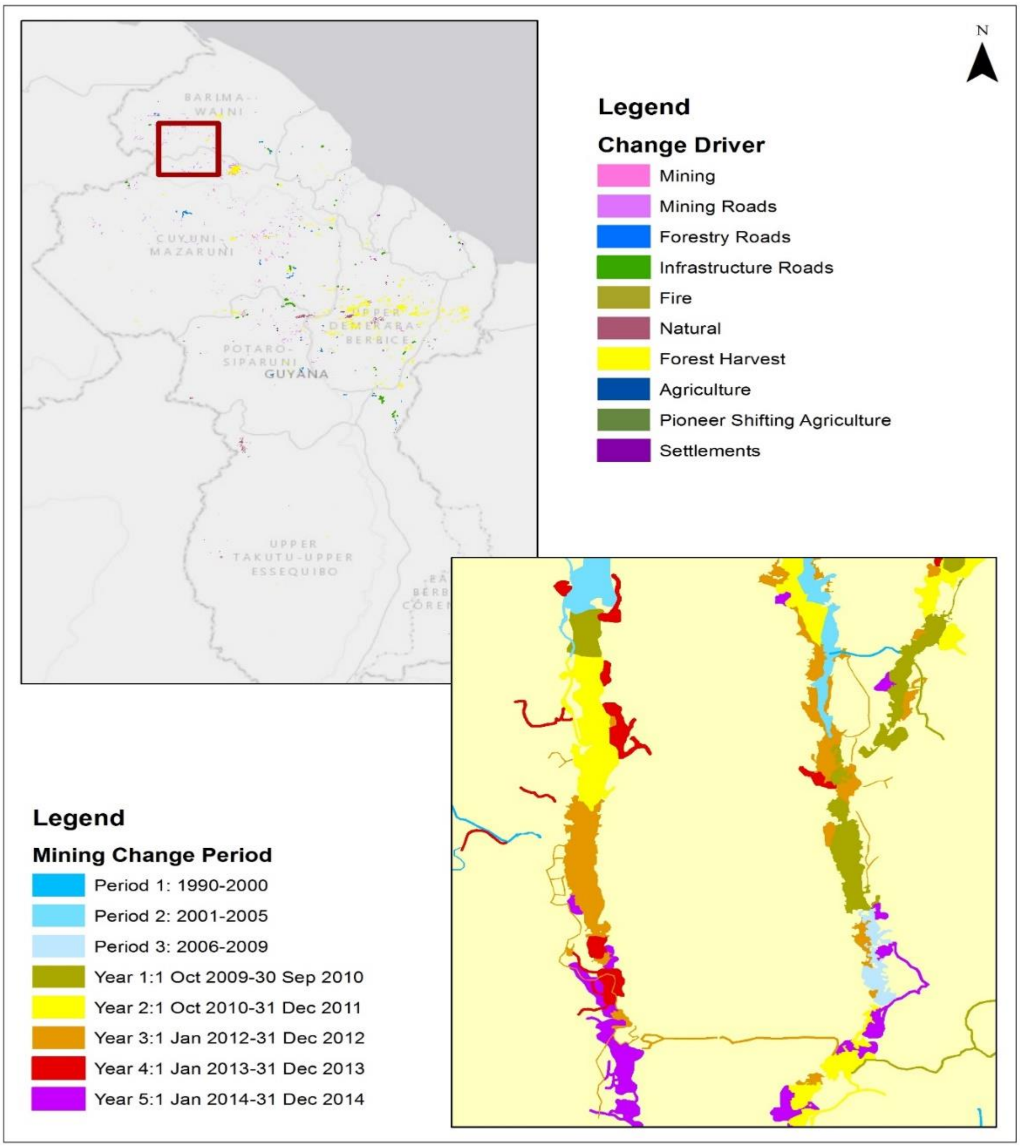
Guyana Forestry Commission

Guyana REDD+ Monitoring Reporting & Verification System (MRVS)

Year 5 Interim Measures Report

1 January 2014 – 31 December 2014



Version 3

30th November, 2015

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.

Guyana Forestry Commission
Ensuring Sustainable Forestry

PREFACE

The Joint Concept Note (JCN) between the Cooperative Republic of Guyana (CRG) and the Government of the Kingdom of Norway identifies the stepwise and progressive development of the Guyana Monitoring Reporting and Verification System (MRVS) as an "Indicator of Enabling Activity" as outlined in the JCN, Section 2. The JCN also outlines the mechanism for financial payments for forest carbon based services to Guyana. These payments are results-based with deforestation and forest degradation measured against an agreed level.

In 2009 Guyana developed a framework for a national MRVS. This framework was developed as a "Roadmap[1]" 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 a number of 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 will support 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, five national annual 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. This fifth assessment (Year 5) covers the calendar year of 2014.

The agreement between Guyana and Norway launched one of the first national-scale REDD+ initiatives in the world. It is important that the development and implementation of the MRVS is seen as a continuous learning process that is progressively improved. This is particularly relevant as the MRVS matures and the trends and drivers of forest change are better understood. This process also assists to inform other countries seeking to take this same path.

In tandem with the work summarised in this report, an accompanying and closely connected programme of work is being implemented by Guyana Forestry Commission (GFC), with the assistance of a specialist firm (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, will be 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. In accordance with the MRVS Road Map both aspects of work started in Year 2.

As the MRVS is being 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 a number of "Interim Indicators for REDD+ Performance in Guyana" for the period 01 January 2014 to 31 December 2014, as identified by the JCN Table 2 These intermediate indicators allow for reporting to take place in the interim, while the full MRVS is under development.

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[1] http://www.forestry.gov.gy/Downloads/Guyana_MRV_workshop_report_Nov09.pdf

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 2014 to 31 December 2014 will be subject to independent third party verification. This is a requirement under the JCN to enable the results-based financial payment for 2014. The fifth verification will take place in November, 2015, and will be conducted annually for the duration of the Guyana/Norway Partnership.

Version 1 of the Report was released for a 1 month period (7th October, 2015 – 7th November, 2015) for feedback. Following the period of public review, Version 2 of the report was developed and included 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 was subject to independent third party verification by Det Norske Veritas (DNV-GL), an independent verification firm contracted by the Government of Norway. This 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 is also developed and is 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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Guyana Forestry Commission

SUMMARY

In early 2015, a revised Joint Concept Note (JCN) under the Guyana/Norway Agreement was issued, and replaced the JCN of 2012. The revised JCN provides an update on progress in key areas of work including the MRVS. REDD+ Interim Indicators and reporting requirements, as had been outlined in the 2009, 2011, and 2012 JCNs, were maintained. The intention is that these interim measures will be phased out as the Monitoring Reporting and Verification System (MRVS) is fully established[2].

The basis for comparison of the area-based interim measures is the 30 September 2009 Benchmark Map[3]. The first reporting period (termed Year 1) spanned 01 October 2009 to 30 September 2010. Thereafter an annual assessment has been conducted. This report presents the findings of the fifth national assessment.

The MRVS reports on forest change, both deforestation and degradation, by change driver through the interpretation of a national coverage of high resolution 5 m imagery. The same dataset has also been used to improve the historical (1990) delineation of forest and non-forest areas. The total forested area used in this assessment is 18.48 million hectares (ha).

Forest change of forest to non-forest excluding degradation between 1 January 2014 and 31 December 2014 (12 months) is estimated at 11 975 ha. Over the Year 5 reporting period, this equates to a total deforestation rate of 0.065%. This rate of change is lower than the previous Year 4 period which was reported as 0.068%. In Year 5, as in previous years an independent map accuracy assessment has been undertaken by a team from the University of Durham. The accuracy of the activity (area) data has been the focus of these assessments to date.

The Year 5 accuracy assessment has independently determined a deforestation rate of 0.062% with a standard error of 0.008% at the 95% confidence interval. The full results of the independent map accuracy assessment are provided in Appendix 7.

Year 5 forest degradation has been calculated and is compared against a 2011 benchmark value of 4 368 ha. Since its first year of assessment (Year 2), forest degradation has fluctuated; from 5 467 ha in Year 2, to 1 963 ha in Year 3 and 4 352 ha in Year 4. Year 5 is reported at 4 231 ha which is in line with Year 4 values and represents a slight decrease. These fluctuations are due to a consolidation of mining operations around existing infrastructure.

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.

The main deforestation driver for the current forest year reported (Year 5) is mining (sites and roads) which accounts for 85% of the deforestation in this period. The majority (83%) of the deforestation is observed in the State Forest Area. The temporal analysis of forest change post-1990 indicates that most of the change is clustered around existing road infrastructure and navigable rivers. In Year 5 the change has continued primarily near the footprint of historical change.

The improvements in detection of forest area due to enhanced resolution is a significant development even though it does not affect the overall deforestation rate for Year 5. This information provides a useful basis for planning an on-going monitoring programme that focuses on key hotspot areas and assists in the development of policies that can mitigate potential impacts of deforestation. These include, but are not limited to, the implementation of the National Land Use Plan as well as any developing Action Plan for advancing a green economy.

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[2] The Participants agree that these indicators will evolve as more scientific and methodological certainty is gathered concerning the means of verification for each indicator, in particular the capability of the MRV system at different stages of development.

[3] 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.

The findings of this assessment will enable targets for REDD+ activities to be designed that aim to bring about the largest positive impact in maintaining 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. In this report, the analysis covers the benchmark period (1990-2009), the first year (Year 1) the second year (Year 2) the third year (Year 3) and the fourth year (Year 4) and fifth year (Year 5) of reporting.

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. In Year 5, for the second time new shifting agriculture areas are reported under forest degradation.

Table S1: Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 2 Period	Year 3 Period	Year 4 Period	Year 5 Period	Difference between Year 5 & Reference Measure
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change (%)/yr*	0.275%	0.054%	0.079%	0.068%	0.065%	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	7 604 754 (66 ha loss)	7 604 580 (174 ha loss)	7 604 425 (155 ha loss)	7 604 314 (111 ha loss)	- 506 ha *(111 ha loss in Year 5)*
2b		Determine the extent of degradation associated with new infrastructure such as mining, roads, settlements post the benchmark period[7].	*ha*	4 368	5 460	1 963	4 352	4 251	117 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[4]	3 685 376[5]	2 159 151	3 106 693	3 366 326	20 452
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	18 289	11 217	11 533	13 823	398 033
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	*ha/yr*	1 706[6]	28	208	395	265	1 441
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).	*ha/yr*	-	-	-	765	167	-

[4] 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. This Reference measure is presented in this Year 4 report for 12 months as Year 4 spans 12 months. The prorated value for this reference measure was presented for Year 2, equated to 15 months to aid comparability with the 15 month period for Year 2. The same is the case for the Reference level for illegal logging for Years 2, 3 and 4.
[5]Computed for the period 1 October 2010 to 31 December 2011. (15 months)
[6] Degradation from forest fires is taken from an average over the past 20 years.
[7] This value is inclusive of all degradation drivers except for rotational shifting agriculture.

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.

Table S2: Impending Interim Measure

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Reference Measure	Year 2 Period	Year 3 Period	Year 4 Period	Year 5 Period	Difference between Year 5 & Reference Measure
7	Encouragement 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	N/A	N/A	N/A	73	N/A

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APPENDICES

ACKNOWLEDGEMENTS

In addition to GFC, a number of agencies and individuals have assisted in providing inputs into the MRVS programme. GFC and Indufor would like to acknowledge the support of the Department of Natural Resources and the Environment 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.
- CI for their role in supporting the implementation of this, as well as other aspects of the Guyana MRVS, and for the exemplary efficiency and expertise in its collaborative role with the GFC.
- ESRI for providing support in GIS software and overall technical support.
- Norwegian Space Centre for supporting the advancement of work on accuracy assessment and evaluation of new satellite systems
- Winrock International for work on the forest carbon monitoring system.
- Guiana Shield Facility and UNDP for supporting work under the MRVS.
- Other Partners

GLOSSARY

The following terms and abbreviations are used throughout the report.

ESA	European Space Agency
Geo FCT	The Forest Carbon Tracking Task force
GFC	Guyana Forestry Commission
GGMC	Guyana Geology and Mines Commission
GIS	Geographic Information System
GLCF	Global Land Cover Facility
GL&SC	Guyana Lands & Surveys Commission
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GPS	Global Positioning System
GV	Green Vegetation
INPE	National Institute for Space Research in Brazil (Instituto Nacional de Pesquisas Espaciais)
IPCC	Inter-Governmental Panel on Climate Change
IRS (LISS)	Indian Remote Sensing Linear Self Scanning Sensor
LAI	Leaf Area Index
LCDS	Low Carbon Development Strategy
LULUCF	Land Use, Land Use Change and Forestry
MERIS	Medium Resolution Imaging Spectrometer
MMU	Minimum Mapping Unit
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MRSid	Multi-resolution Seamless Image Database
MRVS	Monitoring Reporting and Verification System
MS	Multispectral
MSAVI	Modified Soil Adjusted Vegetation Index
Radar	Radio Detection and Ranging
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus Sustainable Forest Management
SAIL	Scattering by Arbitrarily Inclined Leaves
SAVI	Soil Adjusted Vegetation Index
SFA	State Forest Area
SMA	Spectral Mixture Analysis
SPOT	Satellite Pour l'Observation de la Terre
SRTM	Shuttle Radar Topography Mission
SWIR	Short Wave Infrared
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations REDD Programme
USGS	United States Geological Survey
VNIR	Visible and Near Infrared
WWF	Worldwide Fund for Nature

1. INTRODUCTION

1.1 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.

1.2 Guyana Low Carbon Development Strategy

The Cooperative Republic of Guyana has embarked on a national programme that aims to protect and maintain its forests in an effort to reduce global carbon emissions and at the same time attract resources to foster growth and development along a low carbon emissions path.

On 8 June 2009, Guyana launched its Low Carbon Development Strategy (LCDS). The Strategy outlines Guyana's vision for promoting economic development, while at the same time contributing to combating climate change. A revised version of the LCDS was published on 24 May 2010 and subsequently an LCDS Update was presented to the public in March 2013. The LCDS aims to achieve 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 87% of its land area covered by forests, approximately 18.5 million ha. Historically, relatively low deforestation rates have been reported for Guyana.

Guyana's LCDS has expressed Guyana's commitment to providing a model of how to address the second most important source of carbon dioxide emissions world-wide. Deforestation and forest degradation are estimated to contribute approximately 12% of global emissions (IPCC). Guyana's forest resources have the potential to make a large contribution to the emission-reduction efforts targeted by the Kyoto Protocol (as part of the United Nations Framework Convention on Climate Change, UNFCCC).

Guyana currently records a comparatively low deforestation rate, reported in its Interim Measures MRVS Report, as ranging between 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 activity undertaken, as summarised in this Report, forms part of the fifth year of the three-phase Road Map developed for Guyana's MRVS. The objective of the initial MRVS Road Map activity is 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, and this year 5 period covers the commencement of the first cycle of the Phase 2 Roadmap in the area of knowledge and capacity sharing.

1.3 Establishing 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 previous 2010 report prepared by GFC provides a detailed description of this process.

In summary, this process involved:

- Determination of the 1990 forest area using medium resolution satellite images (Landsat) by excluding non-forest areas (including existing infrastructure) as at 1990.
- From this point forward accounting for forest to non-forest land use changes that have occurred between 1990 and 2010 using a temporal series of satellite data.

The 2010 Interim Measures report estimated that as at the benchmark period (30 September 2009) the total forest area that met the above definition was 18.39 million ha (± 0.41 million ha). This figure was further verified by the University of Durham (UoD) with an indicative accuracy of (97.1%).

The 2012 (Year 3) assessment used a forest area (including State Land, State Forest and Amerindian Villages) of 18.50 million ha as the starting point. The increase in forest area resulted from the re-analysis of the 1990 forest / non-forest classification. These boundaries were updated using 5 m satellite imagery. This was a necessary change in order to ensure the delineation of mapped change events are at a consistent resolution with the updated forest/non-forest boundary. This means that historical change was included in the reported forest area figures until year two. From year three forward, the analysis does not take into account historical change mapped from Landsat as it was undertaken using RapidEye imagery. This entails comparing different analyses based on imagery of significantly different resolution. To generate a truly comparative figure, a full 'back cast' analysis of historical change events at the updated RapidEye resolution would be necessary. This is a comprehensive exercise and would essentially entail an extensive long term analysis of all historical mapping periods, with reference to all historical imagery.

Any new land cover change for the Year 4 period has been subtracted from the revised forest area, as it was for Year 2. In year five there was a further shift in the basemap registration. This is due to updating from a GeoCover basemap at 30m resolution to a new basemap aligned with RapidEye's updated ground control points. This resulted in another minor revision in non- forest area. The non-forest area for Guyana has be updated and is benchmarked using this value.

A national coverage of RapidEye was first obtained in 2012 and 2013 - this constitutes a continued improvement on the historical Landsat data used. As with previous years this revision will be subject to independent audit, firstly by the accuracy assessors University of Durham (UoD) and secondly by the project verifiers Det Norske Veritas (DNV).

Similarly, in 2014 (Year 5) the forest area was again revised to a value of 18.48 million ha. This constitutes a difference of some 7 069 ha (gain) when compared to the Year 4 remaining forest area (18 475 478 ha) which would normally be used as the following year's (5) start forest area. The increase is largely a result of updates from RapidEye ground control points which has resulted in an increase in spatial accuracy of the imagery. This has resulted in a revision of the country boundary. Beyond that, the 2014 RapidEye has also enabled more accurate updates and allocation of forest and non-forest land classes which further justify the change. The presence of these area updates acknowledges that improvements are consistently being applied to the program where a genuine change has been recognized. At the same time, it is understood that changes to the total forest area are not ideal for temporal monitoring and may create uncertainty in reported values. That being said, the deforestation rate of 0.065% as reported for Year 5 is not affected with the 7 069 ha change in total forest area as this represents a change of less than 0.001%.

1.4 MRVS Development & Progress

There are several areas that are being actively developed and improved during the period that interim measures are recorded. This includes development of the monitoring systems to facilitate reporting on impending measures such as shifting cultivation and afforestation. The following text under this heading summarises all MRVS development and progress activities. A full outline of these activities is discussed in Chapter 10 (Development Areas).

The transition from medium resolution (30 m) Landsat to high resolution RapidEye images (5 m pixel resolution) has increased the opportunity to better delineate and detect land use change. Year 4 has utilized RapidEye imagery again, with supplementary Landsat 8 imagery used where no RapidEye coverage existed.

It is worth noting that currently there are very few operational medium resolution satellite systems that are freely available, or that obtain images frequently enough to allow national reporting of change. To reduce the risk of inadequate coverage GFC has invested in the tasking of an individual satellite data provider. The system is adaptable and able to analyze new datasets that may become available. Of interest is ESA's Sentinel 2A sensor which may provide a viable alternative to RapidEye. The overall aim is to improve operational methods and to phase out or replace the interim measures.

In following this approach further investment in data analysis and reporting tools and methodologies to monitor change has been made.

Year 5 Development Areas

Guyana has established a robust MRVS that is able to spatially account for the area of deforestation and degradation with confidence. There are several technical improvements that support the progressive introduction of relevant interim measures – i.e. shifting cultivation. Specifically these developments include:

- Continued development of a second reporting framework aligned to the IPCC Land Use, Land-Use Change and Forestry (LULUCF) template for annual assessments. This is based on the IPCC 2003 GPG tabular format. The LULUCF area change has been reported formally for the first time in 2014. To assist with this process a formalized excel-based tool has been developed. See Appendix 6.
- Update of the satellite base map to higher accuracy. RapidEye has updated the positional accuracy over Guyana using control points derived from VHR (Very High Resolution) Digital Globe imagery. The GFC team has updated and improve the existing base maps using RapidEye's improved 3A ortho-corrected product.
- Further sub-division of the non-forest area into the relevant IPCC classes. In preceding reports this area has been presented as 'non-forest'.
- Continued development of methodology and guidelines for mapping and monitoring shifting cultivation.
- Introduced a new interim measure monitoring the regeneration of deforested areas returning to degraded and active forest.
- At the time of the report's release – development of relevant emission factors for degradation due to mining and shifting cultivation activities.
- Refinement of the method for accuracy assessment data collection and analysis.
- Incorporation of deforestation modelling methods to predict future deforestation patterns

- Development of a partnership between FAO and the GFC. FAO has started developing the Space Data Management System (SDMS) which is a cloud-based system hosted at FAO, Rome. SDMS is designed to "Acquire, Query, Process and Deliver Earth Observation Data and Forest information products to participating UN-REDD countries". These processes are to be made available through country-specific web portals. Guyana has participated in this initiative. In Year 6 it is perceived that the SDMS will assist in streamlining the image data processing aspects of the MRVS.
- Increased national ownership of the MRV reporting process in processing and finalizing the MRV reporting process.

Future Development Areas

The future focus is to enhance the MRVS to ensure it keeps in line with international best practice guidance, new datasets, processes and routines. It is also clear that in a short space of time the monitoring programme has provided a clear overview of the location, scale and drivers of forest change. This information provides an understanding of reference levels for REDD+ through better understanding of carbon emission profiles by each driver.

- Integration of new satellite sensors into the MRV i.e. Sentinel 2A & Planet Labs. An accuracy evaluation of Sentinel 2A is proposed prior to integration into future MRV reporting.
- Evaluation of the relationship between remotely sensed data and degradation across two GFOI / ESA study sites.
- Collaboration with an expert-group, that is developing guidance material on appropriate methods to assist with the calculation of uncertainty associated with activity data.
- Further refinement of methods to quantify afforestation resulting from regenerating non-forest areas, and studies to show the carbon accumulation rate on abandoned mining sites. This work links in with Guyana’s planned mining reclamation project and the consideration of appropriate emission factors.
- Tracking of degradation to assess the areas transitioning from degradation to deforestation and those areas that are abandoned.
- Integration of carbon measurements with spatial datasets to create activity-specific emission factors for degradation and shifting cultivation. This work is in on-going collaboration with Winrock International.

2. LAND CLASSES

Tenure classifications in Guyana were changed in 2013 with the number of categories reduced from five to four as outlined in Table 2-1. This change means that Iwokrama and Kaieteur National Park are now amalgamated into a single class termed 'Protected Areas' for technical classification although still separate for administrative purposes.

State Forest Area

According to the Forest Act Section 3, Chapter 61:01, 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. Table 2-1 provides a summary of land eligible for inclusion under the MoU with Norway.

The eligible area of forest, which includes the State Forest Area (SFA) and State Lands under LCDS as calculated from the mapping analysis, is estimated at 14.81 million ha. This excludes Iwokrama, Kaieteur National Park and titled Amerindian Land. Combined, these forested areas make up 3.67 million ha.

Table 2-1: Updated Land Classes[7]

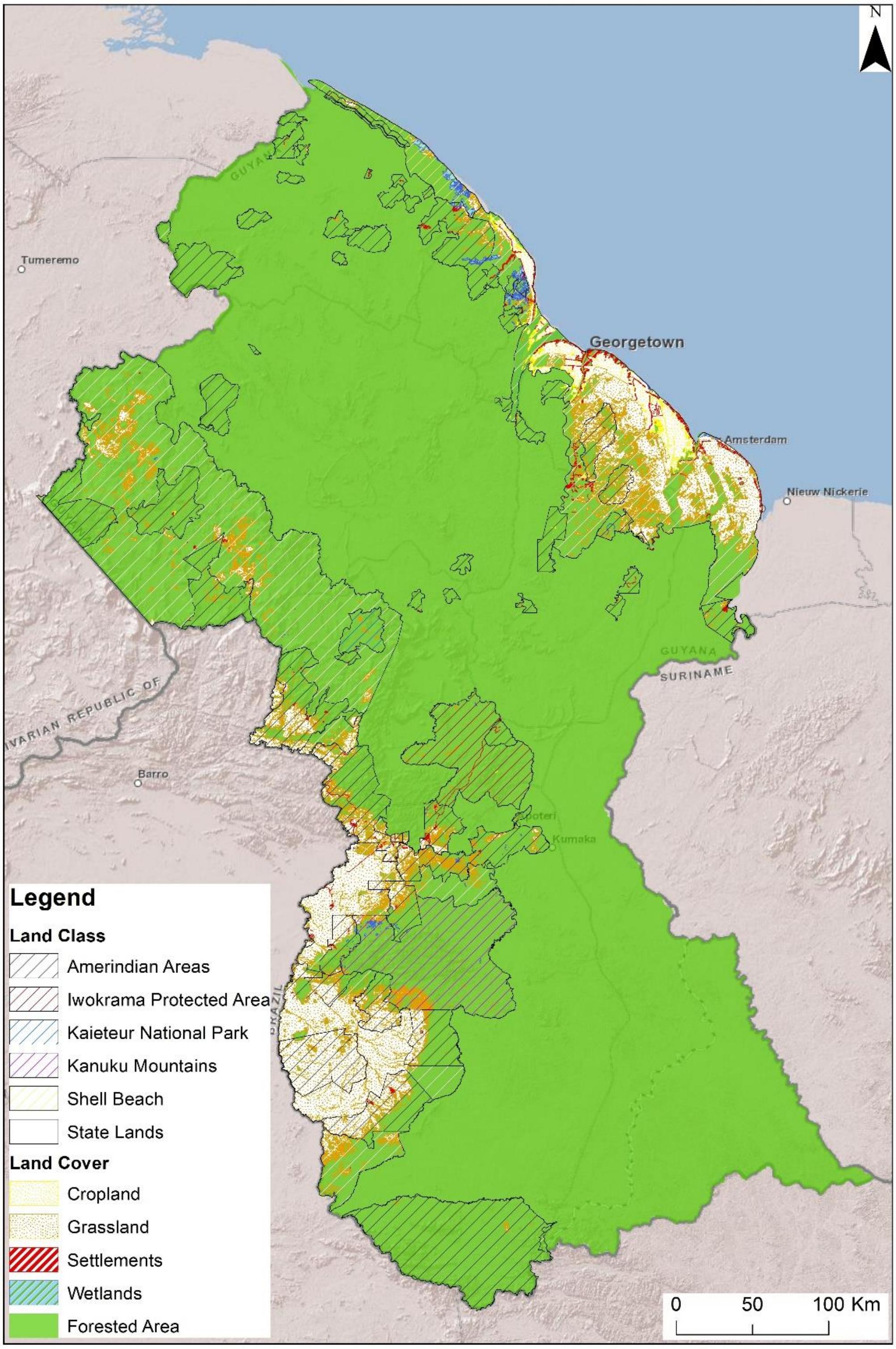
2014 Land Classes	Forest	Non-Forest					
		Grassland	Cropland	Settlements	Wetlands	Other Land	Total
	(Area '000 ha)						
State Forest Area	12 249	196	8	7	129	5	**12 594**
Titled Amerindian lands *(*including newly titled lands*)	2 582	695	3	9	22	4	**3 316**
State Lands	2 560	993	332	44	100	44	**4 073**
Protected Areas*	1 091	26	<1	<1	21	<1	**1 139**
Total Area	**18 483**	**1 910**	**343**	**60**	**273**	**54**	**21 122**

*Included for the purpose of broad classification but conditions may apply regarding payment for service agreements.
**It should be noted that the process for titling Amerindian lands changes the forested and non-forested areas for the remaining categories.

[7] Guyana's forest definition has been applied to distinguish forest and non-forest areas in categories listed.

The location of these areas is shown in Map 2-1.

Map 2-1: Land Classes



3. FOREST & LAND COVER DATASETS

For the interim measures report the total land area is divided by forest and non-forest components as determined at 30 September 2009 (Benchmark). This was originally created from interpretation of the Landsat time series and refined using the RapidEye imagery in 2013. The non-forest area was further subdivided in 2014 into the relevant IPCC non-forest classes.

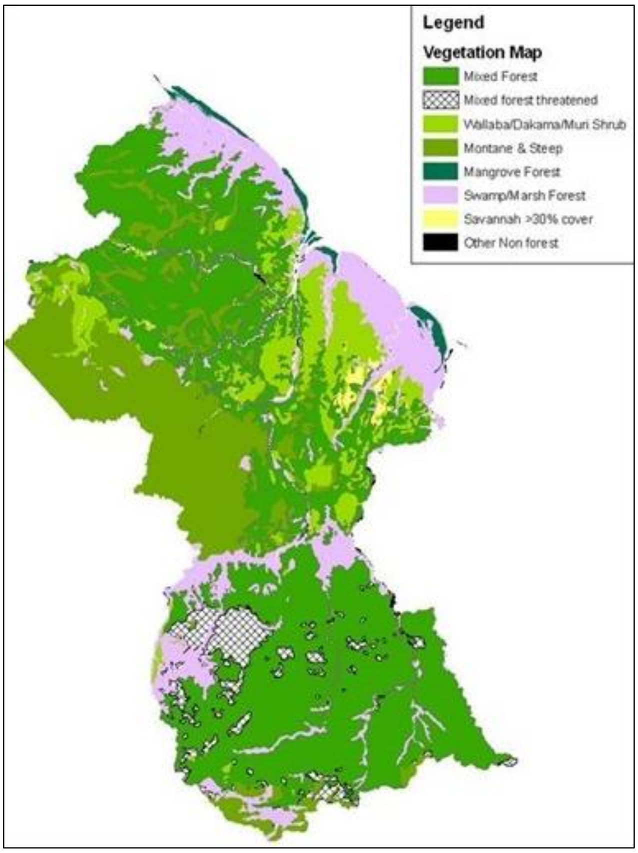
In developing the MRVS, it is important that forest and non-forest components are identified and mapped so that changes between the two classes can be monitored. For areas identified as forested, further stratification is generally required to divide forest types by their potential carbon storage capacity[8].

As a starting point two datasets that depict the different forest types have been considered. Both maps were produced in 2001 by Dr. Hans ter Steege, University of Utrecht, Netherlands, in collaboration with the GFC Forest Resources Information Unit (FRUI).

The first provides a detailed forest vegetation map for the entire State Forest Area (SFA) and was created from various existing vegetation maps. It was updated using interpretations of historical aerial photographs and satellite radar imagery from the Japanese Earth Remote Sensing satellite (JERS 1). The maps completeness was supported by analysis of field data collected during the Commission’s forest inventories.

At the same time a national forest and land use classification map at 1:1 000 000 scale was produced (Map 3-1). This is based mainly on national soil survey data made available by the National Agricultural Research Institute (NARI).

Map 3-1: Simplified National Vegetation Map 1:1 000 000 Scale



[8] In Guyana’s case the forest carbon plots established by GFC and Winrock International show that the carbon stocks across forest types are similar. The basis for the carbon stock stratification is related to accessibility.

Using these maps GFC modified the classification schema to produce a simplified version. This conforms to the six broad land use categories in accordance with IPCC reporting guidelines (Table 3-1). A description of the land use categories is provided in Appendix 3.

Table 3-1: Preliminary Land Use Categories

Class	IPCC Landcover Class	Guyana Landcover Description
Forest Land	Forest Land	Mixed forest
		Wallaba/Dakama/Muri forest
		Swamp/Marsh forest
		Montane forest
		Mangrove forest
		Savannah Forest
		Shifting Agriculture systems
Non forest	Cropland	Cropland
	Grassland	Tropical unmanaged grassland
		Tropical unmanaged shrubland
	Wetlands	Open Water
		Herbaceous unmanaged wetland
	Settlements	Human Settlement areas and roading
		Pre 1990 Mining Area
	Other land	Bare exposed rock outcrops
		Bareland

The intention is to update and refine these maps as appropriate using satellite imagery. The revised map will incorporate change detected from 1990 to September 2009 and will form the basis of the forest stratification map which delineates forest strata by potential carbon stocks. This is an input required for the carbon forest monitoring system to determine the amount of CO_2 sequestered or emitted.

4. 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).

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 superseded with high resolution images from RapidEye.

This progression is outlined as follows:

- 1990 to 2000 – Landsat 30 m
- 2001 to 2005 – Landsat 30 m
- 2006 to 2009 September - Landsat 30 m
- 2009 – 2010 October (Year 1) - Landsat 30 m and DMC (22 & 32 m)
- 2010- 2011 December (Year 2) Landsat 30 m and RapidEye 5 m
- 2012 December (Year 3) RapidEye 5 m supplemented as necessary by Landsat 5 & 7
- 2013 December (Year 4) RapidEye 5 m supplemented as necessary by Landsat 8.
- 2014 December (Year 5) RapidEye 5 m supplemented as necessary by Landsat 8.

Over time several map products have been produced. The first, the Benchmark forest map, was determined through analysing change from 1990 to 2009. The Benchmark map provides a snapshot of forest area as at 30 September 2009.

The 'Year 1' map covers the first year after the benchmark map. For this period all forest to non-forest changes from 2009 to 2010 September were mapped spatially and reported. The main dataset used over this period was 30 m Landsat imagery.

For the 2010-11 assessment, higher resolution 5 m imagery was tasked over previously identified change areas. The area covered was 12 million ha which equated to 56% of Guyana's land area. The improved resolution enabled better identification of change boundaries, drivers of change and areas of forest degradation.

From 2012 onwards high resolution (5 m) coverage has been acquired over Guyana. This has enabled both change and the forest area to be mapped more accurately.

Experience has proven that it is necessary to task the satellite in order to meet specific reporting requirements[9]. If a proactive approach is not adopted then there is a risk that the coverage and image resolution are insufficient to map forest change. This position may change with the recent launch of Sentinel 2A (10 m resolution with an image swath of 280 km)

4.1 Data Structure, Operators and Training

All spatial data is stored on the Network Attached Storage (NAS) at GFC and builds on the archived and manipulated data output from the previous analyses. The NAS is managed by the IT team at GFC and is routinely backed up and stored off-site.

The Year 2 data report recommended a central repository for all spatial information for inter-agency use. GFC holds a consolidated geodatabase of all required GIS datasets. In the latter part of 2014 a partnership with FAO was initiated. This seeks to develop a working model to evaluate the Space Data Management System (SDMS). Potentially, SDMS allows for

[9] The JCN – states that only images collected between August and December of the same calendar year can be used in the analysis. High resolution imagery is required in order to accurately delineate forest degradation around deforestation events.

consolidated online storage of image products that are created during pre-processing. GFC is keen to evaluate this option and run the relevant SDMS modules in parallel to standard MRVS reporting methods adopted by GFC.

As with previous years the relevant datasets that are used for the analysis have been documented and archived. This includes brief metadata about the dataset, its location on the network and anticipated update frequency. Several datasets are actively used and reside on GFC's Forest Resource Information Unit (FRIU) network drive. These datasets are copied into a working folder at the beginning of each year. Care has been taken not to disrupt the structure of FRIU datasets and also to avoid duplication of datasets.

GIS and remote sensing data and layers are stored on the dedicated NAS. Image metadata is recorded. Information recorded includes sensor, path and row, and processing applied. New folders are created as these scenes are processed using ENVI image processing software and all associated files generated are also retained.

All images are named using a common format that identifies the satellite, path and row, image date, provider, processing level (e.g. O = orthorectified) and any post-processing that has been applied to register the imagery to a terrain corrected base mosaic (W = warped/co-registered).

The satellite images are all full band stacks in DAT or GeoTiff format. The DAT format is used due to its interoperability between software.

GFC now has six GIS operators and a GIS manager. All desktop computers are running ArcGIS (10) as provided by ESRI under the LCDS assistance program. Two copies of ENVI have also been installed to enable image processing. In addition several customised toolbars that assist with standardising or automating the mapping process have been developed.

Guyana has released a National Policy on Geographic Information (NPGI) which is currently at the finalisation stage. This policy outlines how Guyana intends to form a National GIS Committee which will work toward consistency in geographic information between all government agencies.

4.2 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. These agencies have been involved in a restructure which means they all now fall under the Department of Natural Resources and The Environment (DNRE). The Department has responsibilities for forestry, mining, environmental management, wildlife, protected areas, land use planning and coordination and climate change.

Table 4-1: Agency Datasets Provided

	Agency	Role	Data Held
Department of Natural Resources & the Environment	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
	Guyana Lands and Surveys Commission (GL&SC)	Management of land titling and surveying of land	Land tenure, settlement extents and country boundary
	Protected Areas Commission	Management of Protected Areas System in Guyana	Spatial representations of all protected areas

To date, interim datasets have been provided by GFC, GGMC, GL&SC and the newly created Protected Areas Commission (PAC). With the creation of PAC in 2012, a new spatial dataset delineating all legally Protected Areas was developed. This is progressively updated as necessary.

4.3 Agency Responsibilities

Guyana Forestry Commission

The GFC is responsible for advising the Minister on issues relating to forest policy, forestry laws and regulations. The Commission is also responsible for the administration and management of all State Forest land. The work of the Commission is guided by a National Forest Plan (2011) that has been developed to address the National Forest Policy (2011).

The Commission develops and monitors standards for forest sector operations, develops and implements forest protection and conservation strategies, oversees forest research and provides support and guidance to forest education and training.

The Forest Resource Information Unit (FRIU) holds a range of operational spatial datasets that are used to assist in the management of forest resources.

Guyana Geology Mines Commission

The main functions of GGMC are to:

- Promote mineral development
- Provide technical assistance and advice in mining, mineral processing, mineral utilization and marketing of mineral resources
- Conduct mineral exploration
- Research the areas of exploration and mining, and utilization of minerals and mineral products.

The GGMC also has a role in the enforcement of the conditions of Mining Licenses, Mining Permits, Mining Concessions, Prospecting Licenses (for Large Scale Operations), Prospecting Permits (for Medium and Small Scale operations) and Quarry Licenses. It is responsible for the collection of rentals, fees, charges and levies payable under the Mining Act.

The GIS section at GGMC routinely collects information using field GPS units. The spatial layer developed holds information on the location of dredge sites and if available the person licensed to operate the dredge. The intention is that this dataset is updated quarterly.

GGMC also holds a spatial layer that defines the location of large and medium scale mining concessions and proposed reconnaissance areas.

Guyana Lands & Surveys Commission

The Guyana Lands and Surveys Commission (GL&SC) remit includes the provision of land policy recommendations and draft land use plans to ensure orderly and efficient utilization of public land resources; advise on land surveying matters, and effective and efficient land administration.

- GL&SC also has a GIS unit that creates and provides geographic information. Several base datasets held by GL&SC have been identified as particularly useful. These include:
    - The extent of larger settlements, in particular, Georgetown
    - The location of registered agricultural leases
    - Historical aerial photography not held by GFC.
- Datasets from GGMC and GL&SC were consolidated into the GIS and used to assist with identification of areas undergoing change.

Section 4.4 provides details of image and GIS datasets considered relevant for the continued monitoring and mapping of temporal forest change in Guyana.

Protected Areas Commission

In 2012, following the passage of the Protected Areas Act, the Protected Areas Commission was established. The mandate of the PAC is to establish, manage, maintain, promote and expand the National Protected Areas System (NPAS). Under the Protected Areas Act, existing and new State owned protected areas, Amerindian protected areas, privately managed protected areas and urban parks such as the Botanical Gardens and Zoological Park comprise the NPAS, which will be managed by the Protected Areas Commission.

The PAC has an important role to play in the MRVS process whereby an important area of land allocation and management as classified under the MRVS relate to Protected Areas. As such, the MRVS Report on the forest cover change in these areas, as well as loss of IFL, relate directly to Protected Areas. This therefore makes the data inputs from the PAC important to the MRVS process and the results of the reporting, a useful data platform for the PAC.

4.4 Monitoring Datasets - Satellite Imagery

In keeping with international best practice, the method applied in this assessment utilizes a wall-to-wall approach that enables complete, consistent, and transparent monitoring of land use and land use changes over time. The core datasets used for the Year 5 analysis include full country coverage at 5 m from RapidEye which is supplemented with Landsat 8 as necessary to accommodate cloud cover.

Presently, the annual change reporting is geared towards satisfying a series of interim measures. This requires that changes in forest land to other land uses be reported relative to the 2009 Benchmark map. Currently changes occurring in land defined as non-forest are not reported. The basic premise is that eventually changes in the six IPCC categories will be reported for the LULUCF sector.

There are licence limitations on the RapidEye imagery that determine public dissemination of the imagery but results of analysis are freely available and can be accessed through the GFC.

RapidEye

The RapidEye constellation consists of five satellites which have been providing high resolution multi-spectral images since the start of RapidEye's commercial operations in February 2009. RapidEye holds imagery in an online image archive, and is also available to be tasked to cover specific areas. RapidEye provides both '1B' and '3A' 5 m resolution products.

The decision to commission this coverage was to ensure national coverage at a resolution high enough to capture forest change and degradation activities. The coverage also allows for robust estimates of change – as required for the national MRVS.

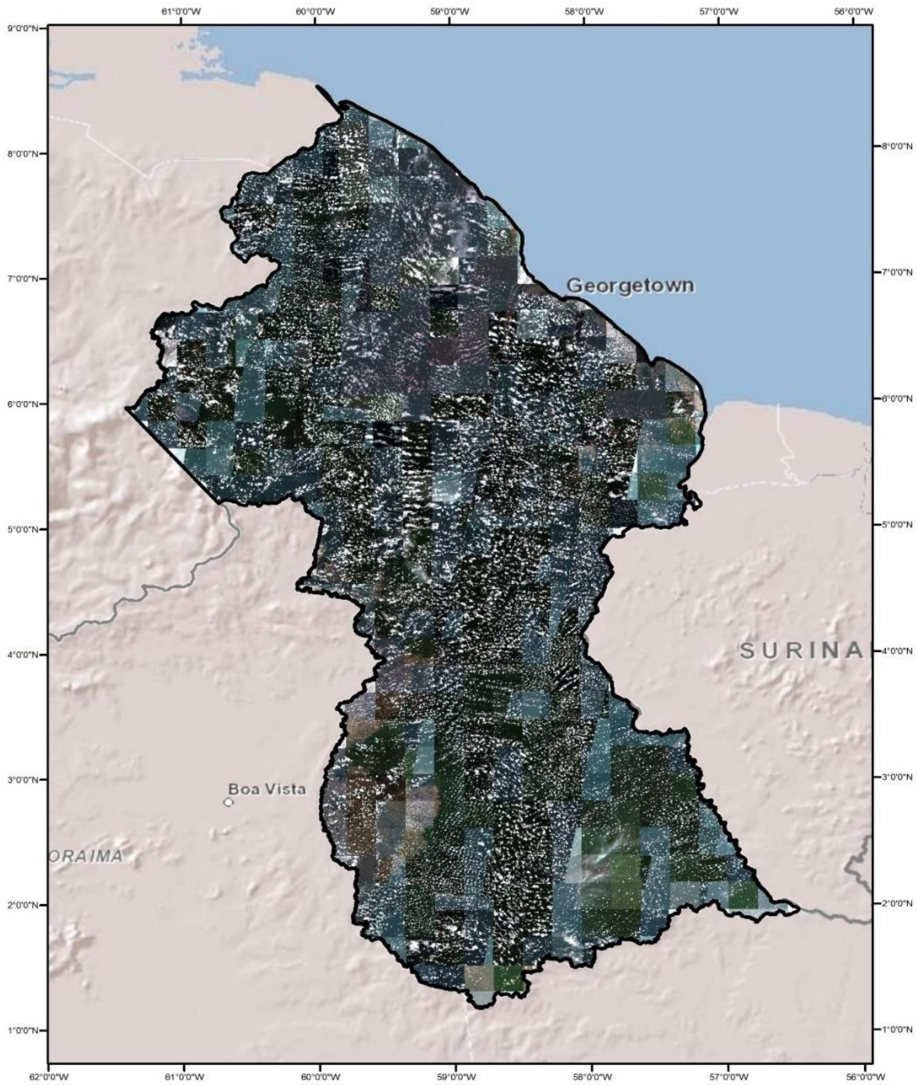
GFC has tasked the RapidEye constellation to provide a countrywide coverage of Guyana.

Since 2012 GFC has progressively improved the positional accuracy of the RapidEye image base. This process initially involved co-registering the RapidEye 'image swaths' to match the existing Geo-Cover base map. The updated tie points were then returned to RapidEye and used to correct 2013 (Year 4) image coverage.

In 2014 RapidEye updated the positional accuracy over Guyana using control points derived from VHR (Very High Resolution) Digital Globe imagery. In the West of Guyana an offset of up to 30 m is observed. This is due to the steep topographic relief and change in the UTM zone.

In Year 5 the GFC team update and improve the existing base maps using RapidEye’s improved 3A ortho-corrected product. The revised basemap will be used as a reference from the next reporting period onwards.

Figure 4-1: 2014 RapidEye Coverage



For the analysis a higher priority is placed on images acquired at the end Year 5 reporting period, with the majority of images acquired from September to December, 2014. Due to the typically cloudy nature of satellite imagery over Guyana multiple scenes over the same location are required. Nearly all areas have three separate images covering each footprint. Supplementary to the RapidEye acquisition, 30 m Landsat 8 data is also analysed. Wall to wall coverage of Landsat imagery for Guyana has been downloaded from the United States Geological Survey (USGS) online catalogue.

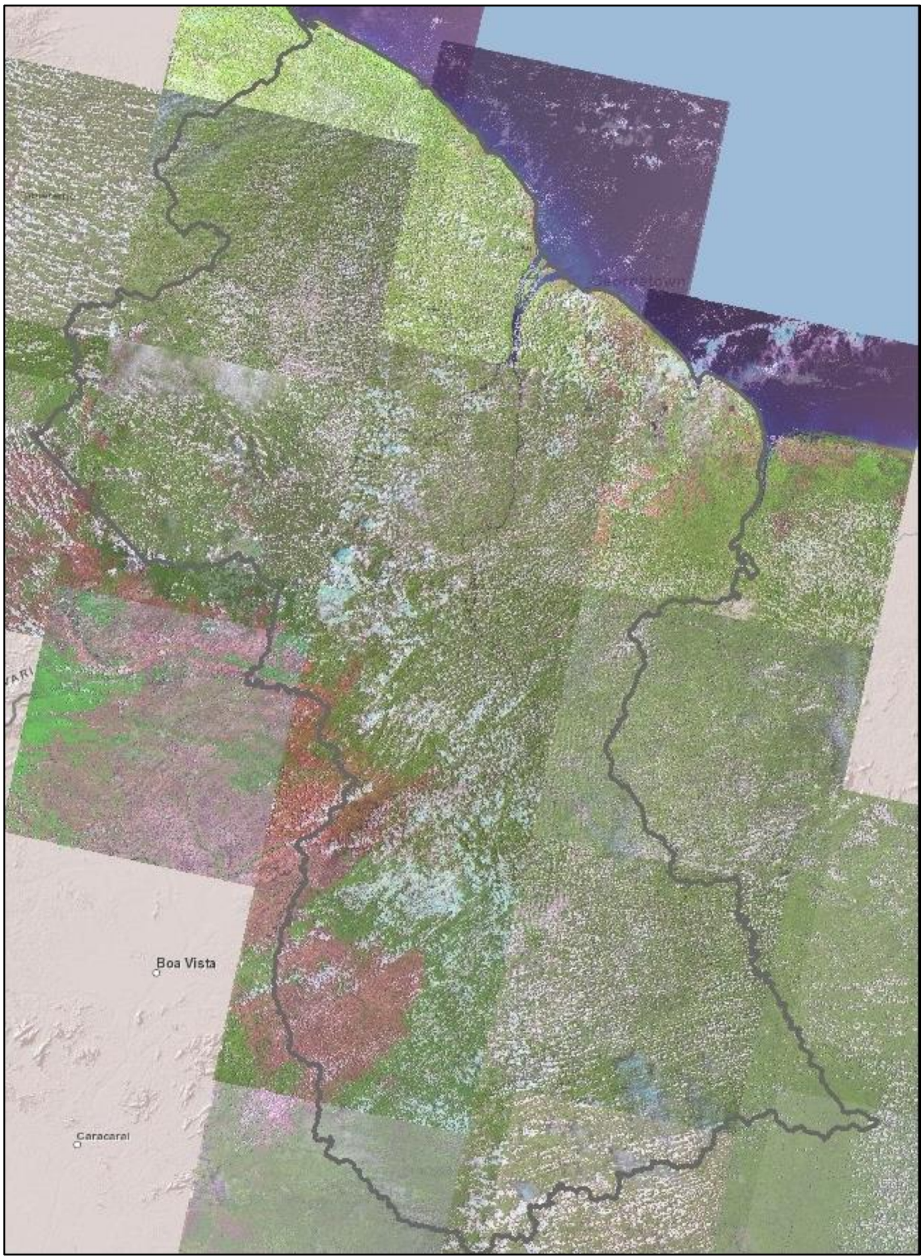
Landsat

Landsat 8 imagery launched on 11 February 2013 also provides temporal coverage over Guyana. This imagery is archived and is freely available and can be sourced from either the United States Geological Survey (USGS) or National Institute for Space Research (INPE) Brazil. Imagery sourced through USGS comes processed as “L1T” or terrain corrected (using SRTM 90 m DTM), whereas INPE imagery typically does not.

Landsat acquires images over the same area every 16 days. The Landsat Data Continuity Mission Landsat 8 provides a source of freely available imagery at 30 m resolution. The sensor collects 11 spectral bands from visible (~0.5μm) to thermal (~12μm) wavelengths.

The figure below shows the Landsat 8 coverage over Guyana for 2014.

Figure 4-2: 2014 Landsat 8 Coverage



To ensure consistency across datasets all imagery is geo-referenced to a base mosaic image which was generated from data provided in MrSid format by the Global Land Cover Facility (GLCF). The GLCF holds a global set of regional images which are divided into tiles and overlap each other seamlessly at their edges. This ensures consistency between images of a similar type, and also between different image types and resolutions.

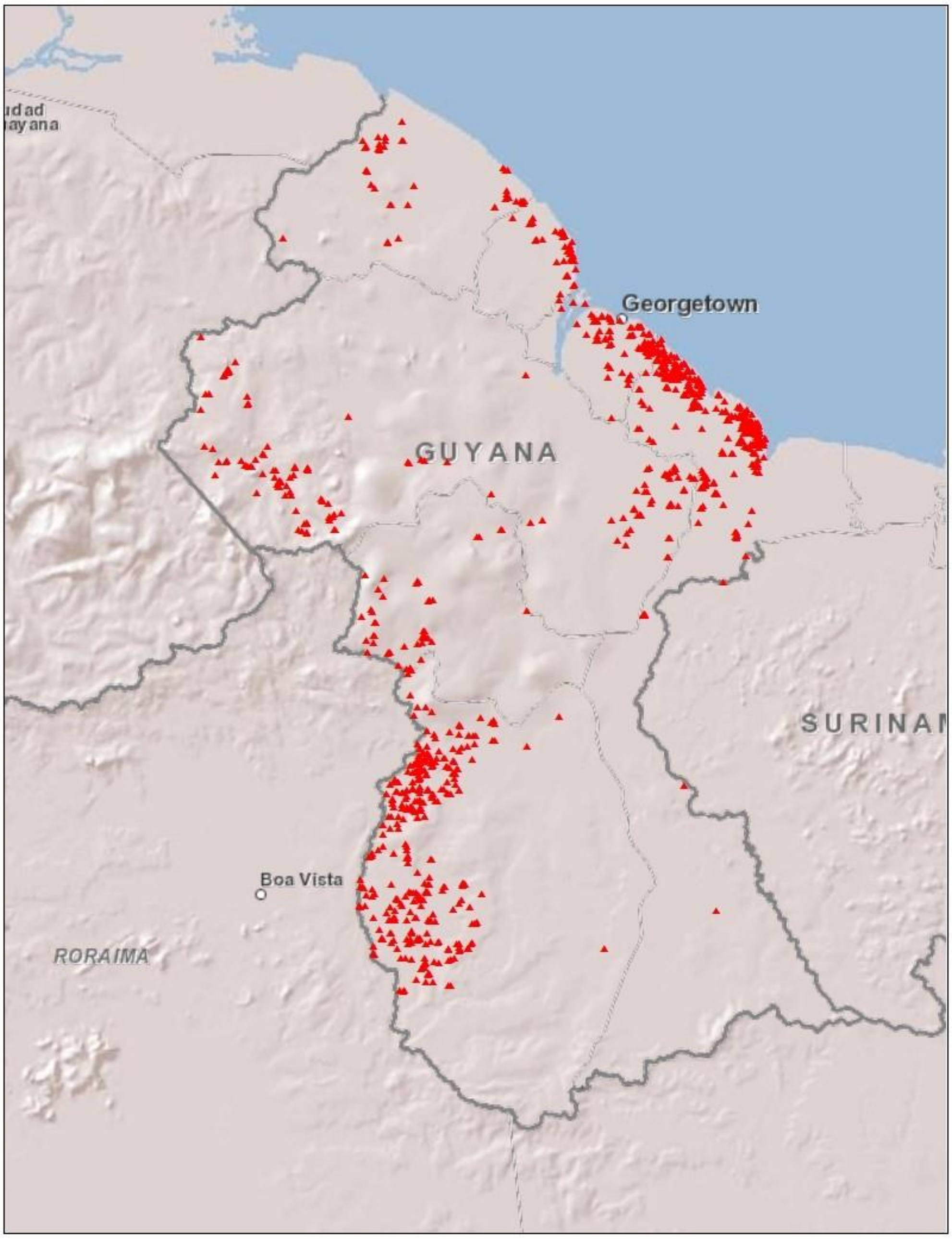
The approach employed in the previous analyses allowed for land cover change greater than one hectare in size to be tracked through time and attributed by its driver (i.e. mining or agriculture). This approach has been continued through into Year 5 using the same methodology. A series of refinements to the image processing chain have been implemented to facilitate the use of higher resolution RapidEye imagery on a national scale.

4.5 Additional Ancillary Satellite Images & Fire Datasets

The Fire Information Resource Management Service (FIRMS) Active fire dataset derived from thermal bands carried on the MODIS satellite is also assessed. This data is freely available and is distributed via FIRMS. This dataset is used to assist with the detection of fire-driven change events.

Previous analyses have utilised FIRMS to assist with identifying fire locations and risk areas. The presence of fire will be confirmed using higher resolution datasets. Figure 4-3 shows the MODIS-identified fire locations for the Year 5 period.

Figure 4-3: 2014 FIRMS Data



4.6 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 resolution data. The results of the independent accuracy assessment and report are provided in Appendix 7.

Currently, there are no commercially available satellites capable of supplying imagery of sufficiently high spatial resolution with appropriate revisit frequency on a national scale. The accuracy assessment conducted for Year 2 (2011-12) noted that a pixel size of at least 1-2 m is needed to identify forest degradation resulting from human infrastructure.

As part of a continuous improvement process GFC and Indufor have developed an operational method that captures high-resolution aerial imagery using a highly portable aerial multispectral imaging system. The camera system (provided by 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 across Guyana ranged 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 stratified random sample that covers the majority of Guyana. The full sample coverage is achieved by including the RapidEye images over areas where it is not possible to safely operate a small aircraft.

The locations of these transects were provided to Indufor by the independent accuracy assessment team from Durham University, UK. Individual image frames acquired over the sample site locations were stitched together to form a mosaic. The mosaics obtained from the system were then delivered to the accuracy assessment team for analysis. The system is versatile enough to operate at low altitude (below 2000 ft) which increases flexibility in cloudy conditions.

In Year 5 the Accuracy Assessment involved the collection of 313 sample units randomly selected from three forest strata organised by risk of deforestation. The accuracy assessment in Year 5 for the High Risk and Medium Risk strata was carried out using repeat coverage GeoVantage aerial imagery. The Low Risk stratum was assessed using repeat coverage RapidEye imagery.

It is recognised that there are practical and operational difficulties in generating an identical dataset with perfect overlap between different Years. For example, there will be areas where GeoVantage data are missing or cannot be collected in areas where long-range flights with a light aircraft are not feasible or safe. In such cases the best available RapidEye data were selected and reinterpreted. Where possible the RapidEye data will be used in parts of the *low risk stratum* where human access is particularly limited and there is no history of logging or mining.

The following figure shows a comparison between the RapidEye imagery and the aerial photography. The left and middle images are from RapidEye and the right image from the aerial survey.

Figure 4-4: Comparative Resolution of the RapidEye and Aerial Imagery

5. DEVELOPMENT OF MAPPING METHODS

Since inception several mapping methods have been developed and refined. The focus has been on improving the determination of forest degradation for a range of drivers (as detailed below). The improvement process combines analysis of satellite imagery supported by field verification.

The aim was to develop monitoring methods for inclusion in the MRV. In some cases these have been further refined and integrated into the MRV in Year 5.

- Evaluation of methods for mapping and integrating of shifting agriculture
- Monitoring Forest Degradation
- Assessment of methods for monitoring change in areas under forest management
- Methodology for monitoring reforestation over mining areas and roads
- Evaluation of methods for monitoring degradation caused by anthropogenic fires.

A summary of the key findings of each is presented as follows:

Monitoring Shifting Cultivation

An evaluation of methods for detecting and mapping of areas under shifting cultivation has been undertaken. There are currently no best practice methodologies for doing this, especially on a national-scale.

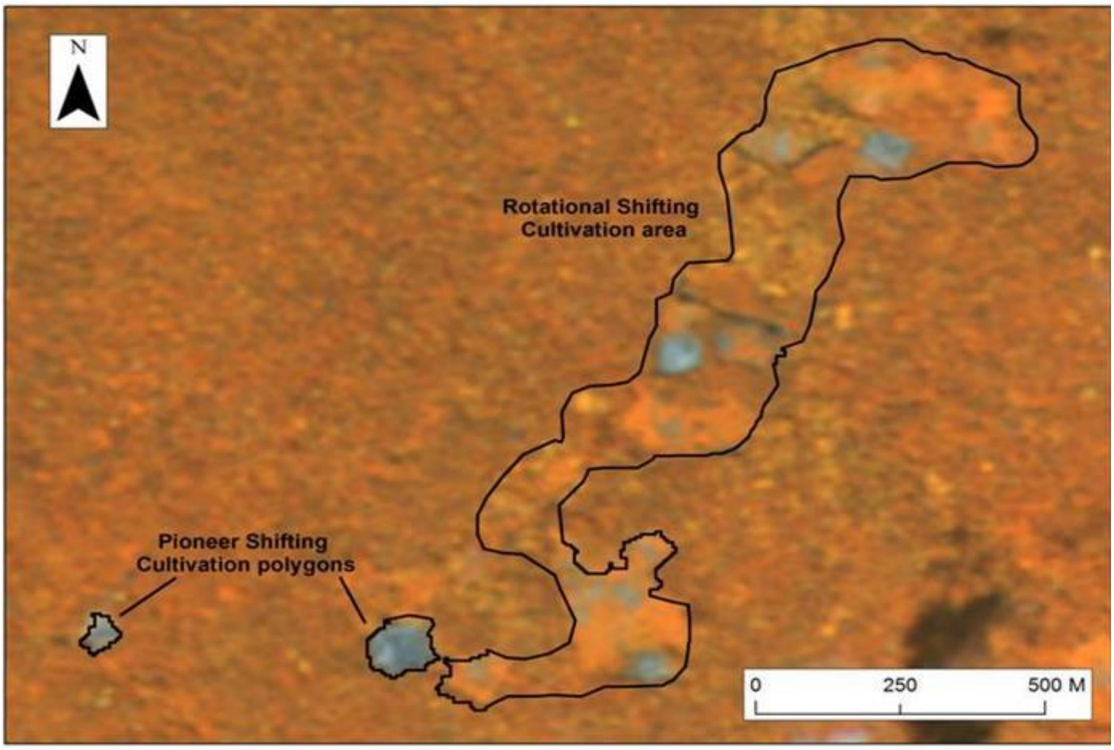
An appropriate detection and mapping methodology was developed and operationalised in the year 4 analysis. The method adopted and extent has been further refined in Year 5. This allows the calculation of previously detected and newly cleared areas >0.25 ha. This is much smaller than the 1 ha minimum mapping unit (MMU) applied to deforestation. A matrix of shifting cultivation types within Guyana is shown below:

Table 5-1: Shifting Cultivation Types

Shifting Cultivation Type	Pre-change landcover	Rationale/Description	Monitoring	Reported
Pioneer	High/Primary forest	Pioneer shifting cultivation consists of newly cut areas which were seen as high forest in the previous year. All available evidence suggests these areas have not historically been degraded or are anthropogenic. They tend to occur around the fringes of historical rotational shifting cultivation areas. A 100% carbon loss is assumed here as the pre change landcover was high forest.	Using RapidEye imagery the evolution of these areas is being monitored from year 4 onward. Minimum Mapping Unit (MMU) = 0.25 ha	Yes
Rotational	Unknown (varied)	Rotational shifting cultivation consists of historically degraded and impacted areas. All available evidence suggests these areas are in various states of succession from newly burnt areas to late successional secondary forest areas. They tend to occur around the areas of long term human habitation. Field work is required to determine a carbon value/emission factor for these systems, as they are technically 'forest remaining forest'.	The boundaries of these areas are delineated, but it is not possible to monitor changes inside the boundaries of historical rotational areas due to the low resolution and infrequent temporal coverage of Landsat images.	No

A spatial representation of these areas is shown in Figure 5-1. It shows the extent of the rotational area and the appearance of two new areas in close proximity to the rotational area.

Figure 5-1: Shifting Cultivation example



Further work in Year 5 will assist in confirming the emission and removal factors. Once calculated these can be linked to the spatial representation. This will enable a calculation of the carbon stock change to be included in the MRV.

As appropriate, these refinements to the mapping process have been documented in the mapping guide.

Monitoring Forest Degradation

The forest degradation method developed in 2011 has been retained for this assessment. This work showed that in Guyana forest degradation around deforestation sites is unique, with the main contributors being the opening of roads linked to new infrastructure, and degradation mainly associated with mining activity - which is dynamic.

The current method uses high resolution 5 m RapidEye to determine the impact of degradation.

The method development was supported by field inspections that measured the stock changes caused by degradation. The field assessment involved the establishment of field transects 20 m in width from the edge of deforestation events. The field measurements suggest that infrastructure-related degradation is restricted to the immediate area around the deforestation site.

Interpretation of the images showed that the forest cover returns to an intact state inside 40 m from the deforested event. Beyond this point it is possible to identify forest disturbances provided the disturbances are large enough (>100 m^2) and the vegetation is disturbed to the point where the soil is exposed.

Based on these results it was concluded that the most pragmatic approach was to use the RapidEye imagery to assist with the identification of degradation events. A set of GIS-based rules were developed. These replaced the default approach used for the Year 1 assessment. This process is documented in the Year 2 MRVS report[10].

[10] www.forestry.gov.gy

Further image coverages obtained in Years 3, 4 and 5 indicate that degraded forest areas are either in transition to a state of deforestation or are only temporary in nature - as shown in section 6.6 of this report. Further work is required to confirm the fate of these areas.

It is also important to consider the possibility that historical mining sites may be re-entered or areas of small-scale prospecting extended. This has been observed in the field with previously abandoned sites and the surrounding areas being revisited and mined.

To ensure these activities are captured in the MRVS, the FRIU team revisits all areas identified in preceding assessments (post 2011) using high-resolution imagery and update areas if changes have occurred.

Monitoring Forest Degradation - Areas under Forest Management

The current interim measure uses post-2008 timber volumes as verified by independent forest monitoring (IFM), and applies the Gain Loss Method based on forest harvest and illegal logging volumes. These values are then compared to the mean volume from 2003-2008. This work evaluated the ability of RapidEye to provide supplemental information through the detection of harvest and roading activities.

The field assessment covered a range of clearance activities associated with forest harvest. These included the formation of roads (primary, secondary and skid trails), log markets, and harvesting operations.

The main findings of this work indicate that:

- The assessment showed that individual canopy openings are too small for detection in high resolution imagery such as RapidEye. A possible exception is if the operations are recent and the harvesting is clustered. However, even in such cases, the harvest yield is relatively low and it is difficult to detect a change in forest cover.
- This finding concurs with other studies that have used the spatial patterns of log landings and road infrastructure (Matricardi et al., 2001,Asner et al., 2005,Souza Jr et al., 2005).

It is suggested that the current interim measure is retained.

- The size of secondary access roads is small (road widths ~3-4 m). Unless detected during formation it is likely that these roads will remain undetected. It is possible to detect larger roads wider than 10 m.

This suggests that small-scale roads associated with forest harvesting cannot be mapped reliably. It should be noted that within the application of the Gain Loss method in the forest management indicator, provision is made for logging infrastructure impacts and collateral/incidental damage. This is informed by field data from forest concessions in Guyana. This is additional justification for continuing to use the Gain Loss method as this is most comprehensive.

Monitoring Reforestation of Mining Areas & Roads

This study addresses the monitoring of reforestation. The reforestation aspect looks at the potential for identifying regeneration (carbon stock accumulation) of abandoned mining sites and roads, using high resolution imagery.

It is clear on the satellite imagery that any type of change in the vegetative cover is detected. It is, however, difficult to determine the composition or structure of this cover. The field inspections indicate that biomass recovery is slow and that no measureable biomass (i.e. woody vegetation >2 cm) across the site may exist.

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 affects the ability of these sites to regenerate. 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. This is currently in design phase and the plan is to collect data from a selection of such sites to estimate the rate of biomass carbon accumulation.

Monitoring Forest Degradation on Sites Affected by Fire

The impact of human induced or anthropogenic forest fires is included in the assessment of the associated emissions (Interim Measure 5). The interim performance indicator is the area burnt each year decreasing compared to the current area.

In Guyana the cause of fires (biomass burning) is associated with forest cover change which, based on local knowledge, is largely human induced. The current detection method uses information from the Fire Information for Resource Management System (FIRMS)

In 2012 the detection of forest fires changed to using high resolution 5 m imagery and FIRMS data. The successful detection of burnt areas depends on the intensity and the scale of the fire.

The land classes attributed can be either deforestation, if it leads to a permanent land use change from forest land to non-forest (>1 ha), or forest degradation, if the area burnt does not lead to a land cover change. Overall the fire detection methodology has been improved by the inclusion of higher resolution imagery. These changes have been incorporated into the Mapping Standard Operating Procedures (SOP).

Stratification for Phase 3 of the Forest Carbon Monitoring System

During 2014/2015, the stratification and location of the plots within the Low Potential for Change (LPfC) area have been determined. This was one of three main strata developed- the High Potential for Change (HPfC), Medium Potential for Change (MPfC) and the Low Potential for Change (LPfC). The forest carbon sampling design stratifies the forests in Guyana by potential for change (high, medium and low) and by accessibility (more and less accessible). A three-phased approach for implementation of data collection was proposed: first, phase of data collection includes high potential for change in more and less accessible strata. The second, phase includes medium potential for change in more and less accessible strata. The third phase was conducted in 2015 and includes low potential for change in more and less accessible strata. It was estimated that 41 cluster plots should be measured to attain the selected precision target, with 26 in the MA zone and 15 in the LA zone. All of the above mentioned stratification and allocation of sample plots were derived through the use of RapidEye imagery and feed into and from a GIS platform.

Community MRVS

The GFC continued work on building capacities within communities to conduct Community Monitoring Reporting & Verification activities (CMRV) within the Kanashen community. Focus was placed on validating field data that were collected to ensure that this was done in compliance with the Standard Operating Procedure. In this regard community members were trained in identifying and calidating unique drivers, and methods of ground truthing the extent of these over time. The GFC further provided guidance to Kanashen in collection of soil samples for estimation of soil carbon content and has been working with tree spotters in Kanashen to identify tree species by the corresponding scientific names.

Some of the challenges encountered related to communities having different forest types and resultant land uses. This can impact on the ease of creating synergies in implementation of CMRV activities across other communities. Another important challenge that is faced is the availability of local facilities and capacities to conduct more advanced aspects of CMRV and related data collection, such as for the testing of soil carbon content. At both the national and the community level, facilities had to be sought abroad to conduct these analyses, at an accompanying cost. There are varying levels of human capacities within the communities upon which the building of the CMRV is dependent. Communities have different learning curves regarding the various components of the CMRV, especially in the more technical areas of forest area and forest carbon measurement and monitoring. Finally the Verification aspect of the CMRV is an integral component to the process, in allowing for transparency and accountability by the respective community. To date, emphasis has been placed on the Monitoring and Reporting aspects. There is now need for equal emphasis to be placed on the Verification aspect, which requires independent third party verification. This needs to be developed and integrated for complete implementation of all aspects of the monitoring system for REDD+ at the community level, as it is for the national scale MRVS.

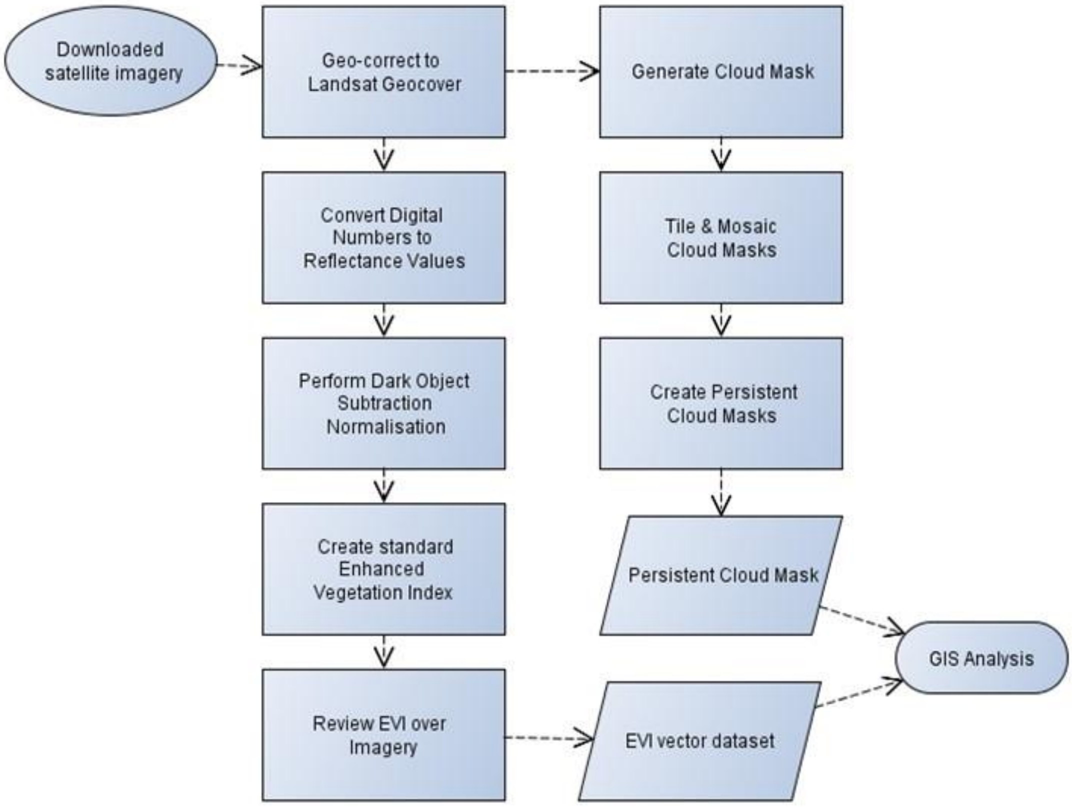
In keeping with the guidance set forth in the MRVS Roadmap Phase 2, the next step is the continued building of capability of local communities and stakeholders to monitor forests. This will be achieved through synthesis of previous experiences and continued implementation of pilots to link and integrate the community and national monitoring. There will be the development and testing of Standard Operating Procedures for the various components of the CMRV, including user friendly documentation for non-technical users. The approach of the development and use of SOPs is employed at the national level to ensure completeness, transparency in procedures and continuity in activities. The GFC will also seek to build capacity on the national and local level to establish an exchange of data on forest change and carbon monitoring, reporting on REDD+ implementation and the continued creation of synergies between CMRV and national MRVS.

Continuing Stakeholder Engagement on the MRVS

Consultation and outreach activities on the MRVS continue to be an integral part of the REDD+ programme. Over the period April to June, 2015, the GFC conducted Ten (10) cluster outreach sessions in Kamarang, Annai, Bartica, Charity, Moruca, Mabaruma, Linden, Kwakwani and Georgetown (NGOs & Civil Society and Private Sector groups). A total of 250 persons comprising 143 males and 107 females attended the workshops which represents a 68% attendance rate.

The primary focus of these workshops was to continue to update stakeholders on the status of REDD+ implementation with a view to building stakeholders' knowledge and capacity to engage in further dialogue on REDD+. Specific focus was placed on the development of the MRVS and other REDD+ related areas, including Guyana’s engagement with the EU Forest Law Enforcement Governance and Trade (EU FLEGT).

Figure 5-2: Image Processing Flow Diagram



5.1 Image Geo-correction

All satellite images are co-registered to the 2005 Landsat Geocover base map. Accurate co-registration is important to ensure that changes detected in future time periods are valid and not simply artifacts caused by inaccurate co-registration. Mismatches should be less than one Geocover pixel (<14.25 m). All GCPs are to be recorded and saved.

5.2 Image Normalization

Radiometric normalisation is a recommended image processing practise to ensure the radiometric values within images obtained over different time periods and by different sensors are calibrated to common reference values. There are many methods applied for the normalisation of images that perform either a relative correction to a single scene or an absolute correction to standard reflectance units.

For practical purposes based on the project timeline, the number of RapidEye images to process, the generally high level of clouds per image and the availability of atmospheric correction data, the dark subtraction radiometric normalisation method implemented in ENVI was chosen.

Each scene is evaluated and the band minimum Digital Number (DN) values were automatically selected from each scene and subtracted from all pixels within the scene with the assumption the band minimum values are dark targets that are only influenced by atmospheric scattering.

The method adopted uses a combination of automated (calculation of vegetation indices) and manual interpretation and editing. The objective of the approach was to use a vegetation index to delineate areas of forest and non-forest.

Identified areas of non-forest within the forest mask represent potential areas of forest change (i.e. deforestation or degradation). The delineated non-forest areas were input into a GIS and used as an ancillary layer in the Year 4 change analysis mapping.

The key to differentiating forest from non-forest is to link the reflectance properties of the vegetation to its structure. Several vegetation indices exist that enhance non-forest detection as described by *Asner (1998).*

For this work the Enhanced Vegetation Index (EVI)[11] as described in *Huete et al.* (1997) was favoured over other vegetation indices as it includes the blue reflectance. The strength of the EVI is in its ratio concept which provides a correction for soil background signal and reduces atmospheric influences, including aerosol scattering. This is particularly relevant given the lack of any aerosols, water vapour, and ozone concentrations to correct atmospheric conditions.

The EVI is calculated with the following equation as presented and described in *Huete et al 200*2,

$$\mathrm{EVI} = G \frac{\rho_{\mathrm{NIR}} - \rho_{\mathrm{red}}}{\rho_{\mathrm{NIR}} + C_1 \times \rho_{\mathrm{red}} - C_2 \times \rho_{\mathrm{blue}} + L} \qquad (1)$$

where G is the gain factor, ρ are atmospherically corrected or partially atmosphere corrected (Rayleigh and ozone absorption) surface reflectances, L is the canopy background adjustment that addresses nonlinear, differential NIR and red radiant transfer through a canopy, and C_1, C_2 are the coefficients of the aerosol resistance term, which uses the blue band to correct for aerosol influences in the red band. The coefficients adopted in the EVI algorithm are, L=1, C_1=6, C_2 = 7.5 and G = 2.5.

The EVI values range from 0 to 1 with low values indicating non-vegetative surfaces and those closer to 1 representing closed canopy forest. The same approach was successfully applied to separate forest and non-forest components for the 1990-2010 period[12].

The method has also been widely discussed in the scientific literature. *Deng et.al. (2007)* found that EVI was effective in vegetation monitoring, change detection, and in assessing seasonal variations of evergreen forests.

Additionally, the EVI has been found to perform well in the heavy aerosol, biomass burning conditions in Brazil *(Miura, Huete, van Leeuwen, & Didan, 1998).Miura, Huete, Yoshioka, and Holben (2001)* and also showed EVI ratio can successfully minimize residual aerosol effects resulting from the dark target-based atmospheric correction. The same approach was applied in this assessment.

The automated change detection process produces a vector layer delineating the potential areas of non-forest. The vector layer is subsequently input into the GIS for review, editing and attribution.

5.3 Persistent Cloud

One potential issue is detection of change in areas of sporadic and persistent cloud. In areas of sporadic cloud (i.e. where at least one period is clear) the change was attributed to the relevant change period. If areas are under persistent cloud cover then it is not possible to evaluate the area for change.

The impact of cloud was assessed by generating cloud masks for each RapidEye and Landsat image to identify those areas of persistent cloud. The masks were generated by a simple band

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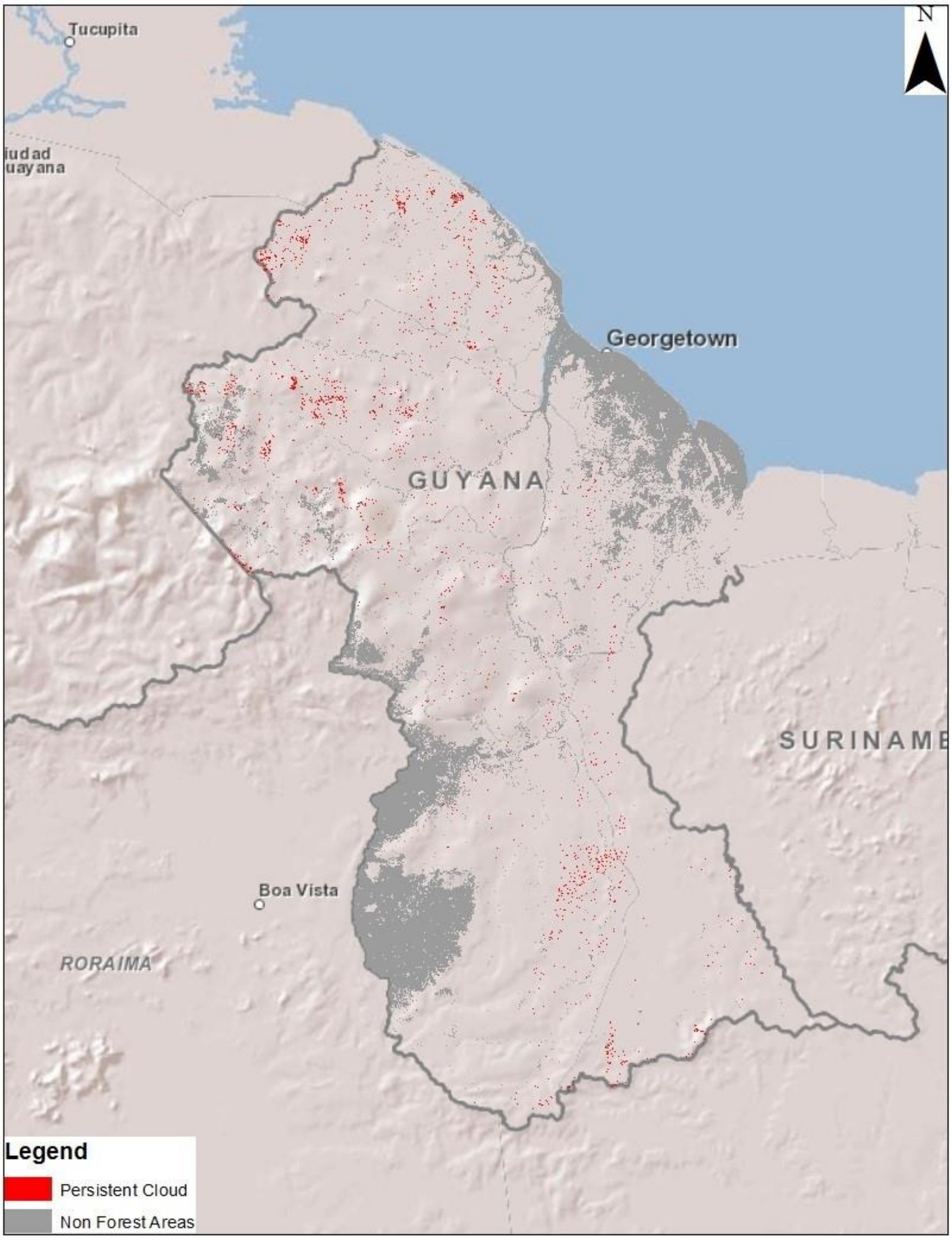
[11] Bholanath & Cort, 2015. National Scale Monitoring, Reporting and Verification of Deforestation and Forest Degradation in Guyana. ISRSE, 2015.

[12] The independent accuracy assessment conducted in 2011 reported the accuracy of the forest and non-forest mapping to be 99%.

threshold approach and edited to remove areas of non-forest. The cloud mask does not identify cloud shadow so it provides only a broad estimate of cloud coverage.

The analysis showed that for Year 5 less than 0.2% of the land area was persistently covered in cloud. The distribution of the cloud is quite scattered and located over the country most notably in the SE and NW of the country as shown on Figure 5-3.

Figure 5-3: 2014 Persistent Cloud Cover



5.4 Spatial Mapping of Land Cover Change

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

5.5 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 would not be considered deforested as they have the ability to regain the elected crown cover threshold.

The five historic 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).

In Year 4, a new driver ‘settlements’ has been added to the driver matrix. It allows the team to describe human settlement driven change such as new housing developments.

5.6 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* ".

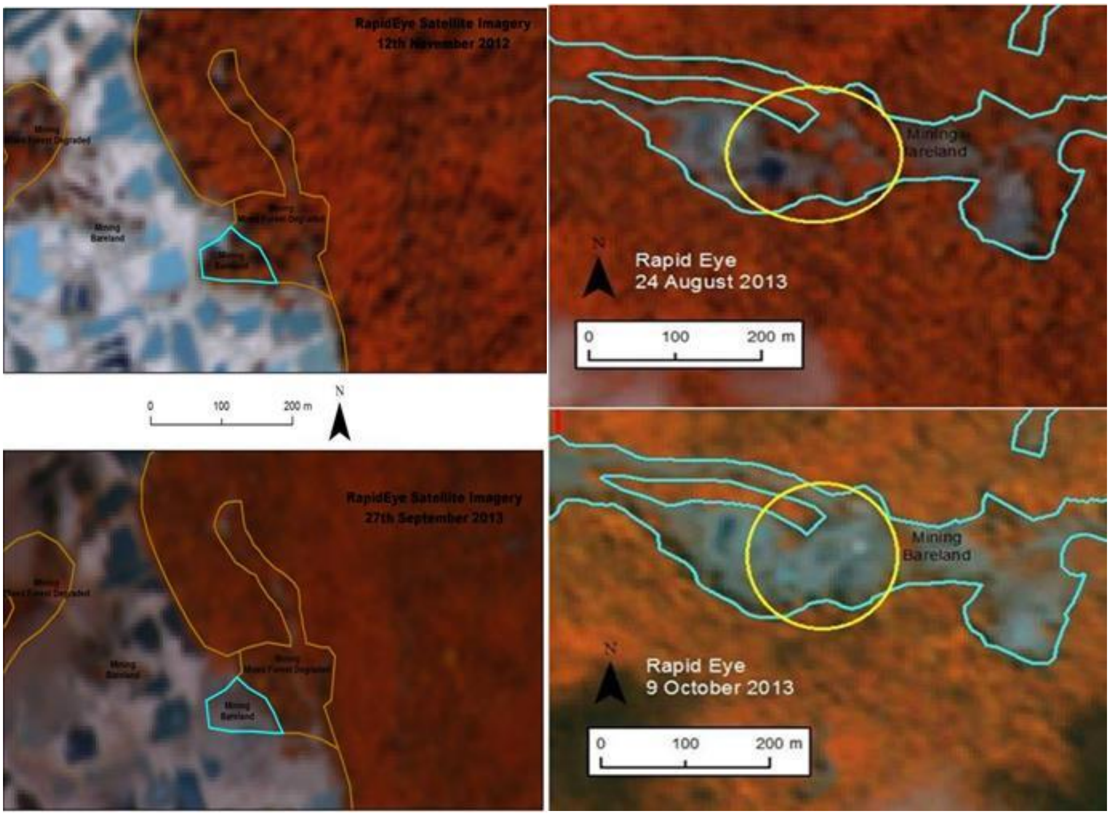
The main sources of degradation are identified as:

- Harvesting of timber (reported since 2011 using the Gain Loss Method)
- Shifting cultivation (prototype method developed in 2012)
- Fire
- Associated with mining sites and road infrastructure.

Image evidence and fieldwork over the last two years 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.

Figure 5-4 shows two sites in transition from a degraded forest state to full deforestation.

Figure 5-4: Degradation Transitioning to Deforestation



In the above examples you can see the edge of a deforestation site moving from a degraded to a deforested state. Figure 5-5 shows one of the abandoned mining sites, only affected temporarily before moving back into a revegetated state.

Figure 5-5: Abandoned Mining Site

5.7 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 on the RapidEye then Landsat images over that location are also assessed. The tile size was chosen to align with the footprint of a single RapidEye tile. The RapidEye tiles were then subset to a 1 km x 1 km grid. The process involves a systematic tile-based manual change detection analysis in the GIS.

The EVI vector outputs from the change detection process are edited as required to delineate new change events. 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 through the use of 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 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 5-2: Summary of Activities & Drivers Captured in the GIS

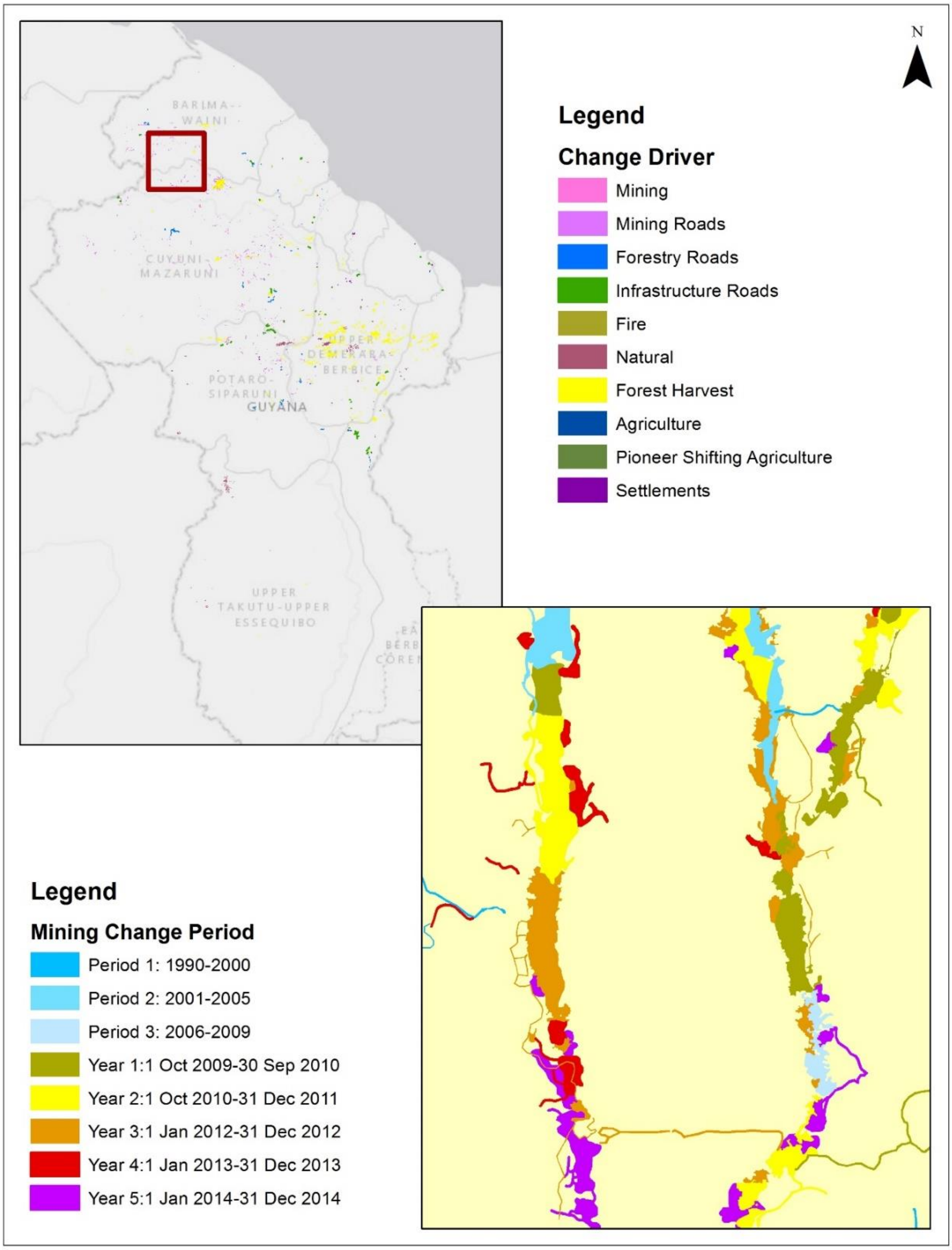
Activity	Driver	Criteria	Ancillary Info Available	Spatially Mapped	End Land Use Class
Forestry	SFM	Fall inside state forest area and is a registered concession	Annual harvest plans, GIS extent of concession, previously mapped layers, Satellite imagery	No. Volumetric measure used	Degraded forest by type
	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 >0.25 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.

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. 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 5-6: Example of Forest Change Mapping



5.8 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 interim 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 activity within the State Forest Area is 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 as a result 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.

6. FOREST CHANGE

The results summarise the Year 5 period (1 January 2014 to 31 December 2014) forest change. This includes estimates of deforestation and degradation for all land eligible under Guyana's LCDS.

As was first introduced in Year 4 and agreed under the JCN, infrastructure associated with the construction of the Amaila Falls hydro power development is itemised separately.

For reference, historical changes relating to the benchmark period (1990 to 30 September 2009 and Year 1 (01 October 2009 to 30 September 2010) are also provided.

Previously 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 area has since been updated using high resolution satellite images. This has meant that the forest/non-forest boundaries have been refined.

As with previous assessments forest is defined in accordance with Guyana's national definition of forest which has remained consistent across the historic benchmark period, and Years 1, 2 and 3.

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). By 2011 the forest cover had reduced to 18.38 million ha due to deforestation. In 2012 the forest cover was reassessed using high resolution imagery and the baseline figure increased to 18.5 million ha. Further updates to the high resolution imagery resulted in a final update in 2014, with an estimated start forest area of 18.48 million ha.

The results for each period are further divided by the five drivers of forest change. This information can be used to provide indicative trends for the periods analysed.

From Year 4 onwards, four main improvements have been implemented:

- The historical non-forest area has been subdivided into its constituent classes. This allows for a description of Guyana's landcover in accordance with IPCC classes.
- Shifting agriculture has been reported for the first time. It is included as a form of forest degradation in the deforestation tables.
- The method for mapping degradation around new infrastructure established in 2011 has been retained for this assessment.
- The impact of cloud (which may obscure change) has been minimized by using multiple high-resolution images acquired over the same location, and creating a persistent cloud mask, to check these areas. As necessary this coverage is supplemented using Landsat 8.

Additional factors that should be considered when evaluating the forest change results include:

- Forest change reported for the Year 5 period is based on interpretation of satellite images acquired for the last four months of 2014.
- The reporting of reforestation of previously forested sites is still under review. This is currently in the design phase and the plan is to collect data from a selection of such sites to estimate the rate of biomass carbon accumulation. Many of these sites are abandoned mining areas. Biomass recovery is known to be very slow. The areas are brought into the MRVS and tagged with the first date at which they appear to be abandoned. In this way it is possible to allocate carbon accumulation rates once these are established.
- Roads visible on the images (>10 m on RapidEye) were included in the analysis. All roads were treated as deforestation events. This is a conservative approach as some vegetation cleared for roads appeared to regenerate. Further work is required to ascertain the regeneration potential of these areas. This is planned and will form part of the carbon monitoring program.

6.1 Changes in Guyana's Forested Area 1990-2014

Historical Analysis

The historical analysis indicates that the total area converted from forest to non-forest between 1990 and 2009 was 74 917 ha. This was calculated by subtracting the initial 1990 forest area as mapped in the GIS from the 2009 September forest area (~19.75 years).

This estimate included all forest to non-forest change i.e. detected mining, road infrastructure, agricultural conversion and fire events that result in deforestation. It does not include forest degradation caused by selective harvesting, fire or shifting agriculture.

The same approach and criteria was applied to calculate the area of deforestation from 2009 to 2010 (Year 1 period). The total area of deforestation for this period was calculated at 10 287 ha. In Year 2 the change figure was similar and reported as 9 891 ha, with a rise in deforestation seen in Year 3 to 14 655 ha. In Year 4 the total area of deforestation was 12 733 ha. This is a decrease of about 1 922 ha when compared to Year 3.

6.2 Year 5 Analysis

For Year 5 the total area of deforestation over the 12 month period is calculated at 11 975 ha. This is a decrease of some 758 ha when compared to Year 4.

The total change and change expressed as a percentage of forest remaining is provided in Table 6-1.

Table 6-1: Area Deforested 1990 to 2014

Period	Years	Analysis resolution	Forest Area ('000 ha)	Change ('000 ha)	Change Rate (%)
Initial forest area 1990		30 m	18 473.39		
Benchmark (Sept 2009)	19.75	30 m	18 398.48	74.92	0.41
Year 1 (Sept 2010)	1	30 m	18 388.19	10.28	0.056
Year 2 (Oct 2010 to Dec 2011)	1.25	30 m & 5 m	18 378.30	9.88	0.054
Year 3 (Jan 2012 to Dec 2012)	1	5 m	*18 487.88	14.65	0.079
Year 4 (Jan 2013 to Dec 2013)	1	5 m	18 475.14	12.73	0.068
Year 5 (Jan 2014 to Dec 2014)	1	5 m	**18 470.57	11.98	0.065

*A new start forest area is used from year 2 to year 4 as the analyses were undertaken using 5m resolution imagery and a 5m resolution updated non forest basemap. This is further explained in section 1.3

**A new start forest area is used from year 5 forward. This is further explained in section 1.3

Based on the initial 1990 forest area, the forest cover change for the 1990-2009 period is estimated at 0.41% (i.e.<1%). As with Year 1, the FAO (1995) equation as cited in Puyravaud (2003) has been used to calculate the annual rate of change. Puyravaud (2003) suggests an alternative to this equation, but at low rates of deforestation the two are essentially the same.

Equation 6-1: Rate of Forest Change

$$q = \left(\frac{A_2}{A_1}\right)^{1/(t_2-t_1)} - 1$$

Whereby the annual rate of change (%/yr or ha/yr) is calculated by determining the forest cover A_1 and A_2 at time periods t_1 and t_2.

If the 1990-2009 period is annualised this represents an average rate of change of about 3 800 ha/yr^{-1} which is equivalent to a deforestation rate of - 0.02%/ yr.

From this point the deforestation increased for the Year 1 period to 0.06% and has remained at a similar level for Year 2 (0.054%). The rate is in fact lower (0.043%) if the change is expressed as an annual rate rather than presented for the entire Year 2 period.

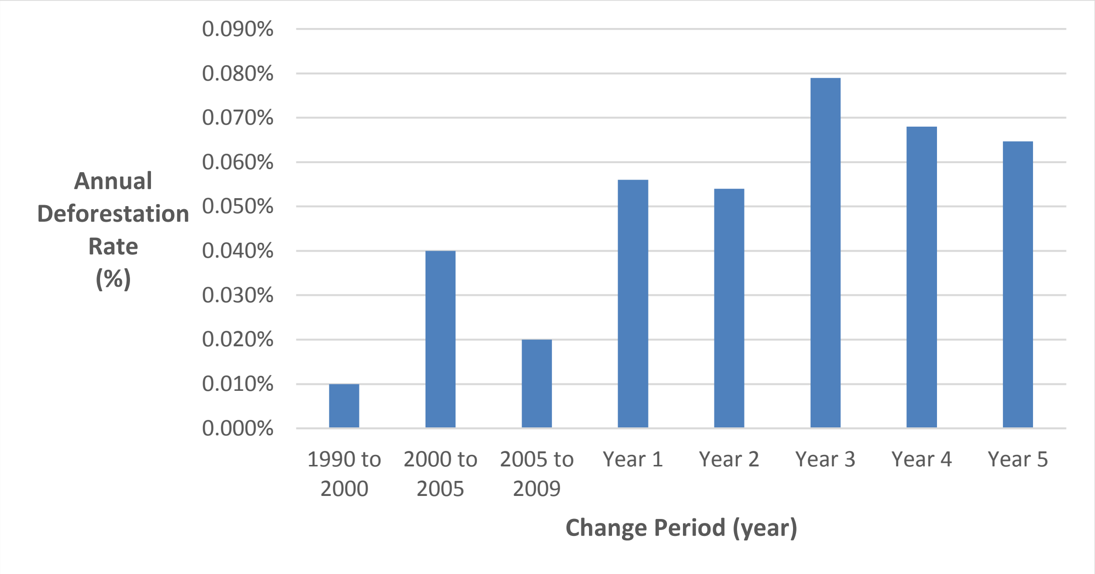
In Year 3 the deforestation rate increased relative to previous years to 0.079%, but in Year 4 a decrease has occurred to 0.068%

Overall, Guyana's Year 4 deforestation rate is low when compared to the rest of South America, which according to the FAO 2010 forest resource assessment (FRA) is tracking at an annual deforestation rate of -0.41%/yr[13].

The following figure shows the deforestation trend by period. The rate presented has been annualised for the benchmark and Year 1 period. The value for the full 15 month assessment period is shown for Year 2. Year 3 (2012), Year 4 (2013) and Year 5 (2014) were annual assessments.

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; 0.068% in Year 4 and 0.065% in Year 5.

Figure 6-1: Annual Rate of Deforestation by Period from 1990 to 2014



6.3 Forest Change by Driver

The forest change was divided and assessed by driver. In Year 5, degradation as measured from the 5 m RapidEye images was also included in the analysis. Details of this methodology are provided in the Year 2 interim measures report which is available from the GFC.

Table 6-2 provides a breakdown by forest change drivers for the benchmark, Year 1, 2, 3, 4 and 5 periods. Interpretation of the change areas during the benchmark period identifies mining (which includes mining infrastructure) as the leading contributor of deforestation (60% of the total), particularly between 2001 and 2005.

The area of deforestation attributed to mining (which includes mining infrastructure) has decreased slightly from Year 4 (11 251) to Year 5 (10 191 ha). Deforestation attributed to mining accounts for approximately 85% of all recorded deforestation in 2014 (Year 5).

[13] A revision to the FRA estimate is expected in 2015.

Table 6-2: Forest Change Area by Period & Driver from 1990 to 2014[5]

Driver	Historical Period			Year 1	Year 2 2010-11 (15 months)		Year 3 2012		Year 4 2013		Year 5 2014	
	1990 to 2000	2001 to 2005	2006 to 2009	2009-10	Deforestation	Degradation	Deforestation	Degradation	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)											
[1]Forestry (including forestry infrastructure)	6 094	8 420	4 784	294	233	147	240	113	330	85	204	62
Agriculture (permanent)	2 030	2 852	1 797	513	52	-	440	0	424	-	817	-
[2]Mining (includes mining infrastructure)	10 843	21 438	12 624	9 384	9 175	5 287	13 516	1 629	[2]11 251	2 955	10 191	3 674
Infrastructure	590	1 304	195	64	148	5	127	13	278	112	141	63
Fire	1 708	235		32	58	28	184	208	96	395	259	265
Settlements									23	20	71	-
Shifting Agriculture										765		167
Year 2 forest degradation converted to deforestation							148		67		22	
Year 3 forest degradation converted to deforestation									200		94	
Year 4 forest degradation converted to deforestation											127	
[3]Amaila Falls Development (Infrastructure roads)					225				64	20	49	20
Area Change	**21 267**	**34 249**	**19 400**	**10 287**	**9 891**	**5 467**	**14 655**	**1 963**	**12 733**	**4 352**	**11 975**	**4 251**
Area Change less Shifting Agriculture										**3 587**		**4 064**
Total Forest Area of Guyana	18 473 394	18 452 127	18 417 878	18 398 478	18 388 190		**18 502 531**		18 487 876		[4]**18 482 547**	
Total Forest Area of Guyana Remaining	18 452 127	18 417 878	18 398 478	18 388 190	18 378 299		18 487 876		18 475 143		18 470 572	
Period Deforestation (%)	0.01%	0.04%	0.02%	0.056%	0.054%		0.079%		0.068%		0.065%	

[1]Forestry infrastructure accounts for the full total of deforestation from forestry activities.

[2]Mining Infrastructure accounts for 918 ha in 2013 out of the total deforestation driven by mining of 11 518 ha, when Year 2 & 3 transitional areas are taken into account.

[3]Amaila Falls Development has been split from other infrastructure driven change for reporting purposes.

[4]Using the updated start forest area as derived from Year 5 mapping.

[5] Area change totals may vary between 1 to 3 hectares owing to the rounding of numbers.

6.4 Degradation

The area of degradation in close proximity to deforestation events in Year 1 was estimated as 92 413 ha – which was calculated using the default method outlined in the Norway/Guyana JCN. In Year 2 infrastructure as measured from satellite imagery was estimated at 5 467 ha. This figure is substantially lower than the figure previously reported.

The difference is due to implementation of a revised and more precise methodology for degradation assessment. In the Year 1 assessment it was not possible to reliably measure degradation from Landsat type imagery (30 m) due to the resolution of the imagery, and the scale of degradation events in Guyana. From Year 2 onwards the approach was changed and high-resolution imagery was used to identify forest degradation events.

In Year 5 the area degraded was 4 251 ha (4 064 excluding shifting agriculture) which is a slight decrease from 4 352 ha as reported in Year 4. The fluctuation in areas mapped as degraded does not track with the associated deforested area. It is thought this is due to significant areas near mining sites being degraded in initial activities and then deforested once the site is fully operational.

The main driver of degradation in Year 5 continues to be mining which accounts for 87% of all degradation mapped. This is expected as mining also accounts for the largest area of deforestation. The established trend is that forest degradation impacts are largely detected around mining areas. The remaining contributors to degradation are from fire (6%) and newly established (pioneer) shifting agriculture areas (4%). Infrastructure and forestry related activities such as degradation during road formation contribute approximately 1% each to total year 5 degradation.

6.5 Transition of Degraded Areas to Deforestation

During the mapping process, areas of historical degradation are revisited. This review checks for any changes in the forest cover and for any expansion. The monitoring process identified that 22 ha of Year 2 areas, 94 ha of Year 3 and 127 ha of year 4 areas had been deforested during the Year 5 reporting period. Table 6-3 provides a summary of the area of each land cover class deforested.

Table 6-3: Transition of Degradation to Deforestation

Period	Driver	Start Land cover Class	Year 3 Deforested (ha)	Year 4 Deforested (ha)	Year 5 Deforested (ha)
Year 2 Degradation Areas	Mining	Mixed Forest Degraded	112	63	22
		Montane Forest Degraded	32	2	-
		Swamp/Marsh Forest Degraded	<1	-	-
		Wallaba/Dakama/Muri Degraded	5	2	-
Total Area (ha)			**148**	**67**	**22**
Year 3 Degradation Areas	Mining	Mixed Forest Degraded		190	87
		Montane Forest Degraded		8	2
		Swamp/Marsh Forest Degraded		1	3
		Wallaba/Dakama/Muri Degraded		2	2
Total Area (ha)				**200**	**94**
Year 4 Degradation Areas	Mining	Mixed Forest Degraded			103
		Montane Forest Degraded			21
		Swamp/Marsh Forest Degraded			1
		Wallaba/Dakama/Muri Degraded			2
Total Area (ha)					**127**

The changes recorded all occur around existing mining areas. Initial evidence suggests that forest areas are degraded during the initial activities. If the areas are fully operationalised then it is probable that these areas recover. Alternatively, if mining proceeds, the areas are converted to deforestation. Further evaluation work is required to better understand the temporal dynamics – i.e. the time taken to deforestation, and if not deforested the carbon emissions due to degradation activities.

6.6 National Trends

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 using Equation 6-1. In general the following trends by driver are observed:

- Forestry related change has remained relatively stable from Years 1 to 5. As in the case of earlier assessments, these are attributed to a forestry driver rather than attributing this change to Infrastructure.
- Agricultural developments causing deforestation have remained stable from Years 1 to 4. However, the reported rate for Year 5 has increased (to 817 ha) when compared to Years 3 and 4.
- Mining remains the largest contributor to deforestation. 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. Mining deforestation has decreased (by 1 327 ha) between Years 4 to 5.
- The area deforested and degraded from fire post 2000 has remained relatively stable. A slight increase (259 ha) has been noted in Year 5.

Table 6-4: Annualised Rate of Forest Change by Period & Driver from 1990 to 2014

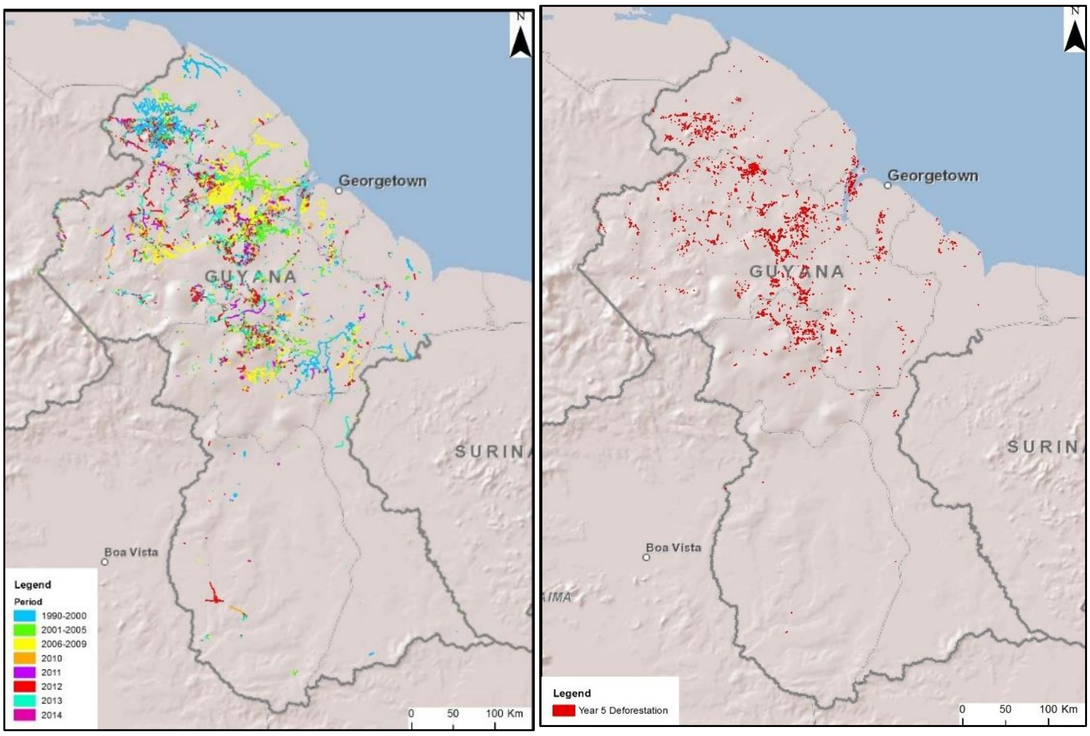
Change Period	Change Period	Annualised Rate of Change by Driver						Annual Rate of Change (ha)
		Forestry	Agriculture	Mining	Infrastructure	Fire	Settlements	
	(Years)	Annual Area (ha)						
1990-2000	10	609	203	1 084	59	171	-	2 127
2001-2005	5	1 684	570	4 288	261	47	-	6 850
2006-2009	4.8	1 007	378	2 658	41	-	-	4 084
2009-10	1	294	513	9 384	64	32	-	10 287
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**

6.7 Deforestation & Degradation Patterns

The temporal analysis of deforestation from 1990 to 2014 is presented in Map 6-1. The map, which presents change from all drivers, shows that most of the change is clustered[14] and that new areas tend to be developed in close proximity to existing activities. Most Year 5 deforestation activities fall close to or inside the footprint of historical change areas in the north and west of the country.

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

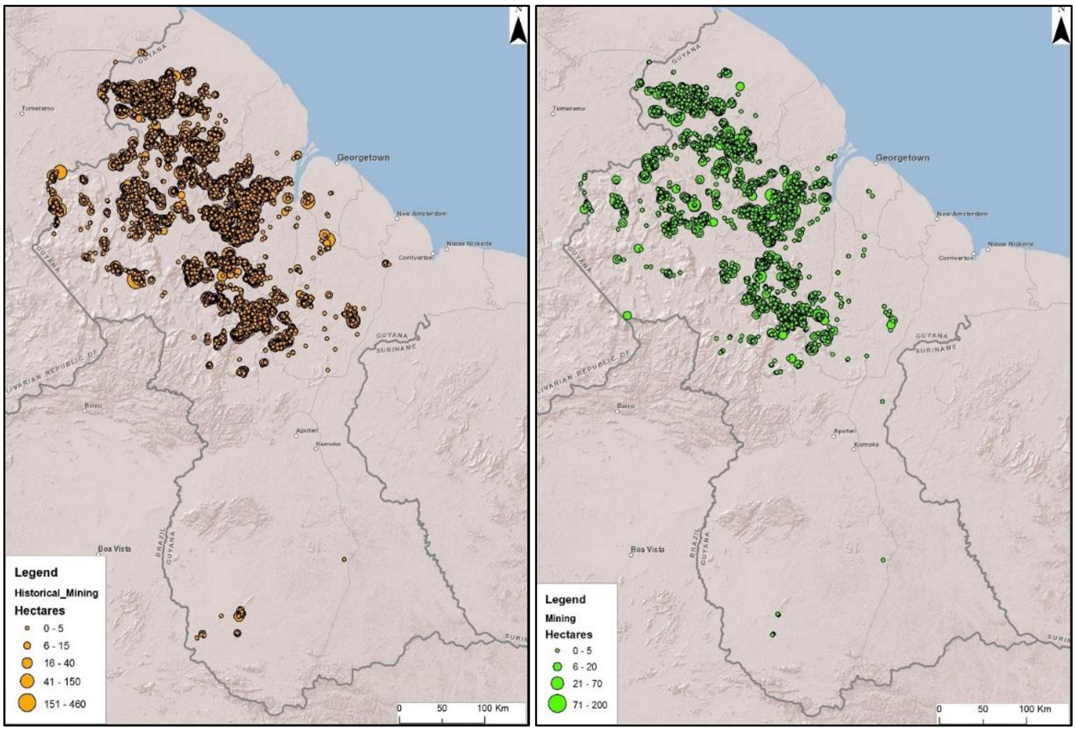
Map 6-1: Historical & Year 5 Forest Change



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 continues in Year 5, with only small areas of change observed in this region.

The following series of maps show the temporal and spatial distribution of deforestation by driver (mining, forestry and agricultural and biomass burning). The relative size of the change is represented by scaling the symbol proportional to the area it represents.

Map 6-2: Mining Spatial & Temporal Distribution Historical and Year 5



Mining

The spatial trend on Map 6-2 shows that mining activities, including associated road construction, are concentrated in the northwest of the country. Forest change related to mining includes mining sites and any infrastructure associated with the operation, and historical degraded areas that have been converted to deforestation. This includes any roads that lead directly to mining.

As with the previous years most of the deforestation activity occurs in the State Forest Area (SFA). In particular Year 5 mining activities are consolidated in the centre of Guyana. Additional mining is observed to the west of the core mining area.

Changes within Kaieteur National Park

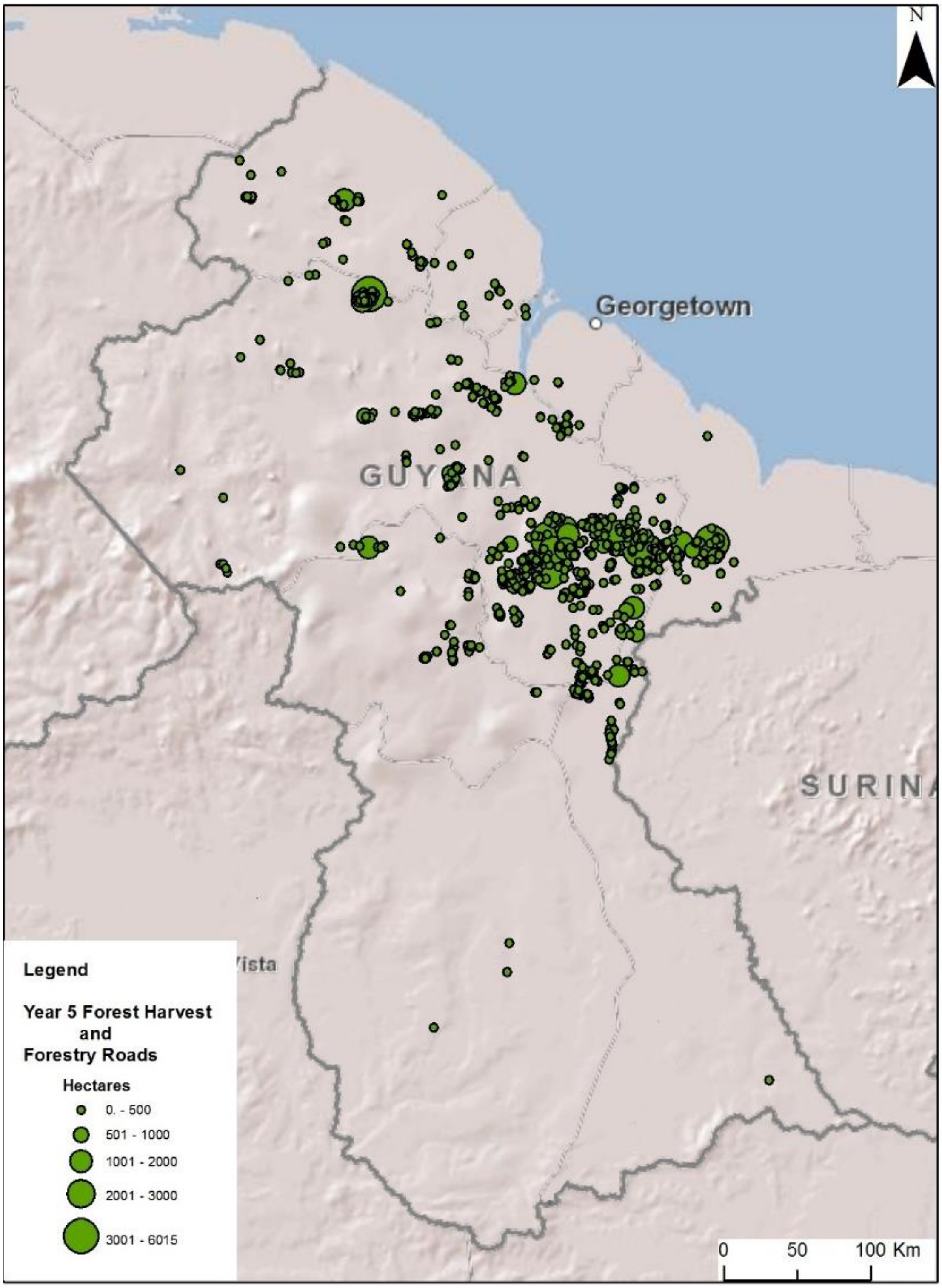
Of the total area of Kaieteur National Park, mining activity accounts for 15.5 hectares of deforestation. Degradation around mining events account for 13 hectares.

Forestry

Map 6-3 shows that the majority of the forestry activities are located inside the SFA. During the Year 5 period, all deforestation events are associated with forestry harvest operations. The main causes of forest clearance include road and log market construction. The reported Year 5 value (of 204 ha) is a decrease when compared to the previous two Years.

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.

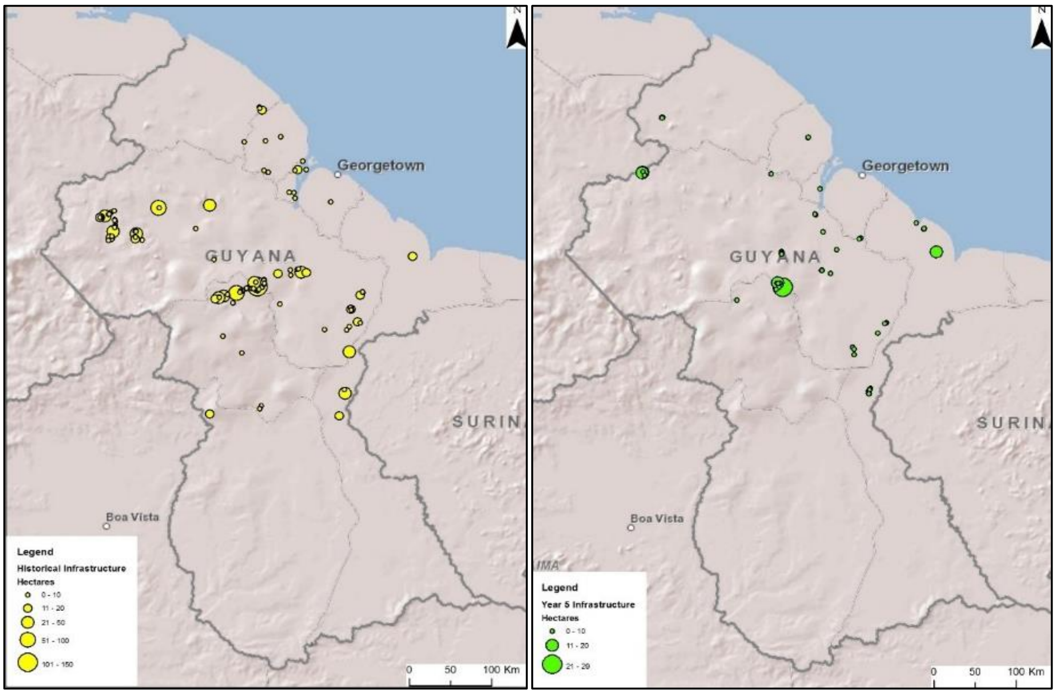
Map 6-3: Forestry Spatial & Temporal Distribution in Year 5



Infrastructure

In Year 5 infrastructure developments have increased compared to Year 3. The area of clearance is in a similar location. The main change is related to road construction activities which are also observed in close proximity to towns. Map 6-4 shows the distribution of infrastructure developments – note the maps include Amaila Falls Road in central Guyana.

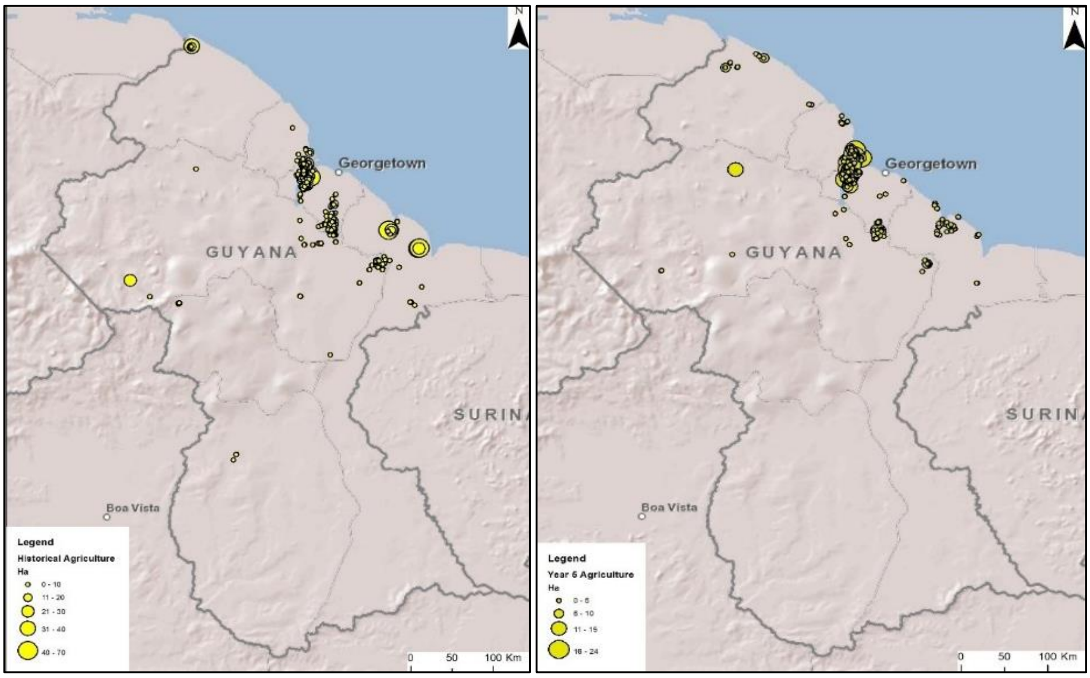
Map 6-4: Infrastructure Roads Spatial & Temporal Distribution Historical to Year 5



Agricultural Development

In Year 5 agricultural developments leading to deforestation have increased to 817 ha. This is an increase when compared to annualised historic and Years 1 to 4 figures. The main areas of development are located close to Georgetown and the north-eastern regions of Guyana. They are in close proximity to the river network.

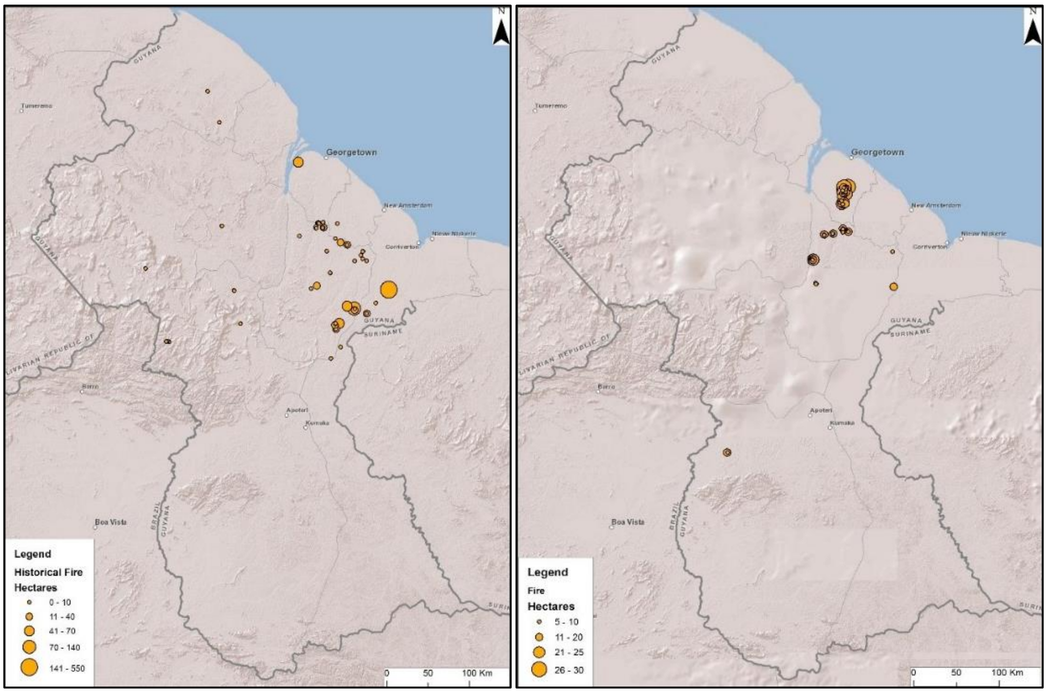
Map 6-5: Agriculture Development Spatial & Temporal Distribution Historical and Year 5



Biomass Burning - Fire

A majority of recurring fire events occur in the white sand forest area surrounding Linden. Burning events can be a precursor to agricultural development, or related to other clearance activities. Fire is also very common in the non-forest savannah areas to the south of the country. Map 6-5 shows the distribution of fires resulting in deforestation.

Map 6-6: Biomass Burning - Fire Temporal and Spatial Distribution Historical to Year 5



6.8 Changes in Categorization of Forest Areas

The areas of State Forest Area (SFA) and State Lands are estimated at 14.83 million ha.

This change does not impact on the overall forest change figures for Year 5, but the re-categorisation of land does change the forest area reported for the State Forest Area, State Lands and Amerindian Villages. The forest areas for Kaieteur National Park and Iwokrama have remained the same.

6.9 State Forest Area

Historical Change

In the previous assessment the total change in SFA between 1990 and 2009 was estimated at 63 646 ha. Overall the SFA accounted for 85% of all deforestation for the benchmark period. Annualised this represented a change rate of 3 200 ha/yr which is equivalent to a deforestation rate of - 0.03%/yr. During the Year 1 period, deforestation in the SFA was calculated at 8 910 ha. Overall 87% of all change for the year occurred inside the SFA.

A similar trend was seen in Year 2 with around 9 362 ha cleared, and a deforestation rate within this sub category of 0.076% (note that this is calculated as a proportion of the land area making up this sub category), which is very similar to Year 1. A small increase is due to the transfer of forested area under the State Forest Estate category to Amerindian titled land. In Year 3 forest change was dominated by mining (95%) followed by forestry activities (2%).

Infrastructure development, fire and agriculture are less prominent and contribute around 3% of the deforestation observed. In Year 4 the trend continued with 94% of deforestation attributed to mining activities. Degradation surrounding new infrastructure such as mining sites has increased from 1 499 ha in Year 3 to 2 616 ha in Year 4.

The patterns for Year 5 are largely similar to those of Year 4. Mining continues to be the main driver for deforestation at 92% of total deforestation. Degradation contributed to mining accounts for some 91%. Infrastructure development, forestry and agriculture make up some 4% of Year 5 deforestation, with the latter increasing from the Year 4 rate of 69 ha to 112 ha. Compared to Year 4, degradation has increased by 328 ha, again largely as a result of mining.

Table 6-5 provides a breakdown of forest change by driver for all periods. Degradation is reported for Years 2 to 5.

Table 6-5 SFA Total Forest Change by Driver from 1990 to 2014[15]

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2012		Year 4 2013		Year 5 2014	
	1990 - 2000	2001-2005	2006 -2009	2009-10	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded
	Area (ha)											
Forestry	6 026	8 253	4 293	270	211	147	229	113	318	85	199	62
Agriculture (permanent)	384	247	62	3	33	-	102	-	69	-	112	-
Mining	10 122	19 930	12 007	8 582	8 788	5 038	12 179	1 499	10 202	2 616	9 326	3 391
Infrastructure	374	1 228	89	24	322	5	44	13	283	108	113	63
Fire (deforestation)	564	67	-	32	5	4	145	125	22	284	60	173
Settlements									11	20	28	-
Shifting Agriculture										287		39
Degradation (Year 2) converted to deforestation							148		62		22	
Degradation (Year 3) converted to deforestation									194		93	
Degradation (Year 4) converted to deforestation											125	
Amaila Falls Development (Infrastructure roads)					255				64	20	49	20
Area Deforested	**17 470**	**29 725**	**16 451**	**8 910**	**9 362**	**5 194**	**12 848**	**1 749**	**11 161**	**3 400**	**10 127**	**3 748**
Total Forested SFA Area (ha)	12 481 363	12 463 894	12 434 169	12 417 718	12 341 893		12 341 893		12 329 045		12 249 224	
Total Forested SFA Remaining (ha)	12 463 894	12 434 169	12 417 718	12 408 807	12 332 530		12 329 045		12 317 884		12 239 097	
Period Deforestation rate (%)	0.01%	0.05%	0.03%	0.07%	0.08%		0.10%		0.09%		0.08%	

[1]Amaila Fals total included in year 5 deforestation values.

[15] Area change totals may vary between 1 to 3 hectares owing to the rounding of numbers.

6.10 Changes in Guyana's State Lands

Historical Change

For the period spanning 1990 to 2009 a deforestation figure of 8 162 ha was reported. This equated to approximately 11% of all deforestation for the benchmark period. Annualised this represented a change rate of 463 ha/yr or an equivalent deforestation rate of 0.01%/ yr. For Year 1 deforestation in State Lands was calculated at 741 ha.

In Year 2 the total area deforested had decreased to 202 ha. Like the SFA, the main contributor to deforestation is mining which accounted for approximately 59% of the change. This is followed by infrastructure in the form of roads, agriculture, fires and lastly forestry.

In Year 3 the level of deforestation increased to 749 ha which is similar to the value reported in 2009-10. The deforestation was shared equally between agriculture and mining. In Year 4 the deforestation figure increased to 912 ha accounting for 8% of total deforestation. Forest degradation also saw an upward trend from 85 ha in Year 3 to 219 ha in Year 4. In Year 4 this accounted for around 5% of all mapped forest degradation.

In Year 5 the deforestation figure increased to 1 331 ha accounting for 11% of total deforestation. Forest degradation increased from 219 ha in Year 4 to 271 ha in Year 5. In Year 5 this accounted for around 6% of all mapped forest degradation. The following table provides a breakdown by driver for the benchmark and Year 1, 2, 3, 4 and 5 periods.

Table 6-6: State Lands Forest Change by Driver from 1990 to 2014[16]

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2012		Year 4 2013		Year 5 2014	
	1990 - 2000	2001-2005	2006 -2009	2009-10	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded
	Area (ha)											
Forestry	24	93	30	24	7	-	6	-	1	-	5	-
Agriculture (permanent)	1 565	2 563	1 735	510	19	-	324	-	353	-	671	-
Mining	306	814	190	175	120	26	331	38	443	131	392	114
Infrastructure	30	72	18	32	47	-	49	-	33	24	22	-
Fire (deforestation)	720	1	-	-	9	4	39	47	70	57	199	93
Settlements									12	-	40	-
Shifting Agriculture										7		64
Degradation (Year 2) converted to deforestation					-				-		-	
Degradation (Year 3) converted to deforestation									-		1	
Degradation (Year 4) converted to deforestation											-	
Amaila Falls Development (Infrastructure roads)											-	-
Area Deforested	**2 645**	**3 543**	**1 974**	**741**	**202**	**30**	**749**	**85**	**912**	**219**	**1 331**	**271**
Total Forested State Land Area (ha)	3 095 485	3 092 840	3 089 297	3 087 324	3 084 306		3 084 306		3 084 104		2 559 890	
Total Forested State Land Remaining (ha)	3 092 840	3 089 297	3 087 324	3 086 583	3 084 104		3 084 104		3 083192		2 558 560	
Period Deforestation rate (%)	0.01%	0.02%	0.01%	0.02%	0.01%		0.02%		0.03%		0.05%	

[16] Area change totals may vary between 1 to 3 hectares owing to the rounding of numbers.

6.11 Amerindian Areas

Forest change and degradation is also monitored for Amerindian areas.

Forest change has been mapped across the titled Amerindian areas. The trend indicates that Year 4 deforestation (660 ha) and the annual rate (0.03%) have increased relative to Year 1 and 2, but the area is less than that mapped in Year 3 (1056 ha).

Mining dominates the change areas and contributes around 92% of the total change for Year 4. The area of forest degradation (734 ha) is dominated by shifting agriculture[17] (62% of the area). Shifting cultivation is often observed in the areas surrounding Amerindian communities. Degradation associated with mining operations contributes 208 ha of the total (~28%).

Mining again dominates the change areas and contributes around 91% of the total deforestation for Year 5. The area of forest degradation (219 ha) is also dominated by mining activity (155 ha or 71%) with the remaining classified as shifting agriculture[18] (64 ha or 29%). Shifting agriculture is often observed in the areas surrounding Amerindian communities.

[17] Shifting cultivation was reported for the first time in Year 4. Reported values are new areas of shifting cultivation > 0.25 ha in area.

[18] Shifting cultivation was reported for the first time in Year 4. Reported values are new areas of shifting cultivation > 0.25 ha in area.

Table 6-7: Amerindian Area Forest Change by Driver from 1990 to 2014[19]

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2012		Year 4 2013		Year 5 2014	
	1990 - 2000	2001-2005	2006 -2009	2009-10	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded	Deforested	Degraded
	Area (ha)											
Forestry	-	-	-	-	15	-	4	-	11	-	-	-
Agriculture (permanent)	55	18	-	-	-	-	13	-	2	-	34	-
Mining	415	694	426	627	267	216	1 005	92	606	208	458	155
Infrastructure	-	4	89	8	-	-	34	-	26	1	6	-
Fire (deforestation)	425	166	0	0	44	20	0	36	4	54	-	-
Settlements									-	-	3	-
Shifting Agriculture										471		64
Degradation (Year 2) converted to deforestation					-		-		5		-	
Degradation (Year 3) converted to deforestation									6		1	
Degradation (Year 4) converted to deforestation											3	
Amaila Falls Development (Infrastructure roads)											-	-
Area Deforested	**895**	**883**	**515**	**635**	**326**	**236**	**1 056**	**129**	**660**	**734**	**503**	**219**
Total Forested Amerindian Area (ha)	2 490 707	2 489 812	2 488 930	2 488 415	2 546 852		2 546 852		2 546 526		2 582 440	
Total Forested Amerindian Area Remaining (ha)	2 489 812	2 488 930	2 488 415	2 487 780	2 546 526		2 546 526		2 545 866		2 581 936	
Period Deforestation rate (%)	0.00%	0.01%	0.00%	0.03%	0.01%		0.04%		0.03%		0.02%	

[19] Area change totals may vary between 1 to 3 hectares owing to the rounding of numbers.

7. VERIFYING FOREST CHANGE MAPPING & INTERIM MEASURES

As part of the MRVS reporting process an independent accuracy assessment is also conducted. The results of the accuracy assessment will be reviewed by independent auditors.

The Accuracy Assessment scope dictates that a third party not involved in the change mapping conducts an assessment of deforestation, forest degradation and forest area change estimates for the Year 4 period (2013). Specifically, the terms of reference asked that confidence limits be attached to the forest area estimates.

The methods applied in this report 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 2014 to 31 December 2014 (Interim Measures Period – Year 5).

This year high-resolution aerial photography (see section 4.6) has been used to assess the wall-to-wall mapping of Guyana undertaken by the Guyana Forestry Commission (GFC).

7.1 Accuracy Assessment Conclusions & Recommendations

1. It is concluded that the estimates of deforestation based on the mapping undertaken by GFC based largely on interpretation of RapidEye imagery is of a good standard.
2. The methods used by GFC, and assisted by IAP, follow the good practice recommendations set out in the GOFC-GOLD guidelines and considerable effort has been made to acquire cloud free imagery towards the end of the census period January to December 2014 (Year 5).
3. The GeoVantage aerial photography was of good spatial resolution and radiometric quality and this helped remove much of the ambiguity and uncertainty associated with the validation process for the Medium and High Risk strata. GeoVantage data were needed to help identify forest degradation and partial deforestation within sample areas.
4. The estimate of the annual rate of deforestation that occurred in 2014 (Year 5) is 0.062%, SE 0.008%. This is almost identical to the deforestation rate derived from the wall-to-wall mapping from the MRVS of 0.065%.
5. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Non-forest and Degraded forest to Non-forest is 12,219 hectares with a standard error of 1,506 ha and a 95% confidence interval (9,267 ha; 15,171 ha).
6. The estimate of the annual rate of the rate change from Forest to Degraded forest between Y4 and Y5 is 0.046% with a standard error of 0.022%.
7. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Degraded forest is 7,377 hectares with a standard error of 1,230 ha and a 95% confidence interval (4,966 ha; 9,787 ha).
8. The new stratification improved the precision of the estimate of deforestation. The Low Risk stratum now contains a very low proportion of samples exhibiting change and accounts for only 5,777 ha of forest loss, of which only 3,354 ha is loss from non-degraded forest. The standard error of the estimate is 1,506 compared with a SE of 1,819 ha in Year 4.
9. The GIS data file containing all of the change sample areas is available and can be used to help cross check interpretations.
10. The results from the change sample analysis confirms GFCs conclusion that mining and mining related infrastructure and clearance for agriculture are the main drivers for both deforestation. For forest degradation mining and mining roads are the dominant cause of change.

8. 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 intention is that these interim measures will be phased out as the MRVS is established[20].

The basis for comparison of a majority of the interim measures is the 30 September 2009 benchmark map[21]. 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 onwards a national coverage of RapidEye was commissioned. Images were acquired from August to December in 2012 and 2013.

A summary of the key reporting measures and brief description for these interim measures are outlined in Table 9-1. The calculations to determine the rate of deforestation (ref. measure 1) are reported in Section 6.

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 measures such as forest degradation this is the second time this has been calculated using direct measurement from high-resolution satellite imagery. For the Year 1 assessment the default measure was applied which meant degradation was calculated by applying a 500 m buffer around mining sites and roads.

[20]The participants agree that these indicators will evolve as more scientific and methodological certainty is gathered concerning the means of verification for each indicator, in particular the capability of the MRV system at different stages of development.
[21]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 8-1: Reported Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 2 Period	Year 3 Period	Year 4 Period	Year 5 Period	Difference between Year 5 & Reference Measure
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change (%)/yr*	0.275%	0.054%	0.079%	0.068%	0.065%	0.21%
s2	Degradation Indicators	National area of Intact Forest Landscape (IFL). Change in IFL post Year 1, following consideration of exclusion areas.	*ha*	7 604 820	7 604 754 (66 ha loss)	7 604 580 (174 ha loss)	7 604 425 (155 ha loss)	7 604 314 (111 ha loss)	-506 ha *(111 ha loss in Year 5)*
2b		Determine the extent of degradation associated with new infrastructure such as mining, roads, settlements post the benchmark period.	*ha*	4 368	5 460	1 963	4 352	4 251	117 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 [22]	3 685 376[23]	2 159 151	3 106 693	3 366 326	20 452
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	18 289	11 217	11 533	13 823	398 033
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	*ha/yr*	1 706[24]	28	208	395	265	1 441
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).	*ha/yr*	-	-	-	765	167	-

[22] 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. This Reference measure is presented in this Year 4 report for 12 months as Year 4 spans 12 months. The prorated value for this reference measure was presented for Year 2, equated to 15 months to aid comparability with the 15 month period for Year 2. The same is the case for the Reference level for illegal logging for Years 2, 3 and 4.
[23]Computed for the period 1 October 2010 to 31 December 2011. (15 months)
[24] Degradation from forest fires is taken from an average over the past 20 years.

8.1 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.

8.2 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 encluding dead wood, litter, and soil to 30 cm which account for the remaining percent[25]. 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 images to identify new areas of development at a one hectare scale. From Year 3 onwards nationwide high-resolution (5 m) images supplemented by medium resolution satellite images have been used. This improves on the Year 2 coverage which was only acquired over 56% of the country.

8.3 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.

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

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.

8.4 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 770 000, 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.

Amerindian titled areas that have been 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.

8.5 Calculation of the Year 5 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.

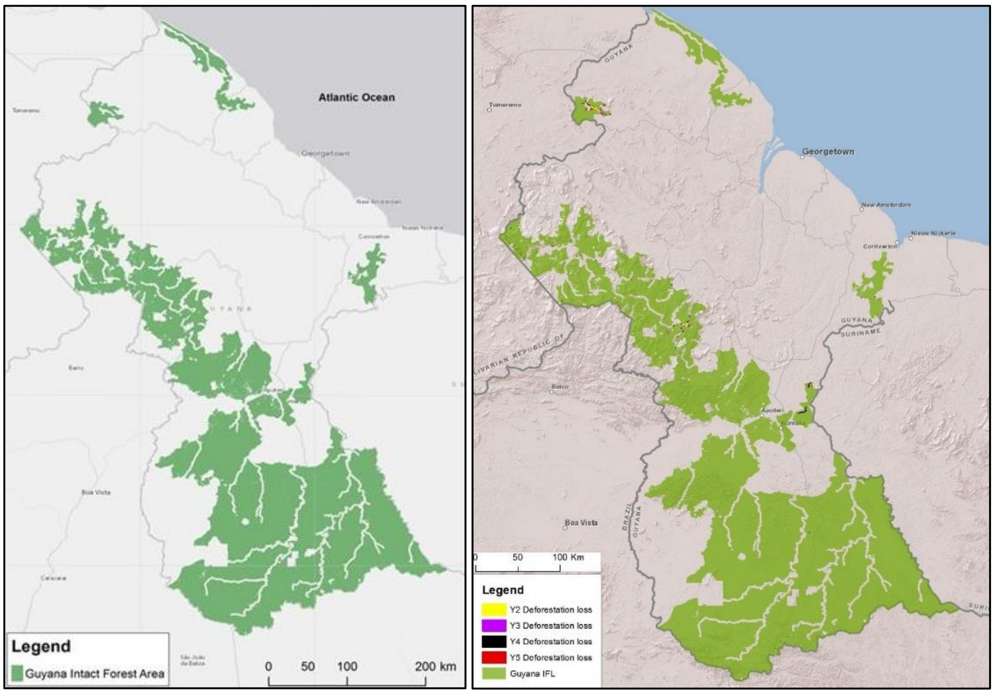
In 2011 approximately 56% of Guyana was imaged with high resolution imagery. This was expanded to full coverage in 2012, 2013 and 2014. This move has improved the spatial coverage and provides a robust means of detecting changes associated with deforestation and degradation. This should enable the replacement of the IFL interim measure with a national monitoring process based on high resolution satellite imagery.

In Year 5 the same benchmark IFL area was used. The analysis identified 111 ha of deforestation, 63 ha of which was mapped in Amerindian areas.

It is proposed that deforestation located in Amerindian areas is not counted in calculating the reduction in financial remuneration. These areas are part of Guyana's continuous land titling and demarcation programme.

Map 8-1 (left) shows the extent of the benchmark IFL as created for the Year 1 period. At this point the total intact forest landscape area in Guyana was estimated at 7.60 million ha. The second map identifies the deforestation that has occurred inside the IFL since Year 1.

Map 8-1: Intact Forest Landscape Maps



8.6 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 reassessed for change.

The MRVS for Year 5 has, within mapping protocols, integrated the assessment of re-entry of existing mines and has included the results of this assessment within the total degradation reported for Year 5. Forest degradation that occurred in Year 5 has been mapped when surrounding Year 2, Year 3 and Year 4 infrastructure and mining.

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 necessarily reflect forest degradation in a practical sense as it is based on applying the 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. As noted in Section 5.6 further work is required to better understand the temporal dynamics of degradation and the carbon emissions should the area not be deforested.

8.7 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 2014 to 31 December 2014:

- 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 as regards to 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 Produce 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:

Emissions, t CO_2/yr = {[Vol x WD x CF x (1-LTP)] + [Vol x LDF] + [Lng x LIF]}*3.67 (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

<u>Wood in long term products</u>

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)[26]

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 2014 to 31 December 2014 is shown in the table below. For this period t CO_2 has reduced by 20,452 t CO_2.

Table 8-2: Interim indicator on Forest Management

Period	**Description**	**Volume (t CO_2)**
1 January 2014 – 31 December 2014	t CO_2 emissions arising from timber harvesting	3 366 326
2003-2008 (annual average)	t CO_2 emissions arising from timber harvesting	3 386 778
Difference (t CO_2)		**20 452**

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

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

8.8 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 5, January 2014 to 31 December 2014, 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 398 033 t CO_2, less than the historic period level.

Table 8-3 Interim Indicator on Illegal Logging

Period	**Description**	**Volume (t CO_2)**
1 January 2014 – 31 December 2014	t CO_2 emissions arising from illegal logging	13 823
2003-2008 (annual average)	t CO_2 emissions arising from illegal logging	411 856
Difference (t CO_2)		**398 033**

Reporting on illegal logging activities is done via the GFC's 32 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 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

8.9 Emissions from Anthropogenic Forest Fires – Measure 5

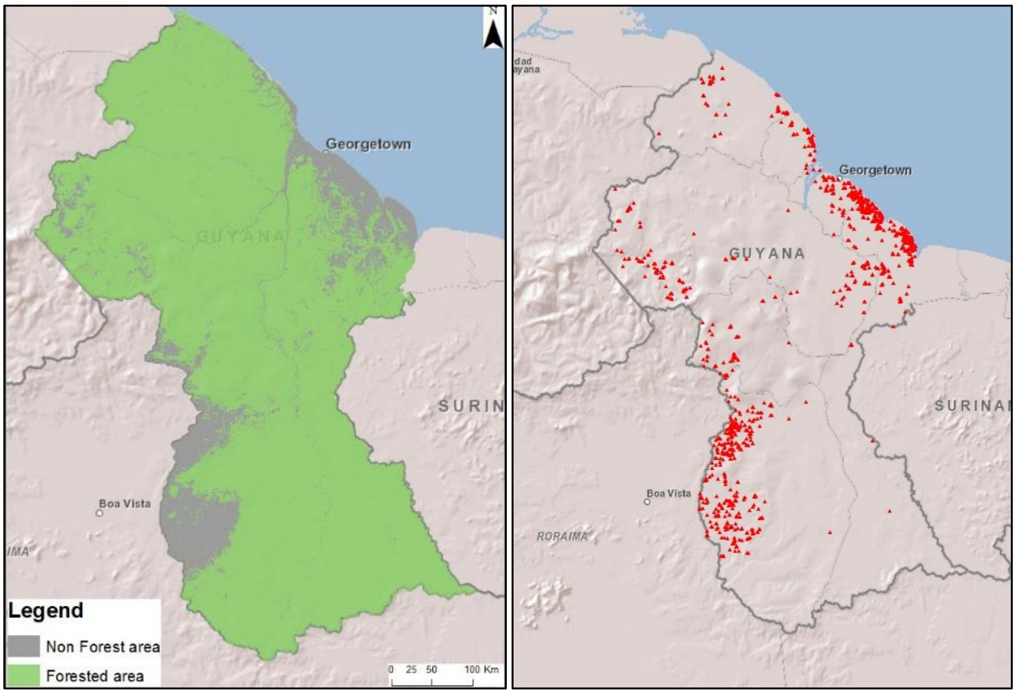
The FIRMS fire point data from MODIS was used to identify potential fire locations (Map 8-2). In addition a systematic review of all fire points was undertaken to validate the presence of fire and establish the extent using the RapidEye imagery. This is an accepted approach that is documented in the 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[27]. 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 Year 2 a considerably lower area of 28 ha was mapped. In Year 3 the area degraded by fire increased to 208 ha and further to 395 ha in Year 4. In Year 5 the area degraded by fire was 173 ha which is lower than reported in the previous two years.

Overall, fire is an immaterial change driver in Guyana with almost all fires occurring within non forest/grassland landscapes as shown in Map 8-2.

Map 8-2: Non Forest Area & FIRMS Fire Data 2010-2014



The main non-forest areas as determined from the 2012 RapidEye imagery are located in the south along the Brazilian border and closer to Georgetown on the coastal fringe.

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

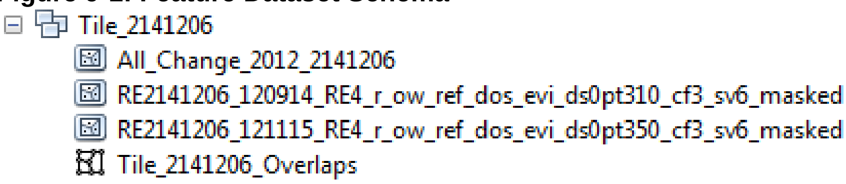
9. ONGOING MONITORING PLAN & QA/QC PROCESSES

A formal QA/QC process has been continually developed over time. The process ensures that the national change analysis is consistent and repeatable. The key elements of the process include:

- Development of the monitoring plan to ensure the provision of satellite data to cover the reporting period. A partnership and supply contract with RapidEye has been initiated.
- Continued tasking of higher resolution (RapidEye) satellite imagery to ensure better delineation of change.
- Facilitating data sharing between agencies through inter-agency training.
- Inclusion of over-flights and capture of geo-referenced oblique photos to confirm vegetation types and change. A database is being built over time containing many thousand aerial oblique photos over different land-cover types in Guyana.
- Integration of a high-resolution airborne camera system to enable an unbiased assessment of map products.
- Upgrading of GPS units to assist with photographic documentation, and geo-tagging.
- Development of routines to automate processing of remote sensing datasets.
- Development of standardized toolbars to enable consistent attribution of change and documentation of drivers of change. Incorporation of GIS datasets in a geodatabase.
- Development of training materials to assist with the attribution of change Review of appropriate peer-review documentation to ensure best practices are adopted in developing methods
- Development of fully aligned IPCC format reporting area change output from an operational MRVS.

The process splits the analysis into RapidEye tiles, maps the change, then merges the tiles back together to form the updated master layer. A feature dataset is created for each tile, which appears like the example shown in Figure 9-1.

Figure 9-1: Feature Dataset Schema



Once each tile is complete it is merged with the new master, an important step is to ensure the edges of the merged tiles are consistent in attribution and topology.

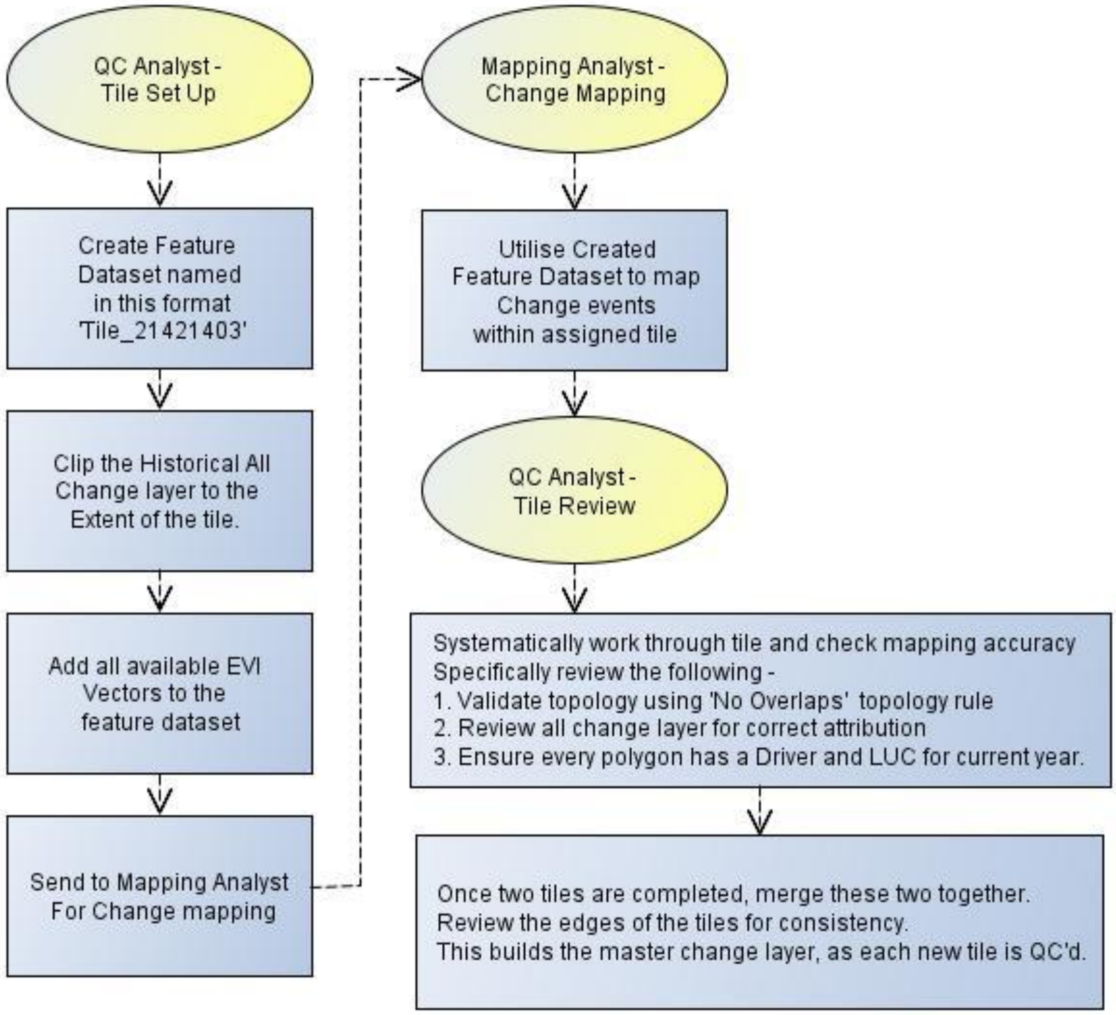
The following description outlines the mapping process while Figure 9-2 shows the technical QC as it is applied.

QC steps -

1. Stitch master datasets together, ensuring consistency.
2. Select rivers and non-forest and clip to remove overlaps.
3. Clip master to country boundary.
4. Check persistent cloud areas.
5. Self-intersect the layer to find any final overlaps.
6. Calculate areas and delete any areas under 25 m² (1 RapidEye pixels) these are considered invalid slithers.

7. Harmonise table to ensure drivers LUCs are consistent.
8. Intersect with land class layer.

Figure 9-2: QC Process Outline



10. DEVELOPMENT AREAS

In 2014 several development areas have been evaluated. This builds on previous work and makes use of the high quality datasets that have been refined and improved since 2009. Of particular interest are the following aspects;

- Evaluation of alternative datasets that could be used in place of commercial satellite data. The rationale being to potentially incorporate freely available imagery into the MRV
- Evaluate the use and accuracy of Global Maps to provide national forest area change estimates
- Over selected sites evaluate alternative sensors for mapping and monitoring degradation. These sites are part of a wider GFOI / ESA research project.
- Modeling of deforestation trends to predict the extent and location of future deforestation activities.

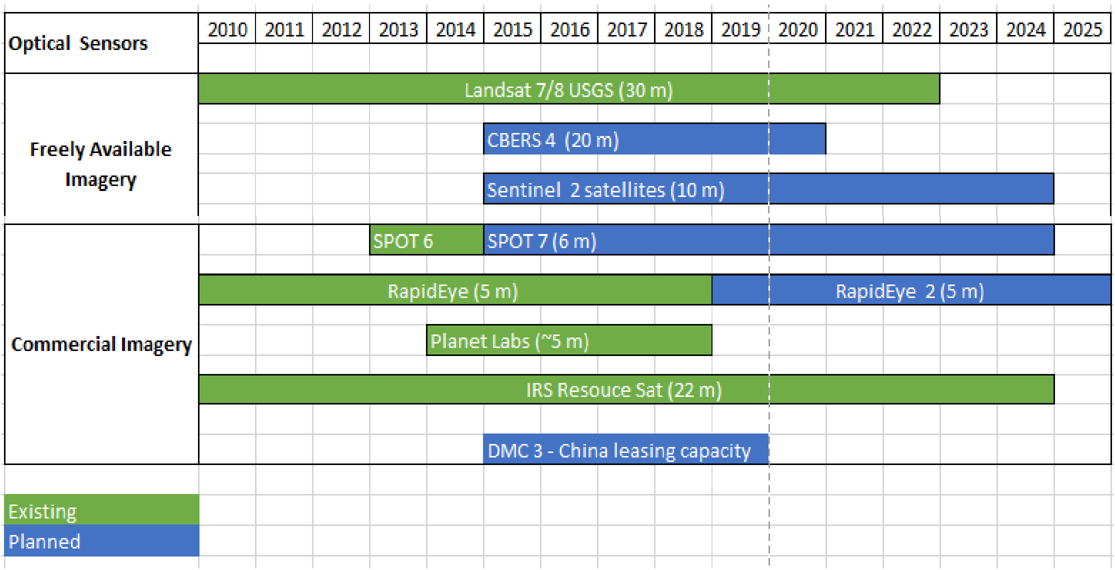
Alternative Image Options

The capability of forest countries to monitor and report change varies - “one size does not fit all”. The lessons learnt from Norway’s bilateral agreements have identified several challenges (NICFI Real-time Evaluations) that merit consideration and reflection on how to best achieve a reduction in global forest deforestation.

Recent improvements in the ability to rapidly process large volumes of satellite imagery to produce 30 m global forest change maps (Hansen et al 2013) signal a shift in monitoring capabilities. A key prerequisite is, however, a continuous a supply of well calibrated satellite imagery that is free and easily accessible. The landmark decision by USGS in 2008 to open the historical Landsat archives to the global community made this a reality.

In summary, Table 10-1 shows the current publically available satellite image providers categorized as either a commercial or free platform supplier. Of particular interest is Sentinel and Planet Labs which are discussed below.

Table 10-1: **Existing & Planned Satellite Missions**



Sentinel

Today there are a variety of EO satellites in orbit although almost all, with the exception of Landsat, are commercial and require tasking. The situation is likely to change with the recent launch of Sentinel-2A (23rd June, 2015, with operational data capture in October 2015), followed by Sentinel-2B scheduled to launch in 2016. Like Landsat, Sentinel hopes to provide imagery that is both free and readily accessible to the general public.

This constellation provides two additional EO satellites capable of imaging the same location every five days at 10 m resolution. The specifications of Sentinel 2 (A & B) make it ideal as a replacement for the current use of Landsat as the supplement image for mapping. Furthermore, at 10 m resolution, it could be reasonably justified as a potential replacement for RapidEye.

A thorough investigation into the dataset will be performed once the data is made available to the general public.

Planet Labs

Over the last two years improvements in technology have led to a decrease in the development costs of satellites. This is evident with the deployment of micro-satellites which is best demonstrated by Planet Labs.

Planet Labs operates a network of satellites known as 'doves'. These are micro satellites measuring roughly 10 cm high x 10 cm wide and 30 cm in length.

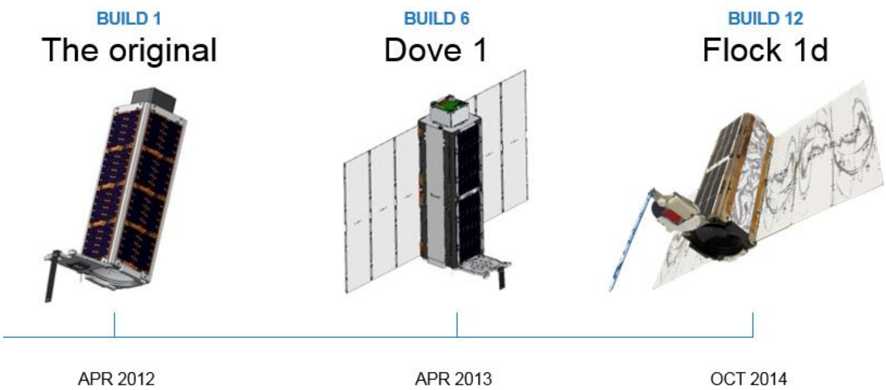
They aim to provide high resolution imagery using a large constellation of doves. This effectively decreases the revisit time and increases temporal resolution. The data sharing policy and pricing of Planet Labs imagery is still being developed, but early indications were that potentially some of the imagery would be freely accessible.

The launch timeline and constellation development is as follows;

- 2013: Launched 71 doves
- 2014: Built 95 new doves.
- 2015: 100+ new doves are commissioned aiming to provide daily capture at 3-5 m resolution.

Over time the technical specifications and design characteristics have been altered based on evaluation of the data produced. The build process has rapidly improved and incorporates progressive refinements of hardware and software and extension of the receiving station network. During this testing phase the images have not been commercially released.

Figure 10-1: Planet Labs Earth Observation Satellites



In 2015 Planet Labs have begun establishing a reseller network and distributing engineering grade imagery via a beta version of the online catalogue.

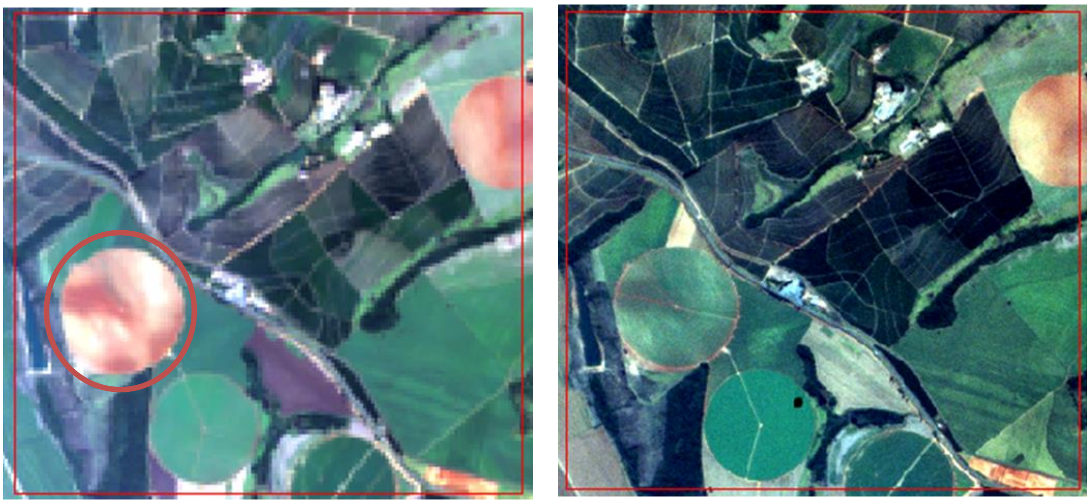
The quality of the engineering grade 1 C imagery has been assessed against earlier releases of Planet Labs imagery and against Landsat. Results indicate that the data quality has continued to improve, however the radiometric quality and consistency of the latest 1C data is still variable. The characteristics of Flock 1C are that it images at 3 m spatial resolution which is resampled from an original pixel size of approximately 4.5 m.

This is illustrated in the following examples, which provide a comparison of Planet Labs image and Landsat over different landscapes.

The main differences include the lack of a near infrared band which assists in determining vegetation vigour and is commonly used to generate vegetation indices. Also the reduced radiometric resolution of the sensor introduces noise across the scene and increases the complexity of normalising multi-temporal coverages. Lastly, the small image extents mean that numerous scenes are required to cover large areas.

In the first example the increased radiometry of the Landsat image enables the separation of individual forest stands with a forested areas. The same information is more difficult to detect from the 1C image. Areas of land cover change are however evident between the two image dates.

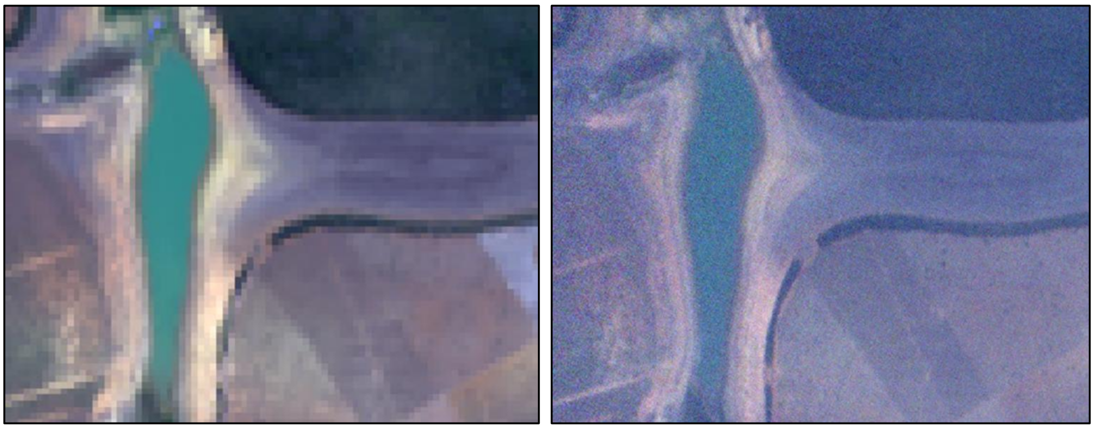
Figure 10-2: Forest Area - Landsat vs Planet Labs



Landsat 8 (30 m) Capture Date: 2014-06-07 *Planet Labs (3 m) Capture Date: 2014-07-07*

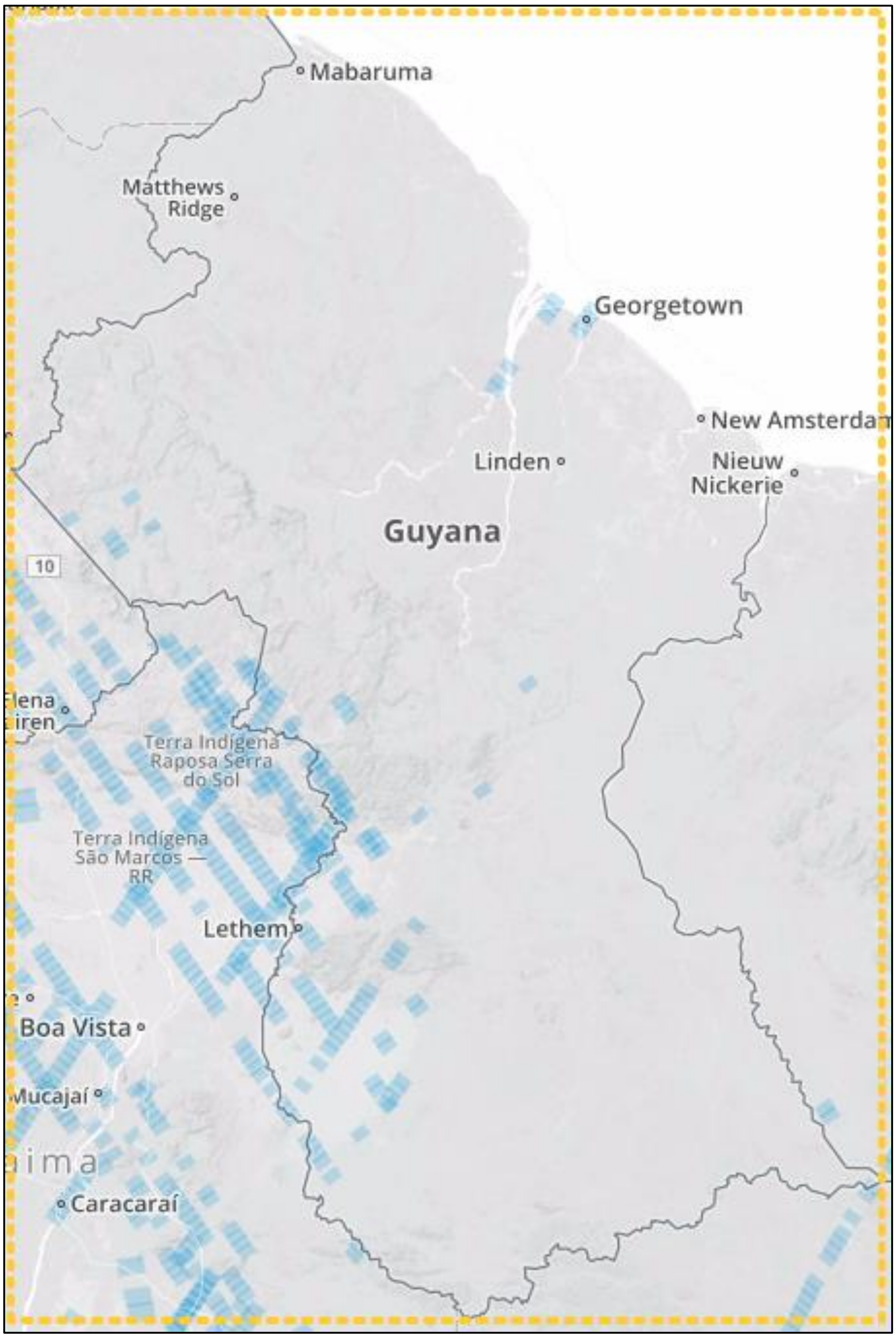
Further factors are also evident with the signal to noise ratio higher on the Planet Labs images. This noise means that the edges features are harder to resolve due to the grainier image. This is evident on the example below which shows the contrast between water, soil and a crop boundary.

Figure 10-3: Comparison of Landsat 8 (left) & Planet Labs (right) Imagery



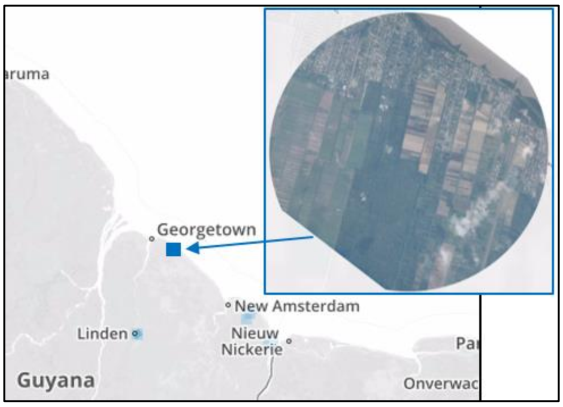
The coverage as at April 2015 over Guyana is infrequent and scattered. This is mostly due to neighbouring countries such as Brazil which are currently tasked at a higher priority for image acquisition.

Figure 10-4: 2015 Planet Lab Coverage Over Guyana



The map (Figure 10-5) illustrates the extent of a single Planet Labs tile which covers an area of approximately 6 000 ha (60 km^2), whereas a standard RapidEye 3A tile is some 62 500 ha (25 km x 25 km). On average, a single Planet Labs tile is approximately 30 MB in size.

Figure 10-5: 2015 Planet Lab Coverage Over Guyana



Currently, when assessed against RapidEye, which is of similar spatial resolution Planet Labs imagery still has operational limitations. However, in a relatively short cycle the company has developed 10 designs over some two and half years. At this development pace there is significant worldwide interest in their final design and release products. Should the data quality improve Planet Labs will have the capability of daily imaging which is a feature that would be particularly useful for multi temporal monitoring – especially in cloudy locations such as Guyana.

Monitoring Degradation - ESA Study Sites

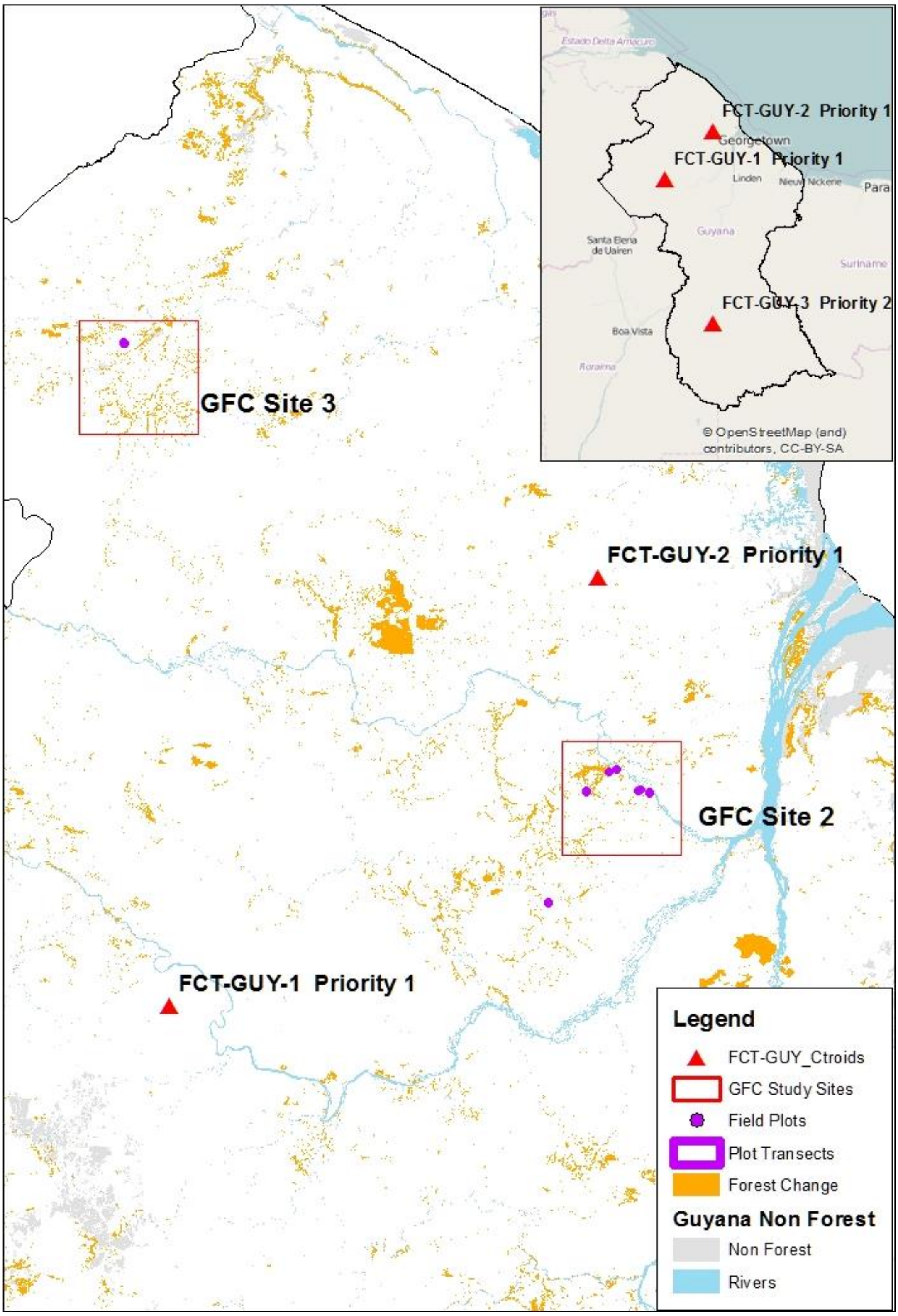
Since 2011, observed degradation in Guyana has been mapped using remote sensing methods primarily with RapidEye 5 m imagery. The accuracy of this method was validated using sub meter resolution aerial photography.

Currently, the method adopted is satisfactorily accurate to approximately 78%. However, it is ostensibly a manual process which includes careful systematic interpretation of satellite imagery to identify degradation surrounding deforestation or shifting agriculture sites.

In light of this, a study has been proposed using high temporal resolution imagery obtained from the SPOT mission to better capture and characterize degradation. The study concentrates on three (60 km x 60 km) sites that cover both degradation via road and mining activities and also that caused by rotational shifting cultivation. Three objectives were identified:

1. Evaluate the ability of high temporal coverages to characterize degradation,
2. Evaluate automated techniques for detecting degradation,
3. Evaluate the transferability of the findings to an operational environment.

Figure 10-6: ESA Study Sites



Approach

Using the designated study sites, a series of methods will be evaluated and compared against the baseline data. The intention would be to use these sites to compare existing data on vegetation ratios (NDVI), decision trees and manual interpretation for the detection of degradation intensity and extent.

Supplementary to this approach, existing work has been previously conducted to determine the impact and drivers of degradation in Guyana. The work however was focused on the detection of degradation rather than the impact in terms of Carbon loss as part of Guyana's MRVS. Therefore, it has an operational focus, whereby the techniques adopted have been tailored towards national reporting. In contrast, the new study proposed focuses on the comparison of various methods; automated, semi-automated and manual approaches.

Datasets

The existing work has useful elements which can be applied to the proposed study. Previous works include the use the following datasets:

- RapidEye 5 m imagery,
- Sub meter aerial photography,

In tandem, field work including transects and quantitative measurements of canopy changes are also currently available to use as baselines. This information can be used for the proposed study sites to develop a time series that identifies degradation in a more systematic manner.

Assessment of further data, such as Sentinel to assist with characterizing degradation and increase temporal frequency by using multiple high resolution sensors will be made possible should contributions from the ESA be approved.

The study proposed offers an opportunity to design and test various options for the measurement and detection of degradation across a range of study sites.

Deforestation Modelling – Predicting Future Rates of Change

A study by Pereira (2014) from the University of Durham developed a spatial model of deforestation using past deforestation trends as established by the MRV. By gaining an understanding of how deforestation and its drivers have evolved over time, a model for predicting future land cover changes from non-mining to mining has been developed to predict changes from 2013 to 2017.

The design of the study takes seven randomly sampled 25 x 25 km grid squares (some 437 500 ha) mapped as deforestation and assigned drivers in line with GOFC-GOLD mapping standards. This process was repeated over three years of change data to determine a change rate. The drivers used were: rivers; mining; shifting cultivation; forestry roads and mining roads.

"Using the Dinamica EGO land cover change model, maps of mining activity from 2012 and 2013 were combined with a set of spatial variables: distance to rivers and roads, mineral deposit locations, existing mines, elevation and soil maps. The model was trained by identifying the changes between 2012 and 2013 and the significance of each spatial variable. Using these results the model formulated the projections for each year between 2013 and 2017."

The results from the 2013 model compared to the observed was accurate to 99.93% in terms of deforested areas driven by mining activities. The location accuracy of these predictions was accurate to 61.82%. These results were then used to predict total deforestation rates by year, in line with current GFC mapping year periods.

Table 10-2: Comparison of Predicted & Actual Total Deforestation Rates

Period	Model Predicted Rate (%)	Actual Mapped Rate (%)	Difference (%)
2012 (Year 3)	0.081	0.079	0.002
2013 (Year 4)	0.077	0.068	0.009
2014 (Year 5)	0.075	0.065	0.010
2015 (Year 6)	0.074	N/A	N/A
2016 (Year 7)	0.071	N/A	N/A

Some similarities are observed between the model predicted and actual mapped rates for total deforestation across all drivers (Table 10-2); year 3 in particular has the smallest difference (0.002%) between the two reported values. The difference however does increase for Year 4 and 5. Pending continuation of Year 6 and beyond, modelled values predict a gradual decrease in deforestation rates down to 0.071% by the end of 2016.

Filtering the drivers by mining activity alone, we see an improvement in the accuracy of the predicted rates of deforestation. Years 3 and 5 are slightly over-estimated (by 0.007%) whilst the Year 4 predicted rate is 0.003% greater than what was actually reported. On average, these rates are more accurate than those reported for deforestation across all drivers. The deforestation trend as a result of mining also suggests a decreasing trend over time, eventually to 0.059% by the end of 2016 however the reported Year 5 rate is already below this prediction.

Table 10-3: Comparison of Predicted & Actual Mining Deforestation Rates

Period	Model Predicted Rate (%)	Actual Mapped Rate (%)	Difference (%)
2012 (Year 3)	0.066	0.073	0.007
2013 (Year 4)	0.064	0.061	-0.003
2014 (Year 5)	0.062	0.055	-0.007
2015 (Year 6)	0.061	N/A	N/A
2016 (Year 7)	0.059	N/A	N/A

While this approach is not a complete substitute for the current mapping process, it is useful as supplementary information to reinforce actual rates of change. Another perspective can be to use the modelling information as another source of accuracy assessment and quality control.

It has important applications especially when related to mining projections and has the potential to be utilized in future management frameworks, focusing on mitigation and monitoring in the most vulnerable locations. Such information is useful for local governments and resource management, especially if the spatial component of the modelling can be improved.

UMd Global Change Map

A study published by Hansen et al 2013 examined global Landsat data from 2000 to 2012. The work reported forest extent, loss, and gain at 30 m spatial resolution.

The results indicated that over a 12 year period globally 2.3 million km^2 of forest were lost and 0.8 million km^2 of new forest were gained. Tropical biomes exhibited both the greatest losses and gains (through regrowth and plantation). Importantly though the tropical forest losses outstripped gains.

In January 2014 a meeting was held at the Norwegian Space Centre (NSC) during which Prof. Matt Hansen demonstrated the University of Maryland's (UMd) Global Change Map. The group assembled included representatives from NSC, the Food and Agriculture Organisation (FAO), United States Geological Survey (USGS) and Indufor Asia Pacific.

The discussion focussed on the merits of evaluating the potential to improve the current global product and evaluating the possible integration of high resolution image datasets. The rationale of investigating both aspects are that forest countries would benefit from the provision of a transparent and openly available forest change map product. Potentially these maps could assist in guiding policy and in meeting REDD+ reporting requirements at the national-level.

As a result of this meeting a project was initiated to compare the maps generated from the University of Maryland global change analysis and the mapping undertaken by Indufor and the Guyana Forestry Commission (GFC). The assessment team involved the University of Durham (UoD) who are responsible for the annual MRVS accuracy assessment in Guyana. This team already had a sound knowledge of land-cover change dynamics across Guyana, and significant experience working with the relevant datasets.

The aim was to assess the relative accuracy of the UMd product compared against the national deforest mapping that is undertaken annually by the Guyana Forestry Commission.

Specifically the study objectives were to:

- Assess the accuracy of the Global Change maps for detection of deforestation for the period 2000-2012 across Guyana.
- Provide a summary of the appropriateness of the global map to monitor temporal change.
- Document and identify classification errors.
- Assess options to improve the global change estimates for Guyana using the existing MRVS change products.
- Report findings and recommendations.

Methods & Datasets

The map accuracy assessment commenced in February 2015. The assessment is based on determining the accuracy of forest and change extent as derived from the UMd 2012 global forest map. This map has been adapted and refined specifically for Guyana using information extracted from the GFC forest and non-forest maps. The validation dataset is based on the national RapidEye 5 m coverage from 2012 and 2013. These datasets have been integrated into a GIS environment.

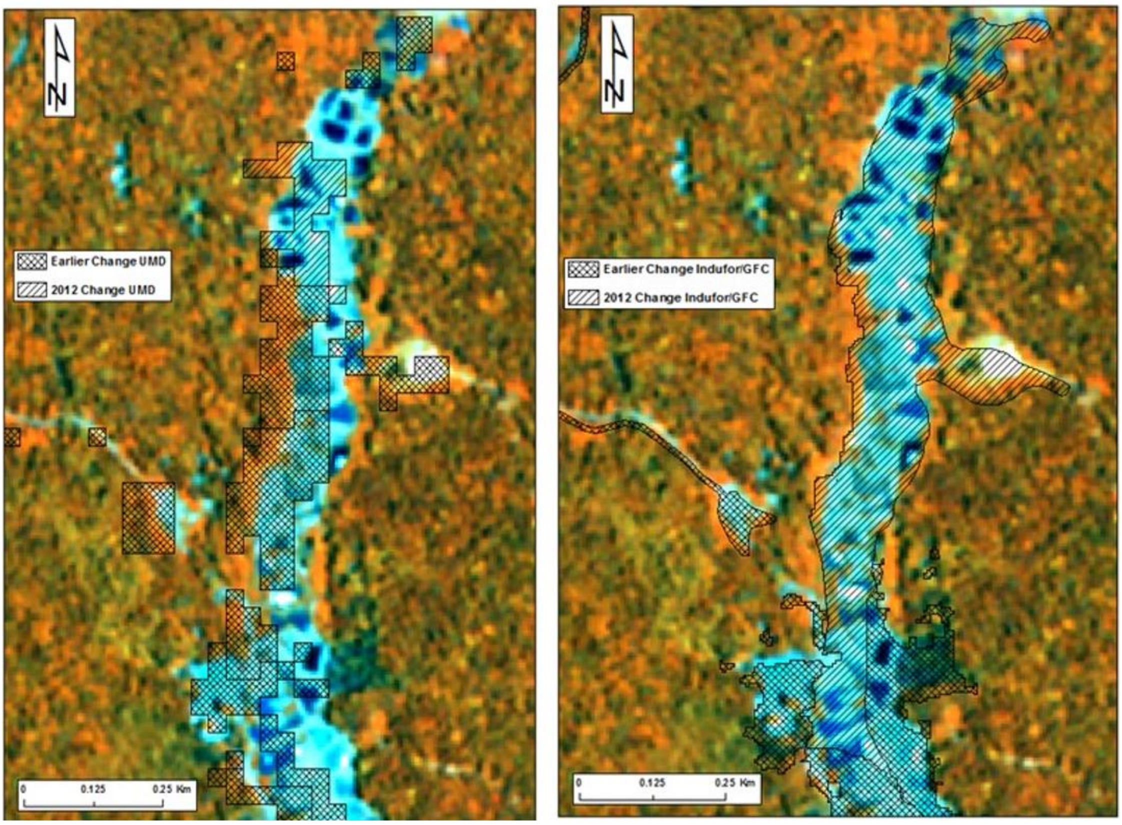
The following table provides a description of the datasets used to undertake the assessment.

Table 10-4: Analysis Datasets

Agency/ Institution	Dataset	Application
GFC	5m-RapidEye & 30m-Landsat Coverage	Image coverage across Guyana
	Change detection layers	2011-2013 GIS layer that identifies forest change since 1990
UMd	Global Change Layer (optimised) based on 30m-Landsat	2013 Guyana forest & non forest coverage
	Landsat footprints	Footprints and dates of Landsat scenes used to generate the Global change layer

For reference the following examples show an initial comparison between the two detection outputs. The first shows the detection from the Global Forest Change product (left) overlaid on RapidEye imagery and the second shows results from the GFC mapping (right).

Figure 10-7: Comparison of Global Change Assessment with GFC Mapping



Approach & Progress

The analysis design is focussed on a quantitative comparison of deforestation in Guyana mapped from two separate wall-to-wall methodologies. The response design data will allow the UMd deforestation estimates to be compared with change reference data & GFC mapping derived from imagery with higher spatial resolution.

Area estimation and accuracy assessment (estimation of uncertainty in area estimates) will follow standard approaches as established over the last four years (UoD, 2010, 2011, 2012 and 2013) of GFC mapping accuracy assessment. This approach is consistent with international best practice and published literature (Stehman 1998, 2001,2009, 2012, Stehman and Czaplewski 1997, McRoberts & Walters, 2012; Olofsson et al., 2013)

The sampling design will use stratified random samples of land areas across Guyana from the GFC change layers (deforestation only) and evaluate these in detail against the UMd identified change areas, and the reference data (5m-RapidEye satellite imagery).

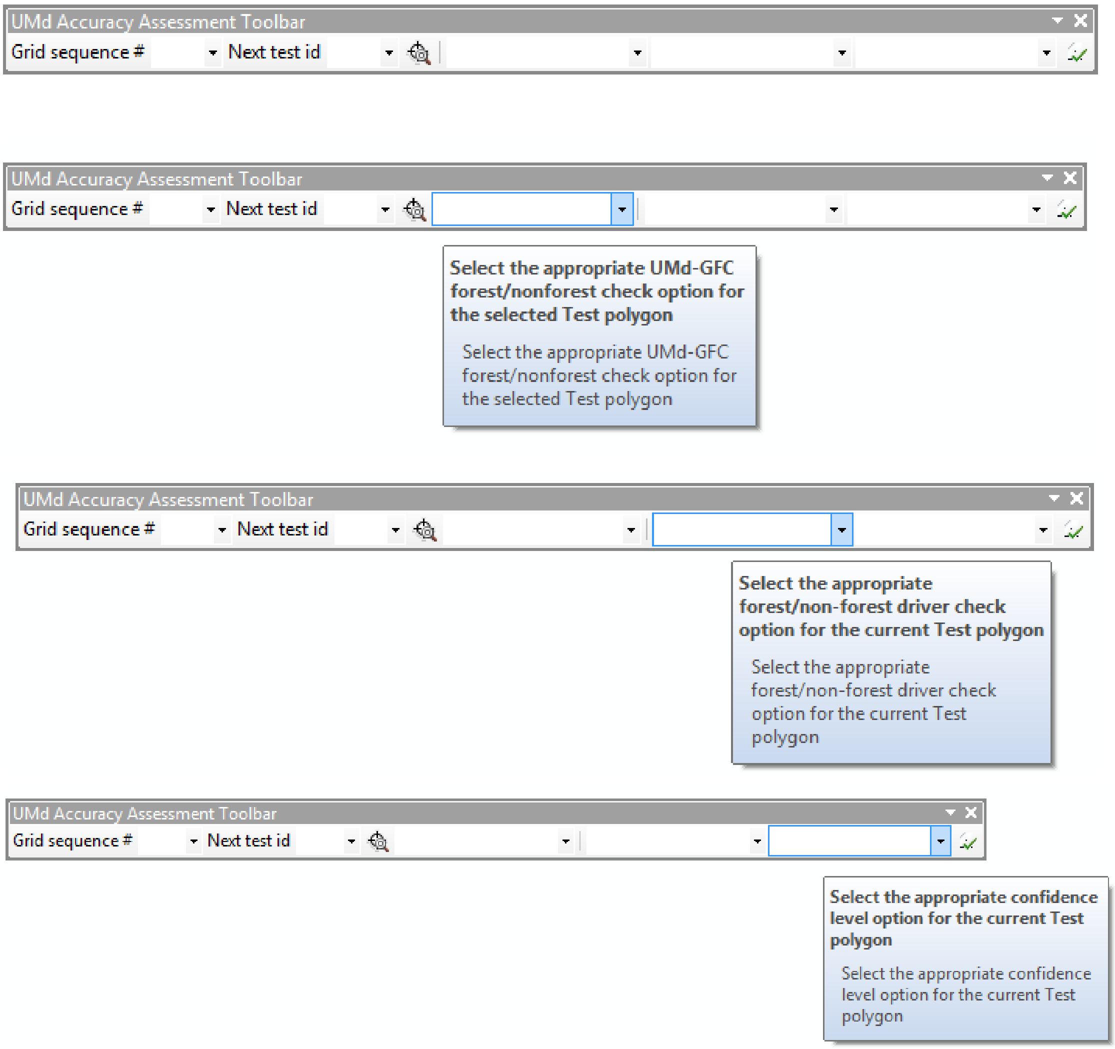
The steps involved and associated progress in undertaking the assessment is outlined below in Table 10-.

Table 10-5: Analysis Steps

Analysis stage	Status	Responsible Parties
Train interpreters in assessing deforestation in Guyana	Completed	UoD
Develop interpretation rules to ensure a standardized and consistent approach	Completed	UoD
Download and pre-process data	Completed	Indufor/UoD
Intersect 2012 & 2013 GFC activity data with corresponding UMd data	Completed	UoD
Compare best available image data & UMd map	In progress	UoD
Compare GFC & UMD map	In progress	UoD
Analyse spatial distribution of the errors	Incomplete	UoD
Analyse any patterns under different change categories. i.e. how accurately does UMD detect different drivers of change in Guyana.	Incomplete	UoD
Analyse whether we can refine estimates using calibration sites.	Incomplete	Indufor/UoD/UMd
Recommendations	Incomplete	Indufor/UoD/UMd
Stakeholder review	Incomplete	Indufor/UoD/GFC/NSC/UMd
Next Steps	Incomplete	Indufor/UoD/GFC/NSC/UMd

The UMd Global Forest Change mapping accuracy will be assessed based on two approaches on a 143 sample units (5km*15km rectangles) based on a stratified random sample framework. In the **first approach**, existing systematic circular samples, 55,119 circles (1-ha circle) in 143 rectangle samples (5 km* 15 km), will be used to checked accuracy of UMd Forest/Non-Forest map using GFC mapping along with RapidEye imagery wherever necessary. A toolbar GUI for use within the ArcMap version 10.2.2 environment has been developed specifically to undertake the accuracy assessment of UMd Global Forest Change layer 2010-2013. It provides a structured approach to the decision making process that each analyst undertakes. The toolbar used for the accuracy assessment of UMd mapping is shown below in Figure 10-8.

Figure 10-8: Durham – screenshot of modified toolbar for UMd



It is expected that the result of this accuracy analysis approach will provide information, mainly, on UMd forest/non-forest mapping accuracy and identify reasons of misclassifications.

The **second approach** is based on actual measurements of Forest/Non-Forest areas with the 143 rectangles (5km*15km) for UMd and GFC maps, respectively. The result of this approach will provide summary information on temporal accuracy. Both of these two approaches will provide a robust estimate of UMd's Global Change map; assess options to improve spatial change estimates using randomly selected high resolution images to adjust national-level estimates. Finally, it is expected that the results will provide necessary information on reliability of UMd's Global Forest Change maps for this region.

The analysis design is focussed on a quantitative comparison of deforestation in Guyana mapped from two separate wall-to-wall methodologies. The response design data will allow the UMd deforestation estimates to be compared with change reference data and GFC mapping derived from imagery with higher spatial resolution.

The results of this work tie in with research being conducted over additional global sites that has been funded by the Norwegian Space Centre. The final results of the Guyana study are expected to be available by the end of 2015.

Preliminary Results

Between 2001 and 2013, the average difference between the UMd and GFC derived products is approximately 2,822 ha based on the second approach, 143 rectangles (5km*15km) (see Table 10-6). The UMd estimated rate of deforestation is approximately 12% less than the GFC reported value between 2001 and 2013.

In 2010 (Year 1) the difference was some 131 ha (approximately 1.3% difference) which is the most accurate assessment of UMd's data against GFC's. Figure 10-9 shows the comparison of the rate of deforestation estimates (in $ha.year^{-1}$) between UMd and GFC.

The results from 2010 form the best comparative analysis between the two mapping methodologies. At this time, GFC was using Landsat imagery to map deforestation hence provides a more direct comparison to the UMd product, also mapped using Landsat. The difference of 131 ha between the two methodologies shows consistency across both parties.

For the historic periods; 2006 to 2009 the difference when annualised is some 9,603 ha (2400 $ha.year^{-1}$) between the two products. However from 2001 to 2005, the annualised difference is 1775 ha (-355 $ha.year^{-1}$). Furthermore, by merging both historic periods together (2001 to 2009) the annualised difference is 783 ha between the two products.

It is worth noting that the GFC mapping data was improved from 30 m Landsat to 5 m RapidEye in 2012. UMd data from Years 3 to present should be obtained to determine if the variation is more consistent between UMd's and GFC's reported deforestation rates since GFC's switch from Landsat to RapidEye.

As the spatial resolution of RapidEye is higher, finer details are better observed and thus the difference in reported values between the two products is likely to increase (see Table 10-6 and Figure 10-8). The current trend of 2011 (partial RapidEye mapping) and 2012 (complete RapidEye mapping) seems to suggest this.

Table 10-6: Comparison of UMd & GFC Acquired Deforestation

Period	UMd Reported Deforestation (ha)	GFC Mapped Deforestation (ha)	Difference (UMd – GFC)	Data	Remarks
2013	6,948.61	12,733.00	-5,960.10	UMd: Landsat GFC: RapidEye	-
2012	6,458.60	14,655.00	-9,106.40	UMd: Landsat GFC: RapidEye	-
2011	5,459.85	9,891.00	-5,839.45	UMd: Landsat GFC: Landsat & RapidEye	GFC data for 1.25 years
2010	10,156.00	10,287.00	-131.00	UMd: Landsat GFC: Landsat	-
2006-2009	29,003	19,400.00	9,603.00	UMd: Landsat GFC: Landsat	-
2001-2005	32,450.00	34,225.00	-1,775.00	UMd: Landsat GFC: Landsat	-
Total	90,476.61	103,509.06	-13,033.24	-	-
Average	15,079.34	17,251.55	-2,172.21		

Figure 10-8: Comparison of UMd & GFC Acquired Deforestation Rates

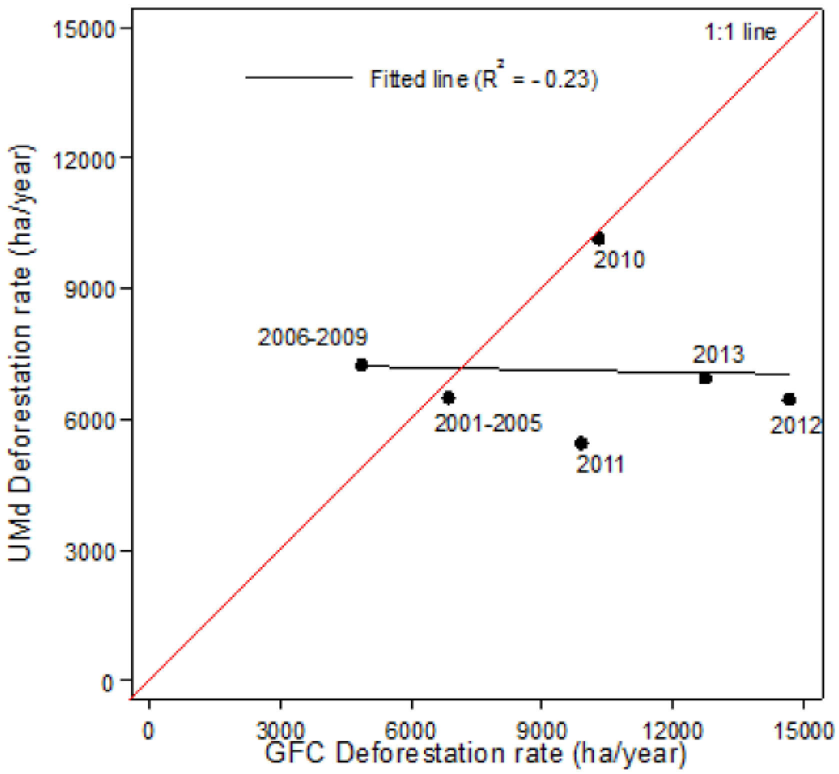


Figure 10-9 shows an example of UMd mapping error that was mapped correctly in GFC forest loss map. Using GeoVantage validation dataset of UoD, Figure 10-10 shows an example of the areas of deforestation missed and/or underestimated in UMd 2013 forest loss map while GFC has mapped correctly using RapidEye.

Figure 10-9: Areas of deforestation missed in UMd Global Forest Change map 2010.

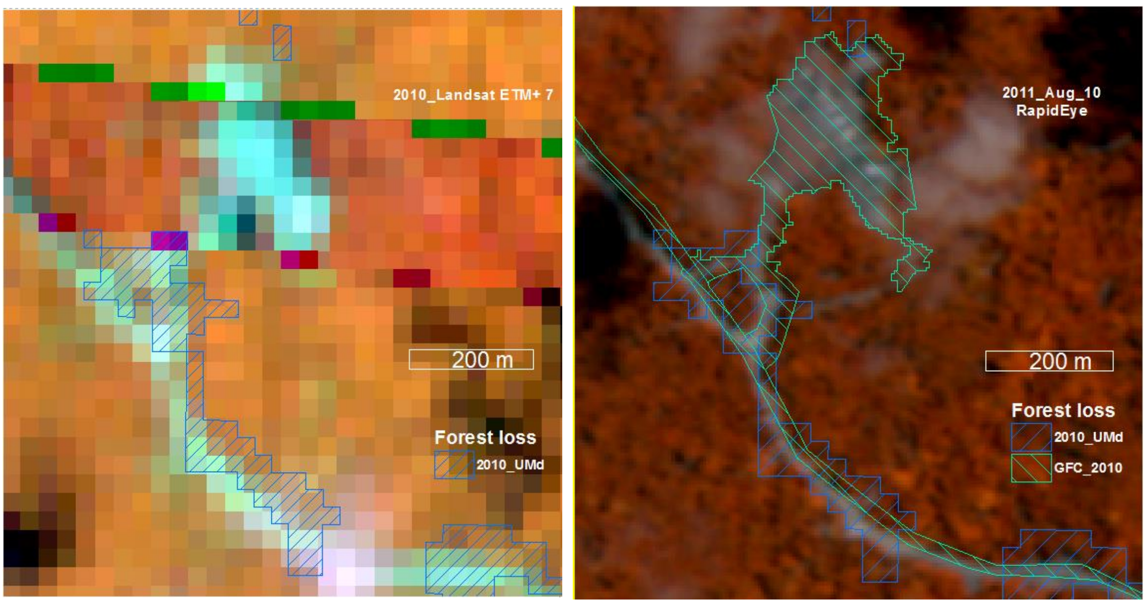
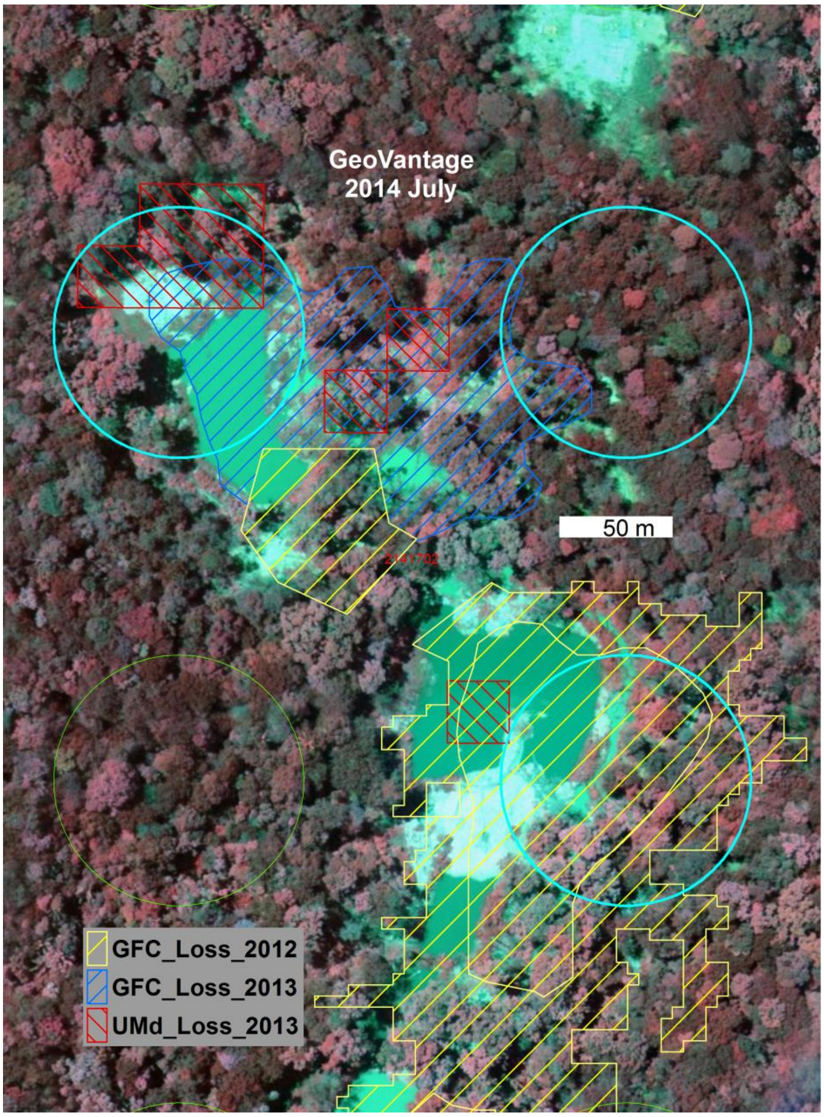


Figure 10-10: Areas within 1ha-circles missed or underestimated in UMd 2013 Forest Loss map.



Future Development

An in depth analysis should be performed once UMd data for 2013 and 2014 is made available. This will provide a more confident trend between the two products in GFC's updated RapidEye format.

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Appendix 1

2013 Follow up Actions

CARS and OBS from Year 3 (2012)	GFC Response	Year 5 Update
<u>**CAR 4 - Minor**</u> **Requirement**: Interim Measure 2.2 **Non-Compliance**: Expanding Staff Capacity in forest carbon monitoring beyond current levels. **Objective evidence:** Although the GIS staff has seen expansion within the staffing the Forest Carbon Monitoring relays heavily on a few individuals and current work load may be heavy for existing local personnel under the programme.	The Forest Carbon Monitoring Unit within the GFC, has built significant capacity over the past 3 years in managing and implementing the activities involved in the execution of the monitoring programme. This is evidenced by dedicated staff who work on the management aspect of this activity, full time, as well as a cadre of field staff from the GFC Forest Resources Management division, who have been trained to perform activities such as data collection, recording and processing. All field activities are managed and executed by local staff, with support from external specialists in the area of design and future system development areas. There is scope to increase the number of local staff in the management aspect of the forest carbon monitoring system from its current level. However, this expansion will be managed with keen consideration to the fact that field work may be more extensive in the current design phase but perhaps less intensive in the full operational stage when relevant system elements	*In addition to the effort outlined in Interim Measures Report Year 4, the following has been done in year 5:* *Oversight and coordination of MRVS Year 5 activities continue to be led by local staff of the GFC.* *The main consultancy involvement is in relation to development work in new areas, and for these as well, there is integral involvement of local staff.* *The adjustment done to task load to reduce field activities of data management function in REDD Secretariat continue to be implemented in year 5.* *Two new staff have been recruited and have been involved in understudying main project areas.* *Synergies and cross fertilisation of REDD+ and MRVS Forest Area Assessment Unit with Forest Carbon Unit continue to be advanced.* *Planning and implementation of REDD+ readiness activities consolidates the mapping and forest carbon staffing structures.*
<u>**CAR 5 – Minor**</u> **Requirement**: Overall Guyana MRV programme **Non-Compliance**: Current system does not establish tolerance levels as part of a QA/QC design framework, necessary for an MRV system **Objective evidence:** • Current manuals cover the activities to be undertaken however it does not cover predefined fall back options for errors in the system • Current QA&QC focus on fixing the problems found but not what the relevancies of the error and whether this has an effect on other data sets.	Manuals of Procedures as seen in Sample Design, Standard Operating Procedures, and Mapping Protocols define system processes for both forest carbon and forest cover monitoring. QA and QC processes are embedded within these systems are designed to reflect best practice as recommended by IPCC, GOFC GOLD as well as methods outlined in peer reviewed, published scientific studies. Current systems are designed to achieve as high accuracy and precisions levels that are possible. For example, main elements of the forest carbon monitoring system aim for statistical results that reflect 95% confidence level +/_ 15% of the mean. Although of minimal occurrence, in instances of errors in data collection and processing, currently, full system checks are performed across datasets. General tolerance levels for main components the forest area and forest carbon monitoring systems may be beneficial to the overall operation of the MRVS as well as integration within the relevant SOPs an aspect on the treatment and classification of known types of errors. Additionally, the GFC will further explore the possibility of using a common error term for field measurement to include, for example,	*In addition to the effort outlined in Interim Measures Report Year 4, the following has been done in year 5:* *The section added to Standard Operating Procedure (SoP) that addresses types of errors and relevance of errors continue to be adhered to.* *Procedures developed and integrated within SoP continue to be implemented and have formed the basis of QA/QC procedures currently in place in the MRVS.* *Uncertainly levels continue to be reported for all data results and are set at %% CI +/- 15% of the mean.*

CARS and OBS from Year 3 (2012)	GFC Response	Year 5 Update
	Monte Carlo type error analysis. GFC is also working with Winrock International in developing an estimate of error due to the use of allometric model. However, the GFC notes that the sources of error from field measurement and the use of allometric equations is generally small compared to the sample error, which as mentioned earlier has been set by GFC at 95% CI of <15% of the mean for total carbon stocks. Sources of error will be examined and included to the extent possible once Monte Carlo type analysis has been developed and GFC staff trained. This will likely undertake a phased approach in implementation. In Year 4, GFC will include further internal consistency checks and assign the acceptable levels of accuracy to the deforestation and degradation mapping products. The actions required should these tolerances exceed the stated objectives will be included in the SoP for Mapping.	
<u>**OBS 2**</u> **Requirement**: Interim indicator 1, 2 and 3 **Potential Non-Compliance**: Inconsistency within the reporting. **Objective evidence:** - Confusion matrix of the forest cover map (year 4) and degradation not considering two-stage sampling design: Although DNV GL acknowledge that stratification has been taken into account in the current monitoring period, the confusion matrix provided in Table 5.1-5.3 seems to determine the different accuracy indicators using secondary sampling units without considering their grouping in primaries (e.g. the total is 54254 which is the number of secondary SUs). In order to obtain unbiased estimates of the different accuracy indicators the sampling design should be considered. Although, the estimate of accuracies should not be very different from the presented ones, GFC to considering the grouping in primaries for producing the confusion matrices and the different accuracy indicators. - Reporting of uncertainties on accuracy indicators: Following Olofsson et al. (2014), it is good practice to report confidence intervals at 95% of the different accuracy indicators (i.e. overall, users and producers). GFC to consider reporting uncertainties of the accuracy indicators in the next monitoring period. - Forest Cover change Matrix: In order to have an estimate of the accuracy of the change map produced for year 4, a confusion matrix of the forest cover change and accuracy indicators should be provided.	• *Confusion matrix of the forest cover map (year 4) and degradation not considering two-stage sampling design:* Degradation was handled in precisely the same was as deforestation in terms of data collection and statistical analysis. If the tables do not make this clear, then we will take special care to be clear in the Year 5 AA report. • *Reporting of uncertainties on accuracy indicators:* The paper by Pontus Olofsson (2014) describes good practice for describing the accuracy of a classified Landsat image. The emphasis being on the rate of deforestation using a change sample analysis. We would point out that the additional analysis provided to illustrate the GFC mapping accuracy was done in addition to the main task of quantifying error on the Y3 -> Y4 change and the change rate. The relevant publication indicating good practice is Potapov et al. (2014). • *Forest Cover change Matrix:* Same as above. • *Deforestation by roads:* The proposal for Y5 is for the AA to measure or re-measure deforestation and degradation areas within each of the primary sampling units. This will remove the "road" area estimation issue.	*There was no opportunity to respond to the DNV GL comments within the 2014 audit reporting period. Nevertheless, in this Observation the audit team raise two separate points.* *First, table 5.1 in the Year 4 Accuracy Assessment Report is a combined error matrix (unweighted) for the Forest-NonForest Year 4 map which was included to illustrate the degree of correspondence between the GFC map product and the independent change sample data. As explained in section 2.3, these data are not needed to estimate deforestation area or rate of change and, as the audit team point out, they cannot be used in this form to estimate area of change. The caption on the figure in the Year 4 report does say that the error matrix data are unweighted but we agree that including these data has unfortunately caused confusion. For the avoidance of misunderstanding the data used for quantitative change estimation are presented in the report in tables 5.3.1 to 5.4.2 of the Year 4 accuracy assessment report.*

CARS and OBS from Year 3 (2012)	GFC Response	Year 5 Update
Section 4.9 seems to indicate that these results would be provided (i.e. Table 4.9.1) but the filled-out table is not found in the report. In previous monitoring periods is was not possible to derive this confusion matrix as there was no reference data on change classes, but now it would be possible to report this confusion matrix of the change map for forest cover change as it has been done for degradation. Hence, GCF is encouraged to consider reporting this in the next monitoring period along with uncertainties in accuracy indicators. GCF to consider the use of the following guidance provided in Olofsson et al. (2014) regarding reporting, yet with some adaptations in order to consider the specific sampling design. - Deforestation by roads: The AA report indicates that the average estimate of deforestation using sampling could have been slightly over-estimated in relation to the estimate provided by wall-to-wall mapping. The issue was mainly related to the sampling units that intersected with roads, that were accounted as loss units, while logically they could be accounted as degraded or forest units. The University of Durham has indicated the urgent clarification of the mapping rules of these cases. The verification team agrees with this and would like to recommend to clarify the mapping rules of these areas for the next monitoring period, and/or to analyse the potential of using proportions of loss in the sampling units instead of a binomial variable, as used in Potapov et al. (2014).		

CARS and OBS from Year 4 (2013)	GFC Response	Year 5 Update
CAR 2 - Minor **Requirement**: Interim Measures 1.1 **Non-Compliance**: Current system does not systematically provide direct alignment between MRVS Reporting tables and the newly designed IPCC Reporting Results tables **Objective evidence:** Currently system is set up to be fully compliant with the IPCC reporting. However, for some categories there is ambiguity as to the categorisation of drivers in MRV report for Norway and certain groupings of data are required from the IPCC data sheets, which are in part due to the categorisation not having been documented in the MRV Report. This could lead to miscategorising deforestation driver by forestry for Y4 (330 ha, table 6.2 p 35) whereby in the IPCC tables, forest infrastructure and mining infrastructure are categorised as one, but in the MRV Reporting tables, these are separated by Driver	Results tables for both MRVS and IPCC reporting aspects are accurate. Our understanding is that this corrective action came about because the initial report formatting in historical periods was not aligned with IPCC formats, as was not planned for or intended at that early stage. For example, forestry roads and mining roads have historically been included in forestry and mining separately in the typical MRVS Reporting tables, whereas under IPCC format being piloted in year 4, they are both grouped in one category. In Year 5 Reporting, the format in which the table is produced and the way in which the area change figures are reported will be altered to align more easily with IPCC classes, and to ensure there is no chance of any ambiguity. There continues to be an interest at the national level in Guyana, to separate infrastructure.	*Clearer alighment of MRVS mapping results with IPCC reporting tables was compelted. This was addressed through updating of the SoP for Mapping as well as a more indepth capacity building on IPCC reporting. The section of the SOP specific to this error was updated to provide for the new EndLUC for forest harvest i.e. Bareland. Sub section 2, table 2-1, and pg. 4 of the SOP has been added.* *Both QC and Mapping analyst were made aware of the update i.e. Any forest harvest event that leads to deforestation will be included in the final calculation for the forestry infrastructure data. Refer to sub section 7.4 (Drivers and Land Use Classes), Forest Harvest table pg. 37 of the SOP.* *Through this alighment process, analyst are now more fully aware of how change is classified according to both IPCC and MRVS. Sub-section 1.5, table 1-1 and pg. 3 of the SOP has been added.*
CAR 4 – Minor **Requirement**: Interim Measures 2.2 and 2.4 **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.	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 for Shifting Agriculture. It is likely that the emission factor will be a function of the forest-fallow cycle and local practices. The results that the Remote	*The mapping of shifting cultivation has been reviewed and the section of the SOP specific to this has been updated to clarify mapping of pioneer and rotational shifting agriculture. Essentially the historical extent of Rotational shifting agriculture has been adjusted.* *Rotational shifting agriculture were extended using historical imagery as a guide whilst Pioneer shifting cultivation now has a more precise distinction in mapping boundaries that makes the separation of pioneer and rotational shifting agriculture more specific and thus, less likely to be misclassified.* *Further there has been additional effort directed towards a rigorous review of previously mapped areas of shifting cultivation to ensure that there is a precise and accurate mapping and attribution of this land use.* *Refer to new improvements ot eh SOP: sub section 7.4, Rotational shifting agriculture pg.34 and*

CARS and OBS from Year 4 (2013)	GFC Response	Year 5 Update
	Sensing analyses can reliably deliver on SA will be reassessed and this will be used with the EF to derive carbon impact in these areas.	*Pioneer shifting agriculture pg. 35 of the SOP.*
<u>**CAR 5 – Minor**</u> **Requirement**: 1.1, 2.1, 2.2, and 2.3 **Non-Compliance**: Required sampling strategy do not require reassessment of stratification over time. **Objective evidence:** - Stratification of the Accuracy Assessment is out of date missing HR area around Matthew Ridge - Stratification for the Biomass stratification is out of date BPMLA 12-2A already under gone forest change	The Change Sample approach used in the Y4 Accuracy Assessment used the same design as Y3 and the analytical approach has resulted in a significant reduction in the Sampling Error of forest loss and forest degradation area estimates. Nevertheless, deforestation is, as the audit team point out, encroaching into areas in the Low Risk stratum implying that the stratification is not optimum. The AA team acquired 10% additional randomly selected clusters in Y4 that were not used in the accuracy assessment but are available for Y5 assessment. In response to the CAR 5 - we note that financial and time resources are limited for acquisition of reference data; that the pattern of mining has changed with time; that 95% of degradation is associated with mining and mining-related infrastructure; that degradation can be identified with a good level of accuracy from aerial imagery and very high resolution satellite imagery. For year 5 the accuracy assessment will seek to revise the sampling stratification to maximize the precision of the estimate given the logistical constraints on the number of first-stage clusters that are randomly selected. Our analysis of the existing stratification using the Neyman allocation equation, illustrates that it is possible to optimize the distribution of samples to achieve the same precision using fewer within-cluster samples. In sum, we will seek efficiencies by (1) improving the stratification using knowledge of deforestation and degradation risk gained from observed patterns, and (2) use a mathematical approach to optimize the number and distribution of first-stage samples allocated to each risk stratum. As part of the Sample Design for the Forest Carbon Monitoring System, and Stratification and the Long Term Monitoring Framework, the revision of the stratification for forest carbon is planned to take place every 5 years. This means that the system having been developed in 2010/2011. This means that in 2016, the stratification is planned for revision. This will mean taking into consideration new infrastructure, areas of deforestation and forest degradation, and allocations. The point made in the CAR is taken and the process of revision of stratification is necessary as land uses are constantly ongoing and as a natural part of this process, brings about varying	*Durham University undertook an analysis of sampling strategies in order to quantitatively assess issues of stratification, sampling efficiency and resource allocation for verification purposes. This resulted in a stratification of Guyana's land area into four classes that better represent risk of deforestation based on actual deforestation data from the period 1990-2013. The precise methods are outlined in the Accuracy Assessmnet Report.*

CARS and OBS from Year 4 (2013)	GFC Response	Year 5 Update
	impacts on forest areas. The SOP for the Forest Carbon Monitoring System will be updated to take account of this likely occurrence and to outline a procedure for addressing this. Whilst there appears to be no expectation for stratification to be revised every month, or even every year, that within the frame of a specific stratification application, that provisions needs to be clearly outlined to address any eventuality – like a randomly selected area, already having undergone forest change. A section is proposed to be added to the SOP for Forest Carbon Monitoring, to address this.	
OBS 1 **Requirement**: Interim Indicator 1.1 **Potential Non-Compliance**: Misclassification of reference samples during Accuracy Assessment **Objective evidence:** Change toolbar to become comprehensible and useable for new people.	The GIS toolbar used for accuracy assessment has become complex as the assessment now incorporates a change sample analysis that compares only two independent reference data sets and compares the latest reference data with the GFC map product. For each of these assessments the accuracy assessment analyst may be required to indicate the driver of change and a possible mapping error should this be observed. For year 5 accuracy assessment, the GIS toolbar will be modified and simplified with the objective that it can be learned quickly by a new operator and that none of the drop down menu items are ambiguous.	*GFC and DU agreed that analysing both the change reference data and the Y5 GIS-mapping was unnecessary because the map analysis did not contribute to the estimation of deforestation (or degradation) area or rate. Furthermore, the presentation of raw contingency tables showing correspondence of reference data with map data had led to unnecessary confusion. The analysis of the map data was a legacy from Years 1-3 when the accuracy assessment used a model-assisted probability-based estimator for deriving forest area. The change-sample approach no longer requires a comparison with map data in order to estimate bias. All change samples are selected at random and so the design is inherently unbiased.* *Therefore, a new simpler toolbar was developed by Durham University. The new toolbar focuses exclusively on guiding the interpreter though the analysis of the change reference data and the process of quantifying change at the hectare scale. See section 4.5.2 for a description and see Figure 4.8 for visualisation of the toolbar used in Y4-Y5.*

Appendix 2

Joint Concept Note on REDD+ Cooperation between Guyana and Norway

Joint Concept Note

Background

On November 9th, 2009, Guyana and Norway signed a Memorandum of Understanding (MoU) regarding cooperation on issues related to the fight against climate change, in particular those concerning reducing emissions from deforestation and forest degradation in developing countries (REDD-plus[1]), the protection of biodiversity, and enhancement of sustainable, low carbon development.

An accompanying Joint Concept Note (JCN) sets out the framework for taking the Guyana-Norway co-operation forward. It sets out how Norway would provide Guyana with financial support for REDD-plus results, and formed the basis for the first payment from Norway to Guyana.

Since the first Joint Concept Note was published, considerable progress has been made in the Guyana-Norway cooperation. The JCN has been updated regularly to reflect this progress and sets out next steps for achieving the 2015 goals of the partnership:

- The first update of the Joint Concept Note was finalized in March 2011 and guided the partnership until December 2012.

- The second update was finalized in December 2012 and guided the partnership up until June 2013.

- For the period September 2013 to November 2014, Norway and Guyana agreed on performance targets for key Strategic Objectives of the partnership. These are available online[2] and will be reported on and assessed.

This current version of the Joint Concept Note is the third update and is intended to guide the partnership for the period from June 2014 to June 2015.

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[1] As defined in the Bali Action Plan (2/CP.13).

[2] https://www.regjeringen.no/globalassets/upload/kld/kl/klima-og-skogprosjektet/guyananorwayannouncement.pdf

Section 1: Introduction

This Joint Concept Note constitutes the overarching framework for taking the Guyana-Norway cooperation to its final year, 2015. Specifically, it addresses Paragraphs 2 (c), 3 and 4 of the MoU signed between Guyana and Norway on November 9th, 2009. The Joint Concept Note sets out how Norway is providing, and will continue to provide, financial support to Guyana, based on Guyana's delivery of results as measured, and independently verified or assessed, against two sets of indicators:

- *REDD-plus Performance Indicators:* A set of forest-based greenhouse gas emissions-related indicators, as described in more detail in Section 3 and Table 2. Results against these indicators will be independently verified according to the established practice of the partnership. These indicators will gradually be substituted as a system for monitoring, reporting and verifying (MRV) emissions from deforestation and forest degradation in Guyana is established. The development of the MRV system is guided by the MRV roadmap.[3]

- *Indicators of Enabling Activities*: Indicators are identified that can be independently assessed through publicly available information on progress regarding a set of policies and safeguards to ensure that REDD-plus contributes to the achievement of the goals set out in Paragraph2(c) of the MoU signed between Guyana and Norway on November 9th, 2009, namely *"that Guyana's LCDS Multi-Stakeholder Steering Committee and other arrangements to ensure systematic and transparent multi-stakeholder consultations will continue and evolve, and enable the participation of all affected and interested stakeholders at all stages of the REDD-plus/LCDS process; protect the rights of indigenous peoples; ensure environmental integrity and protect biodiversity; ensure continual improvements in forest governance; and provide transparent, accountable oversight and governance of the financial support received."* The enablers are described in more detail in Section 2 and Table 1 below.

Norwegian financial support is primarily being channeled through a multi-contributor financial mechanism – the Guyana REDD-plus Investment Fund (GRIF). The support is financing two sets of activities:

- The implementation of Guyana's Low Carbon Development Strategy (LCDS)

- Guyana's efforts in building capacity to improve overall REDD+ and LCDS efforts.

Section 4 sets out how the financial mechanism operates.

The previous concept note updated the longer term goals of the partnership – these goals are further updated in this concept note. The annual progress in developing the MRV system and in strengthening the quality of REDD-plus-related forest governance continues to be defined as steps towards reaching these goals. The Government of Guyana is responsible for making publicly available the necessary data for assessing performance against the given indicators.

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[3] http://www.forestry.gov.gy/Downloads/Terms_of_%20Reference_for_Guyana's_MRVS_Draft.pdf

Section 2: Enabling Activities

The continuation of result-based financial support from Norway to Guyana will depend on publicly observable progress on forest governance, as outlined below.

Section 2.1 Indicators of Enabling Activities

Performance in enabling activities will be measured against progress on six key categories of activities:

Strategic framework:

All aspects of Guyana's planned efforts to reduce deforestation and forest degradation, including forest conservation, sustainable management of forests and enhancement of forest carbon stocks ("REDD-plus"), are being developed in a consistent manner, through an internationally recognized framework for developing a REDD-plus programme, and will continue to evolve over time.

Guyana has chosen the Forest Carbon Partnership Facility (FCPF) as the strategic framework for its REDD+ efforts, with the Inter-American Development Bank (IDB) as the delivery partner. In 2014 Guyana concluded engagement with the IDB for the commencement of implementation of the FCPF with the signing of a Technical Co-operation Agreement between GoG and IDB. The focus will now be on the implementation of the FCPF and to commence the process of preparing the R-Package.

Guyana's REDD-plus efforts have been integrated within the Low Carbon Development Strategy (LCDS), which currently covers the period to 2015. The LCDS was originally launched in 2009, with an addendum in 2013. By June 2015, the LCDS will be updated to reflect progress in implementing REDD+ initiatives, lessons learnt from the Guyana-Norway Partnership and to set out in draft form the focus, initiatives and projects for the next phase of the LCDS (2015-2020).This draft document will then be subject to wide stakeholder consultations, including forest-dependent and Amerindian communities, and other members of civil society.

The contributions to Guyana's LCDS from Norway and other contributors, including the FCPF, will be administered in a transparent manner. Information concerning all expenditures, both planned and implemented, are publicly available on the relevant website of the Government of Guyana, and through national systems of public disclosure, including to the National Assembly.

Goal of the partnership

Guyana and Norway support the relevant decisions of the UNFCCC COPs in Cancun, Durban, Doha, Warsaw and Lima. In particular, the Governments welcome both (i) the Cancun decision to agree a new, global climate agreement by 2015, for implementation from 2020 at the latest and (ii) the Warsaw Framework for REDD+.

The Governments believe that the partnership between the two countries can provide many useful lessons for the crafting of the new global agreement, as well as influencing the effective functioning of other multilateral processes, e.g. the FCPF. This could include lessons on creating effective climate finance mechanisms, setting REDD+ reference levels, and providing practical lessons on the implementation of safeguards. The Government of Guyana's Readiness Package ("R-Package") was prepared and submitted to the FCPF in 2014. Guyana is considering to give an early idea presentation for the Carbon Fund in the April 2015 meeting with the intention of entering the fund´s second pipeline.

Improved Financial Intermediation

Goal of the partnership

It is hoped that by 2015, the financial mechanisms of the partnership can be used as examples of interim flexible climate financing instruments, which allow for rapid approval of projects and stronger national ownership, while at the same time applying internationally recognized standards for fiduciary, environmental and social safeguards.

Continuous multi-stakeholder consultation process:

The LCDS, including the REDD-plus strategy and prioritized LCDS funding needs, is subject to an institutionalized, systematic and transparent process of multi-stakeholder consultation, enabling the participation of all potentially affected and interested stakeholders at all stages of the REDD-plus/LCDS process. This process will continue to evolve over time. Particular attention is given to the full and effective participation of indigenous peoples and other forest-dependent communities.

Goals of the partnership

- Monthly meetings of the Multi Stakeholder Steering Committee (MSSC), with comprehensive minutes of every meeting made publicly available immediately upon approval from the following MSSC meeting. Enable participation of all relevant stakeholders through renewal of invitations to the MSSC,
- Information and consultation program which includes:
    - Keeping the GRIF and LCDS web pages updated with relevant information about the progress of ongoing processes.
    - Wide stakeholder engagement and inclusive consultations of the LCDS.
    - Establishing and operationalizing a Communications Team coordinated by the Office of Climate Change and responsible for communication, information and awareness sessions.
    - The establishment of information and awareness activities that are designed to meet the needs of Amerindian communities, including through the use of non-internet based channels of communication such as in-person meetings, information folders, and traditional media.
    - Coordinated information flows related to the different parts of LCDS implementation, including but not limited to LCDS progress, EITI, FLEGT, FCPF and GRIF projects. Collaboration with the National Toshaos Council (NTC) and MSSC members to function as agents of information sharing.

Governance:

A transparent, rules-based, inclusive governance, accountability and enforcement system for forests in Guyana is being progressively strengthened, in accordance with Guyana's outline REDD-plus Governance Development Plan (RGDP) as outlined in Table 1.

Goals of the partnership

- Execution of EITI Scoping Study along with the preparation of a fully costed Work Plan by February 2015; application for EITI Candidacy presented to the EITI Board by June 2015.

- Continuation of work towards a Voluntary Partnership Agreement (VPA) under the EU FLEGT Action Plan in accordance with the July 2013 Joint EU-GoG Road Map with the intent of signing the VPA by Guyana upon completion of the VPA negotiations, a process which is jointly conducted by the GoG and EU . This will be conditioned upon large consensus of all stakeholders involved and impacted by the VPA, that their inputs have been taken into account, sufficient time given for discussions and engagements at the stakeholder level, and subject to further updating of the Road Map, including that which may emanate from the scheduled April 2015 EU GoG negotiation session.
- Continued implementation of Independent Forest Monitoring (IFM), with the second IFM assessment done at the end April 2014. In keeping with Section 4 of the agreed Terms of Reference for IFM, the next IFM assessments will be conducted at 2 years intervals thereafter, the next one taking place in April 2016 unless other provisions are foreseen in the VPA.
- Ongoing implementation of activities by the Land Reclamation Committee in accordance with its ToR and Work Plan, such as site screening evaluation, backfilling, and stakeholder engagements, will continue and be communicated publicly by June 2015.
- Submission of Guyana's fifth national report by June 2015 to the CBD including to the extent possible a description of the synergies between the protection of biodiversity, REDD+ and the LCDS.
- Revision of the National Biodiversity Strategy and Action Plan and continuing to implement actions to meet the Aichi Targets and the UNCBD Strategic Plan publically communicated by June 2015.
- Implementation of a GoG (MNRE) programme of activities, with actions focused on specific efforts to manage degradation from extractive activities where this needs to be done, including, but not limited to: the operationalizing of a mining school, training and capacity development, applying technology for improved recovery and reduced environmental impact, recruitment of additional mines officers and enhanced enforcement, and continued dialogue with the sectors and relevant stakeholders towards ensuring that sectoral best practices are applied and sustained thereafter.
- Implement a project to mainstream biodiversity protection in the gold mining sector, including completion of ToRs for two (2) Consultancies - ongoing: (i) capacity building of EPA Officers, and (ii) prioritisation of hotspots for monitoring and enforcement of mining-related activities by June 2015.
- Exploration of the development of a GRIF project that focuses on expanding the current mercury free program in addition strengthening the Exploration and Prospecting Unit of the Guyana Geology and Mines Commission so as to help enable environmentally low-impact mining and prospecting for small and medium scale miners.

The rights of indigenous peoples and other local forest communities as regards REDD-plus:

The Constitution of Guyana guarantees the rights of indigenous peoples and other Guyanese to participation, engagement and decision making in all matters affecting their well-being. These rights will be respected and protected throughout Guyana's REDD-plus and LCDS efforts.
Guyana's policy is to enable indigenous communities to choose whether and how to opt in to the REDD+/LCDS process. This will take place only when communities wish to do so with their titled lands, in accordance with Guyana's policy of respecting the free, prior and informed consent of these communities.

Goals of the partnership

- GRIF funding made available to enable the achievement of the Government of Guyana's policy objective of completion of land titling for all eligible Amerindian communities, with progress measured relative to a publicly available timeline.
- GRIF funding made available for all Community Development Plans (CDPs) through the Amerindian Development Fund.
- Opt In mechanism strategy developed and the selection of a community to test the mechanism with a piloting of the mechanism in place by June 2015.
- Implementation of the part of the outreach program under the multi-stakeholder indicator which is tailored and targeted towards the needs of Amerindian communities by June 2015.

Integrated land-use planning and management:

Several aspects of REDD+ relate to the development of a system for environmentally sustainable and climate smart area planning and management.

Goals of the partnership

- By September 2015, Guyana has a formal system in place for holistic area planning and management.
- A key element of this system should be a publicly available map of area use (including, but not limited to, full transparency regarding existing and planned concession and reconnaissance areas for forestry and mining, titled lands for Amerindian communities, areas planned and concessioned for industrial agriculture etc.)
- The MNRE has recently launched a Geospatial Information Management Unit which has created a web-based application (Geonode) for the management and publication of spatial data inclusive of forestry concessions, mining concessions and Amerindian titled lands. The interface allows for non-specialized users to share data and create interactive maps which can all be publically accessed and viewed. By June 2015 the Geonode Server is to be publically available and operational.
- In the process of developing the system for area planning and management and the area use map, formal status of varying degrees of protection should be awarded to a significant part of the areas identified as Intact Forest Landscapes and priority areas for biodiversity. This will gradually replace the Intact Forest Landscapes interim performance indicator.The measures taken will as a whole be in line with Guyana's stated goal of maintaining 99.5 per cent of its forest for the duration of the partnership and stay on a similar trend after 2015,though the degree of forest protection will depend on various factors, including the availability of international climate finance.[4]

- [4] Whilst implementing the IFL Roadmap, it was apparent that there was an urgent need for a technical analysis required to determine priority areas for biodiversity. As such, the Protected Areas Commission (PAC) along with expertise solicited from the University of Kent and Conservation International, completed a Technical Report on the Priority Areas for Biodiversity through consultations with relevant stakeholders. The Report was submitted as a means of verification for JCN 2014. In an effort to progressively implement the IFL Roadmap with consideration given to the recently completed technical gap-analysis report, the PAC has commenced the development of its System Plan and Strategic Plan (2015-2020) which will both provide the framework for protecting and managing existing protected areas and priority areas for biodiversity. In addition, the road

Monitoring, Reporting and Verification:

Guyana has progressed far in developing a national MRV system. Guyana has established a deforestation baseline and performed four forest area assessments for the years 2009-10, 2010-11, 2012 and 2013. The fifth annual assessment for year 2014 is currently being conducted.

Goals of the partnership

- Guyana has implemented the MRV-roadmap and reached a reporting level incorporating several Tier 3 elements by the end of 2015. These Tier 3 elements include, but are not necessarily limited to, the use of high resolution data at national level that allows for disaggregation, the use of methods that provide estimates of greater certainty than lower tiers for key carbon pools, the use of comprehensive field sampling that is linked to GIS based systems which integrates land use and management activity data, and is subject to quality checks, and validations. Further, other areas relevant to Tier 3 reporting, will be explored as stated in the MRV Roadmap.
- Guyana will conclude technical analyses that inform a national reference level that is to be submitted to the UNFCCC. The reference level will reflect the core elements of the reference level agreed by the GoG and the GoN, and also make provisions that the reference level be reassessed at regular intervals as/if global rates decrease. Guyana submitted the reference level to the UNFCCC by December 2014 in accordance with timelines provided by the UNFCCC secretariat – and was one of the first countries in the world to do so.
- Establish mechanisms for data sharing between governmental agencies, so that the MRV data generated can inform policy development in the broader land use sector, e.g. for land use planning, enforcement in the mining sector etc. The Geospatial Information Management Unit under the Ministry of Natural Resources and the Environment will coordinate this work.

Section 2.2 Assessing Progress Against Enabling Indicators

Table 1 below sets out how progress will be measured regarding enabling indicators going forward. These indicators are informed by the long term goals of the partnership as agreed in section 2.1 above, and thereafter updated in accordance with the long term goals.

Guyana and Norway have agreed that the necessary information to assess Guyana's delivery on these indicators will be easily accessible in the public space. Independent assessment of the information thus accessible determines to what degree, the REDD-plus enablers have been met.

map makes reference to site-level management plans for which the PAC is currently drafting through a number of stakeholder consultations for three (3) existing protected areas – Shell Beach, Kanuku Mountains and Kaieteur National Park. In doing so, the management plans will serve as a template for piloting site specific priority areas for biodiversity.

Section3: REDD-plus performance indicators

Guyana is being paid for its performance through an incentive structure which rewards keeping deforestation below an agreed reference level, as well as avoiding increased forest degradation.

The Governments of Guyana and Norway strongly endorse the establishment of such an incentive structure under the United Nations Framework Convention on Climate Change (UNFCCC). To help facilitate such an agreement, the Governments have decided to pilot this incentive structure on a national scale and in a pragmatic, gradually evolving, workable and hopefully replicable manner. Once an international regime is in place, the Guyana-Norway partnership will be adjusted accordingly. Section 3.1 sets out the incentive structure, while Section 3.2 outlines how performance is to be assessed.

Section 3.1 REDD+ incentive structure

The payments due to Guyana for a given year are paid post facto. They are calculated as follows:

1. Measure avoided deforestation by subtracting Guyana's observed deforestation rate against the agreed *reference level*. See Section 3.1.1

2. Determine avoided greenhouse gas emissions by applying a set of *carbon-density proxies* to:
   (i) convert the observed avoided deforestation rate into avoided greenhouse gas emissions;
   (ii) subtract increased emissions from forest degradation based on agreed indicators and their reference levels as set out in table 2.
   See Section 3.1.2.

3. Apply an interim carbon price of US$5 per tonne of avoided emissions, providing Guyana does not exceed an agreed level of deforestation within the context of the Guyana-Norway partnership – see Section 3.1.3. If the deforestation rate is above the levels stipulated in section 3.1.3, payments will be reduced and ultimately cease.

Section 3.1.1 – Measuring Avoided Deforestation and Forest Degradation

Setting a Deforestation Reference Level

For a global REDD+ mechanism to be effective it must incentivize both (i) reductions in deforestation in countries with high levels of deforestation and (ii) maintenance of low deforestation rates in countries that have maintained their forest cover. If only countries with high deforestation rates are compensated for improving their forest protection under an international climate regime, deforestation pressures will move to countries with currently low deforestation, like Guyana, and the overall emissions reduction effect will be diluted or lost.

On the other hand, if a global incentive structure does not ensure global additionality, the international community will be paying for "hot air" and there will be no mitigation impact.

This point is broadly accepted within the UNFCCC negotiations, and there is general agreement that a REDD-mechanism must provide genuine incentives for forest conservation in low deforestation countries, as well as ensure global additionality.

Therefore, Norway and Guyana have – pending the finalization of a UNFCCC reference level methodology – decided to use the "combined reference level" methodology to set a provisional reference level, based on an equal weighting of Guyana's mean 2000 - 2009 deforestation rate and the mean 2005 – 2009 rate in developing countries with deforestation. The "combined reference level" methodology provides incentives for all categories of forest countries, and ensures that emissions from deforestation and forest degradation are reduced cumulatively at a global level.

In setting a historical deforestation baseline for Guyana under the Guyana-Norway REDD+ partnership, the mean value for the 2000-2009 period is used; 0.03% (see Box 1 below for background).

This estimate included all forest to non-forest change i.e. detected mining, road infrastructure, agricultural conversion and fire events that result in deforestation. It does not include forest degradation caused by selective harvesting, fire or shifting agriculture. The same approach and criteria was applied to calculate the area of deforestation from 2009 to 2010 (Year 1 period). The total area of deforestation for this period was calculated at 10 287 ha. In year 2 the change figure was similar and reported as 9 891 ha. For Year 3 the total area of deforestation over the 12 month period is calculated at 14 655 ha. There have been significant improvements in Year 3 in the development of methods of reporting on forest degradation.

This adheres to the principles used for setting the historical deforestation baseline in the Brazilian Amazon Fund.

The "global average deforestation rate" is calculated[5] across 85 developing forested countries by dividing the sum of reported forest area loss in only those countries which lost forest by the starting area of forest across all countries, Data on forest loss is taken from FAOs Forest Resources Assessment 2010 (FRA 2010). For the period 2005-2010 the "global average deforestation rate" was 0.52%. This figure will be subject to revision given new data from e.g. future FAO FRA's or from the IPCC.

The reference level for Guyana is the mean value of these two measures, that is, 0.275%.

Setting Reference Levels for forest degradation indicators.

In the first two years of the partnership, Guyana's MRVS was not sufficiently developed to enable an analysis of forest degradation in Guyana that would enable a facts- based reference level to be established for all degradation indicators. Guyana has made substantial progress in improving the knowledge base for degradation indicators, and the current set of indicators and their associated reference levels are described in Table 2.

[5] The open source Osiris database was used for these calculations (www.conservation.org/osiris). Note that this is an underestimate because it does not include deforestation that occurred within countries that had a net gain in forest, nor does it account for all deforestation in countries that lost forest as some countries' reported forest area loss are net values.

Box 1:

To improve knowledge in historical deforestation rates in Guyana, an analysis of forest area change since 1990 to September 2009 was undertaken using archived Landsat type satellite data that met the IPCC Good Practice Guidelines for Land Use, Land use Change and Forestry (LULUCF). The analysis was conducted by Poyry and subsequently by Indufor upon assignment by the Guyana Forestry Commission. Assessments were conducted for three periods: Year 1 (01 October, 2009 to 30 September, 2010); Year 2 (01 October, 2010 to 31 December, 2011) Year 3 (1 January 2012 to December 31 2012) and Year 4 (1 January 2013 to December 31 2014) with findings subject to independent verification by Det Norske Veritas (DNV GL). The reports are available at www.regjeringen.no/guyana and www.forestry.gov.gy.

Forest Change Area by Period & Driver from 1990 to 2013

Driver	Historical Period			Year 1	Year 2 2010-11 (15 months)		Year 3 2012		Year 4 2013	
	1990 to 2000	2001 to 2005	2006 to 2009	2009-10	Deforestation	Degradation	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)									
Forestry (includes forestry infrastructure)	6 094	8 420	4 784	294	233	147	240	113	330	85
Agriculture (permanent)	2 030	2 852	1 797	513	52	N/A	440	0	424	N/A
Mining (includes mining infrastructure)	10 843	21 438	12 624	9 384	9 175	5 287	13 516	1 629	**11 251	2 955
Infrastructure	590	1 304	195	64	148	5	127	13	278	112
Fire (deforestation)	1 708	235		32	58	28	184	208	96	395
Settlements									23	20
Year 4 Shifting Agriculture										765
Year 2 forest degradation converted to deforestation							148		67	N/A
Year 3 forest degradation converted to deforestation									200	N/A
Amaila Falls development (Infrastructure Roads)					225				64	20
Area Change	**21 267**	**34 249**	**19 400**	**10 287**	**9 891**	**5 467**	**14 655**	**1 963**	**12 733**	**4 352**
Area Change for Year 4 without Shifting Agriculture										3 587
Total Forest Area of Guyana	18 473 394	18 452 127	18 417 878	18 398 478	18 388 190		**18 502 531**		18 487 876	
Total Forest Area of Guyana Remaining	18 452 127	18 417 878	18 398 478	18 388 190	18 378 299		18 487876		18 475 143	
Period Deforestation (%)	0.01%	0.04%	0.02%	0.056%	0.054%		0.079%		0.068%	

**Forestry infrastructure accounts for the full total of deforestation from forestry activities.

**Mining Infrastructure accounts for 918 ha in 2013 out of the total deforestation driven by mining of 11 518 ha, when Year 2 & 3 transitional areas are taken into account.

***Amalia Falls Development has been split from other infrastructure driven change for reporting purposes.

Section 3.1.2 Converting to Avoided Greenhouse Gas Emissions

Guyana is working to implement an IPCC-compliant MRV-system for emissions or removals of carbon from Guyana's forest sector. Until such a system is in place, a set of basic interim (proxy) indicators will be used to assess Guyana's performance. As a more sophisticated forest carbon accounting-system is implemented, these basic indicators will be gradually phased out. The set of interim performance indicators is based on the following assumptions:

- They provide justification and prioritization for near-term implementation of REDD-plus efforts.
- They are based on conservative estimates while encouraging the development of a more accurate MRV system over time through building national capacities.
- They will contribute towards the development of a national MRV-system, based on internationally accepted methodologies and following the IPCC reporting principles of completeness, consistency, transparency, uncertainty, comparability, and encourage independent international review of results.

When calculating reduced emissions from avoided deforestation, an interim default value of 100 tons of Carbon is applied. This interim carbon figure corresponds to 367 tons of CO2. When calculating emissions caused by forest degradation, a default value of 400 tons per hectare is applied, this corresponds to 1468 tons of CO2. These conservative carbon values help to ensure that emission reductions from deforestation are not over-estimated and emissions from forest degradation are not under-estimated.

The interim indicators are described in table 2 below.

Section 3.1.3 Calculating Payment

Payments due to Guyana will be calculated by applying an interim carbon price of US$5/ton CO2, as established in Brazil's Amazon Fund.

However, this price will only be applied if Guyana's observed deforestation rate is below the agreed level. This is explained in the following section.

Agreed maximum level of Deforestation

If designed for maximum effectiveness and efficiency, a future global incentive system could allow for significant variations in individual countries' deforestation rates while still ensuring global additionality.

However, in the absence of a global system, such an approach alone would imply that Guyana would be eligible for significant payments even if it were to increase its deforestation along a business-as-usual trajectory towards the agreed reference level of 0.275%.

However, neither Norway nor Guyana wishes to see such an increase in deforestation, and in November 2009 the Joint Concept Note clearly stated that:

"(…) the Participants agree that Norwegian financial support from 2011 onwards is also dependent on no national-level increase in deforestation over an agreed level that should be as close to historical levels as is reasonable in light of expanded knowledge of these historical rates and the quality of that knowledge. Such a level can only be set when more robust data is available concerning current and historic deforestation."

Box 2:

Mechanism for reducing results based payments if deforestation rate exceeds the agreed maximum level (0,056%)

Deforestation rates (%)	Up to 0.056	0.057-0.062	0.063-0.080	0.081-0.090	0.091-0.1
Reduced compensation (% per 0.0015 increased deforestation)	0	1,5	2,0	2,5	3,0

At the same time, Guyana's national development requires limited but strategic use of forest assets to enable (i) a limited amount of economic activity to take place within the forest, where the economic value to the nation of such activity is very valuable; (ii) a limited amount of essential national infrastructure to be constructed where this is in line with critical development goals; (iii) support for the sustainable development of forest villages. Guyana is reaching a stage of economic development where experience from other countries suggests that enabling these objectives brings further deforestation pressures.

Therefore, pending the introduction of a global incentive system, it would defeat the purpose of making REDD+ an attractive development option for forest countries if this REDD+ agreement meant that no increases at all be allowed in Guyana's historically low deforestation rates. First, the rates are so small that the margin of error of measurements in itself could yield significant annual variations (as measured in per cent). Second, insisting on such strict limitations would probably yield an insufficient incentive structure for the people of Guyana to stick to a low-deforestation development path, as the economic downsides would be disproportionate to the incentive offered.Third, the relevance of historical trends when deforestation rates are extremely low is not as useful a predictor of future pressures on the forest as it is in countries with higher historic rates of deforestation.

There is no given mathematically correct answer to how these concerns should best be balanced. Guyana and Norway have chosen a model that on the one hand enables Guyana to exercise careful, strategic use of limited forest areas for high value economic activity, the construction of essential national infrastructure and sustainable development of forest villages. On the other hand, the model puts in place incentives that would quickly penalize an upward trend in deforestation, see Box 2.

The essence of this approach has two implications:

(i) One-off predictable and controllable deforestation events will be allowed for critical national infrastructure that is part of Guyana's transition to a low carbon development path.[6] During the duration of the current Guyana-Norway partnership, the only such event will be the construction of the Amaila Falls hydro-electricity plant. This plant is the flagship of Guyana's Low Carbon Development Strategy, and is expected to eliminate over 92% of the country's energy-related emissions, after the emissions associated with its construction are accounted for[7]. It will only go ahead after Guyana and Norway have agreed that the necessary Environmental and Social safeguards have been met, and an independent verification agreed by Guyana and Norway confirms the overall beneficial effects of the project from a climate change perspective.

(ii) Economic activities will be permitted within the forest, within a ceiling on deforestation of 0.056 per annum, without any financial penalty apart from the reduction in compensation caused by a smaller margin between the reference level and the verified deforestation level. For any deforestation rate up to this level, Guyana will be eligible for payments equaling the full margin between the reference level and the verified deforestation level. For deforestation rates between 0,056 per cent and 0,1 per cent (unless they relate to the Amaila Falls project as described above), eligibility for payments would be calculated as a gradually decreasing percentage of the payments that would be due if only the margin between the reference level and the verified deforestation level were taken into account, as set out below. At deforestation rates at or above 0,1 per cent, no payments would be due to Guyana for that given year.

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

In sum, this means:

a) that a ceiling on the level of deforestation that can take place before 2015 with any incentives still flowing, has been set at only around 35 per cent of the level of deforestation that the reference level would imply;
b) the accommodation of limited annual upward variations to ensure that the incentive structure still makes REDD+ a positive development choice for Guyana; and
c) that Guyana is incentivized to maintain more than 99.5 per cent of its forest cover for the duration of the partnership.

See Box 3 for a summary description of how performance based payments will be calculated.

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[6] The exception is only from the 'agreed maximum level of deforestation' provision. The emissions resulting from such activities would still be part of the total deducted from the reference level to determine total payments due to Guyana. I.e., emissions from Amaila would still count as deduction in total amount due to Guyana in the years when Amaila was established.

[7] The January 2011 ESIA for the Amaila Falls project can be found at http://amailahydropower.com/latest-news/key-project-documents. Section 5 details how a 92% reduction in net greenhouse gas emissions is calculated.

Norwegian support to GRIF – alone or in combination with other contributors – will not exceed the sum calculated on the basis of the above described methodology.

It is also likely that while support from Norway will provide majority funding for results delivered by Guyana, in a given year, it is unlikely to equal the total sum owed to Guyana. Therefore, to ensure that the incentives which underpin the partnership are fully in place, Guyana and Norway will work together to seek to get other Participants to join the partnership.

Once other Participants are in place with sufficient commitments to the Partnership, this will enable Norwegian (and other Participants') contributions to vary directly with performance, i.e. a reduction in estimated emissions will lead to relatively higher contributions, increases to relatively lower contributions.

Section 3.2 Monitoring Progress Against Reducing Emissions and Enhancing Removals of Carbon in Guyana's Forests

Progress against reducing emissions and enhancing removals of carbon in Guyana's forests will in time be measured through the MRV system that is being put in place as set out in the MRV-system Road-map, which was recently updated with a new version[8].

Pending the implementation of the MRV-system, Table 2 sets out the interim REDD+ performance indicators described above. Guyana and Norway agree that these indicators will evolve as more scientific and methodological certainty is gathered concerning the means of verification for each indicator, in particular the capability of the MRV system at different stages of development. In 2014, a system of parallel reporting will be conducted to pilot reporting on forest carbon emissions for main drivers of deforestation.

Reporting on forest carbon emissions will be done in addition to reporting on the Interim Indicators in Table 2 of the JCN.

A roadmap for the establishment of a national MRV system and accompanying Terms of Reference for the system have been developed to provide a framework for verifiable, performance monitoring, set against international best practice and nationally appropriate circumstances. In years 1, 2 and 3 (2009-2012), implementation has also commenced in a number of administrative and technical areas. Broad based MRV-system Steering and Technical Committees have been established and initial technical work has commenced and advanced in forest area and forest carbon stock assessment and monitoring. The framework has been created for annual reporting on deforestation and forest degradation in accordance with interim REDD+ Performance Indicator that will evolve into a full MRV system. The first product has been the completion of historic reporting on forest/non forest cover and deforestation by driver, over the period 1990 to 2009, accompanied by annual reporting of forest/non forest cover and deforestation and forest degradation results in accordance with REDD+ Interim indicators set out in the JCN. Concurrently, work is also proceeding for field based assessments of forest carbon stock assessment and monitoring, the establishment of demonstration activities, and detailed technical studies on reference level setting and forest degradation, as well as other areas.

During 2009-2013, significant improvements to Guyana's ability to measure deforestation indicators were made. In particular, it was determined (and independently verified) that deforestation rates were extremely low.

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[8] http://www.forestry.gov.gy/Downloads/Terms_of_%20Reference_for_Guyana's_MRVS_Draft.pdf

Box 3:
How will results based payments be calculated?

To calculate the results based payments due to Guyana based on the results in any given year, the following steps will be followed:

1. Subtracting Guyana's reported and verified deforestation rate from the agreed interim reference level of 0.275%;

2. Calculating the carbon emission reductions achieved through avoided deforestation (as compared to the agreed reference level) by applying an interim and conservatively set estimate of carbon loss of 100tC/ha. This value will be replaced once a functional MRV system is in place. The interim carbon loss figure corresponds to 367tCO_2/ha.

3. Subtracting from that number changes in emissions – on a ton-by-ton basis – from forest degradation as measured against agreed indicators and their reference levels, as specified in Table 2.

4. In calculating the carbon effects of forest degradation, an interim and conservatively set carbon density of 400 tC/ha will be applied. Upon agreement under the UNFCCC on how to estimate and account for emissions from degradation, this approach will be adjusted accordingly;

5. The tons of "avoided emissions" is then multiplied with an interim carbon price of US$ 5/ton CO2, as established in Brazil's Amazon Fund.

6. If the deforestation rate in a given rate exceeds 0,0056, the payments will be gradually reduced as a proportion of the sum derived through step 1-4 above, or cease (if at or exceeding 0,1 per cent), as stipulated in section 3.1.3, box 2.

Progress has also been made to gain a greater understanding of how degradation is to be measured, and is leading to further work that is expected to enable progress on refining the reporting on indicators to assess degradation, including that from mining and infrastructure (currently the dominant drivers of degradation).

Guyana and Norway have agreed that annual independent verification of REDD+ performance indicators will be conducted by one or more neutral expert organizations, to be appointed jointly by the Participants. The assessment determines what results Guyana has delivered according to the established indicators for REDD-plus performance. For the first, second and third reporting periods, the measurement of progress was carried out by Poyry and Indufor in collaboration with the Guyana Forestry Commission, and independent verification was carried out by DNV GL. DNV GL was selected on the basis of an international tender process in accordance with Norwegian procurement regulations.

Section 4: Financial Mechanism:

The Guyana REDD+ Investment Fund (GRIF) is channeling REDD-plus financial support from Norway and other potential contributors to the implementation of Guyana's LCDS.

Pending the creation of an international REDD+ mechanism, the Guyana REDD+ Investment Fund (GRIF) represents an effort to create an innovative climate finance mechanism which balances national sovereignty over investment priorities with ensuring that REDD+ funds adhere to globally accepted financial, environmental and social safeguards.

The GRIF is an interim solution for channelling climate finance to Guyana - designed for the Guyana-Norway Partnership up to 2015 - pending the transfer of payment intermediation, and associated processes, to Guyana's national systems. This will be done when it is possible to specify how independent verification of Guyana's adherence globally accepted financial, environmental and social safeguards can be implemented. This will draw on UNFCCC and other relevant guidance.

Until such time as national systems can be used, the World Bank's International Development Association (IDA) was invited by Guyana and Norway to act as Trustee and is responsible for providing financial intermediary services to the GRIF.

The Trustee (i) receives payments for forest climate services provided by Guyana; and (ii) transfers these payments and any investment income earned on these payments, net of any administrative costs, to Partner Entities, for projects and activities that support the implementation of Guyana's LCDS. Transfer of funds takes place on approval by the GRIF Steering Committee, which consists of Guyana and Norway, with observers from Partner Entities, as well as Guyanese and Norwegian civil society.

Partner Entities provide operational services for the approved LCDS investments, and apply their own globally accepted operational procedures and safeguards. As of March 2015, Guyana and Norway have approved as Partner Entities the Inter-American Development Bank (IDB), the World Bank and the United Nations Development Group.

More information on the operation of the GRIF is set out in the Administration Agreement between the Government of Norway and the World Bank.[9]

Improved Financial Intermediation
Improved Financial Intermediation is one of the key objectives of the Guyana-Norway partnership, in order to ensure effective flow of finances to GRIF projects. The lessons learned will be of global relevance. During the period of this JCN, steps to improve financial intermediation will see the Governments of Guyana and Norway:

(i) The GRIF Steering Committee will amend the GRIF Governance Framework document to allow for partner entities to use any instrument they deem appropriate under the GRIF.

(ii) The Governments of Guyana and Norway will encourage the Partner Entities to use the financing instruments they are comfortable with.

(iii) Acknowledging the need for optimizing financing mechanisms to streamline development of GRIF projects and accessing other climate funds, the PMO will be equipped with the resources and provided with the flexibility to fast track project development.

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[9] http://lcds.gov.gy/guyana-redd-investment-fund-grif.html

Table 1 –Key REDD+ Enabling Efforts in 2014/15 (from June 15th 2014 to June 19th 2015):

Goal of Partnership	Description of annual indicators for Years 5 of the Partnership outlining Actions to June 19th 2015	
	ANNUAL INDICATOR	VERIFICATION/EVIDENCE
STRATEGIC FRAMEWORK		
Ongoing National Strategy	By June 2015, the LCDS will be updated to reflect progress in implementing REDD+ initiatives, lessons learnt from the Guyana-Norway Partnership and to set out in draft form the focus, initiatives and projects for the next phase of the LCDS (2015-2020).This draft document will later be subject to wide stakeholder consultations, including with Amerindian and forest-dependent communities, as well as other members of civil society.	Draft updated LCDS document available. Public announcement of wide stakeholder consultations for the LCDS update.
	Continued engagement between IDB and GFC for implementation of the FCPF. R Package prepared	Documentation on the implementation of the FCPF (copies of progress report, deliverables etc) R Package prepared and publicly available
CONTINUOUS MULTI-STAKEHOLDER CONSULTATION		
	Monthly meetings of the MSSC with comprehensive minutes made publically available immediately upon approval from the MSSC meeting	Minutes of meetings available on LCDS web site
	Coordinated approach to outreach and communications with support from the MSSC. Information flow will include climate change, LCDS and technical areas on REDD+ including MRVS, FLEGT, IFM, EITI, and FCPF across various sectors and stakeholder groups.	Annual Stakeholder Engagement Plan approved by MSSC and publically communicated. Copy of renewed invitation to the MSSC and list of invitees. Copies of awareness and communications materials Reports from outreach sessions

	Regular updates of the GRIF and LCDS websites. Update with relevant information about progress of on-going processes. All documents, I including deforestation reports, relevant for the Guyana-Norway partnership are available on one web page.	Matrix of information updates provided. Link to web page with all relevant documents, including, but not limited to the LCDS with its addendum, deforestation reports, accuracy assessment reports, verification reports, independent forest monitoring reports, enabling activities self assessment, enabling activities independent assessment, GRIF-projects, etc. Simplified summary of the MRVS interim measures report adapted to non-experts publicly available.
GOVERNANCE		
Application for EITI Candidacy by June 2015		
	Candidacy application submission to EITI Secretariat	Copy of EITI Candidacy Application.
Signing of the VPA	Continue to work towards a VPA in accordance with the joint GoG-EU Road Map with intent to sign the VPA upon completion of negotiations.	Updates on joint GoG-EU Road Map, widely circulated among stakeholders. Concrete steps are taken to ensure the genuine consultation and participation of all stakeholders involved and impacted by the legality definition and minutes of meetings available and widely circulated among stakeholders. Draft sections of VPA including drafts of the Product Scope, LAS and Transparency Annex, are developed in a participatory way and made available to all stakeholders and agreed with EU.
SLUC/Extractive Industries		

Implementation of a GoG programme with actions focused on specific efforts to manage degradation from extractive activities where this needs to be done	Mining School fully operational and conducting training courses for miners and operators in the sector	Curriculum for the Mining School available and records on number of persons completing courses
	Recruitment of additional field personnel and enhanced monitoring and enforcement	Report on recruitment of additional mines officers by GGMC Completion of 3 new Mining Stations
	Land Reclamation Committee functional and supporting efforts to restore and rehabilitate areas subjected to mining with publically communicated goal for area restored by June 2015.	Minutes of meeting of the Committee 3 Site Specific Action Plan and Progress Reports, publically available
	Continue training and capacity building for new entrants and existing small and medium scale operators	Training reports and materials
GRIF support to sustainable mining	Explore the development of a GRIF project that focuses on strengthening the Exploration and Prospecting Unit of the Guyana Geology and Mines Commission- so as to help enable environmentally low-impact mining and prospecting for small and medium scale miners.	Draft PCN developed and presented to partner entity for consideration.
IFM		
Conduct IFM assessments at 2 year intervals	Preparations in accordance with IFM ToR for next assessment scheduled for April 2016	Communication with European Forest Institute on synergies and transitioning of IFM audits to Independent Monitoring under EU FLEGT. Guyana's presentation at third Negotiation session of the EU and GoG on a FLEGT VPA, (scheduled for April 2015) on role of IFM in EU FLEGT process so far and possibilities of synergies and linkages Evidence of IFM Audits taking place every 2nd year, the last in April 2014 and the next planned for April 2016
CBD		

Prepare Fifth National Report to the CBD, including to the extent possible a description of the synergies between the protection of biodiversity, REDD+ and the LCDS	Submit 5th national report to the CBD	Copy of 5th National Report (including description of stakeholder consultation process and comments compilation) and submission.
Revise the National Biodiversity Strategy and Action Plan (NBSAP)	NBSAP revised to through a process of stakeholder involvement and takes on board recent REDD+ initiatives as well as outlines actions to meet the Aichi Targets and CBD Strategic Objectives	Revised NBSAP publicly available
The rights of indigenous peoples and other forest communities as regards REDD+		
Provision of GRIF resources to enable the achievement of the Government of Guyana's policy objective of completion of land titling for all eligible Amerindian communities, with progress measured relative to a publicly available timeline (ALT project timeline 2012-2016)	Continuation of activities under the titling and demarcation activities under ALT project.	Copies of Absolute Grants and Certificates of Title issued Copies of investigation reports from MoAA and work orders for demarcation from GLSC
Opt In mechanism pilot started by June 2015	Opt In Mechanism Strategy prepared and piloted in one community	Copy of the Strategy Initial report on the piloting of the Opt In Mechanism
GRIF funding made available for all CDPs through the Amerindian Development Fund	Documentation of lessons learned from Initiation Phase in the project document and operations manual for Phase II.	Phase II Project Document and Operations Manual with lessons learnt, publically available on GRIF webpages. Signed project document for Phase II publicly available
	Commencement of funding and implementation of Phase II of the ADF, which will fund 160 CDPs.	List of villages which have received funding under phase II-
FINANCIAL MECHANISM		
Create maximum flexibility for project funding within the current GRIF framework.	Propose change to GRIF Governance Framework allowing for budget support. Conditioned on the GRIF SC decision on changing the Governance Framework; encourage partner entities to use all financing instruments they are comfortable using in Guyana.	Copy of proposal to GRIF Steering Committee on changes to the Governance Framewok. Copy of letter to Partner Entities.

Optimizing project development	Acknowledging the need for optimizing financing mechanisms to streamline development of GRIF projects and accessing other climate funds, the PMO will be equipped with the resources and provided with the flexibility to fast track project development.	Institutional Strengthening Phase II project document submitted to IDB describing the strengthening of the PMO
INTEGRATED LAND USE PLANNING AND MANAGEMENT		
Implementation of a formal system for holistic area planning and management	Present the NLUP to Minister of MNRE and Cabinet for consideration and approval.	Copy of submission of NLUP publically available.
	Continuous public awareness on the NLUP.	Public Awareness materials available.
	Update GIS layer to include forest concession information and available information on mining concessions, agriculture leases and protected areas	Updated GIS dataset available. Written confirmation from affected agencies that the land use plan and related GIS layer are agreed to, and that the plan indeed forms the basis of land use planning in Guyana. Beta version of web-based application (Geonode) for management and publication of spatial data.
	Continually update GIS layer of allocated forest concessions but also including additional information on mining, agriculture and protected areas	Updated GIS dataset available. Annual production of written confirmation from affected agencies that the land use plan and related GIS layer updates are agreed to.
	Revise the IFL layer based on the available data	Updated GIS dataset available. Any revision of the IFL layer should be confirmed by both GoG and GoN.
	Finalize the definition of priority areas for biodiversity	Definition of priority areas for biodiversity established and publically communicated.

	Commence implementation of roadmap to codify formal status of protection for areas identified as IFL and priority areas for biodiversity.	Identification of parameters to map key biodiversity areas. Public communication of the timeline for establishment of the areas of varying degrees of protection. The roadmap will be made publically available. Develop site specific management plans for the National Protected Area System in 2015. The drafting of site-specific management plans will include public consultation. 3 Site Specific Management Plans for Protected Areas. Technical Report on the Priority Areas for Biodiversity publically communicated. (**Parameters & Definition included)

Table 2: Interim Indicators for REDD+ performance in Guyana[10]

Source of emissions or removals	Justification	Interim performance indicator	Monitoring and estimation	IPCC LULUCF reporting
Deforestation indicator:				
Gross deforestation	Emissions from the loss of forests are among the	Rate of conversion of forest area as compared to	Forest cover as of September 2009 will be used as baseline for monitoring gross	Activity data on change in forest land

10 The Participants agree that these indicators will evolve as more scientific and methodological certainty is gathered concerning the means of verification for each indicator, in particular the capability of the MRV system at different stages of development. Based on experiences from the first and second reporting and verification exercise, some adjustments have been made in this table. However, the process has identified a need to develop further detail on the operationalisation of the indicators. Significant improved ability to operationalise the indicators has already been achieved, and this process will continue over the duration of the partnership.

	largest per unit emissions from terrestrial carbon loss.	agreed reference level. Forest area as defined by Guyana in accordance with the Marrakech accords: • Minimum 30% tree cover • At a minimum height of 5 meter • Over a minimum area of 1 ha. Conversion of natural forests to tree plantations shall count as deforestation with full carbon loss. Forest area converted to new infrastructure including logging roads, shall count as full carbon loss, unless otherwise informed by field study that identifies an alternative carbon loss level.	deforestation. Reporting to be based on medium and high resolution satellite imagery and in-situ observations where necessary. Monitoring shall detect and report on expansion of human infrastructure (eg. new roads, settlements, pipelines, mining/agriculture activities etc.)	
Degradation indicators:				
Loss of intact forest landscapes[11]. This indicator will be phased out of reporting on forest degradation under	Degradation of intact forest through human activities will produce a net loss of carbon and is often the	The total area of intact forest landscapes within the country should remain constant.	Using similar methods as for forest area change estimation.	Changes in carbon stocks in forests remaining as forests

[11] Intact Forest Landscape (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)." (See www.intactforests.org)

the MRVS subject to fulfillment of provisions laid out in the JCN on IFL	pre-cursor to further processes causing long-term decreases in carbon stocks. Furthermore, preserving intact forests will contribute to the protection of biodiversity.	Any loss of intact forest landscapes area[12] shall be accounted as deforestation with full carbon loss. The IFL Baseline map developed in the first reporting period will be used to assess changes. Note that this indicator will be subject to review as stipulated in section 2.1.		
Forest management (i.e. selective logging) activities in natural or semi-natural forests	Forest management should work towards sustainable management of forest with net zero emissions or positive carbon balance in the long-term.	All areas under forest management should be rigorously monitored and activities documented (i.e. concession activities, harvest estimates, timber imports/exports). Increases in total extracted volume,expressed in tons of CO_2, (as compared to mean volume 2003 – 2008) will be accounted as	Data on extracted volumes is collected by the Forestry Commission. Independent forest monitoring will act as an additional data source on forest management to complement this information. Accounting of this indicator should be done in terms of carbon units referred as close as possible to extraction of biomass from the	Changes in carbon stocks in forests remaining as forests

[12]When assessing loss of IFL, the established elimination criteria will be applied:

- Settlements (including a buffer 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 a buffer of 1 km on each side);
- Areas used for agriculture and timber production;
- Areas affected by industrial activities during the last 30-70 years, such as logging, mining, oil and gas exploration and extraction, peat extraction, etc.
- Amerindian titles and extentions granted (the footprint of such areas, i.e. without applying a 1 km buffer)

The threshold values for IFL-patches (500 km2, min. width 10 kms) will not be applied in assessing IFL loss.

		increased forest carbon emissions[13] unless otherwise can be documented using the gain-loss or stock difference methods as described by the IPCC for forests remaining as forests. In addition to the harvested volume, an appropriate expansion factor of 25 % (applied to the whole population of trees under forest management, i.e. harvested + remnant trees) shall be used to take account of carbon loss caused by collateral damage, etc, unless it is documented that this has already been reflected in the recorded extracted volume.	above ground carbon pool.	
Carbon loss as indirect effect of new infrastructure.	The establishment of new infrastructure in forest areas often contributes to forest carbon loss outside the areas directly affected by constructions.	High resolution satellite imagery and/or field observations shall be used to detect degradation in a 100m buffer surrounding new infrastructure (incl. mining sites, roads, pipelines, reservoirs etc.).	Medium and high resolution satellite to be used for detecting human infrastructure (i.e. small scale mining) and related degradation.	Changes in carbon stocks in forests remaining as forests

13 The participants agree on the need to create incentives for net-zero or carbon positive forest management practices in Guyana. This will require a sophisticated MRV system to assess the carbon effects of forestry activities. This will be an objective of the MRV system under development. In the interim period, focus will be on incentives for avoiding increased emissions from forest management activities.

		As the benchmark for this indicator, the annualized number of the mapped degraded area from the second reporting period will be used (4368 ha)[14]. Any degradation above this benchmark in subsequent reporting years will result in reduced compensation. Unless other emission factors can be documented through the MRVS, these areas shall be accounted with a 50 % annual carbon loss, i.e. areas mapped in one year will be accounted with a further 50 % carbon loss in subsequent reporting periods.		
Emissions resulting from subsistence forestry, land use and shifting	Emissions resulting from communities to meet their local	Not considered relevant in the interim period before a proper		Changes in carbon stocks in forests

[14]For the second reporting period, Guyana made use of a new and significantly improved method for mapping infrastructure related degradation. A historical proxy analysis of areas affected by degradation from infrastructure was conducted for the period 2000-2010. The total area of a 100m buffer surrounding all new infrastructure was calculated for the historical period, as well as for the for the year 2 reporting period. This analysis indicated that the area affected by new infrastructure in the year 2 reporting period was comparable to the historical period.

As a benchmark for infrastructure related degradation in future reporting periods, the area mapped as degraded in the second reporting period will be used. This area equaled 5460 ha, but as the second reporting period had a length of 15 months, and subsequent reporting periods will be 12 months, this number was annualized. The benchmark is therefore 4368 ha.

cultivation lands (i.e. slash and burn agriculture).	needs may increase as result of *inter alia* shorter fallow cycle or area expansion.	MRV-system is in place.		remaining as forests
Emissions resulting from illegal logging activities	Illegal logging results in unsustainable use of forest resources while undermining national and international climate change mitigation policies	Areas and processes of illegal logging should be monitored and documented as far as practicable.	The monitoring of illegal logging is within the main objectives of the GFC's forest monitoring system, and is informed by an illegal logging database. In addition to reporting on illegal logging via the database, Independent Forest Monitoring will support performance monitoring of forest legality through the IFM framework. Should IFM detect potentially significant challenges with the established forest monitoring system, this indicator will be reassessed. In the absence of hard data on volumes of illegally harvested wood, a default factor of 15% (as compared to the legally harvested volume) will be used. This factor can be adjusted up and downwards pending documentation on illegally harvested volumes, inter alia from Independent Forest Monitoring. Medium resolution satellite to be used for detecting human infrastructure and	Changes in carbon stocks in forests remaining as forests

			targeted sampling of high-resolution satellite for selected sites. Accounting of this indicator should be done in terms of carbon units referred as close as possible to extraction of biomass from the above ground carbon pool.	
Emissions resulting from anthropogenically caused forest fires	Forest fires result in direct emissions of several greenhouse gases	Area of forest burnt each year should decrease compared to current amount	Coarse-resolution satellite active fire and burnt area data products in combination with medium and high resolution satellite data used for forest area changes	Emissions from biomass burning
Indicator on increased carbon removals:				
Encouragement 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) can increase the sequestration of atmospheric carbon.	Not considered relevant in the interim period before a proper MRV-system is in place but any dedicated activities should be documented as far as practicable. In accordance with Guyanese policy, an environmental impact assessment will be conducted where appropriate as basis for any decision on initiation of afforestation, reforestation and carbon stock enhancement projects.		Activity data on change to forest land and changes in carbon stocks in forests remaining as forests

Appendix 3

Year 5 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 shown in Table 2. This archive is dynamic and will be continually added to over time.

Table 1: Image Catalogue Naming Conventions

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)
Acquisition Month	The month of 2014 when image was taken
Mapping Stream	The mapping stream that the imagery is for.
Data Provider	The name of the data provider.
Satellite Instrument	The satellite or instrument of origin

Table 2: Summaryof 2014 Satellite Images

Stack Name	Acquisition Month	Mapping Stream	Satellite/Instrument	Data Provider	Resolution (m)
2040328_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2040328_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2040328_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2040428_2014-09-02_RE3_3A_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2040428_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2040428_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2040428_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2041128_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2041228_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041228_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2041328_2014-08-24_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2041328_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041328_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2041425_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041425_2014-09-08_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041425_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041425_2014-11-30_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2041426_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041426_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2041427_2014-09-27_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041427_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2041428_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2041428_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041428_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041428_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2041524_2014-09-08_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041524_2014-09-12_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041524_2014-09-20_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041525_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041525_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041525_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041525_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5

2041526_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041526_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041526_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2041527_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041527_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041527_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2041528_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041528_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041528_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2041623_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
2041623_2014-09-12_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041623_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2041623_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2041624_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2041624_2014-09-12_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041624_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041624_2014-10-13_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2041625_2014-08-08_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2041625_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2041625_2014-09-06_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041625_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041626_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041626_2014-09-20_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041626_2014-09-25_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041627_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041627_2014-09-20_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041627_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2041628_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041628_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041628_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2041628_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2041722_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
2041722_2014-10-09_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2041722_2014-10-19_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2041723_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
2041723_2014-09-12_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041723_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041723_2014-10-09_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2041724_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2041724_2014-09-12_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041724_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2041724_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2041725_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2041725_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041726_2014-08-24_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2041726_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041726_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041726_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2041727_2014-08-24_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2041727_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5

2041727_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2041727_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2041728_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
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2041822_2014-08-16_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
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2041822_2014-09-30_RE2_3A_298741.tif	September	Year 5	RapidEye 2	RapidEye	5
2041822_2014-10-09_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
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2041823_2014-09-30_RE2_3A_298741.tif	September	Year 5	RapidEye 2	RapidEye	5
2041823_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
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2041826_2014-09-20_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2041826_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2041827_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041827_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2041827_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
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2041922_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
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2041923_2014-10-19_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
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2041925_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2041925_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
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2041926_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041926_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2041926_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2041927_2014-08-30_RE5_3A_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2041927_2014-09-27_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2041927_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2041928_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
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2042024_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
2042024_2014-09-09_RE5_3A_299596.tif	September	Year 5	RapidEye 5	RapidEye	5
2042024_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042024_2014-10-15_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042025_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2042025_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042025_2014-10-15_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042026_2014-09-01_RE2_3A_298739.tif	September	Year 5	RapidEye 2	RapidEye	5
2042026_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042026_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042027_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042027_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2042027_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042028_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042028_2014-08-24_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
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2042123_2014-09-09_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2042124_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
2042124_2014-10-09_RE1_3A_299596.tif	October	Year 5	RapidEye 1	RapidEye	5
2042124_2014-10-19_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2042125_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042125_2014-10-15_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042125_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2042126_2014-09-01_RE2_3A_299596.tif	September	Year 5	RapidEye 2	RapidEye	5
2042126_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042127_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042127_2014-11-04_RE4_3A_299596.tif	November	Year 5	RapidEye 4	RapidEye	5
2042128_2014-09-27_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
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2042224_2014-08-28_RE2_3A_298739.tif	August	Year 5	RapidEye 2	RapidEye	5
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2042225_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042225_2014-10-15_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042226_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042226_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042227_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042227_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042227_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042228_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042228_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2042228_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042326_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5

2042326_2014-10-15_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042326_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2042327_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042327_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042327_2014-11-04_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2042328_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042328_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042425_2014-08-03_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2042425_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042426_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042426_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042427_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042427_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042428_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042428_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042428_2014-11-04_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2042525_2014-08-03_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2042526_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042526_2014-10-04_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042527_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042527_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042527_2014-11-04_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2042528_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042528_2014-09-27_RE4_3A_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2042528_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042528_2014-11-04_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2042625_2014-08-03_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2042625_2014-10-13_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2042626_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042626_2014-11-23_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2042627_2014-11-04_RE4_3A_298879.tif	November	Year 5	RapidEye 4	RapidEye	5
2042627_2014-11-08_RE3_3A_299596.tif	November	Year 5	RapidEye 3	RapidEye	5
2042628_2014-08-02_RE5_3A_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2042628_2014-09-26_RE3_3A_298879.tif	September	Year 5	RapidEye 3	RapidEye	5
2042628_2014-09-27_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2042628_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2042726_2014-08-03_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2042726_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2042727_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042727_2014-11-08_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2042728_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042728_2014-10-20_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2042828_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2042828_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2043028_2014-09-26_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2043028_2014-10-20_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2139605_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139605_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139606_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139607_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5

2139608_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139703_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139704_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139704_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139705_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139705_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139706_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139707_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139708_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139709_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139710_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2139710_2014-09-04_RE1_3A_298739.tif	September	Year 5	RapidEye 1	RapidEye	5
2139710_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139802_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139802_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139802_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2139803_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139803_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2139804_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139804_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139804_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139805_2014-08-20_RE5_3A_299596.tif	August	Year 5	RapidEye 5	RapidEye	5
2139805_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139805_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2139806_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139806_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139807_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139807_2014-10-02_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139808_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139808_2014-10-02_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139809_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139809_2014-09-04_RE1_3A_298739.tif	September	Year 5	RapidEye 1	RapidEye	5
2139809_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139809_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2139810_2014-09-04_RE1_3A_298739.tif	September	Year 5	RapidEye 1	RapidEye	5
2139810_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139810_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139811_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2139811_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139812_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139902_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139902_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2139902_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139902_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2139903_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2139903_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2139903_2014-09-16_RE3_3A_299596.tif	September	Year 5	RapidEye 3	RapidEye	5
2139903_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139904_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2139904_2014-09-16_RE3_3A_299596.tif	September	Year 5	RapidEye 3	RapidEye	5

2139904_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2139905_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2139905_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139905_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2139906_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139906_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2139906_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139907_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139907_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139907_2014-10-02_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2139907_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2139908_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139908_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139909_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2139909_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2139910_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2139910_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2139911_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2139911_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2139912_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2139912_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139913_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2139913_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2139913_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2139914_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2139914_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139915_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2139915_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2139915_2014-09-25_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2139915_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139916_2014-09-03_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2139916_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139917_2014-09-03_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2139917_2014-09-07_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2139917_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2139917_2014-12-16_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140002_2014-09-16_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140002_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2140002_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140003_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140003_2014-09-16_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140003_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140003_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140004_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140004_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140005_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140005_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140005_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140006_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140006_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5

2140006_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140006_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140007_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140007_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140008_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140008_2014-09-26_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2140009_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140009_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140010_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140010_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140011_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140011_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140012_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140012_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140012_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140013_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140013_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140014_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140014_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140014_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140015_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140015_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140015_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140016_2014-09-03_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140016_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140016_2014-09-07_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2140016_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140017_2014-09-03_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140017_2014-09-07_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2140017_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140017_2014-12-16_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140101_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140101_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140101_2014-12-02_RE4_3A_298743.tif	December	Year 5	RapidEye 4	RapidEye	5
2140101_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140102_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2140102_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140102_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140102_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2140103_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140103_2014-09-16_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140103_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140104_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140104_2014-09-16_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140104_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140105_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140105_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140106_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140106_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140106_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5

2140107_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140107_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140108_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140108_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140109_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140109_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140109_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140110_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140110_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140111_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140111_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140112_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140112_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140112_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140113_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140113_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140114_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140114_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140115_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140115_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140115_2014-09-07_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2140115_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140201_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140201_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140201_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140202_2014-09-16_RE3_3A_299596.tif	September	Year 5	RapidEye 3	RapidEye	5
2140202_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140202_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140202_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2140203_2014-09-16_RE3_3A_299596.tif	September	Year 5	RapidEye 3	RapidEye	5
2140203_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2140203_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140203_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140204_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140204_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140205_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140205_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140205_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140206_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140206_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140206_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140207_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140207_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140207_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140208_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140208_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140208_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140209_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140209_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140209_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5

2140210_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140210_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140210_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140211_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140211_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140211_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140212_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140212_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140212_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140213_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140213_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140214_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140214_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140214_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140214_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140215_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140215_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140215_2014-10-29_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140301_2014-10-08_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2140301_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140301_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140301_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140302_2014-10-08_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2140302_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140302_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140303_2014-08-28_RE3_3A_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2140303_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2140303_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140303_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140304_2014-08-28_RE3_3A_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2140304_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140304_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140304_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2140305_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140305_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140305_2014-10-31_RE5_3A_299596.tif	October	Year 5	RapidEye 5	RapidEye	5
2140306_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140306_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140307_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140307_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140307_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140307_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140308_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140308_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140309_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140309_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140309_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140310_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140310_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140310_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5

2140311_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140311_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140311_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140312_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140312_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140312_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140313_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140313_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140313_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140314_2014-09-05_RE2_3A_298740.tif	September	Year 5	RapidEye 2	RapidEye	5
2140314_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140314_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140401_2014-09-02_RE3_3A_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2140401_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140401_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140401_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140402_2014-08-09_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2140402_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140402_2014-12-01_RE3_3A_298743.tif	December	Year 5	RapidEye 3	RapidEye	5
2140402_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2140403_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140403_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2140403_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140403_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2140404_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140404_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140404_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140405_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140405_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140405_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140406_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140407_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140407_2014-09-04_RE5_3A_298790.tif	September	Year 5	RapidEye 5	RapidEye	5
2140407_2014-10-06_RE4_3A_298790.tif	October	Year 5	RapidEye 4	RapidEye	5
2140407_2014-10-07_RE5_3A_298790.tif	October	Year 5	RapidEye 5	RapidEye	5
2140408_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140409_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140409_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140410_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140410_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140410_2014-11-10_RE1_3A_298879.tif	November	Year 5	RapidEye 1	RapidEye	5
2140411_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140411_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140412_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140412_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140413_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140413_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140414_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140414_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140501_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5

2140501_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140501_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140502_2014-08-09_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2140502_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140502_2014-12-01_RE3_3A_298743.tif	December	Year 5	RapidEye 3	RapidEye	5
2140502_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140503_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140503_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140503_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140504_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140504_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140505_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140505_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140506_2014-08-13_RE2_3A_298790.tif	August	Year 5	RapidEye 2	RapidEye	5
2140506_2014-09-04_RE5_3A_299596.tif	September	Year 5	RapidEye 5	RapidEye	5
2140506_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140506_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140506_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140507_2014-08-13_RE2_3A_298790.tif	August	Year 5	RapidEye 2	RapidEye	5
2140507_2014-08-29_RE4_3A_298790.tif	August	Year 5	RapidEye 4	RapidEye	5
2140507_2014-09-04_RE5_3A_299596.tif	September	Year 5	RapidEye 5	RapidEye	5
2140507_2014-10-06_RE4_3A_298790.tif	October	Year 5	RapidEye 4	RapidEye	5
2140507_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140508_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140508_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140509_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140510_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140510_2014-08-29_RE4_3A_298790.tif	August	Year 5	RapidEye 4	RapidEye	5
2140510_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140511_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140511_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140511_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140512_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140513_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140513_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140514_2014-09-06_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140514_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140601_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140601_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140601_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140602_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140602_2014-11-12_RE3_3A_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2140602_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140602_2014-12-01_RE3_3A_298743.tif	December	Year 5	RapidEye 3	RapidEye	5
2140603_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140603_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140604_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140604_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140604_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140604_2014-10-31_RE5_3A_298743.tif	October	Year 5	RapidEye 5	RapidEye	5

2140605_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140605_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140606_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140606_2014-10-31_RE5_3A_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2140607_2014-08-13_RE2_3A_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2140607_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140607_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140608_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140608_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140608_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140609_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140609_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140609_2014-11-10_RE1_3A_299596.tif	November	Year 5	RapidEye 1	RapidEye	5
2140610_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140610_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140610_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140611_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140611_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140612_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140612_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140612_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140613_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140613_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140613_2014-11-08_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2140701_2014-09-02_RE3_3A_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2140701_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140701_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140702_2014-08-09_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2140702_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140702_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140702_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140703_2014-08-27_RE2_3A_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2140703_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140703_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140704_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140704_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140705_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140705_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140705_2014-12-04_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2140706_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140706_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140706_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140707_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140707_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140707_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140708_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140708_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140708_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140709_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140709_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5

2140710_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140710_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140710_2014-11-10_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2140711_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140711_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140711_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140802_2014-08-27_RE2_3A_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2140802_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140802_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140803_2014-08-09_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2140803_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140803_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140804_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140804_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140804_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140805_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140805_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140805_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140806_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140806_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140807_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2140807_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140807_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140808_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140808_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140808_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140809_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140809_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2140810_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140810_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140810_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2140811_2014-08-07_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2140811_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140811_2014-10-28_RE2_3A_298742.tif	October	Year 5	RapidEye 2	RapidEye	5
2140902_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2140902_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2140902_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140902_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2140903_2014-08-09_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2140903_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140903_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140904_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140904_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2140904_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2140904_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2140905_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140905_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140905_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140906_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2140906_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5

2140906_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2140907_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2140907_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140907_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2140908_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140908_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140908_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2140909_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140909_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140909_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2140910_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2140910_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2140910_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141002_2014-10-12_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141002_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2141002_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141003_2014-10-08_RE1_3A_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2141003_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2141003_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2141004_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141004_2014-10-30_RE4_3A_298742.tif	October	Year 5	RapidEye 4	RapidEye	5
2141004_2014-11-16_RE2_3A_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141005_2014-08-28_RE3_3A_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141005_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141005_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141006_2014-09-04_RE5_3A_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2141006_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141006_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2141007_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141007_2014-10-31_RE5_3A_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141007_2014-12-19_RE2_3A_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2141008_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141008_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141009_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2141009_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141009_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141010_2014-08-12_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141010_2014-08-29_RE4_3A_298739.tif	August	Year 5	RapidEye 4	RapidEye	5
2141010_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141010_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141101_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141101_2014-11-09_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141101_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141102_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141102_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141102_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141102_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141103_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141103_2014-10-14_RE2_3A_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2141103_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5

2141103_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141104_2014-10-05_RE3_3A_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141104_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141105_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141105_2014-10-31_RE5_3A_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141105_2014-12-03_RE5_3A_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141106_2014-08-28_RE3_3A_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141106_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141106_2014-10-31_RE5_3A_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141107_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141107_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141107_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141108_2014-09-04_RE5_3A_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141108_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141108_2014-10-29_RE3_3A_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141109_2014-08-12_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141109_2014-10-07_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141109_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141110_2014-08-12_RE1_3A_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141110_2014-10-06_RE4_3A_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141110_2014-12-18_RE1_3A_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141201_2014-09-22_RE4_3A_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141201_2014-10-12_RE5_3A_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141201_2014-11-09_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141201_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141202_2014-09-21_RE3_3A_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141202_2014-11-01_RE1_3A_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141202_2014-11-09_RE4_3A_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141202_2014-12-02_RE4_3A_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141203_2014-10-14_re2_3a_298741.tif	October	Year 5	RapidEye 2	RapidEye	5
2141203_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141203_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141203_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141204_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141204_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141204_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141205_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141205_2014-10-05_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141205_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141205_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141206_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141206_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141206_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141207_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141207_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141207_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141208_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141208_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141208_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141209_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5

2141209_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141209_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141210_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141210_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141210_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141210_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141211_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141211_2014-09-04_re1_3a_298740.tif	September	Year 5	RapidEye 1	RapidEye	5
2141211_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141211_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141301_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141301_2014-09-22_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141301_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141301_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141302_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141302_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141302_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141302_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141303_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141303_2014-10-12_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141303_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141303_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141304_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141304_2014-10-05_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141304_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141305_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141305_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141305_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141305_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141306_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141306_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141306_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141307_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141307_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141307_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141308_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141308_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141308_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141309_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141309_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141309_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141309_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141310_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141310_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141310_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141310_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141311_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141311_2014-09-04_re1_3a_298740.tif	September	Year 5	RapidEye 1	RapidEye	5
2141311_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141312_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5

2141312_2014-09-04_re1_3a_298740.tif	September	Year 5	RapidEye 1	RapidEye	5
2141312_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141401_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141401_2014-09-22_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141401_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141401_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141402_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2141402_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141402_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141402_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141403_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141403_2014-11-12_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2141403_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141403_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141404_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141404_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141404_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141404_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141405_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141405_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141405_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141405_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141406_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141406_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141406_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141407_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141407_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141407_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141408_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141408_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141408_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141408_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141409_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141409_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141409_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141409_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
2141410_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141410_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141410_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
2141410_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141411_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141411_2014-09-04_re1_3a_299596.tif	September	Year 5	RapidEye 1	RapidEye	5
2141411_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141412_2014-08-07_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141412_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141412_2014-09-04_re1_3a_299596.tif	September	Year 5	RapidEye 1	RapidEye	5
2141412_2014-10-11_re5_3a_298790.tif	October	Year 5	RapidEye 5	RapidEye	5
2141412_2014-12-18_re1_3a_298790.tif	December	Year 5	RapidEye 1	RapidEye	5
2141413_2014-08-07_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141413_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5

2141414_2014-09-04_re1_3a_299596.tif	September	Year 5	RapidEye 1	RapidEye	5
2141414_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141414_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141501_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141501_2014-09-22_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141501_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141501_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141502_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2141502_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141502_2014-11-16_re2_3a_299596.tif	November	Year 5	RapidEye 2	RapidEye	5
2141502_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141503_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141503_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141503_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141504_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141504_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141504_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141505_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141505_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141505_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141506_2014-08-09_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141506_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141506_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141506_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2141507_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141507_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2141507_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141508_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141508_2014-09-04_re5_3a_298739.tif	September	Year 5	RapidEye 5	RapidEye	5
2141508_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141509_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141509_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141509_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141510_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141510_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141510_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141510_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
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2141511_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
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2141513_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141513_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
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2141514_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141514_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5

2141601_2014-08-30_re5_3a_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2141601_2014-09-22_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141601_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
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2141602_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141602_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141603_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2141603_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141603_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141603_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141604_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
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2141604_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141604_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141605_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
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2141605_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2141605_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
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2141606_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
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2141607_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141607_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141608_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141608_2014-09-04_re5_3a_298740.tif	September	Year 5	RapidEye 5	RapidEye	5
2141608_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141609_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141609_2014-10-07_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
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2141614_2014-08-17_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
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2141702_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141703_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
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2141703_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141704_2014-08-09_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
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2141704_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
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2141706_2014-10-08_re1_3a_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2141706_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
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2141709_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
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2141710_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141710_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
2141710_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141711_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141711_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
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2141714_2014-08-07_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
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2141801_2014-09-22_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5

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2141804_2014-11-12_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2141804_2014-12-02_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141805_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
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2141805_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141805_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
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2141806_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2141807_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141807_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141807_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141808_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141808_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141808_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2141809_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141809_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
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2141809_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
2141810_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141810_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141810_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
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2141811_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141811_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141811_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
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2141813_2014-12-23_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141813_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141814_2014-08-17_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141814_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141814_2014-12-23_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141814_2014-12-26_re4_3a_298744.tif	December	Year 5	RapidEye 4	RapidEye	5
2141901_2014-08-02_re5_3a_298738.tif	August	Year 5	RapidEye 5	RapidEye	5

2141901_2014-08-30_re5_3a_298739.tif	August	Year 5	RapidEye 5	RapidEye	5
2141901_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2141901_2014-12-16_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2141902_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2141902_2014-08-02_re5_3a_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2141902_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2141902_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141903_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2141903_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141903_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2141904_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2141904_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141904_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141905_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141905_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141905_2014-11-12_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2141905_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2141906_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2141906_2014-10-08_re1_3a_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2141906_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
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2141907_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141907_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141907_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
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2141908_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141908_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141908_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2141909_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141909_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2141909_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141910_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2141910_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141910_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141911_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141911_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2141911_2014-11-09_re5_3a_298743.tif	November	Year 5	RapidEye 5	RapidEye	5
2141911_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141912_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141912_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2141912_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141913_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2141913_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141913_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2141913_2014-12-23_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2141914_2014-10-11_re5_3a_298741.tif	October	Year 5	RapidEye 5	RapidEye	5
2141914_2014-12-23_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2142001_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142001_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142001_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5

2142002_2014-08-02_re5_3a_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2142002_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142002_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142003_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142003_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2142003_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142004_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
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2142004_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2142005_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142005_2014-10-08_re1_3a_298741.tif	October	Year 5	RapidEye 1	RapidEye	5
2142005_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142006_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142006_2014-11-01_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2142006_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142007_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142007_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2142007_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142008_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142008_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2142008_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142009_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142009_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142009_2014-10-31_re5_3a_298743.tif	October	Year 5	RapidEye 5	RapidEye	5
2142009_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142010_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142010_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2142010_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142011_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2142011_2014-11-09_re5_3a_299596.tif	November	Year 5	RapidEye 5	RapidEye	5
2142011_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2142012_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2142012_2014-11-10_re1_3a_298743.tif	November	Year 5	RapidEye 1	RapidEye	5
2142012_2014-12-18_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2142013_2014-10-06_re4_3a_298741.tif	October	Year 5	RapidEye 4	RapidEye	5
2142101_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142101_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142101_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142101_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142102_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142102_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142102_2014-11-22_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2142103_2014-08-01_re4_3a_299596.tif	August	Year 5	RapidEye 4	RapidEye	5
2142103_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142103_2014-11-09_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142104_2014-08-01_re4_3a_299596.tif	August	Year 5	RapidEye 4	RapidEye	5
2142104_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142104_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142104_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2142105_2014-10-08_re1_3a_298741.tif	October	Year 5	RapidEye 1	RapidEye	5

2142105_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142105_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2142106_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142106_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142106_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142107_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142107_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142108_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142108_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142108_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142109_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142109_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142109_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142109_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142110_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142110_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142110_2014-12-04_re1_3a_298744.tif	December	Year 5	RapidEye 1	RapidEye	5
2142111_2014-08-12_re1_3a_298738.tif	August	Year 5	RapidEye 1	RapidEye	5
2142111_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142201_2014-08-02_re5_3a_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2142201_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142201_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142202_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142202_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142202_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142202_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142203_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142203_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142203_2014-11-22_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2142204_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142204_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142204_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142205_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142205_2014-12-03_re5_3a_298744.tif	December	Year 5	RapidEye 5	RapidEye	5
2142205_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142206_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142206_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142206_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142206_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142207_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142207_2014-11-12_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2142207_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142208_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2142208_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142208_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142209_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2142209_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142209_2014-12-19_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142210_2014-08-13_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142210_2014-10-21_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5

2142210_2014-10-29_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142301_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142301_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142301_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142302_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142302_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142302_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142302_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142303_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142303_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142303_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142304_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142304_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142304_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142305_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142305_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142305_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142305_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142306_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142306_2014-11-12_re3_3a_298743.tif	November	Year 5	RapidEye 3	RapidEye	5
2142306_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142306_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142307_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142307_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142307_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142308_2014-08-28_re3_3a_299596.tif	August	Year 5	RapidEye 3	RapidEye	5
2142308_2014-10-31_re5_3a_298790.tif	October	Year 5	RapidEye 5	RapidEye	5
2142308_2014-12-05_re2_3a_298790.tif	December	Year 5	RapidEye 2	RapidEye	5
2142401_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2142401_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142401_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142401_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142402_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2142402_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142402_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
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2142403_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142403_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142404_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142404_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142404_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142405_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142405_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142405_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142405_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142406_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142406_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142406_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142407_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142407_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5

2142407_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142408_2014-08-28_re3_3a_298738.tif	August	Year 5	RapidEye 3	RapidEye	5
2142501_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142501_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142501_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142502_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142502_2014-10-20_re3_3a_298742.tif	October	Year 5	RapidEye 3	RapidEye	5
2142502_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142503_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142503_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142503_2014-09-27_re4_3a_298741.tif	September	Year 5	RapidEye 4	RapidEye	5
2142504_2014-08-01_re4_3a_298738.tif	August	Year 5	RapidEye 4	RapidEye	5
2142504_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142504_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142505_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142505_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142505_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142506_2014-08-27_re2_3a_298738.tif	August	Year 5	RapidEye 2	RapidEye	5
2142506_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142506_2014-12-11_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142507_2014-08-28_re3_3a_298739.tif	August	Year 5	RapidEye 3	RapidEye	5
2142507_2014-11-16_re2_3a_298743.tif	November	Year 5	RapidEye 2	RapidEye	5
2142507_2014-12-05_re2_3a_298744.tif	December	Year 5	RapidEye 2	RapidEye	5
2142508_2014-10-31_re5_3a_298742.tif	October	Year 5	RapidEye 5	RapidEye	5
2142601_2014-08-02_re5_3a_298738.tif	August	Year 5	RapidEye 5	RapidEye	5
2142601_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2142601_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142601_2014-11-04_re4_3a_298743.tif	November	Year 5	RapidEye 4	RapidEye	5
2142602_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
2142602_2014-10-20_re3_3a_298741.tif	October	Year 5	RapidEye 3	RapidEye	5
2142602_2014-12-25_re3_3a_298744.tif	December	Year 5	RapidEye 3	RapidEye	5
2142603_2014-09-02_re3_3a_298739.tif	September	Year 5	RapidEye 3	RapidEye	5
2142603_2014-09-21_re3_3a_298740.tif	September	Year 5	RapidEye 3	RapidEye	5
2142603_2014-09-27_re4_3a_298740.tif	September	Year 5	RapidEye 4	RapidEye	5
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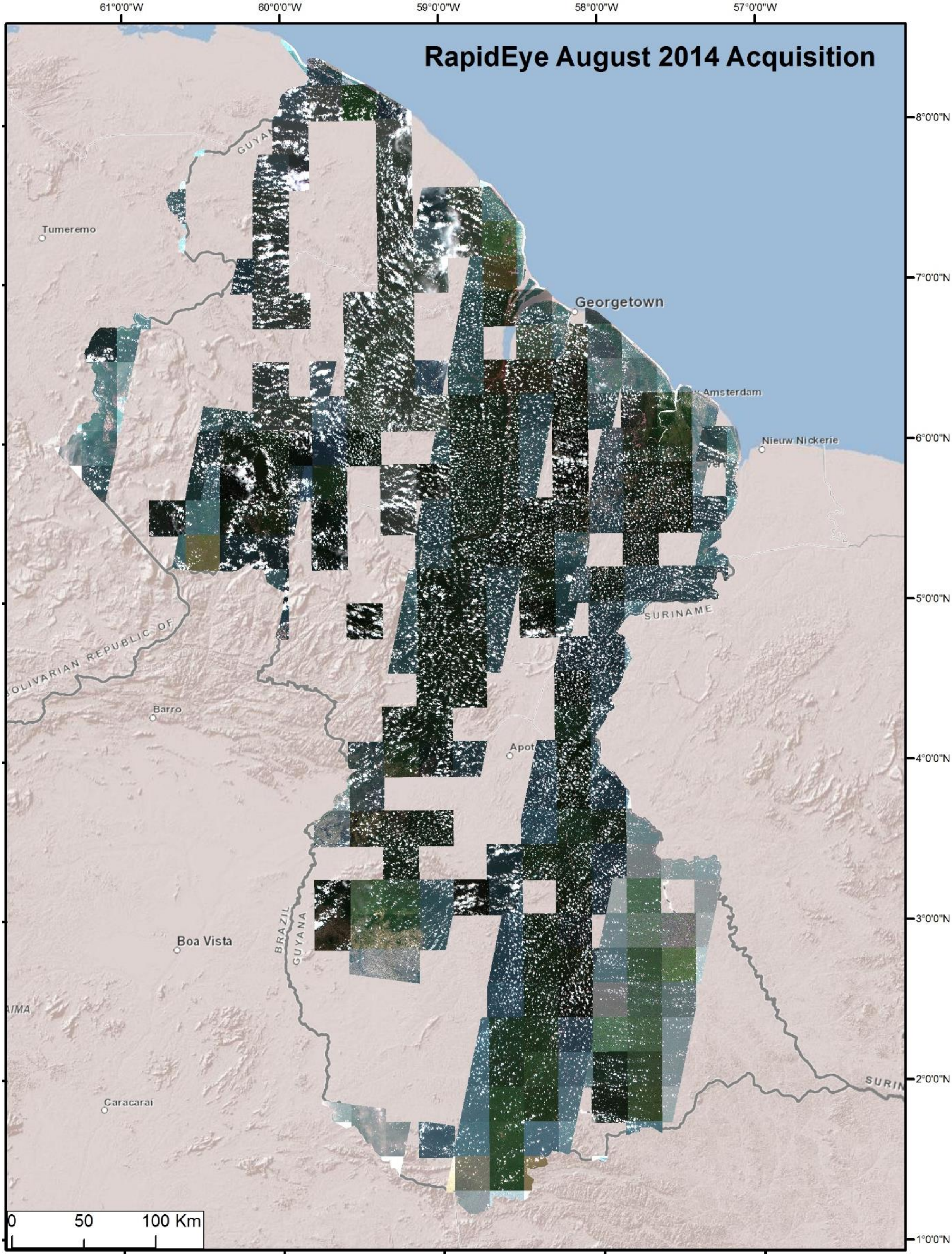
Appendix 4

Monthly RapidEye Acquisitions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5°0'0"N
4°0'0"N
3°0'0"N
2°0'0"N
1°0'0"N
Tumeremo
Georgetown
Amsterdam
Nieuw Nickerie
SURINAME
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Boa Vista
BRAZIL
GUYANA
Caracarai
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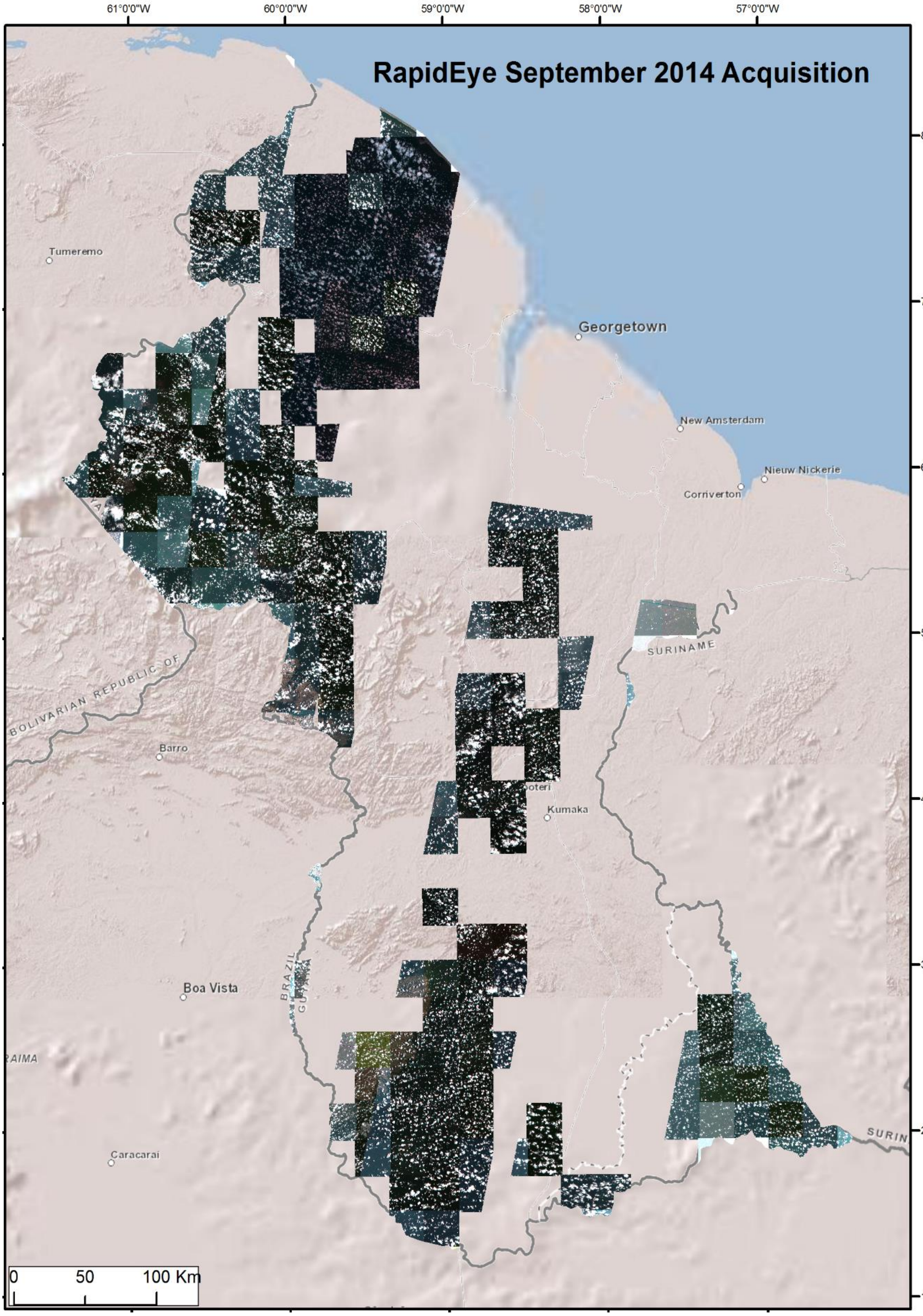
100 Km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1°0'0"N
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Georgetown
New Amsterdam
Nieuw Nickerie
Corriverton
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GUYANA
Caracarai
0
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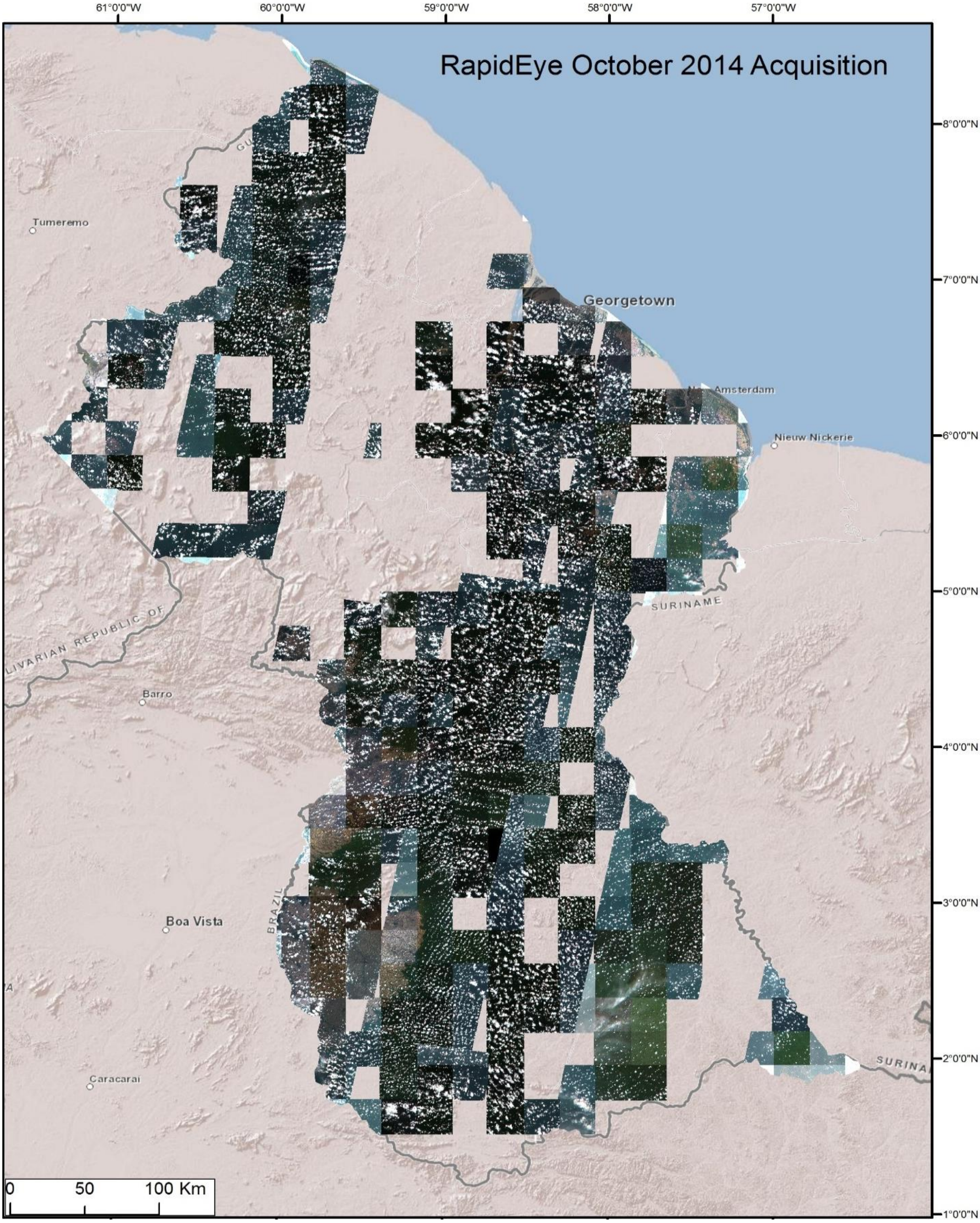
100 Km



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Tumeremo
Georgetown
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BRAZIL
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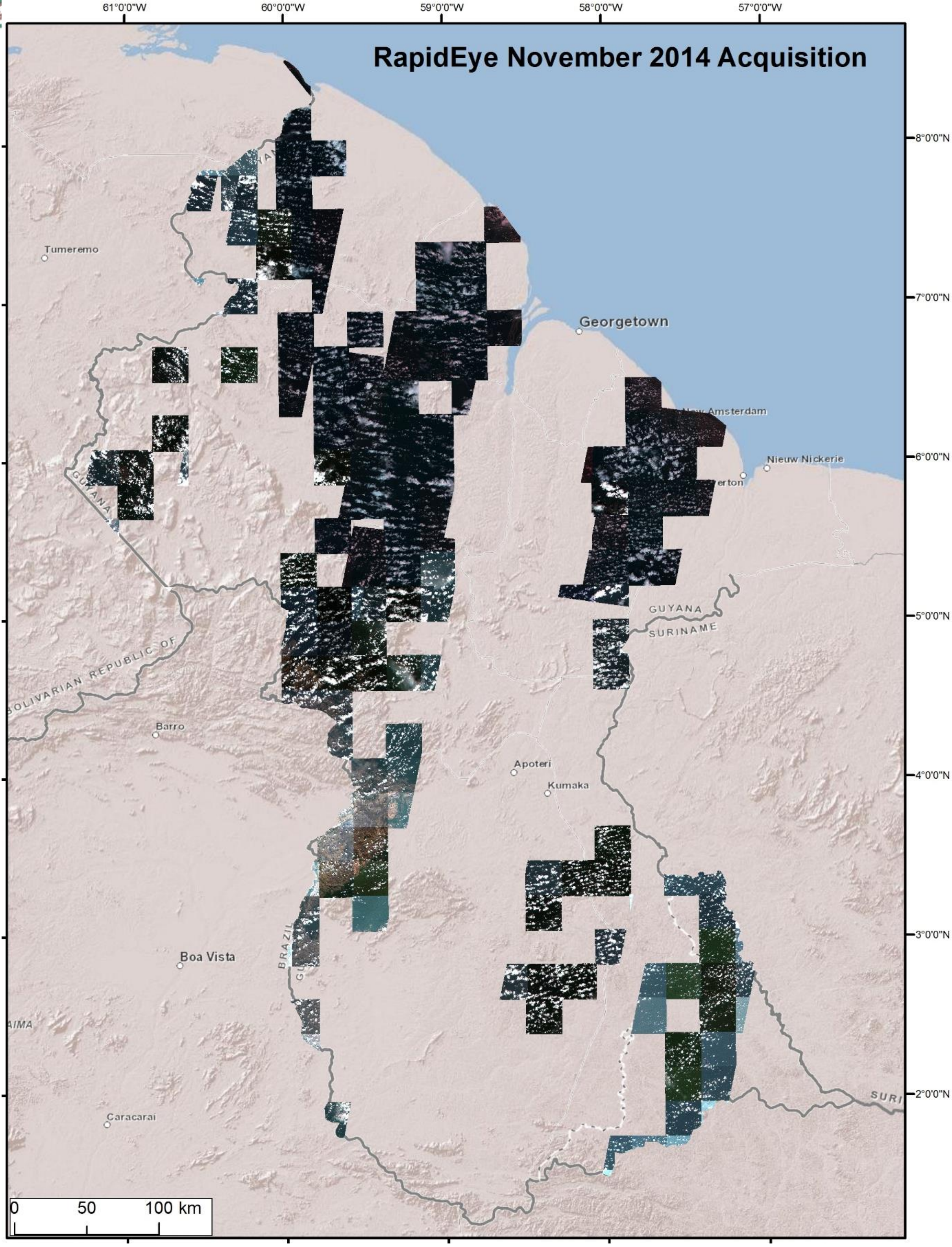
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2°0'0"N
Tumeremo
Georgetown
New Amsterdam
Nieuw Nickerie
GUYANA
SURINAME
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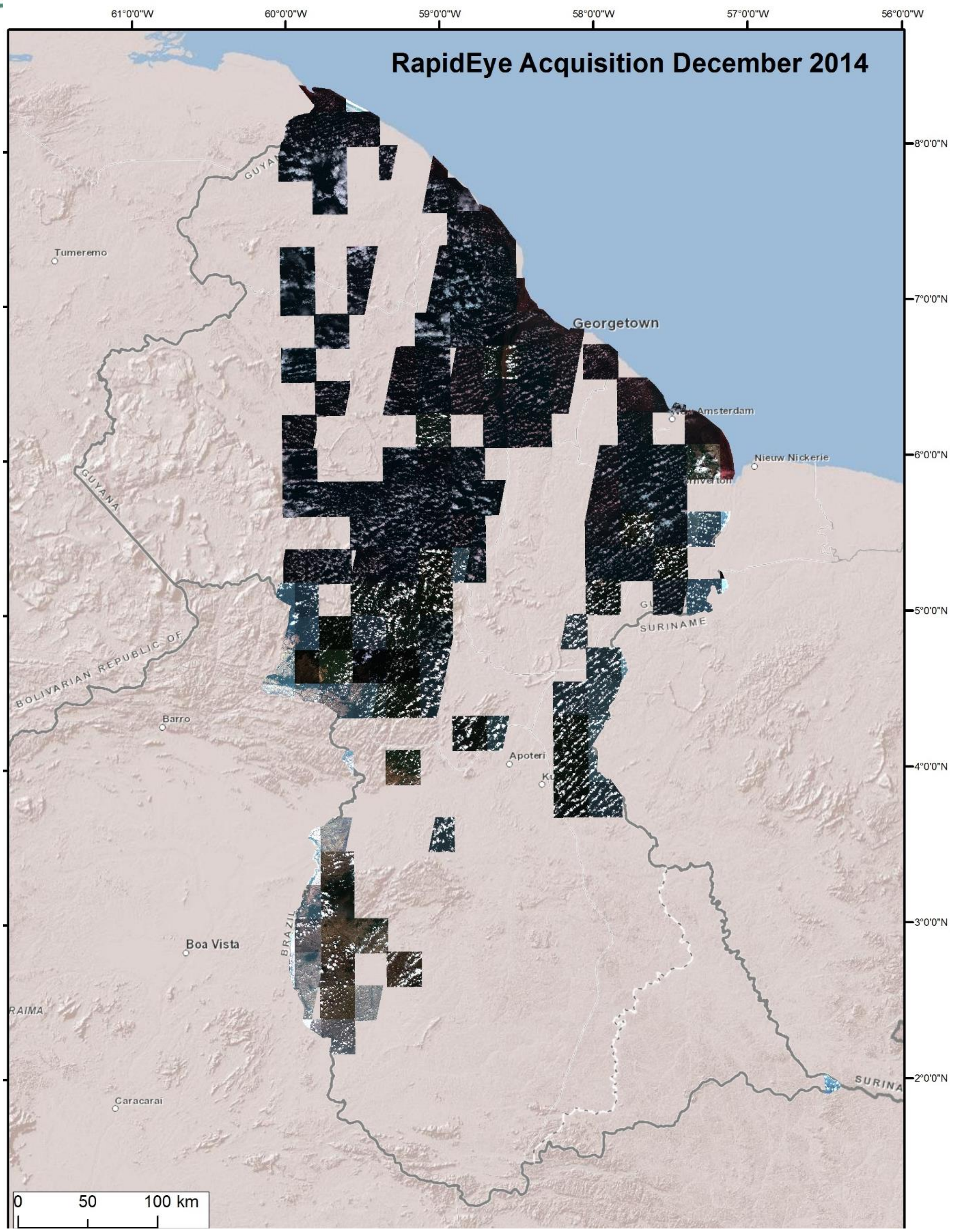
Kumaka
Boa Vista
BRAZIL
Caracarai
0
50
100 km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6°0'0"N
5°0'0"N
4°0'0"N
3°0'0"N
2°0'0"N
Tumeremo
Georgetown
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SURINAME
BOLIVARIAN REPUBLIC OF
GUYANA
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Boa Vista
BRAZIL
Caracarai
0 50 100 km

Appendix 5

Land Use Class Description

IPCC Land Use Categories

The following land use classes will be used as the MRVS is developed. These are briefly introduced below and currently are based on the default categories as defined by IPCC guidelines.

1. **Forest land**

- This category includes all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, sub-divided into managed and unmanaged, and also by ecosystem type as specified in the *IPCC Guidelines*3. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
- During the MRVS development a stratification map will be produced. This builds on existing work undertaken at GFC in 2001 by consolidating the existing forest strata into six classes (see below).

2. **Grassland**

- This category includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used for the forest land category that are not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, subdivided into managed and unmanaged consistent with national definitions.

3. **Cropland**

- This category includes arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forest land category, consistent with the selection of national definitions

4. **Wetland**

- This category includes land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, cropland, grassland or settlements categories. The category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

5. **Settlements**

- This category includes 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 the selection of national definitions

6. **Other land**

- This category includes bare soil, rock, ice, and all unmanaged 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 following table provides an overview of the preliminary land use classification for Guyana.

Guyana Land Use Classes

Land Use	Land Use Type	2001 Classes	Map Classes
Forest Land	Mixed forest	1 to 1.4 & 1.8	Class 1
	Wallaba/Dakama/Muri Shrub Forest	2 to 2.6	Class 2
	Swamp/Marsh forest	3.1 to 3.3	Class 3
	Mangrove	4.1	Class 4

	Savannah >30% cover	5, 6	Class 5
	Montane & steep forest	1.5 -1.7[28], 7.1, 7.2. 8.1	Class 6
	Plantations	Locations in GFC's GIS	Area insignificant
Grassland	Savannah <30% cover	Grouped as non-forest	Class 15
	Grassland		
Cropland	Cropland		Class 17
	Shifting Agriculture		Class 22
Wetland	Wetland open water		Classes 18 and 19
	Herbaceous wetland		
Settlements	Settlements		Class 20
Other land	Other land		Class 18 and 30

Forest Type Mapping by GFC

- In 2001 a series of detailed forest vegetation maps was produced for the entire State Forest Area. These combine various existing vegetation maps with new interpretations of aerial photographs and satellite radar imagery (JERS-1), coupled with analysis of field data collected during the Commission's forest inventories. The resulting maps are to be made available to forest concession holders to assist with their forest management planning activities.
- Secondly, a less detailed map has been produced for the entire country, based mainly on national soil survey data made available by the National Agricultural Research Institute (NARI). This map will be available to all of the Commission's stakeholders.
- To complete this work GFC's Forest Resource Information Unit drew on the skills and experience of former Tropenbos Program Manager, Dr Hans ter Steege. Dr ter Steege has extensive knowledge of Guyana's diverse forest vegetation types and specialist skills in digital cartography.

National Vegetation Map of Guyana

- Produced for the Guyana Forestry Commission and Dr Hans ter Steege, University of Utrecht, Netherlands, in collaboration with the GFC Forest Resources Information Unit 2001.

Methods

- The following provides a summary of the process used to create these maps.
- The National Vegetation Map is based on the GINRIS soil map (1:1 000 000) which was kindly provided for this purpose by the NRMP. Although problems were encountered with the accuracy of the National Map, it was felt that at the 1:1 000 000 scale they were of less importance and that using the GINRIS basemap would ensure compatibility among National Theme Maps.
- In making the National Map, use was made of the usually strong correspondence between major forest and soil types, realizing that the soil map is in fact an interpretation of vegetation cover. Based on the strong correspondence a first forest type was assigned to each of the soil classes. Problems then arose in a few areas.

[28] This class (1.7) has also been identified as potentially threatened by fire.

- For instance, white sands are covered by Wallaba forest, Dakama forest, Muri scrub, or grass, and peat soils may have palm swamp, broadleaved swamp forest, or open swamps.
- To improve the interpretation of the forests on white sand first a digital combination of low forest of Vinks NE-Guyana map (Vink 1957) with the white sands of the soil map was created. Low forest on white sand was classified as Dakama. Then a combination of the new 'Vegetation map' was made with the dry and wet savannah themes of Vink. Dry savannah on white sand was classified as Muri scrub/grassland, dry savannah on other soil as (intermediate) savannah, wet savannah on peat was classified as open coastal swamp, on white sand as wet savannah/muri scrub on white sand, the other as open swamp. Because in the two maps that were intersected edges of similar vegetations are not identical, a great number of small 'stray' polygons were created that had to be manually removed.
- For central and North West Guyana, FIDS maps were used to classify the various white sand areas. In a few cases white sand polygons were split into the different types of forest, especially in central Guyana. Large stretches of wet forest exist in south Guyana. These were digitized into the National Map on the basis of the regional FIDS maps. In other cases large forest areas classified as wet forest were reclassified into mixed forest in accordance with FIDS coverage.
- In the southwest savannah cover from the FIDS maps was superimposed. However, the level of detail was much greater than the other parts of the map and it was decided to use the savannah interpretation of Huber et al (1995) for this vegetation type, which is nearly identical. In the Pakaraimas, also the interpretation of Huber et al. (1995) was used for the open non-forest vegetation types. The forests in this area were not classified on the basis of soil but rather on altitude. Submontane forest from 500-1500 m and montane forest above 1500 m. These areas were obtained by intersecting the vegetation map with altitudes obtained from a digital elevation model of Guyana.
- Several draft versions were produced and discussed. At close inspection it became clear that even at the 1:1 000 000 scale there were inconsistencies between the vegetation map and the river base map[29]. However, as the vegetation map appeared to be correct in most instances no further changes were made.
- A descriptive legend of the map was produced based on ter Steege and Zondervan (2000), Fanshawe 1952, Huber et al 1995 and FIDS reports (de Milde and de Groot 1970 a-g) (see below).
- The map was finally produced in three sizes, A4 (letter), A3 (tabloid) and A0 (1:1 000 000). TIFF & JPG versions for the GFC web page were also produced (See The Map in Appendix 4).

Provisional Forest Types

- The following forest types have been grouped into 1 of 6 forest classes. This classification will form the basis of the forest carbon stratification map. This map groups forest types according to their carbon storage potential and identifies those forest areas under threat of degradation or deforestation. The intention is to use the map to assist with the design of the carbon monitoring plot network.

Class 1: Mixed rainforest

The following mixed forest classes have been merged to form a single class

1. **Mixed rainforests on Pleistocene brown sands in central to NW Guyana**

[29] The rivers base layer has subsequently been improved as part of the MRVS implementation

Forests on the brown sands of the Berbice formation are almost invariably characterised by species of *Eschweilera* and *Licania*. Species, which may be locally dominant are *Eschweilera sagotiana, E. decolorans, E. confertiflora, Licania alba, L. majuscula, L. laxiflora, Chlorocardium rodiei, Mora gonggrijpii, Alexa imperatricis, Swartzia schomburgkii, S. leiocalycina, Catostemma commune, Eperua falcata, Pouteria guianensis, P. cladantha, Aspidosperma excelsum* and *Pentaclethra macroloba*. Mono-dominance is common in forests on brown sands in central Guyana and tends to get less in an eastward direction. Towards the east in Guyana and across the border in Suriname the species mix changes slightly and the more common species are *Goupia glabra, Swartzia leiocalycina, Aspidosperma excelsum, Manilkara bidentata, Terminalia amazonica, Parinari campestris, Vochysia surinamensis, Emmotum fagifolium, Humiria balsamifera, Catostemma fragrans, Hymenaea courbaril, Licania densiflora* and *Eperuafalcata.* The latter forest on light brown sands extends south towards the Kanuku mountains, where it grades into semi-evergreen mixed forest of the Rupununi district (1.4).

2. Mixed rainforests of the Northwest District

The dry land forests of the Northwest District of Guyana and eastern Venezuela are characterised by a high abundance of *Eschweilera sagotiana, Alexa imperatricis, Catostemma commune, Licania* spp. and *Protium decandrum*. These species are found abundantly in almost every dry land forest type in this region. Poor mono-dominant stands of *M. gonggrijpii* are found on the (probably) more clayey soils between the Cuyuni and Mazaruni.

3. Mixed rainforest in the Pakaraimas

Dicymbe altsonii (endemic to Guyana) is the main characteristic and one of the most common canopy species in the 'mixed forests' of the lowland eastern Pakaraima Mountains. *Dicymbe* may be absolutely dominant over large areas. Co-dominants are *Eperua falcata, Eschweilera sagotiana, E. potaroensis, Mora gonggrijpii, Alexa imperatricis, Licania laxiflora, Swartzia leiocalycina, Vouacapoua macropetala* and *Chlorocardium rodiei*. *Eschweilera potaroensis,* an endemic of this region, may be co-dominant in forests around the confluence of the Potaro and Essequibo Rivers.

4. Mixed rainforest in south Guyana

Dry (deciduous) forest types fringe the savannahs in south Guyana. Most of the dry forest stands show high presence of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin* and *Anacardium giganteum.* South of the Cuyuwini river to east of the New River the forest is characterised by a high presence of *Geissospermum sericeum*, *Eschweilera* cf. *pedicellata, Lecythis corrugata, Pouteria coriacea* and *Pourouma* spp. Several other taxa, characteristic of late secondary forest, have fairly high presence this region: *Parkia, Ficus, Sclerolobium, Trichilia, Parkia, Parinari* and *Goupia*. *Eperua falcata(rugiginosa?), Pterocarpus* and *Macrolobium acaciifolium* are common in forests along the rivers in this area.

5. Complex of mixed forest and swamp forest in south Guyana

Large stretches of this type occur in SW Guyana between the upper reaches of the Oronoque and New Rivers. The forest is characterised by high occurrence of *Geissospermum, Pterocarpus* and *Eperua*.

Class 2: Wallaba/Dakama/Muri Scrub Forest

These are forests located on excessively drained white sands and include the following classes;

1. Clump wallaba forest

Clump wallaba forest, dominated by *Dicymbe altsonii* and *D. corymbosa* with co-dominance of *Eperua, Catostemma* and *Hyeronima* is found on excessively drained white sand ridges in the Mazaruni basin.

2. Clump wallaba/wallaba forest

In the upper Mazaruni basin *Dicymbe corymbosa* and *Eperua* spp. dominate nearly all forests on white sand. *Chamaecrista* and *Micrandra* are common co-dominants.

3. Wallaba forests (dry evergreen forest)

Dry evergreen forest on bleached white sands (albic Arenosols) occurs from the Pakaraima escarpment, through central Guyana and northern Suriname into a small narrow portion of French Guiana. *Eperuafalcata* and *E. grandiflora* are strongly dominant and may form, alone or together, more than 60% of the canopy individuals. Common other species in the canopy layer are *Catostemma fragrans, C. altsonii, Licania buxifolia, Talisia squarrosa, Formosacousinhood, Eschweilera corrugata, Aspidosperma excelsum, Terminalia Amazonia, Chamaecrista adiantifolia, Chamaecrista apocouita, Swartzia* spp., *Dicymbe altsonii* (west Guyana only), *D. corymbosa* (ibid.), *Manilkara bidentata* (Pomeroon-Waini water divide) and *Pouteria*.

4. Forests on white sands in south Guyana

Very small patches of forests on white sand are found in south Guyana. In SW. Guyana *Eperua* is the most commonly found tree genus.

5. Dakama forest

Forest dominated by *Dimorphandra conjugata* (Dakama forest) is common on the higher parts of waterdivides from central Guyana to western Suriname. This forest type is characterised by very high standing litter crop (up to 800 ton/ha, Cooper 1982) and is very fire prone. Other species, characteristic for Dakama forests, are *Eperua falcata, Talisia squarrosa, Emmotum fagifolium* and *Swartzia bannia*. *Humiria balsamifera* (Muri) co-dominates the degraded Dakama forest and Dakama-Muri scrub with *Dimorphandra*.

6. Muri scrub/white sand savannah

In areas where fires are very regular or in flood-prone areas Dakama forest degrades into Muri-scrub, dominated by *Humiria* balsamifera. Other common species in this scrub are *Swartzia bannia, Clusia fockeana, Licania incana, Bombax flaviflorum, Ocotea schomburgkiana, Trattinickia burserifolia, Ternstroemia punctata* and *Byrsonima crassifolia*.

Class 3: Swamp/Marsh forest

This class combines Swamps, swamp and marsh forests

1. Open swamps

Herbaceaous and grass swamps in brackish and sweet water with *Cyperus, Montrichardia, Commelina,* Paspalum and *Panicum.*

2. Marsh Forest

Mora excelsa forms extensive stands along the rivers on alluvial silt up to the confluence of Rupununi and Rewa rivers. Canopy associates of the *Mora* forest are *Carapa guianensis, Pterocarpus officinalis, Macrolobium bifolium, Eschweilera wachenheimii, E. sagotiana, Clathrotropis brachypetala, C. macrostachya, Eperua falcata, E. rubiginosa, Catostemma commune, C. fragrans, Pentaclethra macroloba, Vatairea guianensis, Symphonia globulifera, Terminalia dichotoma* and *Tabebuia insigni*.

The rivers in the savannah area are bordered by gallery forest, which is inundated during part of the year. Trees species such as *Caryocar microcarpum*, *Macrolobiumacaciifolium*, *Senna latifolia*, *Zygia cataractae* and *Genipa spruceana* occur along all the rivers in S-Guyana. In the open savannah *Mauritia* is a dominating element in the landscape.

3. Coastal swamp forest

In permanently flooded, flat plains in the present coastal zone a low swamp forest is found. Characteristic species are *Symphonia globulifera, Tabebuia insignis/fluviatilis, Pterocarpus officinalis* and *Euterpe oleracea*. Species that can become locally dominant in this forest type in Guyana are *Pentaclethra macroloba, Vatairea guianensis, Pterocarpus officinalis* and *Virola surinamensis*. *Manicaria saccifera* is commonly found as a narrow belt along rivers. More inland the duration of flooding is less pronounced and forest composition is slightly different. Common species here are *Symphonia globulifera, Virola surinamensis, Iryanthera* spp., *Pterocarpus officinalis, Mora excelsa, Pachira aquatica, Manicaria saccifera* and *Euterpe oleracea*.

Class 4: Mangrove forest

1 Mangrove forests

Mangrove forests occur in a narrow belt of a few kilometres wide along the coast and along the banks of the lower reaches of rivers. The mangrove forest along the coast consists mainly of *Avicennia germinans*, with occasional undergrowth of the salt fern, *Acrostichum aureum*. *Rhizophora* occupies the more exposed, soft silts in river mouths and shores. Where the water is distinctively brackish a third mangrove species can be found, *Laguncularia racemosa*. Further inland mangrove species mix with *Euterpe oleracea* palms and such trees as *Pterocarpus officinalis.*

Class 5 Savannah >30% forest cover

This class contains forest with lower volume that still meets the national definition of forest. Those areas that do not have been excluded and are treated as non-forest

1. **Lowland shrub and grass savannah**

   Lowland grass savannahs

   Lowland savannahs, dominated by the grasses *Trachypogon* and *Axonopus* and the shrubs *Curatella* and *Byrsonima* are found mainly in the southern parts where the Pakaraima Mts. border the Rupununi and Rio Branco savannahs and are also scattered throughout the western part of the region. At slightly higher altitude *Echinolaena* and *Bulbostylis* are also typical. Savannahs on white sands have more sedges and also include more genera typical of the alpine meadows.

   Lowland shrub savannah

   Fire-climax savannah vegetation, which contains characteristic species such as: *Curatella americana, Byrsonima crassifolia, Byrsonima coccolobifolia, Antonia ovata, Palicourearigida*, *Tibouchina aspera* and *Amasonia campestris*. The main grasses belong to the genera *Trachypogon, Paspalum, Axonopus* and *Andropogon* and the main sedges to the genera *Rhynchospora* and *Bulbostylis*

   Highland open vegetation types

2. **Xeromorphic scrub**

   Xeromorphic scrub is found throughout the Pakaraimas. *Humiria, Dicymbe, Clusia* and *Dimorphandra* are typical genera of this vegetation type.

3. **Tepui scrub**

   At high altitudes tepui scrub is found - in Guyana only on Mts. Roraima and Ayanganna. Most characteristic genera are *Bonnetia, Schefflera, Clusia,* and *Ilex*.

4. **Upland savannah**

   Uplands savannahs are very similar in composition to lowland savannahs. The upland savannahs on white sands have more sedges and also include more genera typical of the alpine meadows.

5. **Alpine meadows**

   The alpine meadows are also a very rich and distinct formation within the Guyana Highlands. In Guyana it is only found in the upper reaches of the Kamarang R., Mt. Holitipu and Lamotai Mt., both along the lower Kamarang R. Grasses are usually not dominant but are replaced by *Stegolepis*spp.. Other common genera include *Abolboda, Xyris, Orectanthe, Chalepophyllum, Lagenocarpus* and *Brocchinia*.

Class 6: Montane & steep forest

This class groups forests found at higher altitudes and on steep slopes.

1. **Submontane forest of south Guyana**

Submontane forest is found in the Acarai Mts from 600-800 m. The forest is quite similar to the forest in the Kanuku Mts. with *Centrolobium, Cordia, Peltogyne, Vitex, Inga, Protium, Tetragastris, Parkia, Pseudopiptadenia, Spondias* and *Genipa.* Forests on the mountain tops are dominated by Myrtaceae and *Clusia* on Sierra do Acarai.

2. **Rain forest and evergreen forest on steep hills**

Throughout the central and North West Guyana dolerite dykes penetrate through the sediments. These dykes are often covered with lateritic soils that are rocky, gravelly or clayey. There is little quantitative information available on the forest composition on these soils, except for central Guyana. Common trees are *Eschweilera* spp., *Licania* spp., *Swartzia* spp., *Mora gonggrijpii*, *Chlorocardium rodiei*. On lateritic soils in central Guyana a local endemic, *Vouacapoua macropetala*, forms extensive stands with *Eschweilera sagotiana, Licania laxiflora, Sterculia rugosa, Poecilanthe hostmanii* and *Pentaclethra macroloba*. On the rocky phase of laterite, a low shrubby forest is found. Myrtaceae (*Eugenia* spp., *Calycolpes, Marlierea*) and Sapotaceae (*Ecclinusa, Manilkara*) dominate here. Because of the occurrence of steep slopes landslides are not uncommon on laterite ridges. Often liana forest is encountered on such landslides. Pioneers, such as *Cecropia* spp., *Schefflera morototonii, Jacaranda copaia* and *Pentaclethra macroloba* are also abundantly present on such sites in central Guyana.

3. **Forest on steep hills in Pakaraimas**

Not much is known about specific composition of this forest. The composition, though, is quite similar to mixed rain forest (1.3), with *Dicymbe altsonii, Mora gongrijppii* and *M. excelsa*. In the forests along the foothills of the southern Pakaraima Mts., *Cordia/Centrolobium* forest is found (see 1.7).

4. **Forest on steep hills in south Guyana**

Forests along the foothills and middle slopes of the Kanuku Mts. are characterised by *Cordia alliodora, Centrolobium paraense, Apeiba schomburgkii, Acacia polyphylla, Pithecellobium* s.l., *Peltogyne pubescens, Manilkara* spp., *Cassia multijuga* and *Vitex* spp. *Manikara* dominates the higher areas. Low forest/woodland with *Erythroxylum* and *Clusia* are on slopes with bare rock.

The South Rupununi Savannah, in particular, has rock outcrops with a typical ‘rock vegetation’. The species present on the smallest rock plates are: *Cereushexagonus, Melocactus smithii, Cnidoscolus urens, Cyrtopodium glutiniferum* and *Portulacasedifolia*.

5. **Submontane forests of the Pakaraima uplands**

Submontane forests, from 500 – 1500m, are fairly similar in composition to the lowland forests surrounding them, with species from *Dicymbe, Licania, Eschweilera, Mora, Alexa* being common to dominant. On white sands *Dicymbe, Dimorpandra, Eperua* and *Micrandra* are the most characteristic genera. Dry submontane forest is characterised by *Dicymbe jenmanii* (endemic to the Kaieteur region), *Moronobea jenmanii, Humiria balsamifera, Chrysophyllum beardii, Tabebuia* spp., *Anthodiscus obovatus, Saccoglottis, Dimorphandra cuprea* and *Clusia* spp.

6. **Upper montane forests of the Pakaraima highlands**

Upper montane forests (1500-2000m) are only found on the high table mountains, such as Mts. Roraima, Ayanganna and Wokomung. Typical highland genera such as *Bonnetia tepuiensis, Schefflera, Podocarpus, Magnolia* and *Weinmannia* are found here. Low scrubs with Melastomataceae, Rubiaceae, *Ilex* and *Podocarpus steyermarkii* are also expected.

Non-forest Classes

In 2014 the non-forest areas were mapped from high resolution satellite images and further divided into the following IPCC classes.

- Cropland

- Grassland
- Wetland and open water
- Settlements
- Other land

Literature cited and/or used:

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Appendix 6

IPCC Common Reporting Format Tables

In the year 5 report Guyana has again included the reporting of LULUCF activity 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 4 “remaining“ in the same category in year 5
- land use categories/sub-categories in year 4 “converted to“ other land use categories/sub-categories in year 5

The six land use categories used in the IPCC reporting are[30]:

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 subcateries 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 accessibility[31] (Figure 1). Work is still ongoing to determine the appropriate emission factors land use change drivers across the different strata. These include forest degradation and afforestation – as appropriate

The forest stratification used in the Forest Carbon Monitoring System in year 4 was updated in year 5.

For the year 5 IPCC tables, the forest stratification update means that there were constraints in the calculation of the area change from each PfC and accessibility strata reported in year 4, as only the new stratification was used to analyse the forest area change in this report.

Indufor expects that the stratification update will be used in the spatial analysis of forest area change for year 6 next year. With those results, it will be possible to track and report the area remaining and converted to and from each of the forest strata combination from year 5 to year 6.

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[30] 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.

[31] 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.

The afforestation/reforestation activity in Guyana has been monitored in the MRV and reported when detected.

Guyana classified the non-forest areas into the relevant IPCC land categories. No area changes have been monitored or calculated between non-forest classes from year 4 to year 5 ("Not estimated" (NE) Notation Key used).

Figure 1: Year 5 Stratification of Guyana's Forest Area by Potential for Change

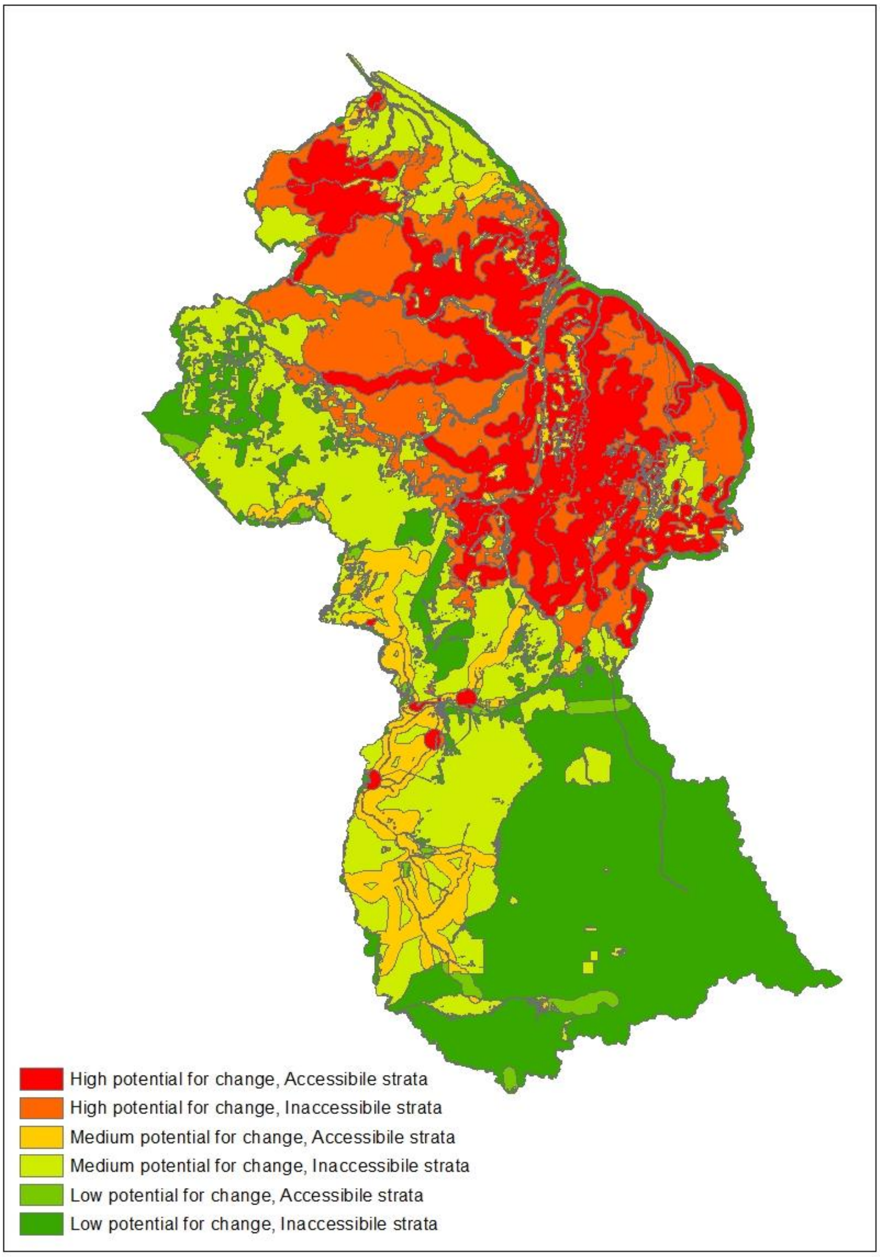


Table 4.1. LAND TRANSITION MATRIX

Inventory 2015

Areas and changes in areas between the previous and the current inventory year

Submission 2015 v1

GUYANA

FROM: 2013 (Year 4) / TO: 2014 (Year 5)	Forest land	Cropland (managed)	Grassland (unmanaged)	Wetlands (unmanaged)	Settlements	Other land	Final area at Y5
	(kha)						
Forest land (HPfC MA)[2]	3557.27	0.0007	NO	NO	0.009	NO	3557.3
Forest land (HPfC LA)[2]	3177.06	NO	NO	NO	0.039	0.0002	3177.1
Forest land (MPfC)[2]	5552.14	0.0004	NO	NO	0.004	0.0041	5552.1
Forest land (LPfC)[2]	6184.05	NO	NO	NO	0.016	NO	6184.1
Cropland (managed)[4]	0.82	343.1	NE	NE	NE	NE	343.9
Grassland (unmanaged)[5]	NO	NE	1909.7	NE	NE	NE	1909.7
Wetland (unmanaged)[6]	NO	NE	NE	272.6	NE	NE	272.6
Settlements[7]	1.37	NE	NE	NE	59.8	NE	61.2
Other land [8]	9.77	NE	NE	NE	NE	54.1	63.9
Final area at Y4 (Initial at Y5)	18482.5	343.1	1909.7	272.6	59.9	54.1	21121.9
Net change [9]	-11.96	0.82	0.00	0.00	1.37	9.77	0.00

Documentation for Notation keys used:

Afforestation/reforestation activity in Guyana occurs through regeneration of abandoned mining sites primarily. These areas are monitored at present and reported when detected, or as not occurring if the value is nil (NO).
There is no human induced conversion from forest to grasslands or forest to wetlands in Guyana (NO).
Land use changes between non-forest land uses were not 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		18,470.6														
1. Forest Land remaining Forest Land	High Potential for Change/More Accessible Forest (HPfC MA) remaining HPfC MA	3,557.3														
	High Potential for Change/Less Accessible Forest (HPfC LA) remaining HPfC LA	3,177.1														
	Medium Potential for Change Forest (MPfC) remaining MPfC	5,552.1														
	Low Potential for Change Forest (LPfC) remaining LPfC	6,184.0														
2. Land converted to Forest Land[10]																
2.1 Cropland converted to Forest Land	Cropland to High Potential for Change/More Accessible Forest	0.0007														
	Cropland to High Potential for Change/Less Accessible Forest	NO														
	Cropland to Medium Potential for Change Forest	0.0004														
	Cropland to Low Potential for Change Forest	NO														
2.2 Grassland converted to Forest Land	Grassland to High Potential for Change/More Accessible Forest	NO														
	Grassland to High Potential for Change/Less Accessible Forest	NO														
	Grassland to Medium Potential for Change Forest	NO														

GREENHOUSE GAS SOURCE & 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]			Net carbon stock change in dead organic matter[4]	Net carbon stock change in soils [4] [6]		Net CO_2 emissions/ removals [8] [9]
				Gains	Losses	Net change		Mineral soils[5]	Organic soils	Gains	Losses	Net change		Mineral soils	Organic soils[7]	
				(t C/ha)						(kt C)						(kt)
	Grassland to Low Potential for Change Forest	NO														
2.3 Wetlands converted to Forest Land	Wetlands to High Potential for Change/More Accessible Forest	NO														
	Wetlands to High Potential for Change/Less Accessible Forest	NO														
	Wetlands to Medium Potential for Change Forest	NO														
	Wetlands to Low Potential for Change Forest	NO														
2.4 Settlements converted to Forest Land	Settlements to High Potential for Change/More Accessible Forest	0.0090														
	Settlements to High Potential for Change/Less Accessible Forest	0.0391														
	Settlements to Medium Potential for Change Forest	0.0040														
	Settlements to Low Potential for Change Forest	0.0158														
2.5 Other Land converted to Forest Land	Other Land to High Potential for Change/More Accessible Forest	NO														
	Other Land to High Potential for Change/Less Accessible Forest	0.0002														
	Other Land to Medium Potential for Change Forest	0.0041														
	Other Land to Low Potential for Change Forest	NO														

Documentation box:

Afforestation/reforestation activity in Guyana occurs through regeneration of abandoned mining sites primarily. These areas are monitored at present and reported when detected, or as not occurring if the value is nil (NO).

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		343.9														
1. Cropland remaining Cropland		343.1														
2. Land converted to Cropland[12]																
2.1 Forest Land converted to Cropland		0.8														
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:

Land use changes between non-forest land uses 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		1909.7														
1. Cropland remaining Cropland		1909.7														
2. Land converted to Grassland[12]																
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:

Land use changes between non-forest land uses 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		272.6														
1. Wetlands remaining Wetlands		272.6														
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:

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	
				(t C/ha)						(kt C)						(kt)
B. Total Settlements		61.2														
1. Settlements remaining settlements		59.8														
2. Land converted to Settlements																
2.1 Forest Land converted to Settlements		1.4														
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:

Land use changes between non-forest land uses 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		63.9														
1. Other land remaining Other land		54.1														
2. Land converted to Other land(12)																
2.1 Forest Land converted to Other land		9.8														
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:

Land use changes between non-forest land uses were not estimated in this reporting period (NE).

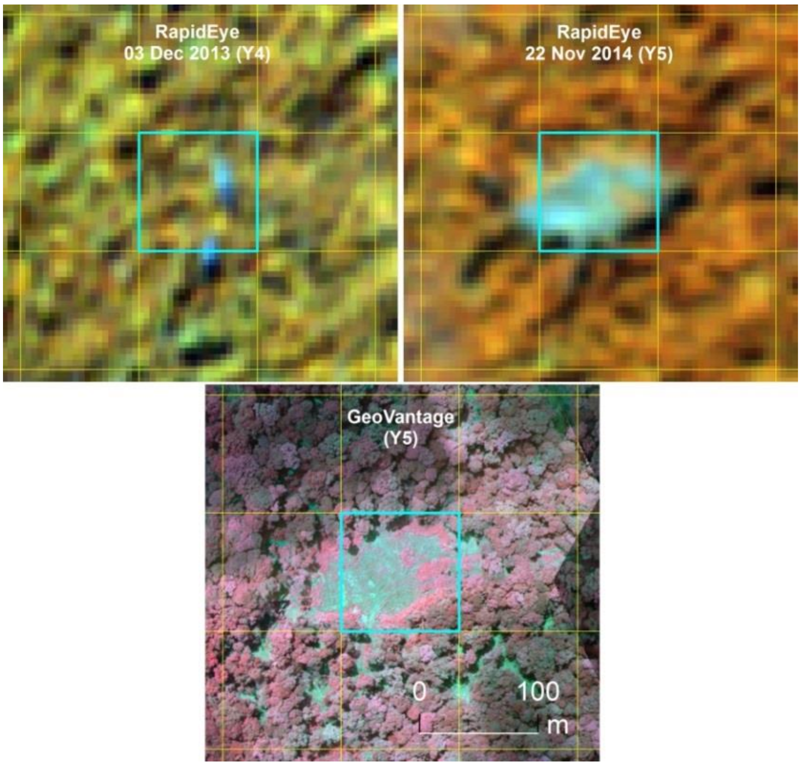
Appendix 7

Independent Accuracy Assessment Report

Guyana Forestry Commission
Guyana REDD+ Monitoring Reporting and Verification System (MRVS)

Accuracy Assessment Report

Year 5



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Nikolaos Galiatsatos, Royal School of Military Survey, UK

2nd October 2015

EXECUTIVE SUMMARY

1. This report was commissioned by Indufor Asia Pacific Ltd for the Guyana Forestry Commission (GFC) in support of a system to Monitor, Report and Verify (MRVS) for forest resources and carbon stock changes as part of Guyana's engagement in the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+). The scope of the work was to conduct an independent assessment of deforestation, forest degradation and forest area change estimates for the period January – December 2014. Specifically, the terms of reference asked that confidence limits be attached to forest area estimates.

2. The methods used in this report follow the recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level and rate of deforestation and the amount of degraded forest area in Guyana over the period 01 January 2014 to 31 December 2014 (Interim Measures Period – Year 5). Very high spatial resolution aerial imagery and high resolution satellite imagery and field visits are used to assess the level and rate of deforestation and forest degradation based on data from the RapidEye satellite constellation system and GeoVantage aerial imagery.

3. A change analysis was conducted using probability sampling with stratification was adopted to provide precise estimates of forest area. Three strata were selected according to "risk of deforestation"; and, the remaining areas were designated as non-forested. The drivers (cause) of change were made from expert image interpretation of very high spatial resolution aerial imagery or high spatial resolution satellite imagery.

4. The estimate of the annual rate of deforestation that occurred in 2014 (Year 5) is 0.062%, SE 0.008%.

5. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Non-forest and Degraded forest to Non-forest is 12,219 hectares with a standard error of 1,506 ha and a 95% confidence interval (9,267 ha; 15,171 ha).

6. The estimate of the annual rate of the rate change from Forest to Degraded forest between Y4 and Y5 is 0.046% with a standard error of 0.022%.

7. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Degraded forest is 7,377 hectares with a standard error of 1,230 ha and a 95% confidence interval (4,966 ha; 9,787 ha).

8. The results from the change sample analysis confirms GFCs conclusion that mining and mining related infrastructure and clearance for agriculture are the main drivers for both deforestation. For forest degradation mining and mining roads are the dominant cause of change.

9. The sample-based estimates for land cover class areas for December 2014 are as follows:
   a. Forest = 17,602,715 ha
   b. Degraded forest = 239,653 ha
   c. Non-forest 2,005,717 ha plus 990,000 ha (in the zero risk stratum) = 2,995,717 ha
   d. Note that the total area of Guyana in the sample-based estimate is 1.5% different from the GIS-based area because the sampling framework uses a 1 km by 3 km grid that intersects with the national boundary polygon.

Glossary of Statistical and Technical Terms and Acronyms used in the Report

Bias	Bias is a term which refers to how far the average statistic lies from the parameter it is estimating. The bias is the average (expected) difference between the measurement and the truth.
Change sample	May also be termed paired sample or a matched sample where the same attribute, or variable, is measured twice under different circumstances. In the Guyana case, the change sample is identical but measured a year apart.
CIR	Colour Infrared or "false colour" imagery
Confidence interval	A confidence interval for a parameter is a random interval constructed from data in such a way that the probability that the interval contains the true value of the parameter can be specified, with the most common being 95% (0.95) or 99% (0.99).
Confidence Level	If independent samples are taken repeatedly from the same population, and a confidence interval calculated for each sample, then a certain percentage (confidence level) of the intervals will include the unknown population parameter. A confidence level of 95% or 0.95 means that there is a probability of at least 95% that the result is reliable
Estimator	An estimator is a rule for "guessing" the value of a population parameter based on a random sample from the population. An estimator is a random variable, because its value depends on which particular sample is obtained, which is random. A canonical example of an estimator is the sample mean, which is an estimator of the population mean.
GeoVantage	Airborne imagery - Very high spatial resolution approx. 0.2-0.3 m pixel size used by the Accuracy Assessment team to validate the mapping of the GFC in the MRV
Orthorectified image	Orthorectification of imagery is a process that systematically removes distortion due to perspective and topography to create a perspective where scale is uniform across the image.
Precision	Precision is a measure of how close an estimator is expected to be to the true value of a parameter
RapidEye	Satellite imagery - High spatial resolution (6 m pixel size) image data used to identify deforestation and forest degradation by the GFC for the MRV.
Reference data	In this context reference data refers to an independent sample collected to validate deforestation and forest degradation data.
RGB	Red-Green-Blue or "near-true colour" imagery.
Simple random sample	A sample drawn from a population using a random mechanism so that every element of the population has a known chance of being included in the sample.
Standard error	The Standard Error of a random variable is a measure of how far it is likely to be from its expected value; it is the standard deviation of the values of a given function of the data (parameter), over all possible samples of the same size.
Stratification	In a stratified sample, subsets of sampling units are selected separately from different strata, rather than from the sampling frame as a whole. Stratified sampling techniques are generally used when the population is heterogeneous, or dissimilar, where certain homogeneous, or similar, sub-populations can be isolated.

Two-stage sampling	In two-stage sampling the population is divided into N clusters. At the first stage a (usually) random sample of the clusters is selected. At the second stage smaller units (sample elements) are selected either randomly or systematically from each cluster.
Variance	A measurement of the degree of spread between numbers in a dataset. Variance measures how far each number in a dataset is from the mean.

List of abbreviations

AA	Accuracy Assessment
CAR	Corrective Action Request
CIR	Colour InfraRed
DN	Digital Number
DU	Durham University
FAAU	Forest Area Assessment Unit
GFC	Guyana Forestry Commission
GIS	Geographic Information System
GL	Guidelines
GL&SC	Guyana Land and Surveys Commission
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GPG	Good Practice Guidance
HR	High Risk Stratum
IAP	Indufor Asia Pacific Ltd
IPCC	Intergovernmental Panel on Climate Change
LR	Low Risk Stratum
MR	Medium Risk Stratum
MRVS	Monitoring Reporting and Verification System
N	North
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus Sustainable Forest Management
RGB	Red, Green and Blue
SE	Standard Error
UNFCCC	United Nations Framework Convention on Climate Change
UTM	Universal Transverse Mercator Coordinate System
Y	Year

LIST OF EQUATIONS

For stratified random sample design

$$(W, Y) = \left(w_{hij}, y_{hij}\right)$$

Mean

$$\hat{\hat{Y}} = \frac{\left(\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}\right)}{w}$$

Confidence limit for the mean

$$\hat{\hat{Y}} \pm StdErr\left(\hat{\hat{Y}}\right).t_{df,\infty/2}$$

Proportions

The procedure estimates the proportion in level $c_k$for variable C as

$$\hat{p} = \frac{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}^{(q)}}{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij}}$$

Total

The estimate of the total weighted sum over the sample,

$$\hat{Y} = \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}$$

Variance and standard deviation of the total

$$\hat{V}(\hat{Y}) = \sum_{h=1}^{H} \frac{n_h(1 - f_h)}{n_h - 1} \sum_{i=1}^{n_h} (y_{hi\cdot} - \bar{y}_{h\cdots})^2$$

The standard deviation of the total equals

$$Std(\hat{Y}) = \sqrt{\hat{V}(\hat{Y})}$$

Confidence limits of a total

$$\hat{Y} \pm StdErr\left(\hat{Y}\right).t_{df,\infty/2}$$

12. AREAS OF ACTIVITY

1.1 To refine and enhance the methodology developed in 2012/13 to assess Year 5 deforestation, taking note of IPCC Good Practice Guidelines and GOFC/GOLD recommendations.

1.2 Outline methodology for change sample analysis including an outline of the (1) sample design, (2) response design, and (3) analysis design.[32] For the design component, reference data to be used should be identified, and literature cited for methods proposed. The design must ensure representativeness of the scenes selected for analysis. The sampling specifications used must be stated.

1.3 Support independent verification of the REDD+ interim measures and national estimates (Gross Deforestation, Intact Forest Landscape, Extent of Degradation associated with new infrastructure, and emissions from forest fires – referred to in the context of the Joint Concept Note between the Governments of Guyana and the Kingdom of Norway, including initial interim results, with a priority being on gross deforestation and the associated deforestation rate (i.e. change over time) and assessing their error margins/confidence bands, and providing verification of the deforestation rate figure for Year 5 as an area change total and by driver.

1.4 Assessment on the area changes (deforestation, degradation), an error assessment on the quality of attribution of types of changes mapped (agriculture, mining, forestry and fire), an examination of why changes were mapped well or not. Make recommendations that can be used to improve efforts in the future. This assessment should be done with the recognition that "best efforts" will have to be applied in situations where there is a challenge in terms of availability of reference data and will have to entail field / overflight verification. The error analysis should highlight areas of improvement for future years to decrease uncertainties and maintain consistency. Additionally, the assessment should also consider the quality on how missing data were treated for national estimation (if this is observed to be the case). It is required that real reference data is used either from the ground, ancillary data (e.g. for concessions), and/or high resolution imagery for reference.

1.5 This change sample analysis is done with the recognition that "best efforts" will have to be applied in situations where there is a challenge in terms of availability of reference data and will have to entail field / over-flight verification. The error analysis highlights areas of improvement for future years to decrease uncertainties and maintain consistency. Additionally, the assessment considers the effect of missing data for national estimation. It is required that real reference data are used either from the ancillary map data (e.g. for concessions), and the data acquired specifically for change sample analysis including aerial photography and high spatial resolution imagery.

[32] GOFC GOLD Sourcebook Section 2.6.

13. FEEDBACK DNV GL AUDIT PROCESS

The DNV GL Audit of the Guyana MRV from Year 4, made one Corrective Action Request (CAR) and two Observations (DNV Report 2014). The italicised text below is extracted from the report verbatim for convenience

13.1 <u>CAR 5</u>

***Requirement**: 1.1, 2.1, 2.2, and 2.3*
***Non-Compliance**: Required sampling strategy requires a reassessment of stratification over time.*

Objective evidence:
Stratification of the Accuracy Assessment is out of date missing HR area around Matthews Ridge
Stratification for the Biomass stratification is out of date BPMLA 12-2A already under gone forest change

Response by the Project Participants:
The Change Sample approach used in the Y4 Accuracy Assessment used the same design as Y3 and the analytical approach has resulted in a significant reduction in the Sampling Error of forest loss and forest degradation area estimates. Nevertheless, deforestation is, as the audit team point out, encroaching into areas in the Low Risk stratum implying that the stratification is not optimum. The AA team acquired 10% additional randomly selected clusters in Y4 that were not used in the accuracy assessment but are available for Y5 assessment. In response to the CAR 5 - we note that financial and time resources are limited for acquisition of reference data; that the pattern of mining has changed with time; that 95% of degradation is associated with mining and mining-related infrastructure; that degradation can be identified with a good level of accuracy from aerial imagery and very high resolution satellite imagery.

For year 5 the change sample analysis will seek to revise the sampling stratification to maximize the precision of the estimate given the logistical constraints on the number of first-stage clusters that are randomly selected. Our analysis of the existing stratification using the Neyman allocation equation, illustrates that it is possible to optimize the distribution of samples to achieve the same precision using fewer within-cluster samples.

DNV Response
DNV GL agrees with proposed planning of GFC however the CAR will not be closed till the next verification once the evidence of the implementation can be verified.
CAR to be closed out during next verification

13.2 Action taken to address CAR 5

Durham University undertook an analysis of sampling strategies in order to quantitatively assess issues of stratification, sampling efficiency and resource allocation for verification purposes. This resulted in a stratification of Guyana's land area into four classes that better represent risk of deforestation based on actual deforestation data from the period 1990-2013. The precise methods used are described in Section 4 of this report.

<u>OBS 1</u>

Requirement: Interim Indicator 1.1
Potential Non-Compliance: Misclassification of reference samples during Accuracy Assessment
Objective evidence: Change toolbar to become comprehensible and useable for new people.

The GIS toolbar used for accuracy assessment in Year 4 became complex as the assessment incorporated a change sample analysis to compare only two independent reference data sets and to compare reference data with the GFC map product. For each of these assessments the accuracy assessment analyst was required to indicate the driver of change and a possible mapping error. For the year 5 change sample analysis, the GIS toolbar was modified and simplified with the objective that it focused entirely on the analysis of change from Year 4 to Year 5. The new toolbar can be learned quickly by any new operator and none of the drop down menu items are ambiguous.

DNV GL Response
DNV GL agrees with proposed planning of GFC however the OBS will not be closed till the next verification once the evidence of the implementation can be verified.

OBS to be closed out during next verification

2.3 Action taken to address OBS
GFC and DU agreed that analysing both the change reference data and the Y5 GIS-mapping was unnecessary because the map analysis did not contribute to the estimation of deforestation (or degradation) area or rate. Furthermore, the presentation of raw contingency tables showing correspondence of reference data with map data had led to unnecessary confusion. The analysis of the map data was a legacy from Years 1-3 when the accuracy assessment used a model-assisted probability-based estimator for deriving forest area. The change-sample approach no longer requires a comparison with map data in order to estimate bias. All change samples are selected at random and so the design is inherently unbiased.

Therefore, a new simpler toolbar was developed by Durham University. The new toolbar focuses exclusively on guiding the interpreter though the analysis of the change reference data and the process of quantifying change at the hectare scale. See section 4.5.2 for a description and see Figure 4.8 for visualisation of the toolbar used in Y4-Y5.

<u>OBS 2</u>
Potential Non-Compliance*: Inconsistency within the reporting.*

Objective evidence:
Confusion matrix of the forest cover map (year 4) and degradation not considering two-stage sampling design: Although DNV GL acknowledge that stratification has been taken into account in the current monitoring period, the confusion matrix provided in Table 5.1-5.3 seems to determine the different accuracy indicators using secondary sampling units without considering their grouping in primaries (e.g. the total is 54254 which is the number of secondary SUs). In order to obtain unbiased estimates of the different accuracy indicators the sampling design should be considered. Although, the estimate of accuracies should not be very different from the presented ones, GFC to considering the grouping in primaries for producing the confusion matrices and the different accuracy indicators.

Reporting of uncertainties on accuracy indicators: Following Olofsson et al. (2014), it is good practice to report confidence intervals at 95% of the different accuracy indicators (i.e. overall, users and producers). GFC to consider reporting uncertainties of the accuracy indicators in the next monitoring period.

Forest Cover change Matrix: In order to have an estimate of the accuracy of the change map produced for year 4, a confusion matrix of the forest cover change and accuracy indicators should be provided. Section 4.9 seems to indicate that these results would be provided (i.e. Table 4.9.1) but the filled-out table is not found in the report. In previous monitoring periods is was not possible to derive this confusion matrix as there was no reference data on change classes, but now it would be possible to report this confusion matrix of the change map for forest cover change as it has been done for degradation. Hence, GCF is encouraged to consider reporting this in the next monitoring period along with uncertainties in accuracy indicators. GCF to consider the use of the following guidance provided in Olofsson et al. (2014) regarding reporting, yet with some adaptations in order to consider the specific sampling design.

Deforestation by roads: The AA report indicates that the average estimate of deforestation using sampling could have been slightly over-estimated in relation to the estimate provided by wall-to-wall mapping. The issue was mainly related to the sampling units that intersected with roads, that were accounted as loss units, while logically they could be accounted as degraded or forest units. The University of Durham has indicated the urgent clarification of the mapping rules of these cases. The verification team agrees with this and would like to recommend to clarify the mapping rules of these areas for the next monitoring period, and/or to analyse the potential of using proportions of loss in the sampling units instead of a binomial variable, as used in Potapov et al. (2014).

2.4 Action taken to address OBS

There was no opportunity to respond to the DNV GL comments above within the 2014 audit reporting period. Nevertheless, in this Observation the audit team raise two separate but points.

First, table 5.1 in the Year 4 Accuracy Assessment Report is a combined error matrix (unweighted) for the Forest-NonForest Year 4 map which was included to illustrate the degree of correspondence between the GFC map product and the independent change sample data. As explained in section 2.3 above, these data are not needed to estimate deforestation area or rate of change and, as the audit team point out, they cannot be used in this form to estimate area of change. The caption on the figure in the Year 4 report does say that the error matrix data are unweighted but we agree that including these data has unfortunately caused confusion. For the avoidance of misunderstanding the data used for quantitative change estimation are presented in the report in tables 5.3.1 to 5.4.2 of the Year 4 accuracy assessment report.

14. AREA REPRESENTATION

The total land area for Guyana is 21,127,762 hectares, calculated from the national boundary Shapefile provided by GFC in 2014. The digital maps contained in the report were obtained from the Guyana Forestry Commission (GFC), the Guyana Land and Surveys Commission (GL&SC). All maps use the WGS 84 datum and are projected to UTM Zone 21N.

14.1 Forest Area

Land classified as **forest** by GFC follows the definition from the Marrakech Accords (UNFCCC, 2001). Under this agreement forest is defined as: a minimum area of land of 1.0 hectare (ha) with tree crown cover (or equivalent stocking level) of more than 10-30% with trees with the potential to reach a minimum height of 2-5 m at maturity *in situ*.

In accordance with the Marrakech Accords, 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.

The forest area was mapped by IAP/GFC by excluding non-forest land cover types, including water bodies, infrastructure, mining and non-forest vegetation. The first epoch for mapping is 1990, and from that point forward land cover change from forest to non-forest has been mapped and labelled with the new land cover class and the change driver. GFC have conducted field inspections and measurements over a number of non-forest sites to verify the land cover type, the degree of canopy closure, the height of the vegetation and its potential to regenerate back to forest. The mapping was based on manual interpretation of satellite imagery at approximately 1:24,000 using ArcGIS software.

The Y5 mapping process involves a systematic review of each 24 × 24 km RapidEye tile which was further zoomed at a resolution of 1:8000 under a sub-tile of 1 × 1 km. It involves editing the EVI vector outputs (generated through series of image processing steps: DN to reflectance, dark subtraction, cloud masking and EVI generation) from change detection processes required to delineate new change events. The input process is standardised through the use of a customised GIS tool. Details of the IAP/GFC Y5 mapping explained in the Standard Operating Procedure for Forest Changes Assessment. Areas mapped as deforested during the period 1990-2009 are used to establish the *deforestation rate* for the benchmark reporting period.

The purpose of this report is to build upon the estimates of deforestation established for Years 1-4 of the Norway-Guyana agreement and to quantify the precision of the estimate of deforestation and forest degradation in Year 5. A second task is to identify the processes (drivers) that are responsible for deforestation and degradation, and where possible to estimate the precision of area estimates.

15. SAMPLING DESIGN FOR VERIFYING YEAR 4 TO YEAR 5 FOREST CHANGE

15.1 Change sample design

The Year 5 change analysis for gross deforestation and forest degradation in Guyana used a stratified random sampling design. Stratification was based on past patterns of deforestation from Period1 (1990) though to Year 4 (Dec 2013), where the primary drivers of land cover change are alluvial gold mining, logging, agriculture and associated infrastructure including roads. The land cover map for Guyana is updated every 12 months based on interpretation of 5m-RapidEye satellite imagery. The mapping covers the entire land area of Guyana and uses multiple looks for every satellite image footprint to compensate for areas obscured by clouds and cloud shadow.

Change analysis is guided by established principles of statistical sampling for area estimation and by good practice guidelines (GOFC-GOLD, 2013, UNFCCC Good Practice Guidance (GPG) and Guidelines (GL)). The purpose of the sampling strategy for the Guyana MRV was to determine the status of the forest resource by assessing changes among different land cover types based on satellite observations. The purpose of stratification is to calculate the within-stratum means and variances and then calculate a weighted average of within-stratum estimates where the weights are proportional to the stratum size. Stratification will reduce the variance of the population parameter estimate and provide a more precise estimate of forest area than a simple random sample.

The sampling design and the associated response design are influenced by the quality and availability of suitable reference data to verify interpretations of the GFC Forest Area Assessment Unit (FAAU). In Year 3, 4 and 5 the GFC Forest Area Assessment Unit (FAAU) used RapidEye as the primary mapping tool and so the whole country is mapped from multiple looks of orthorectified RapidEye resampled data to 5 m pixel size. The response design used GeoVantage aerial imagery as an appropriate fine-resolution source of data to sample land cover changes in areas of the country judged at high or medium risk of deforestation or degradation. Random samples of RapidEye data were used in areas deemed to be at low risk of change.

The feedback from DNV GL and from the Norwegian Ministry of Environment via stakeholder consultation, demonstrates the requirement to optimise the methods used for separate change analysis as an independent approach apart from the IAP/GFC Y5 wall-to-wall mapping in order to reduce the uncertainties in forest change estimates. Therefore, the approach taken in Years 5 allows additional change samples to be generated from the Y4 and Y5 wall-to-wall coverage of RapidEye data. For the medium (MR) and high risk (HR) strata the change sample approach is constrained by the availability of GeoVantage aerial imagery in Y4.

15.2 Improvements to address CAR and Observations

CAR5 in the DNV GL report comes about because the accuracy assessment report reveals deforestation in Years 2, 3 and 4 encroaching into parts of Guyana designated as Low Risk in the sampling stratification used in Years 3 and 4. Despite all of the advantages of a change-sample approach, resampling the same areas can encounter practical and inferential problems if resampling the same areas proves difficult, or if, as time passes, the sample or the stratification of the sampling scheme, is no longer representative of the target population (Schmid-Haas, 1983; Cochran, 1977). The concern expressed in CAR5 is that areas designated as Low Risk, such as around Matthews Ridge, exhibit characteristics of high risk of deforestation and so the sampling strategy could be improved by updating the strata to make these more homogeneous.

Objective evidence:
The chi-square test of homogeneity can be used to determine whether the frequency counts of some categorical variable are distributed identically across two populations. Taking the HR and LR strata from the Year 4 report as two populations and testing for homogeneity will establish whether the current stratification of the samples is efficient. Table 4.1 shows the distribution of individual sample elements for the Year 3 and Year 4 data by stratum and land cover type used to calculate the chi-square (X^2) for the Y3 and Y4.

Table 4.1 The distribution of individual sample elements for the Year 3 and Year 4 data by stratum and land cover type

Year 3	NonForest	Forest	Degradation	Total
HR	4125	17021	434	21580
LR	3311	30100	128	33539
Total	7436	47121	562	55119

Year 4	NonForest	Forest	Degradation	Total
HR	4191	16937	452	21580
LR	3350	30046	143	33539
Total	7541	46983	595	55119

The Chi-square value for Year 3 is 3184 and for Year 4 is 1382 implying that the null hypothesis (H_0) that the strata have the same distribution can be rejected and that the strata are effective and any statistical inferences valid. In 2009-2010, 73% of deforestation in Guyana was found in the "High Risk" stratum however by 2012-2013 this had reduced to 61%. This trend corresponds with the chi-square statistic decreasing from Year 3 to Year 4, suggesting that the strata are becoming more similar. Therefore, it is reasonable to assume that the stratification could be improved by utilising up-to-date information on the patterns of deforestation and forest degradation in Guyana. Stratification allows sampling to produce precision gains in population parameter estimates by classifying the country by creating internally homogeneous strata in terms of risk of deforestation.

For Guyana, the established MRV protocol is for the entire country to be remapped on an annual basis, and so a forest change map will be generated and a reference sample will be needed to validate the IAP/GFC Y5 mapping estimates and its accuracy. The focus of assessment places emphasis on inference that is optimising the precision of the change estimates. Therefore, we generate an *attribute change sample* as the reference data for the change map and to estimate gross deforestation area.

A change sample for reference data will:

1. have a smaller variance than an estimate of change derived from two equivalently sized sets of independent observations provided the correlation coefficient is positive;
2. increase the precision of the change estimate by virtue of the reduction of the variance of estimated change;
3. despite its obvious advantage, encounter practical and inferential problems if resampling the same areas proves difficult, or if, as time passes, the sample or the stratification of the sampling scheme, is no longer representative of the target population (Cochran 1977; Schmid-Haas, 1983);
4. for the same sample size, require no additional resource but allow both map accuracy and area estimation to be performed;
5. be an alternative to wall-to-wall mapping and may be preferred because of lower costs, normally smaller classification error, and rapid reporting of results;
6. have value when assessing any additional forest change map product such as the University of Maryland Global Change map 2000-2012 or any annual updates published by Maryland.

The desired goal of this validation is to derive a statistically robust and quantitative assessment of the uncertainties associated with the forest area and area change estimates.

Several factors potentially impact on the quality of forest mapping (GOFC GOLD, 2013), namely

- The spatial, spectral and temporal resolution of the imagery
- The radiometric and geometric pre-processing of the imagery
- The procedures used to interpret deforestation, degradation and respective drivers
- Cartographic and thematic standards (i.e. minimum mapping unit and land use definitions)
- The availability of reference data of suitable quality for evaluation of the mapping

The Standard Operating Procedure for Forest Change Assessment (GFC and Indufor Ap Ltd, 2015) outlines approaches used to minimize sources of error following IPCC and GOFC-GOLD good practice guidelines as appropriate.

The verification process used follows recognised design considerations in which three distinctive and integral phases are identified: response design, sampling design, and analysis and estimation (Stehman and Czaplewski, 1998).

15.3 Response Design

Table 4.2 summarises the data available to validate the deforestation and forest degradation change estimates for Year 5. It also specifies the areas covered by the GeoVantage aerial photography and the High Resolution RapidEye imagery used for change sample analysis.

Table 4.2: Data sources used for Validation

Application	Dataset used	Provider	Sensor	Spectral Range	Date of Acquisition	Pixel size (m)	Area (ha)	% of Guyana
Forest change assessment	RGB and CIR aerial photography	GeoVantage	4 channel multi-spectral sensor	Visible and NIR	July-Aug 14	0.25-0.60	288,940	1.37
					June – July 15		732,698	3.47
	RapidEye	BlackBridge	5 channel multi-spectral sensor	Visible and NIR	Aug-Dec 13	5	21,127,762	100
					Aug-Dec 14		21,127,762	100

A critical component of any change analysis is the need for appropriate reference data (Herold et al, 2006; Powell et al 2004). It is often the case that reference data itself contains errors and is not a gold standard and at least one study reports large differences of the order of 5-10% between field-based and remotely sensed reference data (Foody, 2010; Powell et al. 2004). Therefore, a key aspect of the response design is to use reference data that allow forest / non- forest land cover to be classified with certainty. Year 4 deforestation and forest degradation was mapped by the IAP/GFC team from RapidEye imagery, while the change sample analysis primarily used GeoVantage RGB and CIR (Colour Infrared) aerial photographs supplemented by the detailed reinterpretation of RapidEye satellite imagery in parts of Guyana that were beyond the safe operational range of light aircraft.

The change sample analysis was carried out in Durham by a small team (three persons) using a rules-based approach. Any misinterpretation or miscalculation of change is most likely to arise from human-error or interpretation using poor quality imagery or areas partially obscured by cloud or cloud shadow.

The Interim Measures for Year 5 includes an assessment of the change of areas of deforestation and forest degradation. Degradation has been mapped alongside Year 5 deforestation using a rule-based approach for infrastructure and for shifting cultivation. Noting exclusions as detailed in Table 4.3.

Table 4.3 Year 4 Deforestation/Degradation Assessment Exclusions

Reference	Criteria
1	Land use change that occurred prior to January 2014 or after December 2014
2	Roads less than a 10 m width.
3	Naturally occurring areas – i.e. water bodies
4	Cloud and cloud shadow

The following sections provide a summary of the datasets available and the way they were used for the change analysis between Y4 and Y5.

4.3.1 GeoVantage aerial imagery

The change reference estimate dataset was captured using GeoVantage's aerial imaging camera system mounted externally to a light aircraft. The camera uses a multi spectral sensor, capturing red, green, blue, and near infrared spectral bands. The spatial resolution of the imagery depends on the altitude that the data is captured. For this project the operating altitude ranged from 2,000 to 5,000 ft and the resultant imagery ranged from 25 to 60 cm pixel size. Deriving a change sample based of aerial imagery over tropical forests is a challenging task given the constraints of weather, cloud cover and navigating the exact same flight path as the previous year. To preserve an optimal ratio of imagery coverage and flight time, GeoVantage imagery was acquired only from rectangles that were within a distance of 150 km from the airstrips where there was enough support (fuel, service, administration) for the operation.

4.3.2 RapidEye satellite imagery

RapidEye is a constellation of five high-resolution visible and near infrared satellites. These acquire five-band multispectral imagery at 6.5 m (resampled to 5 m) nominal ground pixel size. These data were provided to GFC as a Level 3A orthorectified image product using a Landsat orthorectified mosaic for horizontal control and SRTM v4.1 for height control (total accuracy 30m CE90 at worst; February 2011 Product Guide; www.rapideye.de). The imagery was resampled to 5m spatial resolution by cubic convolution. The RapidEye data contain clouds and so a proportion of these data are unusable for change sample analysis. However the majority of these data are of good quality and remain useful for validation purposes. As some parts of Guyana were outside the 150km limit from the safe air operations, the RapidEye imagery was used for the change estimate of the Low Risk stratum.

15.4 Sampling Design

The sampling design refers to the methods used to select the locations at which the reference data are obtained. To assess the area and rate of deforestation a two stage sampling strategy with stratification of the primary units was adopted. In the first stage, a rectangles grid of 5 km by 15 km in size was created within the spatial extent of the country's national boundary[33]. This resulted in 2836 rectangles; note that only rectangles that their centroid was within the national boundary are selected (see Figure 4.1).

[33] According to the Interim Measures Report October 2013, the national boundary was defined by following information received from the GL&SC and with the aid of RapidEye imagery.

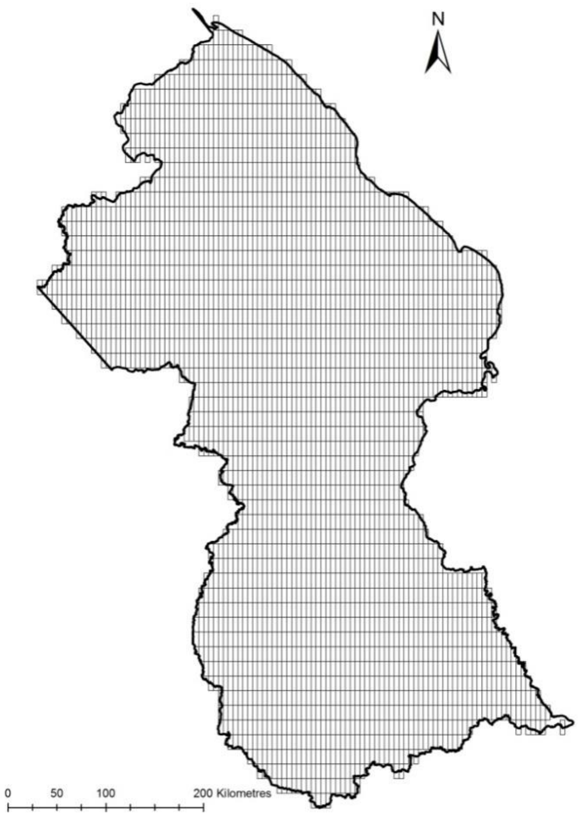


Figure 4.1: A grid of 5km by 15km in size was created, mainly for practical reasons to be compatible with the aerial imagery acquisition.

As the area of the country is large, and deforestation is observed to be clustered around relatively small areas of human activity, it is efficient to adopt a stratified sampling framework rather than use simple random or systematic sampling (Gallego, 2000; Foody, 2004; Stehman, 2001). For each stratum, sample means and variances can be calculated; a weighted average of the within stratum estimates is then derived, where weights are proportional to stratum size. In this case, the goal is to improve the precision of the forest (or deforestation) area using a stratum-based estimate of variance that will be more precise that using simple random sampling (Stehman and Czaplewski, 1998; Stehman, 2009).

The stratified sampling framework was first designed for the accuracy assessment of Y1 when 73% of the deforestation was located in the High Risk stratum and 27% from Low Risk. Since then, the ratio has been changed from 73:27 in Y1 to 61:39 in Y4 (see Figure 4.2). It thus became apparent that the sampling framework could be improved by stratifying using more up-to-date information on risk and that should improve the precision of the deforestation area estimate.

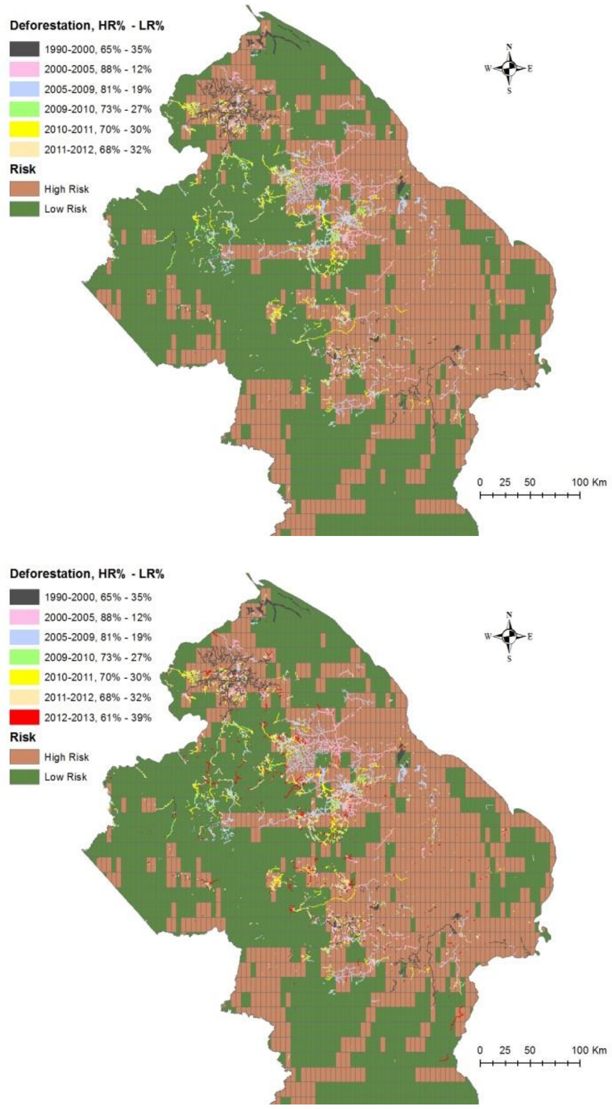


Figure 4.2 Mapped deforestation all period up to Year 3 (left); deforestation all periods up to Year 4 (right) – with Y4 deforestation in Red.

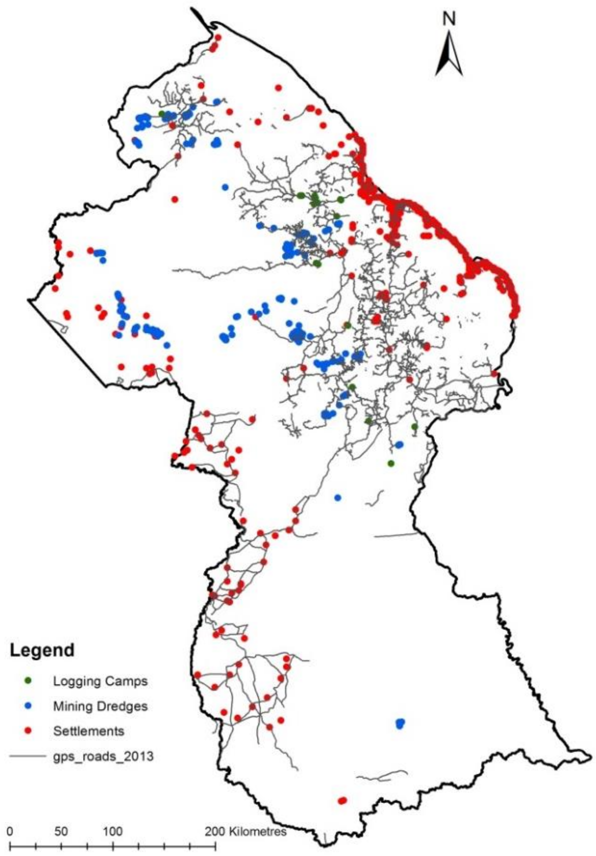
Based on past maps of deforestation (particularly Years 1 to 4), new strata were created. First, we selected the grid rectangles that intersected deforestation events. For every year of deforestation the value 1 (one) was given. If no event was recorded then the value 0 (zero) was given. For example, the rectangle with value 0011 intersects deforestation events that were recorded for Years 3 and 4. When there have been more than two deforestation events or deforestation events for the last two years (Y3 and Y4), then the rectangle was assigned to High Risk (HR) stratum. All other rectangles were assigned to Low Risk (LR) stratum.

After this, and based on geographical data provided by GFC, MR (Medium Risk) grid rectangles were selected from the LR stratum and stratified according to factors closely associated with risk of deforestation and forest degradation. In particular, data about the location of logging camps, mining dredges, settlements, and the existing road network were used (see Table 4.4 and Figure 4.3). This way, all grid rectangles that satisfied the following criteria were selected to be included in the MR stratum.

Contain at least one of: logging camps, mining dredges, or settlements,
OR
Intersect with at least one road.

Last but not least, we used the NonForest map of 1990 to identify rectangles that are almost completely deforested, and therefore no further deforestation event is expected within. When more than 90% of the rectangle contained NonForest in 1990, then this rectangle was assigned to 0R (Zero Risk) stratum.

This resulted in the classification of grid rectangles into four strata: 435 HR, 794 MR, 1476 LR, and 132 0R. (see Table 4.5).



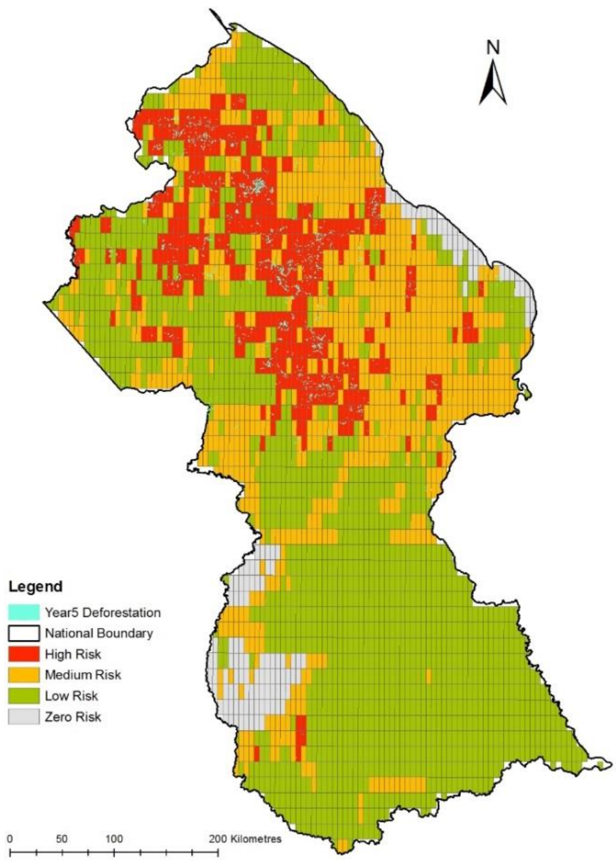


Figure 4.3 Left - Criteria for sampling stratification. Right – Strata with Y5 deforestation map.

Table 4.4 Spatial data used to assist with defining risk strata

Data Group	Layer Name	Created/ Update Frequency	Description
Admin	guyana_boundary	Received August 2014	Updated country boundary for Guyana.
Managed Forest Areas	logging_camps	N/A	Point location of logging camp sites, based on the Annual Operating plan.
Roads	gps roads_dd	3-6 months	All GPS roads and trails as at August 2014.
Mining Areas	mining_dredges	Upon granting of mining permit/licence/claim	Mining Dredge sites normally found in/around rivers
Population	Settlements	N/A	An extraction of a number of larger settlements from the place names point feature class.

The map in Figure 4.4 suggests that there is lower probability of sampling deforestation in the LR stratum than the HR and MR strata and so, in order not to under sample and miss deforestation events in this stratum, a weighting was applied when random points where any two points within a strata should not be located less than 3km along East-West (Latitude) and 1km along North-South (Longitudinal) directions to generate a 3km*1km rectangle surround each of those random points taking as the centre of corresponding rectangle, as second stage. This resulted in 58 HR rectangles, 51 MR rectangles and 204 LR rectangles (see Figure 4.4- right). Therefore, a total of 313 rectangles were selected.

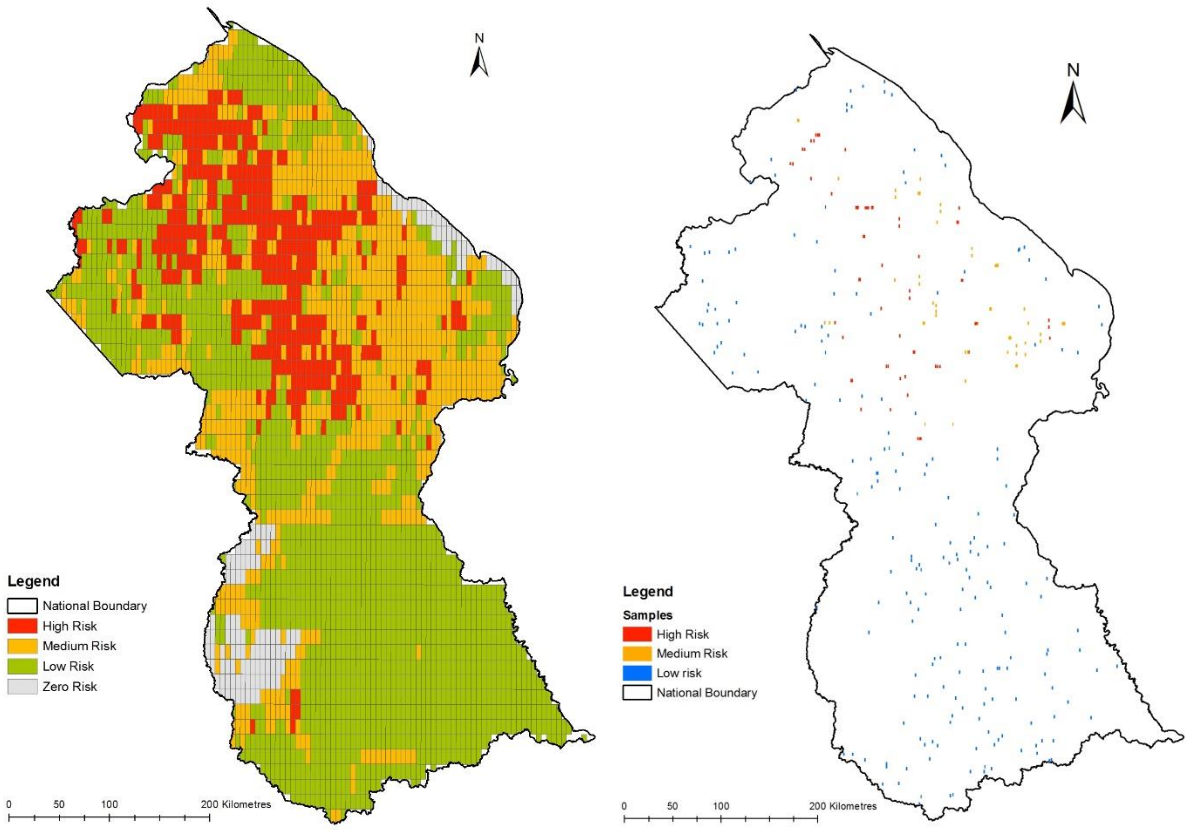


Figure 4.4 High, Medium, Low, and Zero Risk strata (left) and final random sampling of the strata (right image).

Within each first-stage sample (3km*1km rectangle or 300ha), a rectangular 100 m grid was generated. The 100m grid square (1ha) size is considered as the minimum change assessment unit, thereby a total of 300 observations were recorded within each sample (representing the whole area [population] of the sample rectangle (see Figure 4.5). Table 4.5 shows the stratification and area represented by each stratum.

For each sampling unit, the land cover class (e.g. Forest or Non-Forest, Degradation or Non-Degradation) is determined for the Year 5 deforestation and degradation map. The assessment follows an objective procedure where the GIS table for the samples is populated using a GIS toolbar.

Specifically the tools used to interpret and validate the Year 5 map data included the appropriate high resolution photography and satellite imagery (see Table 4.2). Also available were GIS data indicating mining, forestry and agricultural concessions.

Year 5 change analysis involved the collection of 313 equally sized (3km*1km) first-stage sample units (each with 300 ha) with a direct correspondence with Year 4 (see Figure 4.5). The reference data selected for the change sample analysis in Year 5 was a combination of GeoVantage aerial imagery and RapidEye for the high and medium Risk (HR and MR) strata and RapidEye for the Low Risk (LR) stratum. The repeat coverage of GeoVantage aerial imagery was designed to generate the best possible change reference data set, particularly for interpreting forest degradation that can be difficult to identify with certainty on RapidEye 5 m pixel sized imagery.

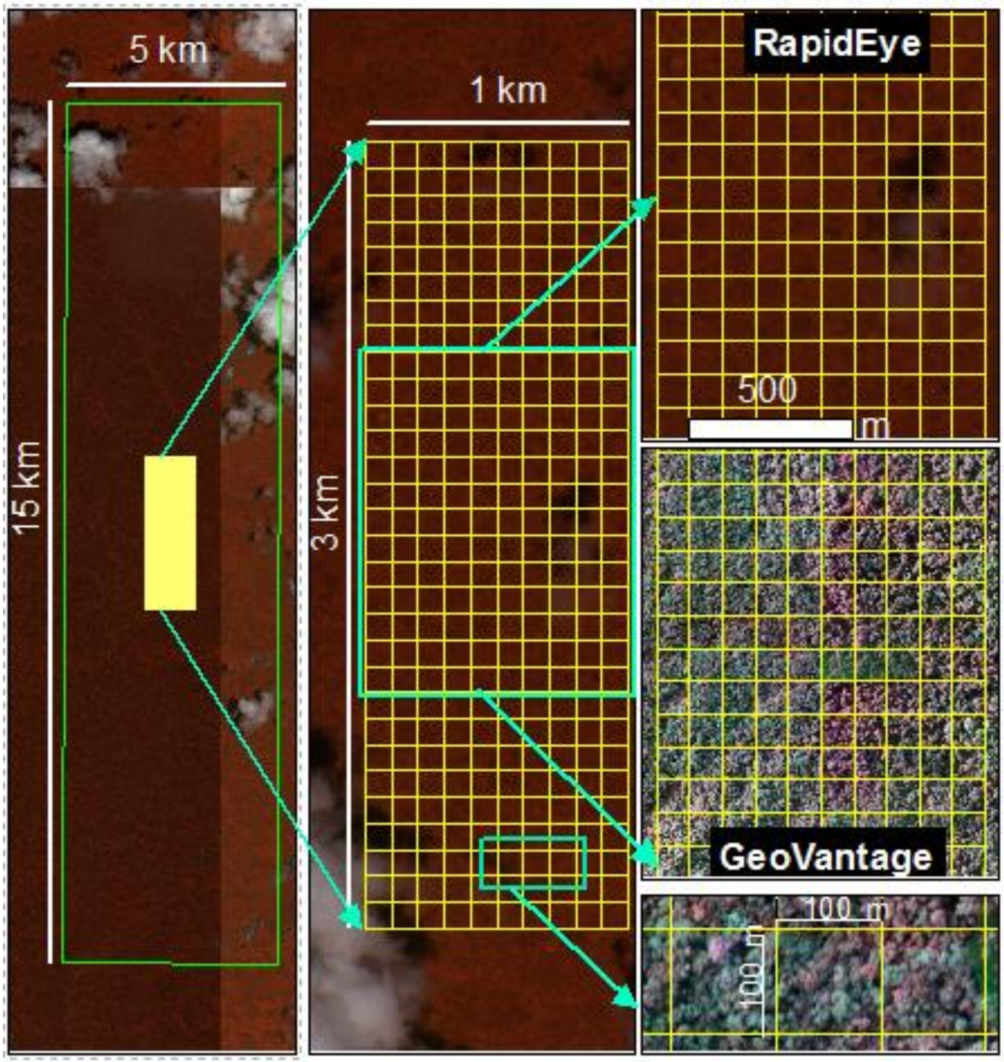


Figure 4.5 Sampling design and primary sample unit used for change sample analysis between Y4 and Y5.

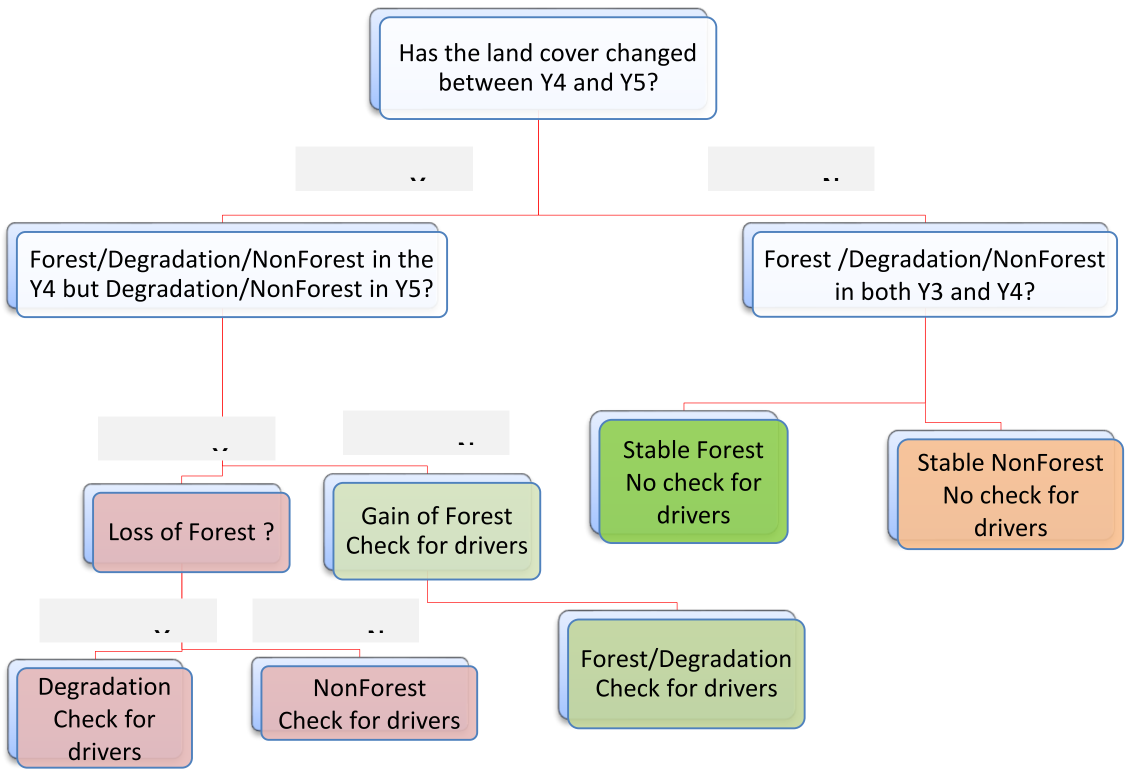
Table 4.5 Area represented by each stratum

	Stratum	Total number of rectangles	Area (ha)	Percent of Guyana (%)
	Country area		21,127,762	100.00
Population	Total Grid	2836	20,778,867	98.35
Stage 1 Random selection within 15km*5km grid	Total sample grid	313	469,500	2.22
	High Risk	58	87,000	0.41
	Medium	51	76,500	0.36
	Low Risk	204	306,000	1.45
3km*1km rectangular samples	**Total sample size**	**313**	**93,900**	**0.44**
	High Risk	**58**	**17,400**	**0.08**
	Medium	**51**	**15,300**	**0.07**
	Low Risk	**204**	**61,200**	**0.29**
	Missing (due to cloud cover)		**2,128**	**0.01**

1.5 Decision Tree for Year 4 – Year 5 Change Analysis

4.5.1 Change for each Land-Cover / Land-use Class

The analysis will report a gross deforestation change estimate based on a stratified random change estimator. This will provide confidence interval information on the deforestation estimate (i.e. the amount of change) which is similar to Year 4 except that the total area of change within each primary sample unit is assessed quantitatively. Put another way, there is no sub-sampling other than to break down the measurement into a hectare-sized grid to make the assessment manageable. Figure 4.6 illustrates a change decision tree where the Y4 land cover is forest. There will be equivalent decisions changes from forest to degraded forest and for forest to non-forest land cover types. These statistics allow change in major land cover categories to be reported and areas estimated.



	Y5 Reference Class			
Y4 Reference Class	Y5 Forest	Y5 Degradation	Y5 NonForest	**Total**
Y4 Forest	Stable Forest	Loss	Loss	
Y4 Degradation	Gain	Stable Degradation	Loss	
Y4 NonForest	Gain	Gain	Stable NonForest	
Total				Change reference samples

Figure 4.6 Decision tree for change sample analysis

When assessing degradation it is important to follow the Mapping Rules that define degraded-forest and non-forest that are detailed in the Standard Operating Procedure for Forest Change Assessment.

The most important points to note are:

1. Only areas of forest degradation that relate to Years 4 and 5 assessed.
2. Areas of shifting cultivation are classified as “Pioneer” and “Rotational” even if they are smaller in size than the minimum mapping unit (1 ha). “Pioneer” areas are evaluated as deforestation and “Rotational” as forest degradation.
3. Areas of water bodies are classified as non-forest.
4. Areas cloud and shadow or missing data are labeled as *Omitted*.
5. Areas representing Year 6 change (post Dec 2014) were also omitted from the analysis as this change postdates the Year 5 reference imagery.

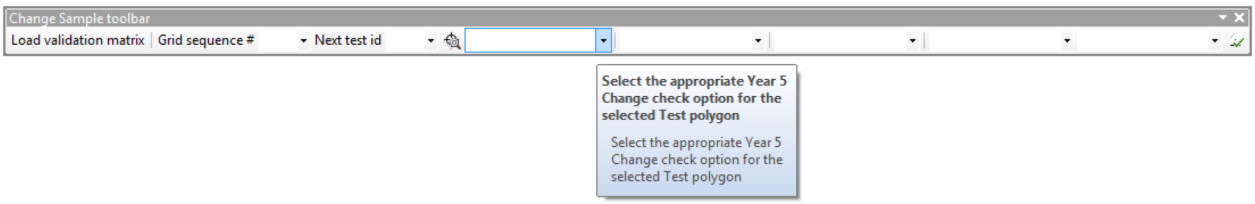
Figure 4.7 illustrates the GIS toolbar developed to assist assessment of change between Year 4 and Year 5. The pair of images at the top of the figure shows a sample hectare where the operator must assess whether change has occurred between the pair of images and record the nature of this change on the interpretation toolbar shown at the bottom of the figure.

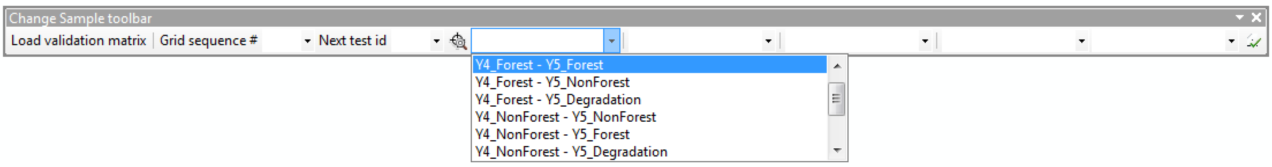
4.5.2 Toolbar design

Five checks or decisions were made by interpretion of each 1 ha sample. Those checks include: Y5 change, appropriate driver, sensor used for decision making, area of change measured and level of confidence in decision. A validation matrix was developed with all possible combinations between the Y5 change and the appropriate change driver combinations. The validation matrix was then used with the toolbar selections to avoid gross errors (Figure 4.7).

Validation matrix to avoid error in combination between a change and drivers of the change

Change check





Driver check

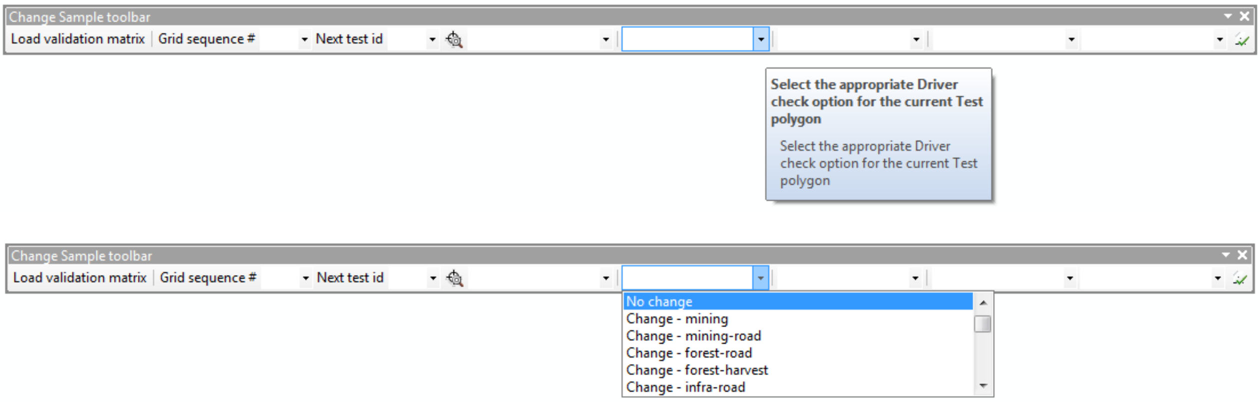
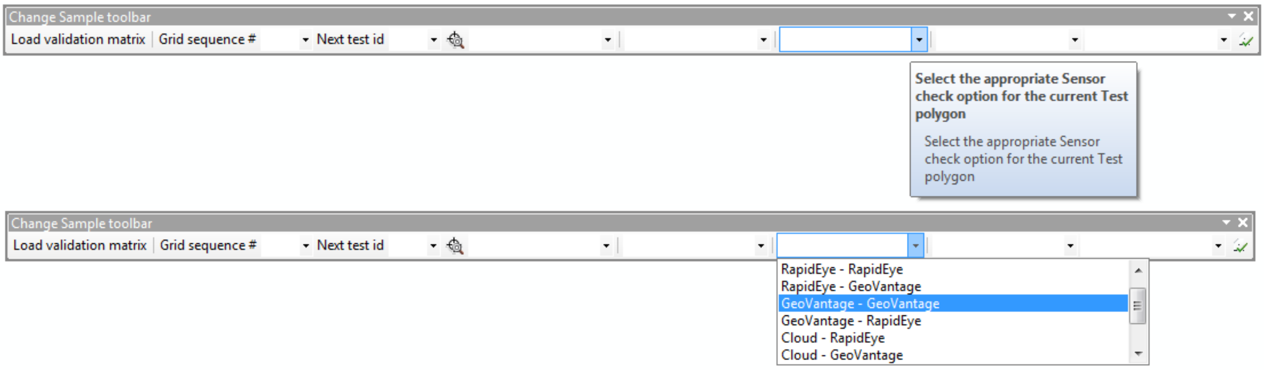
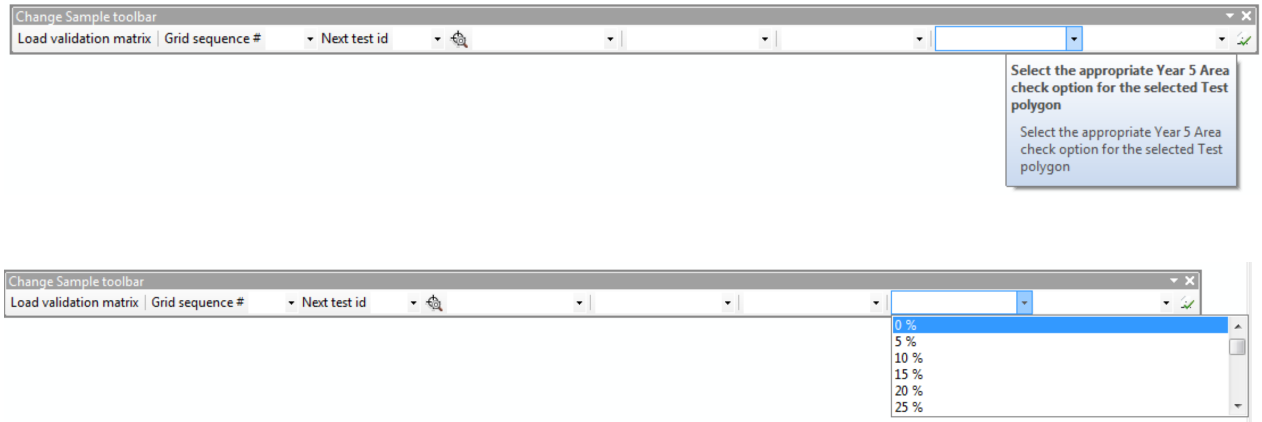


Figure 4.7 Example on the steps followed during decision making processes for each individual 1 ha sample using the DU Change Sample Analysis Toolbar.

Sensors used for interpretation check



Area of change measurement



Confidence in decision

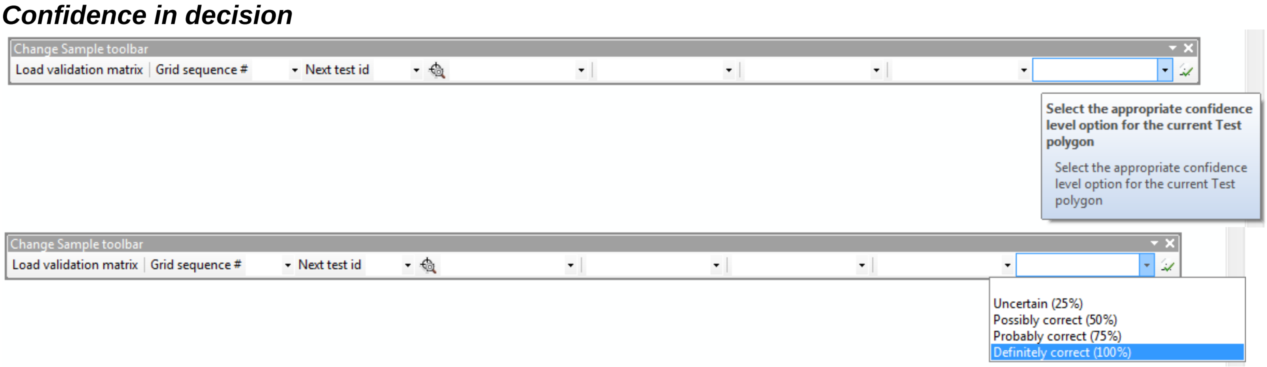


Figure 4.7 Example on the steps followed during decision making processes for each individual 1 ha sample using the DU Change Sample Analysis Toolbar.

The rules for validating each point account for small discrepancies between the original mapping that was digitized at 1:15,000 scale RapidEye. Minor discrepancies might include image-to-image mis-registration. These are distinct from factors that might explain misclassification or mislabeling in the mapping or indeed in the validation of the mapping. Misclassification can occur due to poor radiometric quality of imagery, spectral overlap among classes, scale / resolution of imagery and human error.

Furthermore, where a discrepancy between the Y4 and the Y5 image data is detected, an interpretation will be made of the correct assignment for the sample point. The toolbar allows the interpreter assess change for individual 1 ha sample units by easily combining the Y4 and the Y5 image data. In case of a change scenario (Y4 Forest and Y5 non-forest), the interpreter will make an assessment of the driver causing the change. The toolbar also demands that the data used in change analysis is stipulated. To estimate the actual amount of change between Y4 and Y5, the toolbar provided the interpreter with a drop-down selection on a percentage scale with a 5% precision (0% to 100%); there is 10m square mesh provided to assist measurement within each 1 ha sample (see Figure 4.8). Confidence in each decision is recorded with a label on a 0-4 scale. This allows for uncertainties in interpretation to be removed from the estimation and validation process if required.

The sampling strategy with stratification of the primary units uses a large sample size that will allow for assessment of change in accordance with the GOFC-GOLD (2013) recommendations. Note that the right hand side of the interpretation toolbar contains a dropdown database entry to represent the confidence or certainty of the interpretation. Uncertainty, in this case refers to doubt in the interpreters mind about the nature of the change observed not the classification between forest and non-forest. The uncertainty will refer to confidence in interpreting the driver for change and is recorded on a four interval scale.

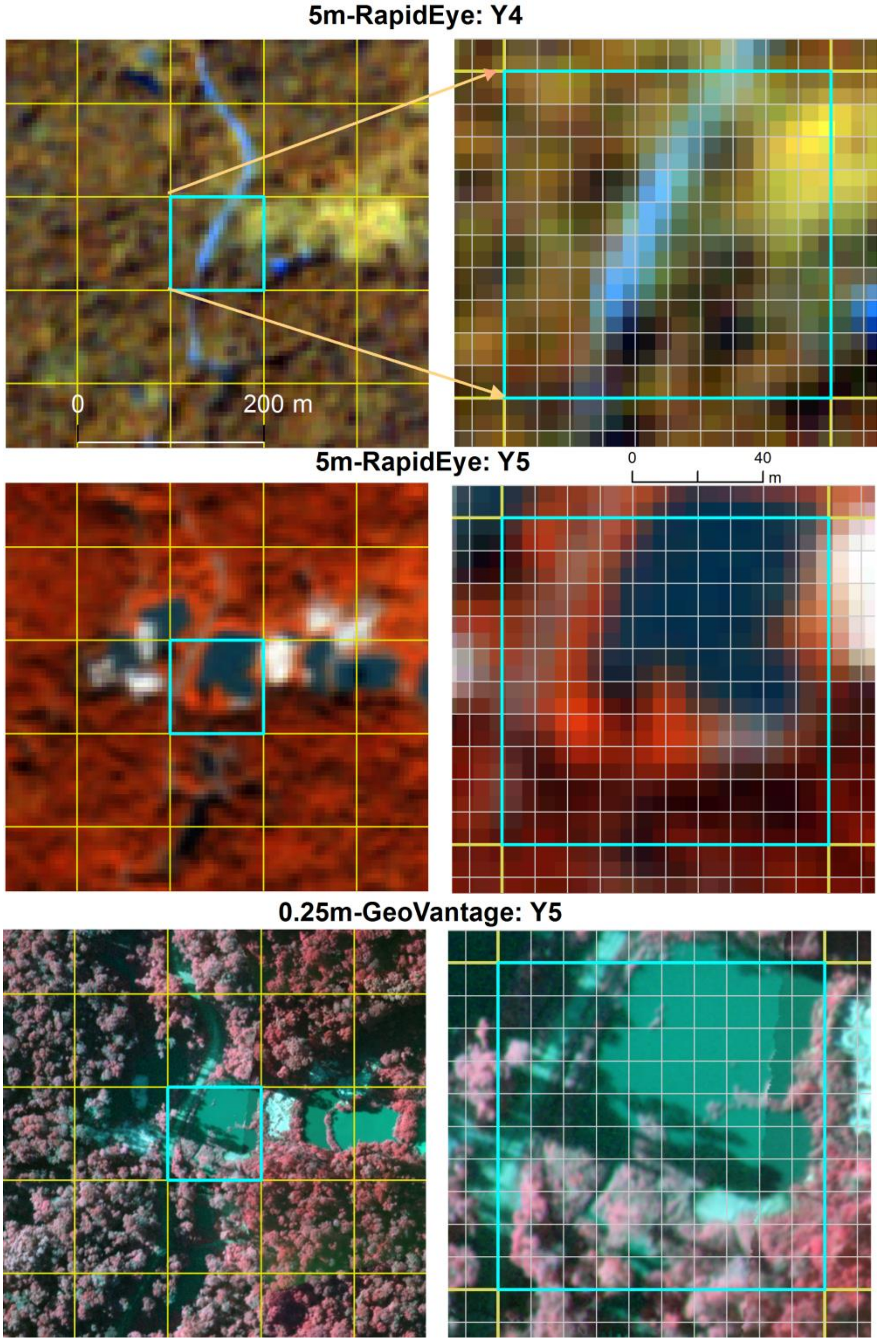


Figure 4.8 10m square mesh used to estimate area within a change sample.

15.5 Precision of Area Estimates for Deforestation and Forest Degradation

The stratified sampling design optimises the probability of sampling deforestation and forest degradation in Year 4 when the area concerned represents only a tiny fraction of the national land area. Furthermore, there are several factors such as cloud cover, accessibility, safety and cost that limit the availability and quality of reference data.

A key consideration is minimising the risk of intoducing any possible bias into the estimates. Bias may arise from sampling, from cloud cover patterns and perhaps from the distribution and coverage of the reference data. Sampling bias can be assessed from the joint probabliity matrices. The distribution of cloud cover has been assessed qualitatively from cloud cover masks but this can be quantified more formally from the sample area data and from the cloud mask data derived from analysis of the RapidEye satellite imagery.

The analysis reported here analysed 93,900 hectares (compared with 55,119 hectares in Year 4). The GeoVantage aerial imagery provides valuable evidence that helped confirm the interpretations of the Change Sample Analysis team, particularly with regard to the drivers for deforestation.

The validation team consists of three well qualified and experienced image interpreters, all of whom visited Guyana many times and have participated in field visits and over-flights. The analysis involved identifying change and paying strict attention of the definitions of 'forest cover', degraded forest cover' and non-forest as well as interpreting the processes driving deforestation and forest degradation. The rules followed are those detailed in the Standard Operating Procedures for Forest Change Assessment: A Guide for Remote Sensing Processing & GIS Mapping. The validation team were very familiar with satellite imagery, particularly GeoVantage and RapidEye.

16. RESULTS

16.1 Change Sample Estimates

5.1.1 Methodology

We treat the design as a stratified random design. The strata are HR, MR and LR. A simple random sample of rectangles from each stratum is taken. Then, within each rectangle, all hectares are systematically evaluated and all change measured quantitatively. This sample design can be analysed routinely using several statistical packages, which we describe below.

The reference data consisted of 313 first-stage sample units stratified into HR (17,400 ha), MR (15,300 ha) and LR (61,200 ha) areas as described in the sampling design (Section 4.4) and randomly sampled within each stratum. This design allows a probability-based inference approach to be applied. This approach assumes (1) that samples are selected from each stratum randomly; (2) that the probability of sample selection from each stratum can be estimated; (3) the sampling fraction in each stratum is proportional to the total population and that the relative sample size reflects, in this case, a ratio of 65:35 between HR and LR stratum respectively. The total sample area omitted due to persistent cloud cover is 2,128 ha which represents 2.27% of the sample.

The area under each of the three strata and total sample area given in table 4.5. Key inputs to the analysis are the total numbers of LR, MR and HR hectares.

Apart from no-change samples (Forest to Forest or NonForest to NonForest or Forest Degradation to Forest Degradation) between Year 4 and Year 5, the key changes include: Forest to NonForest (Figure 5.1), Forest to Forest degradation (Figure 5.2), Forest degradation to NonForest (Figure 5.3).

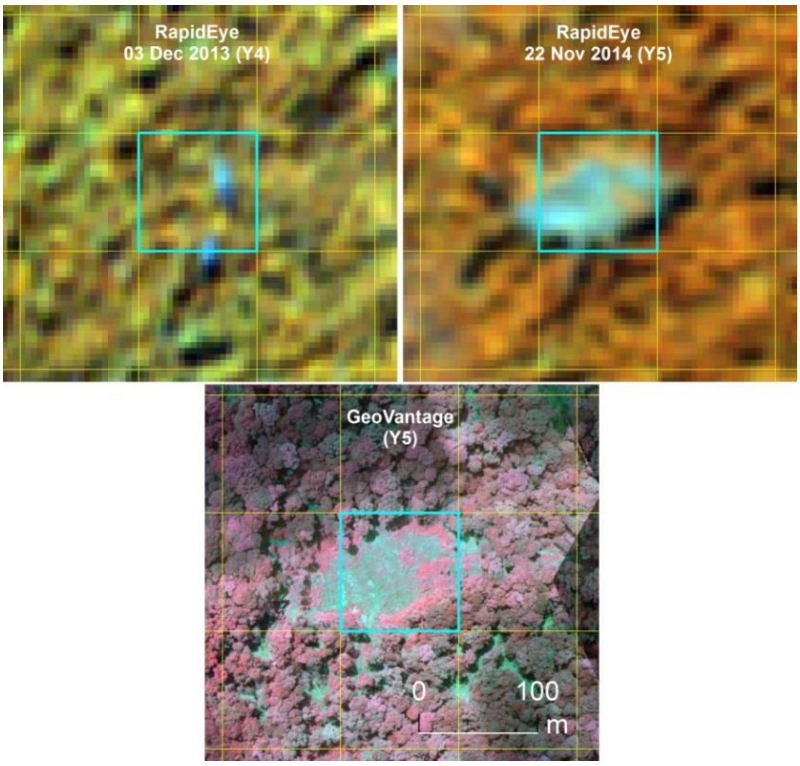


Figure 5.1 Example of 'Forest' to 'NonForest' change by mining for sample unit highlighted in blue. Areas with little degradation sign is evident in Y4 but due to mining activity has converted into NonForest area.

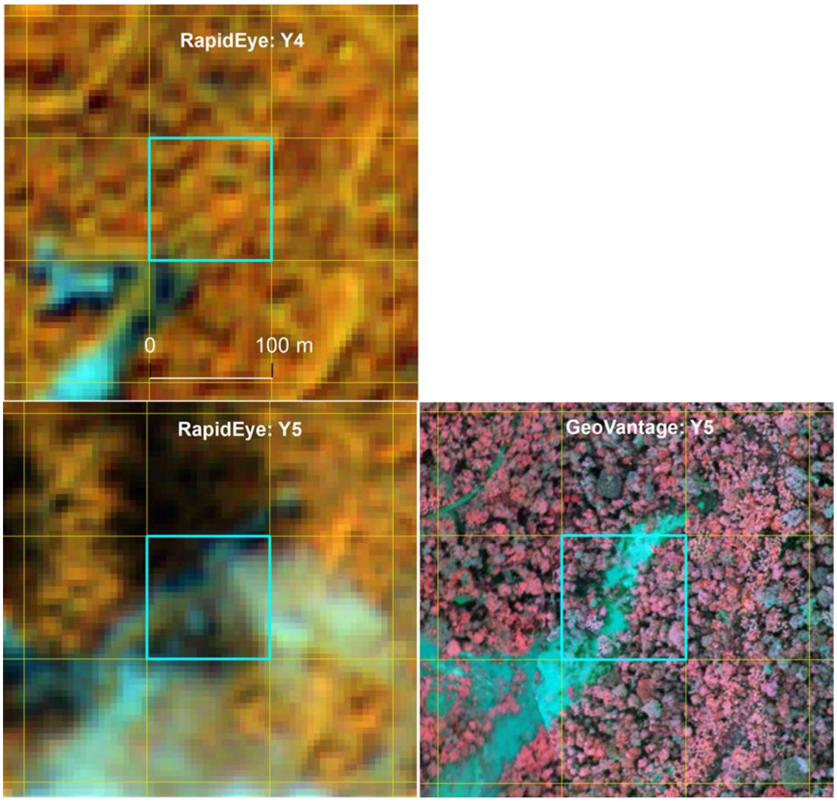


Figure 5.2 Example of ‘Forest’ to ‘Forest degradation’ change by mining for sample unit highlighted in blue. The sample was Forest in Y4 RapidEye and an expansion of mining activity has showed the sample with more than 25% canopy loss of the total sample area (1ha) in Y5 RapidEye and GeoVantage to flag the sample as Forest Degradation.

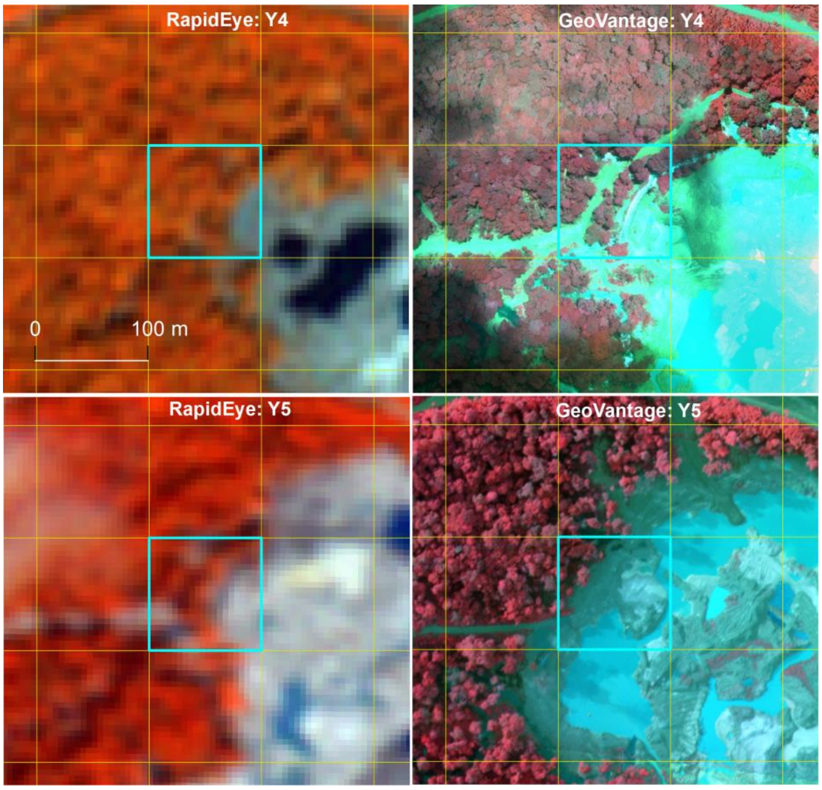


Figure 5.3 Example of ‘Forest degradation’ to ‘NonForest’ change for sample unit highlighted in blue due to mining. In Y4 RapidEye, the area showed a Degradation that has converted into Non-Forest area leaving less than 30% canopy cover to designate as NonForest in Y5 RapidEye and GeoVantage.

5.1.2 Software and estimators

To carry out the analysis, we have used the survey package available with the statistical package R Core Team (2014). This package is free and used by and supported by most of the world's academic statisticians, and increasingly is the commercial tool of choice. The survey package provided in Lumley (2004, 2014) provides functionality similar to that provided by the SAS package[34], and uses the same standard formulae for estimation of means and variances. These formulae are set out below and described conveniently in Lumley (2014).

5.1.3 Definitions and Notation

For a stratified clustered sample design, together with the sampling weights, the sample can be represented by an $n \times (P+1)$ matrix

$$(W, Y) = \left(w_{hij}, y_{hij}\right)$$
$$= (w_{hij}, y_{hij}^{(1)} y_{hij}^{(2)}, \dots \dots \dots, y_{hij}^{(p)})$$

Where
$h = 1,2, \dots \dots \dots, H$ is the stratum number, with a total of H strata
$i = 1,2, \dots \dots \dots, n_h$ is the cluster number within stratum h, with a total of n_h clusters
$j = 1,2, \dots \dots \dots, m_{hi}$is the unit number within cluster i of stratum h, with a total of m_{hi}units
$p = 1,2, \dots \dots \dots, P$ is the analysis variable number, with a total of P variables
$n = \sum_{h=1}^{H} \sum_{i=1}^{n_h} m_{hi}$is the total number of observations in the sample

w_{hij} denotes the sampling weight for observation j in cluster i of stratum h
y_{hij} = $(y_{hij}^{(1)} y_{hij}^{(2)}, \dots \dots \dots, y_{hij}^{(p)})$ are the observed values of the analysis variables for observation j in cluster i of stratum h, including both the values of numerical variables and the values of indicator variables for levels of categorical variables.

Mean

$$\hat{\bar{Y}} = \frac{(\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij})}{w}$$

Where

$$w_{\dots} = \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij}$$

Is the sum of the weights over all observations in the sample.

Confidence limit for the mean

The confidence limit is computed as

$$\hat{\bar{Y}} \pm StdErr\left(\hat{\bar{Y}}\right) . t_{df, \infty/2}$$

Where $\hat{\bar{Y}}$ is the estimate of the mean, $StdErr\left(\hat{\bar{Y}}\right)$ is the standard error of the mean, and $t_{df,\infty/2}$is the $100(1 - {}^{\infty}/_{2})$ percentile of the t distribution with the dfcalculated as described in the section "t Test for the Mean".

Proportions
The procedure estimates the proportion in level $c_k$for variable C as

$$\hat{p} = \frac{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}^{(q)}}{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij}}$$

Where $y_{hij}^{(q)}$ is value of the indicator function for level $C = c_k$
$y_{hij}^{(q)}$equals $\mathbf{1}$ if the observed value of variables C equals c_k, and
$y_{hij}^{(q)}$ equals $\mathbf{0}$ otherwise.

Total
The estimate of the total weighted sum over the sample,

[34] SAS SURVEYMEANS procedure. http://www.math.wpi.edu/saspdf/stat/pdfidx.htm

$$\hat{Y} = \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}$$

For a categorical variable level, $\hat{Y}$ estimates its total frequency in the population.

Variance and standard deviation of the total

$$\hat{V}(\hat{Y}) = \sum_{h=1}^{H} \frac{n_h(1-f_h)}{n_h - 1} \sum_{i=1}^{n_h} (y_{hi\cdot} - \bar{y}_{h\cdots})^2$$

Where

$$y_{hi\cdot} = \sum_{j=1}^{m_{hi}} w_{hij} y_{hij}$$

$$\bar{y}_{h\cdot\cdot} = (\sum_{i=1}^{n_h} y_{hi\cdot}) / n_h$$

The standard deviation of the total equals

$$Std(\hat{Y}) = \sqrt{\hat{V}(\hat{Y})}$$

Confidence limits of a total

$$\hat{Y} \pm StdErr\,(\hat{Y}).\, t_{df,\infty/2}$$

16.2 Changes between Y4 and Y5

1.5.1 Estimates of forest cover in Year 4

We can ignore that we have Year 5 information and obtain estimates of Year 4 forest cover. These can be compared to estimates obtained by other means. Table 5.3.1 shows the total areas classified as Degraded, Forest, and NonForest, together with a standard error and a 95% confidence interval. For example, the estimate of non-degraded Forest cover in Year 4 is 17,619,368 ha, standard error 23,250 ha, and 95% confidence interval (17,573,799 ha; 17,664,937 ha). We note that this estimate is smaller than other estimates seen.

Table 5.3.2 gives the same information as in Table 5.3.1, but shows proportions rather than totals. So, the proportion of Year 4 Forest cover is 0.8877, standard error 0.0012, 95% confidence interval (0.8855, 0.8900). Note that proportions add to one.

Table 5.3.1. Analysis of Y4 hectares of all classes

	Hectares	SE	2.5%	97.5%
Y4 Degraded forest	233,971.4	8,360.4	217,585.4	250,357.3
Y4 Non degraded forest	17,619,368.2	23,249.9	17,573,799.2	17,664,937.2
Y4 Non forest	1,994,052.2	22,225.1	1,950,491.8	2,037,612.7

Table 5.3.2. Analysis of Y4 proportions of all classes

	Mean	SE	2.5%	97.5%
Y4 Degraded forest	0.0118	0.0004	0.0110	0.0126
Y4 Non-degraded forest	0.8877	0.0012	0.8854	0.8900
Y4 Non-forest	0.1005	0.0011	0.0983	0.1027

1.5.2 Estimates of forest cover in Year 5

We now repeat these analyses for Year 5. Table 5.3.3 shows the total areas classified as degraded forest, non-degraded forest, and non-forest, together with a standard error and a 95% confidence interval. For example, the estimate of non-degraded forest cover in Year 5 is 17,604,654 hectares, standard error 23,299 hectares, and 95% confidence interval (17,558,990; 17,650,319) hectares.

Table 5.3.4 shows proportions instead of totals. Otherwise the interpretation is as for Year 4.

5.3.3 Analysis of Y5 hectares of all classes				
	Hectares	SE	2.5%	97.5%
Y5 Degraded forest	236,466.6	8,390.5	220,021.6	252,911.6
Y5 Non-degraded forest	17,604,654.3	23,298.5	17,558,990.1	17,650,318.5
Y5 Non forest	2,006,270.8	22,269.1	1,962,624.3	2,049,917.4

5.3.4 Analysis of Y5 proportions of all classes				
	Mean	SE	2.5%	97.5%
Y5 Degraded forest	0.0119	0.0004	0.0111	0.0127
Y5 Non-degraded forest	0.8870	0.0012	0.8847	0.8893
Y5 Non forest	0.1011	0.0011	0.0989	0.1033

16.3 Estimates of change from Year 4 to Year 5.

We analyse change from Year 4 to Year 5 as follows. We have matched pairs of sample data, where the hectares seen in Year 4 are seen again in Year 5. Therefore it is natural to concentrate upon the change for each pair. This is analogous to the matched paired t-test, where we calculate differences between pairs, and then analyse the differences.

There are three possible outcomes for each pair, depending on how the hectare was classified in Year 4. If the classification had been Forest (non-degraded), the possibilities are Forest in Year 4 and Year 5, Forest in Year 4 and Degraded in Year 5, and Forest in Year 4 and Non Forest in Year 5. Therefore, these will result a total of nine possible combinations of change.

Table 5.3.5a shows estimates for the total number of hectares of each observed combination. As an example, we estimate the area of Guyana which was classified as Forest (non-degraded) in Year 4 and Forest (non-degraded) in Year 5. The estimate is 17,604,654 hectares, standard error 23,299 ha 95% confidence interval (17,558,990; 17,650,319) hectares.

In Table 5.3.5b we estimate the area of Guyana which was classified as Forest in Year 4 and NonForest in Year 5. The estimate is 12,219 hectares, standard error 1,506 hectares, 95% confidence interval (9,267 ha; 15,171 ha). Table-M2 in the appendix gives the same information as Table 5.3.5a, but disaggregated by stratum. Table-M3 in the appendix gives the same information, but shows proportions rather than totals. In Year 5 we found no change from Non-Forest to Forest or Degraded Forest (reforestation). Note that it would be difficult to identify reforestation with any certainty in the LR stratum because only RapidEye data is available. Nevertheless, no reforestation was found in either the HR or MR strata using the high resolution GeoVantage imagery.

Table 5.3.5a. Analysis of Y4-Y5 totals of class changes				
	Hectares	SE	2.5%	97.5%
Y4-Y5 Forest/Degraded to Forest	17,604,654.3	23,298.5	17,558,990.1	17,650,318.5
Y4-Y5 Forest/Degraded to NonForest	12,218.6	1,506.2	9,266.6	15,170.6
Y4-Y5 NonForest to NonForest	1,994,052.2	22,225.1	1,950,491.8	2,037,612.7
Y4-Y5Forest/Degraded to Degradation	236,466.6	8,390.5	220,021.6	252,911.6

Table 5.3.5b. Total deforestation in hectares Y4 to Y5				
	Hectares	SE	2.5%	97.5%
Forest loss	12,218.6	1,506.2	9,266.6	15,170.6

The change from forest to degraded forest shown is estimated quantitatively using 10 m grids within each hectare. The amount of loss is classed as degraded forest up to the point that 30% or less of the area is forest canopy covered; that it would be classed as deforested. In this way partial deforestation and forest degradation is assessed quantitatively within each sample area. The total area for change from Forest to Degraded forest is presented in table 5.3.6 as 7,377 hectares, standard error 1,230 hectares, 95% confidence interval (4,966 ha; 9,787 ha), see table 5.3.7a. Tables 5.3.7 and 5.3.8 show the same data as and totals disaggregated by stratum. Note that no degradation was identified in any of the LR samples.

Table 5.3.6 Total area change from Forest to Degraded from Y4 to Y5				
	Hectares	SE	2.5%	97.5%
Forest Degradation	7,376.7	1,229.8	4,966.3	9,787.1

Table 5.3.7 Proportion Forest Degraded (as %) per hectare by stratum between Y4 and Y5				
Forest Degradation	Mean	SE	2.5%	97.5%
HR	0.00207	0.00034	0.00139	0.00274
MR	0.00020	0.00011	-0.00003	0.00042

Table 5.3.8 Estimate of forest area degraded (in hectares) between Y4 and Y5 by stratum				
Forest Degradation	Hectares	SE	2.5%	97.5%
HR	6,234.1	1,037.9	4,199.9	8,268.4
MR	1,142.5	659.6	-150.2	2,435.3

16.4 Estimating rate of change

The key issue is to estimate the rate of change of gross deforestation. To do this, we restrict attention to hectares which in Year 4 were classified as forest or degraded, and then estimate the rates at which they continued to be Forest, or were classified as non-forest.

Table 5.4.1 shows the rate of change from a forest land cover class (that is undisturbed forest or degraded forest) to non-forest. The estimated rate of change from Year 4 to Year 5 is 0.062% with a standard error of 0.008%, 95% confidence interval (0.047%; 0.076%). The estimated rate of change for undisturbed forest to non-forest is 0.04% SE 0.005 and the rate of change from degraded forest to non-forest is 0.046% SE 0.002, see table 5.4.2.

Table 5.4.1 Mean Deforestation rate per hectare (%) Forest/Degraded forest → Non forest				
	Mean	SE	2.5%	97.5%
Year 5 Forest loss	0.062	0.008	0.047	0.076

Table 5.4.2 Rate of forest change (as %) between Y4 and Y5				
	Mean	SE	2.5%	97.5%
Forest → Non Forest	0.040	0.005	0.029	0.051
Forest → Degraded forest	0.046	0.002	0.002	0.091

16.5 Deforestation rate comparison

Tables 5.4.1 and 5.5.1 show the Year 4 to Year 5 deforestation area and rate data compared. Note that the map-based estimate does not have a standard error associated with it but that the mapping and the change sample estimates for deforestation are of similar magnitude. We note that the MRV Year 5 reported area of forest changed to degraded forest is 4,231 ha; this accounts a 121 ha decrease to the reported Year 4 estimate of 4 352 ha. The sample-based estimate we derive gives a rate of degradation of 0.046% with a standard error of 0.022. This corresponds to an estimated area of degradation of 7,377 ha which is a noticeably larger area that mapped by GFC.

Table 5.5.1 Comparison of Forest Change (Year 4 – Year 5) Estimates Source				
		Forest area change (ha) Year 4 – Year 5	Year 5 Rate (%)	SE of Y5 Rate (%)
IAP/GFC	GIS Deforestation Estimate	11,964	0.065	
DU	Sample Estimate Deforestation	12,219	0.062	0.008
IAP/GFC	GIS Degradation Estimate	4,231[35]		
DU	Sample Estimate Degradation	7,377	0.046	0.022

[35] Excluding areas of forest degradation associated to the rotational shifting cultivation.

17. DISCUSSION

The results divide into two areas that warrant further discussion:

i) reliability of the procedures used to identify deforestation and attribute the correct driver (reason for the change) from satellite imagery;

ii) estimation of drivers of forest loss and forest degradation.

17.1 Sampling

The approach taken by GFC to produce a comprehensive (wall-to-wall) map for forest / non-forest for Guyana is ambitious and provides very precise, location-specific data. The mapped area of forest loss agrees well with the sample-based estimate giving confidence in the precision of the MRV mapping based on RapidEye imagery. The change estimate did not check the map product; rather it estimated forest loss from an independent probability-based sample. The results suggest that forest loss could be estimated to a good level of accuracy using sampling. Deforestation can be identified easily from RapidEye data and so the wall-to-wall coverage makes this task straightforward. Estimating forest degradation is more challenging using RapidEye data and this is where the sample grids of GeoVantage aerial imagery help to identify and quantify degradation and forest loss through degradation creep (loss less than 30% of one hectare).

Using a change sample is clearly the most efficient and powerful way to detect change over a year. The levels of precision achieved are not likely to be much improved by taking a larger sample. For example, in Year 5 the number of first-stage samples increased from 143 to 313 and the total sample size increased from 55,119 ha to 93,900 ha. However the Standard Error of the estimate of forest loss only decreased from 1,819 ha to 1,506 ha. This suggests and taking a larger sample is unlikely to result in any improvement in precision. Indeed there may be an argument for taking a smaller sample as the 55,000 ha Year 4 sample delivered 83% of the current precision, even with less efficient stratification.

Table 6.1 Allocation of samples to strata

Stratum	Area (ha)	First stage samples	Hectares assessed	Proportional allocation	Neyman allocation	Y5-Actual allocation
Low	10,784,358	204	61,200	54.4%	60.14%	65.18%
Medium	5,826,940	51	15,300			
High	3,220,973	58	17,400	45.6%	39.86%	34.82%
Total	**19,832,271**	**313**	**93,900**	**100.0%**	**100.00%**	**100.00%**

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In Year 4 approximately 50% (70) of the 142 first-stage samples were allocated to the Low Risk stratum and 50% (73) to the High Risk stratum. This distribution is not proportional to stratum area and could lead to overestimation of deforestation in the high risk stratum. However, proportional allocation is only optimal if the stratum variances are equal. In Guyana, High Risk samples have a greater variance than Low Risk and so proportional allocation should not be employed. An alternative approach is the Neyman allocation which is a special case of optimal allocation, where the costs of sampling units are the same, or nearly the same, across all strata. This can be assumed here as all units are sampled in approximately the same way. Optimal allocation provides the greatest precision for the least cost.

If the allocations of samples were optimal and used information on sample variance then allocation can be estimated from the Neyman sample optimisation equation, see Table 6.1. It is difficult to alter the distribution of sample locations in a change sample but additional random samples were flown in Y4 (but not analysed) which allows for a more efficient distribution. The actual distribution of samples in divided into three rather than two strata but if MR and HR are combined then the distribution in Year 5 is seen to be much closer to the optimal Neyman allocation than in Year 4.

17.2 Drivers of forest change

The results from the Durham University stratified sample confirms GFCs conclusion that mining and mining related infrastructure is the main driver for deforestation and forest degradation. In the Year 2 Accuracy Assessment report we noted that degradation was difficult to identify particularly in Landsat imagery. In Years 3 and 4 the amount of forest mapped as degraded rose sharply, most probably because of the ability to identify canopy openings and other forms of disturbance from the improved spatial and spectral resolution of RapidEye data and the availability of GeoVantage aerial image data for accuracy assessment.

Figure 6.2 shows the locations of change (Y4-Y5) samples from Forest/Forest Degradation to NonForest (deforestation), with the majority of those are located in areas within the HR stratum. Tables 6.2 show the deforestation data broken down by driver for assessment sample. The percentage refers to the number of one hectare sample out all samples units where change was identified and a driver assigned. The data show a number of areas of forest clearance for agriculture as well as change associated with mining and mining infrastructure. It must be noted (i) that drivers of change are easier to identify on GeoVantage imagery than on RapidEye and (ii) that GeoVantage was not available for the Low Risk stratum giving a possible bias in driver classification by stratum.

A complete breakdown of all the class changes observed from the reference data in Year 4 and Year 5 is shown in the Tables 7a-8b of the appendix of the change sample analysis report.

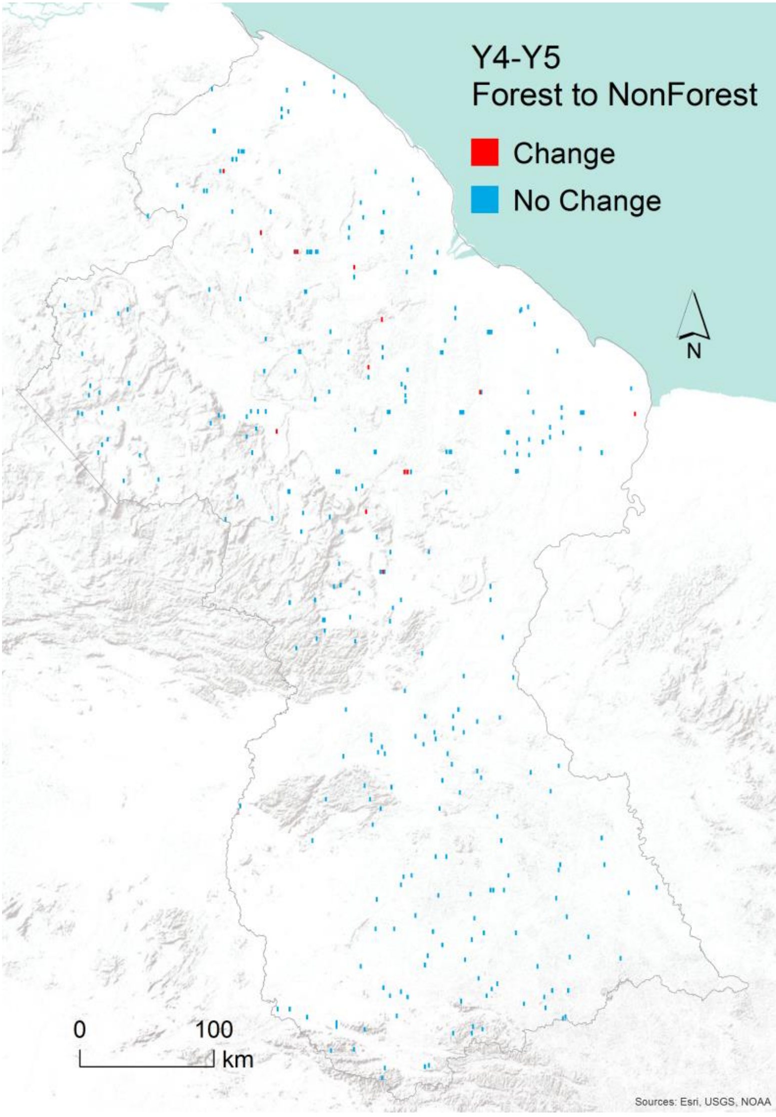

Figure 6.2 Locations of the change samples between Y4 and Y5 from Forest/Forest Degradation to NonForest

Table 6.3 shows that the drivers of degradation relate almost exclusively to mining and mining related activity.

Table 5.5.1 shows a difference of approximately 3146 ha in the estimation of forest degradation between the mapped degradation and the area estimated from the change-sample. It should be noted that the DU value is inclusive of all sources of degradation while the IAP/GFC value only reports the area that meets the current Interim Measures[36] (IM) definition. This definition excludes areas under rotational shifting cultivation which accounts for an additional 2358 ha.

For the remaining 953 ha, there are a number of possible reasons why these estimates might differ. First and most obviously, all of the degradation is found in the high risk and medium risk strata where GeoVantage data is available for accuracy assessment but not for the mapping. Therefore, degradation that does not relate to tree canopy loss might be missed easily in RapidEye data. Other possible reasons for the difference might include:

1. Accounting for the precise date of image capture; RapidEye images acquisition concluded in December 2014 whereas GeoVantage photography data were captured in July 2015.
2. The degradation identified by the accuracy assessment may have already been mapped by GFC; this could occur if degraded forest was mistaken for undisturbed forest in the Y4 imagery.
3. Cloud cover in the RapidEye data used by GFC could have obscured some degradation that could have been detected by the GeoVantage aerial imagery that generally avoided or flew under cloud.
4. The SOP mapping rules are interpreted differently by GFC and the accuracy assessment team because the accuracy assessment was working at the scale of a single hectare a one time.

Table 6.2 Drivers of deforestation between Y4 and Y5

Driver	Proportion
Agriculture	48.44%
Mining	45.31%
Forest road	1.56%
Settlements	1.56%
Unknown	3.12%
Total	100%

Table 6.3 Drivers of degradation between Y4 and Y5

Driver	Proportion
Mining	44.74%
Mining road	39.47%
Settlement	7.90%
Unknown	7.90%
Total	100%

[36] Determine the extent of degradation associated with new infrastructure such as mining, roads, settlements post the benchmark period

18. SUMMARY AND CONCLUSIONS

11. We conclude that the estimates of deforestation based on the mapping undertaken by GFC based largely on interpretation of RapidEye imagery is of a good standard.

12. The methods used by GFC, and assisted by IAP, follow the good practice recommendations set out in the GOFC-GOLD guidelines and considerable effort has been made to acquire cloud free imagery towards the end of the census period January to December 2014 (Year 5).

13. The GeoVantage aerial photography was of good spatial resolution and radiometric quality and this helped remove much of the ambiguity and uncertainty associated with the validation process for the Medium and High Risk strata. GeoVantage data were needed to help identify forest degradation and partial deforestation within sample areas.

14. The estimate of the annual rate of deforestation that occurred in 2014 (Year 5) is 0.062%, SE 0.008%. This is almost identical to the deforestation rate derived from the wall-to-wall mapping from the MRVS of 0.065%.

15. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Non-forest and Degraded forest to Non-forest is 12,219 hectares with a standard error of 1,506 ha and a 95% confidence interval (9,267 ha; 15,171 ha).

16. The estimate of the annual rate of the rate change from Forest to Degraded forest between Y4 and Y5 is 0.046% with a standard error of 0.022%.

17. The estimate of the annual area of change from January to December 2014 (Year 5) Forest to Degraded forest is 7,377 hectares with a standard error of 1,230 ha and a 95% confidence interval (4,966 ha; 9,787 ha).

18. The new stratification improved the precision of the estimate of deforestation. The Low Risk stratum now contains a very low proportion of samples exhibiting change and accounts for only 5,777 ha of forest loss, of which only 3,354 ha is loss from non-degraded forest. The standard error of the estimate is 1,506 compared with a SE of 1,819 ha in Year 4.

19. The GIS data file containing all of the change sample areas is available and can be used to help cross check interpretations.

20. The results from the change sample analysis confirms GFCs conclusion that mining and mining related infrastructure and clearance for agriculture are the main drivers for both deforestation. For forest degradation mining and mining roads are the dominant cause of change.

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20. APPENDIX

Output tables from R Package data analysis

Table-1a Y4 Hectares all classes				
Class	Hectares	SE	2.5%	97.5%
Y4 Degradation	233971.4	8360.35	217585.4	250357.3
Y4 Forest	17619368.2	23249.92	17573799.2	17664937.2
Y4 NonForest	1994052.2	22225.13	1950491.8	2037612.7

Table-2a Y4 Hectares all-classes by stratum				
Class	Hectares	SE	2.5%	97.5%
HR:Y4 Degradation	80004.8	3672.5	72806.8	87202.8
LR:Y4 Degradation	3913.3	853.8	2239.9	5586.8
MR:Y4 Degradation	150053.2	7461.8	135428.3	164678.2
HR:Y4 Forest	2763456.3	6289.7	2751128.7	2775783.9
LR:Y4 Forest	10282335.3	11238.8	10260307.6	10304362.9
MR:Y4 Forest	4573576.6	19356.9	4535637.9	4611515.4
HR:Y4 NonForest	169014.5	5256.2	158712.5	179316.5
LR:Y4 NonForest	721727.6	11210.6	699755.3	743699.9
MR:Y4 NonForest	1103310.1	18456.7	1067135.6	1139484.7

Table-1b Y4 proportions all classes				
Class	Mean	SE	2.5%	97.5%
Y4 Degradation	0.0118	0.0004	0.011	0.0126
Y4 Forest	0.8877	0.0012	0.8854	0.89
Y4 NonForest	0.1005	0.0011	0.0983	0.1027

Table-2b Y4 proportions all-classes by stratum				
Class	Mean	SE	2.5%	97.5%
HR:Y4 Degradation	0.0266	0.0012	0.0242	0.0289
LR:Y4 Degradation	0.0004	0.0001	0.0002	0.0005
MR:Y4 Degradation	0.0258	0.0013	0.0232	0.0283
HR:Y4 Forest	0.9173	0.0021	0.9132	0.9214
LR:Y4 Forest	0.9341	0.001	0.9321	0.9361
MR:Y4 Forest	0.7849	0.0033	0.7784	0.7914
HR:Y4 NonForest	0.0561	0.0017	0.0527	0.0595
LR:Y4 NonForest	0.0656	0.001	0.0636	0.0676
MR:Y4 NonForest	0.1893	0.0032	0.1831	0.1956

Table-3a Y5 Hectares all classes				
Class	Hectares	SE	2.5%	97.5%
Y5 Degradation	236466.6	8390.464	220021.6	252911.6
Y5 Forest	17604654.3	23298.502	17558990.1	17650318.5
Y5 NonForest	2006270.8	22269.062	1962624.3	2049917.4

Table-4a Y5 Hectares all-classes by stratum				
Class	Hectares	SE	2.5%	97.5%
HR:Y5 Degradation	84160.9	3764	76783.6	91538.3
LR:Y5 Degradation	1490.8	527	457.8	2523.8
MR:Y5 Degradation	150814.9	7480.3	136153.9	165476
HR:Y5 Forest	2753239.2	6405.6	2740684.5	2765793.9
LR:Y5 Forest	10278981	11262.9	10256906.1	10301055.9
MR:Y5 Forest	4572434.1	19363.3	4534482.8	4610385.4
HR:Y5 NonForest	175075.5	5343.9	164601.6	185549.4
LR:Y5 NonForest	727504.4	11252.2	705450.5	749558.3
MR:Y5 NonForest	1103691	18459.2	1067511.6	1139870.3

Table-3b Y5 proportion all classes				
Class	Mean	SE	2.5%	97.5%
Y5 Degradation	0.0119	0.0004	0.0111	0.0127
Y5 Forest	0.887	0.0012	0.8847	0.8893
Y5 NonForest	0.1011	0.0011	0.0989	0.1033

Table-4b Y5 proportion classes by stratum				
Class	Mean	SE	2.5%	97.5%
HR:Y5 Degradation	0.0279	0.0012	0.0255	0.0304
LR:Y5 Degradation	0.0001	0	0	0.0002
MR:Y5 Degradation	0.0259	0.0013	0.0234	0.0284
HR:Y5 Forest	0.9139	0.0021	0.9098	0.9181
LR:Y5 Forest	0.9338	0.001	0.9318	0.9358
MR:Y5 Forest	0.7847	0.0033	0.7782	0.7912
HR:Y5 NonForest	0.0581	0.0018	0.0546	0.0616
LR:Y5 NonForest	0.0661	0.001	0.0641	0.0681
MR:Y5 NonForest	0.1894	0.0032	0.1832	0.1956

Table-5a Y4Y5 total class changes				
Class	Hectares	SE	2.5%	97.5%
Y4Y5 Degradation-Degradation	229089.9	8304.6	212813.3	245366.6
Y4Y5Forest-Degradation	7376.7	1229.8	4966.3	9787.1
Y4Y5 Forest-Forest	17604654.3	23298.5	17558990.1	17650318.5
Y4Y5 Degradation-NonForest	4881.4	977.8	2965	6797.8
Y4Y5 Forest-NonForest	7337.2	1146.2	5090.7	9583.7
Y4Y5 NonForest-NonForest	1994052.2	22225.1	1950491.8	2037612.7

Table-6a Y4Y5 total changes by stratum				
Class	Hectares	SE	2.5%	97.5%
HR:Y4Y5 Degradation-Degradation	77926.8	3625.8	70820.4	85033.2
LR:Y4Y5 Degradation-Degradation	1490.8	527	457.8	2523.8
MR:Y4Y5 Degradation-Degradation	149672.4	7452.6	135065.5	164279.2
HR:Y4Y5 Forest-Degradation	6234.1	1038	4199.7	8268.5
LR:Y4Y5Forest-Degradation	0	0	0	0
MR:Y4Y5Forest-Degradation	1142.5	659.6	-150.3	2435.3
HR:Y4Y5Forest-Forest	2753239.2	6405.6	2740684.5	2765793.9
LR:Y4Y5Forest-Forest	10278981	11262.9	10256906.1	10301055.9
MR:Y4Y5Forest-Forest	4572434.1	19363.3	4534482.8	4610385.4
HR:Y4Y5Degradation-NonForest	2078	599.7	902.7	3253.4
LR:Y4Y5Degradation-NonForest	2422.5	671.8	1105.8	3739.3
MR:Y4Y5Degradation-NonForest	380.8	380.8	-365.6	1127.3
HR:Y4Y5Forest-NonForest	3982.9	830	2356.2	5609.6
LR:Y4Y5Forest-NonForest	3354.3	790.5	1804.9	4903.6
MR:Y4Y5Forest-NonForest	0	0	0	0
HR:Y4Y5NonForest-NonForest	169014.5	5256.2	158712.5	179316.5
LR:Y4Y5NonForest-NonForest	721727.6	11210.6	699755.3	743699.9
MR:Y4Y5NonForest-NonForest	1103310.1	18456.7	1067135.6	1139484.7

Table-5b Y4Y5 proportion changes				
Class	Mean	SE	2.5%	97.5%
Y4Y5 Degradation-Degradation	0.01154	0.00042	0.01072	0.01236
Y4Y5 Forest-Degradation	0.00037	0.00006	0.00025	0.00049
Y4Y5 Forest-Forest	0.887	0.00117	0.8847	0.8893
Y4Y5 Degradation-NonForest	0.00025	0.00005	0.00015	0.00034
Y4Y5 Forest-NonForest	0.00037	0.00006	0.00026	0.00048
Y4Y5 NonForest-NonForest	0.10047	0.00112	0.09827	0.10266

Table-6b Y4Y5 proportion changes by stratum				
Class	Mean	SE	2.5%	97.5%
HR:Y4Y5 Degradation-Degradation	0.02587	0.0012	0.02351	0.02823
LR:Y4Y5 Degradation-Degradation	0.00014	0.00005	0.00004	0.00023
MR:Y4Y5 Degradation-Degradation	0.02569	0.00128	0.02318	0.02819
HR:Y4Y5 Forest-Degradation	0.00207	0.00034	0.00139	0.00274
LR:Y4Y5 Forest-Degradation	0	0	0	0
MR:Y4Y5 Forest-Degradation	0.0002	0.00011	-0.00003	0.00042
HR:Y4Y5 Forest-Forest	0.91395	0.00213	0.90978	0.91811
LR:Y4Y5 Forest-Forest	0.93378	0.00102	0.93177	0.93578
MR:Y4Y5 Forest-Forest	0.78471	0.00332	0.77819	0.79122
HR:Y4Y5 Degradation-NonForest	0.00069	0.0002	0.0003	0.00108
LR:Y4Y5 Degradation-NonForest	0.00022	0.00006	0.0001	0.00034
MR:Y4Y5 Degradation-NonForest	0.00007	0.00007	-0.00006	0.00019
HR:Y4Y5 Forest-NonForest	0.00132	0.00028	0.00078	0.00186
LR:Y4Y5 Forest-NonForest	0.0003	0.00007	0.00016	0.00045
MR:Y4Y5 Forest-NonForest	0	0	0	0
HR:Y4Y5 NonForest-NonForest	0.0561	0.00174	0.05269	0.05952
LR:Y4Y5 NonForest-NonForest	0.06556	0.00102	0.06357	0.06756
MR:Y4Y5 NonForest-NonForest	0.18935	0.00317	0.18314	0.19555

Table-M1 Y4Y5 totals changes from Forest/Degraded

Class	Hectares	SE	2.5%	97.5%
Y4FY5 Forest/Degraded-Degradation	236466.6	8390.5	220021.6	252911.6
Y4FY5 Forest/Degraded-Forest	17604654.3	23298.5	17558990.1	17650318.5
Y4FY5 Forest/Degraded-NonForest	12218.6	1506.2	9266.6	15170.6
Y4FY5 NonForest-NonForest	1994052.2	22225.1	1950491.8	2037612.7

Table-M2 Y4Y5 totals changes by-stratum from Forest/Degraded

Class	Hectares	SE	2.5%	97.5%
HR:Y4Y5 Forest/Degraded-Degraded	84160.9	3764	76783.6	91538.3
LR:Y4Y5 Forest/Degraded-Degraded	1490.8	527	457.8	2523.8
MR:Y4Y5 Forest/Degraded-Degraded	150814.9	7480.3	136153.9	165476
HR:Y4Y5 Forest/Degraded-Forest	2753239.2	6405.6	2740684.5	2765793.9
LR:Y4Y5 Forest/Degraded-Forest	10278981	11262.9	10256906.1	10301055.9
MR:Y4Y5 Forest/Degraded-Forest	4572434.1	19363.3	4534482.8	4610385.4
HR:Y4Y5 Forest/Degraded-NonForest	6061	1023.5	4055	8067
LR:Y4Y5 Forest/Degraded-NonForest	5776.8	1037.3	3743.8	7809.8
MR:Y4Y5 Forest/Degraded-NonForest	380.8	380.8	-365.6	1127.3
HR:Y4Y5 NonForest-NonForest	169014.5	5256.2	158712.5	179316.5
LR:Y4Y5 NonForest-NonForest	721727.6	11210.6	699755.3	743699.9
MR:Y4Y5 NonForest-NonForest	1103310.1	18456.7	1067135.6	1139484.7

Table-M3 Y4Y5 proportion changes Forest/Degraded

Class	Mean	SE	2.5%	97.5%
Y4FY5 Forest/Degraded-Degraded	0.01191	0.00042	0.01109	0.01274
Y4FY5 Forest/Degraded-Forest	0.887	0.00117	0.8847	0.8893
Y4FY5 Forest/Degraded-NonForest	0.00062	0.00008	0.00047	0.00076
Y4FY5 NonForest-NonForest	0.10047	0.00112	0.09827	0.10266

Table-M4 Y4Y5 proportion changes by stratum from Forest/Degraded				
Class	Mean	SE	2.5%	97.5%
HR:Y4FY5 Forest/Degraded-Degraded	0.02794	0.00125	0.02549	0.03039
LR:Y4FY5 Forest/Degraded-Degraded	0.00014	0.00005	0.00004	0.00023
MR:Y4FY5 Forest/Degraded-Degraded	0.02588	0.00128	0.02337	0.0284
HR:Y4FY5 Forest/Degraded-Forest	0.91395	0.00213	0.90978	0.91811
LR:Y4FY5 Forest/Degraded-Forest	0.93378	0.00102	0.93177	0.93578
MR:Y4FY5 Forest/Degraded-Forest	0.78471	0.00332	0.77819	0.79122
HR:Y4FY5 Forest/Degraded-NonForest	0.00201	0.00034	0.00135	0.00268
LR:Y4FY5 Forest/Degraded-NonForest	0.00052	0.00009	0.00034	0.00071
MR:Y4FY5 Forest/Degraded-NonForest	0.00007	0.00007	-0.00006	0.00019
HR:Y4FY5 NonForest-NonForest	0.0561	0.00174	0.05269	0.05952
LR:Y4FY5 NonForest-NonForest	0.06556	0.00102	0.06357	0.06756
MR:Y4FY5 NonForest-NonForest	0.18935	0.00317	0.18314	0.19555

Table-7a Y4Y5 totals class-changes from Forest				
Class	Hectares	SE	2.5%	97.5%
Y4Y5Forest-Degradation	7376.7	1229.7	4966.4	9786.9
Y4Y5Forest-Forest	17604654.3	1680.1	17601361.3	17607947.3
Y4Y5Forest-NonForest	7337.2	1146.1	5090.8	9583.6

Table-7b Y4Y5 totals class-changes from Forest by stratum				
Class	Hectares	SE	2.5%	97.5%
HR:Y4Y5 Forest-Degradation	6234.1	1037.9	4199.9	8268.4
LR:Y4Y5 Forest-Degradation	0	0	0	0
MR:Y4Y5 Forest-Degradation	1142.5	659.6	-150.2	2435.3
HR:Y4Y5 Forest-Forest	2753239.2	1327.7	2750636.9	2755841.5
LR:Y4Y5 Forest-Forest	10278981	790.5	10277431.7	10280530.3
MR:Y4Y5 Forest-Forest	4572434.1	659.6	4571141.3	4573726.9
HR:Y4Y5 Forest-NonForest	3982.9	829.9	2356.3	5609.5
LR:Y4Y5 Forest-NonForest	3354.3	790.5	1804.9	4903.6
MR:Y4Y5 Forest-NonForest	0	0	0	0

Table-8a Y4Y5 proportions class changes from Forest				
Class	Mean	SE	2.5%	97.5%
Y4Y5 Forest-Degradation	0.00042	7.00E-05	0.00028	0.00056
Y4Y5 Forest-Forest	0.99916	1.00E-04	0.99898	0.99935
Y4Y5 Forest-NonForest	0.00042	7.00E-05	0.00029	0.00054

Table-8b Y4Y5 proportions class-changes from Forest				
Class	Mean	SE	2.5%	97.5%
HR:Y4Y5Forest.Degradation	0.00226	0.00038	0.00152	0.00299
LR:Y4Y5Forest.Degradation	0	0	0	0
MR:Y4Y5Forest.Degradation	0.00025	0.00014	-0.00003	0.00053
HR:Y4Y5Forest.Forest	0.9963	0.00048	0.99536	0.99724
LR:Y4Y5Forest.Forest	0.99967	0.00008	0.99952	0.99982
MR:Y4Y5Forest.Forest	0.99975	0.00014	0.99947	1.00003
HR:Y4Y5Forest.NonForest	0.00144	0.0003	0.00085	0.00203
LR:Y4Y5Forest.NonForest	0.00033	0.00008	0.00018	0.00048
MR:Y4Y5Forest.NonForest	0	0	0	0

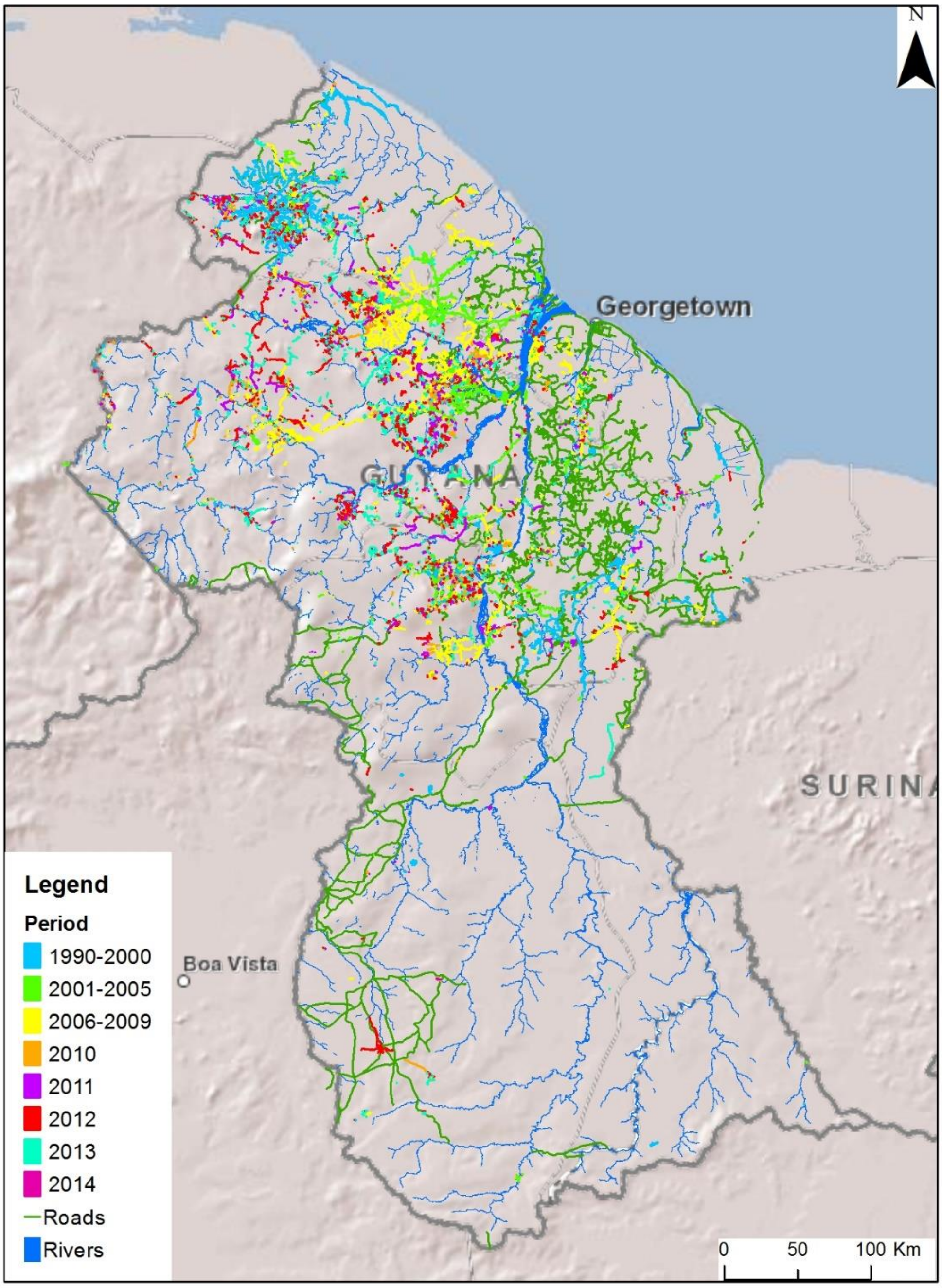
Table-X1 Mean Deforestation per hectare				
Class	Mean	SE	2.5%	97.5%
loss	0.0004017	5.34E-05	0.0002971	0.0005063

Table-X2 Mean Deforestation per-hectare by stratum				
Class	Mean	SE	2.5%	97.5%
HR	0.0013786	0.0002158	0.0009557	0.0018015
LR	0.0002882	0.0000686	0.0001537	0.0004226
MR	0.0000666	0.0000386	- 0.0000091	0.0001423

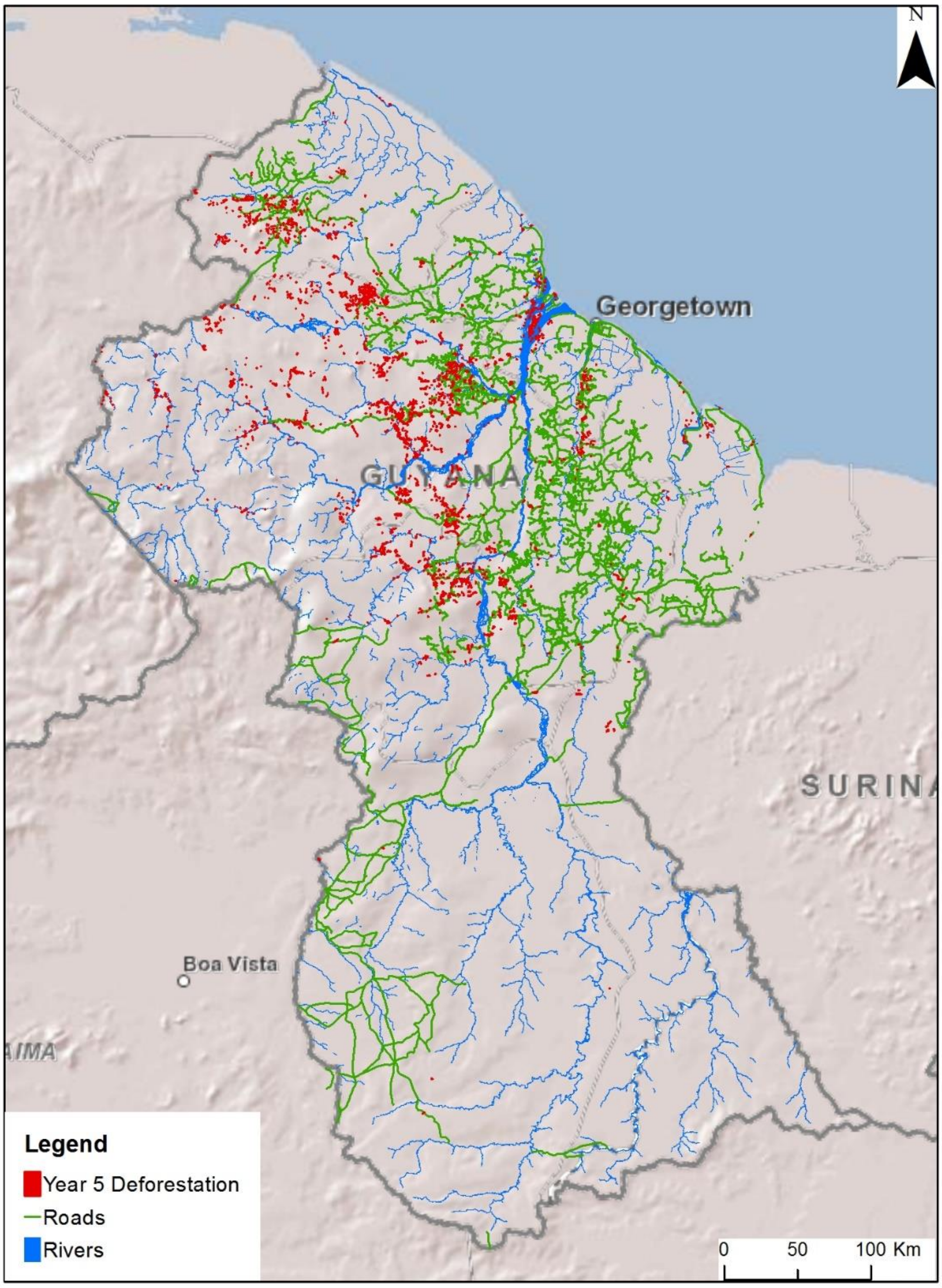
Appendix 8

Maps of Forest Area Change

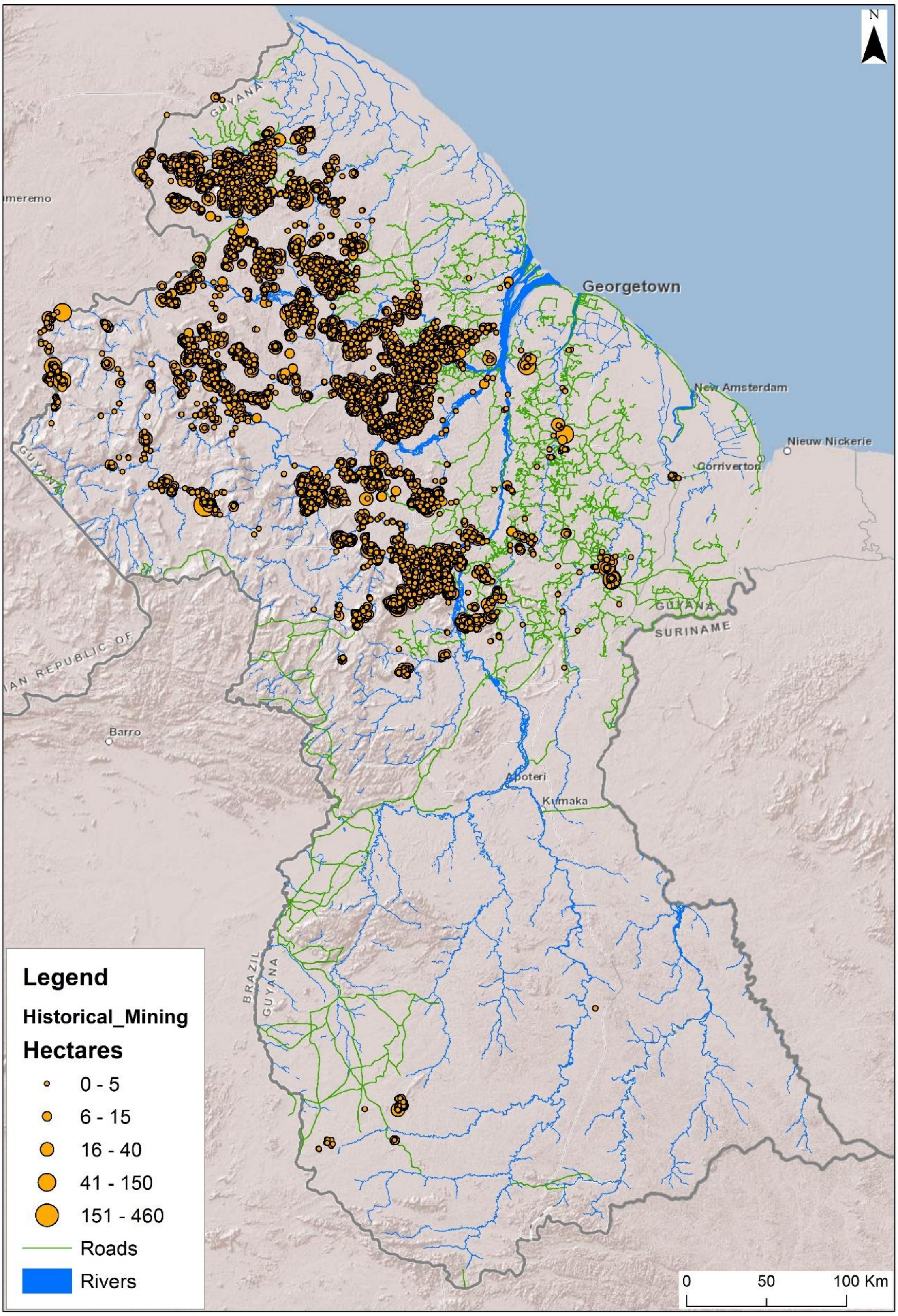
Historical Forest Area Change



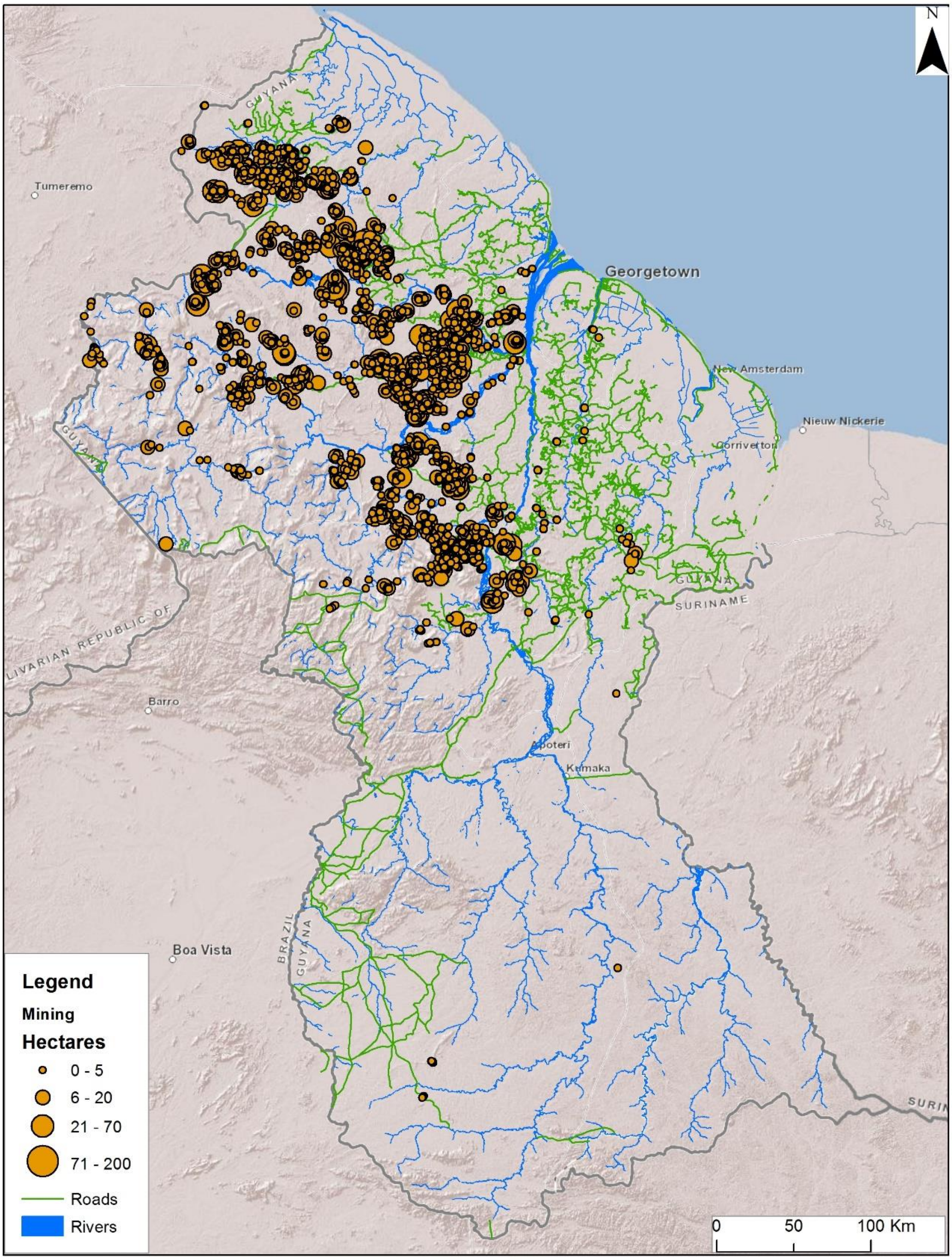
Year 5 Forest Area Change



Historical Spatial Area of Deforestation – Mining



Year 5 Spatial Area of Deforestation – Mining



Appendix 9

Comments and Responss from Public Review Process

Comments on MRVS Year 5 Report Ver. 1 (Conservation International, Guyana)	GFC's Response
CI-Guyana welcomes the opportunity to provide comments on the Year 5 Interim Measures Report (01 January 2014 – 31 December 2014). We commend the Guyana Forestry Commission (GFC) for the dedication it has placed on the completion of an assessment and report of a very high caliber. At this time when countries across the globe are discussing how they intend to contribute to addressing global climate change, the production of Guyana's fifth consecutive assessment of forest carbon is especially important. The continued operation and advancement of forest monitoring continues to place Guyana in the forefront of the global discussions REDD+. We expect that the results of Guyana's forest carbon monitoring efforts will be fully utilized by all agencies and organisations involved in the management of natural resources to ensure effective management of forest carbon. We offer for consideration the following comments and reactions intended to improve the accuracy, clarity, comprehensiveness and robustness of the Year 5 report, and further advance Guyana's Monitoring Reporting and Verification System (MRVS). These are presented noting that the current agreement between Guyana and Norway, under which these assessments have been completed, comes to an end this year and discussions are ongoing towards a continued relationship. Our comments also take into consideration the pioneering nature of Guyana's MRVS, and its potential to transform forest governance globally.	Thank you for the feedback and continued support. One main factor that has impacted on the continuous improvement of the MRVS has been the very constructive inputs, both technical and administrative that have been received every year through the public review process. We value these inputs and hopefully you see them being used and clearly reflected in improving the process for every progressive year's reporting. We have extended efforts to sharing the results across the natural resources management agencies. We also hope that the MRVS can continue to provide annual reporting and bring benefit locally and regionally. The Guyana Norway Agreement provided the main basis for the commencement of the MRVS. Given that this agreement has come to an end in June 2015, Year 6 of the MRVS will depend, in part, on current, ongoing discussions on a continued partnership. Based on the outcome of this, the shape of the Year 6 MRVS will reflect the developments over 2015 and may impact on aspects of future reporting under the MRVS, including satellite imagery options.
The shift toward reporting on LULUCF land classes in alignment with IPCC, and further division of the non-forest land classes will increase the efficiency at the level of national reporting for REDD+ and beyond. Monitoring of regeneration of deforested areas will help further refine assessments of carbon gains and provide insight into the time needed for return to permanent forest biomass cover. Progress to improve reporting on shifting cultivation will also provide important insights into	Our aim in moving to align the LULUCF and IPCC classes was to further advance synergy with international reporting requirements and standards. Our intention is for the medium term plan, to further pursue the establishment of an emission factor for regenerated areas. We have attempted in this year's assessment to commence the spatial reporting on regenerated areas. There is still a bit more that needs to be done to conclude the work on shifting agriculture and it is hoped that this will be concluded within Year 6 and at most,

the dynamics of land-use changes and emissions/sequestration. Such progress and strengths presented provide the foundations for stronger MRVS.	Year 7 of the MRVS development. The cycle of shifting agriculture, which demands a longer term time series of data to ascertain affirmative trends for Shifting Agriculture, will hopefully assist in the determination of firm and final conclusions on the monitoring of this driver. Ultimately however, it is hoped that the focus of the MRVS be based on the main drivers of forest change for both deforestation and forest degradation. As such, it is intended that for small scale, low impact drivers, that do not result in a significant impact on deforestation and forest degradation, and therefore forest carbon emissions, that these eventually be deemphasized in the interest of enhancing focus on the main drivers and maximizing the cost benefit of the programme. Of course, keeping a close watch to ensure that the trend in the drivers in terms of scale and type, do not change over time, and if this indeed happens that the system responds to the monitoring of these changes, should always be an equal priority.
Guyana's MRVS must inform improved land management, especially in forested areas. To this end, measures must be implemented to continue to mainstream the use of the MRVS outputs by land managers and other stakeholders to address the drivers of deforestation and as a layer of monitoring of their operations. The presentation of data on detected change in protected areas and titled Amerindian lands, as done for the intact forest landscape (IFL), is a necessary step in this regards. Making the spatial data on forest change more widely available is also necessary to enable address of the drivers and improve needed transparency.	We agree. The full use of the main results of the national MRVS have significant potential to inform not only decisions on land management but also land use planning. We therefore have available for use and will be ready to disseminate upon request, the results of the MRVS for purposes of national land use policy development, updating/revision of the Natural Resources Sector Strategy, or any other required activities. The data and results of the MRVS have been provided to the Geographic Information Management Unit of the Department of Natural Resources and the Environment which is responsible for further dissemination and analysis across the agencies. This data and results are also made available directly to the Agencies in the Department of Natural Resources and the Environment, along with the satellite imagery (for which 5 user licenses were acquired - RapidEye).

The JCN calls for transparency, including an “*institutionalized, systematic and transparent multi-stakeholder consultation process*” and a MRV system based on “*IPCC reporting principles of completeness, consistency, transparency*,…”. The report gives extensive details as to the methods and data used which is a commendable step towards ensuring transparency. The report however does not provide clear information on a few other aspect important to realizing transparency: 1.3.1 Are the data and images publically available for independent evaluation (beyond those carried out by University of Durham)? 1.3.2 Was external technical support received to carry out the mapping and, if yes, what was the extent and nature of that support? Given the importance of transparency as well as capacity-building under REDD+ readiness activities, it would be useful to clarify these aspects.	Thank you for you feedback on the matter of transparency. We share the view that full transparency can only be achieved if all essential aspects of the MRVS (data input, methods applied, accuracy assessment, results of the verification) embrace the tests of rigor that is expected for a MRVS to be credible and of a high standard. Over the years we have directed a concerted effort to attain a high level of transparency, and more importantly, improve on this level from year to year. Prior to addressing the specific points raised, we believe it is interesting to note the information below regarding the progressive efforts to strengthen and ensure transparency in the MRVS process: - The MRVS Report is subject to accuracy assessment that is done based on an independent data set - The Report is released for a period of one month for public review and feedback - All comments are openly addressed and feedback given to parties - The results are subject to independent verification - The independent verification is subject to a peer review The datasets acquired for the accuracy assessment are available for independent verification and are available, as are all other datasets, to DNV. Technical support has been received to conduct mapping and assessment for Year 5 and this has been decreasing to just focus on development areas and new design work. There has been an evident shift away from integral involvement from consultants in the mapping and assessment process and to more advisory involvement. However, the involvement of the consultants helps to add a layer of validation to finals results and methods that feed into the generation of these results. The GFC agrees that transparency and capacity building are two critical components of a well-developed MRVS.
1.4 Related to 1.2 above, continued detection of change IFL is cause for concern and signals the need for established means of securing forest carbon within this area. The continued absence of deliberate measures to address these continued impacts can jeopardize the success of Guyana’s REDD+ programme.	GFC agrees that monitoring Intact Forest Landscape has been helpful in understanding how larger areas of forests are being impacted by drivers of forest change. It should be noted that the majority of areas that are being lost are on Amerindian Lands which, if allowed for exclusion as the IFL clause speaks to, would eliminate significant areas under IFL loss reporting. Nevertheless, the point is valid as when REDD+ policies are operationalized, these may speak to the addressing of

	drivers (mining has been identified as the main driver leading to loss of IFL), and therefore address the issue of IFL.
2.1 It is noted that the INDUFOR logo does not appear on the Year 5 report whereas it was included in Year 4. We assume that this is an indication of enhanced local capacity for the operation of a rigorous MRVS. If this is so, it should be highlighted within the report.	Indufor's involvement in the Year 5 reporting has been more of an advisory nature. As such, the report is being issued by the GFC only, for the first time. This is clarified in the Preface of the Report. GFC also views this as an indication of growing capacity of the local team to undertake the majority of the national MRVS effort with internal resources.
2.2 We acknowledge the establishment and functioning of the National GIS Committee, the use of a common central repository for data for mainly state natural resource and environment agencies, and progress on a GIS policy. However, for a more effective and transparent MRVS and REDD+ programme, urgent effort is needed to provide the national Spatial Data Infrastructure to ensure involvement of other sectors and to make data more publicly available.	The effort as suggested for an integrated spatial data infrastructure is noted. This effort is being led by the Department of Natural Resources and the Environment. The GFC is engaged in the process, as a member.
2.3 It would be helpful to include a description of progress, plans, and challenges/barriers to the implementation of CMRV. The Year 4 report highlighted the potential for CMRV to contribute to the effectiveness of the national MRVS, and extensive attention is given to CMRV projects and their potential to contribute to the national MRVS in Guyana's communication with the Carbon Fund. The Yr5 report does not however seem to mention CMRV and its role.	Thank you for the comment. We have inserted a sub section that addresses this area in the Report – Section 5. In this section we shared information on its continued work on building capacities within communities to conduct Community Monitoring Reporting & Verification activities (CMRV) within the Konashen community.
2.4 The JCN states that the MRVS should incorporate Tier 3 elements by end of 2015, including "use of comprehensive field sampling that is linked to GIS based systems which integrates land use and management activity data." Beyond the IFM of logging activities, it is not clear in the MRVS Report as to what field sampling has been done or is planned. The use of validation via application of GeoVantage imagery is useful for cross-checking the validity of the RapidEye assessments and reaching some areas of consistent cloud cover. However, it is unclear in the report the extent of application of systematic sampling and ground-visits for validation beyond those mentioned under the monitoring of degradation (p19). There are several places where "field inspections"	This aspect of field based sampling linked to GIS based systems is the basis of the Forest Carbon Monitoring System. To date we have established plots across the three forest carbon strata – high, medium and low potential for change. This has been described in previous MRVS Reports. Work is also ongoing on establishing emissions factors for drivers of forest change, including for forest degradation. These plots are all linked to the GIS platform. Section 5 now includes a sub section that outlines these developments in 2014/2015.

and "field data" are mentioned but no clear explanation of how these were carried out, and their link to the maps.	
2.5 Page i. Reference should be made to Phase 2 of the Roadmap.	Thank you for this feedback. This Section has been modified to include the Phase 2 Roadmap.
2.6 Page i. Table S1 lists Reference Measure of 0.275% for deforestation yet the December 2014 document on Reference Levels proposes 0.25%. Please clarify this difference. 2.29 Reference Measures. The reference level proposal submitted to the UNFCCC in December 2014 sets the reference level "using a global percent of forest carbon emissions of 0.44%, as the global level, and establishing the historic annual average emissions percent level for Guyana (2001-2012). This is different to the reference measure listed in the MRVS (based on 0.52% rate as per FRA 2010 and agreed under JCN). *Summarised	The 0.275% used in the MRVS Report comes from the agreements of the Guyana Norway bilateral cooperation. Guyana has been working on a national position for Reference Level for REDD+ that includes exploration and consideration of other levels.
2.7 Page 3. The improvement in detection of forest area due to improved resolution mentioned should be stated as significant even though it does not affect the overall deforestation rate for Year 5.	Thank you, we agree. We have added this in the Executive Summary of the Report.
2.8 Page 5. Please clarify the total area represented by the "isolated pockets of private lands" under the State Lands category. It is understood to be small but the size will be helpful to better understanding the scale.	This is less than 1% of the total land category as the majority of areas are State Lands that are unallocated and allocated State Lands for purposes of Agriculture and other uses.
2.9 Page 6. The legend of Map 2-1 is difficult to read and the map is unclear at the scale of the report. We suggest using different patterns rather than different colour to distinguish the various areas. Consideration should also be given to including a larger size map in the report, possible in the appendices.	The map has been revised to enhance resolution overall, and visibility of the legend.
2.10 Page 9. In Section 4, does "commensurate with approach 3" mean Tier 3?	Approaches speak to the type of area change representation as explained in: http://www.fao.org/forestry/16663-0d866304c10b8384d90eb4fdef89867df.pdf Approach 3 speaks to tracking of land use conversion on a spatially explicit basis. IPCC outlines three methodological tiers of establishing inventory measurement systems (carbon/biomass, and emission factors) with Tier 3 representing the

	higher order method and lower uncertainties. The Guyana approach, combines Tier 3 for forest carbon and emissions reporting and Approach 3 for activity data. In summary therefore, these are two separate concepts with Guyana using Approach 3 and Tier 3.
2.11 Page 10. Please clarify to whom the datasets mentioned have "been provided" by agencies. Please also include clarification of the conditions which make the progressive updating of the data necessary. 2.13 Page 12. Please clarify the extent to which the maps, images, and datasets are available to the other agencies and the public.	Datasets have been made available to the natural resources agencies including the Guyana Geology and Mines Commission, through the repository of the Geographic information Management Unit of the Department of Natural Resources and the Environment. Conditions of use for the Rapid Eye Imagery allow for full user access as five licences have been acquired from the imagery provider. The details of the licence are available to each licence holder in the RapidEye User Agreement and entails the rights of each licence holder to generate individual products should they so desire. Every updated dataset is provided in the same format as the previous dataset which makes updating of existing layers easier. There are licence limitations on the RapidEye imagery that determine public dissemination of the imagery but results of analysis are freely available and can be accessed through the GFC. This point has been clarified in this Section of the report.
2.12 Page 12. Please clarify the role of the Protected Areas Commission under REDD+/MRVS as done for other agencies.	An outline of the role of the PAC has been included in this section. It is explained that the PAC has an important role to play in the MRVS process whereby an important area of land allocation and management as classified under the MRVS relate to Protected Areas. As such, the MRVS Report on the forest cover change in these areas, as well as loss of IFL, relate directly to Protected Areas. This therefore makes the data inputs from the PAC important to the MRVS process and the results of the reporting, a useful data platform for the PAC.
2.14 Page 16. Please clarify which areas are not feasible or unsafe for flights and if these are located in low risk areas due to distance from settlements, roads, etc.	The areas that were not feasible to fly, and have been unsafe to fly, are the areas that are mountainous to the western part of Guyana and to the deep south. These areas are in low risk stratum and do not have a high occurrence of settlements or roads, etc.
2.15 Section 5. The ER-PIN mentions the potential input of Global Canopy Programme, Project Fauna, and WWF data on shifting cultivation and secondary forests biomass. Please clarify how this data might have been used in this report and its potential to the MRVS.	These initiatives work at the community level in building technical and human capacities and therefore positively impacts on the CMRV, and by extension the national MRVS. It also helps the national MRVS have a wider understanding of shifting cultivation at the community level.

2.16 The approach implemented is robust. The use of EVI is supported by the scientific literature and the transition to RapidEye allows for high spatial resolution and temporal frequency of images. In comparison to Landsat, it is more effective in detecting degradation (see Hojas-Gascon et al 2015 experience in Tanzania). However, as is the case with many studies, there is a need for field data to determine the extent of degradation and related carbon emissions. This appears to be lacking from the current MRVS or the reporting does not make it sufficiently clear as to what field data is being used to cross-check. As GFC would be aware, there is potential for CMRV to contribute data to this process (see GCP/NRDDB/Iwokrama data on biomass in Minabs, ProjectFauna data for different forest types).	Thank you for the observation. GFC and Winrock Int. are in the process of assigning Emission Factors for degradation activities. In terms of the mapping approach the method implemented was developed in 2011. This process involved extensive fieldwork and analysis which is summarised in the Interim Measures Report http://www.forestry.gov.gy/wp-content/uploads/2015/09/Guyana-MRVS-Interim-Measures-Report-Year-2-V3.pdf From this work a Standard Operating Procedure was developed which has been in use since 2011. The mapping process and results have been subjected to independent annual accuracy assessment (University of Durham) which uses airborne aerial photography. In addition, the SOP and results are subject to an annual audit by DNV. Observations and comments made have led to improvements in GFC's SOP. It is anticipated that once the EF are incorporated, that a more accurate estimate of the Carbon emissions will result.
2.17 Progress is being made to refine emissions factors for Guyana and moved towards Tier 3 reporting (in some aspects this has already been achieved). The JCN states that an interim emissions factors of 100tC/ha will be used for reductions in deforestation (significantly below the actual carbon content of most forests in Guyana) and 400tC/ha will be assumed to be emitted by degradation (which is higher than actual emissions). The RL submitted in December 2014, however, is based on 300tC/ha for deforestation. Please clarify at what state these all will be aligned within the MRVS.	At the time of agreement of the JCN and commencement of the Guyana Norway agreement, the MRVS was just starting and as such, the technical work on forest carbon stock assessment had not yet started. We now have the majority of the results of this work which has informed the Report mentioned. An update on the recent development under the Forest Carbon Monitoring System has been included in Section 5. All aspects of this system are available for verification by DNV.
2.18 Page 23. The justification for the use of EVI is sound and well described in Bholanath & Cort, 2015. This information could be included to further clarify for readers.	Thank you for this recommendation. We have referenced this recent Paper in the Report for further reading. Some of the text taken from this Paper is also featured in this section.
2.19 Page 23. It would be helpful to explain how the distribution of the areas under constant cloud cover relates to those of high forest cover change. Further clarification is needed because 0.2% is greater than the annual deforestation rate.	Persistent areas of cloud are located around the coastal area and border with Venezuela. The cloud coverage is random, fragmented and scattered. Areas that cannot be mapped are tagged and revisited in the subsequent assessment periods. Figure 5-3 in the Year 4 and Report shows the persistent cloud coverage over a two year period. This illustrates that if temporal coverage are considered then it is possible for forest change to be detected and reported. There is

	therefore low risk of areas being missed in either the year of assessment of next reporting year.
2.20 Page 25. The addition of "settlements" as a driver in Year 4 is an important advance given urbanization (3.8% annual rate).	This is noted. The GFC shares the view that this is an area that should be continuously monitored and it also allows for synergies with IPCC categorisation.
2.21 Page 30. Assessment of "forest harvest" runs substantial risk of underestimating emissions given potential for illegal activities going undetected.	The GFC's system of monitoring forest management and illegal logging allows for a robust network of human and physical capabilities, spread at strategic point throughout Guyana to monitor logging activities. Through a combination of routine and impromptu audits, the GFC's system has the capability to detect occurrences of illegal logging and prevents these as well. These have been validated through various external audits.
2.22 Page 30. Under Natural Events, please clarify what types of events are included here so as to address the potential for misinterpretation of anthropogenic events as natural.	These changes are due to naturally occurring landsides, wind damage or fire. The remote location of these events is considered when they are mapped. Examples of these are provided in the SOP developed for mapping. These are available in previous Interim Measures Report. http://www.forestry.gov.gy/wp-content/uploads/2015/09/Guyana-MRVS-Interim-Measures-Report-Year-2-V3.pdf
2.23 Page 31. Please clarify the potential for leakage of forest change to Amerindian lands and other lands not eligible under the LCDS.	All areas are monitored based on a "wall to wall" analysis of Guyana's forest and land cover. As such, even though land classes and management systems are separated, all land and forest areas are monitored. There is therefore no potential that there will be leakage within or among categories, or that forest change will go undetected in Amerindian lands or any other category.
2.24 Page 31. A definition of the "carbon monitoring program" and how it contributes to the MRVS would be useful to be included.	A description of the Carbon Monitoring Programme has been provided in the Year 2 and 3 Reports, and a progress update in the Year 4 Report. We try to have each successive report feature on the new elements of the systems being developed and to that effect, we have included in Section 5 of this report the recent developments in the FCMS.
2.25 Page 33. Other studies indicate the rate of forest lost in the region could be higher than the figure cited from the forest resources assessment rates across South America. This further highlights the status of Guyana as a High Forest Low Deforestation country within that context.	This point is noted and we believe highlights the value of not using regional numbers only for forest area and change therein, but national number are proving to be critical in evaluating and analysing each individual country context.
2.26 Page 36. Under National Trends, forestry related degradation is reported to be relatively stable but this is an artifact of the methods for	The method of assessing forest harvest impacts is based on production levels and the gain/loss method. This takes into consideration the rate of legal and illegal logging. The method applied is one that is reflective of the IPCC guidance and

assessment (official records instead of direct/satellite observations) rather than necessarily a reflection of the reality on the ground.	accepted standards and reflects the varying levels of utilization. There has been indeed some movement in production levels across the years. This is reflected in the upward and downward movement in forest carbon impacts from forest harvest activities. Some aspects of forest harvest are reported on based on satellite imagery such as forest roads/infrastructure, however, the GFC's studies have shown over the past three years that the imagery, even at 5m resolution cannot reliably report on levels of harvest. A robust system of forest harvest volumes, that is open to independent verification, is still thought to be the more credible mechanism to report on forest harvest.
2.27 Pages 37-38. Maps 6-1 and 6-2 are very helpful in depicting the patterns and locations of deforestation over time. However, a larger map with greater detail and features (such as roads, rivers and places) to help identify locations should be included in the appendices.	Appendix 8 has been added and includes the recommended maps at larger scale.
2.28 Page 41. It is recognized that the extent of degradation, and thus emissions, will vary by fire intensity and frequency (see studies by Barlow et al as well as Nepstad et al in Brazil) and understory fires may remain undetected by satellite images (Alencar et al). Arnett et al (2015) indicate that RapidEye is capable of detecting low-intensity fires and damage at the tree level. Though the emissions from fires may be relatively small and difficult to detect, the extent to which this information might influence the MRVS should be discussed in the report given that climate change is likely to increase fire frequency and intensity, and that Guyana's MRVS is a model one.	Thank you for the reference. Fire is detected when associated with pastoral, agricultural and shifting cultivation activities. These are classed as land clearance activities, land clearance, or across the savannah regions. Additionally, the MRVS currently separates out degradation by Fire. The SOP outlines the protocols for monitoring degradation by forest fires which is based on the interpretation of the spectral signature (to differentiate this from shifting agriculture) and the extent of forest cover loss (to differentiate this from fire causing deforestation). The analysis is informed by fire points that is provided by FIRMS fire point data from MODIS. Fire frequency has changed over time and increases in frequency during the El Niño. If this weather pattern reoccurs then it likely that degradation events will increase in the drier savannah and coastal regions.
2.30 Page 51. It should be noted that the current methods go above and beyond what was required under the JCN (higher resolution images).	We agree and the main reason for the use of high resolution imagery has been to enable the more detailed mapping of various drivers of forest degradation, including small scale mining areas and infrastructure impacts. The use of RapidEye 5m imagery has worked well for this purposes as it has for the other areas of monitoring for the MRVS.
2.31 Page 51. Please clarify whether the purpose of the sentence; "Above ground biomass and below ground biomass combined represent approximately 75% of total carbon" is to highlight that soil carbon represents the remaining 25%.	The material referenced here is for Bolivia (from GOFC-GOLD Sourcebook). This interpretation is correct.

	In the case of Guyana, the value is 82% in AGB and BGB excluding dead wood, litter, and soil to 30 cm which account for the remaining percent. This has been clarified in the Report.
2.32 Page 51. Please clarify how peat soils and wetlands are treated.	All areas have been included in the national mapping and stratification and are also monitored for forest change through the national mapping effort. Soils are sampled across types and land classes and are included in results provided for each Stratum. Mangrove forest are included in monitoring of forest cover change as are Swamp forests. Wetlands, including the Rupununi wetlands are also include in the national MRVS mapping.
2.33 Page 52. The section on the IFL could be written to provide more clarity on what the IFL is and what its purpose is meant to be.	Text has been added to provide clarity on the Indicator of IFL and how this is part of the national MRVS Interim Reporting.
2.34 Page 53. The definition of industrial logging presented does not seem to be the most appropriate given the rarity of clear-felling in the tropical context.	We agree. This is the elaboration used by the definition of IFL. For this reason we have stated that this is indeed not applicable to the Guyana context.
2.35 Page 53. An area, partly covered by forest, in the Rupununi is allocated for oil exploration.	This point is noted and all areas of forest will continue to be monitored for forest area change in each assessment year. The drivers of forest change are tracked for each period and provided in the reporting format.
2.36 Page 54. The rationale behind the selection of the 50% loss of biomass in degraded areas should be discussed.	This has been a point of discussion for some time. The use of 50% was done at the start of the MRVS Reporting and used in the absence of a country based total at that time. Given that Guyana now has a well-developed system of MRVS, there are firm results that can be used that can well replace the 50% proxy. We will continue to follow up on this for any follow up reporting platforms.
2.37 Page 58. The use of VCS approved methods to estimate emissions from logging is a solid choice.	We also agree with this and for this reason have continued to use this method for this driver.
2.38 Page 69. The acronym ESA should be spelt out.	This has been spelt out in the revised report.
2.39 Page 72. It seems inappropriate to suggest that a scenarios model could act as an accuracy assessment for the mapping. The mapping can assess accuracy of the model but not vice versa. The models can only account for changes that are within its parameters, so while they predict the direction of change, they should not be considered an indicator of the accuracy of maps of actual change.	The intention is not to replace the Accuracy Assessment. The commentary provided outlines an alternative option whereby the Accuracy assessment could be conducted every second year. In the interim period the modelling could be used to support the findings of the annual deforestation mapping.

2.40 Page 76. The comparison with the University of Maryland Global Forest Change map is interesting and relevant work/research though unlikely to yield revisions to the GFC map unless it is intended that this could be a cheaper alternative in the future if it proves high correlation. It would be helpful to include the justification. It does show that the GFC mapping yields higher rates of deforestation and is thus conservative in its estimates of emissions reductions for deforestation.	The UMd assessment was conducted to evaluate the use of such maps at a national-scale. The intention of the exercise was to highlight the applicability of such maps for reporting deforestation. In the future if Guyana were to reduce the frequency of reporting then potentially the Global map may be of use while still allowing Guyana to access performance-based payments in the intervening years.
2.41 Page 78. The y-axis of the graph in figure 10-8 should be labeled.	Figure is revised to include the Y axis label and properly display the trend line positioning.
3. Further development of the MVRS – Gaps	
3.1 The treatment of degradation from logging does not seem adequate in that: 3.1.1 It presents the risk of underestimating the extent of illegal logging activities as it depends on detection by government officials and is set as a percentage of the official records. Evidence of the validity of 15% as an accurate representation of actual illegal logging rates should be provided to justify its use especially given that information from other sources (e.g. www.globaltimber.org.uk) imply that it is not. The UNFCCC's response to the RL proposal (see FCCC/TAR/2015/GUY) states that the GFC assert that 15% is above the actual rate. A more complete study of trade data (especially for China and India) and internal markets for informal timber would help to refine and justify this rate 3.1.2 Assessments of illegal logging by government agencies, regardless of soundness, cannot be considered independent. This is not independent and runs the risk of underestimates. We therefore recommend the commissioning of a fully independent study to estimate the level of illegal logging for each reporting period. We also assume that ongoing work towards meeting requirements under EU-FLEGT will assist in this regard.	We note the points made. At the commencement of the Guyana Norway agreement in 2009, in the absence of a firm figure on illegal logging, the rate was stated as being at a maximum 15%. Over the course of the MRVS implementation, a robust system of reporting has been introduced and implemented and concludes on actual volume total of illegal logging. This is now being used and subject to independent verification every year. EU FLEGT will further help to add another layer of validation to the GFC's systems.
3.2 Amerindian Lands. Page 53. "It is proposed that deforestation located in Amerindian areas is not counted in calculating reduction in financial remuneration". This proposal is problematic given that:	All Amerindian lands are included under the MRVS. All lands for that matter, including all forest and non-forest areas are included under the MRVS. Mapping is done on a "wall to wall" approach and as such all areas despite the land owner,

3.2.1 Amerindian communities are facing invasions and encroachment from outsiders due to mining and road building (GCP 2014). This is likely to increase given the proximity of some roads (e.g. Lethem road) to Amerindian lands. 3.2.2 Disregarding mining or other activities in Amerindian lands could create perverse incentives to focus such activities in these lands and so result in leakage. 3.2.3 If they are not within the LCDS, they can be subject to leakage and negative social and environmental outcomes which need to be monitored. It is assumed that the exclusion of Amerindian lands from the LCDS, and hence the MRVS, is a matter of respect for rights. We further assume that the opt-in mechanism, carried out with due process and FPIC, will provide opportunities for communities to participate and benefit from the initiative. However, given that Amerindian communities face encroachment and illegal activities by outsiders, changes to deforestation rates inside their lands should not be excluded.	manager, land use and forest type are monitored in the MRVS. The GFC reports on areas of forest change and emissions. We certainly will share these point with relevant policy makers who would be the appropriate persons to use these suggestions to inform decision making.
3.3 Costs. We are happy to see the exploration of other technologies as contained in the report related to the work of University of Maryland. Information on comparison of the costs of the current technologies with other feasible technologies would help provide assurances of the cost effectiveness of the technologies employed in the system. This is especially important given the model nature of Guyana's MRVS.	We agree and are pleased to provide this additional aspects of the work under the MRVS Year 5 that has been executed in collaboration with our partners.
3.4 Safeguards. The report should include information on how the MRVS aligns with the safeguard information system as required under the UNFCCC.	Area of work including CMRV, engagement with communities and indigenous villages and stakeholder, alignment with national forest programmes, including the forest carbon monitoring system, have been described in various aspects of the report, largely in Section 5. We will continue to include various additional aspects of our work in follow up reports as it relates to this areas.

Comments on MRVS Year 5 Report Ver. 1 (TAAMOG)	GFC's Response
The Amerindian Action Movement of Guyana (TAAMOG) has perused the fifth performance report which covers the year 2014 on interim measures for reducing emissions for deforestation and forest degradation plus (REDD+), under Guyana's Monitoring, Reporting and Verification System (MRVS).	Thank you. We are pleased to present the fifth annual report under the national MRVS and to build on the progress made over the past 4 years.
Be informed that TAAMOG is delighted to have discovered that Guyana's deforestation rate for the year 2014 is 0.065% quite a reduction from the 2013 rate of 0.068%. This demonstrates the continued excellent leadership, hard work and commitment by the Guyana Forestry Commission (GFC) towards the sustainable management of Guyana's Forests and the fight against global climate change and its dangerous consequences using our own Monitoring, Reporting and Verification System (MRVS). TAAMOG extends congratulations to the Guyana Forestry Commission (GFC) and its workers on this significant achievement.	We note the comment about reducing rates of deforestation and believe that this is a good indicator of policy and field monitoring of land use and management activities.