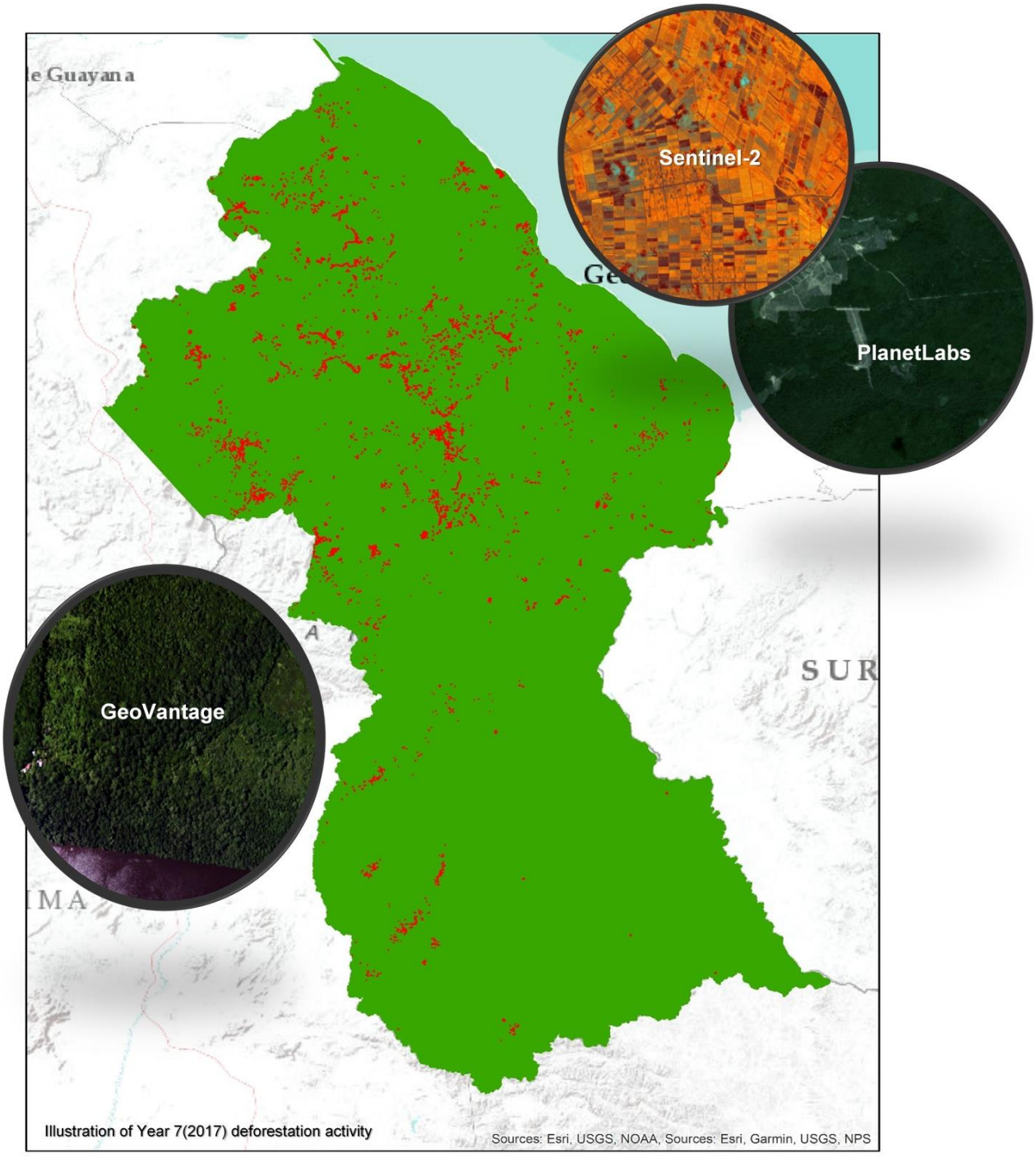
Guyana Forestry Commission

Guyana REDD+ Monitoring Reporting & Verification System (MRVS)

Year 7 Summary Report

1 January 2017 to 31 December 2017



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.

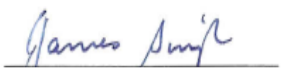
Reporting will continue to be based on the REDD+ Interim Indicators as outlined by the areas expressed in the Joint Concept Note or any other reporting framework agreed between Guyana and Norway, while streamlining these REDD+ performance indicators. It also represents advancement of the implementation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

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.

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 verification by 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. This summarised version is intended to provide a synopsis of the main methods and results of the MRVS.

This Summary Report is issued by the Guyana Forestry Commission (GFC). Indufor has provided support and technical advice to the GFC.



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Guyana Forestry Commission

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.

[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.

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).

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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1. 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.

a.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.

a.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.

a.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 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 2016) 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.

c.1. Improve methodology for treatment of Shifting Cultivation, if deemed necessary.

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

c.2. Build capability of local communities and stakeholders to monitor forests

The GFC embarked on a programme in 2018 to build capacities of 25 Indigenous communities in CMRV. To date there has been 23 communities trained across the country in theoretical and practical aspects of CMRV (please see table below with villages).

Village Name	Region
Tapakuma/St. Denny's	2
Bethany	2
Mashabo	2
Capoey	2
Mainstay	2
Batavia	7
Batavia	7
Riverview	7
Kumu	9
St. Ignatius	9
Moco Moco	9
Shulinab	9
Toka	9
Katoka	9
Rupertee	9
Woweta	9
Surama	9
Kwatamang	9
Annai Central	9
Moraikobai	10
Muritaro	10
Santa Aratak	10
St. Cuthbert's	10

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 greatly 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 social groups involved.

c.3. 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) point 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.

2. DISTRIBUTION OF TENURE & BY IPCC LAND CLASSES

Table 2-1 shows the area by the adopted IPCC classes, as at the end of Year 7 (2017). The revised forest area includes the forest area lost during the Year 7 mapping period.

Table 2-1 - Tenure by Adopted IPCC Land Cover Classes Error! Reference source not found.

2.1 Monitoring Datasets - Satellite Imagery

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.

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 2-1: 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.

3. 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.

3.1 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.

3.2 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:

1. Harvesting of timber (reported since 2011 using the Gain Loss Method)
2. Shifting cultivation (reporting method under review)
3. Fire
4. 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.

Table 3-1: Summary of Activities & Drivers Captured in the MRVS

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 >0.25 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	Yes	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		Yes	Degraded forest by type
Infrastructure	Deforestation	Roads >10 m	Existing road network Satellite imagery	Yes	Settlements
	Degradation	Assess any area >0.25ha within 100 m buffer around deforestation event – road or new infrastructure - revisit sites post 2011 to assess change	Existing deforestation sites, Satellite imagery	Yes	Degraded forest by type
Shifting Agriculture	Degradation	Assess historical patterns	Proximity to rural populations, water sources and Satellite imagery	Yes	Degraded forest by type
Reforestation/ Afforestation	Reforestation	Monitor abandoned deforestation sites	Historical land use change, Satellite images	Yes	Reforestation Forest or land cover by type
	Afforestation	Monitor historical non forest areas	Satellite imagery	Yes	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.

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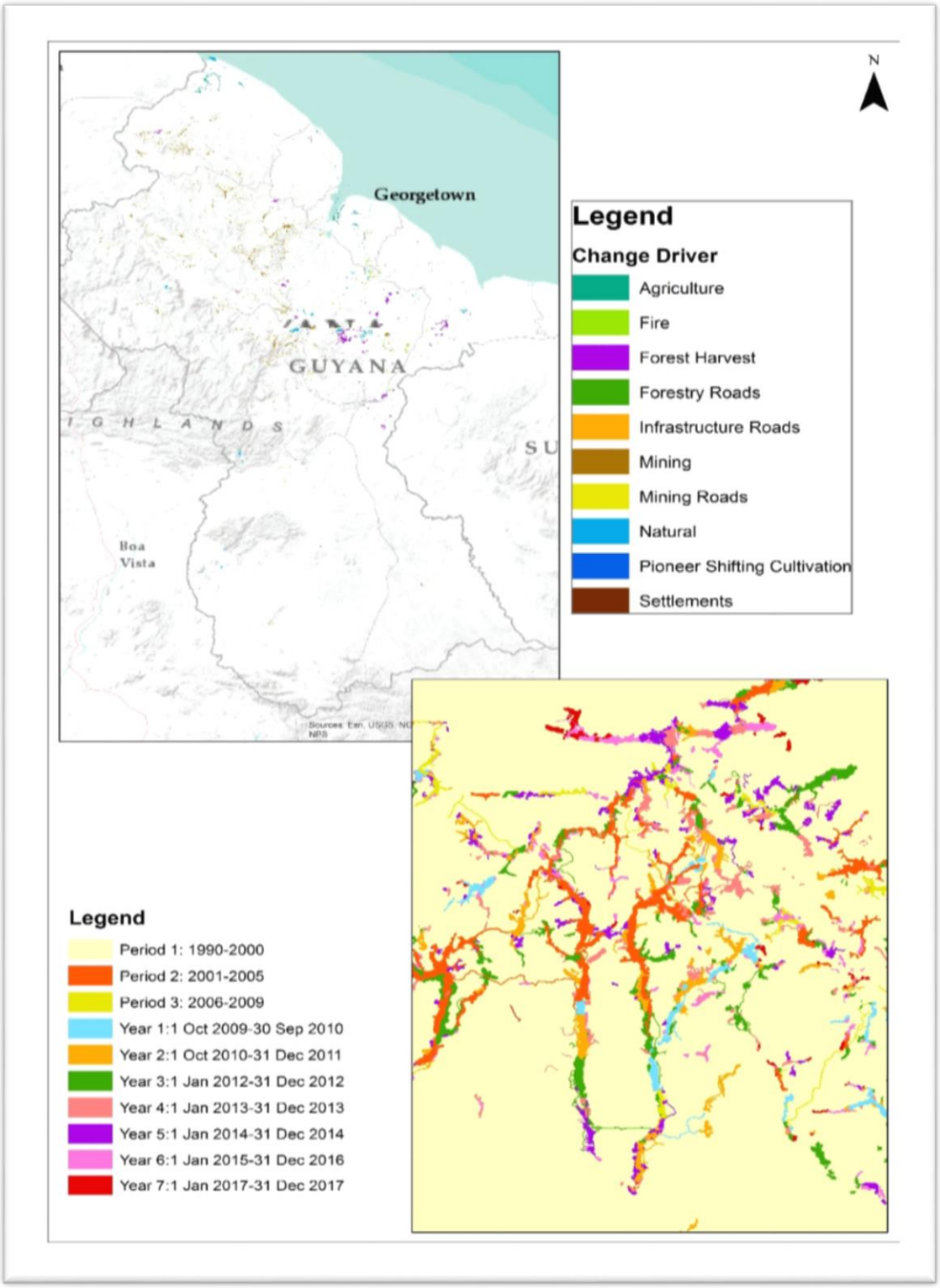
Supplementary GIS layers are also included in the decision-making process to reduce this uncertainty. The decision-based rules are outlined in the mapping guidance documentation, or Standard Operating Procedures (SOPs). This documentation, held at GFC, provides a comprehensive overview of the mapping 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 3-1: Example of Forest Change Mapping



3.3 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.

4. 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 4-1 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 4-1: 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

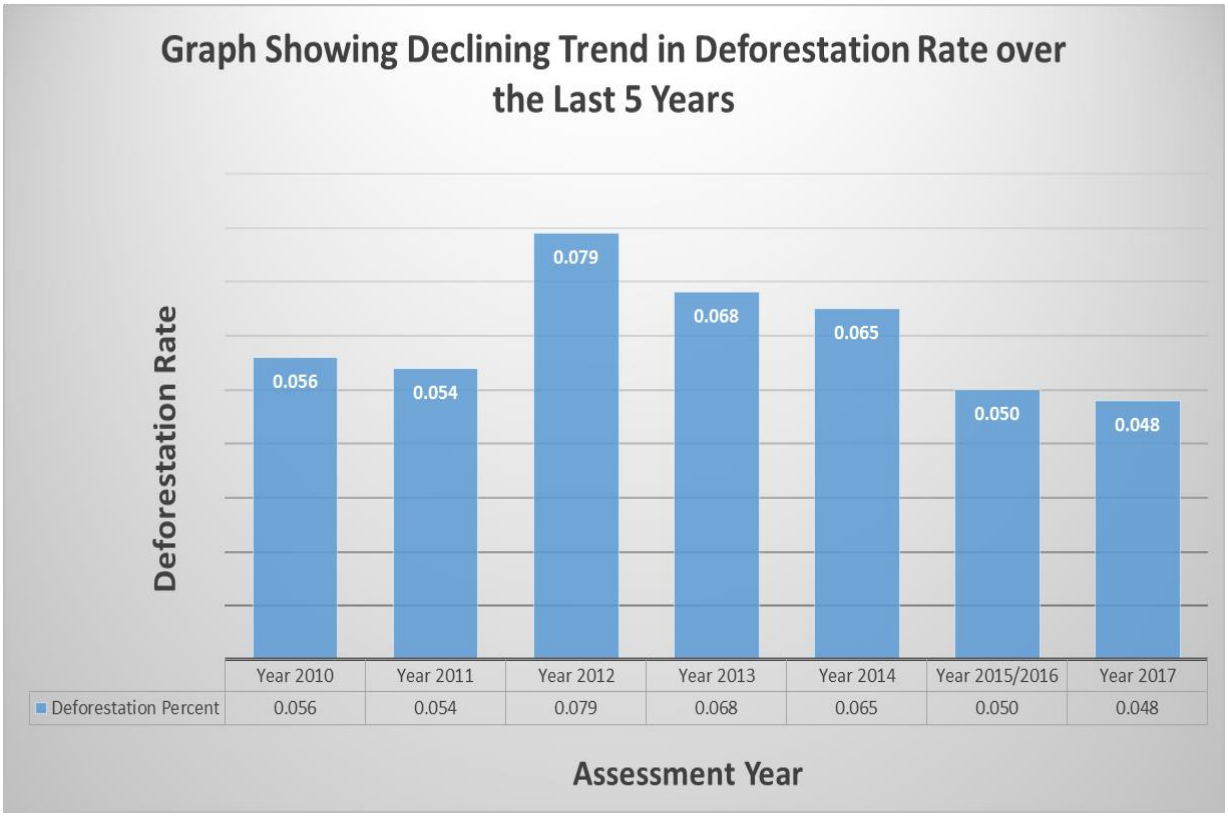
Overall, Guyana's deforestation rate is low when compared to the rest of South America. FAO's 2015 Forest Resource Assessment (FRA) indicated that annual forest loss for the continent is around -0.43%/yr[2].

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.

[2] 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 4-1: Annual Rate of Deforestation by Period from 1990 to 2017



Results for year 2017 deforestation assessment are presented below and show a continuing reduction on the rate of deforestation or loss of forest. The rate of deforestation for Year 2017 is 0.048%, which is a reduction from the year 2016 assessment which concluded on a deforestation rate of 0.05%. Mapping of forest degradation is being finalized for Year 2017.

Table 4-2- Percentage Deforestation by Year

Year	***Deforestation Percent***
Year 2010	0.056
Year 2011	0.054
Year 2012	0.079
Year 2013	0.068
Year 2014	0.065
Year 2015/2016	0.050
Year 2017	0.048

Table 4-3 - Deforestation by Drivers

DRIVERS	**HECTARES OF FOREST LOSS**
Mining	6,495
Mining infrastructure	947
Forestry infrastructure	227
Infrastructure	195
Agriculture	477
Settlements	7
Fire	502
Total	**8,851**

4.1 Forest Change by Driver - Deforestation

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

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 4-4 provides a breakdown by forest change drivers.

Table 4-4: Annualised Rate of Forest Change by Period & Driver from 1990 to 2017

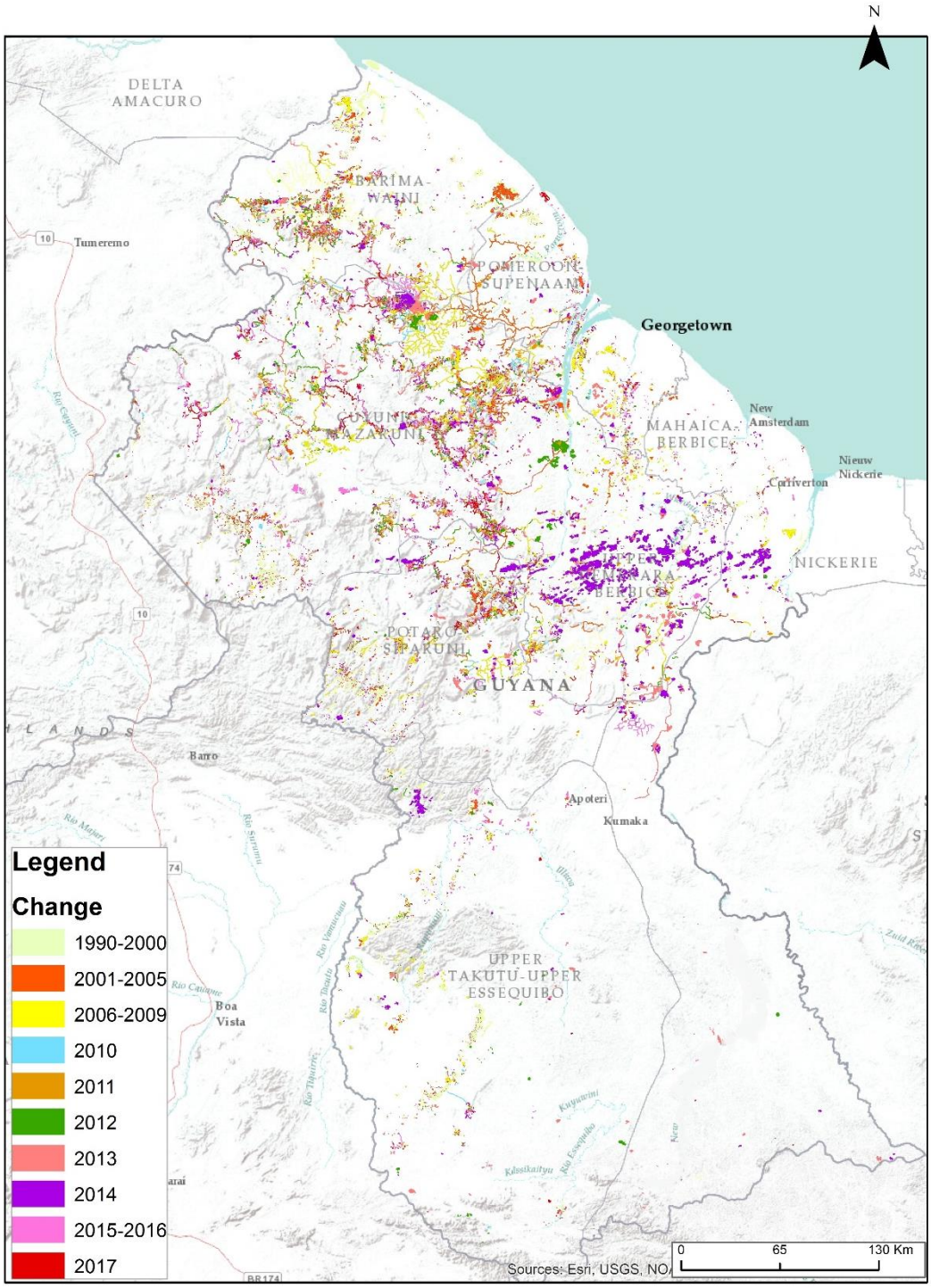
Reference Period	Change Period	Change Period	Annualised Rate of Change by Driver						Annual Rate of Change (ha)
			Forestry	Agriculture	Mining	Infrastructure	Fire	Settlements	
		(Years)	Annual Area (ha)						
Historic	1990-2000	10	609	203	1 084	59	171	-	2 127
	2001-2005	5	1 684	570	4 288	261	47	-	6 850
	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**

4.2 Deforestation Patterns

The temporal analysis of deforestation by reporting periods is presented in Figure 4-. The map, which presents change from all drivers, shows that most of the change is clustered[3] 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

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

Figure 4-2: 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.

4.3 Forest Change Across Land Classes

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

Table 4-5: 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%**	

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 has 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 4-2 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.

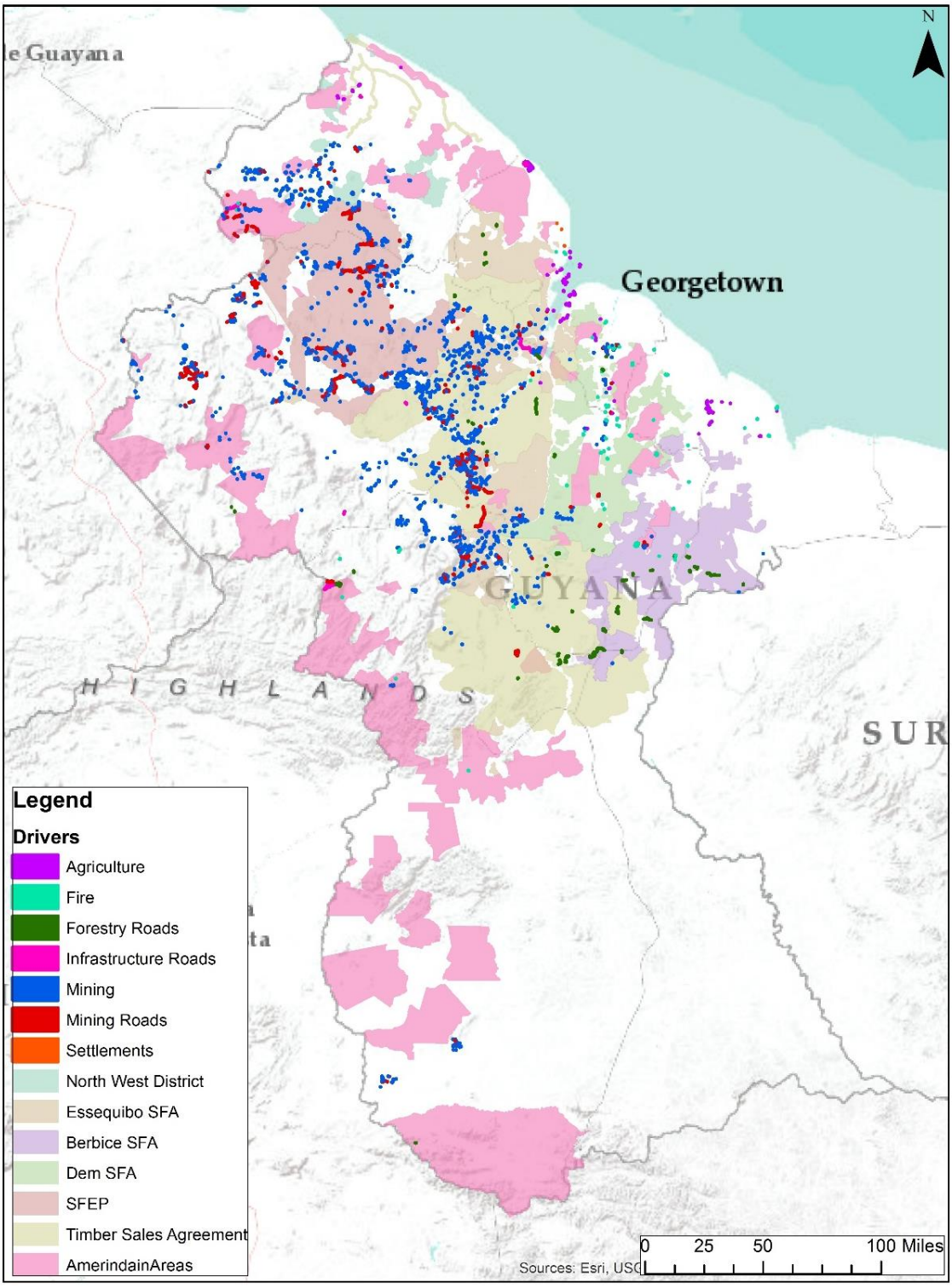
Biomass Burning - Fire
Fire events have declined relative to the spike noted in the previous year (1 509 ha) with an area of 502 ha mapped. Spatially, they follow historic trends, where events occur in the white sand forest area surrounding Linden and extends towards the eastern border of Guyana.

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 4-2 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 4-2Spatial Distribution of Forest Change Drivers (2017)



4.4 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.

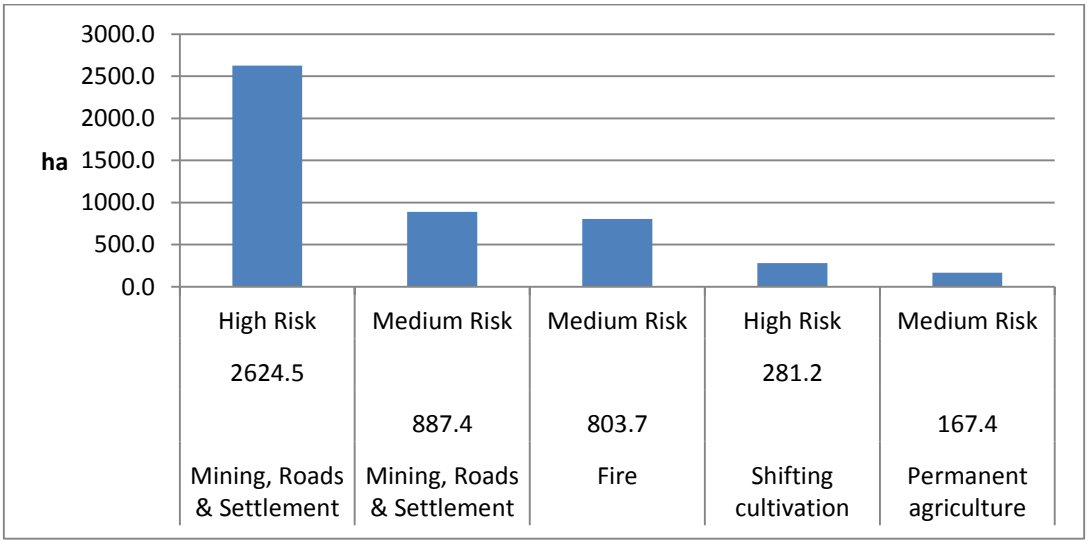
3. In year 6 (covering the 24 months of 2015 and 2016) the existing “wall to wall” degradation method outlined in step 2 was replaced with the sample-based statistical estimation approach.

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



5. 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[4]. 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 **Error! Not a valid bookmark self-reference.**1. The calculations to determine the rate of deforestation (ref. measure 1) are reported in Section 3.3.

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.

[4]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 5-1: 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 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[1]	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[2]	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[3]	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)[4].	*ha/yr*	Not yet established	93	281	N/A

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

[2] 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.

[3] 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.

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

5.1 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.

5.2 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[5]. 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.

5.3 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)*".

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).

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

- 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.

5.4 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.

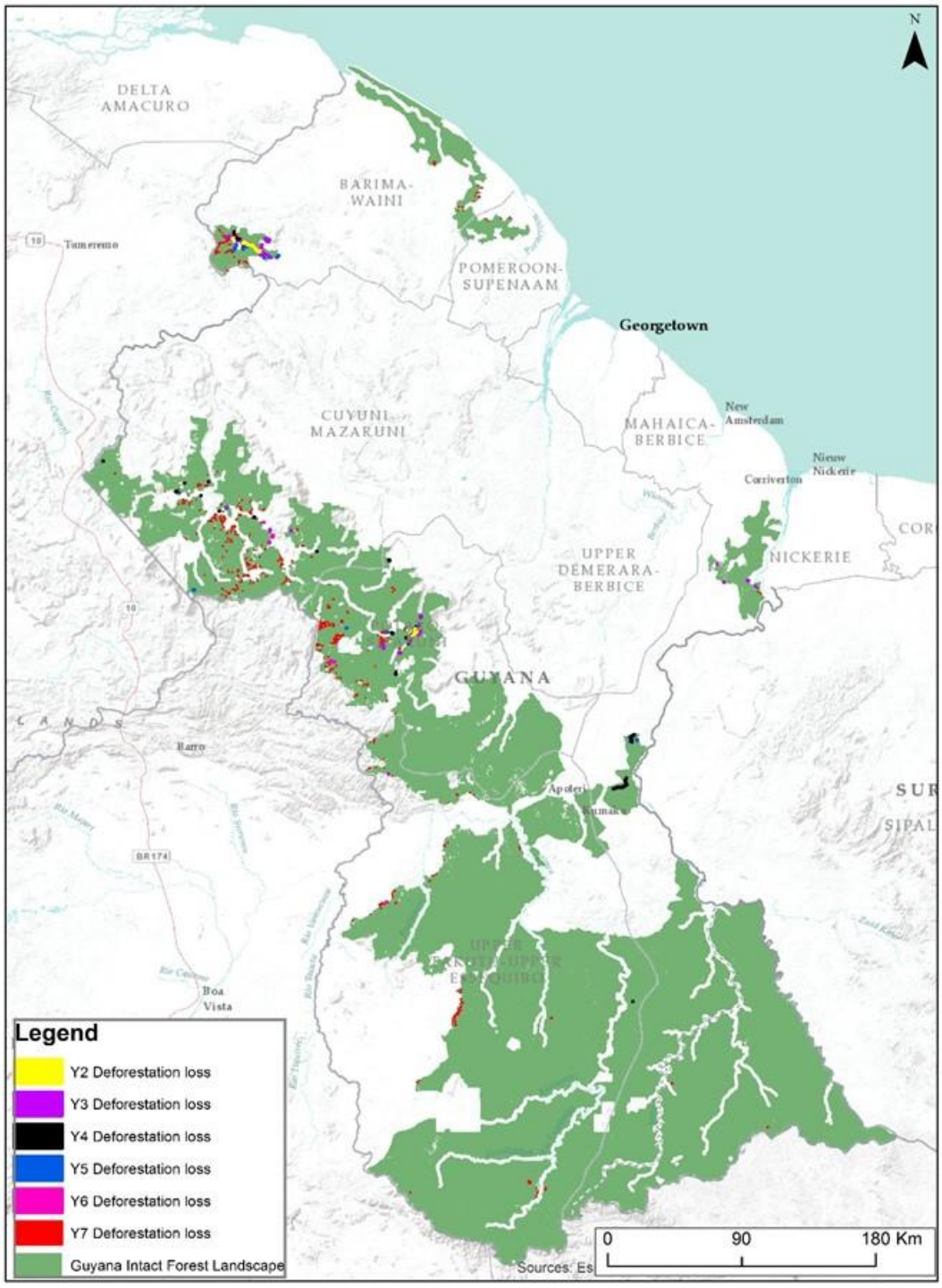
5.5 Calculation of the Year 6 Intact Forest Landscape

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

Map 5-1: Intact Forest Landscape Maps



5.6 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.

5.7 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 2016 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 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 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**

5.8 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.

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.