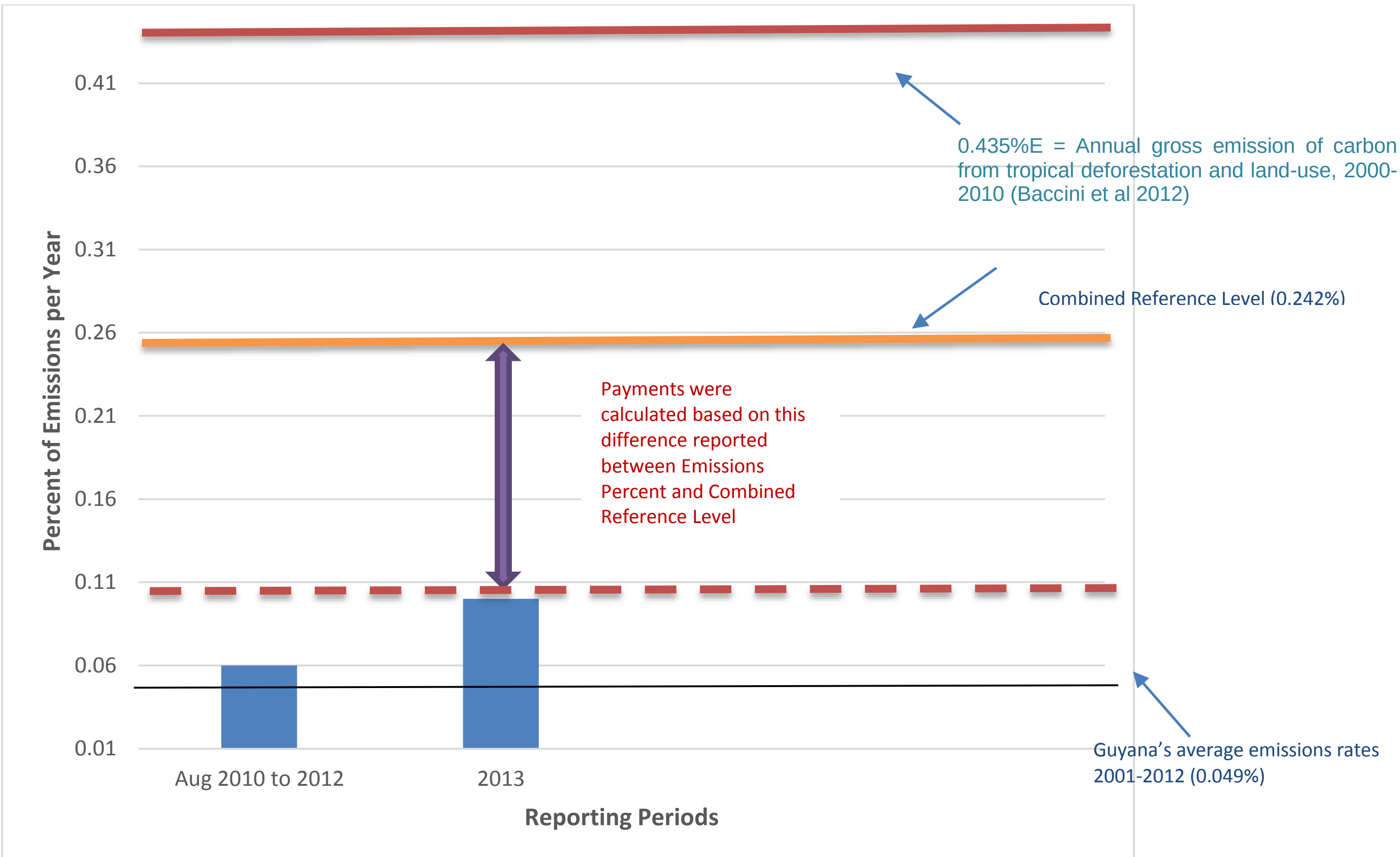


Figure 8: Guyana's Proposal for Reference Level for REDD+

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These are available at: https://www.mediafire.com/folder/mjpw23xbm2ms8/Annex_to_Guyana's_RL_Proposal

ANNEX 1: DETAILS OF HISTORIC EMISSIONS FOR DEFORESTATION BASED ON ALL CARBON POOLS

1.0 Pools/Gases

Pools for Guyana were selected separately for each activity included in the RL (Table 1). For degradation caused by timber harvesting, the soil carbon pool was excluded because it has been shown that selective logging has no impact on soil carbon over a large concession and the litter was also excluded because the impact is very small due to the small area impacted by timber harvesting. The greenhouse gases for Guyana includes CO_2 only.

Table 1. Carbon pools selected to include in the RL according to activity.

Activity	AG Biomass	BG Biomass	Dead Wood	Litter	Soil Carbon	Harvested Wood Products
Deforestation	x	x	x	x	X	
Degradation from Timber Harvesting	x	x	x			

Table 2 provides an overview of each key category addressed by Guyana, including the associated drivers and the pools included in each IPCC required category.

Table 2. Overview of the IPCC categories, drivers, and pools used to estimate emission factors for each key category.

IPCC Category	Driver(s) as defined in MRVS	Pools included		
		Biomass	**Dead organic matter**	**Soil**
Forest Land Remaining Forest Land	Degradation caused by logging	AG & BG tree	Dead wood caused by logging	Not included
Forest Land Converted to Cropland	Agriculture	AG & BG tree, saplings	Standing and lying dead wood, litter	Based on conversion to permanent agriculture
Forest Land Converted to Settlements	Infrastructure including mining roads and forestry Infrastructure	AG & BG tree, saplings	Standing and lying dead wood, litter	Based on conversion to unpaved roads
Forest Land Converted to Other Land	Mining (bare soil)	AG & BG tree, saplings	Standing and lying dead wood, litter	Based on conversion to mining

1.2 Estimating Emission Factors for Deforestation

Field data have been collected to estimate forest carbon stocks and for use in estimating emission factors for all drivers of deforestation. Carbon stocks are estimated for all pools (cf. Table 1 and 2), using country-specific data and conversion factors, and an allometric equation verified through destructive sampling of four large trees, resulting in emission factors that meet IPCC's requirements for Tier 3. All field data were collected and validated using the Standard Operating Procedures (SOP) manual developed for this work. Soil samples were collected to 30 cm depth and the emissions estimated as recommended by the Tier 1 methodology given in the IPCC 2006 AFOLU Guidelines (country specific C stock values used with the default soil factors).

The carbon stock of Guyana's forests is high in comparison to many other tropical forests around the world, averaging about 300 t C/ha (Table 3), with more than 74% in the aboveground biomass. The reason for the high C stocks in Guyana, particularly the HPfC-LA and MPfC-MA&LA strata, is due to the large proportion of trees with DBH >60 cm (about 12% of the live trees), the high proportion of trees with wood density >0.8 (36-58% of live trees), and the lack of human disturbance in the HPfC-LA and MPfC-LA&MA strata. Forests in the MA stratum of the HPfC had the lowest stock, and the LA stratum forests of the HPfC contained the highest stock. There was no statistical difference in forests C stocks between the MA (300.3 t C/ha) and LA (299.9 t C/ha) of the MPfC stratum, thus the two were combined (Table 3). No field data have been collected for the LPfC stratum and thus the C stocks for the MPfC stratum will be used for this area at this time.

The targeted 95% confidence interval was <+/-15% of the mean total carbon stock, excluding soil. The target was achieved in all strata.

Table 3. Carbon stocks in the selected pools in Guyana's forests in the high (HPfC) and medium (MPfC) potential for change forests. MA=more accessible stratum and LA=less accessible stratum. The values in parentheses are the 95% Confidence Interval expressed as a percent of the mean

Carbon Pool	HPfC		MPfC
	MA	LA	MA&LA
	Carbon Stocks (t C ha^{-1})		
Aboveground Tree	193.6	267.6	229.7
Belowground Tree	45.5	62.9	54.0
Saplings	4.2	4.1	3.4
Litter	3.3	5.6	3.4
Dead Wood	13.1	10.8	7.4
Total (without soil)	259.8 (10.3%)	351.0 (13.1%)	300.2 (10.1%)
Soil Carbon (top 30 cm)	43.8 (28.5%)	55.0 (36.1%)	48.0 (47.2%)

The total carbon stocks in Guyana's forests were estimated based on the average (average for period 2001-2012) area for each stratum and the carbon stocks in Table 3. The total C stock of Guyana forests, excluding soil, is 5.57 billion t C; including soil to 30 cm depth the total stock is 6.46 billion t C (Table 4).

Table 4. Total Forest Carbon Stock in Guyana's Forest, without and with soil, based on the average area of forests during the historic period 2001 to 2012.

Forest Carbon Sampling strata		Total C stock per stratum without soil (million t C)	Total C stock per stratum with soil (million t C)
High potential for change	More accessible	916.2	1,070.7
HPfC	Less accessible	1,109.4	1,283.2
Medium potential for change	More accessible	335.2	388.8
MPfC	Less accessible	1,317.8	1,528.5
Low potential for change	More accessible	81.5	94.5
LPfC	Less accessible	1,790.1	2,076.3
TOTAL		5,550.2	6,442.0

The emission factors (Table 5) for deforestation were calculated as:

$$EF_{deforestaton} = \{C_{AGB} + C_{BGB} + C_{LIT} + C_{DW} + C_{sap} + [C_{soil} - (C_{soil} \times F_{LU} \times F_{MG} \times F_{I})]\} \times \frac{44}{12} \quad \text{(Eq.2)}$$

Where:

$EF_{deforestation}$	= gross emission factor for deforestation; t C ha^{-1}
C_{AGB}	= Carbon stock in aboveground biomass pool; t C ha^{-1}
C_{BGB}	= Carbon stock in belowground biomass pool; t C ha^{-1}
C_{LIT}	= Carbon stock in litter pool; t C ha^{-1}
C_{DW}	= Carbon stock in dead wood pool; t C ha^{-1}
C_{sap}	= Carbon stock in saplings; t C ha^{-1}
C_{soil}	= Carbon stock in soil organic carbon pool (to 30 cm); t C ha^{-1}
F_{LU}	= soil stock change factor for land-use systems for a particular land-use, dimensionless
F_{MG}	= soil stock change factor for management regime, dimensionless
F_{I}	= soil stock change factor for input of organic matter, dimensionless

The values of F_{LU}, F_{MG}, and F_{I} used for different activities in Guyana are as follows[40]:

[40] From Table 5.5 in IPCC 2006 AFOLU, Vol. 4, Ch. 5.

Converted to	F_{LU}	F_{MG}	F_I
Permanent agriculture	0.48	1.00	1.00
Unpaved roads	0.82	1.00	0.92
Mining	0.48	1.00	0.92

The change in carbon stocks in the top 30 cm of soil was calculated as the difference between the soil carbon stock before conversion and the soil carbon stock 20 years after conversion (time it takes to reach new steady state), where the soil carbon stock after conversion was estimated based on land use, management and input factors as given in above table. All mining and logging roads are unpaved and the same factors were used for both types of roads—these roads are assumed to be akin to idle land with no further tillage, undergoes substantial initial soil disturbance and <30% of surface is covered by residues, and any inputs are low. For mining, where the soil is highly disturbed, the F_{LU} factor for permanent agriculture was assumed to apply. For simplicity in accounting, we assume the full emission of soil carbon in the year of clearing, rather than spreading the emission over 20 years as suggested by IPCC 2006 (AFOLU).

Table 5. Emission factors for deforestation by driver and stratum based on data collected during 2011-2014.

Stratum	Drivers	t CO_2 ha^{-1} 2011-2014
HPfC More Accessible (MA)	Forestry infrastructure	992.0
	Agriculture	1,036.1
	Mining (medium and large scale)	1,042.3
	Mining infrastructure	992.0
	Infrastructure	992.0
HPfC Less Accessible (LA)	Forestry infrastructure	1,336.7
	Agriculture	1,392.1
	Mining (medium and large scale)	1,399.8
	Mining infrastructure	1,336.7
	Infrastructure	1,336.7
Stratum	Drivers	t $CO_2$$ha^{-1}$ 2011-2014
MPfC Less (LA) and More (MA) accessible	Forestry infrastructure	1,144.0
	Agriculture	1,192.3
	Mining (medium and large scale)	1,199.0
	Mining infrastructure	1,144.0
	Infrastructure	1,144.0

1.3 Historical Emissions from Deforestation

The activity data and emission factors for deforestation were combined to provide estimates of the historical emissions for the period 2001-2012 (Table 6). The total emissions from deforestation between 2001-2012 were **80.7 million t CO_2**. The average annual CO_2 emissions from deforestation over the whole period were **6.73 million t CO_2 yr^{-1}** (Table 7). To provide estimates of annual emissions for each year, the total emission for 2006-2009 were divided by 4 yr instead of the 4.8 yr covered by the remote sensing data and the emissions for 2010-2011 were divided by 1 yr instead of 1.25 yr covered by the remote sensing data, resulting in a total emission period of 12 yr.

About 88% of the total emissions were from deforestation in the HPfC stratum, with about 10% occurring in the MPfC and only 2% in the LPfC strata. Emissions from medium and large scale mining and mining infrastructure accounted for 80% of the total emissions, followed by agriculture (12%), by forestry infrastructure (6%) and other infrastructure (2%).

Average annual emissions have increased over the period 2001-2012 at a rate of approximately 0.96 million tCO2 per year (the slope of the line in Fig. 1). The upward trend is statistically significant and is driven by the large increase in mining activity.

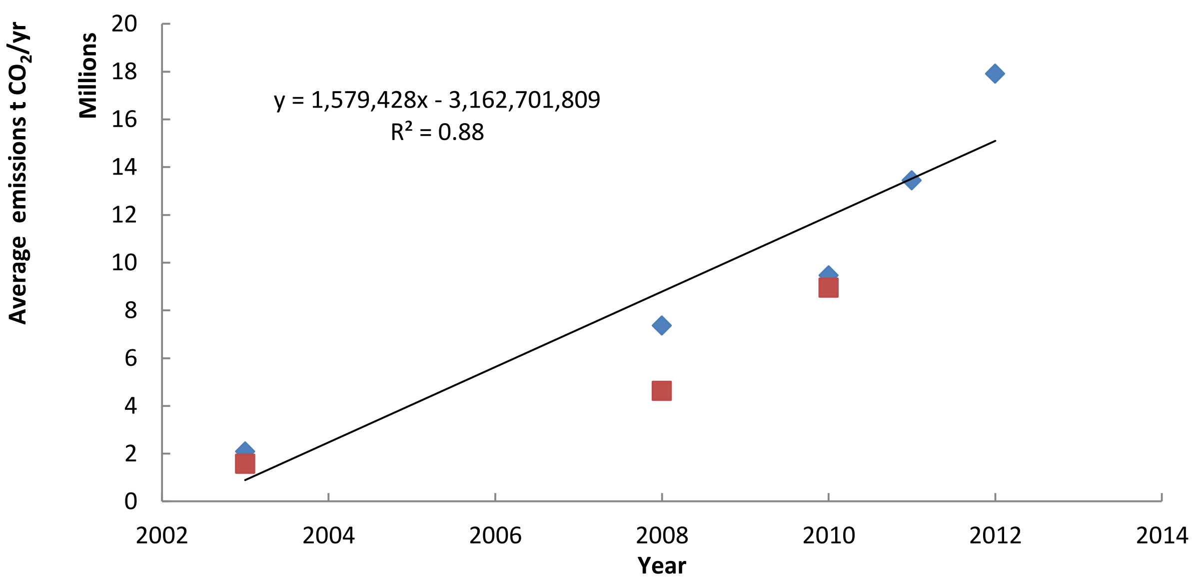

Figure 1. Average annual CO2 emissions for the period 2001-2012 caused by deforestation. The midpoint of 2001-2005 was assumed to be 2003, and the midpoint of 2006-2009 was assumed to be 2008. The blue symbols =total emissions; red symbols =emissions from mining & mining infrastructure.

Table 6. Total emissions for historical period 2001-2012, by driver and stratum.

Stratum	Drivers	Emissions (t CO_2)				
		2001-2005	2006-2009	2009-2010	2010-2011	2012
HPfC-MA	Forestry infrastructure	1,177,114	2,024,240	115,908	180,497	197,933
	Agriculture	62,242	3,006,794	264,021	145,033	266,357
	Mining (medium and large)	5,808,960	8,872,126	3,799,302	4,501,535	6,944,316
	Mining infrastructure	118,729	1,317,858	370,159	631,065	472,141
	Infrastructure	636,490	259,637	3,029	127,826	24,463
HPfC-LA	Forestry infrastructure	11,922	240,148	2,152	39,891	190,456
	Agriculture	428,482	4,103,338	31,674	123,347	245,688
	Mining (medium and large)	1,035,763	5,526,335	3,131,209	4,904,195	6,331,510
	Mining infrastructure	10,974	688,464	319,669	1,098,548	946,605
	Infrastructure	69,879	61,053	-	272,256	42,260
HPfC TOTAL		9,360,554	26,099,992	8,037,124	12,024,192	15,661,730
MPfC-MA&LA	Forestry infrastructure	15,178	247,382	301	24,523	12,778
	Agriculture	40,633	731,181	28,013	14,353	18,963
	Mining (medium & large)	698,444	1,488,963	1,001,542	850,665	1,583,559
	Mining infrastructure	12,024	78,712	83,903	168,506	226,890
	Infrastructure	60,471	149,721	50,505	63,628	89,402
MPfC TOTAL		826,749	2,695,960	1,164,264	1,121,675	1,931,593
LPfC-MA&LA	Forestry infrastructure	399	74,135	2,220	7,826	0
	Agriculture	0	30,271	11,389	0	2,158
	Mining (medium & large)	177,227	537,799	244,927	269,255	258,705
	Mining infrastructure	8,401	15,530	3,700	15,858	4,036
	Infrastructure	59,804	3,338	0	5,433	46,496
LPfC TOTAL		245,831	661,072	262,236	298,372	311,396
ALL	Forestry infrastructure	1,204,613	2,585,905	120,581	252,737	401,168
	Agriculture	531,357	7,871,584	335,098	282,733	533,166
	Mining (medium & large)	7,720,394	16,425,223	8,176,980	10,525,650	15,118,091
	Mining infrastructure	150,128	2,100,563	777,431	1,913,978	1,649,672
	Infrastructure	826,643	473,749	53,534	469,142	202,621
TOTAL		**10,433,135**	**29,457,024**	**9,463,624**	**13,444,239**	**17,904,718**
ALL	Forestry infrastructure	240,923	646,476	120,581	252,737	401,168
	Agriculture	106,271	1,967,896	335,098	282,733	533,166
	Mining (medium & large)	1,544,079	4,106,306	8,176,980	10,525,650	15,118,091
	Mining infrastructure	30,026	525,141	777,431	1,913,978	1,649,672
	Infrastructure	165,329	118,437	53,534	469,142	202,621
ANNUAL TOTAL		**2,086,627**	**7,364,256**	**9,463,624**	**13,444,239**	**17,904,718**

The uncertainty of the total emissions for deforestation is a 95% confidence interval of ±11.7% of the mean. This is based on application of the error propagation equation in Ch.5 of the IPCC GPG (2003) applied to each stratum. At this stage the uncertainty in soil emissions is not included but the total uncertainty with inclusion of soil is not expected to be too different because the emissions from soil are <3% of the total.

Table 7. Summary of total emissions by driver during the historic period 2001-2012.

Drivers	2001-2012	
	t CO_2e	% of total
Forestry infrastructure	4,565,004	6%
Agriculture	9,553,937	12%
Mining (medium and large scale)	57,966,337	72%
Mining infrastructure	6,591,773	8%
Infrastructure	2,025,690	3%
Total	**80,702,740**	**100%**
Annualized	**6,725,228**	

The total emissions from deforestation reported in Table 7, which includes all five IPCC pools), is higher than the total emissions based only on above ground and belowground biomass—reported for determining the RL above of 69.5 million t CO_2. The difference attributed to dead wood, litter and soil carbon pools is estimated to be 11.2 million t CO_2, or about 14% of the emissions including all pools.

The annual pattern of total historic emissions based on inclusion of all five IPCC pools is given in Figure 2.

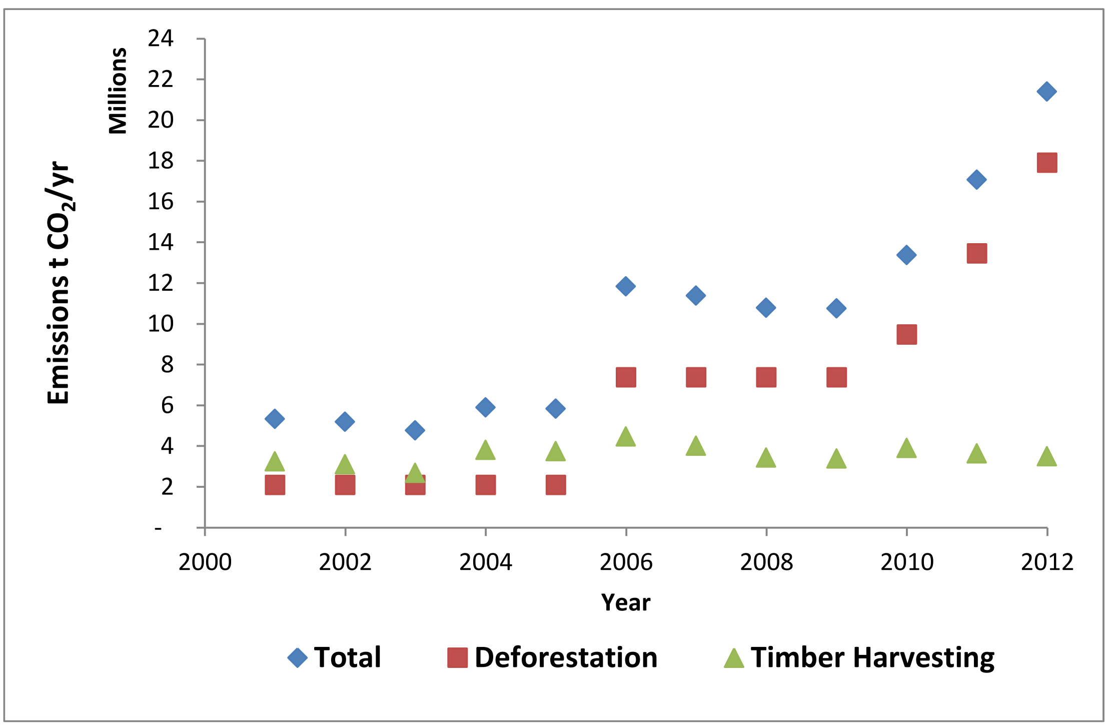

Figure 2. Annual emissions of CO2 from deforestation and degradation from timber harvesting during the historic period 2001-2012.