Guyana Forestry Commission

Guyana REDD+ Monitoring Reporting & Verification System (MRVS)

Year 7 MRVS Report

1 January 2017 to 31 December 2017

Version 2 – January 2019

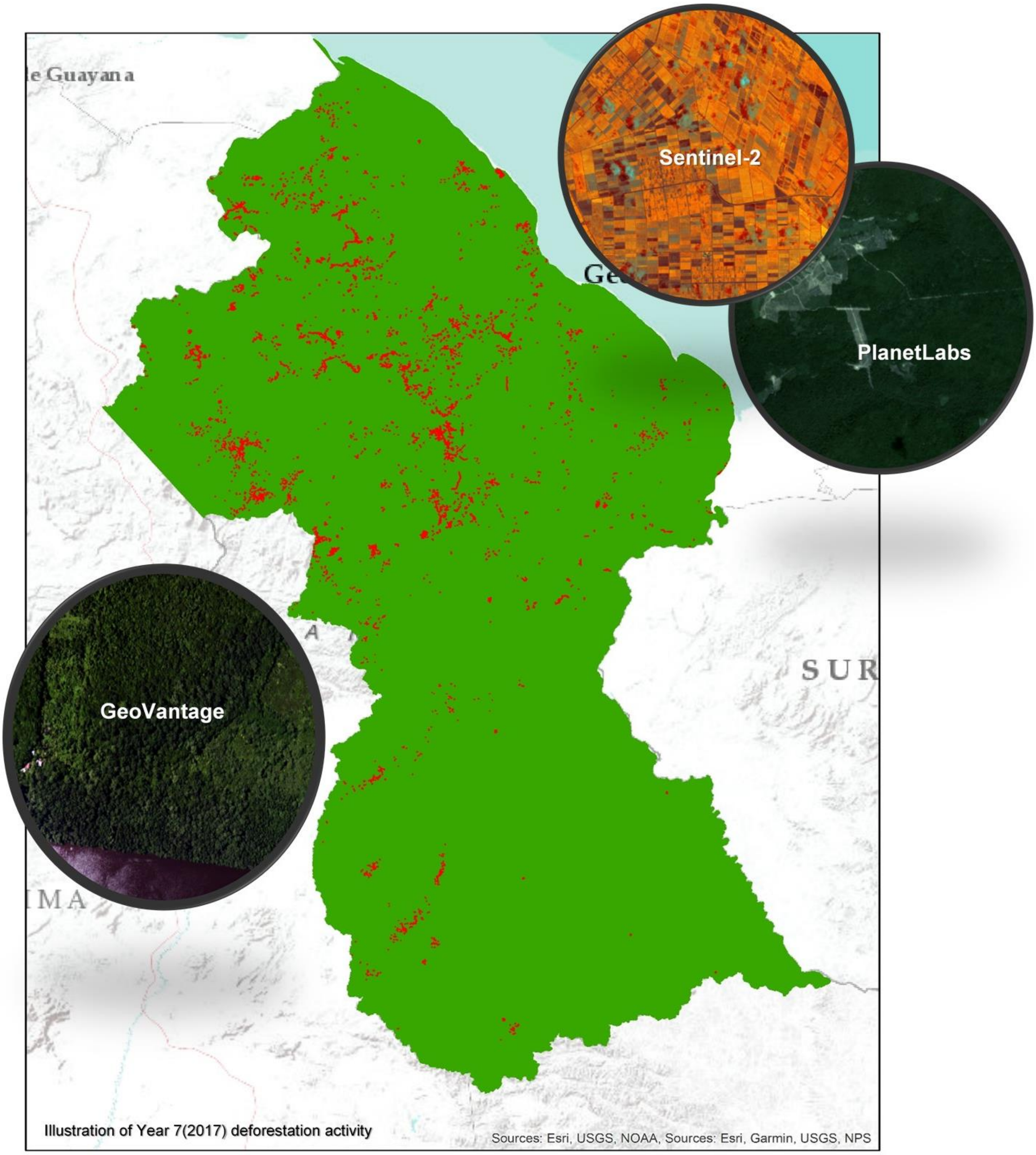

Illustration of Year 7(2017) deforestation activity

DISCLAIMER

The GFC advises that it has made every possible effort to provide the most accurate and complete information in the executing of this assignment.

PREFACE

Guyana has commenced implementation of Years 6-9 (2015- 2019) of the MRVS with continued support from the Government of Norway. This is a successor to MRVS Phase 1 implementation under the climate and forest partnership between the Government of Guyana and the Government of the Kingdom of Norway that was initiated in 2009.

Activities for implementation in Years 6-9 will support the establishment and sustaining of a world-class MRVS as a key component of Guyana's national REDD+ programme. This system will provide the basis for verifiably measuring changes in Guyana's forest cover and resultant carbon emissions from Guyana's forests as an underpinning for results-based REDD+ compensation in the long-term.

It is important that the MRVS is a continuous learning process that is progressively improved. This is particularly relevant as the MRV matures and the trends and drivers of forest change are better understood.

Critically, the results generated from the MRV System have potential applications to a range of functions relating to policy setting and decision making within the natural resources sector, in particular to forest management. Guyana's MRV System has, over the past seven years, generated a wealth of data that can be utilized in improving management of the multiple uses of forests. Within the MRVS Year 6 to 9, the application of this data for decision making will be tested at several levels and scales.

Reporting will continue to be based on the REDD+ Interim Indicators as outlined by the areas expressed in the Joint Concept Note or any other reporting framework agreed between Guyana and Norway, while streamlining these REDD+ performance indicators. It also represents advancement of the implementation of the actions outlined in the MRVS Roadmap Phase 2, towards mainstreaming the system.

In 2009 Guyana developed a framework for a national MRVS. This framework was developed as a "Roadmap" that outlines progressive steps over a 3-year period that would build towards a full MRVS being implemented. The aim of the MRVS is to establish a comprehensive, national system to monitor, report and verify forest carbon emissions resulting from deforestation and forest degradation in Guyana. The first year of the roadmap commencement was 2010 which required several initial reporting activities to commence. These were designed to assist in shaping the next steps planned for the following years. In 2014, a Phase 2 Roadmap was developed for the MRVS. The overall objective of the Roadmap Phase 2 is to consolidate and expand capacities for national REDD+ monitoring and MRV. This has supported Guyana in meeting the evolving international reporting requirements from the UNFCCC as well as continuing to fulfil additional reporting requirements. It will also support Guyana in further developing forest monitoring as a tool for REDD+ implementation.

The initial steps allowed for a historical assessment of forest cover to be completed, key database integration to be fulfilled and for interim/intermediate indicators of emissions from deforestation and forest degradation to be reported for subsequent periods. To date, seven national assessments have been conducted, including the one outlined in this Report. The first assessment period covered 01 October 2009 to 30 September 2010 (Year 1) and the second (Year 2) covered the period 01 October 2010 to 31 December 2011. The third assessment (Year 3) covered the calendar year of 2012, the fourth assessment (Year 4) covers the calendar year of 2013, and the fifth assessment (Year 5) covers the calendar year of 2014. The sixth assessment (Year 6) covers a 24-month period spanning 2015 and 2016, Year 7 a 12 month period - the calendar year of 2017.

In tandem with the work summarised in this report, an accompanying and closely connected programme of work will continue to be implemented by Guyana Forestry Commission (GFC), with the assistance of Winrock International to develop a national forest carbon measurement system and related emission factors. This programme will establish national carbon conversion values, expansion factors, wood density and root/shoot ratios as necessary. Additionally, a detailed assessment of key processes affecting forest carbon, including a summary of key results and capacities as well as a long-term monitoring plan for forest carbon, has been further developed. This aspect of the MRVS work, in tandem with continued work as summarized in this report, will enable a range of areas, including forest degradation to be comprehensively monitored, reported and verified at the national scale.

The GFC has attempted to embrace the broader thrust of the MRVS Phase 2 in looking for new and emerging technical solutions to related MRVS areas, as well as to embrace the requirements of implementing a non-REDD+ payment option for the MRVS. This process started in MRVS Year 6.

As the MRVS continues to be developed, the reporting in this period, as was the case in previous years will be based on several agreed REDD+ Interim Indicators. The Report therefore aims to fulfil the requirements of several "Interim Indicators for REDD+ Performance in Guyana" for the period 01 January, 2017 to 31 December, 2017, as identified by Joint Concept Note.

This Report describes the satellite imagery and GIS datasets, and processing of these data. It also provides a summary of the 'Interim Measures' that report on Guyana's progress towards implementation of REDD+.

The methods and results of the assessment for the period 01 January, 2017 to 31 December, 2017 are subject to independent third-party verification. The verification will be conducted annually for Years 6-9 of the MRVS.

Version 1 of the Report will be released for a 1-month period (November 21, 2018 to December 21, 2018) for feedback. Following the period of public review, Version 2 of the report will be released and include all comments made under the public review process and feedback to each comment, including corresponding revisions to the report to address these comments where these apply. This Version is subject to independent third-party verificationby an independent verification firm contracted by the Government of Norway. The final version of the Report (Version 3) includes all elements of Version 2, and additionally, integrates the findings of the verification process, and is made public via the GFC website.

A summarised version of the Report has also been developed and released for public information.

These Reports are issued by the Guyana Forestry Commission (GFC). Indufor has provided support and advice as directed by the GFC.

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SUMMARY

In 2017 the Monitoring Reporting and Verification System (MRVS) moved into its second phase in line with tasks set out in the MRVS Road Map. This document outlines the stepwise progression and development of the MRVS for the next four years 2017 to 2020.

The framework for reporting continues to be the REDD+ Interim Indicators, as well as the reporting requirements as outlined in the 2009, 2011, and 2012 and 2015 versions of the Joint Concept Note (JCN). It is envisaged that the reference measure as well as the interim performance indicators will only apply while aspects of the MRVS are being developed and will be phased out and replaced by a full forest carbon accounting system as methodologies are further developed.

For reference the ongoing comparison of performance for the area-based interim indicators is against the values reported in the 2009 "Benchmark Map[1]". From that point onwards, the reporting periods are numbed sequentially with year 1 covering 2009 to 2010. This report presents the findings of the seventh national assessment which spans a twelve-month period, 1 January 2017 to 31 December 2017.

The purpose of the MRVS is to track at a national-level forest change of deforestation and degradation, by change driver. Deforestation is monitored using a national coverage of satellite imagery. Degradation estimates are national and are determined using a representative sample. The method provides a robust measure of both deforestation and degradation that aligns with Guyana's desire to pursue a low or no-cost REDD+ implementation option – a key part of the Phase 2 objective.

Deforestation for the period between 1 January 2017 and 31 December 2017 is estimated at 8 851 ha. This equates to an annualised deforestation rate of 0.048% which is lower than the change reported in the previous year (0.050%). This rate is the lowest of all annual periods from 2010 to present, assessed to date. As with previous assessments the deforestation values have been verified using an independent sample by the Durham University (DU) team. This process confirms the accuracy of GFC's mapped deforestation area.

Using a sample-based approach, forest degradation was identified by the Forestry Commission's mapping team and their work was independently verified by Durham University. The area of forest degraded as per the definition used to report the Interim measure 2b is 3 512 ha. This is lower than the change reported in the previous year (5 679 ha).

The main deforestation driver for the current forest year reported is mining (sites), which accounts for 74% of the deforestation in this period. The majority (78%) of the deforestation is observed in the State Forest Area. The temporal analysis of forest changes post-1990 indicates that most of the change is clustered around existing road infrastructure and navigable rivers. In Year 7 (2017) the change has continued primarily near the footprint of historical change. The findings of this assessment assist to design REDD+ activities that aim to maintain forest cover while enabling continued sustainable development and improved livelihoods for Guyanese.

A summary of the key reporting measures and a brief description for these interim measures are outlined in Table S1. For reference, the 2016 and 2017 values are presented. A key indicator of performance is the difference between 2017 and the adopted reference value. Outputs and results are also provided for the intact forest landscape – IFL (Ref. measure. 2). The eligible IFL area of 7.6 million ha as calculated in the benchmark period is used for reference. All land cover changes are measured relative to the original IFL area.

Relevant measures are also reported for forest management indicators (measures Ref. 3 and 4). Where applicable, a reference measure has been included.

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[1]Originally the benchmark map was set at February 2009, but due to the lack of cloud-free data the period was extended to September 2009.

Table S1: Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 6	Year 7	Difference between Year 7 & Reference Measure
					2015-2016	2017	Difference
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change (%)/yr*	0.275%	0.050%	0.048%	0.21%
2	Degradation Indicators	National area of Intact Forest Landscape (IFL). Change in IFL post Year 1, following consideration of exclusion areas.	*ha*	7 604 820	7 604 024 (290 ha loss)	7 603 796 (228 ha loss)	1 024 ha
2b		Determine the extent of degradation associated with new infrastructure such as mining, roads, settlements post the benchmark period[7].	*ha*	4 368	5 679[2]	3 512	856 ha
3	Forest Management	Timber volumes post 2008 as verified by independent forest monitoring (IFM). These are compared to the mean volume from 2003-2008	*t* CO_2	3 386 778[3]	1,892,371	1,740,242	1,646,536 *t* CO_2
4	Emissions resulting from illegal logging activities	In the absence of hard data on volumes of illegally harvested wood, a default factor of 15% (as compared to the legally harvested volume)	*t* CO_2	411 856	9,140	13,169	398,687 *t* CO_2
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	*ha/yr*	1 706[4]	762	804	902 ha
6	Emissions resulting from subsistence forestry, land use and shifting cultivation lands	Emissions resulting from communities to meet their local needs may increase as a result of inter alia a shorter fallow cycle or area expansion. (i.e. slash and burn agriculture)[5].	*ha/yr*	Not yet established	93	281	N/A

[2] Includes 802 ha of degradation from natural causes over the 2-year period.

[3] Assessment completed based in Winrock International Report to the Guyana Forestry Commission, December 2011: ***Collateral Damage and Wood Products from Logging Practices in Guyana.*** This methodology only applies to emissions and not any removals due to re-growth of the logged forest. [2]. The same is the case for the Reference level for illegal logging for Years 2, 3 and 4.

[4] Degradation from forest fires is taken from an average over the past 20 years. This value is inclusive of all degradation drivers except for rotational shifting agriculture. From 2015 the area has been estimated from the sample-based analysis.

[5] Area estimates that capture shifting cultivation activities are calculated using the sample-based approach.

Encouragement of carbon sinks (Ref measure 7) is now under review. Reforestation of previously deforested sites is currently monitored using GIS once a deforestation site shows signs of being abandoned. Evidence suggests that these sites take a considerable time to regenerate. This is unsurprising due to the nature of the soil disturbance and displacement associated with mining activities. It is recommended that a long-term measurement plan be developed to monitor the carbon stock accumulation over time. The purpose of this plan would be to develop a realistic re-measurement interval. Once carbon stocks show signs of recovery, emission factors could be developed and linked to the GIS to provide a carbon stock estimation. The first instance of this measurement is recorded in Year 5. No measurement has been made in Year 6 due to the use of lower resolution Landsat images. Fieldwork and additional work recommence in 2018 (Year 7) with the intention of completing the pilot study in early 2019.

Table S2: Impending Interim Measure

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Reference Measure	
7	Encourageme nt of increasing carbon sink capacity of non-forest and forest land	Changes from non-forest land to forest (i.e. through plantations, land use change) or within forest land (sustainable forest management, enrichment planting)	Not considered relevant in the interim period.	N/A	This measure is still being refined field work commenced in 2018 and was supported by dedicated image capture

1. VERIFYING FOREST CHANGE MAPPING & INTERIM MEASURES

As part of the MRVS reporting process an independent accuracy assessment is conducted. The original scope of the Accuracy Assessment dictated that a third party not involved in the change mapping assesses deforestation, forest degradation and forest area change estimates for each period. Specifically, the terms of reference asked that confidence limits be attached to the forest area estimates.

The scope and process has remained unchanged for all interim measures - except for degradation. The rationale for change is summarised as follows:

From 2017 degradation estimates have been based on analysis of a network of samples of high resolution airborne and satellite images by the GFC team and checked by the DU team. Prior to this the same method was applied but employed as part of the map accuracy process rather than as a basis for the actual estimate. This shift is driven by the relative efficiency of the sample-based approach versus the wide-scale mapping which relied manual interpretation of only changes that surrounded deforested areas.

In keeping with previous reports, the methods applied follow the recommendations set out in the GOFC-GOLD guidelines. The aim is to help identify and quantify uncertainty in the level and rate of deforestation and the amount of degraded forest area in Guyana over the period 1 January 2017 to 31 December 2017 (Interim Measures Period – Year 7).

1.1 Accuracy Assessment Conclusions & Recommendations

The following are the main conclusions and recommendations from the sample-based assessment of deforestation and forest degradation:

1. The estimates of deforestation based on the mapping undertaken by GFC based largely on interpretation of Sentinel-2 and PlanetScope imagery is of a good standard.
2. The methods used by GFC, and assisted by Indufor, follow the good practice recommendations set out in the GOFC-GOLD and GFOI guidelines and considerable effort has been made to acquire cloud free imagery towards the end of the census period with the majority of imagery used for mapping and degradation interpretation from November 2017 to December 2017 (Year 7).

3. The estimate of the total area of change in the 12-month Year 7 period from forest to non-forest and degraded forest to non-forest is 7 733 ha, with a standard error of 1 403 ha and a 95% confidence interval (4 973 ha; 10 472 ha). Of the total degraded area, some 3 512 ha (or 74%) is associated with changes relating to new infrastructure – this value is the figure reported for Interim Measure 2b.
4. The estimate of the annualised rate of deforestation that occurred over the Year 7 (12 month) period is 0.051% with a standard error of 0.0062% and a 95% confidence interval (0.0387%; 0.0630%).
5. The estimate the total area of change in the 12-month Year 7 period from forest to degraded forest between Y6 and Y7 is 4 764 ha, with a standard error of 730 ha and a 95% confidence interval (3 332 ha; 6 196 ha).
6. One change of 0.35 ha was detected within samples that fell within the boundary of the Intact Forest Landscape. The change was interpreted as forest degradation associated with shifting agriculture.
7. The GeoVantage (aerial survey) and PlanetScope data provided sufficient detail (spatial resolution) to assess the Sentinal-2 and PlanetScope deforestation mapping as provided by GFC. It would be difficult to make a precise assessment of degradation without access to high resolution imagery. Sentinel-2 MSI or Landsat ALI data are not sufficient for this purpose.

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ACKNOWLEDGEMENTS

In addition to GFC, several agencies and individuals have assisted in providing inputs into the MRVS programme. GFC and Indufor would like to acknowledge the support of the Ministry of Natural Resources for its strategic guidance.

The continued support and oversight of the members of the MRVS Steering Committee is also acknowledged.

The GFC team would also like to acknowledge the following entities for their support:

- Guyana Geology and Mines Commission for providing location datasets for mining areas.
- Guyana Lands & Surveys Commission for providing spatial data relating to, settlements and agricultural leases.
- Conservation International, Guyana for their role in supporting the implementation of this project.
- WWF for supporting work on CMRV.
- Winrock International for work on the forest carbon monitoring system.
- Other Partners

GLOSSARY

The following terms and abbreviations are used throughout the report.

CMRV	Community Monitoring Reporting and Verification
EITI	Extractive Industries Transparency Initiative
ESA	European Space Agency
FCPF	Guyana Forestry Commission
GFC	Forest Carbon Partnership Facility
GGMC	Guyana Geology and Mines Commission
GIS	Geographic Information System
GL&SC	Guyana Lands & Surveys Commission
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GPS	Global Positioning System
IPCC	Inter-Governmental Panel on Climate Change
KMCRG	Kanuku Mountain Community Representative Group
LCDS	Low Carbon Development Strategy
LULUCF	Land Use, Land Use Change and Forestry
MMU	Minimum Mapping Unit
MODIS	Moderate Resolution Imaging Spectroradiometer
MRVS	Monitoring Reporting and Verification System
NRDDB	North Rupununi District Development Board
Radar	Radio Detection and Ranging
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus Sustainable Forest Management
SFA	State Forest Area/Authorisation
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations REDD Programme
UoD	University of Durham, UK
WWF	Worldwide Fund for Nature

2. INTRODUCTION

2.1 Country Description

The total land area for Guyana is 21.1 million hectares (ha) and spans from 2 to 8° N and 57 to 61° W. Guyana shares common borders with three countries: to the north-west - Venezuela, the south-west - Brazil, and on the east - Suriname.

Guyana's 460 km coastline faces the Atlantic on the northern part of the South American continent. The coastal plain is only about 16 km wide but is 459 km long.

It is dissected by 16 major rivers and numerous creeks and canals for irrigation and drainage. The main rivers that drain into the Atlantic Ocean include the Essequibo, Demerara, Berbice, and Corentyne. These rivers have the classic wide mouths, mangroves, and longitudinal sand banks so much associated with Amazonia, and mud flows are visible in the ocean from the air.

The geology in the center of the country is a white sand (*zanderij*) plateau lying over a crystalline plateau penetrated by intrusions of igneous rocks which cause the river rapids and falls.

2.2 Initiation of REDD+ activities in Guyana

On 8 June 2009, Guyana launched its Low Carbon Development Strategy (LCDS). The Strategy outlined Guyana's vision for promoting economic development, while at the same time contributing to combating climate change. The LCDS has two goals:

1. Transform Guyana's economy to deliver greater economic and social development for the people of Guyana by following a low carbon development path; and
2. Provide a model for the world of how climate change can be addressed through low carbon development in developing countries if the international community takes the necessary collective actions, especially relating to REDD+.

As at September 2009 Guyana had approximately 18.5 million ha. Historically, relatively low deforestation rates have been reported for Guyana.

Approximately 87% of Guyana land area is covered by forests, with a low deforestation rate, 0.02% and 0.079% per annum. Deforestation rates typically expand along with economic development, thus prompting the formation of the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD programme), the Forest Carbon Partnership Facility (FCPF) and the REDD+ Partnership, among others.

The activities undertaken, as summarised in this Report, are part of the three-phase Road Map developed for Guyana's MRVS. The objective of the initial MRVS Road Map was to undertake comprehensive, consistent, transparent and verifiable assessment of forest area change for the historical period of (about) 1990 to 2009 using several period steps of archived Landsat-type satellite data that meet the criteria of the IPCC Good Practice Guidelines for LULUCF.

A Second Phase MRVS Roadmap was developed following a stakeholder consultation process, the year 5 report was the commencement of the first cycle of the Phase 2 Roadmap covering knowledge and capacity sharing aspects.

2.3 Establishing and Monitoring Changes to Guyana's Forested Area

Land classified as forest follows the definition as outlined in the Marrakech Accords (UNFCCC, 2001). Guyana has elected to classify land as forest if it meets the following criteria:

- Tree cover of minimum 30%
- At a minimum height of 5 m
- Over a minimum area of 1 ha.

In accordance with the JCN, the national forest cover as at 1990 based on this definition is used as a start point. The interim measures are benchmarked against 2009 reported values.

In summary, the MRV monitoring process has involved:

- Determination of the 1990 forest area using medium resolution satellite images (Landsat) by excluding non-forest areas (including existing infrastructure) as at 1990. It should be noted that continual updates have been introduced to improve the non-forest boundary based on improved satellite resolution and repeat observation of the forest fringe.
- From this point forward, accounting for forest to non-forest land use changes that have occurred between 1990 and 2009 using a temporal series of satellite data.
- Establishing the benchmark period (1990-2009) and using 30 September 2009 Benchmark Map as a reference point.
- Comparing annual change post 2009 against the 2009 benchmark values

2.4 MRVS Development & Progress

Several areas have been progressively improved since the inception of the MRV. For the current MRV phase 2017-2020 workplan the following are relevant.

Forest Area Monitoring

2.4.1 Conduct national mapping and assessment of change in Forest Area, incorporate advances as necessary and required.

As with previous assessments GFC has incorporated publicly available satellite imagery - Sentinel a constellation commissioned by the European Space Agency (ESA). The two Sentinel satellites 2A and 2B alone, enable repeat imaging of the same spatial location every five days at a spatial resolution of 10 m. Combined with the Landsat constellation (L7 and L8) this increases to 6-7 observations per month.

Further training using FAO's SEPAL forest monitoring software was undertaken in August 2018. In tandem GFC has started using a cloud computing architecture with the support of Indufor and Google (Google Earth Engine) that hosts and serves petabytes of historical and recently acquired images on-demand. With data held in this environment there is less need to individually review, download, or process and analyse satellite imagery as was the norm in the recent past. The Standard Operating Procedures have been updated accordingly.

As the system evolves it is likely to become a method that can be used to support the monitoring of forest change in near-real-time and data behind an inter-agency information and decision support platform.

Forest Carbon Monitoring System

In Year 7, forest carbon measurement featured progress on three main areas: reporting on emissions, revised forest carbon stratification and mapping, and emission factors for main forest degradation drivers. These are described below:

Reporting: A key aspect of the work that was conducted in Year 6 and 7, was that of parallel reporting on forest change, i.e. reporting on both activity and emissions data. In this, the Emissions Reporting tool was updated to report taking account of this development. The activity data and emission factors generated from the MRVS are combined to estimate total CO2 emissions by source or driver under Guyana's REDD+ programme. Both the Workbook for Estimating Historic CO_2 Emissions from Deforestation and Selective Logging and the relevant IPCC Reporting tables have been updated.

Emission Factors: Work has also concluded on developing an emission factor for mining degradation and related infrastructure, as well as shifting cultivation. These along with the emissions reporting on forest harvest (which is done through the Gain Loss Method) completed the emission reporting on the suite of forest degradation drivers prevailing in Guyana.

Carbon Stratification: As part of its national REDD+ program, the Government of Guyana completed a forest carbon stratification in 2011 for the purposes of designing a sampling plan to accurately understand the country's forest carbon stocks[6]. This stratification divided forest area into categories based on two factors: 1) the threat of deforestation, or potential for future land use change (PFC) that exists in the forest area, and 2) the accessibility to the forest area. The inclusion of different threat or PFC classes (high, medium and low) was based on the knowledge that, due to forest degradation, forest areas under higher PFC were likely to have lower carbon stocks than areas under low threat. In 2013, updated spatial input layers were used to revise the stratification[7]. Observed deforestation trends between 2011-2013 led to the inclusion of "distance from non-forest lands in the eastern administrative regions" as an additional variable to establish the PFC classes. A final 2013 stratification map was produced and used for the sampling design and reference level development. Since 2013, development and deforestation trends have continued to be closely monitored in Guyana and some of the input layers used as variables for the stratification map have changed somewhat—roads networks have expanded, concession boundaries have changed and areas that were once forest have undergone land use change. These changes created the need to update the stratification map for future monitoring periods of Guyana's REDD+ program to ensure more accurate accounting of changes in forest carbon stocks. As such, in Year 7, the Forest Carbon Stratification Report with Carbon Maps were updated over the year 7 reporting period.

2.4.2 Conduct Independent Accuracy Assessment for Forest Maps and Change Estimates and Support Independent Verification.

In 2018 further revisions of the forest degradation monitoring approach have been undertaken. This has involved a shift away from manual mapping for forest degradation events around areas to deforestation to the use of a sampling-based approach. Standard Operating Procedures (incl. independent QA/QC checks) have been developed that allow the GFC team to undertake this assessment.

2.4.3 Assess options for continued forest change monitoring in the "non-REDD+ payment" scenario.

In implementing activities under Year 7 of the MRVS, the GFC has continued to assess new measures that are of no cost, or low cost to the implementation and further development of the MRVS. For the reporting period these include:

a. The use of freely available Sentinel 10 metre resolution data. This data source offers increased revisits from the Sentinel satellite, every 5 days. This allows for change areas to be correctly detected and boundaries defined.

b. Use of the Google Earth Engine (GEE). This replaces ENVI that was used in previous years of the MRVS. The GEE has been used for EVI, persistent cloud masking, and will be used in conducting mapping for Year 8.

c. Conducting an assessment of the use of overflights versus PlanteLabs data for degradation mapping and Accuracy Assessment. The Planet constellation comprises approximately 200 satellites micro-satellites imaging areas at (approximately) 3 m

[6] Petrova S, Harris N, Brown S and Persaud H (2011) Spatial techniques for forest carbon stratification and sampling design for Guyana. Submitted by Winrock International to the Guyana Forestry Commission.
[7] Petrova S, Goslee K, Harris N and Brown S (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.

resolution. The satellites follow two different orbits namely International Space Station (ISS) and Sun Synchronous Orbit (SSO). The SSO is common to many earth-observing satellites which have a set equator crossing time and acquire images only on descending orbit. The planet satellites in SSO cross equator at 9:30-11:30 acquiring images of an area almost same time in every revisit. The satellites in ISS however have no fixed equatorial crossing time. For the accuracy assessment only, satellites in the SSO were considered. In keeping with previous years, the same sample transects were analyzed. The locations of these transects were provided to Indufor by the independent accuracy assessment team from Durham University, UK. Multiple Planet images acquired (August to December 2017) over the sample site locations were provided to the accuracy assessment team for analysis. For this assessment the acquisition of the PlanetLab data and the overflight data are run concurrently. Based on the comparison of results, as well as the frequency and reliability of the new data source (PlanetLabs), a decision will be made on future use.

2.4.4 Improve methodology for treatment of Shifting Cultivation, if deemed necessary.

Initial field work and image capture (incl airborne) was completed in 2018. Further analysis and reporting will be undertaken in 2019.

2.4.5 Build capability of local communities and stakeholders to monitor forests

The GFC embarked on a programme in 2018 to build capacities of 22 Indigenous communities in CMRV. The Communities were chosen based on the prevalence of various (and in some cases a combination of) drivers of deforestation and forest degradation. On average 10 persons were engaged at each community level. CMRV reporting is intended to: provide ground based validation of the national map, develop capacities at community level to monitor forest change, and create a circular flow of information and capacities in monitoring and reporting from national to community level and vice versa. 22 communities trained across the country in theoretical and practical aspects of CMRV.

Village Name	Region
Tapakuma/St. Denny's	2
Bethany	2
Mashabo	2
Capoey	2
Mainstay	2
Batavia	7
Riversview	7
Kumu	9
St. Ignatius	9
Moco Moco	9
Shulinab	9
Toka	9
Katoka	9
Rupertee	9
Wowetta	9
Surama	9
Kwatamang	9
Annai Central	9
Moraikobai	5
Muritaro	10
Santa Aratak	3
St. Cuthberts	4

For each of the sessions, the participants were updated on the National MRV system and briefed on the procedures associated with the mapping and identification of the various drivers of deforestation and degradation. Practical sessions included training on the use of GPS (waypoint marking, tracking etc.), compass and map reading. In addition, test areas mapped for various drivers e.g. shifting cultivation, fire were visited.

After ensuring that each participant was familiar with the use of the GPS and reading of the maps etc., 3-6 verification points were selected for ground verification on behalf of the GFC and with that field data will be fed into the national MRV system. At the end of the training, a self-assessment/questionnaire was administered to each participant where they provided feedback their knowledge of CMRV and what it entails.

Overall, the National MRV is an integral component for Guyana in achieving its REDD+ targets and international commitments. CMRV has the potential to assist in feeding information back into the National MRV. This process, if successfully implemented, can significantly reduce the cost for MRV, as well as, ensure that the benefits are spread out across the groups involved.

2.4.6 Prepare scientific publications and syntheses

In 2018 a paper (incl. GFC as an author) was published in Remote Sensing of Environment titled "Quantifying the trade-off between cost and precision in estimating area of forest loss and degradation using probability sampling in Guyana". This paper draws extensively on the Guyana forest change dataset created by the GFC mapping team.

Work is progressing on the paper titled: "Carbon emissions from tropical forest degradation around mining areas in Guyana" The purpose of this paper is to: 1) describe and test two methods for estimating the area of forest degradation (i.e. activity data) and the corresponding emission factors (EF) from activities in the forests surrounding mining, 2) provide estimates of the gross carbon emissions from forest degradation caused by mining, 3) compare the efficacy of estimating emissions by these two methods, and 4) compare the emissions from forest degradation with emissions from deforestation.

An additional technical publication is in preparation on Guyana's REDD+ Accounting experience so far. This is scheduled to be finalised in the first half of 2019.

The GFC further contributed to work by author Alvaro Ivan Lau Sarmiento on the publication: "Assessing biomass and architecture of tropical tress with terrestrial laser scanning, October 30, 2018." The main objective of the study was to explore the use of 3D models from terrestrial laser scanning point clouds to estimate biomass and architecture of tropical trees. In this thesis dataset of forest inventory with the use of a terrestrial laser scanner (TLS) polint clouds and destructive tree harvesting was created from three tropical regions: Indonesia, Guyana and Peru. A total of 1858 trees were traditionally inventoried, 135 trees were TLS scanned and 55 trees were destructively harvested.

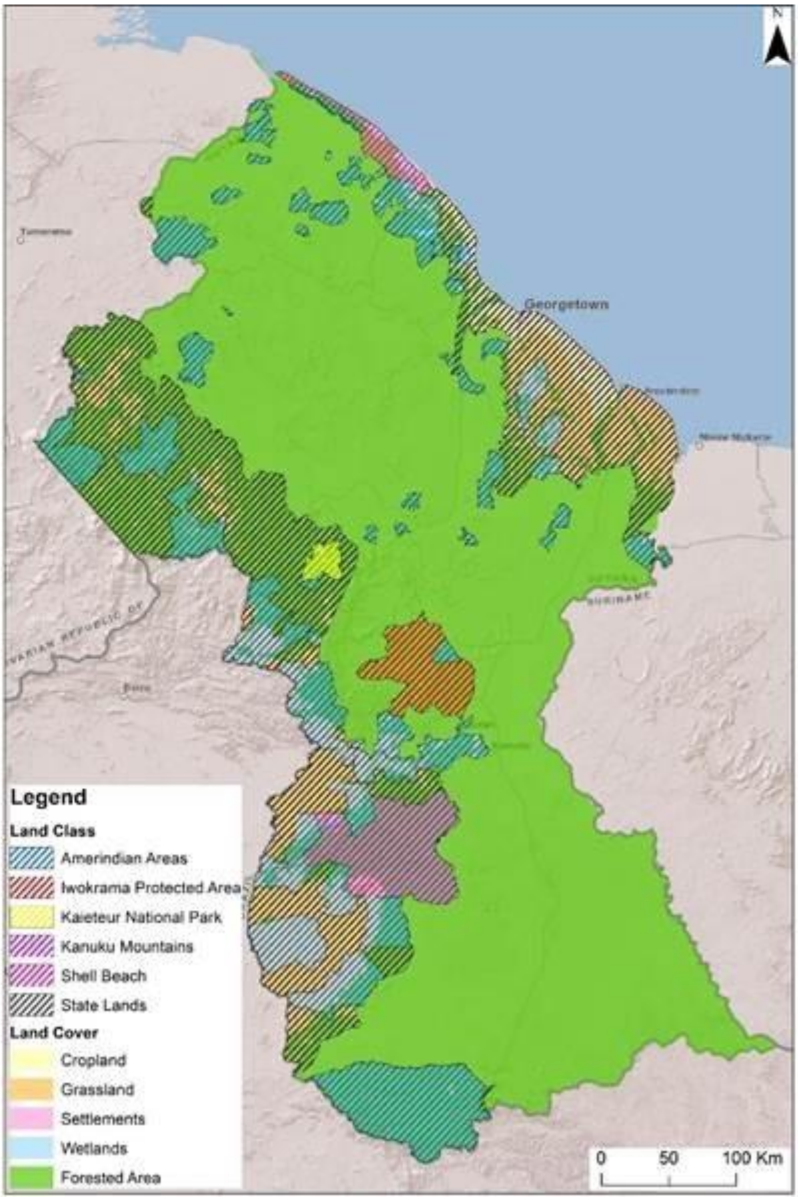
Encouraging resershers to prepare publications and conduct scientific research based on MRVS work have been priorities for the GFC. From the context of within the GFC, the GFC's staff through the field work of the Commission or through the analytical work of staff has contributed to several publication and PhD work mentioned in this section. Three other publications are in the pipeline for 2019. The GFC also is able to use these capacities to develop and contribute to reports showcasing the Guyana model, at various international project levels including at ONFI (through the ECOSEO Project), GFOI, and ACTO.

In terms of outside of the GFC, the Commission has entered into several MoUs on MRVS data sharing and training including with agencies such as the University of Guyana, the Protected Areas Commission, and the Environmental Protection Agency. This has the primary intention to foster research at the University and other technical agency level. The GFC also supports international research work from universities including the University of Leeds.

OVERVIEW OF GUYANA'S LAND CLASSES

There are four main tenure classifications in Guyana, the largest is state forest which is 59% of the total land area, followed by State Lands (20%) Amerindian lands (16%), and Protected Areas (5%). At the commencement of the MRV existing maps of Guyana's land cover developed in 2001 were evaluated and coalesced to align to the six broad land use categories in accordance with IPCC reporting guideline. A description of the land use categories is provided in Appendix 4. The location of these areas are shown below.

Map 0-1: Guyana's Land Classes



State Forest Area

According to the Forest Act, the State Forest Area is that area of State Land that is designated as State Forest. This area of State Forest has been gazetted.

State Lands

For purposes of this assessment, State Lands are identified as areas that are not included as part of the State Forest Area that are under the mandate of the State. This category predominantly includes State Lands, with isolated pockets of privately held land, but does not include titled Amerindian villages.

Protected Areas

To date, the four Protected Areas that come under the scope of the Protected Areas Act are: Iwokrama, Shell Beach, Kanuku Mountains and Kaieteur National Park. Altogether these account for a total of 1 141 000 ha designated as Protected Areas.

Titled Amerindian Land

The Amerindian Act 2006 provides for areas that are titled to Amerindian villages. It includes both initial titles as well as extensions that have been granted to these titled areas.

The areas are: State Forest Area (SFA) and State Lands which are calculated from the mapping analysis, is estimated at 14.8 million ha. This excludes Iwokrama, Kaieteur National Park and titled Amerindian Land. Combined, these forested areas make up 3.69 million ha.

Distribution of Tenure & by IPCC Land Classes

Table 0-1 shows the area by the adopted IPCC classes, as at the end of Year 7 (2017). The revised forest area in Table 0-1 includes the forest area lost during the Year 7 mapping period.

Non-forest classes can shift from one (non-forest) class to another non-forest class.

Table 0-1:

2017 Land Classes	**Forest**	**Non-Forest**					
		Grassland	**Cropland**	**Settlements**	**Wetlands**	**Other Land**	**Total**
	(Area '000 ha)						
State Forest Area	10 973	1 238	132	35	150	37	12 566
Titled Amerindian lands *(*including newly titled lands*)	2 864	323	35	9	39	10	3280
State Lands	3 609	407	44	11	49	12	4 132
Protected Areas*	997	112	12	3	14	3	1 142
Total Area	18 443	2 080	223	58	253	62	21 119

3. MONITORING & SPATIAL DATASETS

The process developed aims to enable areas of change (>1 ha) to be tracked spatially through time, by driver (i.e. mining, infrastructure and forestry). The approach adopted seeks to provide a spatial record of temporal land use change across forested land (commensurate to an Approach 3). Mapping is undertaken by a dedicated team located at GFC and all spatial data is stored on the local server at GFC and builds on the archived and manipulated data output from the previous analyses. The server is managed by the IT department at GFC and is routinely backed up and stored off-site.

3.1 Agency Datasets

Several Government agencies that are involved in the management and allocation of land resources in Guyana hold spatial datasets. Since 2010 GFC has coordinated the storage of these datasets for the MRVS. These agencies fall under the responsibility of the Ministry of Natural Resources (MNR). The Ministry has responsibilities for forestry, mining, and land use planning and coordination.

In 2016, activities of environmental compliance and management, protected areas development and management, national parks management and wildlife conservation and protection were reassigned from the Ministry of Natural Resources to a newly established Department of Environment. This Department of Environment falls under the oversight of the Ministry of the Presidency.

Table 3-1: Agency Datasets Provided

	Agency	Role	Data Held
Ministry Natural Resources	Guyana Forestry Commission (GFC)	Management of forest resources	Resource management related datasets
	Guyana Geology and Mines Commission (GGMC)	Management of mining and mineral resources	Mining concessions, active mining areas
Department of Environment	Protected Areas Commission	Management of Protected Areas System in Guyana	Spatial representations of all protected areas
Ministry of the Presidency	Guyana Lands and Surveys Commission (GL&SC)	Management of land titling and surveying of land	Land tenure, settlement extents and country boundary

Interim datasets have been provided by GFC, GGMC, GL&SC and the PAC. Information is progressively updated as necessary.

3.2 Monitoring Datasets - Satellite Imagery

In keeping with international best practice, the method applied in this assessment utilises a wall-to-wall approach that enables complete, consistent, and transparent monitoring of land use and land use changes over time.

The approach employed allows for land cover change greater than one hectare in size to be tracked through time and attributed by its driver (i.e. mining, shifting agriculture etc.).

The datasets used for the change analysis have evolved over time. Initially the historical change analysis from 1990 to 2009 was conducted using Landsat imagery. From 2010 a combination of DMC and Landsat was used and from 2011 onwards these datasets were primarily superseded with high resolution images from RapidEye. For 2015 and 2016 (Year 6), a combination of Landsat and Sentinel data have been used.

Table 3-2: Sentinel Coverage 2017

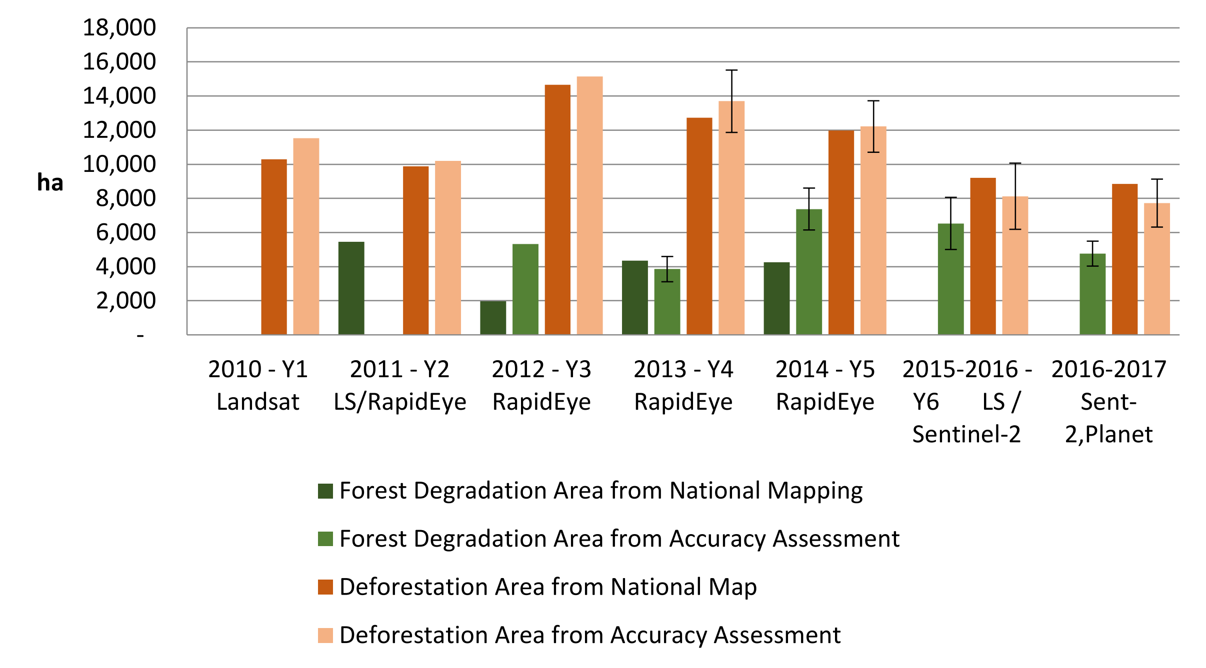
Acquisition Month	Number of Tiles
August	36
September	43
October	23
November	17
December	8
Total	127

Moving forward, data from the Sentinel (2A/2B) Multi-Spectral Imager (MSI) will be the primary dataset for monitoring deforestation, supplemented by Landsat and fire monitoring datasets. Over the 2017 census period, 127 tiles were acquired spanning from August to December.

Degradation is not mapped directly but estimated from a sample of high resolution aerial imagery (GeoVantage, 4 band multispectral) and PlanetScope multispectral satellite images.

Overall, the transition to the Sentinel MSI sensor with 10 m pixel size in the visible and near infrared has not had a detrimental impact on the accuracy of the forest monitoring, as shown the deforestation and degradation estimates are compared against the accuracy assessment results in Figure 4-2.

Figure 3-1: Comparison of Deforestation and Accuracy Assessment Estimates



3.3 Accuracy Assessment Datasets

The purpose of the Accuracy Assessment (AA) is to provide an assessment of the quality of the GFC's mapping of land cover land use change across Guyana. It is established practice that data used for accuracy assessment be either an independent interpretation of the same datasets used for the change mapping or, if available, higher spatial resolution (therefore higher precision) data (Herold *et al*., 2006; Powell *et al*., 2004; Khorram, 1999). The results of the independent accuracy assessment are summarised in this report.

From 2013 to 2015 and from 2017 to 2018, high-resolution imagery has been captured using a Cessna mounted aerial multispectral imaging system. The camera system (Aeroptic, aka GeoVantage) is a flexible unit that can be installed quickly and easily on to various models of light aircraft. The resolution of the images captured over pre-defined samples ranges from about 25 to 60 cm (varied by the altitude of the aircraft at the time of capture), a resolution capable of identifying forest degradation with some certainty.

The strategy employed uses the imaging system to capture high-quality image data at sites pre-determined by a two-stage stratified-random sample design that provides good coverage of the strata with high and medium risk of change. Full sample coverage is achieved by including satellite images over areas the stratum with low risk of forest change and over any area where it is not possible to safely operate a small aircraft.

For year 2016, no aerial capture was undertaken due to the expiry of financing under Phase 1. Consequently, for this period alternative options were evaluated, and PlanetScope images as provided by Planet Labs were used. The Planet constellation comprises approximately 200 micro-satellites imaging areas at (approximately) 3-5m resolution. The satellites follow Sun Synchronous Orbit (SSO), which is common to many Earth-observing satellites which have a set equator crossing time and acquire images only on descending orbit. The Planet satellites in SSO cross equator at 9:30-11:30 acquiring images of an area almost same time in every revisit.

In keeping with previous years, the same sample locations were analysed. The locations of these samples were provided to Indufor by the independent accuracy assessment team from Durham University, UK. Multiple Planet images were acquired (August to December; 2016 and 2017) over the sample site locations and these were provided to the GFC Mapping Team and to Durham University for analysis.

In Year 7 (2017), the Accuracy Assessment involved the collection of 322 sample units randomly selected from three forest strata organised by risk of deforestation. The High Risk and Medium Risk strata was assessed predominantly by using Planet (2016) and GeoVantage/Planet (2017) imagery. The Low Risk stratum was assessed using repeat coverage Sentinel/Landsat imagery.

The GFC and partners have ongoing research project that is evaluating Planet labs along with data collected from overflights. The aim of this study is to match field observations against the data from satellite imagery. This work will be completed in 2019. The intention is to add to our knowledge of the best application of the Planet Labs and to assess to what degree it can replace the overflights for the purpose of the accuracy assessment.

4. NATIONAL MAPPING OF DEFORESTATION & DEGRADATION

Guyana's GIS-based monitoring system is designed to map change events in the year of their occurrence and then monitor any changes that occur over that area each year. Where an area (polygon) remains constant, the land use class and change driver are updated to remain consistent with the previous analysis. Where there is a change in the land cover of an area, this is recorded using the appropriate driver. Deforestation is mapped manually using a combination of repeat coverage Landsat and Sentinel 2 images. National estimates of degradation are estimated by repeat interpretation of series of linear randomly located samples.

The following drivers of land use change are relevant. Drivers can lead to either deforestation or forest degradation.

4.1 Deforestation

Formally, the definition of deforestation is summarised as the long-term or permanent conversion of land from forest use to other non-forest uses (GOFC-GOLD, 2010). An important consideration is that a forested area is only deemed deforested once the cover falls and remains below the elected crown cover threshold (30% for Guyana). In Guyana's context forest areas under sustainable forest management (SFM) that adhere to the forest code of practice are not considered deforested if they regain the elected crown cover threshold.

The anthropogenic change drivers that lead to deforestation include:

1. Forestry (clearance activities such as roads and log landings)
2. Mining (ground excavation associated with small, medium and large-scale mining)
3. Infrastructure such as roads (included are forestry and mining roads)
4. Agricultural conversion
5. Fire (all considered anthropogenic and depending on intensity and frequency can lead to deforestation).
6. Settlements, change such as new housing developments.

4.2 Degradation

There is still some debate internationally over the definition of forest degradation. A commonly adopted definition outlined in IPCC (2003) report is:

"*A direct human-induced long-term loss (persisting for X years or more) of at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation or an elected activity under Article 3.4 of the Kyoto Protocol* ".

The main sources of degradation are identified as:

- Harvesting of timber (reported since 2011 using the Gain Loss Method)
- Shifting cultivation
- Fire
- Associated with mining sites and road infrastructure.

Image evidence and fieldwork has shown that each of these drivers produce a significantly different type of forest degradation. Shifting agriculture and forest harvest operations are temporally persistent. Forest degradation surrounding new infrastructure is different in nature. Image evidence suggests that this type of degradation is dependent on the associated deforestation site, and often is not persistent in nature. Often the sites are either in transition to deforestation or are only temporarily degraded.

Potential to Regain Crown Cover

The GFC reviewed the deforested areas i.e. areas > 1ha in 2013. Mining consistently remains the largest contributor in area terms (~85%), so has been the main focus. The study findings are documented in the 2013 MRV report. The main findings of this work indicate that:

- Abandoned mining sites can be detected and monitored using high resolution imagery. A methodology has been adapted to allow temporal monitoring of these areas in the MRVS.
- The field inspections indicate that the rate of regeneration is very slow. In all historical mining sites visited (period 1990 to 2012) the forest cover had not regenerated to a state where the biomass is measurable.

This indicates that the change in environmental conditions caused by mining inhibits the ability of these sites to regenerate. Hence the biomass accumulation is very low, due to mining impacts on the soil structure. The recommendation was that these sites be revisited after 10 years to determine how the sites are recovering in terms of vegetation types and carbon accumulation rates. The MRVS tracks all deforested sites so if abandoned these areas can readily identified and revisited.

For other land use drivers like abandoned agricultural or burnt areas over time may also afforest, but the combined area is quite small.

4.3 Land Cover Change Analysis

To facilitate the analysis, Guyana has been divided into a series of regularly spaced grids. The mapping process involves a systematic review of each 24 x 24 km tile, divided into 1 km x 1 km tiles at a resolution of 1:8000.

If cloud is present, then multiple images over that location are reviewed. The process involves a systematic tile-based manual change detection analysis in the GIS.

Each change is attributed with the acquisition date of the pre-and post-change image, driver of change event, and resultant land use class. A set of mapping rules has been established that dictate how each event is classified and recorded in the GIS.

The input process is standardised using a customised GIS tool which provides a series of pre-set selections that are saved as feature classes. The mapping process is divided into mapping and QC. The QC team operates independently to the mapping team and is responsible for reviewing each tile as it is completed.

The following Table 3-3 provides an overview of drivers and associated deforestation or degradation activities that are reported spatially in the GIS as part of the MRVS. Appropriate methods have been established for all activities. Reforestation/Afforestation is the only activity not yet reported in the MRVS. The identification of the driver of specific land-use change depends on the characteristics of the change. Certainty is improved by considering the shape, location and context of the change in combination with its spectral properties.

Table 3-3: Summary of Activities & Drivers Captured in the GIS

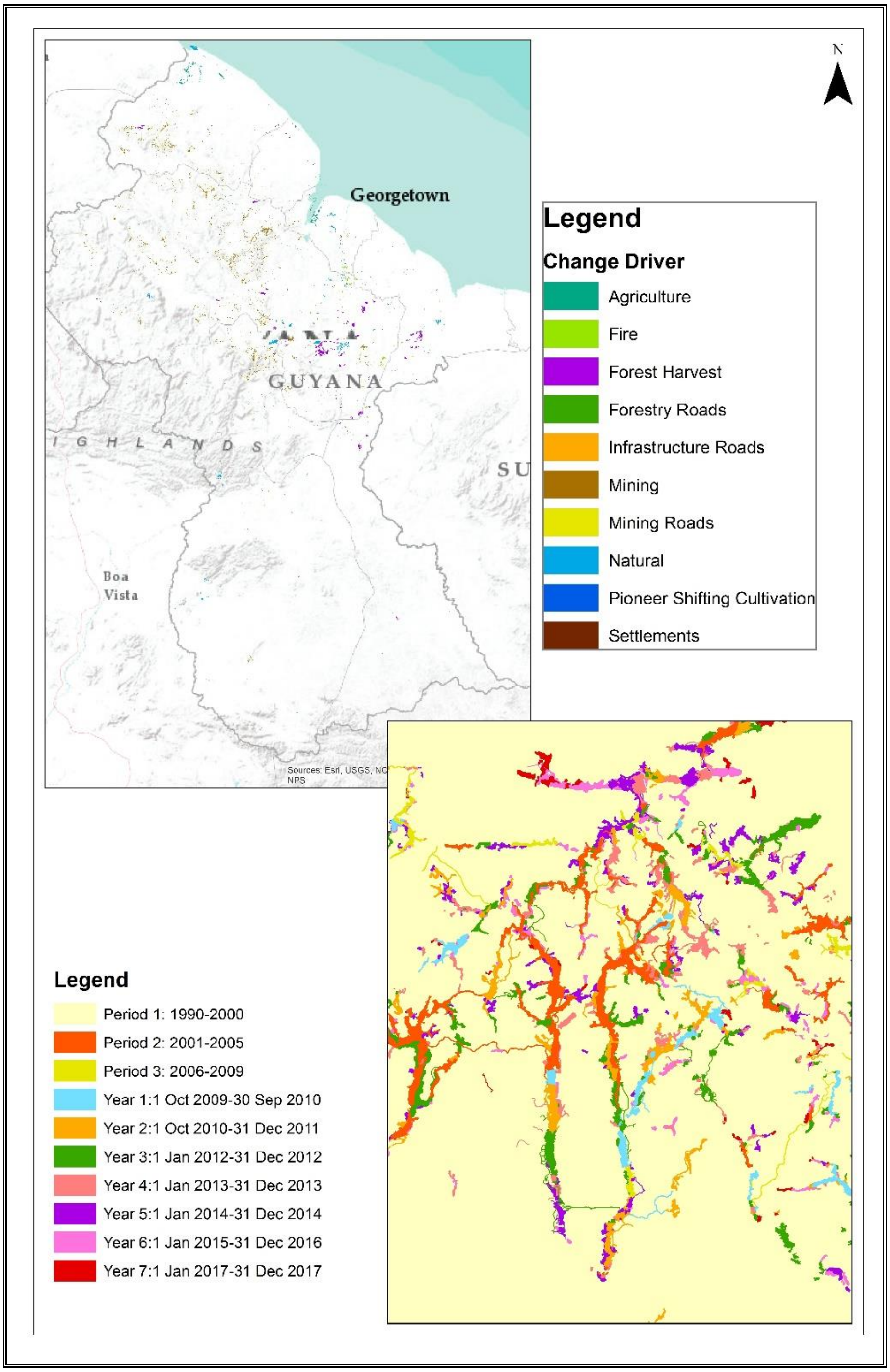
Activity	Driver	Criteria	Ancillary Info Available	Spatially Mapped	End Land Use Class
Forestry	SFM	Fall inside state forest area and is a registered concession	Annual harvest plans, GIS extent of concession, previously mapped layers, Satellite imagery	No. Volumetric measure used	Degraded forest by type
	Infrastructure	Roads > 10m		Yes	Settlements
Settlements	Settlements	Areas of new human settlement	Population data, image evidence.	Yes	Settlements
Mining	Infrastructure	Roads >10 m	Existing road network, Satellite imagery	Yes	Settlements
	Deforestation	Deforestation sites > 1 ha	Dredge sites, GIS extent of mining concessions, previously mapped layers, Satellite imagery	Yes	Bareland
	Degradation	Assess any area >0.5 ha within 100 m buffer around deforestation event &– road or new infrastructure -revisit sites post 2011to assess change	Existing infrastructure incl. deforestation sites post 2011, Satellite imagery	Area estimated using a sample-based method	Degraded forest by type
Agriculture	Deforestation	Deforestation sites > 1 ha	Registered agricultural leases, Satellite imagery	Yes	Bareland or crop land
Fire	Deforestation	Deforestation sites > 1 ha	FIRMs fire points, spatial trends from preceding periods, Satellite imagery	Yes	Bareland or crop land
	Degradation	Degraded forest sites		Area estimated using a sample-based method	Degraded forest by type
Infrastructure	Deforestation	Roads >10 m	Existing road network Satellite imagery	Yes	Settlements
	Degradation	Assess any area >0.5 ha within 100 m buffer around deforestation event – road or new infrastructure - revisit sites post 2011 to assess change	Existing deforestation sites, Satellite imagery	Area estimated using a sample-based method	Degraded forest by type
Shifting Agriculture	Degradation	Assess historical patterns	Proximity to rural populations, water sources and Satellite imagery	Area estimated using a sample-based method	Degraded forest by type
Reforestation/ Afforestation	Reforestation	Monitor abandoned deforestation sites	Historical land use change, Satellite images	Pending	Reforestation Forest or land cover by type
	Afforestation	Monitor historical non-forest areas	Satellite imagery	Pending	Afforestation by land cover class.

Previous assessments and specific projects show that the spatial distribution of change in Guyana follows a pattern and is clustered around existing access routes (GFC Year 1 & 2; 2010, 11; Watt & von Veh, 2009 & von Veh & Watt 2010).

Potentially there is some overlap between drivers as the exact cause of the forest change can be difficult to determine. This is particularly relevant when deciding on the driver of road construction when mining and forestry areas use the same access routes.

Supplementary GIS layers are also included in the decision-making process to reduce this uncertainty. The decision-based rules are outlined in the mapping guidance documentation, or Standard Operating Procedures (SOPs). This documentation, held at GFC, provides a comprehensive overview of the mapping process and rules. The following example provides an overview of the detail captured in the GIS. Evident are temporal changes in forest cover due to a range of forest change drivers.

Figure 3-2: Example of Forest Change Mapping



4.4 Land Use Changes Not (Spatially) Recorded in the MRVS

There are several land cover changes that are not reported spatially in the MRVS at this stage. For completeness the general extent of these areas is mapped to ensure that they are not accounted for as measured land use change – these are listed as follow:

Forest Harvest

Forest harvest activities are accounted for using extraction records. Large concessionaires are required to submit annual plans to GFC that show intended harvesting activities. All blocks require approval before harvesting may commence. This information is recorded in the GIS by GFC and as practical are tracked using satellite imagery.

On the satellite imagery forestry activities within the State Forest Area are often first identified by the appearance of roading and the degradation caused by surrounding selective harvest areas.

These areas are delineated as a single polygon around the spatial extent of the impacted area (degradation because of forest harvest). Following this, a land use class of degraded forest by the forest type is assigned.

Natural Events

Natural events are considered non-anthropogenic change, so do not contribute to deforestation or degradation figures. These changes are typically non-uniform in shape and have no evidence of anthropogenic activity nearby. While these are not recorded in the MRVS, they are mapped in the GIS. These areas are attributed with a land class of degraded forest by forest type or bareland as appropriate.

5. FOREST CHANGE

The results presented summarise the Year 7 period (1 January 2017 to 31 December 2017) forest change.

In terms of background the change for each period has been calculated by progressively subtracting the deforestation for each period from the forest cover as at 1990.

The forest cover estimated as at 1990 (18.47 million ha) was determined using manual interpretation of historical aerial photography and satellite images. This area was determined during the first national assessment (GFC 2010) and verified independently by the University of Durham (UoD, 2010 and 2011).

Overtime, the forest area has been updated after review of higher resolution satellite images. The outcome has been that the forest/non-forest boundaries are improved, but also the forest area changed, in particular at two points in time 2012 and 2014.

Table 5-1 summarises for the entire country the total change and change expressed as a percentage of forest remaining. The forest area at the start of Year 7 is 18 44 million ha.

Table 5-1: National Area Deforested 1990 to 2017

Reporting Period	Year	Years	Satellite Image Resolution	Forest Area	Annualised Change	
				('000 ha)		(%)
Initial forest area 1990	1990		30 m	18 473.39		
Benchmark (Sept 2009)	2009	19.75	30 m	18 398.48	74.92	0.021
Year 1 (Sept 2010)	2010	1	30 m	18 388.19	10.28	0.056
Year 2	2011	1.25	30 m & 5 m	18 378.30	9.88	0.054
Year 3	2012	1	5 m	*18 487.88	14.65	0.079
Year 4	2013	1	5 m	18 475.14	12.73	0.068
Year 5	2014	1	5 m	*18 470.57	11.98	0.065
Year 6	2015-16	2	10 m & 30 m	18 452.16	9.20	0.050
Year 7	2017	1	10 m & 30 m	18 442.96	8.85	0.048

*Continual forest area updates based on remapping, or introduction of higher resolution 5 m resolution imagery

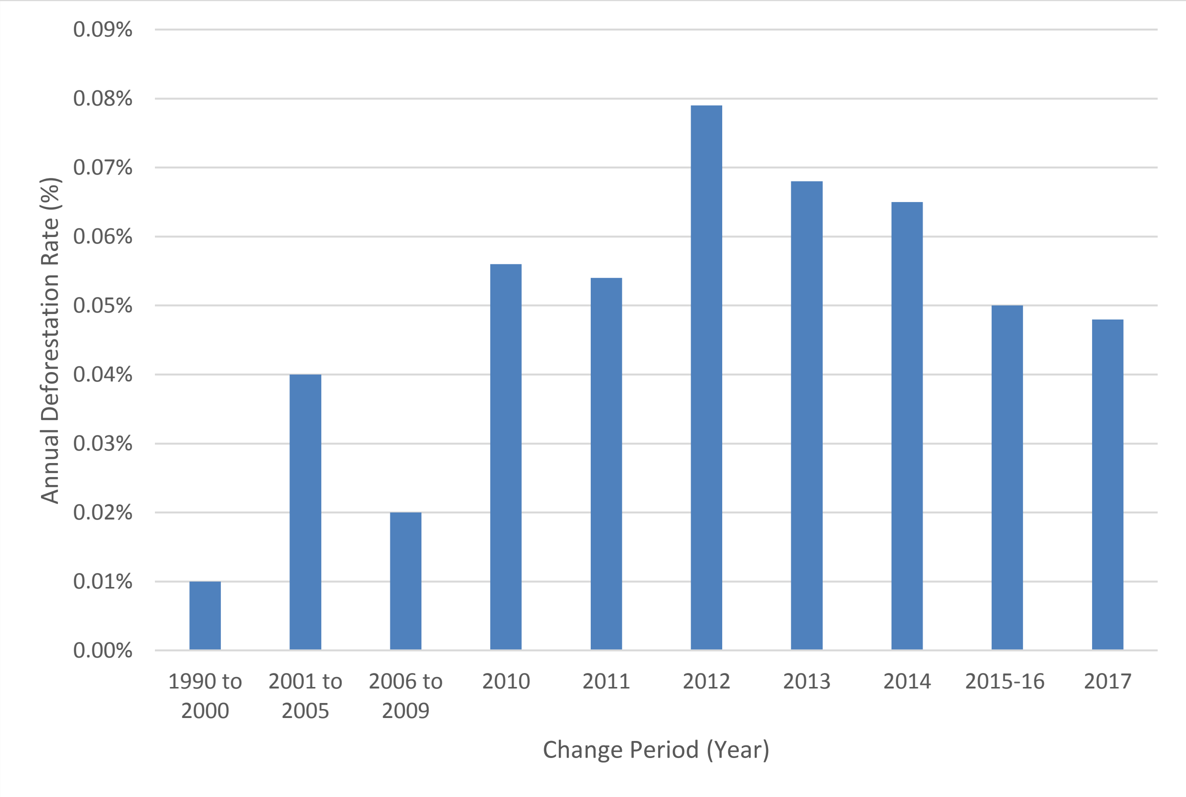
Overall, Guyana's deforestation rate is low when compared to the rest of South America. FAO's 2015 forest resource assessment (FRA) indicated that annual forest loss for the continent is around -0.43%/yr[8].

The following figure shows the annualised deforestation trends for all change periods.

The trend shows that deforestation rates have increased since 1990 and peaked in 2012 (0.079%). Since 2012 (Year 3), there has been a steady decline in annual deforestation rates; with an annualised rate of 0.048% for Year 7, this assessment period.

[8] Change rate based on 14 countries and territories – Guyana values not included in the report. Source http://www.fao.org/3/a-i4793e.pdf

Figure 5-1: Annual Rate of Deforestation by Period from 1990 to 2017



5.1 Forest Change by Driver - Deforestation

The forest change was divided and assessed by driver. For this assessment degradation estimates use a sample-based approach.

Table 5-2 provides a breakdown by forest change drivers

The temporal analysis provides a useful insight into deforestation trends relative to 1990. A more meaningful comparison is provided if the rates of change are divided by driver and annualised. In general, the following trends by driver are observed:

- In this reporting period, mining remains the largest contributor to deforestation, at 7 442 ha. The area of deforestation also includes roads used to access mining sites and areas of degradation that have been converted to deforestation. This includes roads that lead direct to mining sites.
- Forestry related change has remained relatively stable is around 200 ha. Forest roads, as in the case of earlier assessments, are attributed to a forestry driver rather than attributing this change to Infrastructure.
- Agricultural developments causing deforestation peaked at Year 5, with an increase to 817 ha. Over past two reporting periods it has been less than 500 ha rates akin to Years 3 and 4.
- Deforestation from fire has declined to around 500 ha. This compares to the previous high of 1 509 ha in 2016 which was due to several large fire events.

Table 5-2: Annualised Rate of Forest Change by Period & Driver from 1990 to 2017

Reference Period	Change Period	Change Period	Annualised Rate of Change by Driver						Annual Rate of Change (ha)
			Forestry	Agriculture	Mining	Infrastructure	Fire	Settlements	
		(Years)	Annual Area (ha)						
Historic	1990-2000	10	609	203	1 084	59	171	-	2 127
	2001-2005	5	1 684	570	4 288	261	47	-	6 850
	2006-2009	4.8	1 007	378	2 658	41	-	-	4 084
	2009-10	1	294	513	9 384	64	32	-	10 287
MRV Phase I	2010-11	1.25	186	41	7 340	298	46	-	7 912
	2012	1	240	440	13 664	127	184	-	14 655
	2013	1	330	424	11 518	342	96	23	12 733
	2014	1	204	817	10 191	141	259	71	11 975
MRV Phase II	2015-16	2	313	379	6 782	217	1 509	8	9 208
	2017	**1**	**227**	**477**	**7 442**	**195**	**502**	**7**	**8 851**

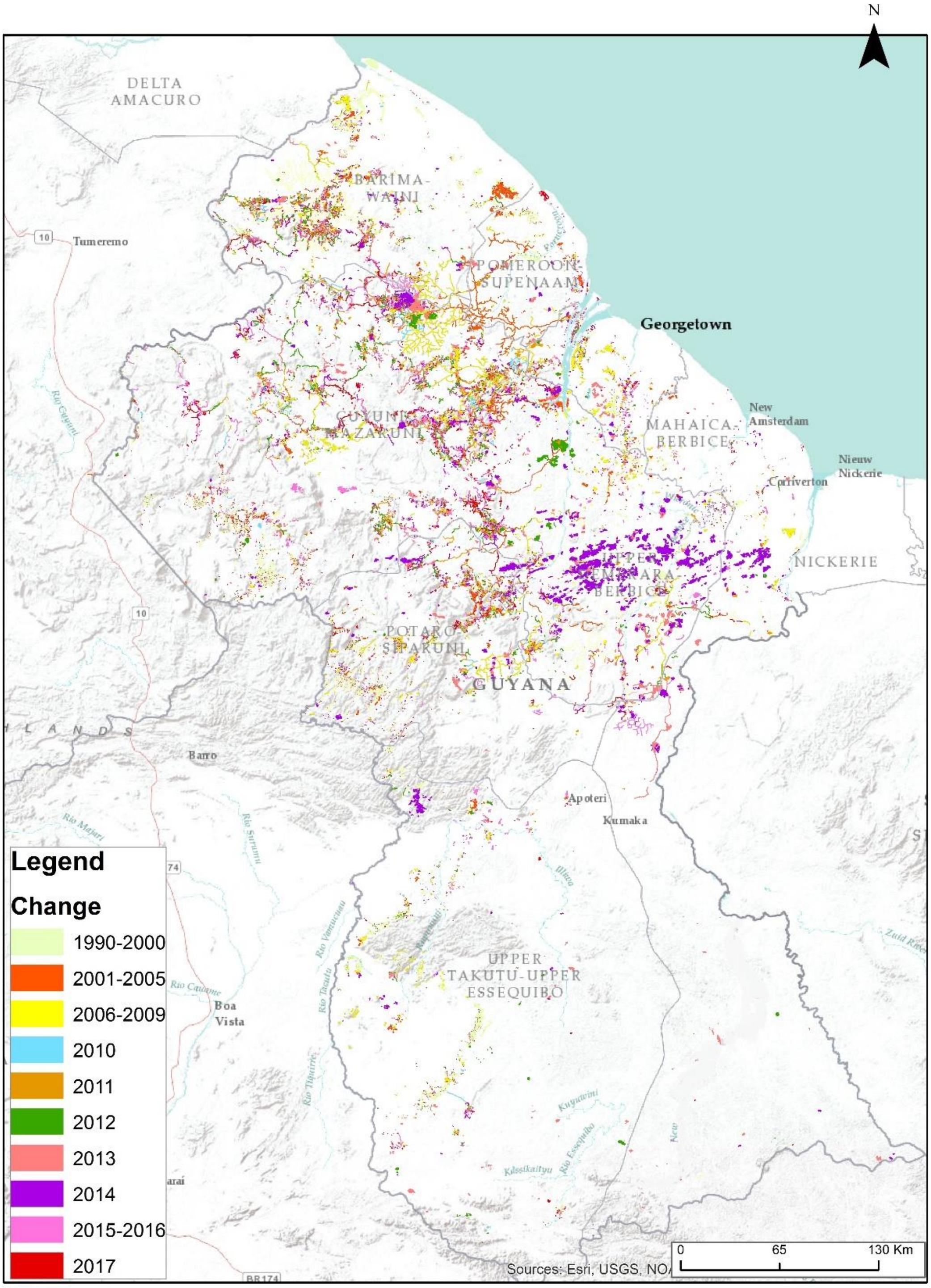
5.2 Deforestation Patterns

The temporal analysis of deforestation by reporting periods is presented in Figure 5-2. The map, which presents change from all drivers, shows that most of the change is clustered[9] and that new areas tend to be developed near existing activities. Most MRV phase II deforestation activities fall close to or inside the footprint of historical change areas in the north and west of the country.

In Year 7, the most outstanding trend in the deforestation results has been the decline in deforestation level from the driver of mining. The main reasons for the continuing decline in this driver, which has progressively decreased since 2013 (following its peak in year 2012) are: increase in monitoring activities at the level of the Mining Commission at mining operator level, a decline in the price of gold on the international market, and a consolidation in some regions of larger scale mining activities rather than only small scale operations. We have note seen any change in drivers or the general trend in the role of each driver over the total deforestation results. The underlying factor behind the declining deforestation rate is the continued prioritization of addressing the impacts of mining on forest and the consolidation of work at the various natural resources agencies to preemptively mitigate the impacts of gold mining on forests.

[9]For the purposes of display the areas of deforestation have been buffered to make them more visible.

Figure 5-2: Forest Change by Reference Period



The distribution pattern also shows that areas of increased activity tend to be clustered around the existing road infrastructure and navigable rivers as both provide accessibility. Historically very little change has been observed beyond central Guyana. This trend continues, with only small areas of change observed in this region.

5.3 Forest Change Across Land Classes

The following table provides a summary by change driver and land class for the 2017 assessment.

Table 5-3: 2017 Area Change by Driver & Land Class

Land Class	Area Change by Driver & Land Class						Total Change	Proportion of Total
	Forestry	Agriculture	Mining	Infrastructure	Fire	Settlements		
	Area (ha)							%
State Forest Area	205	61	6 388	33	245	4	6 935	78%
Titled Amerindian lands *(*including newly titled lands*)	14	23	460	72	127	2	699	8%
State Lands	7	393	572	90	124	1	1 188	13%
Protected Areas*	2	0	22	0	6	0	30	0%
Total	227	477	7 442	195	502	7	8 851	100%
Change from previous period (%)	-27%	26%	10%	-10%	-67%	-18%	-4%	

Trends by driver for the reporting year are follow and are supported by the driver map presented in Figure 5-3.

Mining

As with the previous year's most of the deforestation activity occurs in the State Forest Area (SFA). Mining activities are consolidated in the centre of Guyana. The area mined has increased by 10% from the previous assessment, but still sits well below the 2012 value which marked a point where the gold price was the highest since 1980. Post 2012 the price has declined to around USD1200/ounce. This combined with limited accessibility, and strengthened monitoring of mining areas, have gradually reduced the area mined.

Forestry

Most forestry activities are located inside the SFA. During this period, all deforestation events are associated with forestry harvest operations. The main causes of forest clearance include road and log market construction. The reported value 227 ha is a slight decrease when compared to the previous year

Under the existing interim measures, forest harvesting is reported in terms of carbon removal (tCO_2) rather than spatially. However, overall activity at the harvest block level (100 ha) across concessions is monitored.

Forest harvesting in general has declined and is linked to some forest concessions ceasing operations.

Infrastructure

Infrastructure developments (195 ha) contributes a small area with the level change relatively stable between reporting periods. The area of clearance is in a similar location. The main change is related to road construction activities and tends to be near townships. Figure 5-3 shows the distribution of infrastructure developments.

There have been a few new hinterland roads constructed to enhance access to villages.

Agricultural Development

Agricultural developments leading to 477 ha deforestation, which is slight increase (26%) on the previous period. The main areas of development are located close to Georgetown and the north-eastern regions of Guyana. Development tends to be near river networks.

There has been an overall consolidation of agriculture on existing lands and this has resulted in the decreasing level of new areas of clearance.

Biomass Burning - Fire

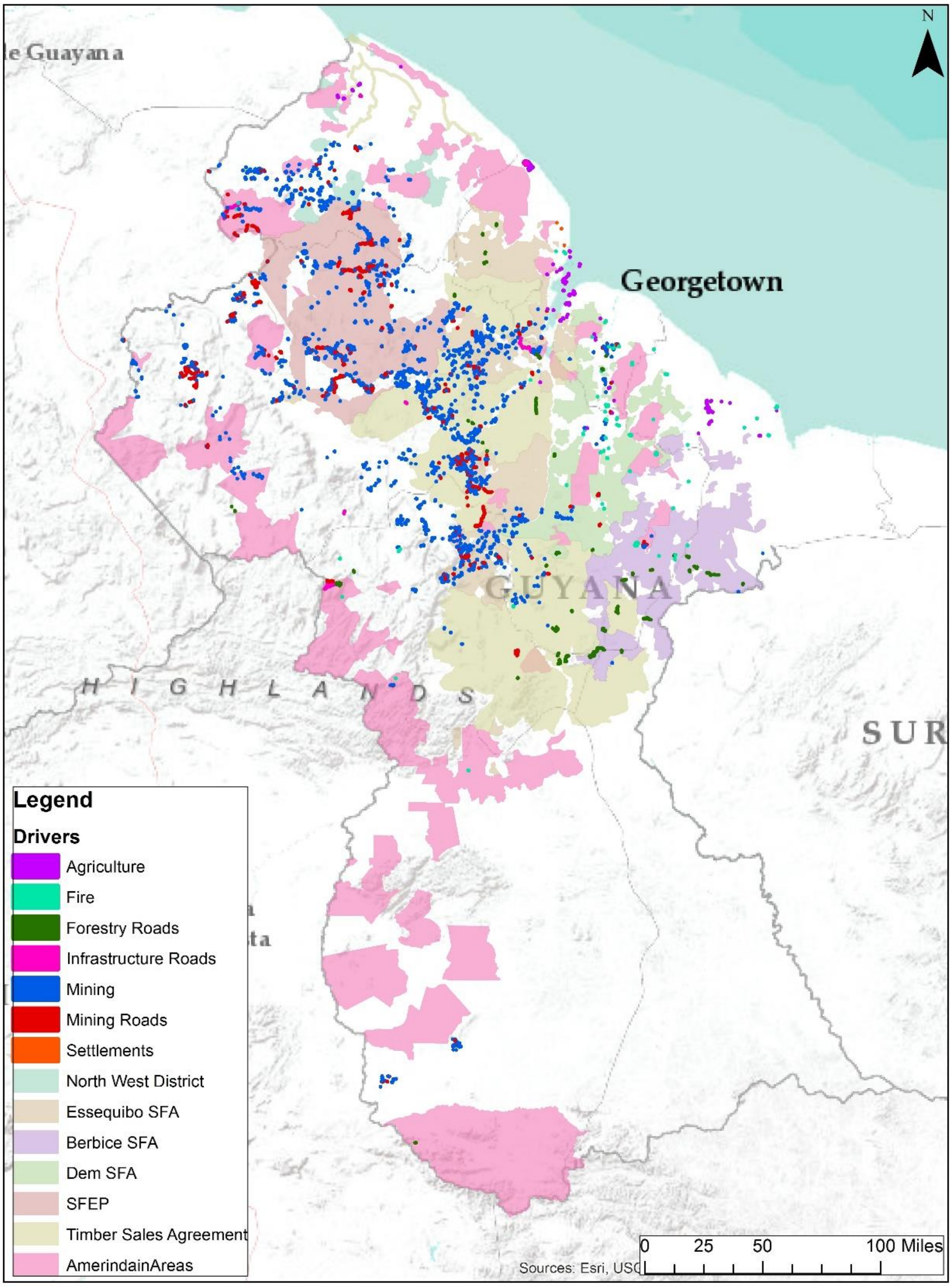
Fire events have declined relative to the spike noted in the previous year (1 509 ha) with an area of 502 ha mapped. Spatially, they follow historic trends, where events occur in the white sand forest area surrounding Linden and extends towards the eastern border of Guyana.

It is possible that burning events may be a precursor to agricultural development or related to other clearance activities. Fire has also been observed in the non-forest savannah areas to the south of the country. Figure 5-3 shows the distribution of fires resulting in deforestation.

The large fire events are tied to a prolonged dry spell and are most commonly observed on the drier sand and grassland areas.

The following map shows the temporal and spatial distribution of deforestation by driver (mining, forestry and agricultural and biomass burning) for 2017 reporting period. Mining dominates the map as it is the largest single driver of change

Figure 5-3Spatial Distribution of Forest Change Drivers (2017)



5.4 Forest Degradation

The methodology for reporting degradation has evolved since the inception of the MRVS. Improvement in the process have been introduced in a stepwise manner and sought to recognising advances imaging technologies (spatial and temporal) and estimation processes.

Three refinements have occurred:

1. The default approach outlined in the Norway/Guyana JCN stipulated that a 500 m buffer be drawn around deforested areas which returned a degradation estimate of 92 413 ha in year 1.
2. This was replaced using an approach based on interpretation of high resolution 5 m spatial resolution imagery, with the estimate reducing to 5 467 ha in year 2. The same approach was retained for years 3-5 where the monitoring focussed on the area surrounding deforested sites.

In tandem, from Year 3 onwards a process for independent verification was included. This involved checking the accuracy of the forest degradation mapping by the GFC teams by randomly sampling areas of change. This process provided a statistical estimate of both gross deforestation and forest degradation.

3. In year 6 (covering the 24 months of 2015 and 2016) and year 7 (2017) the existing "wall to wall" degradation method outlined in step 2 was replaced with the sample-based statistical estimation approach.

In summary, the method for measuring degradation has been adapted. In previous years the GFC team had manually mapped degradation surrounding areas of confirmed deforestation. To determine the accuracy of this mapping a sampling design was overlaid and for each sample, high resolution imagery used to re-map change. The remapping and allocation of change drivers was conducted by an independent team. From this sample it was possible to determine the accuracy of the GFC mapping and report expected upper and lower area bounds (i.e. at 95% CI the estimate is +/- X ha).

The approach described above has been improved each year, so the changes introduced reflect several advancements in methodologies, data availability and wider consideration of the importance of degradation as a source of carbon emissions.

Changes have included; refinement of the change strata so to optimize the number of refence samples, evaluating PlanetScope relative to airborne capture from the GeoVantage camera system, moving away from producing a map of degradation, as under the slated Interim Measure as it only focused on mapping degradation around newly deforested areas.

The refinements methods are incremental with an aim to optimize the process by considering;

- the data costs i.e. PlanetScope vs. GeoVantage ,
- time taken by GFC to produce a degradation map as opposed to the sampling approach
- the end use of the information given that deforestation is the main contributor to carbon emissions – this is still mapped using the wall to wall method.

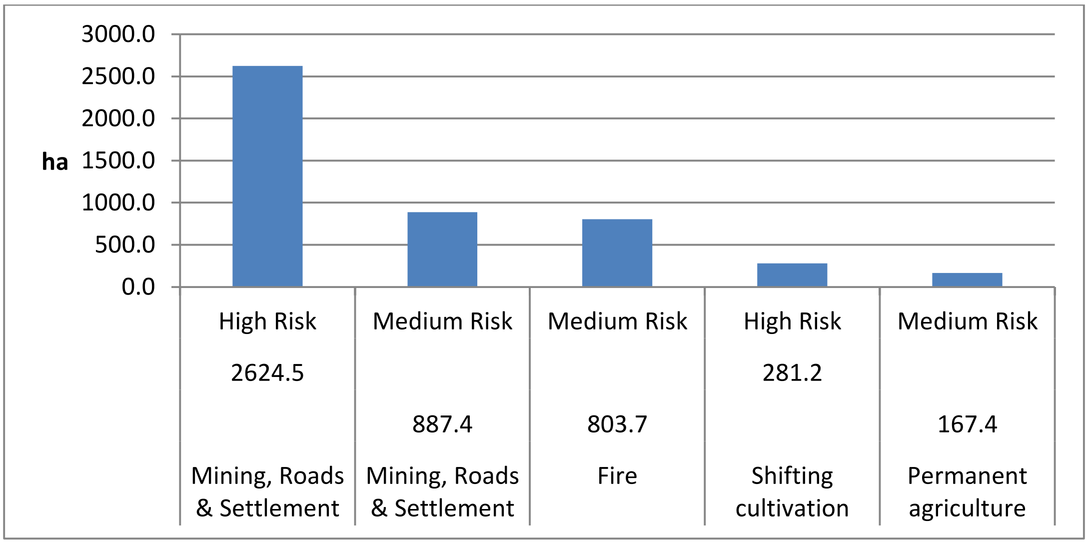
The refinements are supported by the development of Standard Operating Procedures that allow GFC team to undertake the sample assessment, run the analysis and calculate degradation estimates. The accuracy assessment team from Durham independently are retained in the process to assess the degradation mapping, and estimates provided by the GFC team.

The estimated total area of change over the 12-month Year 7 period from forest to degraded forest (between Y6 and Y7) is 4 764.3 ha SE 730.4 ha (2.5% 3,332.5 ha 97.5% 6,196.3 ha). Of the total degraded area, some 3 512 ha (or 74%) is associated with changes relating to new infrastructure (This is the value reported for Interim measure 2). The largest contributor is mining, followed by settlements and mining roads. Emissions resulting from anthropogenic forest fires account for 804 ha (16%) whilst shifting cultivation contributes 281 ha (6%) of the total estimated degradation.

Mining and associated roads are the dominant drivers for forest degradation accounting for around 81% of the total change for Year 7. Settlements account for 6% and permanent agriculture for (2%) and shifting agriculture for (11%). Shifting cultivation is often observed in the areas surrounding Amerindian communities and within Titled Lands.

The High Risk stratum dominates the change areas and contributes around 61% of the total degradation area for Year 7. The Medium Risk stratum contributes 39% of the estimated area of forest degradation (1 859ha). The areas impacted by fire and conversion to permanent agriculture are located in the Medium Risk stratum, see Figure 6-4.

Figure 5-4 Forest Degradation by Risk Stratum and Change Drivers (2017)



6. INTERIM MEASURES

On 9 November 2009 Guyana and Norway agreed on a framework that establishes the pathway of REDD+ implementation. Under this framework several forest-based interim measures have been established.

In 2015, a revised Joint Concept Note (JCN) under the Guyana/Norway Agreement was issued, and replaced the JCN of 2012. The revised JCN updated the progress in key areas of work including on the MRVS. REDD+ Interim Indicators and reporting requirements, as had been outlined in the 2009 JCN, were maintained.

The basis for comparison of a majority of the interim measures is the 30 September 2009 benchmark map[10]. The first reporting period (Year 1) is set from 1 Oct 2009 to 30 Sept 2010. The means of monitoring and estimation during the interim period are identified as medium resolution satellite images. This includes: a time series of Landsat TM and ETM+, a composite of daily acquired MODIS (250 m resolution) taken as close as possible to the end of the benchmark reporting period September 2009.

For Year 2, RapidEye was tasked over the most actively changing areas (12 million ha). As with preceding periods Landsat, MODIS and ASAR radar data were also used to ensure a full national coverage.

From year 3 to year 5 a national coverage of RapidEye was commissioned. Images were acquired from August to December of each year. For Years 6 and 7, national coverage from Sentinel 2 satellite was used for deforestation mapping.

A summary of the key reporting measures and brief description for these interim measures are outlined in Table 5-4. The calculations to determine the rate of deforestation (ref. measure 1) are reported in Section 5.

Outputs and results are provided for the Intact Forest Landscape (ref. measure 2) and forest management indicators (ref. measure 3 and 4) are outlined in this section.

For forest degradation, a sample-based approach was used to estimate this value. For Year 7, this was calculated from the interpretation of high spatial resolution Aeroptic (previously known as GeoVantage) airborne and PlanetScope satellite imagery.

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[10]Originally the benchmark map was set at February 2009, but due to the lack of cloud-free data the period was extended to Sept 2010.

Table 5-4: Reported Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 6	Year 7	Difference between Year 7 & Reference Measure
					2015-2016	**2017**	**Difference**
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change (%)/yr*	0.275%	0.050%	0.048%	0.21%
2	Degradation Indicators	National area of Intact Forest Landscape (IFL). Change in IFL post Year 1, following consideration of exclusion areas.	*ha*	7 604 820	7 604 024 (290 ha loss)	7 603 796 (228 ha loss)	1 024
2b		Determine the extent of degradation associated with new infrastructure such as mining, roads, settlements post the benchmark period[7].	*ha*	4 368	5 679[11]	3 512	856
3	Forest Management	Timber volumes post 2008 as verified by independent forest monitoring (IFM). These are compared to the mean volume from 2003-2008	*t CO_2*	3 386 778[12]	1,892,371	1,740,242	1,646,536 *t CO_2*
4	Emissions resulting from illegal logging activities	In the absence of hard data on volumes of illegally harvested wood, a default factor of 15% (as compared to the legally harvested volume)	*t CO_2*	411 856	9,140	13,169	398,687 *t CO_2*
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	*ha/yr*	1 706[13]	762	804	902
6	Emissions resulting from subsistence forestry, land use and shifting cultivation lands	Emissions resulting from communities to meet their local needs may increase as a result of inter alia a shorter fallow cycle or area expansion. (i.e.. slash and burn agriculture)[14].	*ha/yr*	Not yet established	93	281	N/A

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[11] Includes 802 ha of degradation from natural causes over the 2-year period.

[12] Assessment completed based in Winrock International Report to the Guyana Forestry Commission, December 2011: ***Collateral Damage and Wood Products from Logging Practices in Guyana.*** This methodology only applies to emissions and not any removals due to re-growth of the logged forest. [2]. The same is the case for the Reference level for illegal logging for Years 2, 3 and 4.

[13] Degradation from forest fires is taken from an average over the past 20 years. This value is inclusive of all degradation drivers except for rotational shifting agriculture. From 2015 the area has been estimated from the sample-based analysis.

[14] Area estimates that capture shifting cultivation activities are calculated using the sample-based approach.

6.1 Interim Reporting Indicators

The following provides a description, justification and performance measurement for each of the seven indicators. Historically only the first five of the seven measures are reported, with IM6 being added and reported in Year 4.

6.2 Gross Deforestation – Measure 1

Emissions from the loss of forests are identified as among the largest per unit emissions from terrestrial carbon loss in tropical forests. Above ground biomass and below ground biomass combined represent approximately 82% in Above Ground Biomass and Below Ground Biomass including dead wood, litter, and soil to 30 cm which account for the remaining percent[15]. Several key performance indicators and definitions have been developed as follows.

Interim Performance Indicators

- Comparison of the conversion rate of forest area as compared to agreed reference level as set out in the JCN.
- Forest area as defined by Guyana in accordance with Marrakesh Accords.
- Conversion of natural forest to tree plantations shall count as deforestation with full loss of carbon.
- Forest area converted to new infrastructure, including logging roads, shall count as deforestation with full carbon loss.

Gross Deforestation Monitoring Requirements

Using the benchmark forest cover map as a base (30 September 2009) the intention is to identify activity data related to:

- Expansion of human infrastructure (e.g. new roads, settlements and mining and agricultural expansion.

Monitoring Approach

The accepted approach as outlined in the JCN, uses medium resolution satellite images to identify new areas of development at a one-hectare scale.

6.3 Degradation Indicators - Measure 2

The interim measure provided to monitor degradation is based on the definition of Intact Forest Landscapes (IFL).

"*IFL is defined as a territory within today's global extent of forest cover which contains forest and non-forest ecosystems minimally influenced by human economic activity, with an area of at least 500 km^2 (50 000 ha) and a minimal width of 10 km (measured as the diameter of a circle that is entirely inscribed within the boundaries of the territory)*".

[15]Results derived from field study conducted in Guyana as part of the Forest Carbon Monitoring System.

The reason for this indicator stems from the concept that degradation of intact forest through human activities will produce a net loss of carbon and is often the precursor to further processes causing long-term decreases in carbon stocks.

Furthermore, preserving intact forests will contribute to the protection of biodiversity. The extent of Intact Forest was determined at the end of September 2010. It is a requirement that the total area of intact forest must remain constant from this date. In determining the IFL, only those areas that meet the forest definition are included.

Within the areas that qualify as IFL, the following rules (first 4 bullets are elimination criteria) are defined:

- Settlements (including a buffer zone of 1 km).
- Infrastructure used for transportation between settlements or for industrial development of natural resources, including roads (except unpaved trails), railways, navigable waterways (including seashore), pipelines, and power transmission lines (including in all cases a buffer zone of 1 km on either side).
- Agriculture and timber production used for local use.
- Industrial activities during the last 30-70 years, such as logging, mining, oil and gas exploration and extraction, peat extraction, etc.

Areas with evidence of low-intensity and old disturbances are treated as subject to "background" influence and are eligible for inclusion in an IFL. Sources of background influence include local shifting cultivation activities, diffuse grazing by domestic animals, low-intensity village-based selective logging, and hunting.

6.4 IFL Data Sources & Methods

The following provides a description of process and datasets used to generate the IFL. The datasets used were available as at 2010. Since the generation of the reference IFL layer GFC has continued to improve the quality of the base datasets and moved to high-resolution countrywide coverage. This has enabled continuous monitoring of forest change (deforestation and degradation) at a national level. It is proposed that the IFL be replaced in the near term to reflect these improvements.

The areas excluded from IFL are:

Settlements

The population of Guyana is approximately 782 000, of which 90% reside on the narrow coastal strip (approximately 10% of the total land area of Guyana). Guyana's coastal strip ranges from 10 to 40 miles (16 to 64 km) in width.

Settlement extents were provided by GL&SC for six municipalities. In addition, the Bureau of Statistics provided 2002 census data for settlements with population >1000 people. The approximate extent of these settlements was determined from satellite imagery. The national Gazetteer which provides a spatial location of settlements was used to identify the remaining settlements. Included are Amerindian titled areas that were digitised as at 2009.

Infrastructure, Mining & Navigable Rivers

Infrastructure used for transport was identified using satellite images and assisted by GPS tracks. Infrastructure associated with SFM is not subtracted from the IFL unless it connects settlements.

Only those roads that can be mapped from medium resolution satellite imagery or those leading to settlements have been included.

Historical and current mining areas and the associated infrastructure from 1990 to 30 September 2009 are subtracted from the IFL. These areas have been mapped from medium resolution satellite imagery

Navigable waterways and seashore are as defined from medium resolution images and 1995-96 radar imagery. Only those rivers identified from satellite imagery (~30 m width) have been included in the analysis. All of the rivers mapped in Year 1 are considered navigable.

Permanent Agriculture & Forest Production

Areas of permanent agriculture as identified from satellite imagery and supported by available agricultural leases are digitised from paper maps by GL&SC. Forest production areas under SFM are held by GFC and are available in a GIS format. These areas are excluded from the IFL.

Industrial-scale Exploitation of Resources

Industrial-scale exploitation of timber (clear-felling with no natural regeneration), peat extraction and oil exploration are not practiced in Guyana in the period under review.

Background Sources

Background sources such as shifting cultivation. Shifting cultivation areas have been defined from medium resolution satellite imagery.

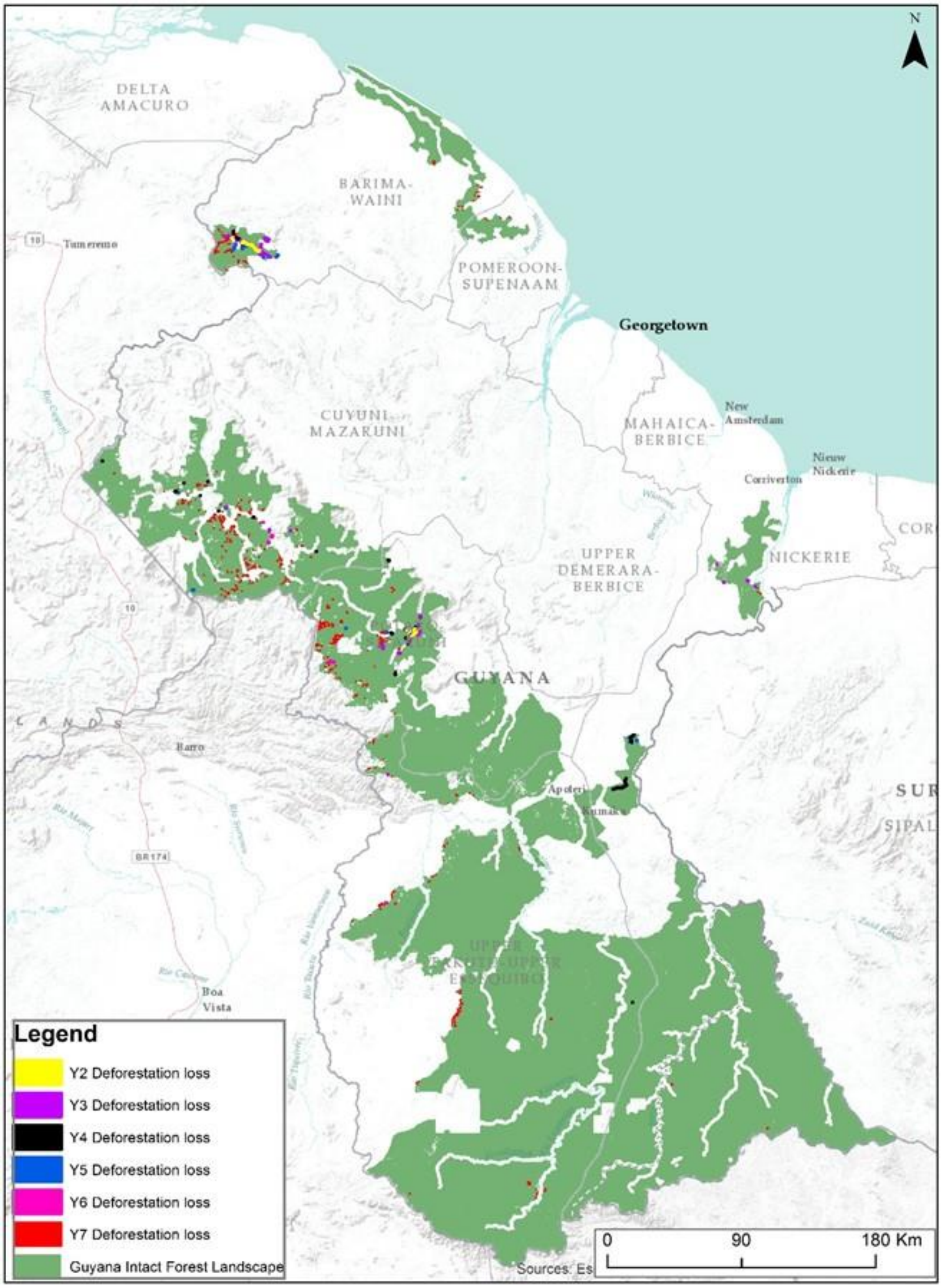
6.5 Calculation of the Year 6 Intact Forest Landscape

In accordance with the interim indicators the total area of intact forest must remain constant from the benchmark date (30 September 2009) onwards. Any change in area shall be accounted for as deforestation with full loss of carbon. The intention of the IFL is to allow a user to determine whether a specific activity falls within or outside an IFL with a margin of error of less than 1 km.

For this report the same benchmark IFL area was used. The analysis identified 227.6 ha of deforestation, 184.6 ha of which was mapped in Amerindian areas and 32.7 ha in State Lands. In the previous reporting period a similar area (290 ha) of intact forest was lost.

When the Intact Forest Landscape was established in Guyana the total area was estimated at 7.60 million ha. The map below identifies the deforestation that has occurred inside the IFL since Year 2. The change to the 2009 IFL have been increased in size to improve the visualisation

Figure 5-4: Intact Forest Landscape Maps



6.6 Carbon Loss as Indirect Effect of New Infrastructure – Measure 2b

The carbon loss associated with new infrastructure was determined by buffering the extent of areas detected in the medium resolution imagery by 500 m. This is the default option if the extent of degradation cannot be mapped. This was the case for Year 1 as there were a very limited number of high resolution scenes available over Guyana.

For the Year 2 assessment, high resolution 5 m imagery was tasked and over 12 million ha were acquired. This area covered the most actively changing areas. The approach taken for Year 2 was to visually assess the satellite imagery surrounding new infrastructure for signs of forest degradation. Analysis of the images and follow up fieldwork indicated that degradation around new infrastructure was fragmented and was directly related to the deforestation activity.

The degradation impact was localised and did not extend further than 40 m from the deforestation site. Based on these findings a conservative 100 m buffer was applied around all new Year 2 infrastructure. Any forest degradation observed inside this buffer was mapped.

In Year 3, 4 and 5 this approach was retained. Furthermore, areas of degradation identified in Year 2 and 3 were revisited and re-assessed for change.

From year 6 onwards the method for estimating forest degradation in Guyana transitioned to a statistical change assessment that uses a stratified random sampling design.

Interim Performance Indicators

- Determine the extent of degradation associated with new infrastructure such as mining, roads and settlements.
- If it cannot be determined from medium resolution imagery (either directly or using a remote sensing technique) then a buffer of 500 m is applied from the external edge of each deforestation site. A 50% loss in biomass is assumed.

The area of degradation for the Year 1 period (1 Oct 2009 to 30 Sept 2010) was estimated at 92 413 ha. This area does not accurately reflect observed forest degradation as the figure is derived from applying a 500 m buffer around all detected deforestation events greater than one hectare.

The Year 2 area is considerably lower at 5 460 ha. This can be attributed to the method applied which is based on interpretation of high-resolution satellite images rather than the calculation and application of a generic buffer to all new infrastructure.

Degradation continued to fall in Year 3 with only 1 963 ha mapped. Of interest in Year 3 is the fact that areas of previous degradation have been deforested (141 ha). Under Interim Measures 50% of the carbon loss over these areas has already been accounted. In Year 5 the area was 4 251 ha which is some 117 ha below the reference measure and 101 ha less than Year 4 reported degradation. Further work is required to better understand the temporal dynamics of degradation and the carbon emissions should the area not be deforested.

For Year 6 (6 543 ha) and Year 7 (4 764 ha) the estimates of forest degradation in Guyana are based on a statistical change assessment that uses a stratified random sampling design. Stratification is based on historic patterns of deforestation from Period 1 (1990) though to Year 4 (Dec 2013), where the primary drivers of land cover change are alluvial gold mining, logging, anthropogenic fire, agriculture and associated infrastructure including roads.

Overall there is a decrease in forest degradation that mirrors the similar decrease in deforestation. However, it should be noted that the definitions of forest degradation as outlined in the Standard Operation Procedure have changed between Y6 and Y7 and this may have an impact on the statistics.

6.7 Forest Management – Measure 3

Management

Under interim measures, forest management includes selective logging activities in natural or semi-natural forests.

The intention of this measure is to ensure sustainable management of forest with net zero emissions or positive carbon balance in the long term. The requirement is that areas under SFM be rigorously monitored and activities documented such as harvest estimates. The following information is documented by the GFC and available for review for the period 1 January 2017 to 31 December 2017, with the annualised total presented:

- Production by forest concession
- Total production.

The reporting requirements include data on extracted timber volumes post 2008 and are available for verification. These are compared against the mean volume from 2003-2008. Any increase in extracted volume above the 2003-2008 mean is accounted for as an increase in carbon emissions. This is unless otherwise documented using the Gain Loss or stock difference methods as described by the IPCC for forests remaining forests. In addition to harvested volume, a default expansion factor shall be used to account for losses due to harvesting i.e. collateral damage. This is unless it can be shown this is already accounted for in the recorded extracted volume.

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

Monitoring of Extracted Volume: Monitoring in the forest sector is coordinated and executed by the GFC and occurs at four main levels: forest concession monitoring, monitoring through the transportation network, monitoring of sawmills and lumberyards, and monitoring ports of export.

For forest harvesting and transport, monitoring is done at station level, at concession level and supplemented by random monitoring by the GFC's Internal Audit Unit and supervisory staff. At all active large concessions, resident forest officers perform the function of ensuring that all monitoring and legality procedures are strictly complied with. In instances of breach, an investigation is conducted and, based on the outcome, action is instituted according to GFC's standard procedures for illegal actions and procedural breaches.

Prior to harvesting, all forest concessions must be in possession of valid removal permit forms. Permit numbers are unique to operators and are issued along with unique log tracking tags. Production volumes are declared at designated GFC offices with checks made to verify legality of origin and completion of relevant documents, including removal permit, production register and log tracking. Removal permits require that operators declare: date of removal, type of product, species, volume, destination, vehicle type, vehicle number, name of driver/captain, tags, diameter of forest product (in case of logs) and other relevant information. This is one of the initial control mechanisms that is in place whereby monitoring is done for proper documentation and also on the declared produce, etc. Control and quality checks are also undertaken at another level once entered in the centralised database for production. Removal permits, and log tracking tags are only valid for a certain period and audit for use beyond that time is also an important part of the QA/QC checks conducted by the GFC. The unique identity of each tag and permit by operator also allows QA/QC to be conducted for individual operators' use. Thus, checks are allowed across time, by operator and by produce being declared.

In the case of large forest concessions, only approved blocks (100 ha) in Annual Plans are allowed to be harvested in a given year. Harvesting outside of those blocks, even if these areas are within the legally issued concessions, is not permitted. As such, this forms part of the QA/QC process for large concessions (Timber Sales Agreements and Wood Cutting Leases). As one prerequisite for approval of Annual Plans, forest inventory information at the pre-harvest level must be submitted, accompanied by details regarding the proposed operations for that 12-month period, such as maps, plans for road establishment, skid trail alignment etc. The QA/QC process that is executed at this initial stage requires the application of the guidelines for Annual Plans which must be complied with prior to any such approval being granted. A new addition to the monitoring mechanism has been the use of bar code scanners that allow for more real-time tracking of legality of origin of forest produce.

In the case of Amerindian lands and private property, the documentary procedures outlined above regarding the removal permitting and log tracking, are only required if the produce is being moved outside the boundaries of the area. From this point onwards, the procedures that apply to State Forest concessions, apply to this produce as well.

Data Collection: Following receipt of removal permits and production registers, monthly submissions are made to GFC's Head Office for data entry. There is a dedicated unit in the GFC's Management Information System section that is responsible for performing the function of data collection, recording, and quality control. Data is entered in SQL databases custom designed for production totals. This database has built in programmatic QA/QC controls that allow automatic validation and red flagging of tags being used by unauthorised operators, or permits being incorrectly, incompletely or otherwise misused, and cross-checking of basic entry issues including levels of production conversion rates, etc.

As a second stage of QA/QC all entries are validated, and the validated data is then secured in a storage area in the database. There are security features at several levels of the database operations including a read/write only function for authorised users, and change tracking of production information by staff, as well as others. At the end of every month, data is posted to the archives and a separate unit of the GFC is responsible for cross-checking volume totals by species, concession and by period, and preparing the necessary report for external consumption.

Forest Products included in IMR: in tabulating the declared volumes for forest management, the following primary products that are extracted from the forest were:

- Logs
- Lumber (chainsawn lumber)
- Roundwood (piles, poles, posts, spars)
- Splitwood (shingles, staves)
- Fuelwood (charcoal, firewood)

Logging Damage – Default Factor

In 2011 progress was made in developing a methodology and finalising factors to assess Collateral Damage in a Technical Report developed by Winrock International for the GFC: *Collateral Damage and Wood Products from Logging Practices in Guyana,* December 2011.

The objective of the report is to examine how emission factors were developed that relate total biomass damaged (collateral damage) and thus carbon emissions, to the volume of timber extracted. This relationship will allow the estimation of the total emissions generated by selective logging for different concession sizes across the entirety of Guyana. The following field data have been collected with which the emission factors have been developed:

1. Measurements in a sample of logging gaps to collect data on the extracted timber biomass and carbon in the timber tree and the incidental carbon damage to surrounding trees.
2. Estimating the carbon impact caused by the logging operations such as skid trails. Although selective logging clears forest for roads and decks, their emissions will be estimated through the stock-change method based on estimates of area deforested by logging infrastructure determined in the land cover change monitoring.

Accounting for the impact of selective logging on carbon stocks involves the estimation of a number of different components:

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

The **emissions** from selective logging are expressed in equation form as follows:

$$\text{Emissions, t } CO_2/yr = \{[Vol \times WD \times CF \times (1-LTP)] + [Vol \times LDF] + [Lng \times LIF]\}*3.67 \quad \text{(Eq. 1)}$$

Where:

Vol = volume of timber over bark extracted (m^3)

WD = wood density (t/m^3)

CF = carbon fraction

LTP = proportion of extracted wood in long term products still in use after 100 yr (dimensionless)

LDF = logging damage factor—dead biomass left behind in gap from felled tree and incidental damage ($t\ C/m^3$ extracted)

Lng = total length of skid trails constructed to extract Vol (km)

LIF = logging infrastructure factor—dead biomass caused by construction of infrastructure (t C/km of skid trail to extract the Vol)

3.67 = conversion factor for t carbon to t carbon dioxide

Wood in long term products

Not all the carbon in harvested timber gets emitted to the atmosphere because a proportion of the wood removed may be stored in long term wood products. Total carbon stored permanently into wood products can be estimated as follows.

$$C_{WP} = C * (1 - WW) * (1 - SLF) * (1 - OF)$$ (Eq. 2)[16]

Where:

$C_{WP:}$ = Carbon stock in long-term wood products pool (stock remaining in wood products after 100 years and assumed to be permanent); t C ha^{-1}

C = Mean stock of extracted biomass carbon by class of wood product; t C ha^{-1}

WW = Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product

SLF = Fraction of wood products with a short life that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product

OF = Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product

The methodology presented here is a module in an approved (double verified) set of modules for REDD projects posted on the Verified Carbon Standard (VCS) set of methodologies. The reported difference between the annual mean for the period 2003-2008 and the assessment year of 1 January 2017 to 31 December 2017, presented an an annualised total, is shown in the table below. For this period t CO_2 has reduced by 1,646,536t CO_2.

Table 5-5: Interim Indicator on Forest Management

Period	Description	Volume (t CO_2)
1 January 2017 – 31 December 2017	t CO_2 emissions arising from timber harvesting	1,740,242
2003-2008 (annual average)	t CO_2 emissions arising from timber harvesting	3 386 778
Difference (t CO_2)		**1,646,536**

6.8 Emissions Resulting from Illegal Logging Activities – Measure 4

Areas and processes of illegal logging must be monitored and documented as far as practicable. Monitoring and estimation of such areas is recommended to be done by assessing the volumes of illegally harvested wood. In the absence of hard data, a default factor of 15% (as compared to the legally harvested volume) is required to be used. It is stated in the Joint Concept Note that this factor can be adjusted upwards and downwards pending documentation on illegally harvested volumes, inter alia from Independent Forest Monitoring. Additionally, medium resolution satellite imagery can be used for detecting human infrastructure and targeted sampling of high-resolution satellite images for selected sites.

In the historic reporting, the default level of 15% of harvested production of 705 347 m^3 corresponding to 411 856 t CO_2, is used in the absence of a complete database of illegal activities being in place at that time. This level includes provision for collateral damage arising from logging activities. Production volumes are recorded in custom designed databases which are updated monthly by the GFC, subject to internal verification, and are backed up and stored monthly offsite.

[16] This is directly from the VCS (Verified Carbon Standard) approved methodology for wood products –6CP-W Wood Products November 2010

The rate of illegal logging for the assessment Year 7, 1 January 2017 to 31 December 2017, is informed by a custom designed database that is updated monthly, and subject to routine internal audits. This database records infractions of illegal logging in Guyana in all areas. This level for the reporting period 398,687 t CO_2, less than the historic period level.

Table 5-6 Interim Indicator on Illegal Logging

Period	**Description**	**Volume (t CO_2)**
1 January 2017 – 31 December 2017 (annualised)	t CO_2 emissions arising from illegal logging	13,169
2003-2008 (annual average)	t CO_2 emissions arising from illegal logging	411 856
Difference (t CO_2)		**398,687**

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

Explanatory Note 1

The following steps are taken in the computation of gross emissions from forest management activities:

Step 1: Compile background data to inform computations

- Compile annual production of forest products
- Compile annual area under harvest of various categories of Operators taking into consideration blocks under harvest by large concessions, small forest concessions areas, and titled Amerindian Areas involved in forestry activities.
- Compute Yield in cubic meters per hectares by dividing the harvest level by the area size.

Step 2: Computing impact of incidental impact and collateral damage emanating from logging activities. Factors derived from data collected from 121 Logging Plots.

- Compute total skid trails constructed during the assessment period.
- Applying a logging damage factor of 0.95 t C/m3, and a logging infrastructure factor of 32.84 t C/km, derive total gross carbon emission impact from collateral damage and logging infrastructure by:

  (Area under harvest in hectares **X** Average Yield per ha in cubic meters) **X** Logging Damage Factor of 0.95 t C/m3)

  X (length of skid trails of that year in km **X** logging infrastructure factor of 32.84 t C/km)

Step 2 results in t C of collateral damage and infrastructure impacts from forest harvest, which then multiplied by 3.67 as the multiplier of t C to CO2, is the total CO2 emanating from forest management activities resulting from collateral damage and forest infrastructure.

Step 3: Computing the actual impact of extracted wood including provision for storage in long term wood products. Long term wood products storage computation based on Winjum et al 1998.

- Compute total gross emissions emanating from wood extracted by:

  (Area under harvest in hectares **X** Average Yield per ha in cubic meters)

X (Average carbon storage value per cubic meters of 0.4 t C/m3) – (Carbon Stored in Long Term Wood Products computed by method proposed in Winjum et al 1998)

Step 3 results in the computation of total gross emissions taking account of wood stored in Long Term Wood Products and is converted to CO2 by multiplying the above product by 3.67.

Step 4: Computing the total CO2 emissions from total forest management

- Results of Step 2 + Results of Step 3

Explanatory Note 2

The following steps are taken in the computation of the total emissions from illegal logging activities:

Step 1: Compile background data to inform computations

- Compile annual illegal logging timber volume
- Compile annual area under harvest of various categories that may have been subject to illegal logging.
- Compute Yield in cubic meters per hectares by dividing the illegal logging production by the area size

Step 2: Computing impact of collateral damage emanating from illegal logging activities. Factors derived from data collected from 121 Logging Plots.

- Applying a logging damage factor of 0.95 t C/m3, derive total gross carbon emission impact from collateral damage by:
  (Area under harvest in hectares **X** Average Yield per ha in cubic meters)
  X Logging Damage Factor of 0.95 t C/m3)

Step 2 results in t C of collateral damage from illegal logging activities, which then multiplied by 3.67 as the multiplier of t C to CO2, is the total CO2 emanating from illegal logging activities resulting from collateral damage.

Step 3: Computing the actual impact of extracted wood including provision for storage in long term wood products. Long term wood products storage computation based on Winjum et al 1998.

- Compute total gross emissions emanating from wood extracted by:

(Area under harvest in hectares **X** Average Yield per ha in cubic meters)

X (Average carbon storage value per cubic meters of 0.4 t C/m3) – (Carbon Stored in Long Term Wood Products computed by method proposed in Winjum et al 1998)

Step 3 results in the computation of total gross emissions taking account of wood stored in Long Term Wood Products and is converted to CO2 by multiplying the above product by 3.67.

Step 4: Computing the total CO2 emissions from total illegal logging

- Results of Step 2 + Results of Step 3

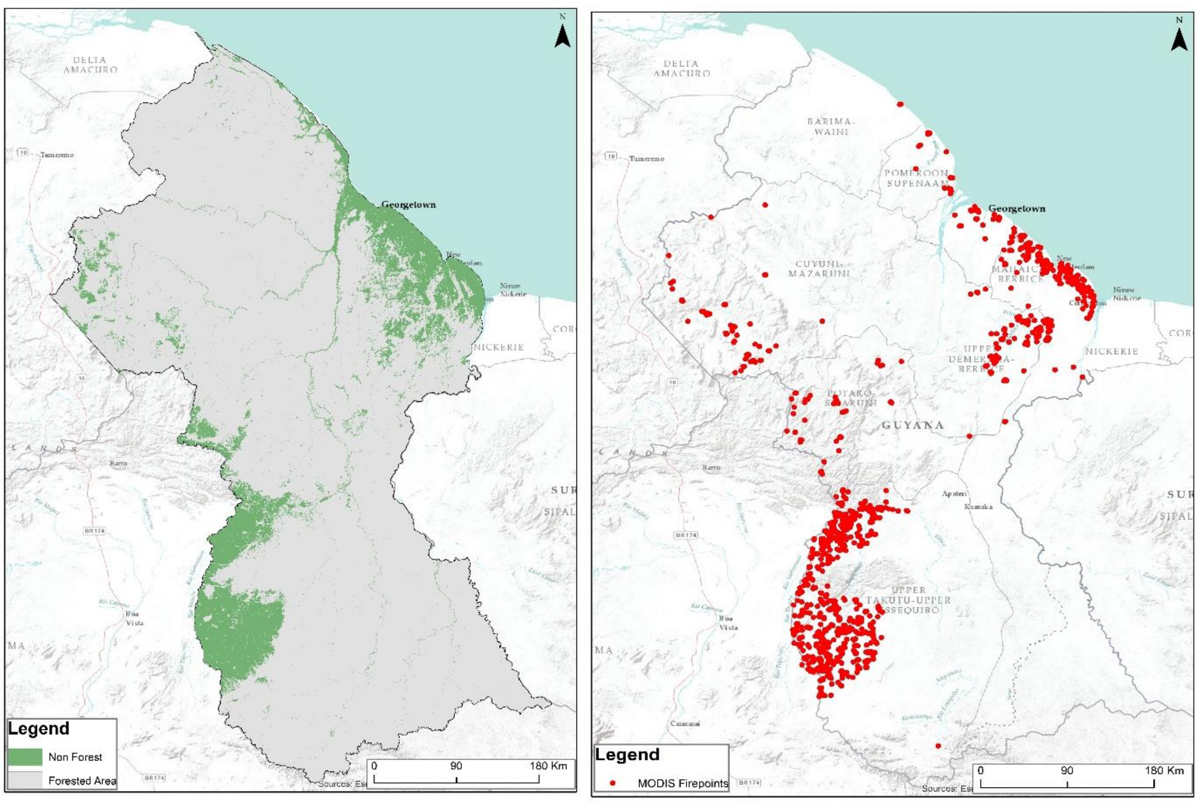
6.9 Emissions from Anthropogenic Forest Fires – Measure 5

The FIRMS fire point data from MODIS was used to identify potential fire locations. In addition, a systematic review of all fire points was undertaken to validate the presence of fire and establish the extent using Sentinel imagery. This is an accepted approach that is documented in the GOFC-GOLD sourcebook.

The initial approach used to set a reference level was to calculate the area burnt for the 1990 to September 2009 period. Over this 19-year period a total of 33 700 ha of forest was identified as degraded by burning[17]. This equated to a mean annual area of 1 700 ha. The mean area burnt was accepted as a suitable Interim Measures benchmark against which all subsequent change could be compared. In this reporting period the area degraded is 804 ha. This value has been calculated using a sample-based estimation approach.

Overall, fire is an immaterial change driver in Guyana with almost all fires occurring within non-forest/grassland landscapes as shown.

Figure 5-5: Non Forest Area & FIRMS Fire Data 2017



The main non-forest areas are located in the south along the Brazilian border and closer to Georgetown on the coastal fringe.

[17] This does not include areas deforested because of fire events. This has been recorded as deforestation. The .El Niño weather pattern is known to have occurred during this period.

7. REFERENCES

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Appendix 1

Satellite Image Catalogue

All new imagery that is available has been added to the existing archive at GFC. The following table describes the naming conventions and column headings for the image catalogue as below. This archive is dynamic and will be continually added to over time.

Image Naming Conventions

Landsat Image Stack Name	Image name in the following format: Satellite (2-3), Path (4), Row (1-3) _ Image Date (YYMMDD)_Image Provider (1)_Processing level (1-2)
Sentinel Image Stack Name	Image name in the following format: datatake sensing start time_data take sensing stop time_tile ID
Acquisition Month	The month when image was taken
Mapping Stream	The mapping analysis that the imagery is for.
Data Provider	The name of the data provider/source of data
Satellite Instrument	The satellite or instrument of origin

Summary of 2017 Satellite Images

Stack Name	Satellite/Instrument	Data Provider	Resolution(m)	Aquistion Year	Aquistion Month
20170816T142039_20170816T142034_T21NUE.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142034_T21NVD.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142034_T21NVE.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142034_T21NVF.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142034_T21NVG.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NTC.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NUB.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NUC.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NUD.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NVB.tif	Sentinel	ESA	10	2017	August
20170816T142039_20170816T142143_T21NVD.tif	Sentinel	ESA	10	2017	August
20170819T143049_20170819T143043_T20NRN.tif	Sentinel	ESA	10	2017	August
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20170822T143749_20170822T143810_T20NQM.tif	Sentinel	ESA	10	2017	August
20170822T143749_20170822T143810_T20NQN.tif	Sentinel	ESA	10	2017	August
20170822T143749_20170822T143810_T20NQP.tif	Sentinel	ESA	10	2017	August
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20170829T142749_20170829T143011_T20NQM.tif	Sentinel	ESA	10	2017	August
20170829T142749_20170829T143011_T20NRH.tif	Sentinel	ESA	10	2017	August
20170829T142749_20170829T143011_T20NRK.tif	Sentinel	ESA	10	2017	August
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20170829T142749_20170829T143011_T20NRM.tif	Sentinel	ESA	10	2017	August
20170829T142749_20170829T143011_T20NRN.tif	Sentinel	ESA	10	2017	August

20170829T142749_20170829T143011_T20NRP.tif	Sentinel	ESA	10	2017	August
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20170903T142851_20170903T142954_T21NTD.tif	Sentinel	ESA	10	2017	September
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016_20171116_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
017_20171121_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
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023_20171128_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
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032-w_20171115_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
033_20171116_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
034_20171124_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
030-w_20171127_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
036_20171124_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
037_20171117_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
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039_20171117_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
040_20171118_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
041_20171118_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
035_20171127_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
043_20171125_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
042_20171118_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
044_20171124_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
046_20171120_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
045_20171123_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
048_20171123_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
050_20171125_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
047_20171124_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
053_20171128_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
052_20171128_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	November
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001-e_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
001-w_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
002_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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007_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
008_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
009_20171219_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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013-n_20171214_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
013-s_20171214_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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021-e_20171212_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
021-w_20171212_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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025-c_20171216_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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051_20171218_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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055_20171203_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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057_20171205_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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061-w_20171204_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
064-e_20171206_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
064-w_20171206_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
066_20171218_bgrnir.tfw	Aerial Imaging Camera System	GeoVantage	0.25-0.6	2017	December
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Appendix 2

Corrective Actions Request (CARS) Year 6

YEAR 6 Corrective Actions

<table>
<tr><th rowspan="2">CARS AND OBS</th><th colspan="2">GFC's Response</th></tr>
<tr><th>@ time of audit</th><th>GFC Update</th></tr>
<tr><td>

2014- CAR 4 MINOR

Non-Compliance: Biomass assessment plots of degraded forest within shifting cultivation areas are not adequately reflected within overall biomass calculation.

Objective evidence:

- Fieldwork evidence shows that most, if not all, SA mapped as pioneer actually is rotational.
- Fieldwork evidence shows that the currently map identification of primary forest in shifting cultivation areas has led to the allocation of areas as primary forest where ground truthing of the same areas identified the area as rotational agriculture/degraded secondary forest.

Audit results Year 6 audit

GFC has started work on the re-stratification of its forest types however due to the delays with the Norway /Guyana Agreement and the priorities for the Year 6 reporting the CAR has not been fully implemented.

CAR remained open and will be verified during the next audit.

</td><td>

The brief inspection conducted during the audit indicated that rotational shifting cultivation was classified as pioneer. It is worth noting that this the first year shifting cultivation has been reported. It is anticipated that as an approach 3 MRVS and with further repeat image coverages the attribution of both historical and new shifting cultivation areas will be improved.

While the areas in question still fall within Guyana's definition of forest, it is recognised that this is secondary forest. It is expected that the historical extent of shifting cultivation areas will improve in line with annual coverages of high resolution imagery. The current work on Emission Factors by GFC will account for the differing carbon contents.

It is planned for field assessments to be conducted to inform an emission factor for Shifting Agriculture.

This will inform the impact that this activity has on biomass. This will remove the dependence of categorising shifting agriculture type using remove sensing methods only, which evidently has specific challenges.

It is envisaged that an Emission Factor will be developed in 2015-2016 for Shifting Agriculture. It is likely that the emission factor will be a function of the forest-fallow cycle and local practices.

The challenge will be how to count for the net emissions from this activity. It is still being assessed whether Shifting Cultivation mosaics are lengthening or shortening or

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A large percentage of shifting cultivation occurs within the forest around the Rupununi Savannah. This has resulted in the conversion to secondary forest. Additionally, this is also a resulting impact from the prolonged periods of drought, which results in fires, as well as floods in this area. This area now forms a new stratum, resulting from post-stratifying the forest in the district, covering the area where this driver occurs. The Guyana Post-stratification report (2018) contains more information, which adequately addresses this issue.

The Emission Factor Report for Shifting Cultivation (2018) also provides substantial evidence, that the emission factor is very small. Considering that the initial stock is already low when reporting the emissions resulting from this driver, it is very small in comparison to other drivers of deforestation and forest degradation in Guyana. Notwithstanding this, this driver still remains important and will be reported on in the future.

</td></tr>
</table>

	stable. This determination will help to decide their role. Once an estimate of the average C stock is derived in different Shifting Cultivation mosaics then this can be used with pioneer shifting cultivation—i.e. first time cleared, as the net effect will not be the C stock of the forest to begin with but the C stock of initial forest minus the long term	
2015- OBS 2 **Potential Non-Compliance**: Original hypotheses around forest stratification (grouping of forest types) not confirmed in final stratum. **Objective evidence**: Originally GFC demonstrated and argued that carbon content within different forest types were negligible and as such could be group all under forest. However, this was based on data collected predominantly within the traditional forest logged by commercial operations. Now that new data is getting available from the savannah areas (in LPfC stratum) where forest types appear to have lower carbon content, it is not clear if this original conclusion to group all forest types together holds true. **Observation remains open**	It is intended that following the completion of the three phases of data collection, matters such as those outlined in the objective evidence will be examined. One approach is to consider post stratification of the LPfC area where this matter seems to be prevalent. We note that this was not an issue in the other two strata of HPfC and MPfC where there are multiple forest types and a prevalence of logged and unlogged forest, along with other land use and land management activities. GFC will collate the results of the data analysis from the LPfC stratum and examine this further. This will be further examined in Year 6.	Two reports were compiled to test these hypotheses, using the empirical data collected over the years. The first report, Guyana Stratification Options Assessment Report (2018), was conducted using ex-post stratification approach applying the known carbon stocks from the existing plots to new groupings to test whether clear differentiation can be determined and to assess the degree of uncertainty in alternate stratification arrangements. The variables tested are Forest Types, Rainfall, Elevation, Soil Types, and Latitude. The Analysis revealed that none of the alternatives more accurately or efficiently captured the forest carbon stocks or changes in forest carbon stocks in Guyana, and thus we propose that Guyana should retain its existing stratification based on PfC and accessibility. The second report, Guyana Post-stratification report (2018), was compiled based on field data collected to test the Hypothesis proposed by the DNV team that the areas around the Savannah have low carbon content. The findings of the data proved the hypothesis correct. Because of this finding, a post-stratification was justified, hence, the emergence of a seventh stratum (Savannah forest) which was introduced to the updated stratification, and as such the Revised Stratification Report (2018) now reflect this finding.
2016 (Year 6) CAR 2 MINOR **Non-Compliance**: Incomplete SOP of mapping degradation & deforestation	The Mapping SOP will be updated in 2018 to reflect the change in the degradation method. As part of that process GFC will provide additional	A Standard Operating Procedures (SOP) was created for degradation mapping. The *Guyana REDD MRV Statistical Change Assessment Standard Operating Procedure Guide* gives practical advice

Objective evidence: • Current SOP does not address the changes that have been adopted in relation to the determination of degradation • Current SOP makes reference to Rapid Eye applicability whilst this is no longer used. **CAR now a MINOR**	documentation that outlines the approach. This will include supporting analysis of field measurements collected across sites representative of degradation. Inclusion of text and materials to ensure the approach is well documented and can be replicated in the future. For Year 7, national data on forest degradation will be estimated from a stratified random change sample. The reference data used for the analysis will be PlanetScope, Sentinel and, where available, GeoVantage aerial imagery. The SOP will be updated to clarify that RapidEye data has been superseded with more recent earth observation satellites. The documentation that relates to the image processing chain will also be adapted to more accurately reflect current use of freely available image sources and subsequent improvements that are being made to image analysis processes.	on and examples of how to assess forest change from a stratified random sample, identify the drivers for change in forest land cover and the time period when the change took place. The guide covers the following topics: • definitions of deforestation, degradation and forest change • detailed change and change driver category descriptions • rules for identifying and quantifying change • illustrated examples for identification of the drivers of forest change • how to identify the time that change took place • how to assess the certainty of the interpretation The Mapping SOP was updated to reflect the changes from RapidEye to use of more freely available images. The mapping guide provides technical outline on how to prepare satellite imagery for mapping the drivers of change in forest land cover. The guide covers the following topics: • Definitions of deforestation, degradation and forest change • Land use changes recorded in the MRVS • Data structure & agency Information • Image processing • Mapping procedure • QA/QC processes
2016 (Year 6) CAR 3- MINOR **Non-Compliance**: Accuracy Assessment have become part of value determination instead of quality control **Objective evidence**: · With the adoption of the sampling technique of the degradation through the accuracy assessment team the degradation value is not subject to the same level of independent assessment as the deforestation data receives	The element of independent assessment of the change data will be reintegrated in year 7. It is intended that the revised degradation methods will be routinely applied to future years. To enable this GFC will develop in conjunction with Durham University a training module that allows the estimation or 'accuracy assessment' methods to be replicated at GFC.	An ArcGIS Toolbar add-in for tracking degradation was created to update and track changes. A SOP has also been created to reflect the new methodology adopted for tracking degradation.The toolbar was installed at GFC on 6th September 2018 to work with ArcGIS 10.6. Training on how to interpret and assess Forest Degradation was conducted by Durham University team at the GFC from the 28th March – 6th April 2018. The Durham University team ran a refresher training session with the GFC mapping team on 21st August 2018.

through the accuracy assessment. **CAR now a MINOR**	An innovation for Year 7 will be the development of a new SOP that will allow GFC staff to conduct the change interpretation part of the forest degradation estimation process. GFC staff will be trained in the use of the reference data and the methodology for change assessment using the bespoke GIS toolbar. Durham University will then be provided with the change data and will undertake the statistical analysis of the forest degradation results and provide tabular data/analysis for reporting purposes. In so doing, Durham University will continue to support the approach and will be responsible for auditing the GFC's interpretation of change and associated deforestation and degradation estimates. In this way the process supports GFC to attain the necessary skills required to perform the assessment while also incorporating the independent verification process –which is an integral part of the MRVS. The accuracy assessment report will be replaced with an independent report on GFC's results and estimates by Durham University	The GFC mapping team completed the interpretation of the sample areas provided by Durham University. This was then followed by consistency checks which was done by all members of the GFC mapping team on randomly selected samples. Quality assurance on the GFC sample interpretations was undertaken by Durham University team. In 2019 the process will be repeated.
2016 (YEAR 6) CAR 4 MINOR **Non-Compliance**: Lack of clarity in SOP and Report that minimum acceptable mapping requirements for the information needs of GFC remain fulfilled. **Objective evidence**: With the increasing developments around images that are available in the open source market and commercial market and the GFC's adoption of some of these elements in Year 6, the GFC needs to more effectively justify that the	The GFC recognises the fast pace that new sensors are becoming available. We intend to add clarity in both the SOP for Mapping as well as in future Reports that document the integrating of these developments. A fuller justification will be provided, including a checklist with test scenarios that the new developments meet the defined minimum criteria of the GFC's MRVS which include: fulfilling the requirements of the SOP for Mapping, remaining consistent to the definition of	In the Updated Mapping SOP there is a Section (**Section 4.2**) that explains and justifies the use of Sentinel imagery.

existing defined minimum criteria of the MRVS remain fulfilled under the new technologies that have been used and that these meet the needs of GFC to continue its reporting requirements under the UNFCCC and/or Donor Countries. Current SOP does not contain QA/QC controls to verify that images may not be correctly aligned over time. **CAR to be closed out during next verification**	forest, and uniformly applying the MMU. Additionally, structural changes will be made to the Year 7 and future reports to more effectively present these new developments and show how they are synergistic to the existing main tenants (including defined minimum criteria) of the MRVS.	
2016 (Year 6) CAR 5 MINOR **Non-Compliance**: No operational linkage between CMRV and the national MRV **Objective evidence**: · Although initial capacity building, training, and data-gathering exercises have commenced and continued between GFC and its partner organizations implementing the CMRV progress with local Amerindian communities, no operational link between the monitoring or with the data gathered and the greater MRVS system has been made to date, nor has there been any progress made with regards to the opt-in mechanism and a corresponding pilot program, which according to the JCN, should have commenced in 2015. · JCN Table 1 key REDD+ enabling Efforts. Requires the start of a pilot during 2015 for the Opt-In Mechanism. However, the verification team realizes that the GFC and its corresponding Ministry have undergone a restructuring where by some of the Ministries responsibilities may have moved to Office of	The Office of Climate Change is the lead agency coordinating the implementation of the Opt In Mechanism. The GFC is not the lead agency for this REDD+ activity. The GFC will support the implementation of the Opt In as it advances however, with the Commission not being in the leadership role in this project, the GFC cannot dictate the pace or method of implementation. The GFC stands ready to support the Opt In in any way requested. The Commission will look out for those requests. Notwithstanding this, the GFC will continue to work with partners, including the WWF, on CMRV related work as far as practicable whilst the Opt In evolves to a piloting status. This work will seek to support the national MRVS and vice versa. The Commission is careful to not create a parallel/divergent track to what may be required under an Opt In mechanism and for this reason stand ready to support this process when needed and in the way needed.	Over the years, the GFC along with a few of its partners have provided support, engaged in various CMRV outreaches, and training exercises across the country. In 2014 and 2017, communities from the NRDDB and Konashen have received training in CMRV related activities. The GFC, in continuing its support to this process has initiated a program in phase 2 to train representatives from 22 Indigenous communities across the country in CMRV. So far, 22 villages with over 37 individuals trained. The training involved both practical and theoretical aspects of the National MRV. Participants were provided with an overview of the national MRV system, past work done on CMRV and taught on procedures associated with the mapping and identification of the various drivers of deforestation and degradation. Practical exercises included training on the use of GPS (waypoint marking, tracking), compass and map reading. In addition, test areas mapped for various drivers e.g. shifting cultivation, fire, mining were visited. Following each engagement, the participants were asked to utilize some of the skills gained from the training to facilitate some field verification exercises on behalf of the Commission, which is intended to feed into the national MRVS. So far, the response has been positive with just a handful of communities remaining to submit.

Climate Change, hence the team seeks further information on how and if the GFC will support the new government body with the implementation of the JCN requirements. **CAR to be closed out during next verification**		
2016 (YEAR 6) OBS 1 **Requirement**: Overall Guyana MRV programme **Potential Non-Compliance**: Potential misunderstanding by stakeholders on how the applied MRV methodology is driven by existing experience and knowledge within the programme **Objective evidence:** Currently the programme is still modifying its methodology to incorporate the changes away from RapidEye and Geovantage. Although this may have impact in actual data there is a need to verify that methodology remain consistent with the build-up experience to date. **Obs to be verified during next audit**	Since 2009 GFC has progressively improved the MRVS to recognize changes in data availability, improvements in sensor's spatial and temporal resolution. It is envisaged that GFC will continue to take advantage of new technologies and as appropriate add these to the MRVS. As new elements are added these are rigorously tested by GFC to ensure that they meet the established MRVS reporting standards and interim measures. Compliance against these standards and measures is verified annually through the accuracy assessment and audit process. In 2018 GFC plan to update the existing SOP to reflect the changes incorporated to ensure that any new methods adopted are well described and able to be replicated. Some amount of structural modifications will also be made to the Year 7 Report to focus more on the current work and approaches whilst showing that the methods applied remain consistent.	Improvements to the MRV have been ongoing and SOP have been updated to reflect the improvements in sensor technology and availability. Improvements are progressive and in this reporting period the GFC team have focussed on updating the SOP around the use of Sentinel data for forest change detection and use of a sample-based approach for providing estimates of degradation. The reporting format has been revised with the intention of improving its readability.

Appendix 3

IPCC Common Reporting Format Tables

Guyana is reporting the land use changes detected in year 7 in the Common Reporting Tables (CRF) format of the IPCC. The CRF tables report land use area by:

- land use categories/sub-categories in year 6 “remaining” in the same category in year 7
- land use categories/sub-categories in year 6 “converted to” other land use categories/sub-categories in year 7.

The six land use categories used in the IPCC reporting are[18]:

1. **Forest land**: All land with woody vegetation consistent with the country thresholds used to define forest land, including vegetation structure that currently is below the threshold, but *in situ* could potentially reach the threshold values.
2. **Cropland**: Cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the forest land category.
3. **Grassland**: Including rangelands and pasture land that are not considered cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the forest land category.
4. **Wetlands**: Areas of peat extraction and land that are covered or saturated by water for all or part of the year and that do not fall into the categories above or into the settlements category. It also includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.
5. **Settlements**: All developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.
6. **Other land**: This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.

The stratification into land use subcategories is country specific and depends on national circumstances.

For the forest land category, Guyana defined the subcategories by the forest stratification approach used in the Forest Carbon Monitoring System developed and implemented by GFC and Winrock International. This is based on the Potential for Future Change (PfC) which results in three strata: high (HPfC), medium (MPfC), and low (LPfC) potential for change. In addition to stratifying by potential for change, the forests are also stratified by accessibility: More or Less accessible[19] (Figure 1). Work is still ongoing to determine the appropriate emission factors land use change drivers across the different strata.

In past years, the afforestation/reforestation activity in Guyana has been identified in the MRV and reported when detected. This process, however, did not constitute a full analysis of afforestation/reforestation at a national level. In year 7, the analysis has focused only in deforestation, and has not included the detection of land conversion to forest.

The non-forest land area in Guyana was classified into the relevant IPCC land categories (Cropland, Grassland, Settlement, Wetlands and Other Land). Indufor notes that the MRVS work mainly focuses in monitoring the changes from forest land to non-forest land uses (deforestation). Land use changes occurring within non-forest classes (i.e. conversion from grassland to cropland, etc.) and area remaining (i.e. cropland remaining cropland) are not part of the MRVS.

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[18] IPCC. 2006. Volume 4: Agriculture, Forestry, and Other Land Use. Eggleston, H. S., L. Buendia, K. Miwa, T. Ngara and K. Tanabe. Eds. In: Penman, J., M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe and F. Wagner. Eds. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme. IGES, Japan.

[19] 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.

In this report, the total area for non-forest land categories was estimated using a layer recently updated by GFC at the end of year 6. The forest land area converted to other land uses (deforestation) in year 7 were added to these non-forest classes to estimate their final area at year 7. No area changes have been monitored or calculated between non-forest classes from year 6 to year 7, For other non-forest ("Not estimated" (NE) Notation Key was used).

Figure 1: Year 7 Stratification of Guyana's Forest Area by Potential for Change

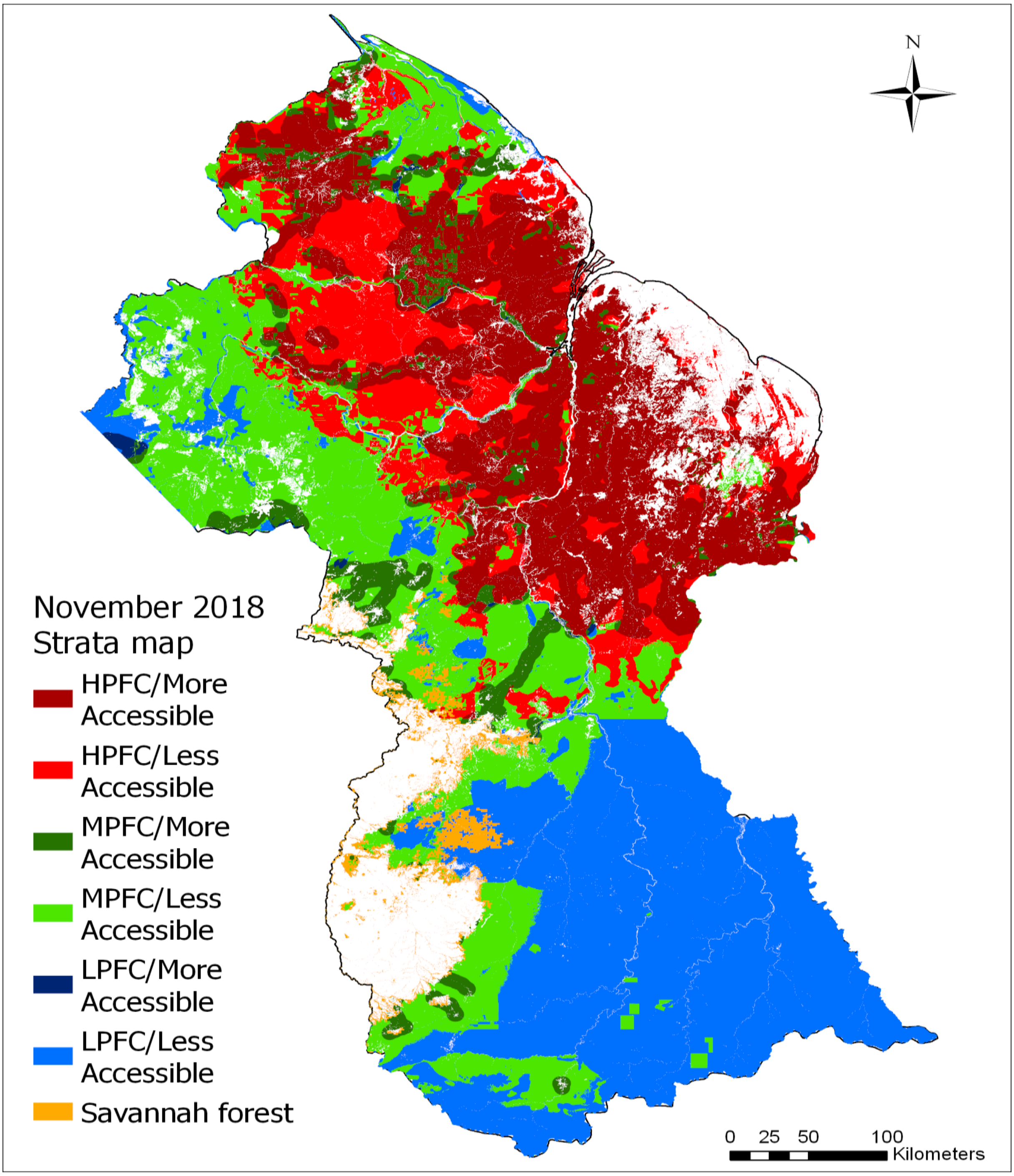

Table 4.1. LAND TRANSITION MATRIX — **Inventory 2018**

Areas and changes in areas between the previous and the current inventory year — **Submission 2018 v1**

GUYANA

TO: 2017 (Year 7) / FROM: 2016 (Year 6)	Forest land	Cropland (managed)	Grassland (unmanaged)	Wetlands (unmanaged)	Settlements	Other land	Initial Area (Year 6)
	(kha)						
Forest land (HPfC MA)(2)	4,624.9	0.1285	NO	NE	0.6600	3.7959	**4,629.5**
Forest land (HPfC LA)(2)	2,258.4	0.3341	NO	NE	0.1118	2.0577	**2,260.9**
Forest land (MPfC MA)(2)	1,384.7	0.0106	NO	NE	0.0384	0.4469	**1,385.2**
Forest land (MPfC LA)(2)	4,441.2	0.0001	NO	NE	0.1011	0.8981	**4,442.2**
Forest land (LPfC MA)(2)	208.5	0.0006	NO	NE	0.0022	0.0532	**208.5**
Forest land (LPfC LA)(2)	5,525.7	0.0030	NO	NE	0.0181	0.1905	**5,525.9**
Cropland (managed)(4)	NE	NE	NE	NE	NE	NE	**343.0**
Grassland (unmanaged)(5)	NE	NE	NE	NE	NE	NE	**1,928.3**
Wetland (unmanaged)(6)	NE	NE	NE	NE	NE	NE	**291.1**
Settlements(7)	NE	NE	NE	NE	NE	NE	**60.2**
Other land (8)	NE	NE	NE	NE	NE	NE	**54.3**
Final area (Year 7)	**18,443.3**	**343.5**	**1,928.3**	**291.1**	**61.2**	**61.7**	**21,129.1**
Net change (9)	**-8.85**	**0.48**	**0.00**	**0.00**	**0.93**	**7.44**	**0.0**

Documentation for Notation keys used:

Afforestation/reforestation activity in Guyana occurs through regeneration of abandoned mining sites primarily. These areas are not monitored at present and have been reported as not estimated (NE).

There is no human induced conversion from forest to grasslands or forest to wetlands in Guyana (NO).

Area in non-forest land uses (area remaining and land use changes) have not been estimated in this reporting period (NE).

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Forest Land

GREENHOUSE GAS SOURCE & SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						Net CO_2 emissions/ removals [8] [9]
Land-Use Category	Subdivision[1]	Total area[2] (kha)	Area of organic soil[2] (kha)	Carbon stock change in living biomass per area [3] [4]			Net carbon stock change in dead organic matter per area[4]	Net carbon stock change in soils per area [4]		Carbon stock change in living biomass[3] [4]			Net carbon stock change in dead organic matter[4]	Net carbon stock change in soils [4] [6]		
				Gains	Losses	Net change		Mineral soils[5]	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils[7]	
				(t C/ha)						(kt C)						(kt)
A. Total Forest Land		18,443.3														
1. Forest Land remaining Forest Land	Forest HPfC MA remaining Forest	4,624.9														
	Forest HPfC LA remaining Forest	2,258.4														
	Forest MPfC MA remaining Forest	1,384.7														
	Forest MPfC LA remaining Forest	4,441.2														
	Forest LPfC MA remaining Forest	208.5														
	Forest LPfC LA remaining Forest	5,525.7														
2. Land converted to Forest Land[10]		NE														
2.1 Cropland converted to Forest Land		NE														
2.2 Grassland converted to Forest Land		NE														
2.3 Wetlands converted to Forest Land		NE														
2.4 Settlements converted to Forest Land		NE														
2.5 Other Land converted to Forest Land		NE														

Documentation box:

Afforestation/reforestation activity in Guyana occurs through regeneration of abandoned mining sites primarily. These areas are not monitored at present and have been reported as not estimated (NE).

TABLE 4.B SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Cropland

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						Net CO_2 emissions/ removals [10] [11]
Land-Use Category	Subdivision [1]	Total area[2] (kha)	Area of organic soil[2] (kha)	Carbon stock change in living biomass per area [3] [4]			Net carbon stock change in dead organic matter per area[4]	Net carbon stock change in soils per area [4]		Carbon stock change in living biomass[3], [4], [6]			Net carbon stock change in dead organic matter[4] [7]	Net carbon stock change in soils [4] [8]		
				Gains	Losses	Net change		Mineral soils[5]	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils[9]	
				(t C/ha)						(kt C)						(kt)
B. Total Cropland		343.5														
1. Cropland remaining Cropland		NE														
2. Land converted to Cropland[12]		NE														
2.1 Forest Land converted to Cropland	Forest HPfC MA converted to Cropland	0.13														
	Forest HPfC LA converted to Cropland	0.33														
	Forest MPfC MA converted to Cropland	0.01														
	Forest MPfC LA converted to Cropland	0.00														
	Forest LPfC MA converted to Cropland	0.00														
	Forest LPfC LA converted to Cropland	0.00														
2.2 Grassland converted to Cropland		NE														
2.3 Wetlands converted to Cropland		NE														
2.4 Settlements converted to Cropland		NE														
2.5 Other Land converted to Cropland		NE														

Documentation box:

Cropland remaining area and non-forest land uses converted to Cropland were not estimated in this reporting period (NE).

TABLE 4.C SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Grassland

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						Net CO_2 emissions/ removals (10) (11)
Land-Use Category	Subdivision (1)	Total area(2) (kha)	Area of organic soil(2) (kha)	Carbon stock change in living biomass per area (3) (4)			Net carbon stock change in dead organic matter per area(4)	Net carbon stock change in soils per area (4)		Carbon stock change in living biomass(3), (4), (6)			Net carbon stock change in dead organic matter(4) (7)	Net carbon stock change in soils (4) (8)		
				Gains	Losses	Net change		Mineral soils(5)	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils(9)	
				(t C/ha)						(kt C)						(kt)
B. Total Grassland		1,928.3														
1. Grassland remaining Grassland		NE														
2. Land converted to Grassland(12)		NE														
2.1 Forest Land converted to Grassland		NO														
2.2 Cropland converted to Grassland		NE														
2.3 Wetlands converted to Grassland		NE														
2.4 Settlements converted to Grassland		NE														
2.5 Other Land converted to Grassland		NE														

Documentation box:

Grassland remaining area and non-forest land uses converted to Grassland were not estimated in this reporting period (NE).

There is currently no human induced conversion from Forest to grasslands in Guyana (NO)

TABLE 4.D SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Wetlands

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						
Land-Use Category	Subdivision (1)	Total area(2) (kha)	Area of organic soil(2) (kha)	Carbon stock change in living biomass per area (3) (4)			Net carbon stock change in dead organic matter per area(4)	Net carbon stock change in soils per area (4)		Carbon stock change in living biomass(3), (4), (6)			Net carbon stock change in dead organic matter(4) (7)	Net carbon stock change in soils (4) (8)		Net CO_2 emissions/ removals (10) (11)
				Gains	Losses	Net change		Mineral soils(5)	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils(9)	
				(t C/ha)						(kt C)						(kt)
B. Total Wetlands		291.1														
1. Wetlands remaining Wetlands		NE														
1.1 Peat extraction		NE														
1.2 Flooded land remaining flooded land		NE														
2. Land converted to Wetlands		NE														
2.1 Land converted for Peat extraction		NE														
2.2 Land converted to flooded land		NE														
2.3 Land converted to other wetlands		NE														

Documentation box:

Wetlands remaining area and non-forest land uses converted to Wetlands were not estimated in this reporting period (NE).

Non-forest area remaining and land use changes between non-forest land uses were not estimated in this reporting period (NE).
The Wetlands category was not subdivided (NE)

TABLE 4.E SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Settlements

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						
Land-Use Category	Subdivision [1]	Total area[2] (kha)	Area of organic soil[2] (kha)	Carbon stock change in living biomass per area [3] [4]			Net carbon stock change in dead organic matter per area[4]	Net carbon stock change in soils per area [4]		Carbon stock change in living biomass[3], [4], [6]			Net carbon stock change in dead organic matter[4]) [7]	Net carbon stock change in soils [4] [8]		Net CO_2 emissions/ removals [10] [11]
				Gains	Losses	Net change		Mineral soils[5]	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils[9]	
				(t C/ha)						(kt C)						(kt)
B. Total Settlements		61.2														
1. Settlements remaining settlements		NE														
2. Land converted to Settlements		NE														
2.1 Forest Land converted to Settlements	Forest HPfC MA converted to Settlements	0.7														
	Forest HPfC LA converted to Settlements	0.1														
	Forest MPfC MA converted to Settlements	0.0														
	Forest MPfC LA converted to Settlements	0.1														
	Forest LPfC MA converted to Settlements	0.0														
	Forest LPfC LA converted to Settlements	0.0														
2.2 Cropland converted to Settlements		NE														
2.3 Grassland converted to Settlements		NE														
2.4 Wetland converted to Settlements		NE														
2.5 Other Land converted to Settlements		NE														

Documentation box:

Settlements remaining area and non-forest land uses converted to Settlements were not estimated in this reporting period (NE).

TABLE 4.F SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Other land

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA		IMPLIED CARBON-STOCK-CHANGE FACTORS						CHANGES IN CARBON STOCK						Net CO_2 emissions/ removals [10] [11]
Land-Use Category	Subdivision [1]	Total area[2] (kha)	Area of organic soil[2] (kha)	Carbon stock change in living biomass per area [3] [4]			Net carbon stock change in dead organic matter per area[4]	Net carbon stock change in soils per area [4]		Carbon stock change in living biomass[3], [4], [6]			Net carbon stock change in dead organic matter[4] [7]	Net carbon stock change in soils [4] [8]		
				Gains	Losses	Net change		Mineral soils[5]	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils[9]	
				(t C/ha)						(kt C)						(kt)
B. Total Other Land		61.7														
1. Other land remaining Other land		NE														
2. Land converted to Other land[12]		NE														
2.1 Forest Land converted to Other land	Forest HPfC MA converted to Other Land	3.8														
	Forest HPfC LA converted to Other Land	2.1														
	Forest MPfC MA converted to Other Land	0.4														
	Forest MPfC LA converted to Other Land	0.9														
	Forest LPfC MA converted to Other Land	0.1														
	Forest LPfC LA converted to Other Land	0.2														
2.2 Cropland converted to Other land		NE														
2.3 Grassland converted to Other land		NE														
2.4 Wetlands converted to Other land		NE														
2.5 Settlements converted to Other land		NE														

Documentation box:

Other Land remaining area and non-forest land uses converted to Other Land were not estimated in this reporting period (NE).

Appendix 4

Stakeholder Feedback

SUMMARY OF FEEDBACK ON MRVS YEAR 7 REPORT

Reviewer Feedback on MRVS Year 7 Report	GFC Feedback
NICFI	
1. In relation to Figure 3-1 p.11 of the MRVS report it would be useful with some further high-level information on deforestation and degradation in terms of trends – deforestation has gone down, is this due to measures taken, drivers changing etc? Some indication of *why* we see the trends we do would be helpful.	In Year 7, the most outstanding trend in the deforestation results has been the decline in deforestation level from the driver of mining. The main reasons for the continuing decline in this driver, which has progressively decreased since 2013 (following its peak in year 2012) are: increase in monitoring activities at the level of the Mining Commission at mining operator level, a decline in the price of gold on the international market, and a consolidation in some regions of larger scale mining activities rather than only small scale operations. We have note seen any change in drivers or the general trend in the role of each driver over the total deforestation results. The underlying factor behind the declining deforestation rate is the continued prioritization of addressing the impacts of mining on forest and the consolidation of work at the various natural resources agencies to preemptively mitigate the impacts of gold mining on forests. Text added to Section 5.2.
2. Method for estimating degradation has changed. While the technical parts of this is explained, the report would benefit with an explanation of *why* this method changed. Was it to reduce uncertainties, reduce costs or for other reasons?	Yes, that is correct. The method for measuring degradation has been adapted. In previous years the GFC team had manually mapped degradation surrounding areas of confirmed deforestation. To determine the accuracy of this mapping a sampling design was overlaid and for each sample, high resolution imagery used to re-map change. The remapping and allocation of change drivers was conducted by an independent team. From this sample it was possible to determine the accuracy of the GFC mapping and report expected upper and lower area bounds (i.e. at 95% CI the estimate is +/- X ha). The approach described above has been improved each year, so the changes introduced reflect several advancements in methodologies, data availability and wider consideration of the importance of degradation as a source of carbon emissions. Changes have included; refinement of the change strata so to optimize the number of refence samples, evaluating PlanetScope relative to airborne capture from the GeoVantage camera system, moving away from producing a map of degradation, as under the slated Interim Measure as it only focused on mapping degradation around newly deforested areas. The refinements methods are incremental with an aim to optimize the process by considering; • the data costs i.e. PlanetScope vs. GeoVantage , • time taken by GFC to produce a degradation map as opposed to the sampling approach • the end use of the information given that deforestation is the main contributor to carbon emissions – this is still mapped using the wall to wall method.

	The refinements are supported by the development of Standard Operating Procedures that allow GFC team to undertake the sample assessment, run the analysis and calculate degradation estimates. The accuracy assessment team from Durham independently are retained in the process to assess the degradation mapping, and estimates provided by the GFC team. Text added to Section 5.4.
3. We look forward to an update on the use of Planetlab data versus overflights.	The GFC and partners have ongoing research project that is evaluating Planet labs along with data collected from overflights. The aim of this study is to match field observations against the data from satellite imagery. This work will be completed in 2019. The intention is to add to our knowledge of the best application of the Planet Labs and to assess to what degree it can replace the overflights for the purpose of the accuracy assessment. Text added to Section 3.3.
4. The report states that the forest definition is of 30% crown cover, but that it is not deforestation if crown cover is regained. What are the timeframes for this and the cut-off point for how long it must remain under the 30% threshold limit to be counted as deforestation? More detail here would be helpful.	The GFC reviewed the deforested areas i.e. areas > 1ha in 2013. Mining consistently remains the largest contributor in area terms (~85%), so has been the main focus. The study findings are documented in the 2013 MRV report. The main findings of this work indicate that: Abandoned mining sites can be detected and monitored using high resolution imagery. A methodology has been adapted to allow temporal monitoring of these areas in the MRVS. The field inspections indicate that the rate of regeneration is very slow. In all historical mining sites visited (period 1990 to 2012) the forest cover had not regenerated to a state where the biomass is measurable. This indicates that the change in environmental conditions caused by mining inhibits the ability of these sites to regenerate. Hence the biomass accumulation is very low, due to mining impacts on the soil structure. The recommendation was that these sites be revisited after 10 years to determine how the sites are recovering in terms of vegetation types and carbon accumulation rates. The MRVS tracks all deforested sites so if abandoned these areas can readily identified and revisited. For other land use drivers like abandoned agricultural or burnt areas over time may also afforest, but the combined area is quite small. Text added to Section 4.2.
5. We understand from the report that work is being done on emission factors. However, more detail on which emission factors have been used in estimations would make the report more transparent.	Indeed, during the period 2017, work continued on forest carbon monitoring. A section has been added to Section 2.4 on MRVS Development and Progress in the Year 7 Report. This is presented below for reference: In Year 7, forest carbon measurement featured progress on three main areas: reporting on emissions, revised forest carbon stratification and mapping, and emission factors for main forest degradation drivers.

	These are described below: ***Reporting:*** A key aspect of the work that was conducted in Year 6 and 7, was that of parallel reporting on forest change, i.e. reporting on both activity and emissions data. In this, the Emissions Reporting tool was updated to report taking account of this development. The activity data and emission factors generated from the MRVS are combined to estimate total CO2 emissions by source or driver under Guyana's REDD+ programme. Both the Workbook for Estimating Historic CO2 Emissions from Deforestation and Selective Logging and the relevant IPCC Reporting tables have been updated. ***Emission Factors:*** Work has also concluded on developing an emission factor for mining degradation and related infrastructure, as well as shifting cultivation. These along with the emissions reporting on forest harvest (which is done through the Gain Loss Method) completed the emission reporting on the suite of forest degradation drivers prevailing in Guyana. ***Carbon Stratification:*** As part of its national REDD+ program, the Government of Guyana completed a forest carbon stratification in 2011 for the purposes of designing a sampling plan to accurately understand the country's forest carbon stocks20. This stratification divided forest area into categories based on two factors: 1) the threat of deforestation, or potential for future land use change (PFC) that exists in the forest area, and 2) the accessibility to the forest area. The inclusion of different threat or PFC classes (high, medium and low) was based on the knowledge that, due to forest degradation, forest areas under higher PFC were likely to have lower carbon stocks than areas under low threat. In 2013, updated spatial input layers were used to revise the stratification21. Observed deforestation trends between 2011-2013 led to the inclusion of "distance from non-forest lands in the eastern administrative regions" as an additional variable to establish the PFC classes. A final 2013 stratification map was produced and used for the sampling design and reference level development. Since 2013, development and deforestation trends have continued to be closely monitored in Guyana and some of the input layers used as variables for the stratification map have changed somewhat—roads networks have expanded, concession boundaries have changed and areas that were once forest have undergone land use change. These changes created the need to update the stratification map for future monitoring periods of Guyana's REDD+ program to ensure more accurate accounting of changes in forest carbon stocks. As such, in Year 7, the Forest Carbon Stratification Report with Carbon Maps were updated over the year 7 reporting period. Text added to Section 2.4.

[20] Petrova S, Harris N, Brown S and Persaud H (2011) Spatial techniques for forest carbon stratification and sampling design for Guyana. Submitted by Winrock International to the Guyana Forestry Commission.
[21] Petrova S, Goslee K, Harris N and Brown S (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.

CI Guyana	
This review is intended to provide a technical assessment of the Year 7 MRVS Interim Report. Guyana's MRVS is a national system with great potential to set the learning curve and standard for the development of similar systems. The Guyana Forestry Commission (GFC) and partners should be commended once again for their dedication towards conducting the Forest Area and Carbon Assessments and reporting at such a high technical caliber. Specifically, it is important to acknowledge the credible move toward newer satellite constellations with the aim of improving overall efficiency of the report. At the same time, this allows reporting to evolve from interim reporting to a fully-fledged forest monitoring system that may be able to respond to the interests of the various sectors.	Thank you, noted.
SUMMARY *Pg i: Reforestation of previously deforested sites is currently monitored using GIS once a deforestation site shows signs of being abandoned. Evidence suggests that these sites take a considerable time to regenerate.* ➢ Having an understanding of the time taken for forest cover to be regenerated might be beneficial for further investigation or research. This is true especially for mining –bareland areas.	Yes, this is considered important to further improve knowledge of the time it takes for areas to revegetate. It is now possible to better understand the land use and cover change patterns as these are stored in the GIS. GFC consider that a pragmatic approach would be to revisit sites of the 2013 study to document any changes that have occurred. This would assist to confirm any earlier assumptions made. For all indications however, the process is slow. Text added to section 4.2.
2.4.5 Build capability of local communities and stakeholders to monitor forests ➢ How were these communities chosen? Can an indication of the participation be provided, for example adding the number of participants per community to table. *Pg. 6 Overall, the National MRV is an integral component for Guyana in achieving its REDD+ targets and international commitments. CMRV has the potential to assist in feeding information back into the National MRV. This process, if successfully implemented, can significantly reduce the cost for MRV, as well as, ensure that the benefits are spread out across the groups involved.* ➢ How does the GFC envision the use of the CMRV in reporting?	The Communities were chosen based on the prevalence of various (and in some cases a combination of) drivers of deforestation and forest degradation. On average 10 persons were engaged at each community level. CMRV reporting is intended to: provide ground based validation of the national map, develop capacities at community level to monitor forest change, and create a circular flow of information and capacities in monitoring and reporting from national to community level and vice versa. Text added to Section 2.4.5.
2.4.6 Prepare scientific publications and syntheses	This has been a priority for the GFC. From the context of within the GFC, the GFC's staff through the field work of the

➢ How are local researchers encouraged to prepare publications from within and outside of the GFC?	Commission or through the analytical work of staff has contributed to several publication and PhD work mentioned in this section. Three other publications are in the pipeline for 2019. The GFC also is able to use these capacities to develop and contribute to reports showcasing the Guyana model, at various international project levels including at ONFI (through the ECOSEO Project), GFOI, and ACTO. In terms of outside of the GFC, the Commission has entered into several MoUs on MRVS data sharing and training including with agencies such as the University of Guyana, the Protected Areas Commission, and the Environmental Protection Agency. This has the primary intention to foster research at the University and other technical agency level. The GFC also supports international research work from universities including the University of Leeds. Text added to Section 2.4.6.
3.1 Agency Datasets ➢ The Guyana Lands and Surveys Commission is under Ministry of the Presidency and no longer under the Ministry of Natural Resources. See table reference on page 9.	Thank you for pointing this out. Indeed this is correct. We have made the modification. Correction made to Table 3-1.
Figure 5-2: Forest Change by Reference Period ➢ Map provides a good representation of forest change. Very clear.	Noted.
2016 (Year 6) CAR 5 MINOR: Non-Compliance: No operational linkage between CMRV and the national MRV ➢ It is noted that the GFC has commenced work on addressing this CAR.	Noted.