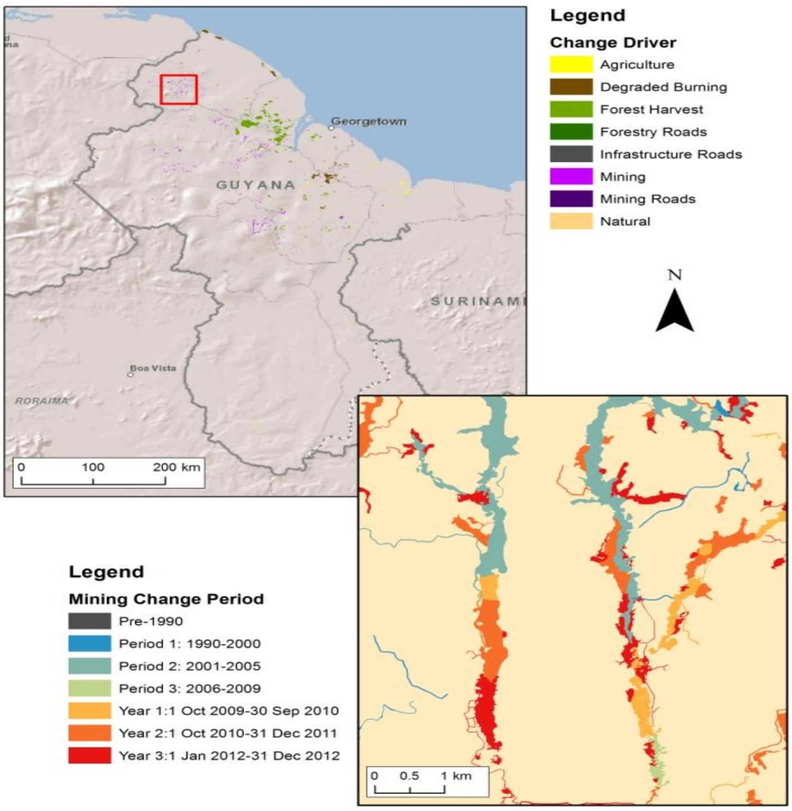
Guyana Forestry Commission

Guyana REDD+ Monitoring Reporting & Verification System (MRVS)

Year 3 Interim Measures Report

01 January 2012 – 31 December 2012

Version 3



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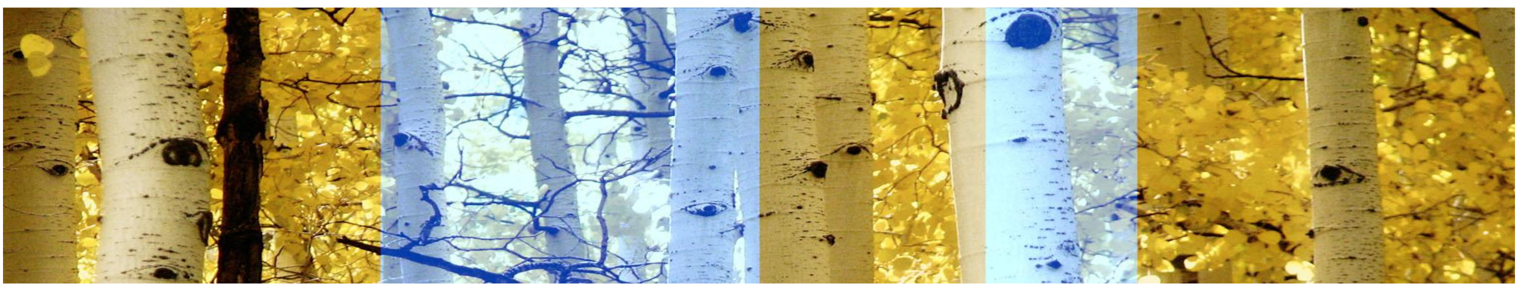

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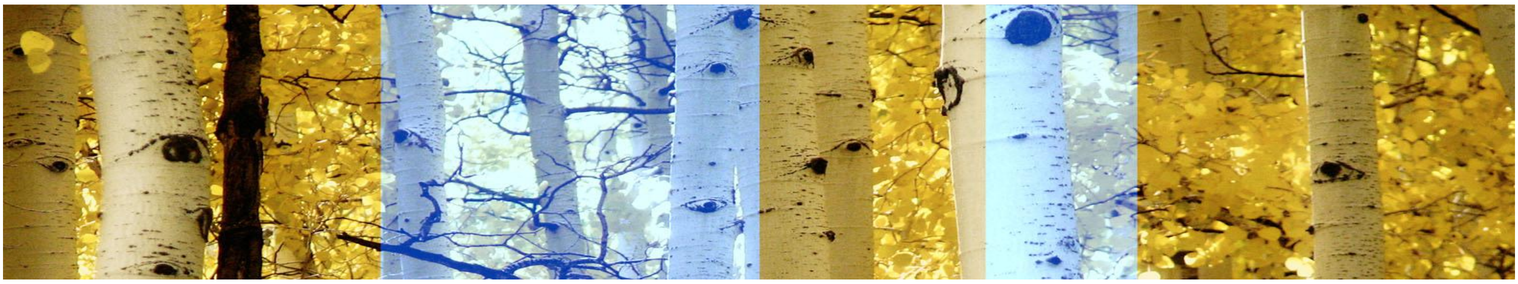

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PREFACE

The Joint Concept Note (JCN) between the Government of Guyana 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 that the mechanism for financial payments for forest carbon based services to Guyana. These payments are result-based with deforestation and forest degradation measured against an agreed level.

In 2009, Guyana developed a national framework for an MRVS. This framework was developed as a "Roadmap[1]" that outlines progressive steps over a 3 year period that will 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 started at 2010 and required a number of initial reporting activities to commence. These were designed to assist in shaping the next steps planned for 2011 and 2012.

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, three national annual assessments have been conducted, including the one outlined in this Report. The first assessment period covered Year 1 (01 October, 2009 to 30 September, 2010) and the second (Year 2) covering the period 01 October, 2010 to 31 December, 2011. The 2012 assessment covers the twelve month period from 1 January 2012 to December 31 2012.

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

This report aims to fulfil in part, the deliverables of Specific Activity Areas 1-3 of the forest area assessment initiative of Guyana's MRVS, as provided by Indufor and the GFC. The programme of work under Year 3 of the MRVS Roadmap in forest area assessment, extends to February 2013. At the completion of this all specific activities identified in the Terms of Reference will be completed, specifically item 4 (an independent Accuracy Assessment) as well as the associated capacity building activities.

In tandem with the work summarised in this report, an accompanying and closely connected programme of work is being implemented by 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 for Guyana, 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 Years1 and 2 will be based on several agreed REDD+ Interim Indicators. The Report therefore aims to fulfill the requirements of a number of "Interim Indicators for REDD+ Performance in Guyana" for

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

the period 01 January, 2012 to 31 December, 2012, as identified by the JCN Table 2. In other words, the reporting on these intermediate indictors will allow for reporting to take place in the interim, while the full MRVS is under development.

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 its Low Carbon Development Strategy (LCDS).

The methods and results of the assessment for the period 01 December, 2012 to 31 December, 2012 will be subject to independent third party verification.

This is a requirement under the JCN to enable the results-based financial support for 2013. The verification will take place for the third time in 2013, 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 (16th October to 16th November 2013) for feedback. At this stage the independent accuracy assessment work was being finalised. Following the period of public review, the Report was revised to produce Version 2 that integrated stakeholder feedback and responses, as well as the report of the independent accuracy assessment. This Version was subject to independent third party verification by Det Norske Veritas, an independent verification firm contracted by the Government of Norway. Following the completion of the verification by end of November 2013, Version 3 of the report was developed, which builds on Version 2, and integrates corrective actions recommended of the independent verification process. This version of the Report (Version 3), will be made public via the GFC's website.

This Report is issued jointly by Indufor and the Guyana Forestry Commission (GFC).

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Comment from Norwegian Ministry of the Environment and Ronald E. McRoberts:

First of all, we would like to take this opportunity to congratulate you on submitting the third Interim Measures Report under the Guyana-Norway partnership. The work on MRV Guyana is doing is of high relevance not only to this partnership, but to the global REDD+ discussions in general.

The authors are commended for a comprehensive and detailed report. Progress in estimating emissions factors and in-country building capacity is particularly encouraging.

Comment from The Amerindian Action Movement of Guyana:

TAAMOG congratulates the GFC for the Third Performance Report which is very comprehensive and accurate produced jointly with Indufor as part of MRVS roadmap for REDD+, and Performance Reporting process under the Memorandum of

Understanding (MOU) between the Governments of Guyana and Norway. This is a significant achievement.

Response to Comments:
As we progressively build the elements of the MRV System, we aim to achieve a high quality of routine, accurate, complete, and consistent performance reporting that covers deforestation and forest degradation aspects that integrates robust mechanism of monitoring and independent verification. In this context, we indeed hope to contribute to national and international discussions on REDD+ and MRVS.

Comment from Norwegian Ministry of the Environment:

A notable feature of the report is that the deforestation rate seems to have gone up in the third year compared to previous years. While this is of course a result that should be taken seriously, it is also important to keep in mind that the progress on MRV in Guyana now makes us all able to be more informed about these results. Understanding what happens makes it possible to tailor interventions, and this is an important element to consider.

Comment (edited) from The Amerindian Action Movement of Guyana:

TAAMOG views the report as technically sound and moreso its technical analysis which show that there is an increase of 0.079% in Deforestation as a result of Mining. For the year 2 reporting period Guyana's deforestation rate was 0.054%. But given this increase Guyana's deforestation rate continues to remain very very low far less that 0.1% which is among the lowest in the world, provides a sound indicator that Guyana continues to effectively practice Sustainable Forestry Management.

Response to Comments:
We share this view and continue to develop the MRVS as an objective and technical instrument that serves a broader purpose beyond informing on deforestation rate. At the same time, in all instances, including those when there is an increase in deforestation rate, these results are submitted at the policy level with an objective of informing discussions and programmes in relevant areas.

SUMMARY

In December 2012, a revised Joint Concept Note (JCN) under the Guyana/Norway Agreement was issued, and replaces the JCN of 2011. The revised JCN provides an update on 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 Monitoring Reporting and Verification System (MRVS) is 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) is set from 01 October, 2009 to 30 September, 2010 with second reporting period (Year 2) covering 01 October 2010 to 31 December 2011, a fifteen (15) month period. This report covers Year 3 which spans a twelve month period from 1 January to 30th December 2012

For the Benchmark and Year 1 analyses, medium resolution satellite images were used to calculate the forest area, in accordance with Guyana's national definition of forest for REDD+, as at 1990.

The total forested area at this point was estimated as 18.39 million hectares (ha) (with an indicative accuracy of 97.1%). In 2012, as planned Guyana's forest area was re-evaluated using RapidEye 5 m imagery. This analysis has resulted in an increase in the forested area by approximately 110 000 ha to 18.5 million of which 15.5 million ha is administered by the State. The revised 2012 forest area is used as the reference point from which the rate of change is calculated.

Forest change between 1 January 2012 and 31 December 2012, was determined using high resolution 5 m imagery for the whole of Guyana. The change reported in this assessment captures only the change that took place in the 12 month period under review – Year 3. The use of a national coverage of 5 m imagery is a significant improvement over Year 2 which used a combination 5 m and 30 m imagery to achieve national coverage. This improvement has allowed the boundaries and the drivers of change to be mapped with greater certainty.

The inclusion of Landsat 7 images into the detection process has enabled the assessment of change for areas under persistent cloud. This allows for spatial tracking of forest change areas through time as outlined under Approach 3 of the IPCC Good Practice Guidelines.

Forest change of forest to non-forest excluding degradation between 1 January 2012 and 31 December 2012 (12 months) is estimated at 14 655 ha. Over the Year 3 reporting period, this equates to a total deforestation rate of 0.08%. This rate of change is higher than Year 2 period (15 months) which was reported as 0.054%.

Significant progress was made in Years 2 and 3, in mapping forest degradation. The area of degradation as measured by interpretation of the 5 m RapidEye satellite imagery in the 2011 assessment was 5 467 ha. This has reduced in 2012 to 1 963 ha. Evidence suggests that this reduction is due to a consolidation of mining operations around existing infrastructure. This has reduced prospecting activity which leads to degradation.

The main findings of the Year 3 accuracy assessment as conducted by University of Durham (attached as Appendix 8) are as follows;

- The methods used by GFC and Indufor follow the good practice recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level

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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.

and rate of deforestation observed in Guyana over the Interim Measures Period – Year 3.

- We conclude that the quality of the mapping undertaken by GFC & IAP based largely on interpretation of RapidEye imagery is of a good standard. The prevalence statistic is a good measure of overall correspondence between the map and reference data. We found that for Year 3 the prevalence was 0.9964 or 99.64% for the High Risk stratum and 0.9987 or 99.87% for the Low Risk Stratum and 99.77% overall. This is a very high figure, much better than one would expect from automated classification of multispectral remotely sensed data, and is almost certainly explained by the high spatial and radiometric resolution of the RapidEye multispectral imagery and the meticulous and manual process of interpretation and on-screen digitizing. We also note that the verification reference data are of a very high quality.
- At the 95% confidence level, the estimate of Year 3 forest area, based on the model-assisted stratified sampling design is 5,920,724 ha ± 13,732 hectares in the High Risk stratum and 12,468,131 ± 9,835 hectares in the Low Risk stratum. When combined and weighted, this gives a model-assisted Year 3 estimate of 18,392,291 ± 11,690 hectares for Guyana compared with a figure of 18,392,781 hectares from the GFC/IAP map. Note that the observed difference between Durham and IAP/GFC of 490 hectares is not statistically significant.
- The Year 3 forest degradation data has a correspondence (prevalence) between reference image interpretation and IAP/GFC mapping of 0.997 or 99.7%. This statistic is derived from both High and Low Risk strata and excludes areas of cloud cover and areas beyond the Guyana border and coastline.
- The Year 3 deforestation rate is 0.08% which is the same rate as calculated by GFC & Indufor.

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 systems as methodologies are proven.

The main deforestation driver for the current forest year reported (Year 3) is mining which accounts for 93% of the deforestation in this period. It should be noted that the driver of mining, includes mining infrastructure. A majority (83%) of 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 3 the change has continued to follow this trend with further expansion relatively constrained. This is evident from the decrease in the area of degradation.

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 the newly developing Strategic Plan for the natural resources sector.

Comment from Norwegian Ministry of the Environment:

We note with substantial interest that the time series that is being built up seems to make it possible to learn more about the dynamic of forest converting drivers in the country, and the MRVS could potentially be a highly significant policy development tool in this regard.

Another interesting finding is that all Year 3 deforestation falls inside the footprint of historical change areas. This shows again that the MRVS can also inform policy development and interventions.

Response to Comment:

The intention of the MRV System is to inform policy and programmes for overall natural resources management and REDD+ development in Guyana. At the inception stage of the MRVS development, the Roamdap for the MRVS for Guyana proposes the development of the System based on drivers of deforestation and forest degradation. Over the last three years in the implementation of the MRVS Roadmap, we have undertaken a policy based approach which speaks to drivers of forest change that are systematically monitored over time and reported on at every reporting period. As the time series is further strengthened, we now have a very useful instrument to inform monitoring and management programmes for natural resources planning and utilization, which is intended to inform policy development.

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. Table S2 identifies those measures that have not yet been accounted for in the MRVS. In this report, the analysis covers the benchmark period (1990-2009), the first year (Year 1) the second year (Year 2) and the third year (Year 3) 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. It is recommended that due to the national monitoring system implemented, the IFL measure will be phased out.

Comment from Norwegian Ministry of the Environment:

We want to highlight that the phasing out of this indicator is subject to other progress as described in the JCN of 2012, and that the implementation of the monitoring system alone is therefore not a sufficient justification for phasing out the indicator.

Response to Comment:

We agree that the JCN is of course seen as the guiding document. It does however, need to be acknowledged that Guyana can be viewed as exceeding good practice guidelines as set out for forest monitoring for MRVs and a more advanced approach has been applied. Given that the country is now covered at 5 m resolution any change in forest state at and below the minimum mapping unit are very evident. This makes for a transparent unbiased assessment of forest change. The accuracy of the mapping is subject to two independent assessments, a formal accuracy assessment and an overall audit. It is suggested that IFL and the context that this proxy has been applied under is now outdated. The IFL concept is really meant to provide a high level assessment of regional change using medium resolution imagery. Guyana has since year 2 moved beyond medium resolution enabling it to provide spatially explicit assessment of forest change that extends beyond the boundary of the IFL.

Relevant measures are also reported for forest management indicators (measures Ref. 3 and 4). Where applicable, a reference measure has been included. It is envisaged that prototype methods that have been developed in Year 3 to account for emissions from shifting cultivation and activities that result in carbon sinks (i.e. SFM or enrichment plantings.) will begin to be integrated into the MRVS in 2014.

Table S1: Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 2 Period	Year 3 Period	Difference Y3 and Reference Measure
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change* $(\%)/yr^{-1}$	0.275%	0.054%	0.079%	-0.20%
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[4]
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	-2 405
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[5]	3 685 376[6]	2,159,151	-1,227,627
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	-400,639
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	ha/yr^{-1}	1 706[7]	28	208	-1 498[8]

Comment from Norwegian Ministry of the Environment:

This is a very helpful table. One thing that we have also commented in previous years is that it would be very interesting to also see an assessment of uncertainty on the reported change rate (0.079 % for Year 3). We are aware that the accuracy assessment will be available in a few weeks. Will this year's accuracy assessment also include uncertainty assessment on the change rate? If not, could you please explain why it is not possible to present this uncertainty?

Comment by Ronald E. McRoberts (comment summarised)

The authors state that the accuracy assessment for 2013 is yet to be completed. What are the impacts of this missing assessment on annual estimates of deforestation?

Two issues are of concern. First, without an assessment of uncertainty, where is the evidence that differences between year 3 and previous years are statistically significantly different? If they are not statistically significantly different, then the differences should be attributed to factors such as classification and random sampling errors rather than to actual change on the ground. Second, none of the estimates was

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4 Difference total in Year 3 is based on reduced balance from Year 2.

5 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 3 report for 12 months as Year 3 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 he Reference level for illegal logging for Years 2 and 3.

6 Computed for the period October 1 2010 to December 31 2011. (15 months)

7 Degradation from forest fires is taken from an average over the past 20 years.

8 Difference total in Year 3 is based on original reference level of 1,706 ha. Forest fires are reported in spatial extent for the interim period but will transition to forest carbon emissions reporting when MRV System is fully operational.

adjusted for classification error. A map estimate is subject to classification error which, if it is systematic, induces bias into the estimation process.

The overall classification accuracy for 2012 was stated to be 98.6% (Section 8.2). Although that is an excellent accuracy, it does not necessarily indicate that the map-based estimates of change are not influenced by classification error.

Response to Comments:

For historic periods, deforestation rate for periods presented were annualised.

Uncertainty assessment is presented for the rate of change using a model-assisted difference estimator for which bias and variance within sampled statra are subject to assessment using probability-based estimators. Please refer to the Appendix for the full report on Accuracy Assessment. Page 23 of the Accuracy Assessment Report notes that:

Although the expectation is that probability-based estimators are unbiased, this cannot be assumed. An elegant approach that combines the advantages of simple random sampling with model-based estimators is the model-assisted difference estimator (McRoberts 2010; McRobertset al. 2010a; McRoberts et al. 2010b, Næsset et al. 2011). A model-assisted estimator used map data to make an initial inference but uses the probability-based sample to validate the result (McRoberts and Walters 2012). In this analysis the model-assisted difference estimator has been applied separately to each stratum since forest area can be calculated easily from the GIS. Bias and Variance are estimated from the probability-based sample within each stratum.

The Norwegian Ministry of Environment raise an important question about presenting uncertainty on deforestation rates. The rate of change of forest cover is calculated from measured deforestation in year n divided by measured forest area from year n-1. There are uncertainties associated with both the forest cover change (numerator) and the initial forest cover (denominator) in this calculation. The confidence intervals associated with these values are based on separate accuracy assessments, albeit using the same model-assisted difference estimator (McRoberts, 2010) to derive a Confidence Interval (CI). It should certainly be recognised that the rate is based on data with differeing levels of certainty; Year 3 forest cover CI is smaller than Year 2 and based on a larger sample.

Table S2: Impending Interim Measures

The following measures are currently not included in the MRVS. The intention is that these measures will be phased in and monitored once the MRVS becomes operational.

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Reference Measure	Year 2 Period	Year 3 Period	Difference Y3 and Reference Measure
6	Emissions resulting from subsistence forestry, land use and shifting cultivation lands (i.e. slash and burn agriculture).	Emissions resulting from communities to meet their local needs may increase as a result of inter alia a shorter fallow cycle or area expansion.	Not considered relevant in the interim period.	N/A	N/A	N/A	N/A
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

TABLE OF CONTENTS

APPENDICES

ACKNOWLEDGEMENTS

In addition to GFC, a number of agencies and individuals have assisted in providing inputs into the MRV program. GFC and Indufor would like to acknowledge the support of the Ministry of Natural Resources and the Environment and the Office of Climate Change for their strategic guidance.

The continued support and oversight of the members of the MRVS Steering Committee and the Multi-Stakeholder Steering Committee of the LCDS are also especially acknowledged.

The GFC team would also like to acknowledge the following colleagues 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.
- ESRI for providing support in GIS software and overall technical support.
- Norwegian Space Centre for supporting the advancement of work on accuracy assessment
- The Clinton Climate Initiative for strategic guidance in the development of the MRVS framework.
- IADB for their role in supporting the implementation of this, as well as other aspects of the Guyana MRVS.
- The Project team of Global Canopy Programme, North Rupununi District Development Board and the North Rupununi communities, Iwokrama and other partners working on the CMRV Project in Region 9.
- Winrock International for work on the forest carbon monitoring system.
- Guiana Shield Facility for supporting work under the MRVS.
- Other Partners

GLOSSARY

The following terms and abbreviations are used throughout the report.

AGLB	Above Ground Live Biomass
ASAR	Phased Array Type C-band Synthetic Aperture Radar
AWiFS	Advanced Wide Field Sensor
CLAS	Carnegie Landsat Analysis System
CMRV	Community Monitoring Reporting and Verification System
DMC	Disaster Monitoring Constellation
DN	Digital Number
DTM	Digital Terrain Model
ESRI	Environmental Systems Research Institute
EVI	Enhanced Vegetation Index
FCPF	Forest Carbon Partnership Facility
FIRMS	Fire Information for Resource Management System
FPIC	Free Prior Informed Consent
FRIU	Forest Resource Information Unit (GFC)
FTP	File Transfer Protocol
GCP	Global Canopy Programme
GEMI	Global Environmental Monitoring Index
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
ITTO	International Tropical Timber Organisation
JCN	Joint Concept Note
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
NARI	National Agricultural Research Institute, Guyana
NAS	Network Attached Storage
NDAVI	Normalised Difference Vegetation Index

NIR	Near Infrared
NPAS	National Protected Areas System
NRDDB	North Rupununi District Development Board
PAC	Protected Areas Commission
Pan	Panchromatic
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 centre 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 Government 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 8th June 2009 former President Bharrat Jagdeo launched Guyana's Low Carbon Development Strategy (LCDS). The Strategy outlines Guyana's vision for promoting economic development, while at the same time contribute to combating climate change. A revised version of the LCDS was published on 24th May 2010 and subsequently an LCDS Update was presented to the public in March 2013 by President Donald Ramotar. 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 third year of the three-phase Road Map developed for Guyana's MRVS. The objective of this 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.

1.3 Establishing Forested Area

Land classified as forest follows the definition as outlined in the Marrakech Accords In accordance with 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 change 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 uses a forest area (includes 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. Any new land cover change for the Year 2 period has been subtracted from the revised forest area.

> *Comment from Norwegian Ministry of the Environment*:
>
> *We note that the forest area has been reassessed based on availability of higher resolution satellite imagery. Could you please briefly explain how consistency with the existing maps from previous years was ensured?*
>
> *Response to Comment:*
>
> *The delineation of forest area was conducted with RapidEye 5 m imagery. At this resolution it is more readily apparent if areas meet the elected forest definition. In particular, areas previously identified as non-forest in 1990 were re-assessed and re-allocated as appropriate. This improvement work has resulted in an updated forest area. The intention is that this revised area be used as the benchmark from year 3 onwards.*

A national coverage was obtained in 2012 and constitutes an improvement on the previous 30m dataset used. As with previous years this revision will be subject to independent audit by the accuracy assessors University of Durham (UoD) and secondly by the project verifiers Det Norske Veritas (DNV).

1.4 Overview of National Process for MRVS Implementation and Update on Progress

The Roadmap for Guyana's MRVS was developed through a multi-stakeholder consultative process involving a wide cross section of stakeholders. This multi-stakeholder process was facilitated through two MRVS workshop that were held in 14 September 2009 and on 27-29 October 2009.

The Roadmap was designed to consider a number of necessary steps and different types of gaps (data, eligibility, capacity, and institutional, and methodological) to be addressed in various phases with a focus on the building of national capacities. The associated timeline of the Roadmap is 2010/11 for Phase 1, 2011/12 for Phase 2 and post 2012/13 for the implementation phase.

A REDD Secretariat has been established at the Guyana Forestry Commission to coordinate and execute REDD+ work and operates in close collaboration with key partners including the Office of Climate Change and non-Governmental stakeholders. As part of the development of the MRVS, a MRVS Steering Committee was convened in November 2009 and tasked with the overall responsibility of strategic oversight of the implementation of all MRVS activities. Some of the other tasks include:

- Ensuring that scope aligns with the agreed requirements of projects
- Providing advice on the means by which key stakeholder groups are kept informed of progress in the development of the MRVS
- Contribution of inputs from the respective agencies that each member is a part of, to ensure close cohesion and coordination of MRVS activities implementation.

The Steering Committee comprises representation from:

- Office of Climate Change (OCC)
- Guyana Lands & Surveys Commission (GL&CS)
- Guyana Geology & Mines Commission (GGMC)
- Ministry of Amerindian Affairs (MOAA)
- Environmental Protection Agency (EPA)
- Guyana Forestry Commission (GFC)
- Private sector (Forest Producers Association (FPA), Guyana Gold and Diamond Miners Association (GGDMA)
- Education sector (University of Guyana(UG))
- Civil society (National Toshaos Council (NTC)) organisations.

Within the MRVS Steering Committee, a Technical Sub-Committee was established to advise the Steering Committee on the more technical areas of the MRVS such as GIS & Remote Sensing related areas. This Technical Sub-Committee comprises representation from technical officers of the EPA, GL&SC, GGMC and GFC.

The current composition of the MRVS Steering Committee ensures that there is input from the major sectors involved in the process as well as allowing for the provision of data and technical advice into the process of the development of the MRVS. In contributing to the work of the MRVS Steering Committee, the GL&SC is the agency responsible for administration of State Lands in Guyana as well as for the granting of agricultural leases; this agency therefore provides information on land use and boundaries of Amerindian villages and is a key partner in the demarcation process.

The GGMC is the overall regulatory body for the mining sector in Guyana. As such, this agency provides to the MRVS SC, information on land use within the mining sector as well as potential areas identified for mining in the future. These mining activities mainly occur within the State Forest Estate (SFE) as well.

The Environmental Protection Agency is responsible for the promotion, facilitation and coordination of effective environmental management and protection; and the sustainable use of Guyana's natural resources. The GFC is responsible for the management and regulation of Guyana's State Forest Estate and overseeing the implementation of REDD + activities in Guyana.

The Ministry of Amerindian Affairs has the responsibility of enhancing the quality of life of Amerindian People in Guyana through the formulation and implementation of policies and programmes that facilitate cultural, social and economic development, promote equity and advance the rights of Amerindian people. Given that the MRVS would be developed with a capacity building approach and be community centered, the MoAA is an appropriate inclusion.

With the further inclusion of UG, FPA and GGDMA, the views of not only the private sector but those of the tertiary education and research facility (UG) are reflected. With the combination of the state regulatory agencies, private sector and civil society on the MRVS Steering Committee, this allows a planned and coordinated approach to the overall development of the MRVS. Another important consideration is that there is stakeholder involvement in the process through the addition of entities such as the National Toshaos' Council.

As of 31 December 2012, a total of twelve meetings of the MRVS Steering Committee had been held. Among the main discussion points at these meetings were the following:

a) The launch and progress in implementation of the Community MRV project, being implemented by the North Rupununi District Development Board (specifically Annai, which is the pilot site), Iwokrama, the Global Canopy Programme, with technical support from the GFC. The project sought to take the national MRV System to a greater level of detail on the ground to ensure that the execution of methodologies was appropriately applied for the community level, including in the mapping of drivers.

b) The process of development of reference level for REDD+, the emissions and removals for all REDD+ activities, along with the decisions that were made as outcomes of COP 17 in this regard.

c) Data collection for Phase 1 of the Forest Carbon Monitoring System (FCMS), which focused on collection of Regrowth plots, Logging infrastructure for the quantification of collateral and incidental damage and Biomass data

d) Year 2 Forest Area Change Assessment and Monitoring, which covered the period October 2010- December 2011 including the methodology to be used, applicable and appropriate QA/QC procedures in place and the independent verification that follows the conducting of the Accuracy Assessment.

e) Details on the method and process to be undertaken for MRVS Year 3 assessment, including options on provision of satellite imagery. A decision was made by the members of the MRVS Steering Committee that RapidEye optical satellite imagery was the preferred option for use in the Year 3 assessment.

f) Staff and capacity requirements of the GFC to continue its work on the development of the components of the MRVS, more specifically in the Forest Carbon Monitoring System and the Forest Area Change Assessment and Monitoring.

g) Data sharing requirements and modalities amongst the key natural resources management agencies involved in the MRVS- GFC, GGMC, GL&SC and the EPA.

Progress on the Implementation of the MRVS Roadmap

Over the 2012 period, work has continued on the implementation of the MRVS Roadmap, in execution of technical aspects of the Forest Area Change Assessment and Monitoring and the Forest Carbon Stock Assessment, as well as in continued capacity building.

In the first quarter of 2012, reporting on forest area change was completed for the Year 2 period, October 2010- December 2011. In the Year 2 reporting period, Landsat 5 was in the process of being decommissioned and Landsat 7 had data quality issues (stripes) for coverage over Guyana. Consequently, higher-resolution 5 m images were acquired over identified area of forest change. A total area of 12 million ha (56% of Guyana's land area) was assessed at this higher resolution. The improved resolution enabled better identification of change boundaries, drivers of change and areas of forest degradation. In particular, it was revealed that it was possible to map small-scale forest degradation using high resolution imagery. Consequently, substantial progress was made in Year 2 in mapping forest degradation.

A key outcome of the work on the Forest Carbon Monitoring System (FCMS) is the development of a national look-up table of emission factors that meets international standards – IPCC GPGs. In 2012, a draft of this Report was completed, and received feedback from key partners. Additionally, the Report was subject to independent technical report. In 2013, this Report is being revised for finalisation in early 2014. This structure will likely replace the existing REDD+ Interim Indicators in the future. These include standards for levels of uncertainty of ground data and the development of QA/QC (quality assurance/control) procedures for all data collection and analyses. Other areas in which significant progress was made include the use of spatial analysis techniques to develop a forest carbon stratification map, which was then used to establish the sampling design and location of the sample plots needed to determine the emission factors for deforestation. This allowed for an analysis of the main drivers of degradation and deforestation and identification of the best method for estimating carbon stock changes for each. Based on the analysis, the Stock Change method was selected for measuring deforestation and the Gain–Loss method was identified for forest degradation.

Comment from Ronald E. McRoberts:

The Report states that the stock-change method was used to estimate deforestation. Was this really the case? Based on the extensive use of classified satellite imagery, it seems more likely that the gain-loss method which focuses on estimating activity areas (change classes) was used.

Section 7.1 indicates that classification of change from forest to non-forest was based on comparisons of maps. This sounds a lot like the stock change rather than the gain-loss method?

Response to Comment:

This aspect of the discussion focuses on the forest carbon monitoring system and not the forest area assessment aspect. The FCMS is another aspect of the MRVS development.

Ongoing training and capacity building occurred for GFC staff in collecting field-based data used to determine emission factors. These emission factors will then be used, in conjunction with the activity data obtained from the remote sensing analyses, to generate estimates of CO_2 emissions. This allowed for the determination of emission factors for Guyana in terms of the emissions and removals of CO_2 per unit of activity data. These factors were derived from data collected by GFC staff. Importantly, a long-term monitoring plan for the FCMS was developed for implementation as part of the MRV system. These objectives as well as those of future work on the FCMS have been achieved and assisted by ongoing capacity-building sessions to train GFC staff and other relevant stakeholders in the implementation of the FCMS.

In December 2012, the Joint Concept Note (JCN) was revised to reflect the progress made in the MRVS. It also has a new list of compliance measures, including Submission of a Reference Level Proposal to the UNFCCC; use of 100m buffer for degradation; recommendations for the GFC to take MRVS beyond Tier 2 to Tier 3; and full operationalizing of reporting on emissions and removals.

Along with the implementation of the key areas of Forest Area Change Assessment and Monitoring and the Forest Carbon Stock Assessment, Guyana commenced initial work on evaluating opportunities for incentivizing the protection of its ecosystem services, including forest carbon, through exploration of Payment for Ecosystem Services (PES) schemes. These schemes seek to incentivize protection and sustainable management of ecosystem services including, but not limited to, forest carbon.

In concert with its forest carbon monitoring activities, the GFC is evaluating how measuring and monitoring systems for additional ecosystem services could potentially fit into its national MRV system for forest carbon. Results from the stakeholder workshops suggest that biodiversity, water and landscape beauty are likely to be the most feasible ecosystem services that could be incorporated into Guyana's MRV system. The Essequibo River Basin was identified as a geographic region of interest for monitoring ecosystem services.

Guyana commenced work on exploring methods and approaches for establishing reference levels for REDD+, which resulted in an assessment of a set of guidelines and/or criteria for the establishment of RLs in keeping with UNFCCC decisions, and development of a historical trend reference scenario for Guyana for the time period 2000 to 2011.

Throughout 2012, Guyana continuously sought, through various local and international fora, to learn from, and share experiences with other organisations and countries that are involved in REDD+; Guyana also worked closely with local and international organizations to facilitate the successful development, implementation and maintenance of the activities detailed in the MRVS Road Map. This work continues in 2013.

Community MRV in Guyana

In 2012, work on Community MRV has advanced in Guyana with an objective of configuring methods and approaches for national MRV at community level. One exemplary case of CMRV has been advanced in the work done with the collaboration of the Iwokrama International Centre for Rainforest Conservation and Development (Iwokrama), Global Canopy Programme (GCP) and the North Rupununi District Development Board (NRDDB)[9] with funding from Norad (Civil Society Climate and Forest Initiative).

This project is being executed in close collaboration with the national MRVS and there has been a growing partnership in this area between the GFC, other members of the MRVS Steering Committee and the CMRV Project team.

This project seeks to fill an important priority in the development of REDD+ policy that has been recognised by the international community that focuses on the full and effective engagement of indigenous peoples and local communities and the potential contribution of their knowledge, to monitoring and reporting of activities; it includes the development of appropriate guidelines for effective participation and leadership of indigenous peoples and local communities in monitoring and reporting.

The need for local community engagement in monitoring activities has also been recognised by the Government of Guyana's planning for its MRVS. The intention of the project is to build capacity for local communities in the North Rupununi region of Guyana to measure, monitor and report on key indicators and metrics such as forest carbon stocks and biodiversity and to verify that such monitoring produces reliable information that can feed into the national MRVS within the framework of Guyana's LCDS.

These activities under the CMRV are developed with the aim to be compliant with the IPCC Good Practice Guidelines for LULUCF and will be technically guided by the UNFCCC, UN REDD as well as GOFC-GOLD on MRV. MRV activities and estimates also seek to follow the five IPCC reporting principles and, thus, will be transparent, comparable, consistent, and as accurate and complete as possible, so as to reduce uncertainties, as far as national capabilities and capacities permit. The monitoring systems and their results will be open to independent review as agreed by the Conference of the Parties. The main goal will be one of developing efficient methodologies that provide high-quality results.

A strong focus of the community MRV project is towards building capacity that will be practical, sustainable and achievable at the relevant community level in Guyana as stakeholders will be required to manage the demonstration projects. The CMRV initiative includes elements of local capacity-building, as well as building the capability of the natural resources management agencies in Guyana and especially at the level of the Guyana Forestry Commission.

During 2012, there has been notable progress in a number of areas of the CMRV:

In the area of Governance, Decision Making and Stakeholder Participation, a Process Document outlining the Free Prior and Informed Consent Framework used in the CMRV

[9] The North Rupununi District Development Board (NRDDB) is a registered Trust and an established non-governmental, non-profit, community-based organisation currently representing 16 communities. It is an autonomous body, initially comprising of representatives from 12 indigenous communities in the North Rupununi. In 1996, it was legally established to link the 12 communities with the Iwokrama International Centre for Rain Forest Conservation and Development, government agencies, and other institutions, on issues relating to community development in the North Rupununi. The NRDDB provides a mechanism for community leaders to meet, discuss, and make decisions relating to the NRDDB operation for their respective communities. The NRDDB is recognised as one of the leading community based organisations in Guyana. Since the formation of the NRDDB, membership has increased from 12 to 16 communities. The NRDDB's Bina Hill Institute, established in 2001, works with several partners and has established the Youth Learning Centre (YLC) which provides practical courses to Amerindian Youths and an opportunity to further their education and capacities in leadership and in conservation-based development skills as well as in culture and traditional knowledge skills. Over the next few years, the YLC and Bina Hill Institute hope to expand its training efforts significantly. The major areas identified by local people are in natural resource management, traditional knowledge systems, and building capacity for both occupational and economic development. Also planned is knowledge-building in a community-based approach to climate change, REDD+ and Guyana's LCDS.

Project, was developed. The Paper reflects on the experience of the North Rupununi District Development Board (NRDDB) in integrating the right of FPIC into the decision-making of the Community MRV project. It is a work in progress and is expected to be used as a working draft to be further reviewed and improved. The hope is that it can contribute to the production of a locally developed user-friendly guide to FPIC for local CMRV. The FPIC Note draws on and credits the established governance and decision-making structure of the NRDDB and summarizes first-hand experiences in incorporating FPIC into the CMRV project. It provides standard FPIC definitions and a few relevant citations of FPIC policy, law and jurisprudence. It is cognizant of the fact that Free, Prior and Informed Consent "is a rapidly evolving field where laws, norms and practices are in a dynamic phase of definition". (The Forests Dialogue Paper – Making FPIC work for forests and people")

The second area of advancement is in the work done on Community Demonstration Site (CDS) Report of the Annai Amerindian Village/District with ground-truthed mapping of deforestation and forest degradation of community lands, preliminary assessments of related deforestation and forest degradation drivers and preliminary assessments of community forest carbon.

A preliminary report was produced summarizing the various sources of information collected and collated by the CMRV project during the field implementation period from December 2011 to April 2013. Due to its status as a CDS, villages in the Village district of Annai (Annai, Kwatamang, Rupertee, Suramaand Wowetta) were the focus of additional data collection beyond what was carried out in the other 11 project villages in North Rupununi (Apoteri, Aranaputa, Crashwater, FairView, Katoka, Kwaimatta, Massara, Rewa, Toka, Yakarinta and Yupukari) as part of the CMRV which included monitoring of wellbeing, natural resources, biomass, and forest change. The CMRV-data is significantly supplemented by a traditional farm survey carried out by the Makushi Research Unit (MRU)[10] which explored aspects of rotational farming practices in community forests of the North Rupununi villages.

In 2012, as an initiative supported by the CMRV project, the MRU led a survey, in close collaboration with the CMRV monitors, in a sample of households in 12 villages to review traditional framing practices and associated activities and cultural values. The goal was to assess changes and impacts over a 17 - 20 year period, using some of the baseline information available from the MRU 1995-6 farming research and involving some of the original MRU researchers, with a priority of tracking the current scope of traditional farming practices and cultural values.

Through the CMRV project, the Project Management Team (PMT) and the CREW (Community Resource and Environment Workers) from each of the participating villages, received training in field methods, including the application of household questionnaires and the use of handheld technology for data collection. As such, the data presented in this report is a product of the great efforts of the CREW and PMT as well as the members of the local Makushi Research Unit (MRU) with technical support from Iwokrama, NRDDB and GCP.

Emanating from this activity, a CMRV Practitioners Report entitled: "Lessons Learned and Recommendations Report for CMRV Practitioners" was developed.

Overall, the CMRV project although yet in Phase 1 of implementation, has contributed to a number of areas in addition to technical reporting and assessment. Capacities built in a total of 39 Community Monitors (CREWs) from the sixteen communities who were trained in new technologies and methodologies for data collection, with a complement of 32 CREW deployed at all times. Sixteen Community Resource Maps produced using data collected by CREWs to upgrade and digitize community sketch maps. Information leaflet produced on CMRV Process

[10]The MRU grew out of eleven Makushi villagers trained as community researchers in 1995 under the tutelage of Janette Forte, the then head of the Amerindian Research Unit of the University of Guyana, to carry out two research sub-projects commissioned by Iwokrama with funding from UNDP through the GEF. These were "Amerindian Lifestyles and Biodiversity Use" and "Makushi Women's Ethnobotany and Ethnomedicine". These two reports were then published by the NRDDB under the title "Makusipe Komanto Iseru" through the CIDA Gender Equity Fund coordinated by Vanda Radzik. The core group comprising seven women and one man named themselves the Makushi Research Unit and the MRU was incorporated under the NRDDB. The group has had a flexible membership and has been carrying out socio-economic, cultural and environmental research and related activities.

for use by the National Toshaos' Council and other Villages. This is planned for Phase 2 of the CMRV work.

The CMRV project team continues to give updates to the MRVS Steering Committee on its progress and to receive guidance on how best to establish synergies with the national MRVS to allow for most effective compatibility. The Memorandum of Understanding between the NRDDB and the GFC that established the Community Demonstration Site (CDS) in the phase 1 of the CMRV is being renewed for the phase 2 CMRV project which is entitled REDD COMPASS – "Community-Powered Assessment of Ecosystem Services & Safeguards"

1.5 Mining in Guyana and Initiatives to Monitor and Minimize the Impact of Mining on Forests

The gold mining sector has been playing an increasingly important role in the national development of Guyana, with production reaching unprecedented levels in 2012. The growth of the industry has resulted in significant job creation and stimulated economic activity in remote communities and across the country. Increased investment in the sector has resulted in innovative technology being utilized to effect more efficient recovery and production.

With this in mind, progressive and continuous development and improvement in mining practices are seen as a phased undertaking to be executed through a strategic programme of work in the short to medium term.

Overall in 2012 gold and bauxite exports represented 50% and 10% respectively of total export revenues[11]. Gold export earnings were US$716.9 million, 38.7% higher than the 2011 level, reflecting favourable world prices and the higher volumes exported. The average export price per ounce of gold increased by 6.0% to US$1,575.4 per ounce from US$1,486.5 per ounce in 2011.

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

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

Guyana's capital account also reflected a surplus in 2012 and this was driven by significant growth in foreign direct investment (FDI), mainly investments in the mining and quarrying, among two other sectors, resulting in total FDI increasing for Guyana by 19% to US$293.7 million in 2012. Net domestic credit by the banking system expanded in 2012 with strong contributions from the mining sector of 51.5%.

Mining is an important part of the Guyanese economy, contributing 10.6% to the nation's annual GDP in 2012[12]. Between 2007 and 2012 there was 14% growth of the total export value of mining[13].

In 2011, it was estimated that 13,800 people are directly employed for the small and medium scale mining of gold and diamonds, and 19,000 indirectly employed in mining support industries. For bauxite an estimated 2,070 are directly employed[14]. It was shown that up to 15% of Guyanese citizens are economically dependent on small-scale mining[15].

The mining sector has also contributed to the development of hinterland infrastructure. A large number of mining companies develop infrastructure for areas in which they operate and

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11 GuyanaBureau of Statistics; Bank of Guyana
12 GuyanaBureau of Statistics
13 GuyanaBureau of Statistics
14 Guyana's Gold & Diamond Mining Sector (2005-2010)_May 2011_ GGMC
15 Small Scale Mining - World Bank - 2010

allow multiple use of these access ways, for not only mining operators but also for forestry activities, as well as other uses. This results in the opening up of previously inaccessible areas for commercial as well as community level utilization.

It is expected that mining will continue to be the key driver of the economy, and that growth will be strong (although dependant on international commodity prices). An interest to pursue this sectoral expansion with foreign investor involvement has been expressed by the Ministry of Finance[16].

Accompanying projected developments in the sector is a programme of work that has already started and that will be further advanced in the next few years. These efforts are systemic interventions to improve the REDD+ model. There are two main initiatives which between them have the foundations of an outline programme to reduce degradation from the mining sector. These are the implementation of the Ministry of Natural Resources and the Environment of Guyana (MNRE's) Draft Strategic Framework 2013 - 2018 and the mandates of the committees that are implementing the recommendations of the Sustainable Land use Committee (SLUC).

As part of the new ministry's planning processes, MNRE collaborated with Strategic Environmental Advice (SEA) to prepare a Strategic Framework for the Ministry for the period 2013-2018. The objectives of this report were to conduct a thorough review and analysis of the regulatory and institutional landscapes to help MNRE shape its strategy to address environmental and natural resource issues within the framework of Guyana's LCDS. This activity resulted in the development of the Ministry's Strategic Framework Document and Strategic Plan. The Strategic Framework makes a number of recommendations, including those that relate directly to the mining sector such as activities to improve reclamation of mined out areas, and initiatives to address impacts on deforestation and forest degradation from mining.

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

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

Further the GGMC has also advanced work in developing and implementing Codes of Practice on Mining. The codes include those relating to avoiding environmental degradation form mining. GGMC is currently revising the codes of practice[17], e.g. on the use of mercury and wastewater management. The draft codes of practices have been reviewed. The drafts have also been shared with the mining community, so that they understand future compliance requirements by the GGMC and the Guyana Gold and Diamond Miners Association.

The Mining School was established and incorporated in 2012 to function under the supervision of the MNRE through the GGMC[18]. The School will offer miners short courses (between one and six months) once the draft curriculum has been approved. The draft curriculum has been developed in consultation with relevant stakeholders, including EPA and GGDMA and will be further developed through a project with support from the WWF. The School will focus on

[16] Budget 2012: Remaining on Course, United in Purpose, Prosperity for all, Budget Speech - Minister of Finance - Mar 2012

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

[18] http://www.nre.gov.gy/Mining%20school%20to%20launch%20training%20programmes%20in%20January.%20December%2005%202012.html

geology, mining methods, exploration technology, surveying and computer applications for mining operations and mineral explorations.

To complement these efforts, there has also been development on the operational end. The improvement of technology and mining practices are very important to (1) shift miners away from the use of mercury and (2) to improve the recovery efficiency mining operations. New technologies such as centrifuge systems can increase recovery rates in mines from 30% to 80% compared to traditional practices. This means that a mine need only be worked once, after which it can be closed and the forest restored. Inefficient traditional practices encourage sites to be reworked a number of times, thus not allowing the forest an opportunity to recover.

In tandem with these initiatives at the Ministry, GGMC and sector levels, the MRVS has been advancing efforts to improve the MRVS and to further refine the degradation indicator. This is enabled by acquiring on a continuous basis, high resolution imagery for national mapping and by refining mapping efforts from the early stages of the MRV to reflect new methods that have been developed in years 2 and 3.

1.6 Overview of Capacity Building Efforts in Guyana's MRVS Implementation

Capacity building continues to be integral to the successful implementation of REDD+ and the MRV system. Over the 2012 period, the GFC's approach remained that of targeting not only the staff of the GFC, but stakeholder groups such as the MRVS Steering Committee, and wider groups such as indigenous and hinterland communities as well as forestry associations, civil society and women and youth.

In continuing capacity building for staff in the areas of forest areas change assessment and monitoring, key focal areas included execution of image pre-processing, the GIS mapping process and accuracy assessment. The team updated the previous mapping guide manual prepared for the first assessment. Staff were engaged from the initiation of activities on the Year 2 assessment, to ensure exchange of ideas and capacities from consultant to staff and vice versa.

For the forest carbon stock assessment, areas of capacity building included training on emission factor calculation and use of a tool designed for this purpose. This training activity specifically targeted the use of an emissions factor tool for the generation of data on emissions factors for the drivers of change. Staff were trained to use, manage and modify the tool as necessary. Other areas included training on QA/QC, as well as training on the use of statistics and other function to calculate various parameters such as uncertainty, sampling and data collection.

Detailed discussions were held on issues relating to the development of reference level and historic emissions; a reference level tool developed and a Long Term Monitoring Plan for the Forest Carbon Monitoring System for Guyana with experts from Winrock International.

Along with the staff of the GFC, staff of Guyana Geology and Mines Commission, as well as representatives of the University of Guyana were subject to training on Forest Change Assessment, A Guide for Remote Sensing Processing & GIS Mapping. The training had essentially and primarily been on demonstrating the analysis for year 2 forest changes. The main topics covered included pre-processing of satellite images, how to map forest change and identifying the drivers of change in forest land cover as well as land use. Such activities serve to enable strengthening of the capacities in these agencies to conduct these activities

Staff of the GFC were subject to training on the Greenhouse Gas Inventories (GHGI) through the CD REDD II Workshop for the Processing of GHG Inventories for Guyana. This is an ongoing process, with this specific objective of building capacities of countries to prepare national GHGIs. Staff were involved in producing a GHG inventory for the forestry sector, which required collecting and processing activity data with the Agriculture and Land Use Software (ALU).

Through work on the exploration of Payment of Ecosystem Services (PES) schemes for Guyana, staff of the GFC and other natural resources management agencies, environmental and indigenous NGOs and targeted indigenous groups were able to address the topic of exploring ecosystem services with consideration of options for the incorporation of ecosystem services into Guyana's MRVS.

Staff of the GFC as well as wider stakeholders were exposed to sessions on REDD+ including Guyana's engagement with the Forest Carbon Partnership Facility (FCPF), and Guyana's Low Carbon Development Strategy (LCDS) as it relates to Sustainable Forest Management. Training on the key forest policy, National Forest Policy Statement of 2011 and on the National Forest Plan of 2011 were conducted, as well as sessions on the Code of Practice for Timber Harvesting. Strengthening capacity within the GFC is an ongoing process that targets staff at all levels. Efforts are proving successful because the technical staff of the GFC and other agencies remained committed, learn quickly, are fully engaged and work hard in the field. Success is also attributable to their willingness to learn and to transfer their knowledge to other staff and relevant stakeholders.

1.7 MRVS Development Areas

There are several areas that are being actively developed and improved during the period that interim measures are recorded. This includes development of monitoring systems to facilitate reporting on impending measures such as shifting cultivation and afforestation.

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.

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 national satellite data. 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 undertaken in the following areas;

- Annual Reporting using IPCC structure for annual assessments using reporting tables from IPCC 2003 GPG.
- Further development of methods to monitor and map shifting cultivation.
- Spatial mapping of forest harvesting activities. The potential development of linkages to log extraction information (on-going).
- Development of methods to map afforestation resulting from regenerating non-forest areas.
- Improvements in existing data layers such as the non-forest layer (naturally occurring) and historical pre-Year 2 change layers.
- Development of GIS-based tools to allow further automation of forest change reporting.
- Evaluation of airborne high resolution camera system to capture data for the accuracy assessment.
- Integration of carbon measurements with spatial datasets to create activity-specific look-up values.
- Development of the MRVS to ensure repeatability in calculations and improved documentation of datasets and processes.

Further training has also been undertaken with a full-time Remote Sensing specialist embedded in GFC's Forest Resources Information Unit (FRIU).

> *Comment from Norwegian Ministry of the Environment*:
>
> *We are encouraged also to see the progress Guyana seems to be making on adapting the monitoring format to IPCC standards and on developing operational methods to measure emissions from shifting cultivation as well as carbon sinks in the form of enhancements.*
>
> *Response to Comment: Work has started in these areas in 2012, in the development of methodologies, and is planned to futher advance in the next reporting period.*

2. LAND ELIGIBLE UNDER GUYANA'S LCDS

Under the Memorandum of Understanding (MOU) between Guyana and Norway, not all land is included in Guyana's Low Carbon Development Strategy (LCDS). Only lands under the ownership of the State are initially included in the LCDS. In 2012, additional land was transferred from State Lands and State Forest Area to titled Amerindian lands as part of Guyana's land titling process. 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, these State Lands are identified as areas that are not included as part of the State Forest Estate 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 Part. Altogether these account for a total of 1 141 000 ha designated as Protected Areas.

Titled Amerindian Land

As provided for in the Amerindian Act 2006, these are 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 14.84million ha. This excludes Iwokrama, Kaieteur National Park and titled Amerindian Land. Combined, these forested areas make up 3.66million ha.

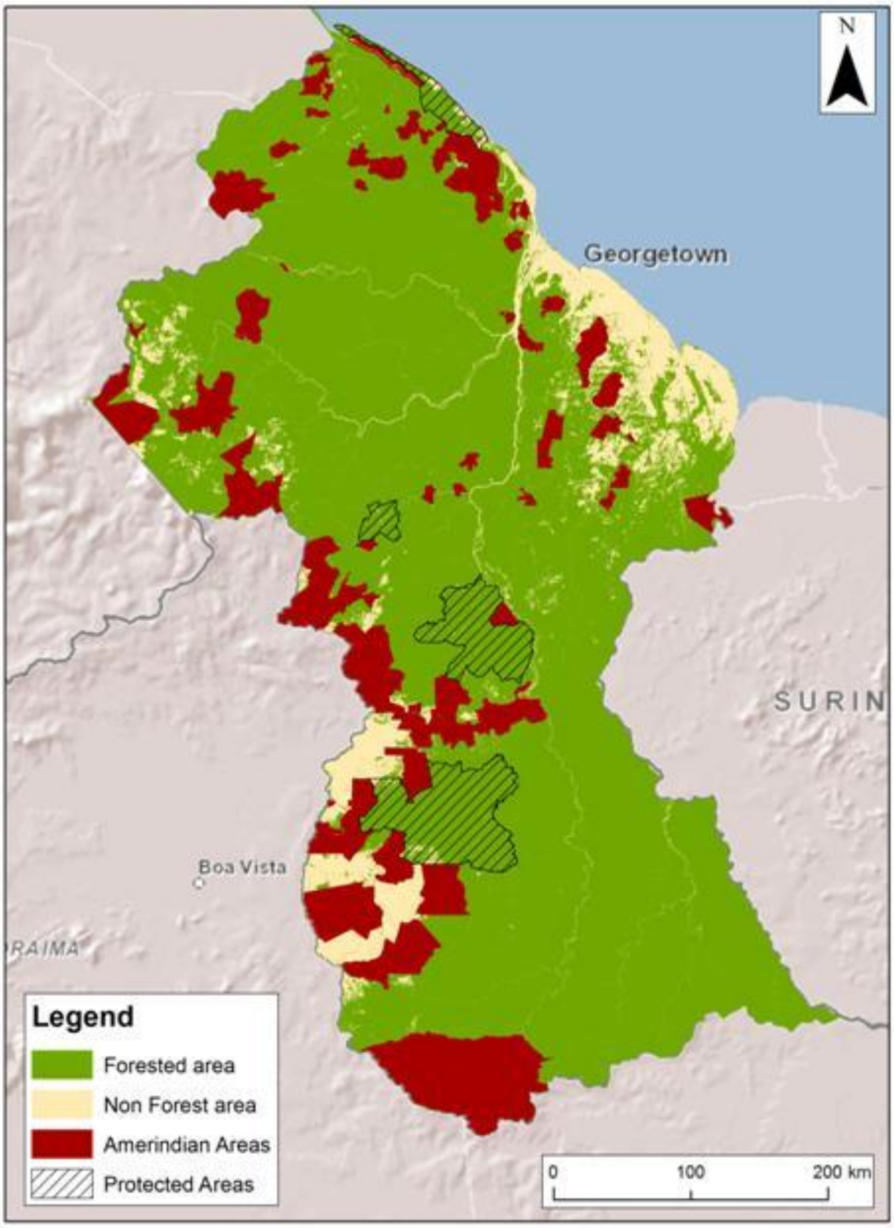
Table 2-1: Updated Land Classes[19]

2012 Land Classes	Eligibility Status	Non Forest	Forest	Total
		(Area '000 ha)		
State Forest Area	Included	332	12 274	12 606
Titled Amerindian lands (*incl newly titled lands*)	Excluded	722	2 559	3 281
State Lands	Included	1 533	2 567	4 100
Protected Areas*	Included	41	1 100	1 141
Total Area (ha)		**2 628**	**18 500**	**21 128**

***Included for the purpose of broad classification but conditions may apply regarding payment for service agreements.**

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

Map 2-1: LCDS Eligible Areas



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

3. FOREST & LAND COVER DATASETS

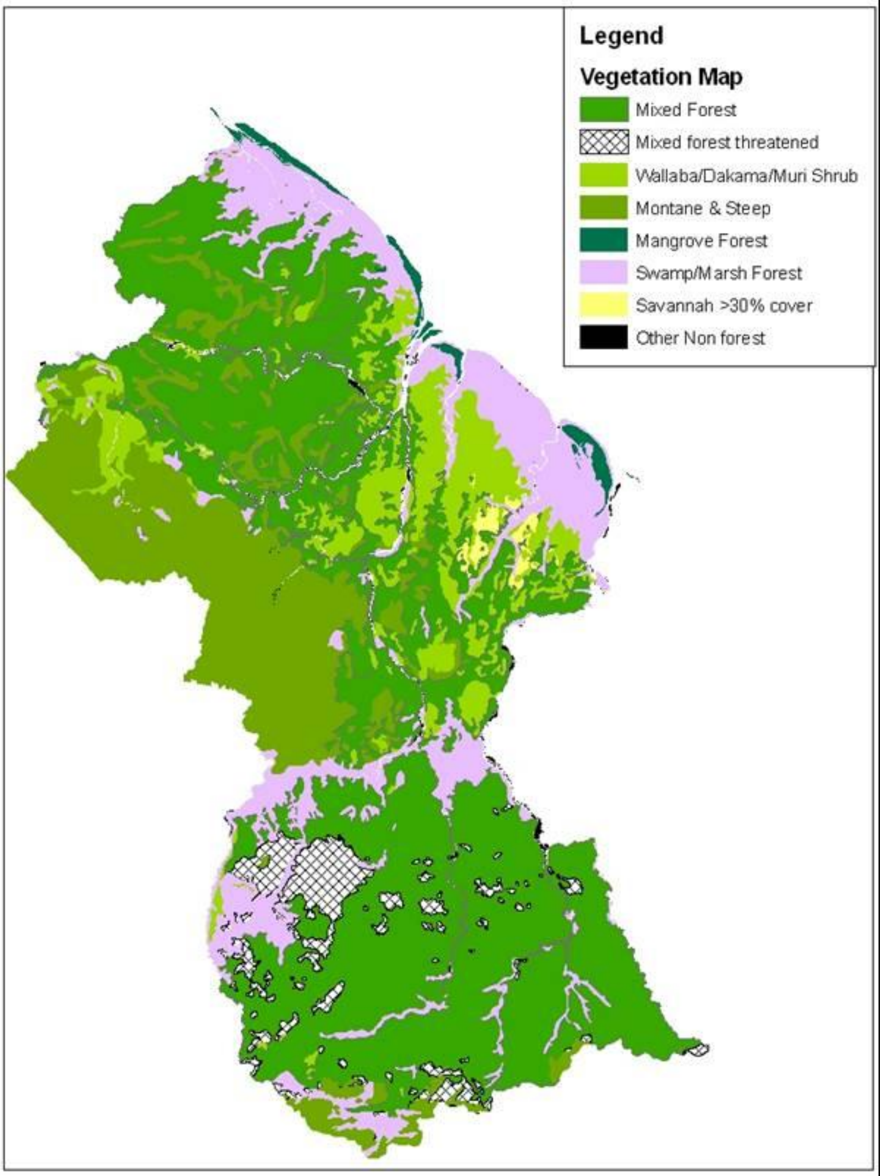
For the interim measures report the total land area is divided by forest and non-forest components as determined at 30 September 2009 (Benchmark). This has been created from interpretation of the Landsat time series.

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 required to divide forest types by their potential carbon storage capacity. The stratification process is still on-going, but as a starting point two datasets 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.

The first provides a detailed forest vegetation map for the entire State Forest Area (SFA) and was created from various existing vegetation maps and 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



Using these maps as a starting point GFC has modified this classification to produce a preliminary classification. 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	Land use Category	Land Use Type	Comment
Forest Land	Forest Land	Mixed forest	Grouped as forest for Interim measure reporting with Guyana's definition of forest applied for quantification within categories
		Wallaba/Dakama/Muri Shrub Forest	
		Swamp/Marsh forest	
		Montane forest	
		Mangrove	
		Savannah >30% cover	
Non forest	Grassland	Savannah <30% cover Grassland	Grouped as Non forest for Interim measure reporting with Guyana's definition of forest applied for quantification within categories
	Cropland	Cropland	
		Shifting Agriculture	
	Wetland	Wetland open water	
		Herbaceous wetland	
	Settlements	Settlements	
	Other land	Other land	

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 at GFC aims to enable areas of change (>1 ha) to be tracked through time, by driver (i.e. mining, infrastructure and forestry). The approach adopted seeks to provide a spatial record of temporal land use change within 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
- 2011- 2012 December (Year 3) RapidEye 5 m supplemented as necessary by Landsat

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.

In 2012 full RapidEye coverage was 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 to ensure effective land use change monitoring as required to adhere to best practice. If a proactive approach is not adopted then there is a risk that a national-level assessment could not be conducted either due to lack of suitable imagery or because of a delay in the provision of GeoFCT datasets.

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. In 2013 GFC is considering an upgrade to ArcGIS server, and the provision of a consolidated geodatabase. The intention is that this geodatabase will hold all of the geospatial datasets produced by FRIU and REDD mapping units. The implementation of a central repository for geographic data provides an industry standard method for usage and manipulation of spatial data.

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. Raw image datasets as provided by image providers are retained and have been catalogued using the analysis period they relate to. 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 the latest version of ArcGIS (10) as provided by ESRI under the LCDS assistance program. Two copies of ENVI have also been installed to enable image processing. Both are dongle versions and include maintenance contracts. 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 a 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 Ministry of Natural Resources and The Environment (MNRE). The ministry 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**
Ministry 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, a new spatial dataset delineating all legally Protected Areas is available for the year 3 analysis. As such, the land categorization will be updated to include all Protected Areas as a new land class.

Comment from Norwegian Ministry of the Environment:

It is very interesting to see that Guyana has created a Protected Areas Commission. Is there already an assigned focal point for REDD+ relevant work in this Commission?

Response to Comment:

The Protected Areas Commission comes under the Ministry of Natural Resources and the Environment. Within the Ministry, there is a focal person for Climate Change and REDD+.

The Ministry of Public Works is overseeing the development of the Amalia Hydropower Project. This planned hydroelectric project includes roading and site clearance. Spatial representations of these areas are being updated as the project develops.

These datasets will be incorporated into the year 3 analysis to assist in the detection of land use change events.

4.3 Agency Responsibilities

Guyana Forestry Commission

The GFC is responsible for advising the subject 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 data that are used to assist in the management of forest resources.A summary of the spatial layers is provided in Table 4-2.

Table 4-2-2: Available GIS Datasets

Feature Class	Feature Dataset	Created / Update freq	Layer Description
Administrative	GY_Boundary_2009	August 2010	Updated country boundary for Guyana as at August 2010
	GY_Boundary_2012	January 2012	Updated country boundary for Guyana as at January 2012 (from hi-res imagery)
	GY_Regions	January 2012	Regional Boundary representation for each of the 10 regions of Guyana
	GY_protected_areas	December 2012	Representation of all legally protected areas in Guyana as provided by the PAC.
Agricultural Leases	Year_1_Agricultural_Leases	August 2010	Agricultural lease areas as provided by GL&SC
Amerindian Areas	Year_1_Amerindian_areas	December 2010	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
	Year_2_Amerindian_areas	December 2011	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
	Year_3_Amerindian_areas	December 2012	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
FIRMS	Historical_Fire_Locations	August 2010	Historical point locations of fires as derived from the MODIS based FIRMS dataset.
	Year1_Fire_Locations	August 2011	Point fire locations for year 1analysisfromOctober 2009–October 2010
	Year2_Fire_Locations	January 2012	Point fire locations for year 2analysisfromOctober 2010– December2011
	Year3_Fire_Locations	December2013	Point fire locations for year 3analysisfromDecember 2011–December 2012
Hydro	Waterbody	August 2010	Water body layer, digitised from geo-corrected Landsat imagery.
Forest Stratification	Year1_Forest_strata_map	January 2011	Forest Stratification map generated after year 1 change detection analysis.
GGMC Mining Areas	Year1_LRG_Scale_Concessions	January 2011	Large scale concessions areas for Year 1 provided by GGMC
	Year1_MED_Scale_concessions	January 2011	Medium scale concession areas for Year 1 provided by GGMC
	Year2_AllClosedProjectAreas	January 2012	Year 2 analysis of project areas that are no

Feature Class	Feature Dataset	Created / Update freq	Layer Description
			longer in operation
	Year2_Auction_Areas_current_region	January 2012	Areas that were auctioned in the current regions for year 2 analysis
	Year2_Claim_licence_Recommended	January 2012	Areas where Claim licences were recommended for year 2 analysis
	Year2_GGMC_Reserved_Area	January 2012	Areas set aside by GGMC for year 2 analysis
	Year2_Large_scale_min_prop_region		Areas where large scale mining occur
	Year2_Mineral_licences_region	January 2012	areas where licences were allocated for mineral mining according to region for year 2 analysis
	Year2_Reconnaissance_Area_region	January 2012	Prospecting areas that may eventually be mined for year 2 analysis
	Year2_Special_mining_permit_region	January 2012	Areas where special mining permits are allocated for year 2 analysis
	Year3_Claim_Licences_jan2013_wgs8421N	January 2013	Areas where licences were issued by GGMC to conduct mining for year 3 analysis
	Year3_Mineral_Licence_jan2013_wgs8421N	January 2013	Areas where licences were allocated for mineral mining by region for year 3 analysis
	Year3_Prospecting_Licence_jan2013_wgs8421N	January 2013	Areas where licences were issued by GGMC for prospecting mining areas for year 3 analysis
	Year3_Special_mining_permit_jan2013_wgs8421N	January 2013	Areas where special mining permits were allocated for year 3 analysis
Managed Forest Areas	State_Forest_2006	2006	Layer showing state forest boundary.
	TSA_WCL_Merged	6monthly	A merged layer showing all activeTSA"s and Wood Cutting Leases (WCL) (large forest concessions)
	activeSFEP_Merged	6monthly	A merged layer of all active State Forest Exploratory Permits.
	activeSFPs_Merged	6months	Active State Forest Permits (small forest concessions). By Division–Demerara, Essequibo, Berbice, NorthWest
	logging_Camps	NA	Point location of logging campsites, based on the Annual Operating plan.
	harvest_Areas	NA	Polygons showing extent of harvest activities (pre 2008, 2008 & 2009)
Population	Municipalities	Aug2010	Polygon file showing area covered by the municipalities of Guyana
	Placenames		Point file showing places of interest
Roads	gpsroads_dd	3-6months	All GPS roads and trails as at August 2010.
Soil & Vegetation	soil_data	1960s	National Soil map of Guyana. Produced by NARI.
	GY_Vegetation_Map	2001	National vegetation map of Guyana. Produced by Dr. ter Steege.

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 to update this dataset quarterly.

GGMC also holds a spatial layer that defines the location of large and medium scale mining concessions. Recently GGMC also provided the GIS layer with updated 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.

The following section 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). The PAC under the Protected Areas Act provides for the establishment and management of a national system of protected areas- including a mechanism for sustainable long term financing (the National Protected Areas Trust Fund). 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 System.

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 3 analysis include full country coverage at 5 m from RapidEye which is supplemented with Landsat 7 as necessary to accommodate cloud.

Presently, reporting satisfies interim measures. This requires that changes in forest land to other land uses be reported relative to the benchmark map. Currently changes occurring in land defined as non-forest are not reported. Changes from non-forest to forest however, are being reported. The basic premise is that eventually changes in the six IPCC categories will be reported for the LULUCF sector.

> *Comment from Norwegian Ministry for the Environment:*
>
> *It is stated that changes from non-forest land to forest land is being reported. We cannot seem to find information on this in the report. Is this because this reporting is not part of the interim measures reporting (that only accounts for gross deforestation – i.e. without regrowth)?*

Response to Comment:

Currently the monitoring methods developed are being evaluated. These areas are historical deforestation sites that could potentially regenerate. These areas are tracked, but further work is required to assess the potential carbon stocks across these sites. These are currently not part of the interim measures for reporting in this period as gross deforestation is the main indicator reported on for deforestation.

RapidEye

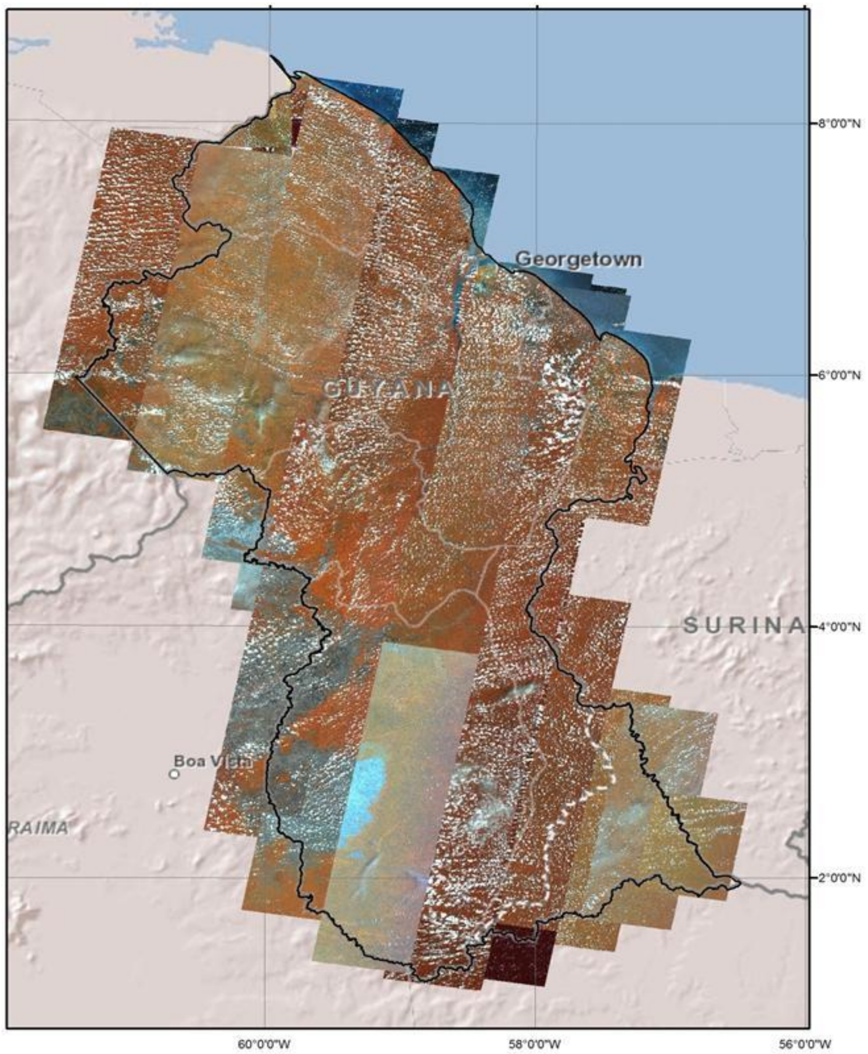
The RapidEye constellation consists of five satellites which have been providing high resolution multi-spectral images since the start of RapidEye's commercial operations in February 2009. RapidEye holds imagery in an online image archive, and is also available to be tasked to cover specific areas for custom acquisition. RapidEye provides both '1B' and '3A' 5 metre 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 as to also enable robust estimates of change – as required for the national MRVS.

GFC has tasked the RapidEye constellation to provide a countrywide coverage of Guyana. For the Year 3 assessment GFC has undertaken to improve the positional accuracy of this image base. As a first step RapidEye has provided a 1B product as 'image swaths' to GFC to co-register them to match the existing Geo-Cover basemap. Once corrected this dataset is returned to RapidEye. This process enables the location of all subsequent RapidEye tiles to match this base. Once a tile is ordered it is downloaded via FTP.

Figure 4-1 shows the RapidEye coverage of Guyana for the 2012 or year 3 mapping period.

Figure 4-1:2012 RapidEye Coverage



Higher priority has been placed on images acquired at the end Year 3 reporting period, with the majority of images collected being acquired in November 2012. Due to the typically cloudy nature of satellite imagery over Guyana multiple scenes over the same location are required. Nearly all areas have 3 separate images covering each footprint. Supplementary to the RapidEye acquisition, 30 metre Landsat 7 data will be used. Wall to wall coverage of Landsat imagery for Guyana has been downloaded from the United States Geological Survey (USGS) online catalogue.

Landsat

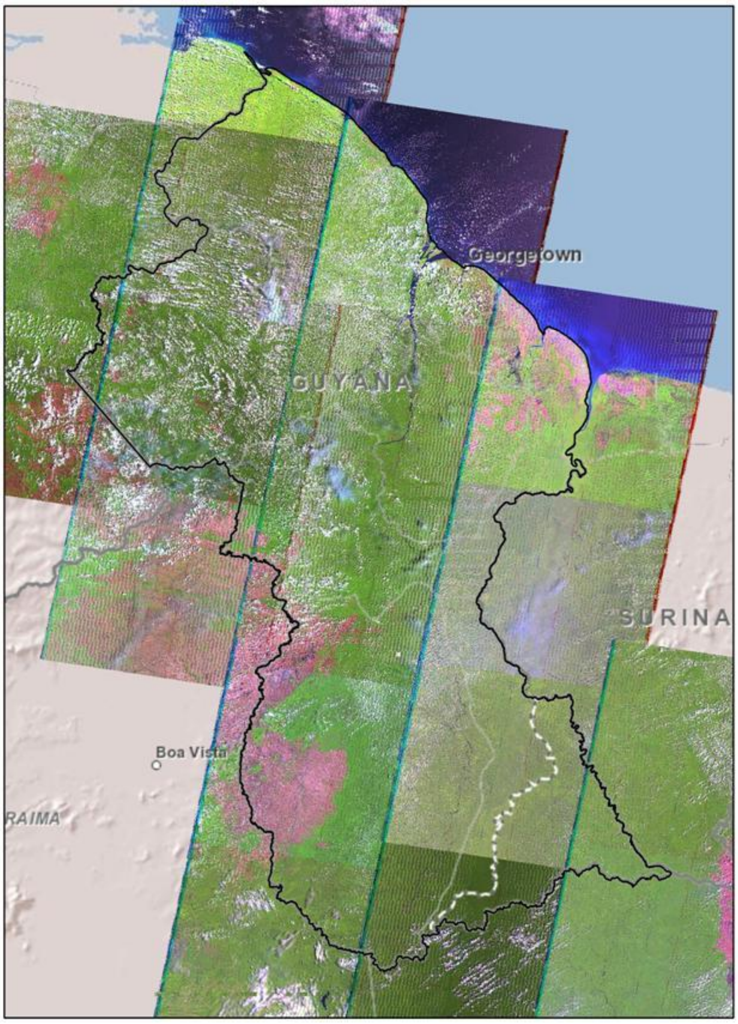
Landsat 7 imagery at 30 m resolution also provides temporal coverage over Guyana. This imagery is archived and is freely available and can be sourced from either the United States Geological Survey (USGS) or National Institute for Space Research (INPE) Brazil. Imagery sourced through USGS comes processed as “L1T” or terrain corrected (using SRTM 90 m DTM), whereas INPE imagery typically does not.

Since May 2003 a scan line correction fault has caused a striping effect on the images. This fault has reduced the utility of Landsat 7 images for automated processing and mapping, although it is still practical to use it visually for monitoring temporal change.

As of 18 November 2011, Landsat 5 imagery became unavailable due to the degrading electronic component, which is preventing the transmission of images to ground stations. This is a significant loss in image provision. Landsat acquires images over the same area every 16 days. The Landsat Data Continuity Mission moved into its next phase on 11 February 2013 with the launch of Landsat 8. Landsat 8 will continue to offer freely available imagery at 30 m resolution. For the Year 3 analyses the launch was too late, however this will provide useful image data for any future analyses. Landsat 8 includes 11 spectral bands from visible (~0.5µm) to thermal (~12µm) wavelengths.

The figure below shows the coverage of Landsat 7 imagery available for the year 3 change detection analysis.

Figure 4-2: 2012 Landsat 7 Coverage



To ensure consistency, all imagery is being 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.

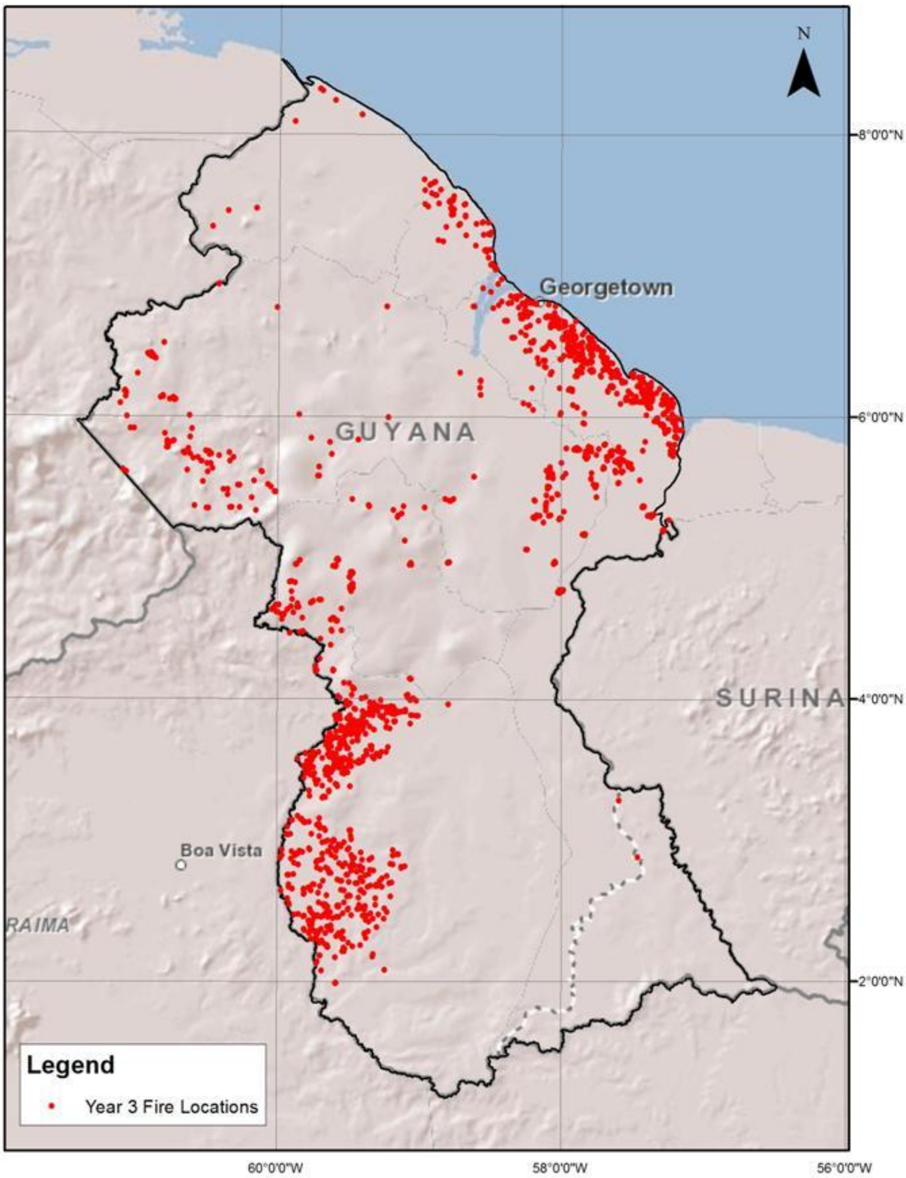
The approach employed in the previous analyses allowed for land cover change greater than one hectare in size to be tracked through time and attributed by its driver (i.e. mining or agriculture). This approach has been continued through into Year 3 using the same methodology. A series of refinements to the image processing chain have been implemented to facilitate the use of higher resolution RapidEye imagery at 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 has also been acquired. This data is freely available and is distributed via FIRMS. This dataset will assist with attributing anthropogenic fire-driven change events.

The Year 1, 2 and 3 analyses all utilised FIRMS to assist with detecting fire locations. This information was acquired using the Moderate Resolution Imaging Spectroradiometer (MODIS). This dataset will be used to identify risk areas. The presence of fire will be confirmed using higher resolution datasets. Figure 8 shows the identified fire locations for the Year 3 period.

Figure8:2012 FIRMS Data



4.6 Accuracy Assessment Datasets

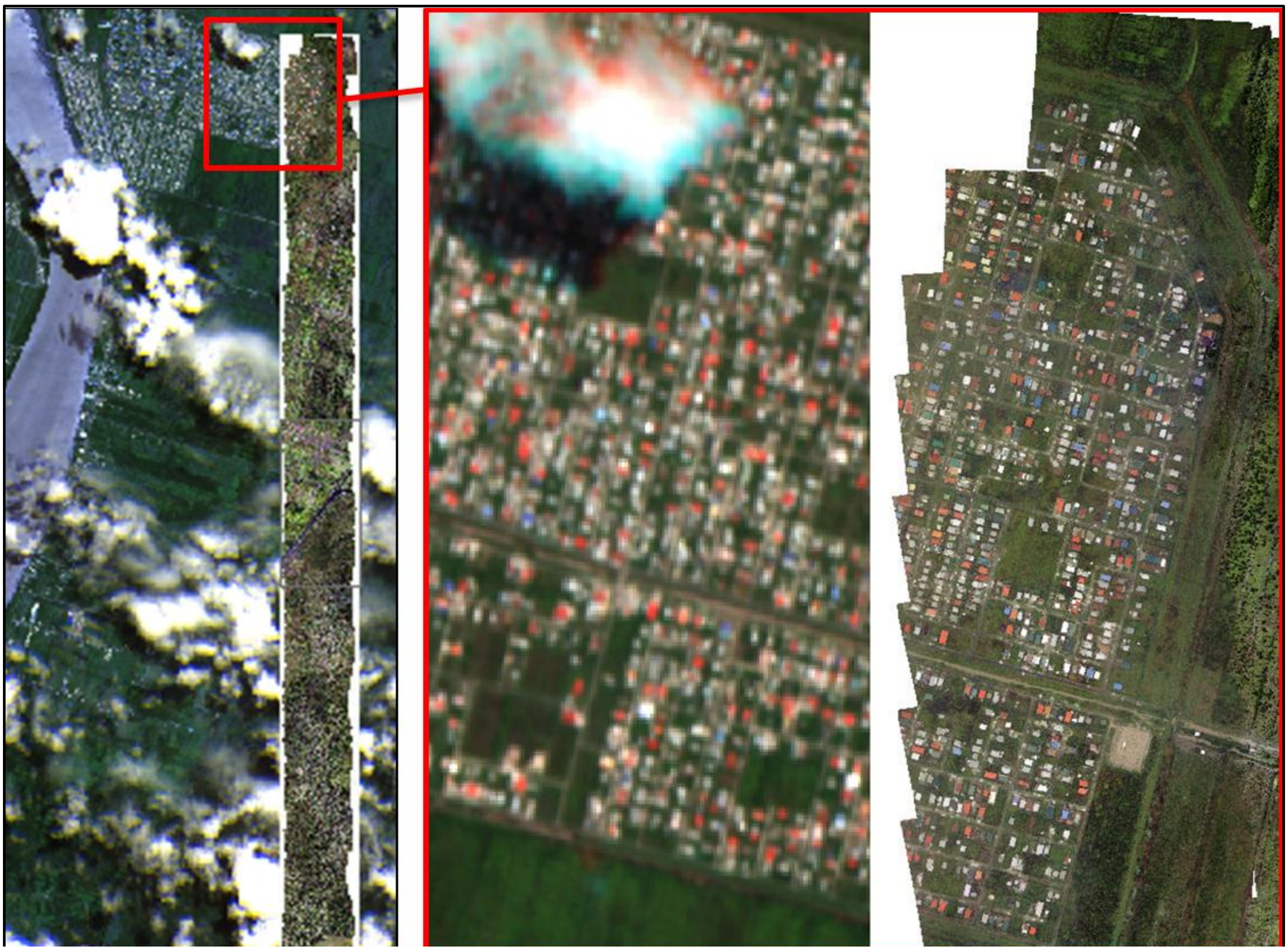
The purpose of the Accuracy Assessment (AA) is to provide a quantitative determination of the quality of the Guyana Forestry Commission's (GFC) mapping of land cover land use change over Guyana. Deforestation and forest degradation are identified from country-wide land cover land use mapping where change is identified by expert manual interpretation at a mapping scale of 1 ha. The primary data source for mapping was 5 m resolution RapidEye multi-spectral satellite imagery. It is established best practice that data used for accuracy assessment be of higher spatial resolution than what was used in the original image interpretation and mapping exercise. However, at present there are no commercially available satellite data providers capable of supplying imagery of sufficiently high spatial resolution and with appropriate frequency of acquisition at 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 Indufor and GFC conducted an operational trial to evaluate the effectiveness of capturing high resolution aerial imagery using a novel and highly portable aerial multispectral imaging system. The camera system (provided by GeoVantage) is designed to be a highly flexible system that can be installed quickly and easily on to various models of light aircraft. The resolution of the images used in Guyana ranged from about 25 to 60 cm, a resolution capable of identifying forest degradation with some certainty.

The strategy involved using the GeoVantage imaging system to capture high-quality image data at sites pre-determined by a stratified random sample that covers the whole of Guyana. The location 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 aerial system successfully imaged over 80% of the sample sites within a one month period. The system is versatile enough to operate at low altitude (2000 ft) which increases flexibility in cloudy conditions. In addition, a selection of Worldview VHR satellite images was purchased to cover areas of Guyana that are particularly inaccessible even to overflight from light aircraft.

Cloud cover remains a hindrance to the successful capture of satellite imagery, especially in countries such as Guyana where cloud-free high-resolution imagery is almost impossible to acquire in a short period of time. In this context, the GeoVantage system provides a technically robust and highly practical method for acquiring a large sample of high-resolution imagery across a large area in a short space of time. Without this type of dataset it would not be possible to perform a robust accuracy assessment to assess the quality of deforestation and particularly forest degradation mapping. 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 4-3: Comparative Resolutionof the RapidEye and Aerial Imagery



5. DEVELOPMENT OF MAPPING METHODS

During year 3 several mapping methods have been developed. The focus of this work has been on improving the determination of forest degradation for a range of drivers (as detailed below). The improvement process has been based on the analysis of satellite imagery and further verified by field inspections.

This focus has been to develop monitoring methods for inclusion in the MRV. In some cases these methods are still being evaluated and will be integrated into the MRV in Year 4.

- 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 the method to monitor degradation caused by anthropogenic fires.
- Evaluation of methods for mapping and integration of shifting agriculture into the annual reporting framework.

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

Monitoring Forest Degradation

In Guyana forest degradation is unique, with the main contributors being the opening of roads linked to new infrastructure, and degradation mainly associated with mining activity - which is rapid and dynamic. The forest degradation method developed in 2011 has been retained for Year 3.

In Year 2 GFC and Indufor expanded on this work and used high resolution 5 m RapidEye to determine the impact of degradation. This resulted in the development of an operational GIS-based method for identifying and monitoring forest 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 that 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[20].

Monitoring Forest Degradation on Old/Abandoned Mining Sites

It is also important to consider the possibility that historical mining sites maybe 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 MRV, the FRIU team revisit 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

[20] www.forestry.gov.gy

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 skidder tracks), 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 yield is relatively low to detect 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 and that improvements to the log tracking system be evaluated. This would allow the extraction information to be linked spatially to the harvest blocks.

Comment from Norwegian Ministry for the Environment:

The section on forest degradation monitoring is very interesting. As these methods were developed for the Year 2 reporting, we are aware that these methods are described in more detail in the Year 2 IMR. On the other hand, these experiences could be of high value to other countries trying to achieve degradation monitoring. Are you and your partners planning on submitting the experiences related to degradation monitoring to scientific journals?

Response to Comment:

Yes, this is being considered. The methods adopted are well developed and functional for Guyana.

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. This is in spite of intact forest which is a potential source of seed surrounding these sites.

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.
- 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 greater 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 concession in Guyana.

Comment from Norwegian Ministry for the Environment:

It is very interesting to see that in mining sites revisited (1990 – 2012), no forest cover have regenerated. This indicated that the environmental impacts of mining methods used in the past are indeed significant. We agree that a long term measurement plan is a good idea.

Response to Comment:

Land reclamation is found to be a prerequisite for regeneration and reforestation activities to occur. A Technical Work Group led by the Ministry of Natural Resoruces through the GGMC has been formed to coordinate these efforts. These are part of a longer term programme of work.

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 SOP.

Monitoring Shifting Cultivation

An evaluation of methods for detecting and mapping of areas under shifting cultivation was also undertaken. There are currently no best practise methodologies for doing this, especially at a national scale.

In the meantime a prototype detection and mapping methodology has been developed that will be integrated in Year 4 and applied at the national-level.

It is expected that this work will assist in providing an understanding of the scale and dynamics associated with shifting cultivation practices. The main findings from a pilot study indicate that:

- Areas of shifting cultivation can be mapped from high resolution images.
- The potential level of effort required to accurately quantify shifting cultivation should be considerable relative to the potential gains. It is proposed that as a first step the real extent of shifting cultivation be mapped. Once this is completed the monitoring would involve the detection and mapping of newly cleared areas. These areas would then be tracked through time.
- In 2014 this process will be integrated into the MRVS and is included as part of the GIS mapping process. The intention is that the analysis will locate and define the scale of shifting cultivation within Guyana. Over time this analysis will provide an understanding of the temporal frequency of shifting cultivation activities.

- Further work is required to determine 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.

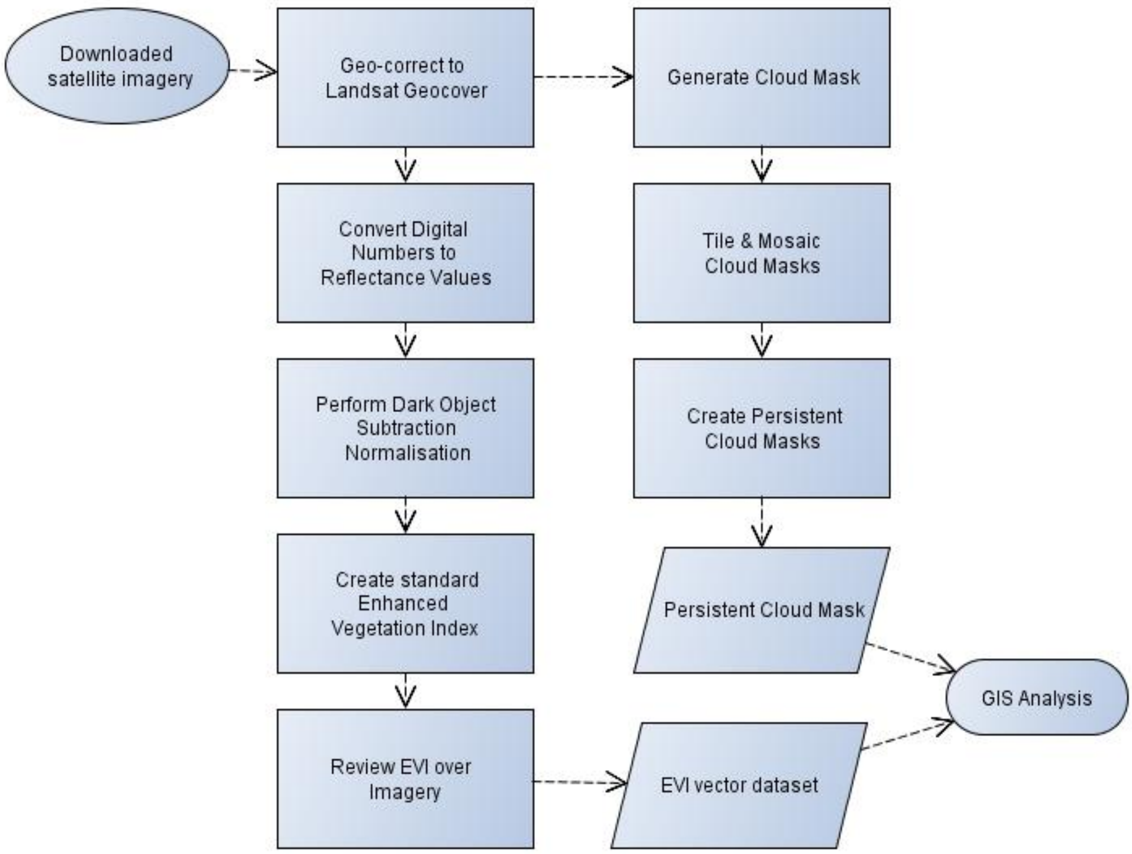
As appropriate these refinements to the mapping process have been documented in the mapping guide

6. IMAGE PROCESSING

The image processing follows the process documented in **Figure 6-1**. The process is automated to produce a GIS change layer that is derived from the EVI vegetation ratio. A second aspect is the creation of a persistent cloud mask. All data is to be tied to the Landsat Geo-cover dataset and ground control points retained.

Once the EVI-change layer is produced direct interpretation and manual editing of the change area is conducted. The following pre-processing steps are undertaken in ENVI using customised routines. A brief description of each step is provided as follows with the stepwise process explained in further detail.

Figure 6-1: Image Processing Flow Diagram



6.1 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.

6.2 Image Normalisation

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 was 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 3 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) 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 signals 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 using 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 reflectance's, 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[21].

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)* 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.

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

6.3 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. An additional gap mask was also created for the Landsat to mask out areas of no data caused by the failure of the on-board scan line corrector. The masks were generated by a simple band 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 3 less than 1% of the land area was persistently covered in cloud. The distribution of the cloud is quite scattered and located over the northern half of Guyana as shown on Figure 6-2.

Figure 6-2: 2012 Persistent Cloud Cover

6.4 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 change that occurs over that area each year. Where a polygons status 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 the polygon, 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.

6.5 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 forest code of practice would not be considered deforested as they have the ability to regain the elected crown cover threshold.

The five anthropogenic change drivers that lead to deforestation include:

- Forestry (clearance activities such as roads and log landings)
- Mining (ground excavation associated with small, medium and large scale mining)
- Infrastructure such as roads (included are forestry and mining roads)
- Agricultural conversion
- Fire (all considered anthropogenic and depending on intensity and frequency can lead to deforestation)

6.6 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:

- Selective and illegal harvesting of timber (not reported spatially in the current MRVS)
- Shifting cultivation (method developed in prototype in 2012)
- Fire
- Associated with mining sites and road infrastructure

6.7 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 24km tile, divided into 1km x 1km tiles at a resolution of 1:10 000.

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 as provided. The RapidEye tiles were then subset to a 1km x 1km grid. The process involves a systematic tile-based manual change detection analysis in ArcMap.

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 is 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. Some activities are not yet accounted for 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 6-1: Summary of Activities & Drivers Captured in the GIS

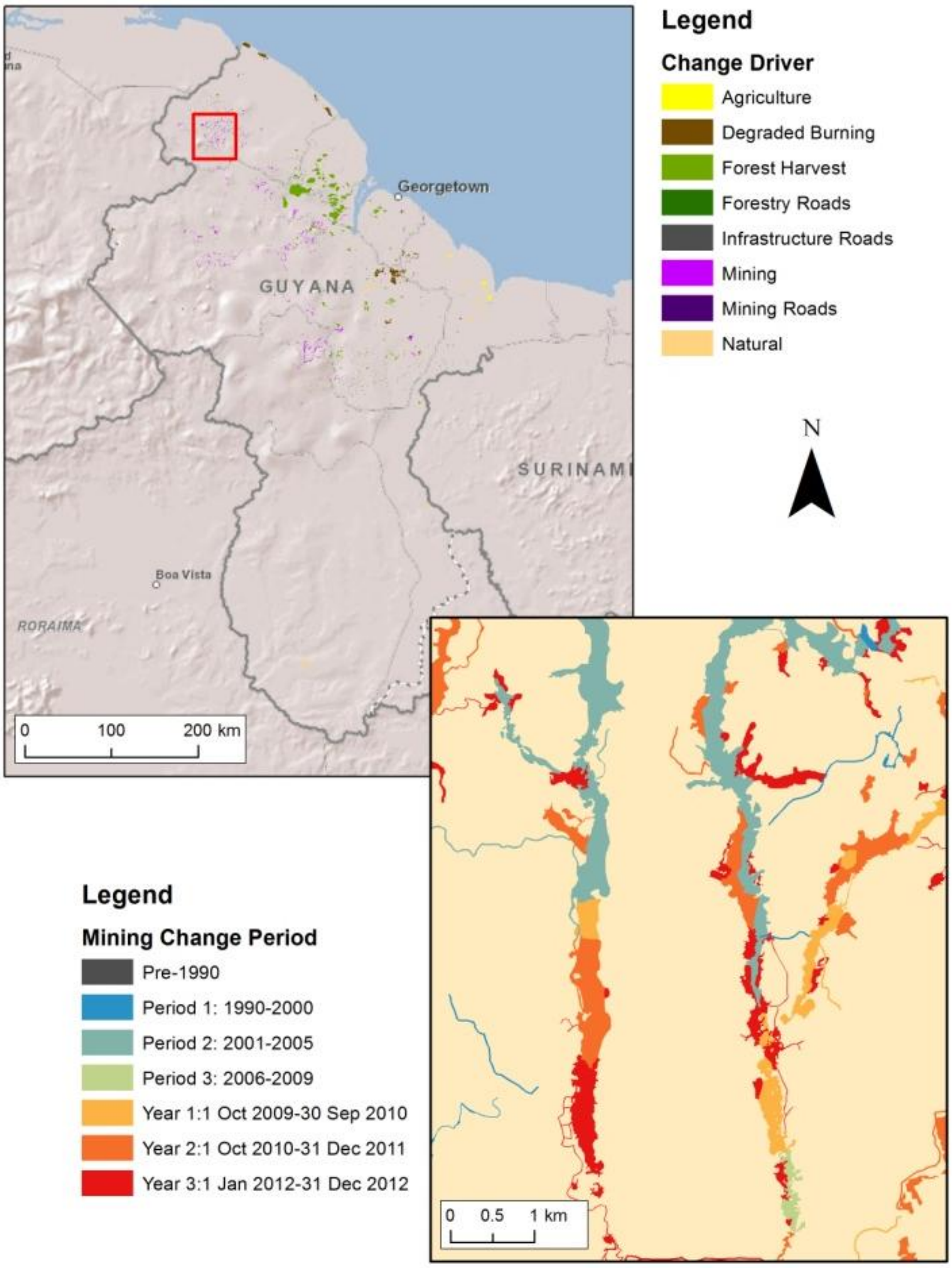
Activity	Driver	Criteria	Ancillary Info Available	Spatially Mapped	End Land Use Class
Forestry	SFM	Fall inside state forest area and is a registered concession	Annual harvest plans, GIS extent of concession, previously mapped layers, Satellite imagery	No - volumetric measure used	Degraded forest by type
	Infrastructure	Roads > 10m		Yes	Settlements
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 area within100 m buffer around deforestation event – road or new infrastructure -revisit sites post 2011to assess change	Existing infrastructure incl. deforestationsites 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 area 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	No - Method under development	Forest Cropland
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 also 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 6-3: Example of Forest Change Mapping



6.8 Land use Changes Not Recorded Spatially 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.

Shifting Agriculture

Work on detecting shifting cultivation has commenced with an interim methodology adopted. This work is in readiness to enable monitoring of areas under shifting cultivation in Year 4 (2014). Such areas of shifting cultivation are not currently reported in the MRVS.

Agriculture is differentiated from shifting agriculture as it is a permanent land use change for a forest class to a non-forest class. In contrast shifting agriculture areas (forest degradation) are not rotational and are irregular in shape. In the GIS mapping, a land use class of 'Cropland' is assigned.

Forest Harvest

Forest harvest activities are accounted for using extraction records. 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 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.

7. FOREST CHANGE

The results summarise the Year 3 period (1 January 2012 to 31 December 2012) forest change. This includes estimates of deforestation and degradation for all land eligible under Guyana's LCDS.

The measurement period for Year 3 is calculated over a 12 month period with the satellite imagery used to assess and calculate the land cover change acquired from August 2012 to December 2012.

As agreed under the JCN, infrastructure associated with the construction of the Amaila Falls hydro power development is itemised separately. For Year 3, no additional clearance has been observed.

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 and 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 to18.38 million ha due to deforestation. In 2012 the forest cover was reassessed using high resolution imagery and baseline figure increased to 18.5 million ha. This revised figure has been used as the revised 1990 reference point from which all change is subtracted.

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.

For the Year 3 detection, four main improvements have been implemented:

- Unlike preceding periods, the Year 3 assessment has used repeat coverage of high-resolution RapidEye images over previously detected change areas. This coverage has also extended to provide full national coverage.
- This has allowed better delineation and detection of change. Notably roads > 10 m have been mapped in Year 3. In previous assessments only roads detected on Landsat 30 m data were mapped.
- A 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 minimised by using multiple high resolution images acquired over the same location. This coverage has been supplemented by Landsat 7.

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

- Forest change reported for the Year 3 period is based on interpretation of satellite images acquired for the last four months of 2012
- Although not required for the interim measures reporting, degradation (shifting cultivation and forest harvesting and afforestation) were mapped as observed.
- 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.

7.1 Changes in Guyana's Forested Area 1990-2012

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.

7.2 Year 3 Analysis

For Year 3 the total area of deforestation over the 12 month period is calculated at 14 655 ha. This is an increase of about 4 600 ha when compared to Year 2.

The total change and change expressed as a percentage of forest remaining is provided in Table 7-1.

Table 7-1: Area Deforested 1990 to 2012

Period	Years	Forest Area ('000 ha)	Change ('000 ha)	Change (%)
Initial forest area 1990		18 473.39		
Benchmark (Sept 2009)	19.75	18 398.48	74.92	0.41%
Year 1 (Sept 2010)	1	18 388.19	10.28	0.056%
Year 2 (Oct 2010 to Dec 2011)	1.25	18 378.30	9.88	0.054%
Year 3 (Jan 2012 to Dec 2012)	1	18 487.88	14.65	0.08%

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 7-1:
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 (0.05%). 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.

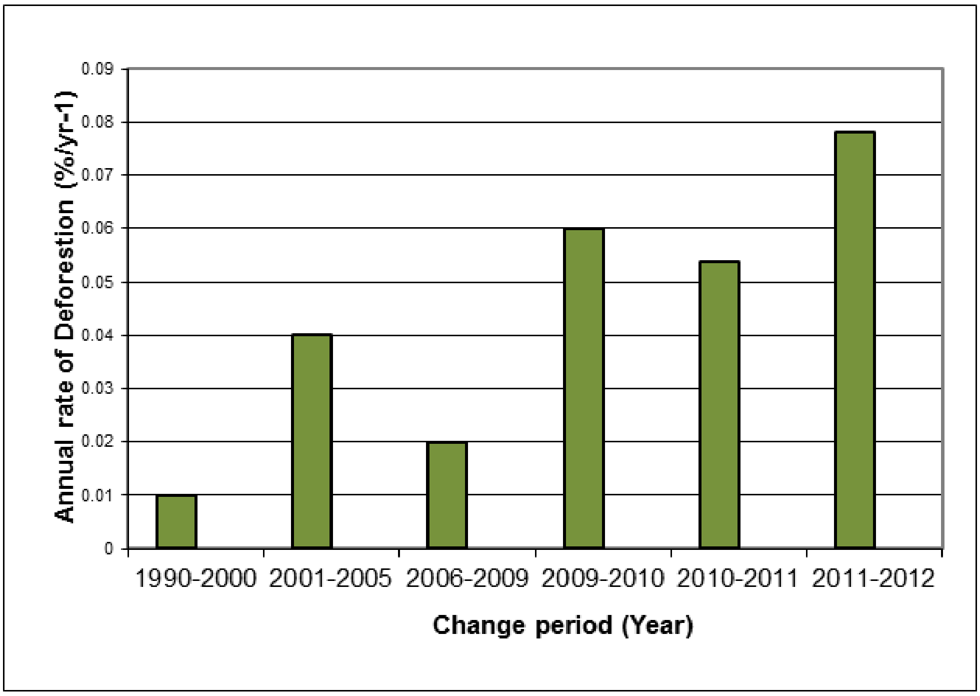
In Year 3 the deforestation rate has increased relative to previous years to 0.079%.

Overall, Guyana’s Year 3 deforestation rate is still low when compared to the rest of South America, which according to the FAO 2010 forest resource assessment is tracking at an annual deforestation rate of -0.41%/yr.

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.

The trend suggests that deforestation rates have increased since 1990 but have remained reasonably constant over the last two assessment periods with a small decrease shown in Year 2 which has switched to an increase in Year 3.

Figure 4:Annual Rate of Deforestation by Period from 1990 to 2012



7.3 Forest Change by Driver

The forest change was divided as assessed by driver. In Year 2, 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 7-2 provides a breakdown by forest change drivers for the benchmark, Year 1, 2 and 3 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.

This trend continues with the area of deforestation attributed to mining (which includes mining infrastructure) showing a sharp increase in Year 1 with approximately 9 000 ha deforested in this year.

In Year 2, this trend continues with a similar area deforested over the past 15 months. Mining is still the main driver of forest change and in Year 2, accounted for 94% of all recorded deforestation. This continues to be the case in Year 3 with the area of deforestation attributed to mining increasing to around 13 516 ha. This is approximately 93% of all recorded deforestation in 2012.

Table 7-2: Forest Change Area by Period & Driver from 1990 to 2012

Driver	Historical Period			Year 1	Year 2 2010-11 (15 months)		Year 3 2012	
	1990 to 2000	2001 to 2005	2006 to 2009	2009-10	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)							
Forestry (includes forestry infrastructure)	6 094	8 420	4 784	294	233	147	240	113
Agriculture (permanent)	2 030	2 852	1 797	513	52	N/A	440	0
Mining (includes mining infrastructure)	10 843	21 438	12 624	9 384	9 175	5 287	13 516	1 629
Infrastructure	590	1 304	195	64	148	5	127	13
Fire (deforestation)	1 708	235		32	58	28	184	208
Degradation (year 2) converted to deforestation							**148**	
Amaila Falls development					225			
Area Change	**21 267**	**34 249**	**19 400**	**10 287**	**9 891**	**5 467**	**14 655**	**1 963**
Total Forest Area of Guyana	18 473 394	18 452 127	18 417 878	18 398 478	18 388 190		18 502 531	
Total Forest Area of Guyana Remaining	18 452 127	18 417 878	18 398 478	18 388 190	18 378 299		18 487876	
Period Deforestation %	0.01%	0.04%	0.02%	0.056%	0.054%		0.079%	

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

****Mining Infrastructure accounts for 1,434ha in year 2012 out of the total deforestation in this category of 13,516ha.**

7.4 Degradation

Degradation associated with deforestation caused by new, Year 2 infrastructure as measured from satellite imagery was estimated at 5 467 ha. This figure is substantially lower than the previous Year 1 estimate of 92 413 ha.

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. For Year 2 and 3 the approach was changed and the RapidEye used to identify forest degradation events – the JCN provides for remote sensing and field observations to be used as well.

In year 3 the area degraded has reduced substantially from 5 467 ha in year 2 to 1 963 ha in year 3. This sharp increase is thought to be related to the tendency to deforest areas immediately rather than gradually.

The main cause of degradation in Year 3 continues to be mining which accounts for 83% of all degradation mapped. This is expected as mining also accounts for the largest area of deforestation and it is evident that it is around deforestation events that forest degradation impacts are largely detected. The remaining contributors to degradation are from fire (13%) and forestry related activities such as degradation during road formation (6%).

7.5 Transition of Degraded Areas to Deforestation

In 2012 degradation mapped in the previous year was revisited to check for any changes in the forest state and for any expansion. The monitoring process identified 148 ha that had switched from degradation to deforested over the reporting period. Table 7-3 provides a summary of the area of each land cover class deforested.

Table 7-3: Transition of Degradation to Deforestation

Driver	Year 2 Land cover Class	Year 3 Deforested (ha)
Mining	Mixed Forest Degraded	111.5
	Montane Forest Degraded	31.7
	Swamp/Marsh Forest Degraded	0.3
	Wallaba/Dakama/Muri Degraded	4.6
Total Area (ha)		**148.1**

All of this change occurred around existing mining areas and is located in the State Forest Area.

7.6 National Trends

The temporal analysis provides useful insight into trends in total deforestation relative to 1990. A more meaningful comparison is provided if the rates of change are annualised using Equation 7-1.

- Forestry related change has remained relatively stable between Years 1 to 3. 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 increased in Year 3 and are in line with historical levels.
- 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 increased in Year 3. This is related to an increase in gold extraction figures. The majority of the activity is still constrained to areas mined in Year 2.
- Deforestation from fire events has increased relative to the post 2000 period. The area is still similar to the mean area of deforestation from1990 to 2000.

Table 7-4: Annualised Rate of Forest Change by Period & Driver from 1990 to 2012

Change Period	Change Period	Annualised Rate of Change by Driver					Annual Rate of Change (ha)
		Forestry	Agriculture	Mining	Infrastructure	Fire	
	(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**

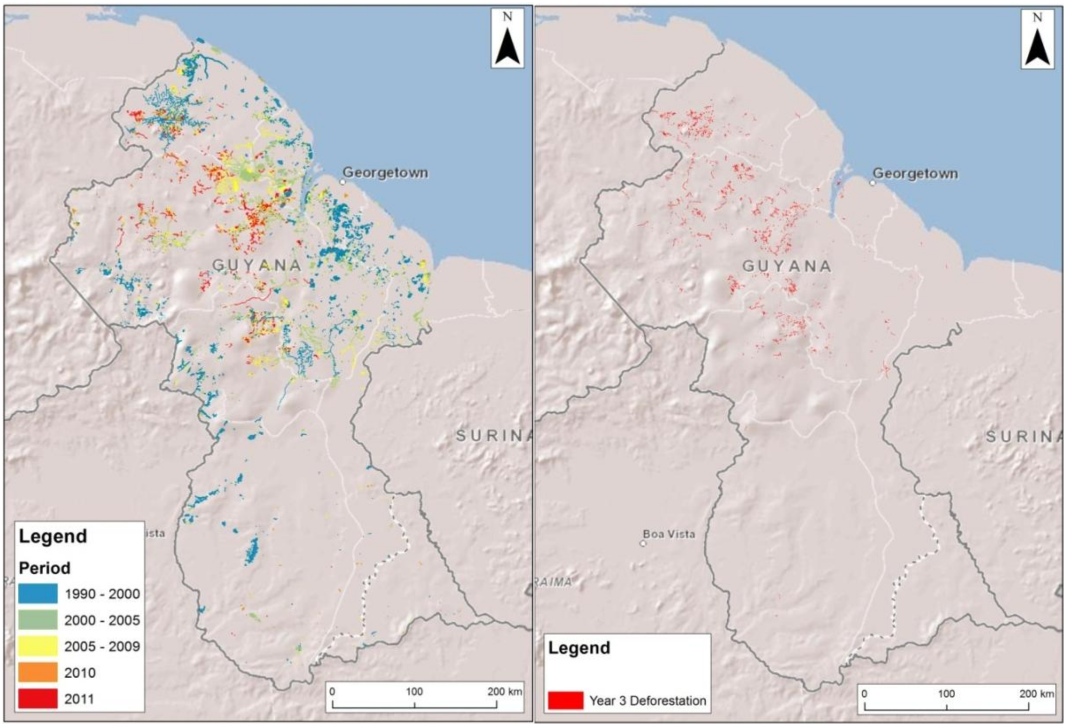
7.7 Deforestation & Degradation Patterns

The temporal analysis of deforestation from 1990 to 2012 is presented in Map 7-1. The map presents change from all drivers. The map shows that most of the change is clustered[22] and

[22]For the purposes of display the area of deforestation has been buffered to make it more visible.

that new areas tend to be developed in close proximity to existing activities. All Year 3 deforestation activities fall inside the footprint of historical change areas.

Map 7-1: Historical &Year 3 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. Even though the entire country is covered with high resolution satellite images no additional change in Year 3 is observed in southern Guyana.

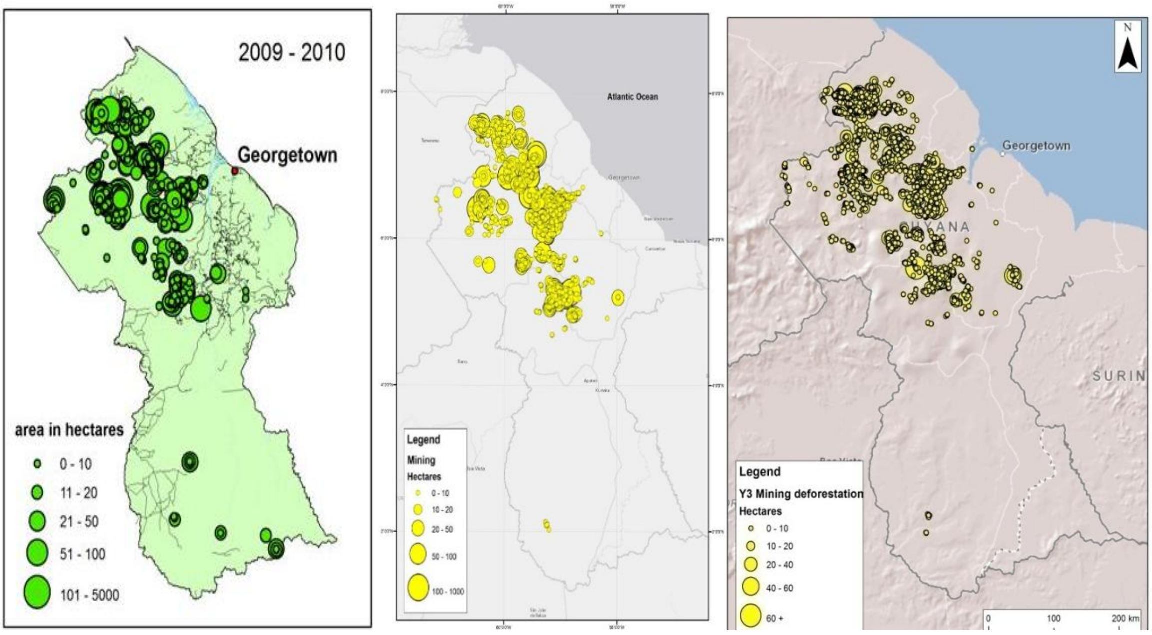
The following series of maps show the temporal and spatial distribution of deforestation by driver (mining, forestry and agricultural and biomass burning). The relative size of the change is represented by scaling the symbol proportional to the area it represents.

Mining

The spatial trend on Map 7-2 shows that mining activities including associated road construction are concentrated in the northwest of the country. Forest change associated with mining includes mining sites and any infrastructure associated with the operation, and Year 2 degraded areas that have been converted to deforestation. This includes any roads that lead directly to mining.

As with previous years most of the deforestation activity occurs in the SFA. In particular Year 3 mining activities are consolidated in the centre of Guyana. Additional mining is observed to the west of the core mining area. No new activity is observed along the Guyana/Brazil border.

Map 7-2: Mining Spatial & Temporal Distribution Y1, Y2 & Y3



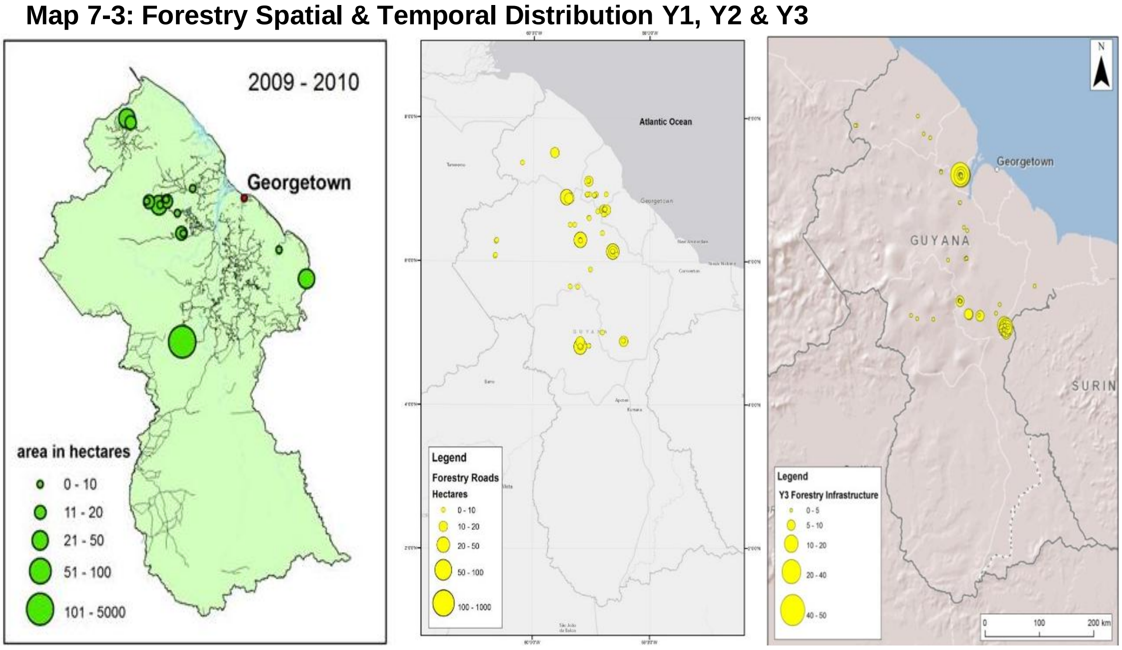
Forestry

Map 7-3 shows that a majority of forestry activities are located inside the SFA. During the Year 3 period, all deforestation events are associated with forestry harvest operations. The main causes of forest clearance include road and log market construction. The area detected is relatively stable (at <300 ha /year) if compared to the last three years.

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

The following map indicates that spatially, forestry activities are focused in GFC-registered active forest concessions.

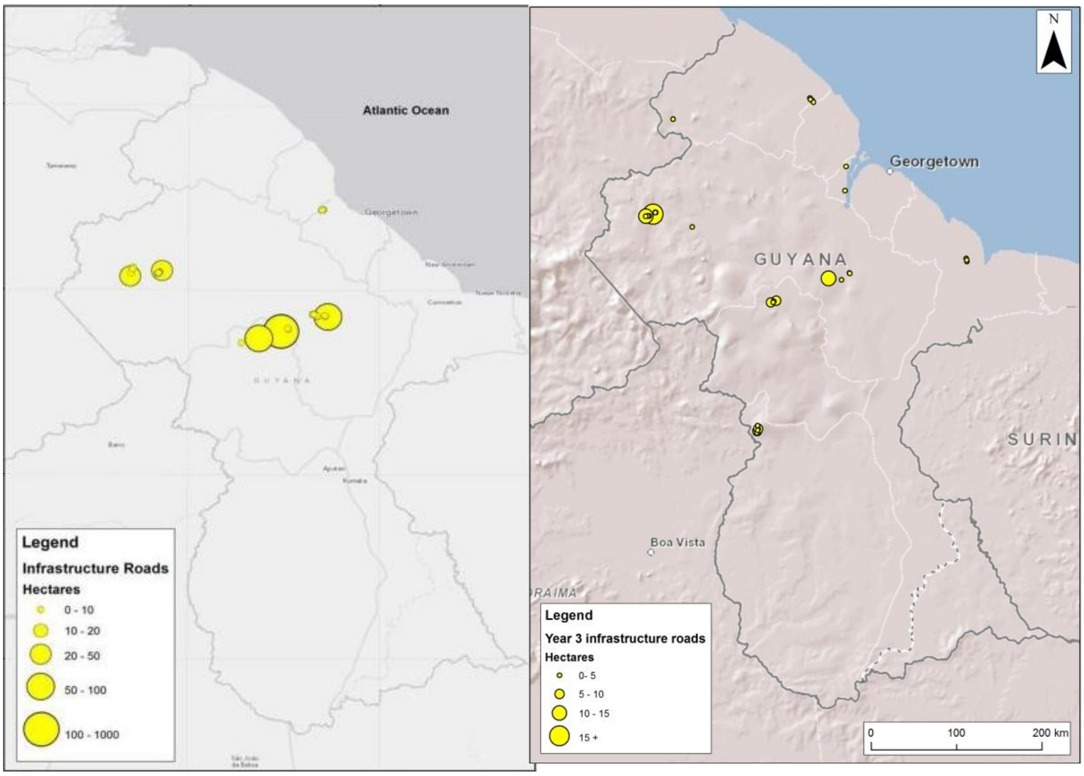
Map 7-3: Forestry Spatial & Temporal Distribution Y1, Y2 & Y3



Infrastructure

In Year 3, infrastructure developments have reduced compared to Year 2 (<150 ha) which was higher due to construction of the access road to the Amaila falls hydro project. The area of clearance is located in a similar location. The main change is related to road construction activities which are also observed in close proximity to towns. The following map shows the distribution of infrastructure developments – note the Year 2 map (left) includes the Amaila falls road.

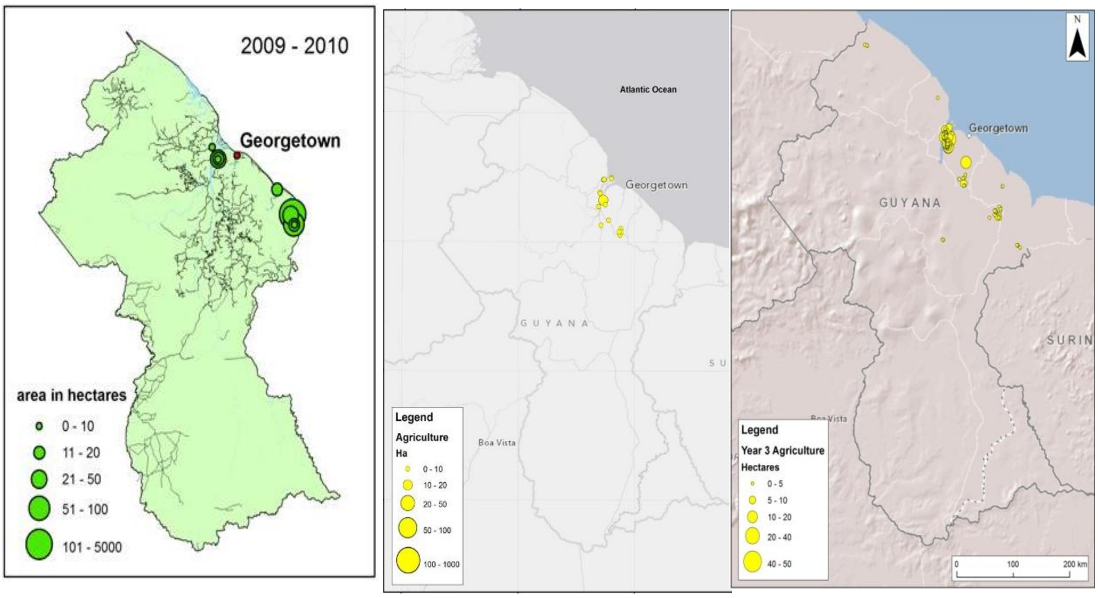
Map 7-4: Infrastructure Roads Spatial & Temporal Distribution Years 2 & 3



Agricultural Development

In Year 3 agricultural developments leading to deforestation have increased to 440 ha which is in line with 2009-10 levels. The main areas of development are located close to Georgetown or in close proximity to the river network. In Year 2, less development is seen around the coastal region close to Suriname (Map 7-5).

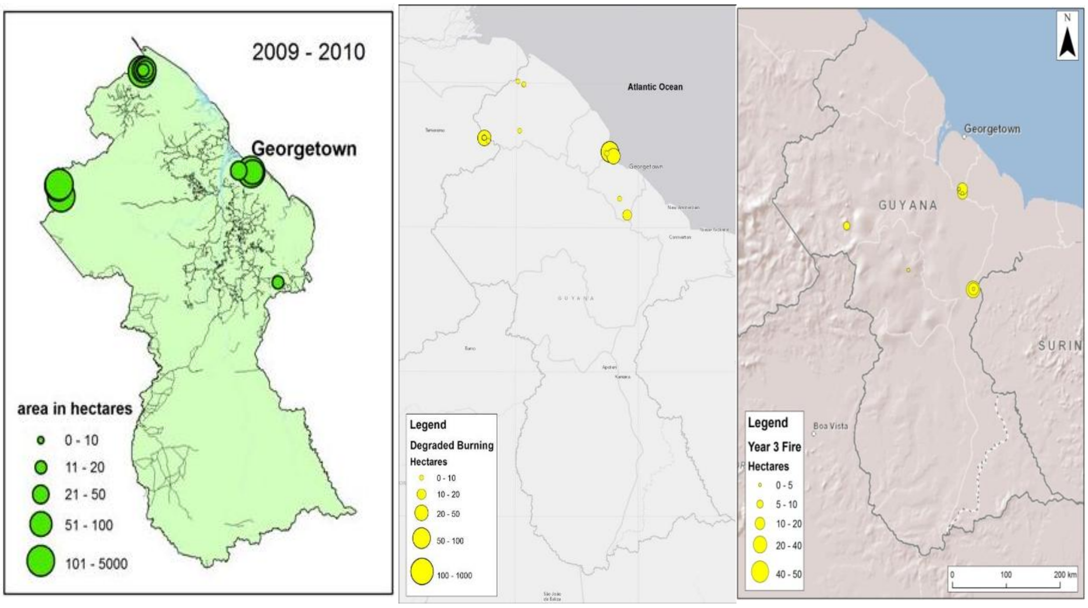
Map 7-5: Agriculture Development Spatial & Temporal Distribution Y1, Y2 & Y3



Biomass Burning - Fire

A majority of recurring fire events occur along the coastal zone close to Georgetown and in the white sand 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 7-56 shows the distribution of fires resulting in deforestation.

Map 7-6: Biomass Burning - Fire Temporal and Spatial Distribution Y1, Y2 & Y3



Comment from Norwegian Ministry for the Environment:

Another interesting finding is that all Year 3 deforestation falls inside the footprint of historical change areas. This shows again that the MRVS can also inform policy development and interventions.

Response to Comment:

Yes, it allows for targetted internvention and potentially further improvements in compliance monitoring.

7.8 Changes in Guyana's LCDS Eligible Areas

Under the Memorandum of Understanding (MOU) between Guyana and Norway, not all land is included in Guyana's Low Carbon Development Strategy (LCDS). Only lands under the ownership of the State are initially included in the LCDS. This includes the State Forest Area and State Lands, and Protected Areas.

The areas of State Forest Area (SFA) and State Lands under LCDS are estimated at 14.84 million hectares. This has reduced from 15.43 million due to the re-categorisation of additional land from the State Forest Areas and State Lands to Amerindian villages.

This change does not impact on the overall forest change figures for Year 3, but the re-categorisation of land, does change the forest area reported for the State Forest Area, State Lands and Amerindian Villages for Year 3. The forest areas for Kaieteur National Park and Iwokrama have remained the same.

7.9 State Forest Area

Historical Change

In the previous assessment the total change in State Forest Area (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 also 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), 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.

Year 3 Change

Forest change is 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. Degradation surrounding new infrastructure such as mining sites has reduced from 5 201 ha in Year 2 to 1 749 ha in Year 3. This accounts for 76% of all Year 3 degradation mapped. The remaining degradation is accounted for by degradation caused by fire or from road construction activities associated with forestry operations.

Table 7-5 provides a breakdown of forest change by driver for all periods including Year 3. Degradation is reported for the Year 2 and 3 periods.

Table 7-5: SFA Total Forest Change by Driver from 1990 to 2012

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2012	
	1990 - 2000	2001-2005	2006 -2009	2009-10	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)							
Forestry	6 026	8 253	4 293	270	211	147	229	113
Agriculture (permanent)	384	247	62	3	33		102	0
Mining	10 122	19 930	12 007	8 582	8 788	5 038	12 179	1 499
Infrastructure	374	1 228	89	24	322	5	44	13
Fire (deforestation)	564	67		32	5	4	145	125
Degradation (year 2) converted to deforestation					225		148	
Area Deforested	**17 470**	**29 725**	**16 451**	**8 910**	**9 362**	**5 194**	**12 848**	**1 749**
Total Forested SFA Area (ha)	12 481 363	12 463 894	12 434 169	12 417 718	12 341 893		12 341 893	
Total Forested SFA Remaining (ha)	12 463 894	12 434 169	12 417 718	12 408 807	12 332 530		12 329 045	
Period Deforestation rate (%)	0.01%	0.05%	0.03%	0.07%	0.08%		0.10%	

7.10 Changes in Guyana's State Lands

Historical Change

For the period spanning 1990 to 2009 a deforestation figure of 8 161 ha was reported. This equated to approximately 11% of all deforestation for the benchmark period. Annualised this represented a change rate of 463ha/yr or equivalent deforestation rate of- 0.01%/ yr. For Year 1 deforestation in State Lands was calculated at 742 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.

Year 3

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. Overall, in Year 3 the change located in State Lands accounts for around 5% of the national total. Correspondingly, the area of degradation mapped around new infrastructure is also small. A total of 85 ha are mapped with 38 ha attributed to mining and the remaining area fire.

Error! Not a valid bookmark self-reference. provides a breakdown by driver for the benchmark and Year 1, 2 and 3 periods.

Table 7-6: State Lands Forest Change by Driver from 1990 to 2012

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2012	
	1990-2000	2001-2005	2006-2009	2009-10	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)							
Forestry	24	93	30	24	7		6	0
Agriculture	1 565	2 563	1 735	510	19		324	0
Mining	306	814	190	175	120	26	331	38
Infrastructure	30	72	18	32	47		49	0
Fire	720	1			9	4	39	47
Area Deforested	**2 645**	**3 543**	**1 974**	**741**	**202**	**30**	**749**	**85**
Forested State Land Area	3 095 485	3 092 840	3 089 297	3 087 324	3 084 306		3 084 306	
Forested State Land Area remaining	3 092 840	3 089 297	3 087 324	3 086 583	3 084 104		3 084 104	
Period Deforestation rate (%)	0.01%	0.02%	0.01%	0.02%	0.01%		0.02%	

7.11 Areas Excluded from the LCDS

Forest change and degradation is also monitored but not currently included in the LCDS area.

Forest change has been mapped across the titled Amerindian areas. The trend indicates that Year 3 deforestation (1 056 ha) and annual rate (0.04%) have increased relative to Year 1 and 2. Around 101 ha of this total are located within the Intact Forest Landscape[23] (see section 9.5) which is subject to deductions under the Interim Measures. It was advocated that Amerindian areas that have been titled and/or demarcated following the benchmark as part of the continuous process of land titling, should be eligible for exclusion from IFL and an adjustment to the benchmark.

Mining dominates the change areas and contributes around 95% of the total change for Year 3. Similarly the greatest area of degradation is also seen around mining areas. Overall change inside Amerindian areas accounts for 7% of the total change for Year 3.

Table 7-7: Amerindian Forest Change by Driver from 1990 to 2012

Driver	Benchmark Period			Year 1	Year 2 2010-11		Year 3 2011-12	
	1990-2000	2001-2005	2006-2009	2009-10	Deforestation	Degradation	Deforestation	Degradation
	Area (ha)							
Forestry					15		4	0
Agriculture	55	18	0	0	0		13	0
Mining	415	694	426	627	267	216	1 005	92
Infrastructure	0	4	89	8	0		34	0
Fire (deforestation)	425	166	0	0	44	20	0	36
Area Deforested	**895**	**883**	**515**	**635**	**326**	**236**	**1 056**	**129**
Forested Amerindian Lands	2 490 707	2 489 812	2 488 930	2 488 415	2 546 852		2 546 852	
Forested land Remaining	2 489 812	2 488 930	2 488 415	2 487 780	2 546 526		2 546 526	
Period Deforestation rate (%)	0.00%	0.01%	0.00%	0.03%	0.01%		0.04%	

[23] "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)".

8. VERIFYING FOREST CHANGE MAPPING & INTERIM MEASURES

The accuracy analysis will be conducted in October and November and included as an addendum to this report. These results will be evaluated during the independent audit conducted by DNV.

The scope of the Accuracy Assessment is for a third party not involved in the change mapping to conduct an assessment of deforestation, forest degradation and forest area change estimates for the Year 3 period (2012). Specifically, the terms of reference asked that confidence limits be attached to 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 2012 to 31 December 2012 (Interim Measures Period – Year 3).

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

8.1 Year 2 Accuracy Assessment Conclusions & Recommendations

In Year 2 the accuracy assessment concluded that the quality of the mapping undertaken by GFC which was based largely on interpretation of Landsat and RapidEye imagery was of a good standard.

An indication of the quality of the mapping is the prevalence statistic. This showed the correspondence between the map and reference data was high at 0.986 or 98.6% agreement. Several recommendations were made at the conclusion of the assessment and as appropriate these have been actioned in Year 3. The recommendations are listed as follows:

1. RapidEye data was identified as ideally suited for the task. It was recommended that the RapidEye data coverage be extended into the low-risk strata (the rest of the country) to help identify areas mapped as non-forest. These areas were identified as degraded or intact forest but were mislabelled from poor quality Landsat data.

   It would greatly assist Accuracy Assessment if the planning for the acquisition of high resolution imagery used to validate the mapping over the Primary Sampling Units (PSU) grid squares could be completed early in the Year 3 process (August to December).

2. The identification and addition of navigable water bodies to the GIS will assist in improving the mapping and should improve the definition of high risk strata by helping to predict areas of forest at risk. It is recognised that the acquisition of RapidEye data, as it extends to large areas of Guyana, will result in the need to update and improve the quality of the maps (back casting). This process is supported as it will result in better quality maps and area estimates.

3. Ensure that GFC staff are familiar with the validation process and have powerful workstations to be able to undertake some of this work in house.

4. Allow sufficient time for the independent validation. The sample size used in 2012 appears insufficient for a full quantitative analysis of degradation drivers, particularly when sampling low-risk strata. It is estimated that a sample of 80—100 Primary Sampling units will provide a sufficiently large sample to yield an area estimate, particularly if the additional PSUs are allocated to the high-risk stratum where Year 2 degradation is most likely to be found.

5. Perhaps design the over-flights and field work to take place after the photo-interpretation to allow particular areas of ambiguity or uncertainty to be validated.

6. GFC has continued to improve their standards of surveying and mapping with the Accuracy Assessment exercise presenting a good opportunity to evaluate these improvements. It is recommend that GFC will continue the effort and define standards for spatial data acquisition as clearly as possible and apply appropriate quality control measures.

9. 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 December 2012, a revised Joint Concept Note (JCN) under the Guyana/Norway Agreement was issued, and replaces the JCN of 2009. The revised JCN updated on 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[24].

The basis for comparison of a majority of the interim measures is the 30 September 2009 benchmark map[25]. 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 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.

In Year 3 a national coverage of RapidEye was commissioned. Images were acquired from August to December 2012.

A summary of the key reporting measures and brief description for these interim measures are outlined in Table. The calculations to determine the rate of deforestation (ref. measure 1) has been covered in Section7.

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 this was calculated by applying a 500 m buffer around mining sites and roads.

It is envisaged as the MRVS is expanded prototype methods implemented in Year 2 will be integrated. The focus of these developments is to account for emissions from shifting cultivation and activities that result in carbon sinks i.e. SFM or enrichment plantings.

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[24]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.

[25]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 9-1: Reported Interim Measures

Measure Ref.	Reporting Measure	Indicator	Reporting Unit	Adopted Reference Measure	Year 2 Period	Year 3 Period	Difference Y3 and Reference Measure
1	Deforestation Indicator	Rate of conversion of forest area as compared to the agreed reference level.	*Rate of change (%)/yr^{-1}*	0.275%	0.054%	0.077	-0.20%
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 (63ha loss)	7,604,580	174[26]
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	-2 405
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[27]	3 685 376[28]	2,159,151	-1,227,627
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	-400,639
5	Emissions resulting from anthropogenic forest fires	Area of forest burnt each year should decrease compared to current amount.	*ha/yr^{-1}*	1 706[29]	28	208	-1 498[30]

9.1 Interim Reporting Indicators

The following provides a description, justification and performance measurement for each of the seven indicators. At this stage only the first five of the seven measures are reported.

9.2 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 75% of total carbon[31]. 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.

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[26] Difference total in Year 3 is based on reduced balance from Year 2.
[27] 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.
[28] Computed for the period October 1 2010 to December 31 2011
[29] Degradation from forest fires is taken from an average over the past 20 years.
[30] Difference total in Year 3 is based on original reference level of 1,706 ha. Forest fires are reported in spatial extent for the interim period but will transition to forest carbon emissions reporting when MRV System is fully operational.
[31] Indicative figures C/ha for tropical low land forest in Bolivia (GOFC-GOLD). This is not necessarily the case in peat soils, where this pool is more 'important' than below-ground biomass and in some strata may even be more important than above-ground biomass.

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. In Year 3 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.

9.3 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 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 ae 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.

9.4 IFL Data Sources and 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.

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 between 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.

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 and 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 have been included as IFL. Shifting cultivation areas have been defined from medium resolution satellite imagery.

9.5 Calculation of the Year 3 Intact Forest Landscape

The requirement under interim measures is that 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. **Map 9-1** (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.

In 2011 approximately 56% of Guyana was imaged with high resolution imagery. This was expanded to full coverage in 2012. 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 3 the same benchmark IFL area was used. The analysis identified 174 ha of deforestation, 101 ha of which was mapped in Amerindian areas (identified as grey areas on the Year 3 IFL map).

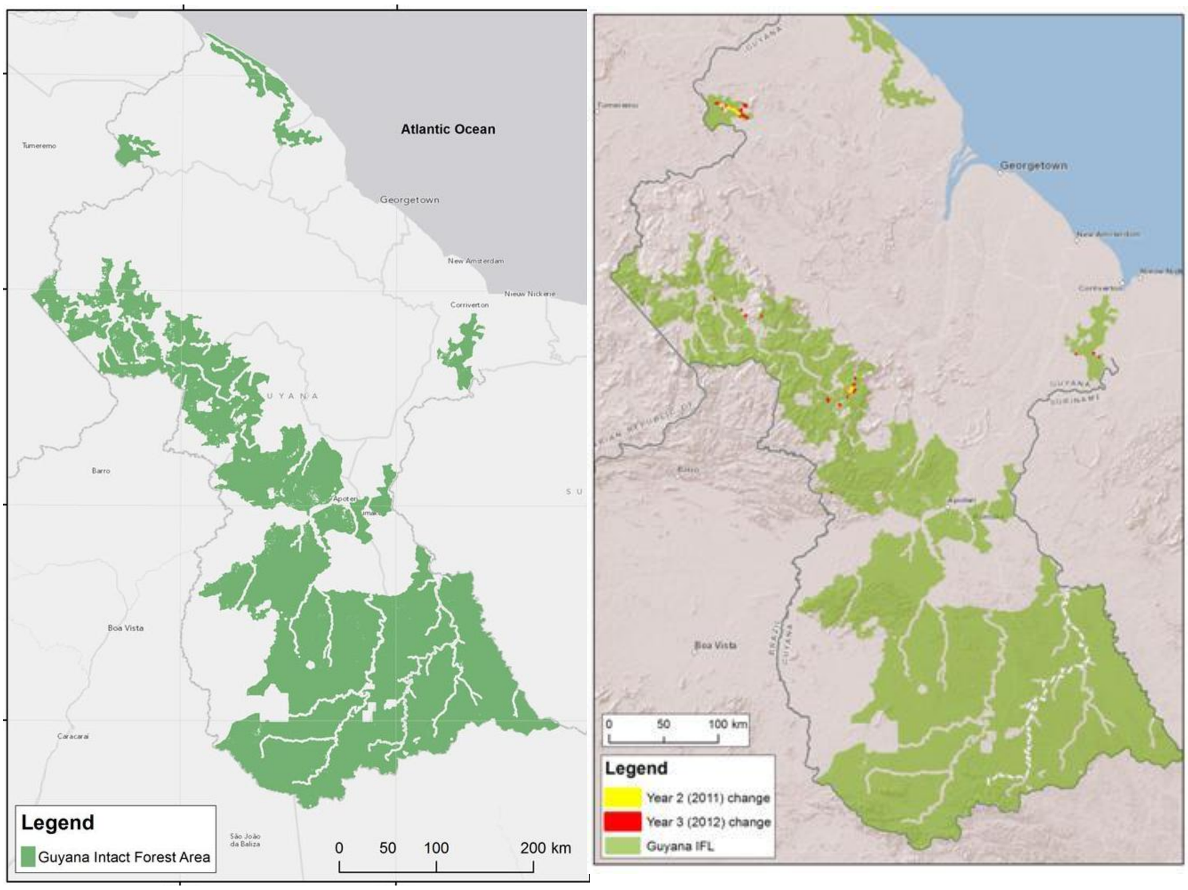
It is proposed that deforestation located in Amerindian areas is not counted in calculating the reduction in financial remuneration, as these areas are excluded from the LCDS. Further the areas are part of the Government of Guyana's continuous land titling and demarcation programme.

> *Comment from the Norwegian Ministry for the Environment:*
>
> *It is proposed that IFL change within Amerindian areas is not accounted for in the calculation of the financial remuneration. In our view, the IFL indicator is meant to assess performance in keeping IFL areas intact at an overall, national level, and that all change to IFL should therefore be calculated. As commented previously, any amendments to the IFL indicator relates to progress also on other deliverables in the JCN of 2012, and until this more overarching discussion takes place, we suggest keeping the indicator in its current form.*

Response to Comment:

The continued retention of a less scientific measure such as the IFL is not really in keeping with the overall intention of the JCN. Once on detection as part of the MRV and then again due to enforcement of this rudimentary proxy deforestation measure. Further, IFL intentionally makes provisions for "exclusions" and settlements such as titled Amerindian areas, qualify for such exclusions. The fact that these cannot all be determined upfront as the process of land titling in Guyana is a continuous one, should not, in our view, be reason to prevent these from being excluded when titles are granted for Amerindian Villages. This, in our view, may be seen as an unintended disadvantage of the continuous land titling programme for Amerindian Villages.

Map 9-1: Bench Mark Intact Forest Landscape & Y2 & 3 Changes



9.6 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 was 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 field work 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 this approach was retained. Furthermore areas of degradation identified in Year 2 were revisited and assessed for change.

MRVS Year 3 has integrated within mapping protocols, the assessment of re-entry of existing mines and has included the results of this assessment within the total degradation reported for Year 3. Forest degradation that occurred in year 3 has been mapped when surrounding both year 2 and year 3 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 (Oct 1 2009 to Sept 30 2010) was estimated at 92 413 ha. This area does not necessarily reflect forest degradation in a practical sense.

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 for.

> *Comment from Norwegian Ministry for the Environment:*
>
> *It is good to see that measurements of existing mining sites have been integrated within mapping protocols. Revisiting degradation sites is important, as degradation is a process that could happen over several years. This realization was also the reason why the original indicator was formulated as "50 % carbon loss per year". Of course, the new mapping method eliminates the need for applying such a default factor, but the sites should still be revisited to capture any degradation that happens after the first year.*
>
> *Response to Comment:*
>
> *Yes, the aim is to also continue to refine and improve the methodology.*

9.7 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 2012 to 31 December 2012:

- 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 holder. Upon declaration, the harvested produce is verified, permits collected and checked and sent to the GFC's Head Office for another level of audit, 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 based on the 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's offices with checks made at this stage on legality of origin, 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 done 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 for 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 the GFC's head office where data entry is done. 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 for 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, a separate verifier, not involved in the data entry, validates all entries made as accurate and correct and posts validated data to secured storage areas in the database. There are security features at several levels of the database functioning including 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.

A continuous process of further development and strengthening of the GFC's databases has been identified. This will specifically focus on strengthening of the procedural and illegal logging databases and also on the Amerindian/Private Property production databases.

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

- Logs
- Lumber (Chainsawn Lumber)
- Roundwood (Piles, Poles, Posts, Spars)
- Splitwood (Shingles, Staves)
- Fuelwood (Charcoal, Firewood)

Logging Damage– Default Factor

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

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

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

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

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

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

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

Where:

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

WD = wood density (t/m^3)

CF = carbon fraction

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

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

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

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

3.67 = conversion factor for t carbon to t carbon dioxide

Wood in long term products

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

$$C_{WP} = C * (1 - WW) * (1 - SLF) * (1 - OF) \quad \text{(Eq. 2)}$$ [32]

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

This 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 2012 to 31 December 2012 is shown in the table below. For this period t CO_2 has reduced by 1,227,627 t CO_2. It should be noted that the historic rate for 2003-2008 (called the Reference Measure), that was used in the Year 2 MRVS Report for the period ending 2011, was prorated for 15 months as the assessment period for year 2 was 15 months (October 2010 to December 2011). Given that year 3 (January – December 2012) is a period of 12 months, the Reference Measure for this indicator was reverted to a 12 month level. For this reason, the reference measure in this year 3 report is slightly lower than that for the year 2 report.

Table 9-2 Interim indicator on Forest Management

Period	Description	Volume (t CO_2)
1 January 2012 – 31 December 2012	t CO_2 emissions arising from timber harvesting	2,159,151
2003-2008 (annual average)	t CO_2 emissions arising from timber harvesting	3,386,778
Difference (t CO_2)		**-1,227,627**

9.8 Emissions Resulting from Illegal Logging Activities – Measure 4

It is required for areas and processes of illegal logging to 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.

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

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 705,347m^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 1 January 2012 to 31 December 2012, 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 is 400,639 t CO_2 less than the historic period level.

Table 9-3 Interim indicator on Illegal Logging

Period	**Description**	**Volume (t CO_2)**
1 January 2012 – 31 December 2012	t CO_2 emissions arising from timber harvesting	11,217
2003-2008 (annual average)	t CO_2 emissions arising from timber harvesting	411,856
Difference (t CO_2)		**-400,639**

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 results in a total volume being reported as illegal logging for any defined time period.

9.9 Emissions from Anthropogenic Forest Fires – Measure 5

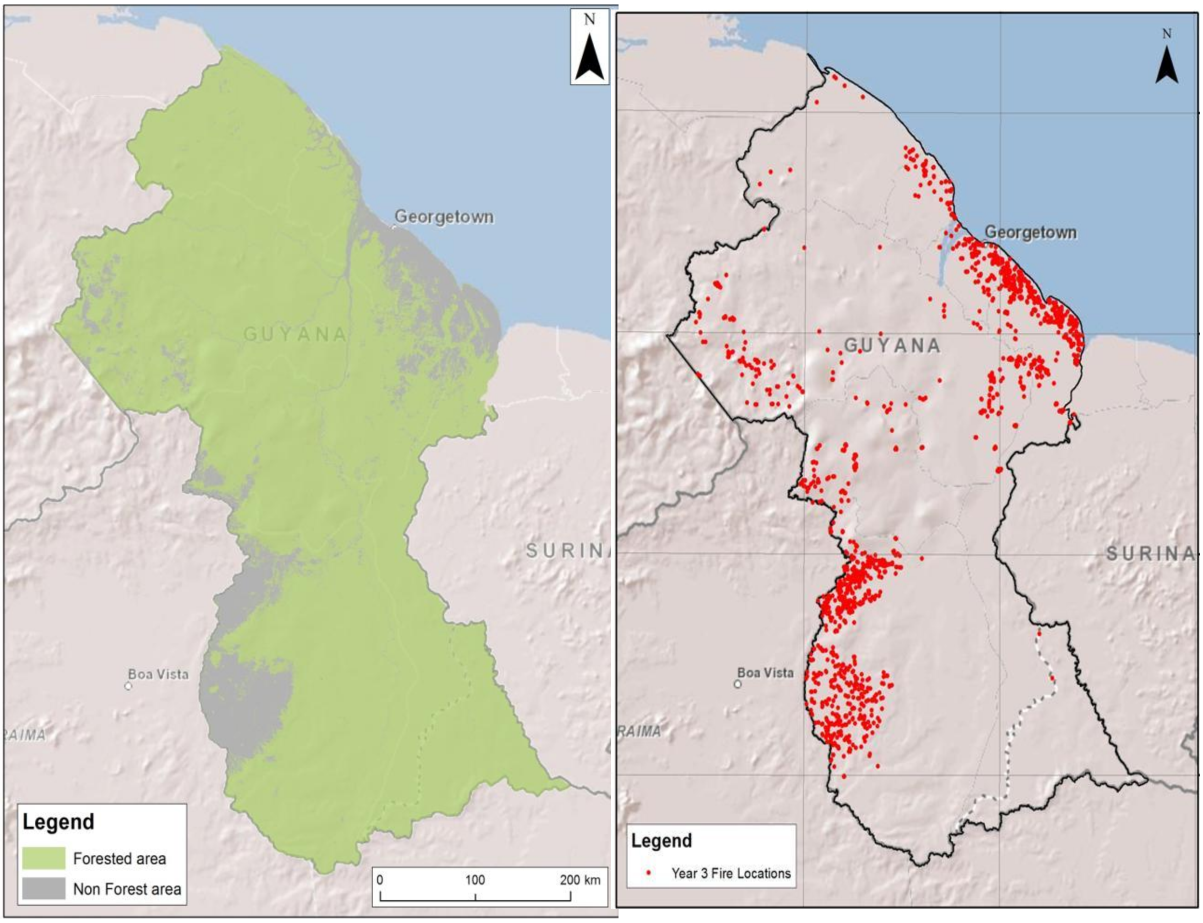
The FIRMS fire point data from MODIS was used to identify potential fire locations (Map 9-2). In addition a systematic review of all fire points was undertaken to validate the presence of fire and establish the extent using the RapidEye imagery. This is an accepted approach that is documented in the 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[33]. 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 value of 28 ha was calculated. In Year 3 the area degraded by fire has increased to 208 ha.

[33]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.

Map 9-2: Non Forest Area &FIRMS Fire Data 2010-2012



The spatial pattern of the fire locations from FIRMS also suggests that many of the fires detected from the MODIS sensor are located in the non-forest areas. 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.

Comment from the Norwegian Ministry for the Environment:

A question out of mere curiosity; Do you have knowledge about the reason for the historical fire rates in Guyana being so massively higher than in the recent few years? Was the El Niño event described in the footnote that severe, or could there be other reasons?

Response to Comment:

In 2000 there was a major fire event located around Linden. This occurred during an extended period of dry weather which was associated with the El Niño.

10. ONGOING MONITORING PLAN & QA/QC PROCESSES

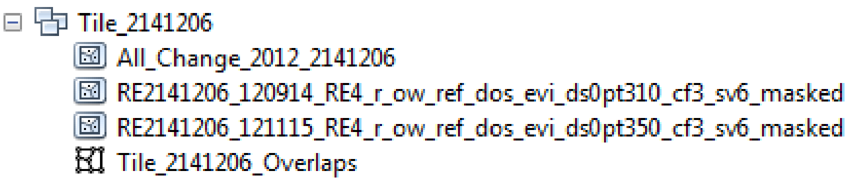
There is a formal QA/QC process that has been developed over time. The process ensures that the national change analysis is consistent. The key elements of the process include;

- 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.
- Facilitate 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.
- Upgrade 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 data sets 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 reporting formats output from an operational MRVS

The following description outlines the mapping process while Figure 10-2 shows the technical QC as it is applied.

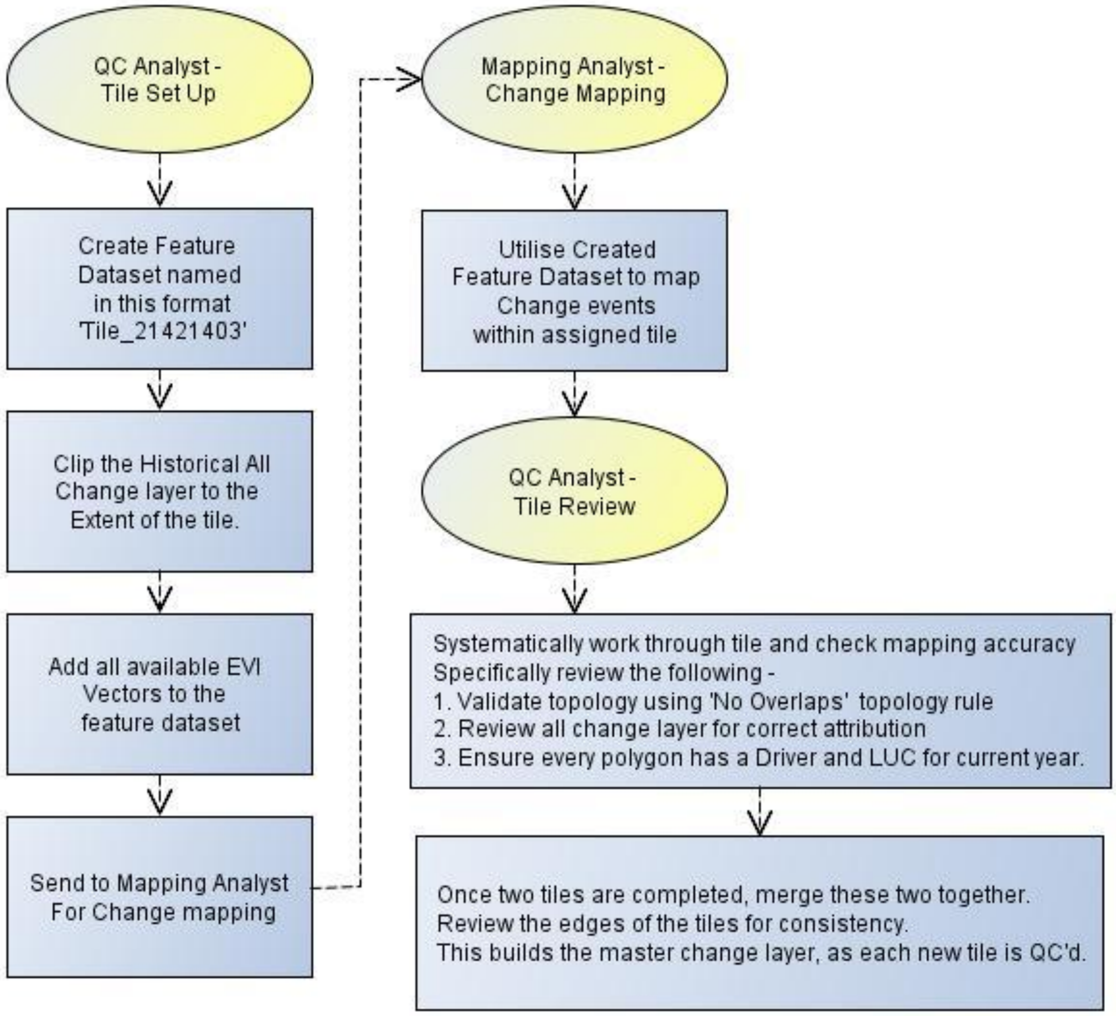
The process splits the analysis into RE tiles, maps the change, then merges the tiles back together to form the updated master layer. A feature dataset is created for each tile, which appears like the example shown in Figure 10-1.

Figure 10-1: Feature Dataset Schema



1. 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.
2. 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 25m² (1 Rapideye pixels) these are considered invalid slithers.
    7. Harmonise table to ensure drivers LUCs are consistent
    8. Intersect with land classes layer

Figure 10-2: QC Process Outline



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Appendix 1

2011 Follow up Actions

Observation	DNV Recommendation	Year 3 Progress
CAR 3 – Minor Requirement: Interim Indicator 2b – Carbon loss as indirect effect of new infrastructure. Non Compliance: Accuracy Assessment contains too few sample plots to provide sufficient accuracy on the degradation levels. Objective evidence: During the current accuracy assessment it was concluded that current sample plan resulted in too few plots that contained degradation and not a high enough confidence interval can be achieved.	Implementation of effective sampling implemented in Year 3.	A revised method of Accuracy Assessment was completed in Year 3. This involved the collection of aerial photography over 80 samples randomly spread throughout Guyana. The application of the new methodology has allowed for adequate sample points to be taken to reflect representative results for the national programme.
CAR 6 – Minor Requirement: QA & QC Non Compliance: Not all the data is completed in the data forms and or electronic sheets. Objective Evidence: Evidence was found that some data sheets from the forest did not contain all information that was required to be completed.	Data sheets are to reflect full completeness even in the case of secondary data. This will be an area of attention in the Year 3 verification.	A complete re check was done on all data sheet and the electronic system and updates made to sheets where required. These checks confirmed that only secondary information in limited cases was detected. System available for verification.
CAR 7 – Minor Requirement: Interim Measures 2b – Carbon Loss and indirect effect of new infrastructure. Non Compliance: Degradation only includes new degradation from newly established mines but not re-opening of existing mines. Objective evidence: While the GFC is currently assuming that active degradation will only occur around recently active mining areas. During the field assessment it has become apparent that mining companies do come back to older sites to investigate the potential for extension by digging prospection pits (of about 1.5 by 2meters). From Current text it is unclear whether this would be falling under the definition of new or not.	DNV to obtain clarification from Norwegian Government. Year 3 to address the aspect on degradation relating to re-opening of existing mines.	GFC awaits clarification from DNV and Government of Norway. In lieu of this however, MRVS Year 3 has addressed this area by integrating within mapping protocols, the assessment of re-entry of existing mines and has included the results of this assessment within the total degradation reported for Year 3.Forest degradation that occurred in year 3 has been mapped when surrounding both year 2 and year 3 infrastructure and mining.
OBS 1 Requirement: Interim indicators 3 Forest Management Potential Non-Compliance: Errors in Mapping of activities due to the existing and passed way of position recording. Objective evidence: During the field visit to Mabura audit team was not able to locate stumps using GFC GOS due to the fact that past GPS positions were not properly converted to current used GPS coordinates.	DNV to observe in Year 3 if during audit similar issues arise in the execution of the audit work	Position recording has been addressed with consistency checks made.
OBS 2 Requirement: Interim indicator 1, 2 and 3 Potential Non-Compliance: Errors in data processing and delay timelines. Objective Evidence: Analyse imagery as early as possible in assessment period. Prioritising of some activities to expedite mapping process.	DNV notes the challenges faced by GFC in terms of timely resource availability to deliver assessment. Will observe if this continues to be a challenge.	For the year 3 assessment this has continued to be somewhat of a challenge for the GFC with delays experienced in the availability of resources to complete MRVS assessment.

Appendix 2

Accuracy Assessment Report

Guyana REDD+ Monitoring Reporting and Verification System (MRVS)

Accuracy Assessment Report

November 2013

EXECUTIVE SUMMARY

1. This report was commissioned by Indufor for the Guyana Forestry Commission in support of a system to Monitor, Report and Verify (MRV) 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 Jan – Dec 2012. 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 1 January 2012 to 31 Dec 2012 (Interim Measures Period – Year 3). Very high spatial resolution aerial imagery and high resolution satellite imagery and field visits are used to assess the wall-to-wall mapping of Guyana undertaken by Indufor (IAP) and Guyana Forestry Commission (GFC) based primarily on data from the German RapidEye satellite constellation system, supplemented only where necessary by Landsat.

3. A two-stage sampling with stratification of the primary units was adopted to provide precise estimates of forest area. Two strata were selected according to "risk of deforestation", that is, land proximal to settlements, roads, logging concessions and known mining dredge sites, and other low risk land area. Interpretations of deforestation and degradation drivers were made from expert image interpretation of very high spatial resolution aerial imagery or high spatial resolution satellite imagery.

4. For the Year 3 Forest–Non-forest map, the results show a correspondence (prevalence) of 99.76% between reference image interpretation and IAP/GFC mapping for all the 55,119 one-hectare plots sampled from both strata. This demonstrates a very high level of correspondence between the MRV maps and the reference data: 99.56% in High Risk stratum and 99.89% in Low Risk stratum. This compares with 94.5% in High Risk and 99.08% in Low Risk for Year 2.

5. The estimate of Year 3 forest area for Guyana, based on the stratified sampling design is estimated as 18,392,292 ha. The Confidence interval range for the High Risk Stratum is 11,690 ha and the CI range for the Low Risk stratum is 9,835 ha (95% CL). The estimate of the area of Year 3 deforestation is 15,145 hectares. The CI range for Year 2 forest area was 79,765 ha for High Risk and 58,873 ha for Low Risk (95% CL).

6. For the Year 3 the accuracy of the mapping of Intact Forest Land is 99.96%. Correspondence (prevalence) is 99.47% in High Risk stratum and 99.98% in Low Risk stratum.

Table 11-1: Comparison of Forest Change Estimates

Source	Forest area remaining at the end of Year 3 (ha)	Forest area change Year 3 (ha)	Benchmark Rate (%)	Year 3 Rate (%)
GFC / Indufor GIS Map Estimate	18,392,782	14,655	0.021	0.08
Durham Sample-based Estimate	18,392,292	15,145	0.021	0.08

7. In Year 3 the amount of forest mapped as degraded by GFC/IAP has fallen from 5467 ha to 1963 ha. The correspondence between the mapping and the sample-based assessment is close 99.69%. This compares to a correspondence of 97.08% for Year 2.

8. Based on sampling, we estimate a Year 3 deforestation rate (12 months of change) of 0.08% compared with 0.08% derived by GFC and IAP. Dredge mining and road construction are the principal causes of deforestation and degradation.

9. The DU estimate of 1990 forest area is 18,481,329 ± 13,616 ha at 95% confidence limit. The estimate of 1990 Forest area is 65,526 ha more that the GFC/IAP mapping which, given the confidence interval is a very close agreement.

TERMS OF REFERENCE

The objective of this section is to explain the methods used to:

i) Derive forest area and degradation estimates
ii) quantify the drivers for the types of change mapped, and
iii) derive the deforestation rate for year 3. This includes the results of REDD+ Interim Indicators as outlined in the MRVS Year 1 assessment, and assessing their error margins/confidence bands.

Specifically, the objectives are targeted towards:

- Providing confidence and credibility in the estimates derived from the mapping exercise, nationally and at the international level;
- Providing a greater understanding of error patterns and to provide recommendations on how these may be used to inform a continuous improvement programme for future years;
- Providing the client with the resources needed to improve local ownership and capacity for the Guyana Forestry Commission and its partners to use and produce such data for themselves in future.

Specific areas of activity

1. To refine and enhance the methodology developed in 2010/11 and in 2011/12 to assess deforestation, taking note of IPCC Good Practice Guidelines and GOFC/GOLD recommendations.
2. To outline a methodology for accuracy assessment including an outline of the (1) sample design, (2) response design, and (3) analysis design.[34] For the design component, reference data are identified, and relevant literature is cited to support the approach taken.

[34] GOFC GOLD Sourcebook Section 2.6.

3. To report on REDD+ interim measures and national estimates (Gross Deforestation, Intact Forest Landscape, Extent of Degradation associated with new infrastructure, and report of the processes driving deforestation and degradation) 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), providing verification of the deforestation rate figure for Year 3 as a total and a breakdown by driver, assessing the error margins/confidence bands on deforestation area estimates.

This assessment 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 accuracy assessment including very high spatial resolution aerial imagery and high spatial resolution imagery.

1. AREA REPRESENTATION

The total land area for Guyana at the Benchmark period 2009[35] is reported in the Interim Measures Report to be 21.1 million hectares. This figure is based on GIS polygon data of Guyana's National boundary and is used when calculating area based statistics. 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. For mapping, the GFC uses ArcGIS v.10 software.

o 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 for 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 Landsat TM and ETM+ imagery at approximately 1:24,000 using ArcGIS software. Mapping was conducted for GFC by Pöyry Consultants for the following epochs: 1990, 2000, 2005, 2009 and 2010 (See GFC/Pöyry Interim Measures Report, March 2011). The 2009 epoch represents the Benchmark period for the Interim Measures and for the MRVS.

Areas mapped as deforested during the period1990-2009 are used to establish the *deforestation rate* for the benchmark reporting period.

In 2012, as part of an improvement process Guyana's forest area was re-evaluated using RapidEye 5m orthorectified imagery. This analysis has resulted in an increase in the forested area by approximately 110,000 ha to 18.5 million ha.

The purpose of this report is to build upon the estimates of deforestation established for Years 1& 2 and to quantify the precision of the estimate of deforestation and forest degradation in Year 3. 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.

[35] The precise area edited to account for coastal erosion between 1990 and 2010 is given as 21,128,606.0 ha.

2. SAMPLING DESIGN FOR VERIFYING YEAR 3 FOREST CHANGE AND FOREST DEGRADATION MAPPING

o Maps to be validated

The accuracy assessment task is to assess the accuracy of a countrywide thematic land use map digitized in the main from high spatial resolution RapidEye imagery, supplemented in a few areas by Landsat TM and ETM+ imagery. The map depicts **Forest / Non-Forest** area for Year 3 and includes a map class showing areas interpreted as **degraded forest** broken down into a year class to indicate when the degradation occurred. The map contains classes for deforestation attributed to all epochs of change mapped since 1990. The maps were generated at a minimum mapping unit (MMU) of 1 ha using automated methods with areas then edited using ArcGIS software at 1:15,000 scale for RapidEye scenes (the majority) and 1:24,000 scale for Landsat TM and ETM+ scenes.

The thematic accuracy of the maps was assessed using the following well established procedures:

1. Select the thematic criteria to be assessed and identify the data to be used for validation;
2. Determine the number of sample areas to be assessed;
3. Select the sample areas using an appropriate random or stratified sample;
4. Prepare a sampling grid and decision tree for thematic assessment;
5. Conduct sampling.

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, 2009), 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 and degradation
- Cartographic and thematic standards (i.e. minimum mapping unit and land use definitions)
- The availability of field reference data for evaluation of the results.

It is clear that accepted approaches were used to minimize these sources of error following IPCC and GOFC-GOLD good practice guidelines as appropriate.

Mapping of 1990 and through the reference period (1990-2009) suffered from cloud cover, temporal specificity of image acquisition and uneven spatial distribution of high resolution reference imagery over Guyana. This situation improved in Years 2 and 3 with the country-wide acquisition of RapidEye data in 2012.Sample selection for Year 3 has improved since Year 2 because RapidEye imagery covers most of Guyana with a few exceptions where persistent cloud cover prevented useful data being acquired within the available timeframe.

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).

o **Response Design**

Table 11-2: *Data sources used for Validation* summarises the data available to validate the Year 3 (2012-2013) *Forest/non-Forest* and *forest degradation* map polygons and attribute labels. It also specifies the areas covered by the GeoVantage aerial imagery and a selection of Very High Resolution (VHR) imagery used to validate the Year 3 mapping.

Table 11-2: Data sources used for Validation

Application	Dataset used	Provider	Sensor	Spectral Range	Date of Acquisition	Pixel size (m)	Area (ha)	% of Guyana
Forest assessment	RGB and CIR aerial imagery	GeoVantage	4 channel multi-spectral sensor	Visible and NIR	Aug-Oct 13	0.25-0.60	288,940	1.37
	QuickBird	DigitalGlobe	MS	Visible and NIR	07 Sep 12	2.4	9,077	0.04
						Total	298,017	1.41

A critical component of any accuracy assessment 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 3 deforestation and degradation was mapped by the IAP/GFC team from RapidEye imagery supplemented in a few areas by Landsat TM and ETM+, while the accuracy assessment primarily used GeoVantage RGB and CIR (Colour InfraRed) aerial imagery supplemented by QuickBird satellite imagery in parts of Guyana that were beyond the safe operational range of Cessna light aircraft.

The 2010 (Year 1) Durham University Accuracy Assessment report concluded that RapidEye and IKONOS data were of sufficient spatial resolution to identify deforestation and the main drivers of deforestation. In particular, areas of agriculture could be distinguished from shifting cultivation and that infrastructural features such as mine dredges & camps and roads associated with mining and logging could be mapped with confidence. In Year (2) the Accuracy Assessment report concluded that areas of degradation and its likely driver (cause) were difficult to identify with confidence from RapidEye and Landsat data. Very high spatial resolution satellite data are difficult to task for wide area coverage and so an alternative source of high resolution imagery (airborne capture) was sought to support the accuracy assessment exercise for Year 3 in order to have sufficient spatial resolution to identify degradation.

The mapping and digitising was undertaken by a small team of 5 GFC staff using a semi-automated feature extraction supported by a rules-based manual interpretation method. For consistency, the Accuracy assessment was also carried out in Durham by a small team (four persons) using the same rules-based approach. Any misinterpretation or labelling error is most likely to arise from human-error or interpretation using poor quality imagery or areas partially obscured by cloud or cloud shadow.

For this reason the response design allows areas of obvious uncertainty to be coded as *Omitted*. It is helpful that the classification is binary in nature and the accuracy assessment team are not faced with the more complicated task of assessing forest or land cover type where spatial, spectral and radiometric resolution can be limiting factors (Khorram, 1999).

The Interim Measures for Year 3 includes an assessment of the mapping of areas of forest degradation. Degradation has been mapped alongside Year 3 deforestation using a rule-based approach for infrastructure and for shifting cultivation. Noting exclusions as detailed in table 2-2.

Table 11-3: Year 3 Deforestation/Degradation Assessment Exclusions

Reference	Criteria
1	Land use change that occurred prior to Jan 2012 or after Dec 2012
2	roadsless than a 10 m width.
3	naturally occurring areas – i.e. water bodies
4	cloud and cloud shadow

The following provides a summary of the datasets available and the way they were used for the accuracy assessment.

GEOVANTAGE IMAGERY

The Accuracy Assessment (AA) dataset was captured using GeoVantage's aerial imaging camera system. The system mounts externally on to most light aircraft – for the imaging in Guyana, both a Cessna 172 (Figure 2-1) and 206 were evaluated.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 2000 to 5000 ft. This corresponded to imagery that ranged from 25 to 60 cm. GeoVantage's system is designed to enable the pilot to operate the system and fly the aircraft simultaneously. However, for this project the system was customised - it was therefore decided that the pilot would be accompanied by an operator. The operator's primary role is to operate the camera system. The operator also assisted the pilot in navigation due to the complexity, distribution and number of sample rectangles. Navigation includes selecting the best path between rectangles, selecting the correct rectangle to sample and within each rectangle selecting the appropriate lines for the pilot to fly.

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 (see Figure 2-2).

RAPIDEYE

RapidEyeis a constellation of five high-resolution visible and near infrared satellites. These acquire five-band multispectral imagery at 6.5m 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 for which an unusable data mask (udm) file was produced and delivered by RapidEye. This mask highlights the areas of unusable data within an image but it fails to detect small clouds, haze and cloud shadows. However the data are of good quality and remain useful for validation purposes.

As some parts of Guyana were outside the 150km limit from the airstrips, the RapidEye imagery was used for the accuracy assessment of these parts (see Figure 2-2).

QUICKBIRD

QuickBird-2 was launched in October 2001 and raised in orbit in April 2011 to extend the operational life of the mission. The product acquired for the assessment has 2.62m nominal nadir-looking spatial resolution with four spectral bands (red, green, blue, and near-infrared). It was rectified with the use of rational polynomial coefficients that were provided with the product. Typically this provides an accuracy of 23m CE90 excluding terrain effects. In practice, it proved geometrically accurate enough for the validation purposes.

After careful search in the Archive of GeoEye, only two frames were found to be cloud-free and within the area where GeoVantage could not cover (see Figure 2-2).

LANDSAT

The Landsat TM and Landsat ETM+ data from 1990 was used in order to check that the assessment of 1990 Forest/ Non-forest was correct. This was necessary because the additional spatial detail of the aerial imagery showed that there was the potential for error in the 1990 maps because some areas mapped as non-forest were in fact forests covered and the reason for misclassification was due to differences in forest type that are not apparent from satellite imagery. We note that the Landsat data were referenced to the Landsat GeoCover dataset which is a collection of high resolution satellite imagery provided in a standardized, orthorectified format (http://glcf.umd.edu/research/portal/geocover/). Landsat data were not be used for map accuracy assessment, but to check for misclassifications.

Figure 11-1: The Cessna 172 and the GeoVantage instrument

The following map provides an overview of the image data used for the accuracy assessment.

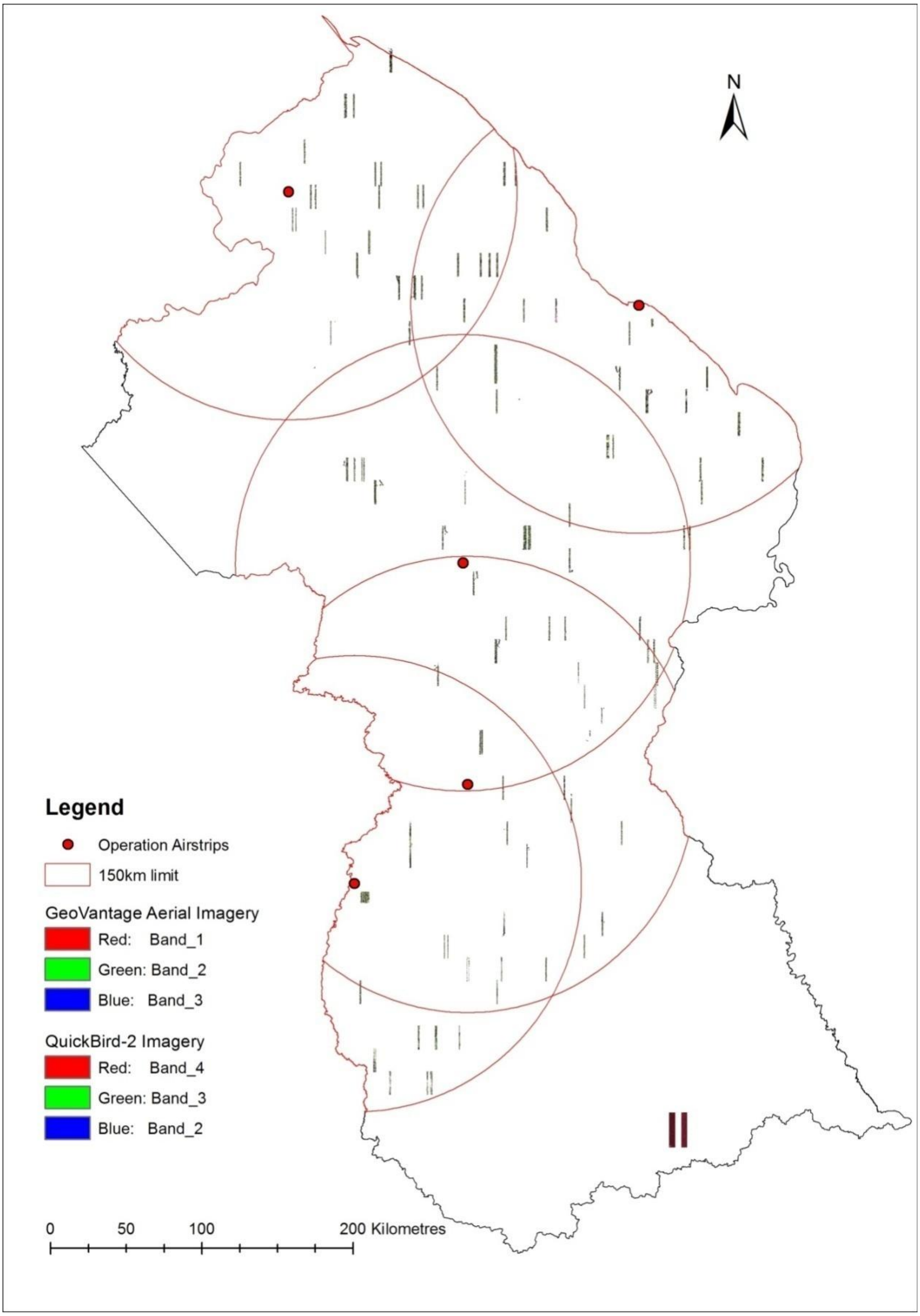


Figure 11-2: High Resolution Imagery available for validation

- **Data Provided by Guyana Forestry Commission**

The Forest Resource Information Unit (FRIU) holds a range of operational spatial data that were used to assist in the stratification into areas of high and low risk of deforestation. A summary of the spatial layers updated for Year 3 mapping is provided in Table 11-4.

Table 11-4: GFC GIS Datasets

Data Group	Layer Name	Created/ Update freq	Description
Admin	guyana_boundary	Received August 2013	Updated country boundary for Guyana.
Hydro	Waterbodies (GFC)	Received August 2013	Waterbodies layer, digitised from geo-corrected Landsat imagery. Layer integrated into the 1990 forest / non-forest map
Managed Forest Areas	State_Forest_2006	2006	Layer showing the extent of the state forest boundary.
	TSA_WCL_Merged	6 monthly	A merged layer showing all active Timber Sales Agreements (TSA) and Wood Cutting Leases (WCL) (large forest concessions)
	PropSFEP_Merged	6 monthly	A merged layer of all proposed State Forest Exploratory Permits
	activeSFEP_Merged	6 monthly	A merged layer of all active State Forest Exploratory Permits.
	activeSFPs_Merged	6 months	All active State Forest Permits (small forest concessions). Merged by Division – Demerara, Essequibo, Berbice, North West
	logging_Camps	NA	Point location of logging camp sites, based on the Annual Operating plan.
	harvest_Areas	NA	Polygons showing extent of harvest activities (pre 2008, 2008 & 2009)
Roads	gpsroads_dd	3-6 months	All GPS roads and trails as at August 2013.
Agricultural Leases	GFCAGleases	Upon titling	Agricultural leases that fall within the State Forest Estate (Administrative Regions: 1, 2, 3, 6, 7, 8 and 10)
Mining Areas	LRG_Scale-Aug2010_region, MED_Scale-Aug2010_region, Mining_dredges	Upon granting of mining permit/licence/claim	Large and Medium scale mining areas including dredge locations. Received March 2012.

- **Sampling Design**

The sampling design refers to the methods used to select the locations at which the reference data are obtained.

To assess the Year 3 deforestation map a two stage sampling strategy with stratification of the primary units was adopted. In the first stage, a rectangles grid of 5km by 15km in size was created within the spatial extent of the country's national boundary[36]. This resulted in

[36] 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.

2837rectangles; note that only rectanglesthat their centroid was within the national boundary are selected (Figure 2-3).

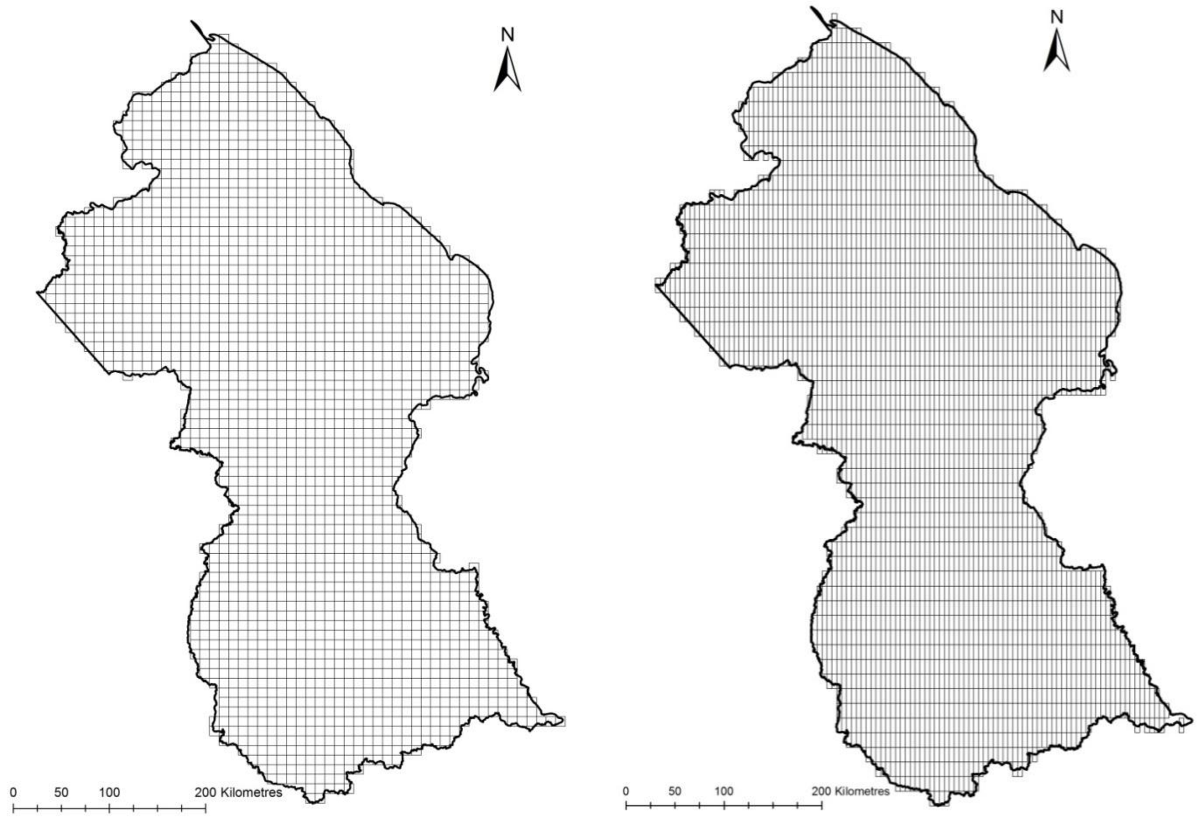


Figure 11-3: While in previous years a grid of 10x10km^2 was used, this year a grid of 5km by 15km in size (right image) was created, mainly for practical reasons with the aerial imagery acquisition.

To optimize the process of acquiring aerial imageryfrom the by GeoVantage sensor, a more elongated sampling grid was chosen and from the 10x10km^2 squares a 5x15km^2 rectangles shape was selected. The North-South direction was chosen because it follows the shape of Guyana, and works well with the GeoVantage software.

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, 2009b). Based on geographical data provided by GFC, grid rectangles were stratified according to factors closely associated with risk of deforestation. In particular, data about the location of logging camps, mining dredges, settlements, and the existing road network were used (see Table 2-4 and Figure 2-4). This way, all grid rectangles that satisfied the following criteria were selected.

Contain at least one of: logging camps, mining dredges, or settlements,

OR

Intersect with at least one road.

This resulted in the classification of grid rectangles into two strata. The ones that satisfied the criteria (named "High Risk") and the ones that did not satisfy the criteria (named "Low Risk"). This resulted in 1018 "High Risk" squares and 1819 "Low Risk" squares (see Figure 11-4).

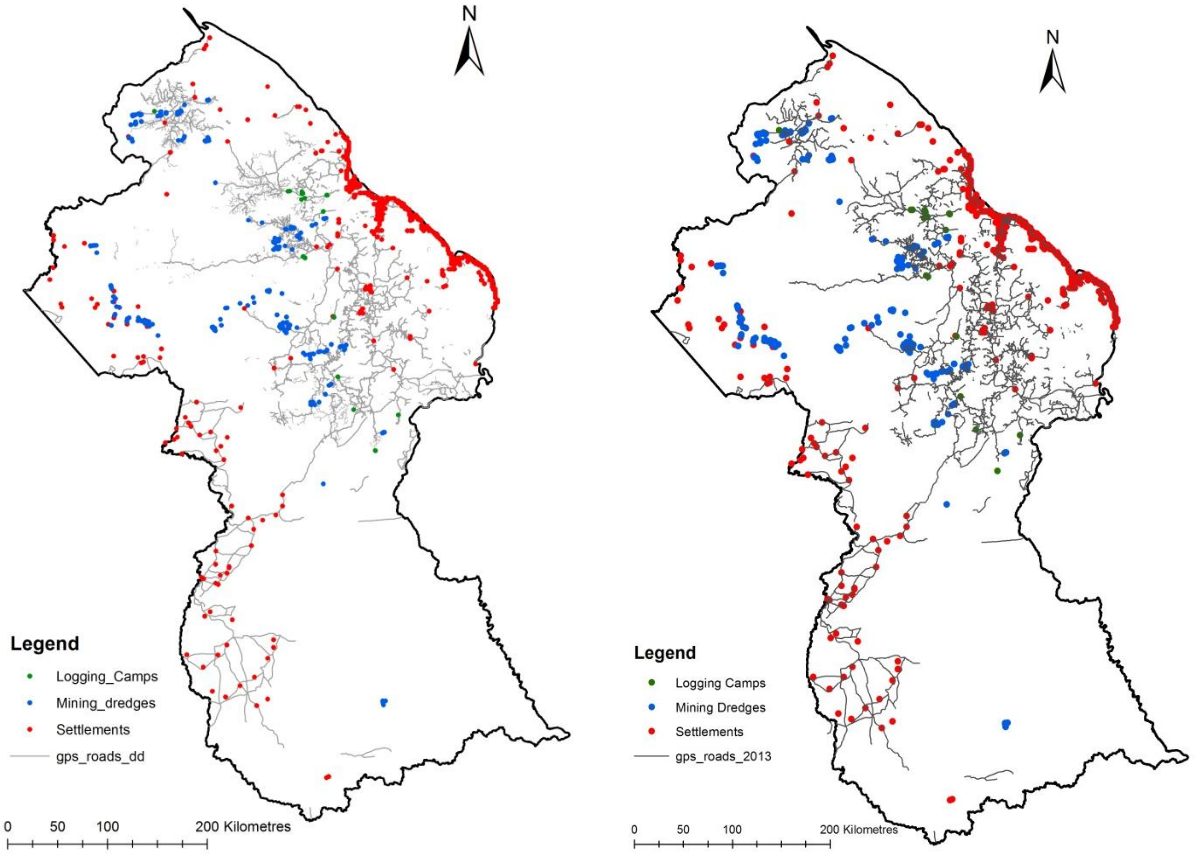


Figure 11-4: Criteria for sampling stratification - left map Year 2 and right map Year 3. Notice the difference between roads in Y2 and roads in Y3. This is because in Y3 the roads shapefile was restricted to include only those roads wider than 10m:

The map in figure 2-5shows an overlay in red colour of the deforestation data on the sampling stratification map. It demonstrates that about 67% of the deforestation for Year 2 falls within the "High Risk" stratum with the remaining 33% falling within the "Low Risk" rectangles. Note that the risk strata have changed between Year 2 and Year 3.

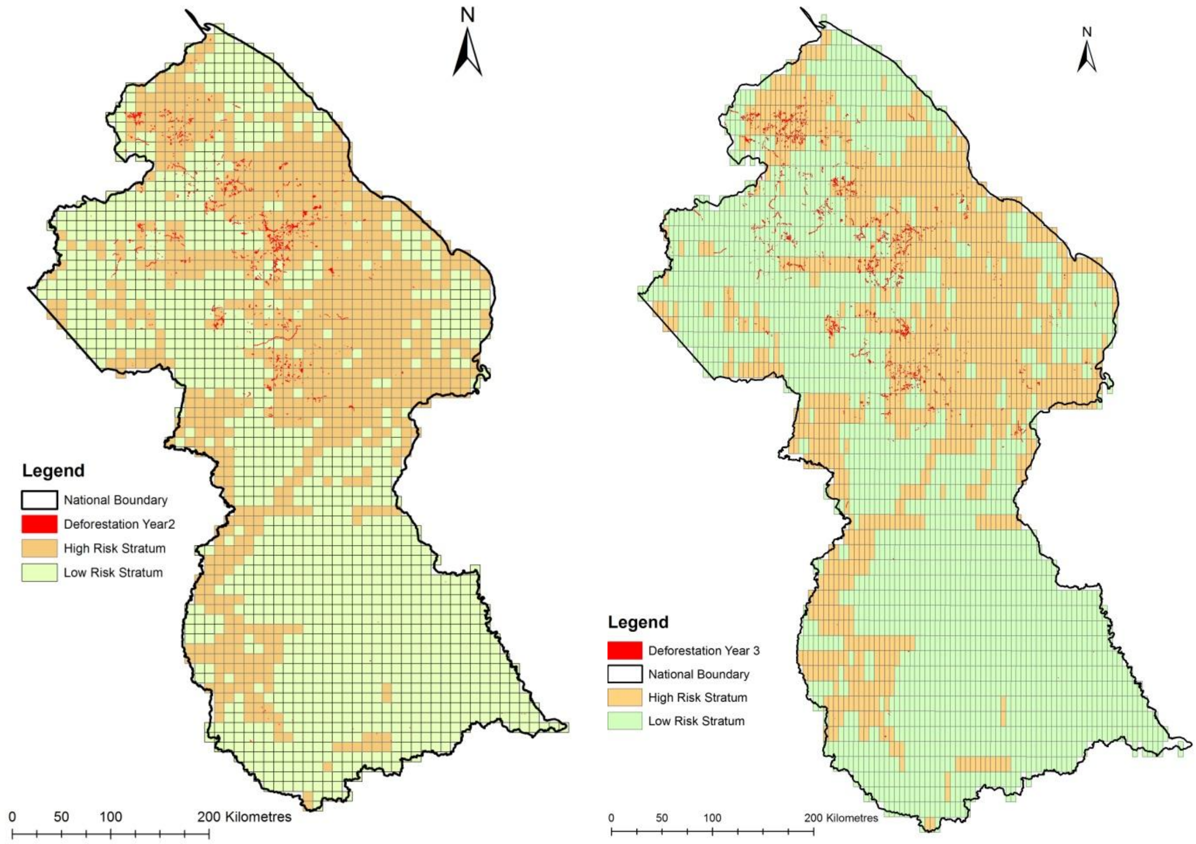


Figure 11-5: Mapped deforestation as Year 2 (left); deforestation mapped as Year 3 (right)

Table 2-4: Spatial data used to assist with Stratification

Data Group	Layer Name	Created/ Update Frequency	Description
Admin	guyana_boundary	Received August 2013	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	gpsroads_dd	3-6 months	All GPS roads and trails as at January 2013.
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 2-5 suggests that there is lower probability of sampling deforestation in the Low Risk stratum than the High Risk stratum and so, in order not to under sample and miss deforestation events in this stratum, a weighting was applied when randomly selecting rectangles to analyse in detail. As the area ratio of High Risk to Low Risk is 35:65, we decided to randomly sample 65% of HR and 35% of LR. This resulted in 662 “High Risk” rectangles and 637 “Low Risk” rectangles. As it would have been unrealistic to sample all these rectangles, one ninth of them was randomly selected from the initial dataset while keeping the ratio 662:637 constant (see Figure 11-6 and Table 2-5).

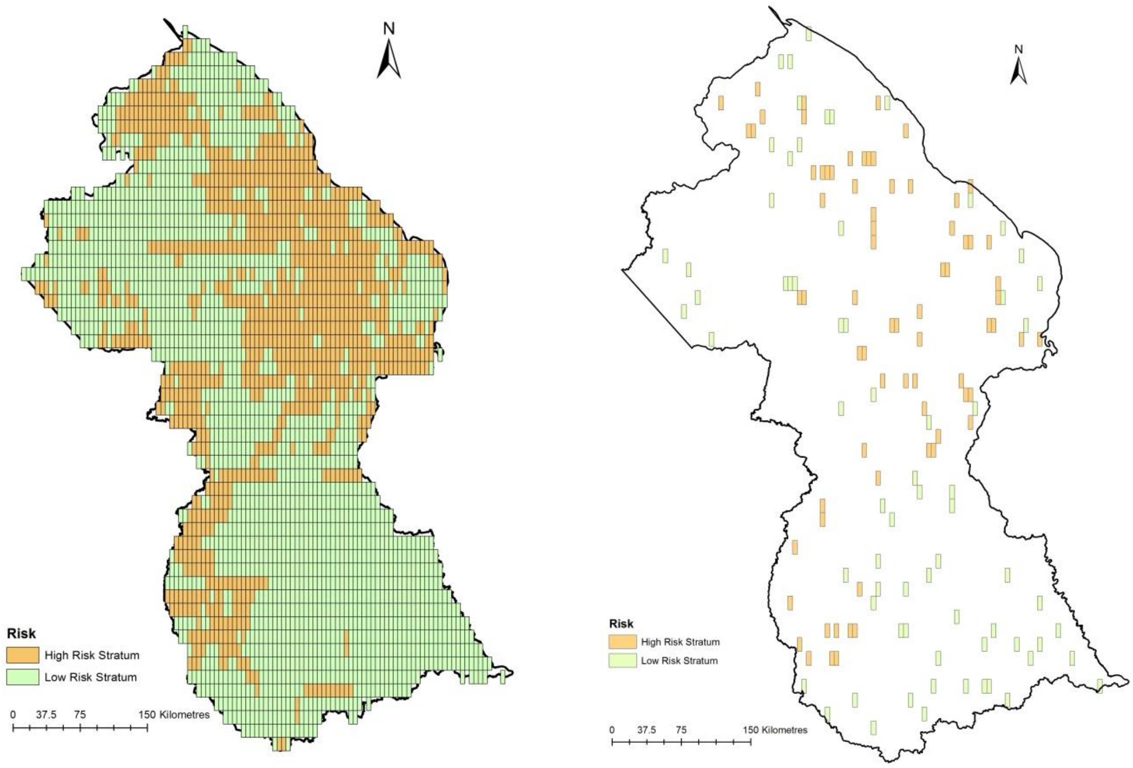


Figure 11-6: High and Low risk strata (left) and final random sampling of the High Risk (65%) Low Risk (35%) strata (right image).

Table 11-5Area represented by each stratum

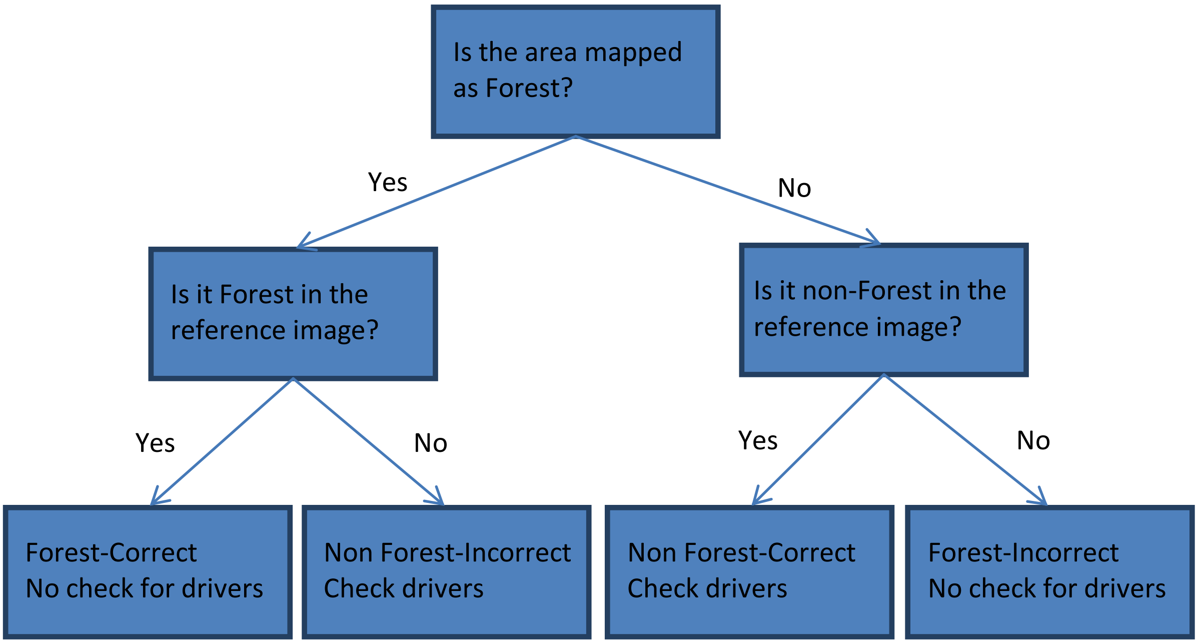
Stratum	Total number of rectangles	Area (ha)	Percent of Guyana (%)
Total Grid	2837	21,161,033	100.16
High Risk	1018	7,586,408	35.91
Low Risk	1819	13,574,625	64.25
HR 65% random	662	4,937,823	23.37
LR 35% random	637	4,751,349	22.49
1/9 of HR 65%	73	543,935	2.57
1/9 of LR 35%	70	522,332	2.47

Within each grid square, a systematic sample of points spaced at regular 200m intervals was created, yielding more than 300 points in each sample square. These points were then buffered to create a circular sampling area of one hectare in size corresponding to the minimum mapping unit (MMU), see Figure 11-9. Each of the grid squares was assigned an ID according to its centre point location, and each of the sampling circles has an ID according to its respective centre point location. In total 55,119one-hectare sampling areas became available for accuracy assessment.

For each primary sampling unit, the land cover class (e.g. Forest or Non-Forest, Degradation or Non-Degradation) is determined for the Year 3 deforestation and degradation map. The assessment follows a systematic procedure where the GIS table for the samples is populated using the ArcGIS toolbar shown in Figure 11-10.

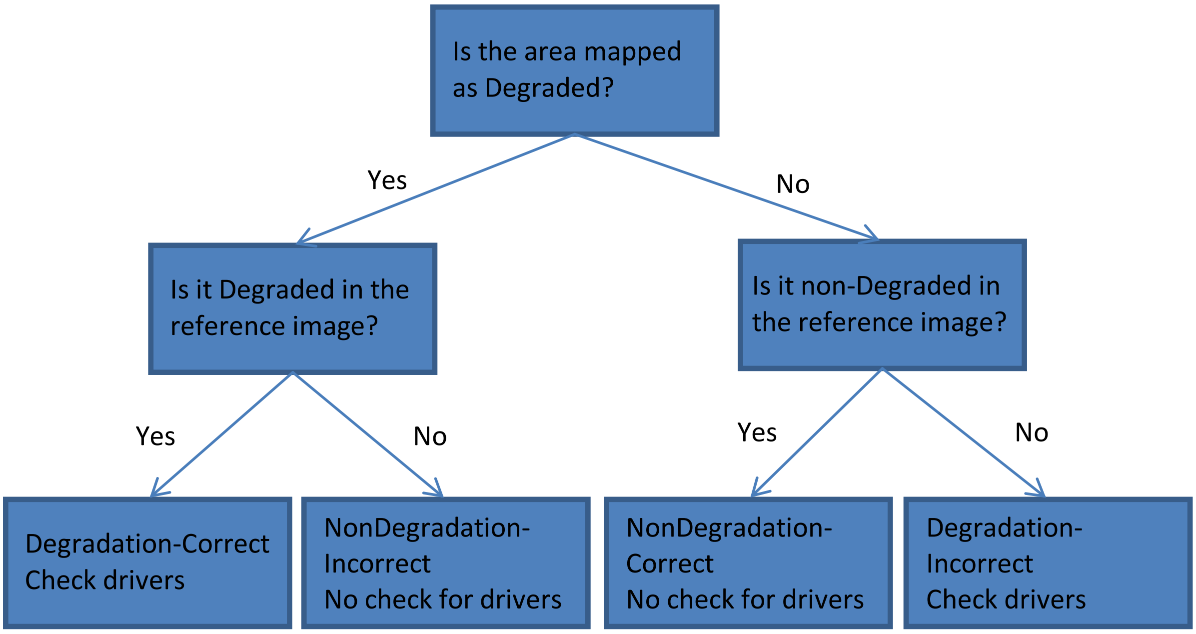
Specifically the tools used to interpret and validate the Year 3 map data included the 1990 Landsat data and the appropriate high resolution aerial and satellite imagery (see Table 11-2). We also had available land use maps and GIS data indicating mining, forestry and agricultural concessions.

For the Year 3 (2012/2013) map the interpretation proceeds as follows:



- The interpretation steps for deforestation accuracy assessment. Confidence levels were added for each decision.

When assessing the Year 3 map, any areas seen to be incorrect were labelled with the appropriate deforestation driver or marked as afforested. The approach to interpreting the correct driver relied on following the Mapping Rules that include identifying the cause of deforestation and also field and aerial survey experience. Figures 2-7 and 2-8 illustrate the interpretation decision steps for deforestation and forest degradation respectively.



- The intrerpretation steps for forest degradation accuracy assessment. Confidence levels were added for each decision.

The most important points to note are:

1. Areas of forest degradation that relate to Year 3 are estimated; degradation that was identified and interpreted as Year 4 are recorded as such, but not included in the area estimates.
2. Areas of shifting cultivation are generally small in size (under five ha) and are treated as degraded forest as these have the potential to return to canopy closed woodland.
3. Areas of infrastructure including settlements are classified as non-forest as are water bodies.
4. Areas of cloud, cloud shadow, or missing data are labeled as *Omitted*.
5. Areas representing Year 4 change (post Dec 2012) were also omitted from the analysis as this change postdates the Year 3 reference imagery. These areas are labeled as Year 4 in the GIS database.

The rules for validating each point account for small discrepancies between the original mapping that was digitized at 1:15,000 scale RapidEye or 1:24,000 scale Landsat TM and ETM+. Minor discrepancies might include digitizing error due to map generalization and map-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 mapping and the validation data is detected, an interpretation will be made of the correct assignment for the sample point. A toolbar was created so that both errors of omission and commission could be tagged; that is each label A, B, C, D in table 2-6 could be selected. For errors of omission, the interpreter could assign the correct land cover class and, if the area has been deforested in the 2012-13 period, make an assessment of the driver causing the change. The toolbar also included a confidence label on a 0-4 scale. This allows for uncertainties in interpretation to be removed from the estimation and validation process if required.

The two-stage sampling strategy with stratification of the primary units uses a large sample size that will allow for assessment of the true extent of false positives and negatives in accordance with the GOFC-GOLD (2006) 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 percentage scale.

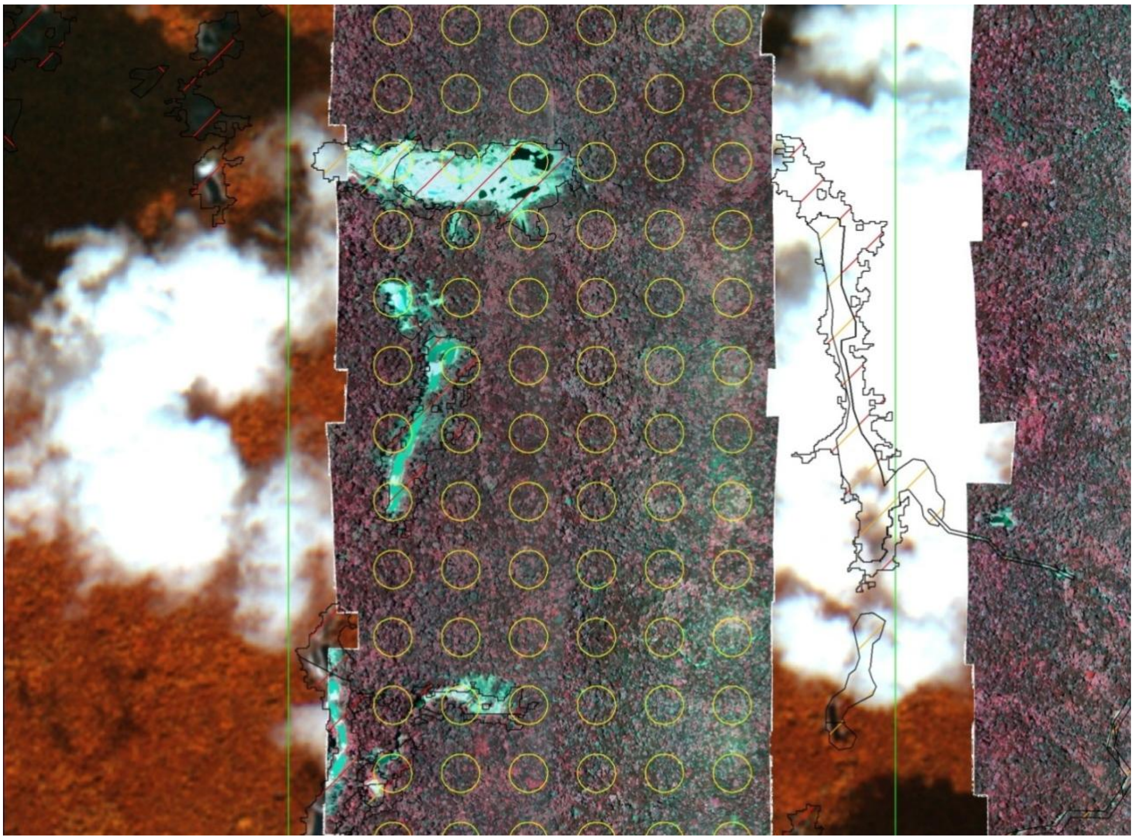


Figure 11-9: Systematic sampling showing one hectare sample points superimposed on a false colour GeoVantage image (scale 1:15,000)

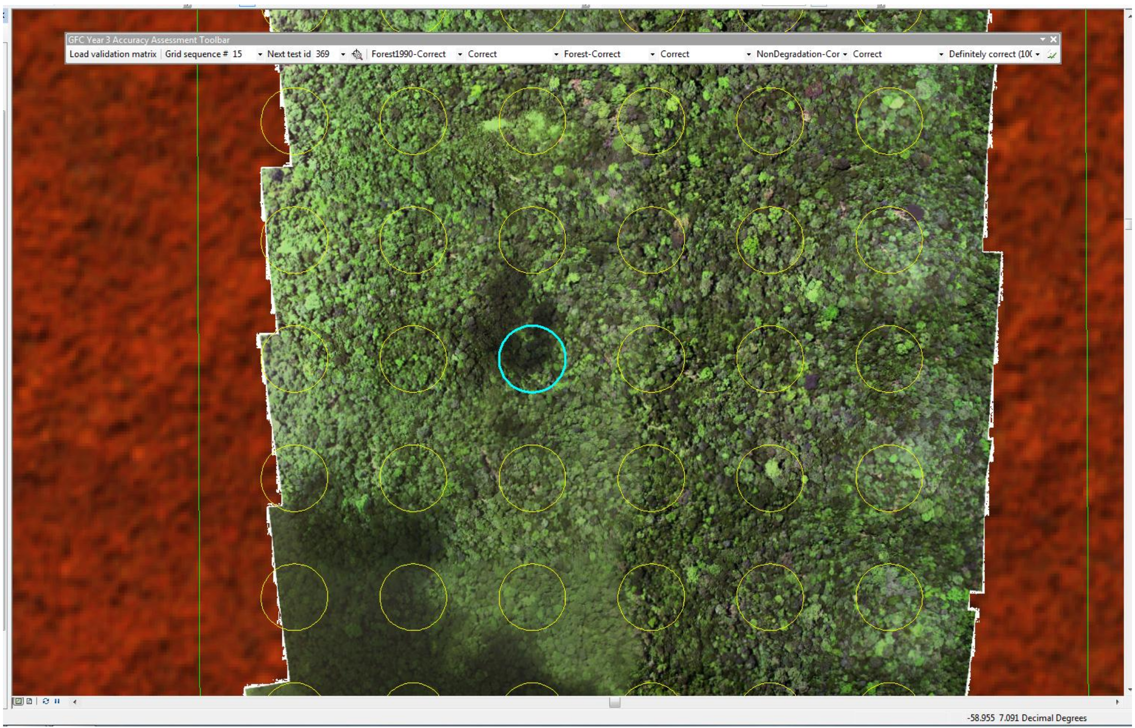


Figure 11-10: The ArcGIS Interpretation Toolbar as seen at the top of the Image. Notice the difference in spatial resolution between the reference image (GeoVantage) and RapidEye at the background. Scale 1:10,000.

- ### Analysis and Estimation

The analysis procedure, assisted by the toolbar provides the process to validate the points within each sample grid square. These data were recorded in a database, one for each stratum, and used to generate a cross tabulation between reference data and the maps. The structure of the tabulation, sometimes called a confusion- or error-matrix is shown in Table 11-6. This matrix is widely used to quantifying the quality of the classification and characterizing the error (Foody, 2002; Story and Congalton 1986; Van Oort 2007). The labels assigned to sample points in the reference data are cross-tabulated against the mapped classes for each sampling frame.

Table 11-6: Structure of accuracy assessment matrix

		Reference Data			
Map	Class	No change	Change	% of Total Area	User Accuracy
	No change	A	B	X	
	Change	C	D	Y	
	Total	x’	y’	100	
Producer Accuracy					

Cells **A** and **D** represent map areas that have been validated as correct. Counts in cell **B** are false negatives and those in cell **C** false positives. Interpretation of these data assumes that the reference data are error free, that the sampling is unbiased and of sufficient size. Nevertheless, the confusion matrix provides a simple and convenient method to illustrate the nature of any disagreement between the map and the reference data.

The accuracy of a class is expressed in two ways, as a user's and producer's accuracies (Story and Congalton 1986; Van Oort, 2005). The user's accuracy indicates the probability that land classified into a given land cover class by the map is actually that class on the ground. It is also referred to as the error of commission as sample points that are incorrectly classified are commissioned into another class (i.e. forest misclassified as non-forest or the reverse).

The producer's accuracy provides a measure of accuracy of the classification scheme. The producer accuracy is also known as the error of omission because areas that have been incorrectly classified are “omitted” from the correct class. This accuracy indicates how well the sample points falling on a given land cover type are classified, i.e., it is the probability of how well the reference data fitted the map.

For a simple random sample the user's accuracy is calculated by dividing the number of correctly classified sample points in each class by the total number of sample points classified in each class (row total).The producer's accuracy value is calculated by dividing of the total number of correctly classified plots in each class by the total reference data plots in each class (column total).

Unlike a simple random sample, raw counts in a stratified sample cannot be directly used to make unbiased statistical estimates. For stratified random sampling, each cell must be converted into an estimated joint probability (the proportion of total class counts per percentage class area) before the assessment statistics are derived.

- **Precision of Area Estimates for Year 3 Deforestation and Forest Degradation maps**

The two-stage sampling with stratification of the primary units design optimises the probability of sampling deforestation and degradation in Year 3 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.

3. RESULTS

Results are organised into four sections. First, an assessment is made of the quality of the Year 3 deforestation and degradation mapping undertaken by IAP and GFC. This is based largely on interpretation of RapidEye imagery.

Secondly, we assess the consistency of the interpretations made by the Durham validation team to ensure that the quality of the reference data is of a good standard.

Thirdly, we present estimates of forest area and deforestation rate for Year 3 (2012-13) based on the two-stage sampling design with stratification of the primary units. Finally, we assess the Year 3 forest degradation data and the mechanisms responsible for that degradation.

○ Quality of Mapping

The prevalence statistic is a good measure of overall correspondence between the map and reference data. We found that for Year 3, prevalence was greater than 0.99 or 99% agreement, see table 3-1. This is a very high figure, better than one would expect from automated classification of multispectral remotely sensed data, and is almost certainly explained by the process of interpretation and careful editing. We also note that the reference data used for the validation are not perfect, 1.27% of the sample area could not be used because of missing reference data or because the ground was obscured by cloud or cloud shadow. This compared favourably with 14% in the Year 2 analysis. Missing reference data were excluded from the analysis.

Table 11-5:Error matrix for the Forest-Non-forest Year 3 map.

Forest-non Forest	**Class**	**Reference Images**			
		Forest	**Non-forest**	**Total**	**User Accuracy**
Year 3 Map	Forest	44447	71	44518	99.84%
	Non-forest	58	9512	9570	99.39%
	Total	44505	9583	54088	
	Producer Accuracy	99.87%	99.26%		99.76%

583samples omitted due to cloud and cloud shadow and 130 omitted as Year 4 deforestation

Table 11-2: Probability matrix for the Forest-Non-forest Year 3 map.

Combined	**Class**	**Reference Images**		
		Forest	**Non-forest**	**User Accuracy**
Year 3 Map	Forest	0.9984	0.0016	0.9984
	Non-forest	0.0061	0.9939	0.9939
	Producer Accuracy	0.9940	0.9984	0.9962

Table 3-1 is not weighted by strata and should only be used to note the correspondence between Map and Reference data. Note, however, that 71 of the sample areas that were mapped as forest were found to be non-forest. While this is a small number it warrants further analysis because it means that areas of deforestation are being missed by the wall-to-wall mapping and it is important to understand why this is happening. Equally interesting 58 samples mapped as non-forest were found to be forest covered. The majority of these incorrect forest and incorrect non-forest areas are attributable to areas where RapidEye data was of poor quality or that the data was cloud covered, despite repeat imagery being available for most areas.

The validation team consists of four well qualified and experienced image interpreters, two of whom visited Guyana many times and have participated in field visits and over-flights. They acted as mentors for the other interpreters. Every effort was made to inform the team validating the mapping about the geography of Guyana, forest types, definitions of land cover, definitions of deforestation, the processes driving deforestation and the rules that were followed by the original mapping team. The validation team were very familiar with satellite imagery, particularly GeoVantage, RapidEye and Landsat TM, ETM+.

The analysis reported here analysed approximately 55,000 hectares. Assessment also included information from field inspections and aerial over-flights conducted in good conditions in August/September2013. The GeoVantage imagery and geo-positioned oblique aerial imagery provides valuable evidence that helped confirm the interpretations of the validation team, particularly with regard to the drivers for deforestation.

Table 11-3**: Error matrix for the Year 3 Forest Degradation mapping HR Stratum.**

High Risk	**Class**	**Reference Images**			
		Degradation	**Non-degradation**	**Total**	**User Accuracy**
	Degradation	519	102	621	83.57%
	Non-degradation	163	13463	13626	98.80%
	Total	682	13565	14247	
Producer Accuracy		76.10%	99.25%		98.14%

Table 11-4**: Error matrix for the Year 3 Forest Degradation mapping LR Stratum.**

Low Risk	**Class**	**Reference Images**			
		Degradation	**Non-degradation**	**Total**	**User Accuracy**
	Degradation	138	39	177	77.97%
	Non-degradation	21	27897	27918	99.92%
	Total	159	27936	28095	
Producer Accuracy		86.79%	99.86%		99.79%

Table 11-5**: Probability matrix for the Year 3 Forest Degradation mapping HR & LR strata combined.**

Combined	**Class**	**Reference Images**			
		Degradation	**Non-degradation**		**User Accuracy**
	Degradation	0.8163	0.0765		0.9143
	Non-degradation	0.0017	0.9956		0.9983
Producer Accuracy		0.9979	0.9286		0.9586

An experiment was conducted to ensure that the data used to validate the mapping was as precise as possible. This involved blind replication of two sample grids. Each interpreter analysed the same grids, which were in the High Risk stratum. The grids were purposely selected to include areas of high activity (mining, forest roads, agriculture, etc) and used Landsat, RapidEye, and QuickBird data. The results are shown in Table 11-and demonstrate that with initial training the team were consistent over 93% of the time.

Table 11-6: Agreement Among Interpretation team Members

Source	Interpreter 1	Interpreter 2	Interpreter 3	Interpreter 4
Interpreter 1	Deforestation	93.78%	95.06%	95.28%
Interpreter 2	90.99%		93.35%	93.35%
Interpreter 3	91.20%	89.91%		98.71%
Interpreter 4	90.56%	89.48%	97.21%	Deforestation Drivers

This exercise was followed by discussion among the members of the assessment team about how to follow the Indufor MRVS Image Interpretation Guide (Indufor2012). The results demonstrate that it is difficult to achieve a level of image interpretation that is better than 95% correct; Foody (2010) discusses the impact of imperfect ground reference data and demonstrates the impacts it can have on reported Producer's accuracy. This study of consistency does not allow us to conclusively attribute an error value to the reference data. However, it demonstrates that we have made best efforts to reduce interpreter bias through training and by acquiring a good set of data to evaluate interpretations.

- **Forest Area Estimates**

Areas estimates are based on a model-assisted difference estimator(McRoberts, 2010) to derive a Confidence Interval (CI) based on the assumption that the sample is randomly selected and unbiased.

The reference data consisted of 55,119 primary sample units stratified into High and Low risk areas as described in the sampling design (Section 2.4) 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 High and Low Risk stratum respectively. Note that the probability of encountering deforestation in each stratum can be estimated from the map data by query to the GIS; 67% of Year 3deforestation is located in the High Risk Stratum and 33% in the Low Risk stratum. However, it was important not to under-sample the Low risk stratum as the drivers for deforestation are not known with absolute certainty. Therefore, despite randomisation, there are several possible sources of bias that include:

1. Selecting sample grids, from the random sample within each stratum, by availability of suitable reference data, because the reference data are themselves selected randomly and do not cover the whole population.
2. The reference data may be of variable quality and that quality may be distributed unevenly between strata.
3. The maps were produced from manual image interpretation and the validation also used manual interpretation based on a 1-ha minimum mapping unit. Operator bias could be present either in the distribution of errors in the maps and also in the interpretation of the reference data.

Although the expectation is that probability-based estimators are unbiased, this cannot be assumed. An elegant approach that combines the advantages of simple random sampling with model-based estimators is the model-assisted difference estimator (McRoberts 2010; McRoberts*et al*. 2010a; McRoberts *et al*. 2010b, Næsset et al. 2011). A model-assisted estimator used map data to make an initial inference but uses the probability-based sample to validate the result (McRoberts and Walters 2012). In this analysis the model-assisted difference estimator has been applied separately to each stratum since forest area can be calculated easily from the GIS. Bias and Variance are estimated from the probability-based sample within each stratum.

At the 95% confidence level, the estimate of Year 3 forest area, based on the model-assisted stratified sampling design is 5,920,724± 13,732 hectares in the High Risk stratum and 12,468,131 ± 9,835hectares in the Low Risk stratum. When combined and weighted, this gives a model-assisted Year 3estimate of 18,392,292 ± 11,690 hectares for Guyana compared with a figure of 18,392,782 hectares from the IAP/GFC map (Table 3-7).

The differences between the model-based estimates and the maps are shown in Table 3-7. Note that the observed difference between Durham and IAP/GFC of 490 hectares is not statistically significant.

Note that the deforestation rate shown is calculated over a 12 month period and has been annualised.

Table 11-7: Summary of forest area estimates (in hectares) comparing mapped areas and areas estimated from a model-assisted difference estimator

Estimate	Year 3 (ha)	Year 3 Loss (ha)	Year 3 (%)
GFC / Indufor Estimate	18,390,782	14,655	0.08
Durham Estimate	18,392,292	15,145	0.08

Tables 3-8 and 3-9 list the error matrices and the statistics used to estimate the forest area and confidence limits for the 95% (Figure 3-1) and 99% confidence levels. Only the 95% confidence level data is reported in the conclusion and executive summary.

The following terms are relevant to the calculation of the confidence limits.

$\boldsymbol{\phi}$ = area to be estimated

x_i = random sample element

E=Expected value

$$\text{Bias }(\Phi) = E[\Phi] - \Phi = \frac{predicted\ positive - predicted\ negative}{n}$$

$$\text{Variance}(\phi) = \frac{1}{n(n-1)} \sum_{i=1}^{n} (\bar{x}_i - x_i)^2$$

Table 11-8: High Risk Error Matrix used for Forest Area Estimates forYear 3

High Risk Stratum	**Class**	**Reference Images**			
		Forest	**Non-forest**	**Total**	**User Accuracy**
Year 3 Map	Forest	15259	59	15318	99.61%
	Non-forest	35	6072	6107	99.43%
	Total	15294	6131	21425	
Producer Accuracy		99.77%	99.04%		99.56%

Bias (**ϕ**)	0.00112019	Sensitivity	0.997712	Producer's accuracy (Forest)
		Specificity	0.990377	Producer's accuracy (Non-Forest)
Forest	5,929,222.00	Predicted positive	0.996148	User's accuracy (Forest)
Total land	7,586,408	Predicted negative	0.994269	User's accuracy (Non-Forest)
		Prevalence	0.995613	Correspondence
ϕinit (from model)	0.781559			
ϕ	0.780438			
Variance(**ϕ**)	2.04788924E-07	Area estimate		
		Upper	Lower	**CI Range**
95% CL	0.000905	5,927,590	5,913,858	13,732
99% CL	0.001358	5,931,023	5,910,424	20,599
ϕinit 95%		5,936,088	5,922,356	13,732

Table 11-9: Low Risk Error Matrix used for Forest Area Estimates for Year 2

Low Risk Stratum	**Class**	**Reference Images**			
		Forest	**Non-forest**	**Total**	**User Accuracy**
Year 2 Map	Forest	29188	12	29200	99.96%
	Non-forest	23	3440	3463	99.34%
	Total	29211	3452	32663	
Producer Accuracy		99.92%	99.65%		99.89%

Bias (ϕ)	-0.00033677	Sensitivity	0.999212625	Producer's accuracy (Forest)
		Specificity	0.996523754	Producer's accuracy (Non-Forest)
Forest	12,463,559	Predicted positive	0.999589041	User's accuracy (Forest)
Total land	13,574,625	Predicted negative	0.99335836	User's accuracy (Non-Forest)
		Prevalence	0.998928451	Correspondence
ϕinit (from model)	0.918151256			
ϕ	0.918488029			
Variance(ϕ)	3.28072025E-08	Area estimate		
		Upper	Lower	**CI Range**
95% CL	0.000362255	12,473,048	12,463,213	9,835
99% CL	0.000543383	12,475,507	12,460,754	14,752
ϕinit 95%		12,468,476	12,458,642	9,835

Figure 3-1: Confidence intervals for 95% confidence limit on deforestation area estimates

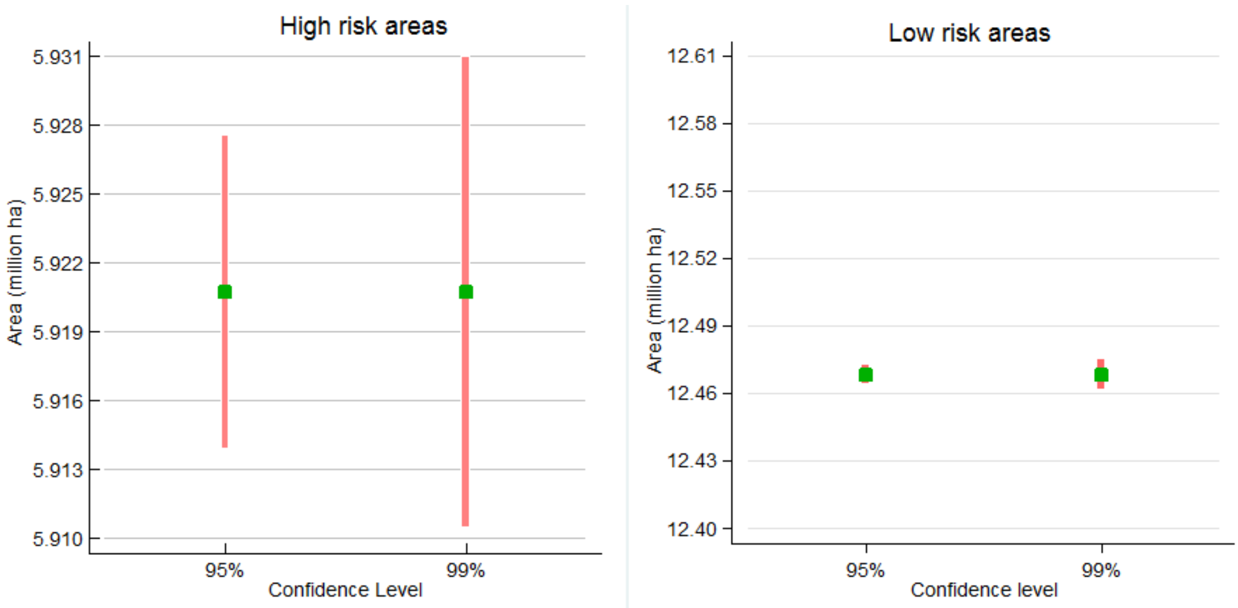


Table 3-10:Deforestation accuracy assessment for Intact Forest Landscape

Year 3 Forest-Non-forest IFL		Reference Images			
Both HR and LR	**Class**	**Forest**	**NonForest**	**Total**	**User Accuracy**
	Forest	14595	0	14595	100.00%
Year 3 IFL	**Non-forest**	6	232	238	97.48%
	Total	14601	232	14833	
	Producer Accuracy	99.96%	100.00%		99.96%
				238	Omitted
				0	Year 4
7604820	ha			108	1990
				15179	

Table 3-11:Degradation area estimates High Risk stratum

High Risk	**Class**	**Reference Images**			
		Degradation	**Non-degradation**	**Total**	**User Accuracy**
	Degradation	519	102	621	83.57%
	Non-degradation	163	13463	13626	98.80%
	Total	682	13565	14247	
Producer Accuracy		76.10%	99.25%		98.14%
Bias		-0.00428160		Sensitivity	0.760997
				Specificity	0.992481
Degraded forest		3,865.00		Predicted positive	0.835749
Total land area		7,586,408		Predicted negative	0.988038
				Prevalance	0.981400
ϕinit		0.000509		0.000511	0.000508
ϕ		0.004791		0.007076	0.002506
Var(p)		1.30565823E-06			
95% CL		0.002285		0.007076	0.002506
99% CL		0.003428		0.008219	0.001363
ϕinit 95% CL		0.002285		0.002795	-0.001776

Table 3-12:Degradation area estimates Low Risk stratum

Low Risk		**Reference Images**			
	Class	**Degradation**	**Non-degradation**	**Total**	**User Accuracy**
	Degradation	138	39	177	77.97%
	Non-degradation	21	2789 7	27918	99.92%
	Total	159	27936	28095	
Producer Accuracy		86.79%	99.86%		99.79%
Bias		0.00064068		Sensitivity	0.867924528
				Specificity	0.998603952
Degraded forest		1,463		Predicted positive	0.779661017
Total land area		13,574,625		Predicted negative	0.999247797
				Prevalance	0.997864389
ϕinit		0.000107775		0.000107851	0.000107699
ϕ		-0.000532909		1.85135E-05	-0.001084331
Var(p)		7.60166341E-08			
95% CL		0.000551422		1.85135E-05	-0.001084331
99% CL		0.000827133		0.000294225	-0.001360042
ϕinit 95% CL		0.000551422		0.000659197	-0.000443648

Table 3-13:Degradation accuracy assessment for Intact Forest Landscape

Year 3 Degradation in IFL		**Reference Images**				
Both HR and LR	**Class**	**Degradation**	**NonDegradation**	**Total**	**User Accuracy**	
	Degradation	132	10	142	92.96%	
Year 3 IFL Map	**NonDegradation**	2	13876	13878	99.99%	
	Total	134	13886	14020		
	Producer Accuracy	98.51%	99.93%		99.91%	
				652	Omitted	
				38	Year4	
				469	Drivers	
				15179		

- ### Gross Deforestation Rate

The IAP/GFC maps show a Year 1 to Year 2 (Oct 2010 to Dec 2011) deforestation rate over a period of 15 months of 0.053% and a Year 2 to Year 3 deforestation rate over a period of 12 months of 0.08%. The model-assisted deforestation rate over the same period is 0.08%. This compares to an estimate from Year 2 of 0.065% using the identical model.

The main source of disagreement in the area estimates derives from:

i) deforestation due to Year 3 mining that was not detected by the operators in the high risk stratum

ii) areas mapped as non-forest that were in fact forested and could be seen as forest on the high spatial resolution GeoVantageor QuickBird imagery. There were also areas where RapidEye was not available to the interpreters mainly because it was cloud covered, or sites were unluckily obscured by persistent cloud cover in every RapidEye scene.

The difference in area estimated from the random sample is in fact rather small although it carries a large uncertainty due to the low number of sample points that intersect with year 3 deforestation (or degradation). The estimate is improved by GFC tidying up mapping errors observed in Year 1 and Year 2 of the MRV process and by increasing the sample size and the spatial resolution of the imagery used for validation.

Tidying up the maps has, as expected, led to adding forest that was mapped previously as non-forest back into the calculations. More than doubling the sample size has added time to the validation period for the MRV but it has resulted in a reduction of the uncertainty in the area estimates. Importantly it should be noted that the estimates for deforestation show very low bias which suggests that the mapping has been undertaken in a systematic and consistent fashion.

We conclude that the GOFC-GOLD handbook provides a widely accepted set of good practice guidelines for the use of satellite imagery in support of Monitoring, Reporting and Validating (MRV) forest resources and carbon stock changes. The methods used by IAP and GFC follow the good practice recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level and rate of deforestation observed in Guyana over the Interim Measures Period – Year 3.

- ### Drivers of Forest Change

Assessment of the quality of attribution of types of changes mapped (agriculture, mining, forestry and fire) is assessed for of the 55,000 one hectare samples. This assessment was carried out recognising that “best efforts” were applied in the interpretation of forest degradation using satellite imagery assisted by mapping rules. The accuracy assessment was able to interpret the drivers of forest change and degradation more easily using high quality aerial imagery. Table 3-12 and Figure 4-5 show the deforestation data broken down by driver for the wall-to-wall mapping and the DU accuracy assessment sample. These data highlight the difficulty of identifying roads even in the 6.5 m spatial resolution RapidEye imagery compared to the GeoVantage aerial imagery. Areas that appear on satellite imagery as mining, are often in fact related to mining infrastructure. Table 3-13 and Figure 4-6 suggests also that degradation associated with mining tends to be overestimated using satellite imagery. The overall agreement between the GFC/IAP wall-to-wall mapping and the Accuracy Assessment sample data is 99.69%. Within the High Risk stratum the Producers Accuracy for forest degradation is 83.57% which demonstrates overestimation of degradation (in this case from mining and the User’s Accuracy for forest degradation is 76.10% which indicates an under recording of degradation (in this case from roads). The conclusion is that overall there is an impressive level of agreement but that high resolution imagery is needed to understand the patterns of over and under recording of degradation drivers. This observation underpins the need for high resolution reference data in any accuracy assessment of forest degradation. Additionally, the multi-date satellite imagery for the GFC/IAP mapping and the use of aerial imagery for the accuracy assessment means that the amount of missing data in the national area estimation analysis amounts to only 1.08%.

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 Year 3 the amount of forest mapped as degraded by GFC/IAP has fallen from 5467 ha to 1963 ha. The confidence intervals derived from the accuracy assessment is large but the correspondence between the mapping and the sample-based assessment is close 99.69%. RapidEye imagery is sufficiently detailed to allow interpretation of forest structure and canopy openings in a way that is impossible with Landsat imagery. Any disagreements however, appear to relate to the difficulty of identifying minor roads and distinguishing natural canopy openings and forms of anthropogenic disturbance even from the improved spatial and spectral resolution of RapidEye imagery.

Table 3-12: Deforestation by driver from GFC/IAP mapping and DU ‘incorrect’ samples

	GFC/IAP	DU
Agriculture	3.02%	5.48%
Fire	1.27%	6.85%
Mining	83.30%	45.21%
Roads	12.41%	42.47%

Table 3-13: Degradation by driver from GFC/IAP mapping and DU 'incorrect' samples

	GFC/IAP	DU
Fire	10.58%	0.54%
Mining	79.39%	48.39%
Roads	10.03%	51.08%

Figure 3-2: Deforestation by driver from GFC/IAP mapping and DU 'incorrect' samples.

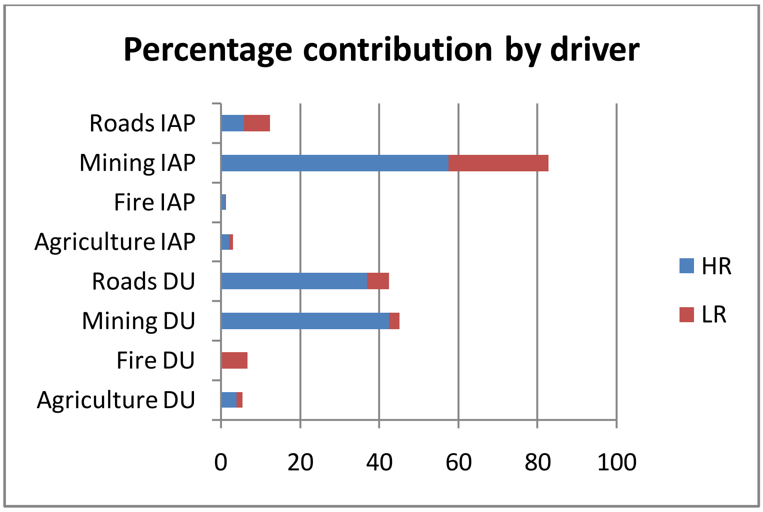
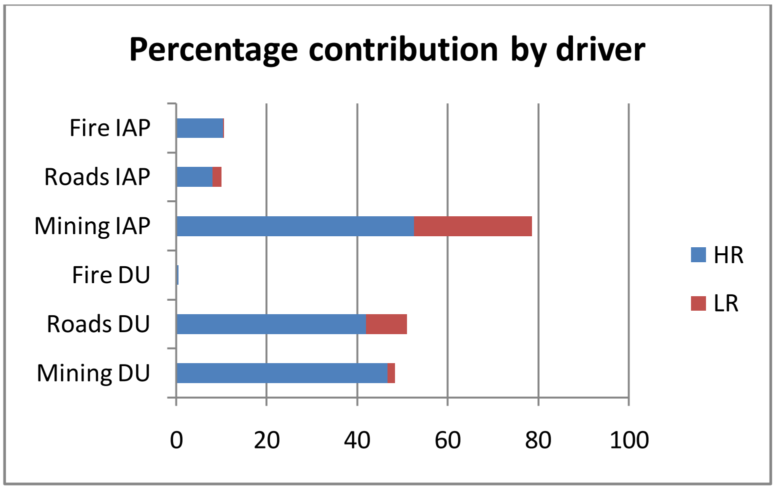


Figure 3-3: Forest degradation by driver from GFC/IAP mapping and DU 'incorrect' samples.



4. DISCUSSION

The results divide into three important 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) representativeness of the sample used to estimate bias and precision of the forest area mapping;

iii) assessment of the process to assistvalidation and verification in future years.

- **Reliability**

There is a large literature highlighting the difficulties associated with mapping and verifying deforestation rates in the world's humid tropical forests (e.g. Achard et al. 2002; Grainger 2008; Hanson et al 2008; Hanson et al 2010). Any approach that uses satellite imagery to overcome the lack of reliable forest inventory data will need to account for errors caused by areas obscured by clouds (and cloud shadows) and low spatial resolution imagery. In addition to errors where deforestation has been missed, there is also the difficulty of interpreting and accounting for areas of degradation that do not constitute deforestation.

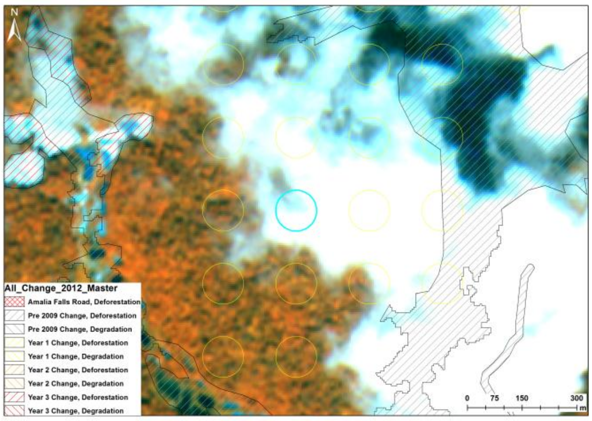
The approach taken by GFC/IAP to develop a wall-to-wall mapping exercise is ambitious but will generate very precise, location specific data. Once established in a GIS the data can be updated relatively easily but adding to the map units when new deforestation is identified from new imagery or fieldwork. The Interim Measures agreement, however, cause difficulties when modifying mapping data in a GIS as areas "deforested" or "degraded", because once accounted for these land over classes should remain with the same label. In reality, there are isolated instances where sampling has revealed misclassification of areas that are labelled as "deforested" or "degraded" but which are actually intact forest. Principally these relate to the 1990 Forest/ Non-forest map which GFC/IAP have updated using the RapidEye and 1990 Landsat image in combination. The accuracy assessment team also made an assessment of the updated 1990 map even though this was outside of the terms of reference.

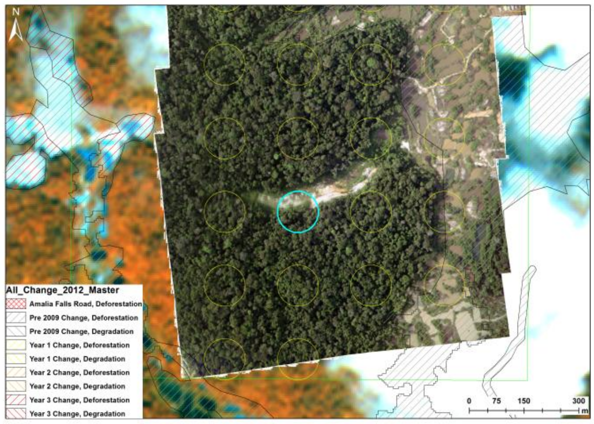
Year 1990 Forest-NonForest		Reference Images			
Both HR and LR	**Class**	**Forest**	**NonForest**	**Total**	**User Accuracy**
	Forest	45370	98	45468	99.78%
Year 3 Map	**NonForest**	250	8498	8748	97.14%
	Total	45620	8596	54216	
	Producer Accuracy	99.45%	98.86%		99.36%
				903	Omitted

The results show 99.36% agreement overall with a bias of 0.001669 (slight overestimation of forest area) for the High Risk stratum and a bias of -0.00576 (slight underestimation of forest area) in the Low Risk stratum. The DU estimate of 1990 forest area is 18,481,329± 13,616 ha at 95% confidence limit. The estimate of 1990 Forest areas is 65,526 ha more that the GFC/IAP mapping which, given the confidence interval is a very close agreement.

The accuracy assessment exercise for Year 3 used a large sample size of over 55,000 ha. It concludes that the GFC/IAP mapping corresponds well to actual land cover and the forest area is mapped very precisely. Overall the misclassifications can be understood when the RapidEye imagery is compared directly with the reference data. See **Error! Reference source not found.**Figures 4-1 to 4-4 for examples.

Figure 4-1: Mining area missed in mapping due to cloud cover

<table>
<tr><th>RapidEye 2012</th><th>GeoVantage 2013</th></tr>
<tr><td>


</td><td>


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

Figure 4-2: Roads not mapped

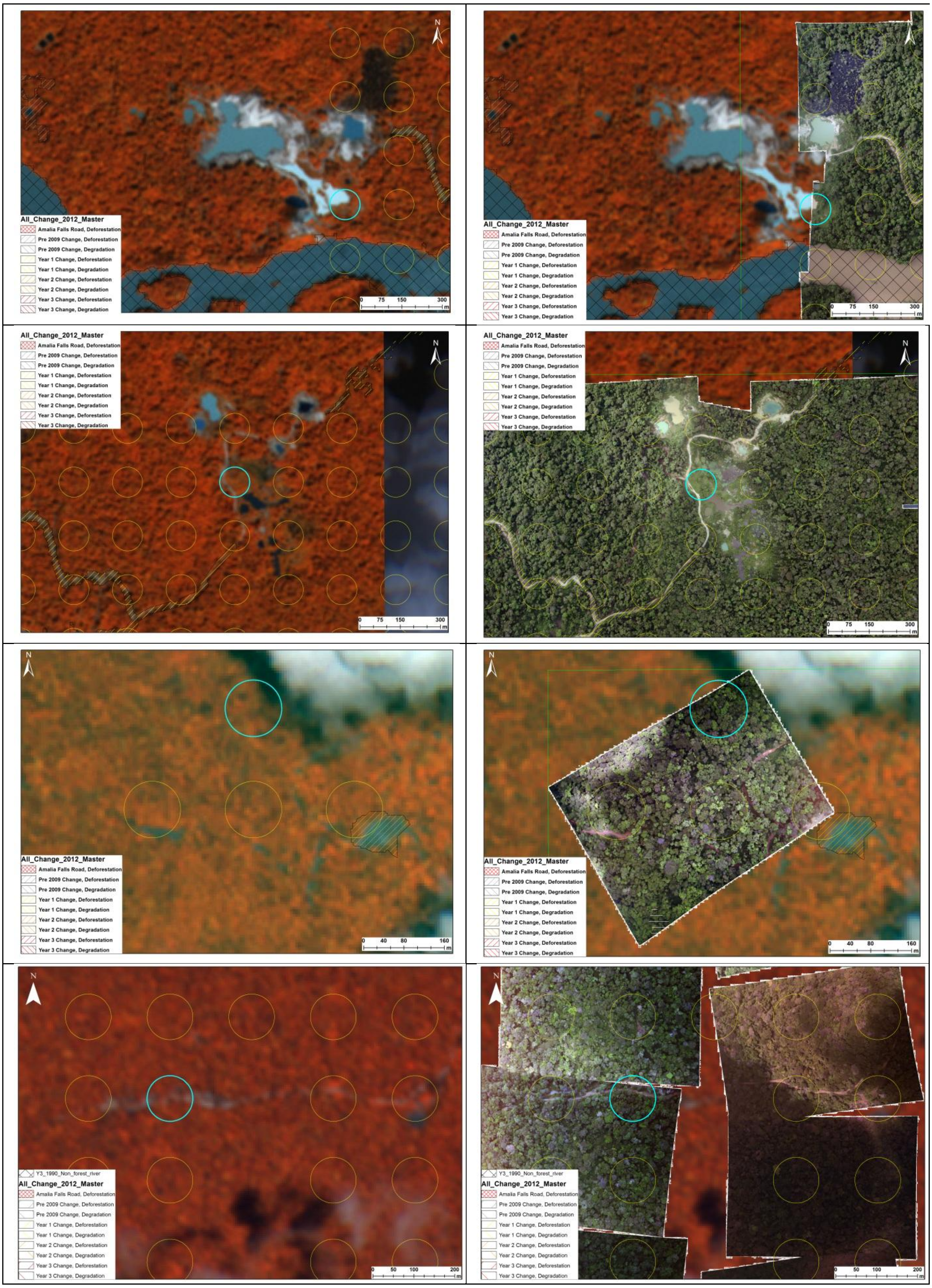


Figure 4-3: Non-forest areas – missed in mapping since 1990

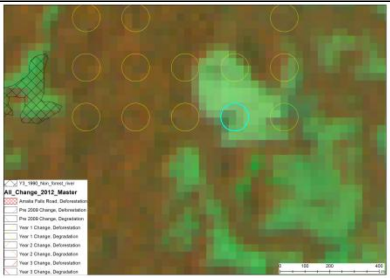
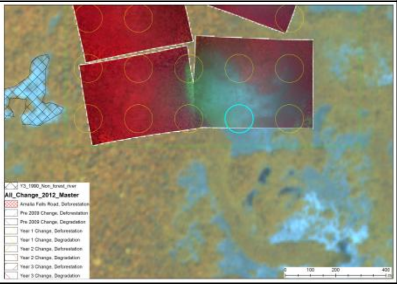
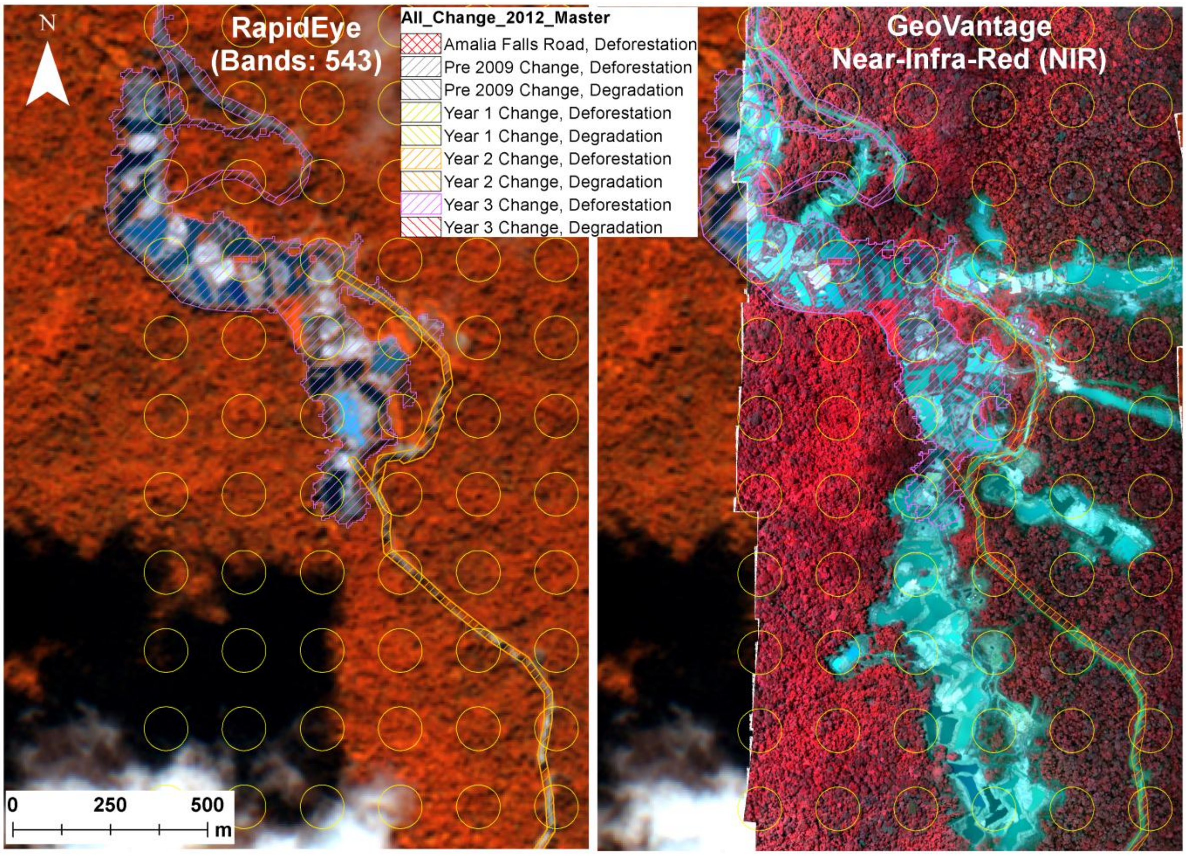
Landsat 1990	RapidEye 2012	GeoVantage 2013
		
1990 Non-forest – Incorrect, Incorrect 1:5000		

Figure 4-4: Deforestation from mining in year 4 (2013)



5. SUMMARY AND CONCLUSIONS

We conclude that the quality of the mapping undertaken by GFC-IAP based largely on interpretation of RapidEye imagery is of a good standard. The prevalence statistic is a good measure of overall correspondence between the map and reference data. We found that for Year 3 the prevalence was 0.9964 or 99.64% for the High Risk stratum and 0.9987 or 99.87% for the Low Risk Stratum and 99.77% overall. This is a very high figure, much better than one would expect from automated classification of multispectral remotely sensed data, and is almost certainly explained by the high spatial and radiometric resolution of the RapidEye multispectral imagery and the meticulous and manual process of interpretation and on-screen digitizing. We also note that the verification reference data are of a very high quality with very few sample points obscured by cloud or cloud shadow. Only a very small percentage of the mapped area of Guyana and of the GeoVantage aerial imagery and QuickBird satellite reference data could not be used. Missing reference data were excluded from the analysis.

1. We conclude that the GOFC-GOLD handbook provides a widely accepted set of good practice guidelines for the use of satellite imagery in support of MRVS for forest resources and carbon stock changes. The methods used by IAP and GFC in this report follow the good practice recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level and rate of deforestation in Guyana over the period January to December 2012 (Year 3).
2. The Year 3 forest degradation data has a correspondence (prevalence) between reference image interpretation and IAP/GFC mapping of 0.997 or 99.7%. This statistic is derived from both High and Low Risk strata and excludes areas of cloud cover and areas beyond the Guyana border and coastline.
3. The deforestation mapping was assisted by computer-based image processing that was used to automatically threshold RapidEye data (and Landsat data in a few cloud covered areas) by using the Enhanced Vegetation Index (EVI). The second stage is one of manual interpretation and editing of the polygon boundaries generated from the EVI threshold.
4. The Year 3forest area map (IAP-GFC) and the error-adjusted estimate (from this assessment) differ by a very small amount. The differences are primarily due to difficulties in interpreting forms of forest degradation and separating these from roads and other forms of infrastructure that constitute deforestation. There are other cases where the RapidEye coverage is not available or when sites are missed due to persistent cloud cover or shadow. The GIS data file containing all of the sample areas is available and can be used to help cross check interpretations from high spatial resolution imagery with field-based interpretation.
5. The IAP-GFC maps show a deforestation rate over the 12 month period of Year 3 of 0.08%. This study shows a deforestation rate over the same period of 0.08%.

6. RECOMMENDATIONS

Assessment of tropical deforestation and degradation is a far from trivial exercise that requires a high level of experience in satellite image interpretation, GIS data handling, spatial analysis and statistical estimation. The MRVS GIS for Guyana contains many hundreds of satellite images and the vast majority of these are needed to undertake the assessment because single-period duplication helped circumvent cloud cover and multi-period imagery was needed to track changes as part of the interpretation process. The high spatial resolution imagery had large file sizes that made use of the GIS for map quality assessment a slow and painstaking process. The process of validation was based on a two-stage sampling design with stratification of the primary units.

The interpreters underwent a training exercise designed to highlight examples of the different land cover types and deforestation drivers in Guyana. The interpreters performed a blind assessment of the same grids so that any disagreements could be highlighted, discussed and any interpretation improved before the validation process began.

With regard to improving the validation process for assessments in future years, we make the following recommendations:

1. The RapidEye data are of generally excellent quality and ideally suited to for the task. We recommend that the wall-to-wall RapidEye data acquisition be continued as it demonstrated a marked improvement in mapping accuracy.
2. Errors are generally associated with complex land cover changes such as forest degradation or forest re-growth. It is important that GFC staff is fully familiar with these processes and have seen examples on the ground or in high resolution imagery.
3. Allow sufficient time for the QC and Accuracy Assessment. The sample size for accuracy assessment needs to be of sufficient size for a full quantitative analysis of degradation drivers, particularly when some categories have low abundance.
4. The GeoVantage aerial imagery was of good spatial resolution and radiometric quality and this helped remove much of the ambiguity and uncertainty associated with the validation process. There was very little uncertainty associated with the assessment of deforestation. Forest degradation is known to be very difficult to identify but we note that forest degradation could be identified with the GeoVantage imagery and recommend that this type of imagery is used in future assessments, particularly of shifting cultivation area is to be included in the MRV in future years.
5. We witnessed an effort from GFC/IAP to improve their standards of interpretation, mapping and quality control. The challenge will be to maintain this standard of mapping into future years with dedicated and experienced staff.

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Appendix 3

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) set out the framework for taking the Guyana-Norway co-operation forward. It set 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. An update of the Joint Concept Note was finalized in March 2011 and has guided the partnership until December 2012.

Since the first Joint Concept Note was published, considerable progress has been made in the Guyana-Norway cooperation.

This current version of the Joint Concept Note replaces the concept note of March 31 2011.

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

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Section 1: Introduction

This Joint Concept Note constitutes the overarching framework for taking the Guyana-Norway cooperation forward. 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 below. 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.[2]

- *Indicators of Enabling Activities*: Indicators are identified that can be independently assessed[3]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 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 first payment to the GRIF was made in October, 2010 and the second payment in March 2011 for results achieved between October 1, 2009 and September 30, 2010. The third contribution was announced in December 2012 for forestry results from January 1st to December 31st 2011 and for results on indicators of Enabling Activities from October 1st 2010 to December 21st 2012.

The contents of this concept note have been updated to include the longer term goals of the partnership towards its end in 2015. The annual progress in developing the MRV system and in

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

3 Up until now the enabling activities have been 'verified', this have been a challenging exercise since qualitative and subjective views highly influence the understanding and verification of the indicators. The Governments of Guyana and Norway have therefore chosen to change the language from'verified' to 'independently assessed' in order to accommodate for the qualitative nature of these indicators.

2

strengthening the quality of REDD-plus-related forest governance will 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.

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 is developing its REDD-plus efforts under the Forest Carbon Partnership Facility (FCPF), managed by the World Bank. Furthermore, all REDD-plus efforts will, at all stages, be fully integrated with Guyana's Low Carbon Development Strategy (LCDS). 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, will be publicly available on the relevant website of the Government of Guyana, and through national systems of public disclosure, including to the National Assembly.

Guyana has chosen the Forest Carbon Partnership Facility (FCPF) as the strategic framework for its REDD+ efforts. The Readiness Preparation Proposal (RPP) will be finalized during 2012 with IDB as the delivery partner.

Goal of the partnership

Guyana and Norway support the relevant decisions of the UNFCCC COPs in Cancun, Durban and Doha, and in particular the decision to agree a new, global climate agreement by 2015, for implementation from 2020 at the latest. The Governments believe that the partnership between the two countries can provide many useful lessons for the crafting of the new 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. By the end of 2014, the Governments will make one or more joint submissions to the UNFCCC, covering each area where there the Governments believe that there are shared lessons that will help the global multilateral process. As well, the Government of Guyana's Readiness Package ("R-package") will be prepared and assessed by the FCPF's Participants Committee (PC) in the fall meeting 2014, contingent on financial resources from FCPF, or other resources, being available in time to do so.

Improved Financial Intermediation

Subject to IDB decision-making processes, the IDB Financial and Safeguards Intermediary role will be operational in the first half of 2013.

By the end of 2013, an outline strategy will be prepared setting out how the interim financial mechanisms could in the future be transitioned into national systems once mutually agreed benchmarks for independent assessment of financial, social and environmental safeguards are met. This could form part of a submission into the UNFCCC process, as a contribution to global efforts to design effective REDD+ finance mechanisms.

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 will be 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.
- Information and consultation program in place by June 2013, leading to a sustainable intensification of outreach activities both in the hinterland and elsewhere, including: :
    - From January 2013 keeping the GRIF and LCDS web pages updated with relevant information about the progress of ongoing processes.
    - Initiating in January 2013 a responsible body for communication, information and consultations - located either in the Office of Climate Change (OCC), the Project Management Office (PMO) or REDD Secretariat. The body will be established in January 2013 and, subject to timely availability of GRIF resources, will be fully operational by the end of 2013, with the ability to lead the development and sustain the implementation of the elements identified below.
    - The establishment of information and consultation routines tailored specifically to the needs of Amerindian communities, including non-internet based channels of communication like 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, IFM, EITI, FLEGT, FCPF and GRIF projects.
    - Collaboration with the National Toshaos Council (NTC) and MSSC members to strengthen their capabilities to function as agents of information sharing.
    - Develop annual stakeholder engagement and awareness plans consistent with the conceptual process framework developed, to be implemented starting in early 2014.

Governance:

A transparent, rules-based, inclusive forest governance, accountability and enforcement system for forest governance in Guyana is being progressively strengthened, in accordance with Guyana's outline REDD-plus Governance Development Plan (RGDP) and the enabling activities for 2012, as outlined in table 1.

Goals of the partnership

- Application for EITI Candidacy presented to the EITI board by May 2013, application for EITI compliance at the last EITI board meeting in 2015.
- Commencement of formal negotiations with the EU by the end of 2012, with the aim of agreeing to a Voluntary Partnership Agreement (VPA) under the EU FLEGT Action Plan, by March 2015. Ratification of the VPA by Guyana by September 2015. Development of a plan for the implementation of the VPA to be completed by the end of 2015.
- Continued implementation of Independent Forest Monitoring (IFM), with the first IFM assessment due by the end of 2013; 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 December 2015
- Enforcement and implementation of activities outlined by the Special Land Use Committee (SLUC) – and communicated publicly – will continue in 2013.
- The fifth national report submitted by 31 March 2014 to the CBD, including to the extent possible a description of the synergies between the protection of biodiversity, REDD+ and the LCDS.
- Implementation of a GoG (MNRE) programme, with actions focused on specific efforts to manage degradation from extractive activities where this needs to be done, including, for example: the start up of an enhanced miners' environmental knowledge programme through a mining extension service initiative and enhanced dialogue with the sectors and relevant stakeholders towards ensuring that sectoral best practices are applied and sustained thereafter.

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. There shall be a mechanism to enable the effective participation of indigenous peoples and other local forest communities in planning and implementation of REDD-Plus strategy and activities.

Guyana's policy is to enable indigenous communities to choose whether and how to opt in to the REDD-plus/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 by 2015, with progress measured relative to a publicly available timeline.
- GRIF funding made available for all CDPs through the Amerindian Development Fund.
- Opt In mechanism designed based among other things on evaluation of the piloting experience of the mechanism, and implemented starting in July 2015.

- Implementation starting by June 2013 of the part of the outreach program under the multi-stakeholder indicator which is tailored and targeted towards the needs of Amerindian communities.

Integrated land-use planning and management:

Several aspects of REDD+ relates to the development of a system for environmentally sustainable and climate smart area planning and management. Several of the current interim performance indicators and enabling activities are directly relevant in this context. To ensure sustained positive impact from our combined efforts, the long term goal should be for these indicators and activities to result in a formalized system for 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.)
- 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.

Monitoring, reporting and verification:

Guyana has progressed far in developing a national MRV system. Guyana has established a deforestation baseline and performed two forest area assessments for the years 2009-10 and 2010-11.

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 further explored as stated in the MRV Roadmap.
- Guyana will conclude technical analyses that inform a 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. The aim is to submit the reference level to the UNFCCC by mid 2014, if this is technically feasible. If

this goal proves impossible to meet due to technical challenges, the deadline can be extended after written agreement by both parties

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.

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

The "global average deforestation rate" is calculated[4] 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 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.

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:

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[4]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.

8

- 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."

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.[5] 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[6]. 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.

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[5] 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.

[6] 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.

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

Examples of reductions in compensation at levels above agreed maximum level:

Deforestation rate (%)	Up to 0.056	0.07	0.08	0.09	0.1
Reduced compensation (%)		25	45	70	100

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.

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 be sufficient to 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.

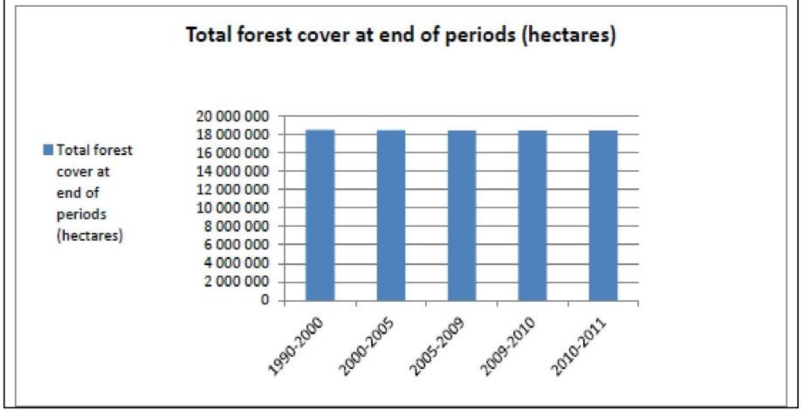
11

Box 1:
To improve knowledge on historical deforestation rates in Guyana, an analysis of forest area change since 1990 to September 2009 has been undertaken, using archived Landsat-type satellite datathat met the IPCC Good Practice Guidelines for Land Use, Land Use Change and Forestry (LULCF). The analysis was conducted by Pöyry-New Zealand, upon assignment by the Guyana Forestry Commission. The report was subsequently subject to independent verification by Det Norske Veritas (DNV). The reports can be downloaded at www.regjeringen.no/guyana or www.forestry.gov.gy

	Historical period				
	1990 - 2000	2001 - 2005	2006 - 2009	Year 1 2009 -2010	Year 2 2010 – 2011 (15 months)
Driver			Area (ha)		
Forestry	6094	8420	4784	294	234
Agriculture	2030	2852	1797	513	72
Mining	10843	21438	12624	9384	9205
Infrastructure	590	1304	195	64	149
Fire	1708	235		32	136
Area deforested	21267	34249	19400	10287	9796
Total forest area of Guyana	18 473 394	18 425 127	18 417 878	18 398 478	18 388 190
Total forest area of Guyana remaining	18 452 127	18 417 878	18 398 478	18 388 190	18 378 394
Deforestation %	0,01 %	0,04 %	0,02 %	0,06 %	0,05 %

The estimates include all forest to non-forest change, i.e. detected mining, road infrastructure, agricultural conversion and fire events that result in deforestation. They do not include degradation caused by selective harvesting, fire or shifting agriculture. It should be noted that the numbers for the historical analysis are annualized, but that firm enough data to establish actual rates for any given year are not available. Insights gathered from countries where such data exist, indicate that there is most probably a fairly significant year-on-year variation.

A key conclusion to be drawn from the study is that forest cover in Guyana has remained relatively stable over the 20 year benchmark period, as illustrated below:



12

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 0,056, 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.

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[7].

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.

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

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

13

circumstances. In years 1, 2 and 3 (2009-2011), 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 2009-2011, 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.

Progress has also been made to gain a greater understanding of how degradation is to be measured, and this leading to further work in 2013 and onwards, when new scientifically-based knowledge will 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 and second reporting periods, the measurement of progress was carried out by Poyry, Indufor and WinRock in collaboration with the Guyana Forestry Commission, and independent verification was carried out by DNV. DNV 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 byGuyana and Norway to act as Trustee and is responsible for providing financial intermediary services to the GRIF.

14

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 December 2012, 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.[8]

Improved Financial Intermediation

The Guyana REDD+ Investment Fund (GRIF) has experienced significantly slower than anticipated progress, although important lessons have been learned. The two Governments recognize the need for disbursements from the GRIF into Guyana's economy and relevant LCDS and REDD+ investments to strengthen the effectiveness of REDD+ as an intrinsic part of Guyana's sustainable development. As such, work is being undertaken to allow for a more flexible, fit-for-purpose financial mechanism that would ensure the application of internationally recognized safeguards while allowing for stronger Guyanese ownership. As part of this, a pilot for an IDB role as Financial and Safeguards Intermediary is being developed, with the goal of it being operational in the first half of 2013.

Goal of the partnership

The proposed role for the IDB as Fiduciary Safeguards Intermediary will ensure compliance with IDB's fiduciary, environmental and social safeguards for simpler projects. If proven suitable for the implementation of a range of GoG–activities it can also be useful to the further development of Guyana's domestic institutional capability.

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 (in this case IDB) standards for fiduciary, environmental and social safeguards.

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

Table 1- Key REDD+ Efforts in 2012/13 (from 21 December 2012 to 15 June 2013):

Improved REDD+ Governance

Through 2012, the Government of Guyana continued to improve governance standards within the REDD+-related forest dependent sectors. These efforts to improve REDD+ -related governance, will continue in 2013 and onwards. The information necessary to assess Guyana's completion of the actions below will be easily accessible in the public space.[9]Based on the goals of the partnership presented in section 2 the following actions will take place between December 21st 2012 and June 15th 2013:

Strategic framework

- Continued engagement between the IDB and the GFC with the aim of advancing an agreement on the FCPF, contingent on the completion of IDB's internal processes of approval of Guyana's FCPF programme.
- Guyana will publish its LCDS Addendum which will highlight its updated REDD+ strategy, including learnings to date from the Guyana-Norway partnership and an outline plan for advancement on the FCPF programme.

Continuous multi-stakeholder consultation process

- Monthly meetings of the MSSC, with comprehensive minutes of every meeting made publicly available immediately upon approval from the following MSSC meeting.
- Establishment of a Communications and Outreach team within the OCC, PMO or REDD+ secretariat, in anticipation of GRIF resources for its operations (see next point).
- With reference to the long term goals: Information and consultation project concept note presented to GRIF SC. The project will be addressing general information concerning Climate change and REDD+, LCDS and the Norway Guyana partnership, specific information on Amerindian land titling, the opt-in mechanism, FLEGT, EITI, IFM, GRIF projects and other relevant information. The project will recognize the need of tailored and non-internet based information to indigenous groups and others without stable internet access.
- Regular updates of the GRIF and LCDS webpages.

Governance

- Application for EITI Candidacy at EITI board meeting in May 2013.
- Develop an interim definition of legality for the EU FLEGT VPA for Guyana by end of June 2013.
- Outline in 2013 a GoG (MNRE) programme, with a particular focus on specific efforts to manage degradation from extractive activities where this needs to be done, including, for example: an enhanced miners' environmental knowledge programme through a mining extension service initiative and enhanced dialogue with the sectors and relevant stake holders towards ensuring sectoral best practices are applied and sustained thereafter, where necessary

[9] http://www.lcds.gov.gy/ and http://www.regjeringen.no/nb/dep/md/tema/klima/klimaogskogprosjektet/norge-og-guyana-avtale-om-a-bevare-guyan.html?id=592318

16

The rights of indigenous peoples and other local forest communities as regards REDD+

- Present the Amerindian Land Titling project to the GRIF steering committee, after the normal GRIF public hearing period for new project notes is concluded
- Opt-in concept note ready and pilot community for opt-in mechanism selected.
- Strategy and development of tailored information and consultations for hinterland communities addressed in the outreach program.
- Initiating implementation of Community Development Plans through the Amerindian Development Fund.

Integrated land-use planning and management

- Strategic Approach to land use planning publicly communicated by March 2013.
- Establish a plan, timeline and responsible agency for the development of a map of area use (including, but not limited to: existing and planned concession and reconnaissance areas for forestry and mining, titled lands for Amerindian communities, areas planned and concessioned for industrial agriculture etc.)
- Based on the evolving area use map, determine a roadmap by June 2013 to codify the formal status of varying degrees of protection for the areas identified as Intact Forest Landscapes and priority areas for biodiversity.This will gradually replace the Intact Forest Landscapes interim performance indicator.

17

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 largest per unit emissions from terrestrial carbon loss.	Rate of conversion of forest area as compared to 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	Forest cover as of September 2009 will be used as baseline for monitoring gross 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.)	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.

18

		informed by field study that identifies an alternative carbon loss level.		
Degradation indicators:				
Loss of intact forest landscapes[11]	Degradation of intact forest through human activities will produce a net loss of carbon and is often the pre-cursor to further processes causing long-term decreases in carbon stocks. Furthermore, preserving intact forests will contribute to the protection of biodiversity.	The total area of intact forest landscapes within the country should remain constant. 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.[13]	Using similar methods as for forest area change estimation.	Changes in carbon stocks in forests remaining as forests
Forest management (i.e. selective logging) activities in natural or semi-natural forests	Forest management should work towards sustainable management of	All areas under forest management should be rigorously monitored and	Data on extracted volumes is collected by the Forestry Commission. Independent forest	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)

[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.

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

[13] The analysis of loss of IFL area during the second reporting period was conducted after the verification process had ended. The result reported under this indicator for the second reporting period will therefore be verified in relation to the year 3 verification.

19

	forest with net zero emissions or positive carbon balance in the long-term.	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 increased forest carbon emissions[14] 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	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 above ground carbon pool.	

14 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.

20

		extracted volume.		
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.). As the benchmark for this indicator, the annualized number of the mapped degraded area from the second reporting period will be used (4368 ha)[15]. 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	Mediumand 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

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[15]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. This exercise will be verified in the next verification of the interim performance indicators.

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 new benchmark is therefore 4368 ha.

21

		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 cultivation lands (i.e. slash and burn agriculture).	Emissions resulting from communities to meet their local needs may increase as result of *inter alia* shorter fallow cycle or area expansion.	Not considered relevant in the interim period before a proper MRV-system is in place.		Changes in carbon stocks in forests 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	Changes in carbon stocks in forests remaining as forests

22

			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 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 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	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		Activity data on change to forest land and changes in carbon stocks in forests remaining as forests

23

	sequestration of atmospheric carbon.	assessment will be conducted where appropriate as basis for any decision on initiation of afforestation, reforestation and carbon stock enhancement projects.		

24

Appendix 4

Year 3 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.

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 2012 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

Summaryof2012SatelliteImages

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
L7P229R58_121014_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P229R58_121115_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P229R59_121014_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P229R59_121115_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P230R56_121005_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P230R56_121122_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P230R57_121005_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P230R57_121122_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P230R58_120919_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P230R58_121021_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P230R59_120919_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P230R59_121106_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P231R55_120910_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R55_120926_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R55_121028_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R56_120910_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R56_121028_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R57_120910_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R57_121028_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R58_120910_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R58_121028_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R59_120910_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R59_120919_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P231R59_121021_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R59_121028_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P231R59_121106_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P232R54_120715_U_O.tif	July	Year 3	USGS	Landsat 7 ETM+
L7P232R54_120901_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P232R54_120917_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P232R55_120715_U_O.tif	July	Year 3	USGS	Landsat 7 ETM+
L7P232R55_120901_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
L7P232R55_121003_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P232R56_120917_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P232R56_121003_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P232R56_121206_U_O.tif	December	Year 3	USGS	Landsat 7 ETM+
L7P232R57_121003_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P232R57_121120_U_O.tif	November	Year 3	USGS	Landsat 7 ETM+
L7P233R55_120908_U_O.tif	September	Year 3	USGS	Landsat 7 ETM+
L7P233R55_121010_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P233R55_121026_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P233R56_121010_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
L7P233R56_121026_U_O.tif	October	Year 3	USGS	Landsat 7 ETM+
R1P313R73_121006_lw.tif	October	Year 3	INPE	ResourceSat1
RE2141311_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141411_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141412_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141413_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141511_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141512_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141513_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141611_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141612_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141613_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141614_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141711_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141712_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141713_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141714_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141812_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141813_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141814_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141912_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141913_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141914_120812_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2139809_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139810_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139811_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139910_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139911_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139912_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139913_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140010_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140011_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140012_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140013_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140110_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140111_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140112_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140113_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140114_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140210_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140211_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140212_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140213_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140214_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140311_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140312_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140313_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140314_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140411_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140412_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140413_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140414_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140511_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140512_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140513_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140514_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140611_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140612_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140613_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140711_120903_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139708_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139807_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139808_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139809_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139810_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139811_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139907_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139908_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139909_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139910_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2139911_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140007_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140008_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140009_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140010_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140011_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140107_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140108_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140109_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140110_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140111_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140208_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140209_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140210_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140211_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140212_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140308_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140309_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140310_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140311_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140312_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140408_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140409_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140410_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140411_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140412_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140508_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140509_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140510_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140511_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140512_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140609_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140610_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140611_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140612_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140709_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140710_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140711_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140809_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140810_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140811_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140909_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140910_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2141009_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2141010_120913_RE3_r_ow.dat	September	Year 3	RapidEye	RapidEye 3
RE2140805_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140806_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140807_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140808_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140905_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140906_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140907_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140908_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141005_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141006_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141007_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141008_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141009_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141105_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141106_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141107_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141108_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141109_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141205_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141206_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141207_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141208_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141209_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141305_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141306_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141307_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141308_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141309_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141406_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141407_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141408_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141409_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141506_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141507_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141508_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141509_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141510_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141606_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141607_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141608_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141609_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141610_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141706_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141707_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141708_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141709_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141710_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141807_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141808_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141809_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141810_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141907_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141908_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141909_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2141910_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142007_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142008_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142009_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142010_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142011_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142107_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142108_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142109_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2142110_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139606_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139704_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139705_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139706_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139803_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139804_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139805_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139806_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139903_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139904_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139905_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139906_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140003_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140004_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140005_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140006_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140103_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140104_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140105_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140106_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140107_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140203_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140204_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140205_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140206_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140207_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140303_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140304_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140305_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140306_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140307_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140404_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140405_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140406_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140407_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140504_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140505_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140506_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140507_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140604_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140605_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140606_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140607_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140608_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140704_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140705_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140706_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140707_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140708_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140804_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140805_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140806_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140807_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140808_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140905_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140906_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140907_120914_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139913_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139914_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139915_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139916_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2139917_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140013_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140014_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140015_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140016_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140017_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140114_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140115_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140116_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140214_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140215_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140314_120918_RE4_r_ow.dat	September	Year 3	RapidEye	RapidEye 4
RE2140810_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140811_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140907_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140908_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140909_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140910_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141007_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141008_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141009_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141010_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141108_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141109_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141110_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141208_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141209_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141210_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141211_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141308_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141309_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141310_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141311_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141408_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141409_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141410_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141411_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141412_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141508_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141509_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141510_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141511_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141512_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141609_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141610_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141611_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141612_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141709_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141710_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141711_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141712_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141809_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141810_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141811_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141812_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141813_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141909_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141910_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141911_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141912_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2141913_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2142009_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2142010_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2142011_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2142110_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139805_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139806_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139807_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139808_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139905_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139906_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139907_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139908_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2139909_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140005_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140006_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140007_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140008_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140009_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140106_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140107_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140108_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140109_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140206_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140207_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140208_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140209_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140306_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140307_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140308_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140309_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140406_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140407_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140408_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140409_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140410_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140506_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140507_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140508_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140509_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140510_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140607_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140608_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140609_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140610_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140707_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140708_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140709_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140710_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140807_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140808_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140809_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140810_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140811_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140907_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140908_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140909_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140910_120929_RE5_r_ow.dat	September	Year 3	RapidEye	RapidEye 5
RE2140907_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140908_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140909_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141006_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141007_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141008_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141009_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141010_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141106_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141107_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141108_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141109_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141110_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141206_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141207_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141208_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141209_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141210_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141307_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141308_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141309_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141310_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141407_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141408_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141409_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141410_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141507_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141508_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141509_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141510_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141511_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141607_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141608_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141609_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141610_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141611_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141707_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141708_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141709_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141710_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141711_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141808_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141809_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141810_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141811_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141908_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141909_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141910_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2141911_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142008_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142009_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142010_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142011_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142108_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142109_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142110_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2142208_121005_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140305_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140306_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140307_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140308_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140405_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140406_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140407_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140408_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140505_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140506_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140507_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140508_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140605_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140606_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140607_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140608_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140609_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140705_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140706_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140707_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140708_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140709_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140806_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140807_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140808_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140809_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140906_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140907_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140908_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140909_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141006_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141007_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141008_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141009_121005_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139802_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2139803_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2139902_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2139903_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140002_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140003_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140101_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140102_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140103_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140104_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140201_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140202_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140203_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2140204_121024_RE1_r_ow.dat	October	Year 3	RapidEye	RapidEye 1
RE2040428_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2041128_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2041228_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140302_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140401_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140402_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140501_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140502_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140503_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140601_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140602_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140603_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140701_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140702_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140703_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140802_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140803_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140902_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140903_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141002_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141003_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141004_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141101_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141102_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141103_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141104_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141201_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141202_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141203_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141204_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141301_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141302_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141303_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141304_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141401_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141402_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141403_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141404_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141501_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141502_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141503_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141504_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141505_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141601_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141602_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141603_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141604_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141605_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2141702_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2040328_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2040428_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140101_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140102_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140201_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140202_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140301_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140302_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140401_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140402_121025_RE2_r_ow.dat	October	Year 3	RapidEye	RapidEye 2
RE2140907_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140908_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140909_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140910_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141007_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141008_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141009_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141010_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141107_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141108_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141109_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141110_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141207_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141208_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141209_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141210_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141211_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141308_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141309_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141310_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141311_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141408_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141409_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141410_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141411_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141412_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141508_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141509_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141510_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141511_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141512_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141608_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141609_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141610_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141611_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141612_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141708_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141709_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141710_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141711_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141712_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141809_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141810_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141811_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141812_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141909_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141910_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141911_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141912_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141913_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2142009_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2142010_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2142011_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2142109_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2142110_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139806_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139807_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139808_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139905_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139906_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139907_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139908_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139909_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140005_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140006_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140007_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140008_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140009_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140105_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140106_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140107_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140108_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140109_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140205_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140206_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140207_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140208_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140209_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140306_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140307_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140308_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140309_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140406_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140407_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140408_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140409_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140410_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140506_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140507_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140508_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140509_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140510_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140606_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140607_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140608_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140609_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140610_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140706_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140707_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140708_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140709_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140710_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140807_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140808_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140809_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140810_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140907_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140908_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140909_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2140910_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141007_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2141008_121030_RE3_r_ow.dat	October	Year 3	RapidEye	RapidEye 3
RE2139606_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139704_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139705_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139706_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139803_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139804_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139805_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139806_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139903_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139904_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139905_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2139906_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140003_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140004_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140005_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140006_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140103_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140104_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140105_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140106_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140107_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140203_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140204_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140205_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140206_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140207_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140303_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140304_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140305_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140306_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140307_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140404_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140405_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140406_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140407_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140504_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140505_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140506_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140507_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140604_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140605_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140606_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140607_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140608_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140704_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140705_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140706_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140707_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140708_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140805_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140806_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140807_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140808_121109_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2141303_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141304_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141305_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141306_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141403_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141404_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141405_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141406_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141503_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141504_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141505_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141506_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141507_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141603_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141604_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141605_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141606_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141607_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141703_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141704_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141705_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141706_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141707_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141804_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141805_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141806_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141807_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141904_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141905_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141906_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141907_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142004_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142005_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142006_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142007_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142008_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142104_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142105_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142106_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142107_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142108_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142204_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142205_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142206_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142207_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142208_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142305_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142306_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142307_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142405_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142406_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2142407_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142505_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142506_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142507_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142605_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2142606_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2040328_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2040428_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140101_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140102_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140103_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140104_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140201_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140202_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140203_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140204_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140301_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140302_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140303_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140304_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140401_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140402_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140403_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140404_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140501_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140502_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140503_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140504_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140601_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140602_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140603_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140604_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140605_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140701_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140702_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140703_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140704_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140705_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140802_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140803_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140804_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140805_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140902_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140903_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140904_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140905_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141002_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141003_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141004_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141005_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141102_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141103_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141104_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141105_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141106_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141202_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141203_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141204_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141205_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141206_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141302_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141303_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141304_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141305_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141306_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141403_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141404_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2141405_121115_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2041627_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041628_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041727_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041728_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041827_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041828_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041928_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2042028_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2042128_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2042228_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2042328_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141601_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141602_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141603_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141701_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141702_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141703_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141801_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141802_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141803_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141901_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141902_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141903_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142001_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142002_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142003_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142004_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142101_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142102_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142103_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142104_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142201_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142202_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142203_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142204_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142301_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142302_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142303_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142304_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142401_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142402_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142403_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142404_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142501_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142502_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142503_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142504_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142505_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142601_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142602_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142603_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142604_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142605_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142702_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142703_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142704_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142705_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142802_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142803_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142804_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142902_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2142903_121116_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2041128_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041228_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2041328_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041427_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041428_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041527_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041528_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041627_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041628_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041727_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041728_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141101_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141102_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141201_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141202_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141301_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141302_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141401_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141402_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141501_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141502_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141503_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141601_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141602_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141603_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141701_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2141702_120820_RE5_r_ow.dat	August	Year 3	RapidEye	RapidEye 5
RE2041524_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041525_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041526_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041527_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041624_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041625_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041626_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041627_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041724_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041725_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041726_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041727_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041824_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041825_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041826_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041827_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041828_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041924_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041925_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2041926_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041927_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041928_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042025_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042026_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042027_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042028_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042125_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042126_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042127_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042128_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042225_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042226_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042227_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042228_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042326_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042327_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042328_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042426_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042427_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042428_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042526_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042527_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042528_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042626_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042627_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042628_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042726_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2042727_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142101_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142201_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142301_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142401_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142501_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142601_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2142602_121117_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2041528_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041628_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141501_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141502_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141503_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141504_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141601_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141602_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141603_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141604_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141701_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141702_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141703_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141704_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141801_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141802_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141803_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141804_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141805_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141901_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141902_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141903_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141904_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141905_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142001_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142002_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142003_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142004_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142005_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142102_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142103_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142104_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142105_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142202_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142203_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142204_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142205_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142206_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142302_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142303_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142304_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142305_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142306_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142402_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142403_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142404_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142405_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142406_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142503_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142504_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142505_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142506_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2142603_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142604_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142605_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142606_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142703_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142704_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142705_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142803_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2142804_121112_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041128_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041228_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041328_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041428_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041528_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2041628_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2140902_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2140903_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141002_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141003_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141101_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141102_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141103_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141201_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141202_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141203_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141301_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141302_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141303_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141304_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141401_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141402_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141403_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141404_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141501_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141502_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141503_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141504_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141601_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2141602_121118_RE2_r_ow.dat	November	Year 3	RapidEye	RapidEye 2
RE2139811_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2139911_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2139912_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2139913_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2139914_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2139915_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140012_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140013_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140014_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140015_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140112_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140113_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140114_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140115_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140212_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140213_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140214_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140215_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140312_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140313_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140314_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140412_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140413_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140414_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140513_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140514_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2140613_121119_RE4_r_ow.dat	November	Year 3	RapidEye	RapidEye 4
RE2041623_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041624_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041723_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041724_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041822_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041823_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041824_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041923_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041924_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2041925_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042023_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042024_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042025_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042123_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042124_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042125_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042223_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042224_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042225_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042426_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042525_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042526_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2042626_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2042726_121119_RE3_r_ow.dat	November	Year 3	RapidEye	RapidEye 3
RE2140508_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140509_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140510_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140607_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140608_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140609_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140610_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140707_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140708_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140709_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140710_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140807_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140808_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140809_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140810_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140811_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140907_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140908_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140909_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140910_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141008_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141009_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141010_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141108_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141109_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141110_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141208_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141209_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141210_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141211_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141308_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141309_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141310_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141311_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141408_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141409_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141410_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141411_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141412_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141509_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141510_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141511_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141512_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141609_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141610_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141611_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2141612_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139606_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139705_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139706_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139707_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139708_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139805_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139806_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139807_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139808_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139905_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139906_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139907_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139908_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2139909_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140005_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140006_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140007_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140008_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140009_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140106_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140107_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140108_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140109_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140206_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140207_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140208_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140209_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140306_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140307_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140308_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140309_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140406_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140407_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140408_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140409_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140410_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140506_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140507_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140508_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140509_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140510_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140607_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140608_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140609_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140610_121125_RE5_r_ow.dat	November	Year 3	RapidEye	RapidEye 5
RE2140209_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140306_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140307_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140308_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140309_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140310_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140406_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140407_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140408_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140409_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140410_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140506_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140507_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140508_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140509_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140510_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140607_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140608_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140609_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140610_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140707_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140708_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140709_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140710_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140807_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140808_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140809_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140810_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140811_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140907_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140908_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140909_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140910_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141007_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141008_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141009_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141010_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141108_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2141109_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141110_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141208_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141209_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141210_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141211_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141308_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141309_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141310_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141311_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141408_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141409_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141410_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141411_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141412_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141508_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141509_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141510_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141511_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141512_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2141609_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139606_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139705_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139706_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139707_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139708_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139805_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139806_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139807_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139808_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139905_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139906_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139907_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139908_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2139909_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140005_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140006_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140007_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140008_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140009_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140106_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140107_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140108_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140109_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140206_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140207_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140208_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140209_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140306_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140307_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140308_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140309_121126_RE1_r_ow.dat	November	Year 3	RapidEye	RapidEye 1
RE2140607_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140608_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140609_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140610_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140707_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140708_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140709_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140710_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140807_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140808_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140809_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140810_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140811_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140907_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140908_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140909_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140910_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141008_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141009_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141010_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141108_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141109_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141110_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141208_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141209_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141210_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141211_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141308_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141309_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141310_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141311_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141408_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141409_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141410_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141411_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141412_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
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RE2141510_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141511_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
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RE2141609_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141610_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141611_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141612_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141709_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141710_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141711_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141712_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141713_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141809_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141810_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141811_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141812_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141813_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141909_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141910_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141911_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141912_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2141913_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139606_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139705_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139706_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139707_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139708_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139805_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139806_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139807_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139808_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139809_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139905_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139906_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139907_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139908_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2139909_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
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RE2140008_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140009_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140106_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140107_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2

Stack name	Acquisition Month	Mapping Stream	Data Provider	Satellite/Instrument
RE2140108_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140109_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140206_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
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RE2140208_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140209_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140306_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140307_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140308_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140309_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140310_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
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RE2140708_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140709_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2
RE2140710_121221_RE2_r_ow.dat	December	Year 3	RapidEye	RapidEye 2

Appendix 5

GIS (Spatial) Datasets

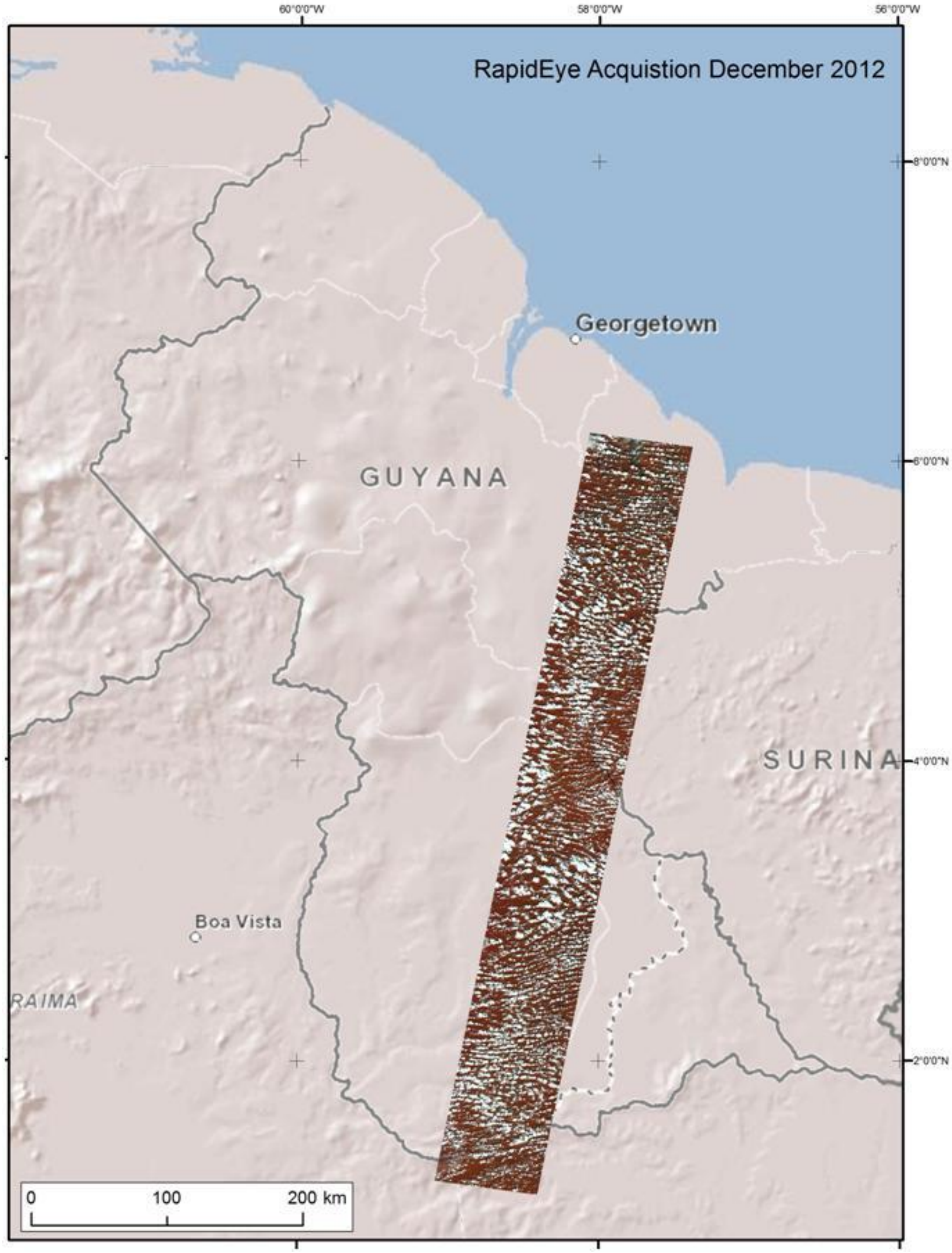
Existing GFC GIS Geo-database layers

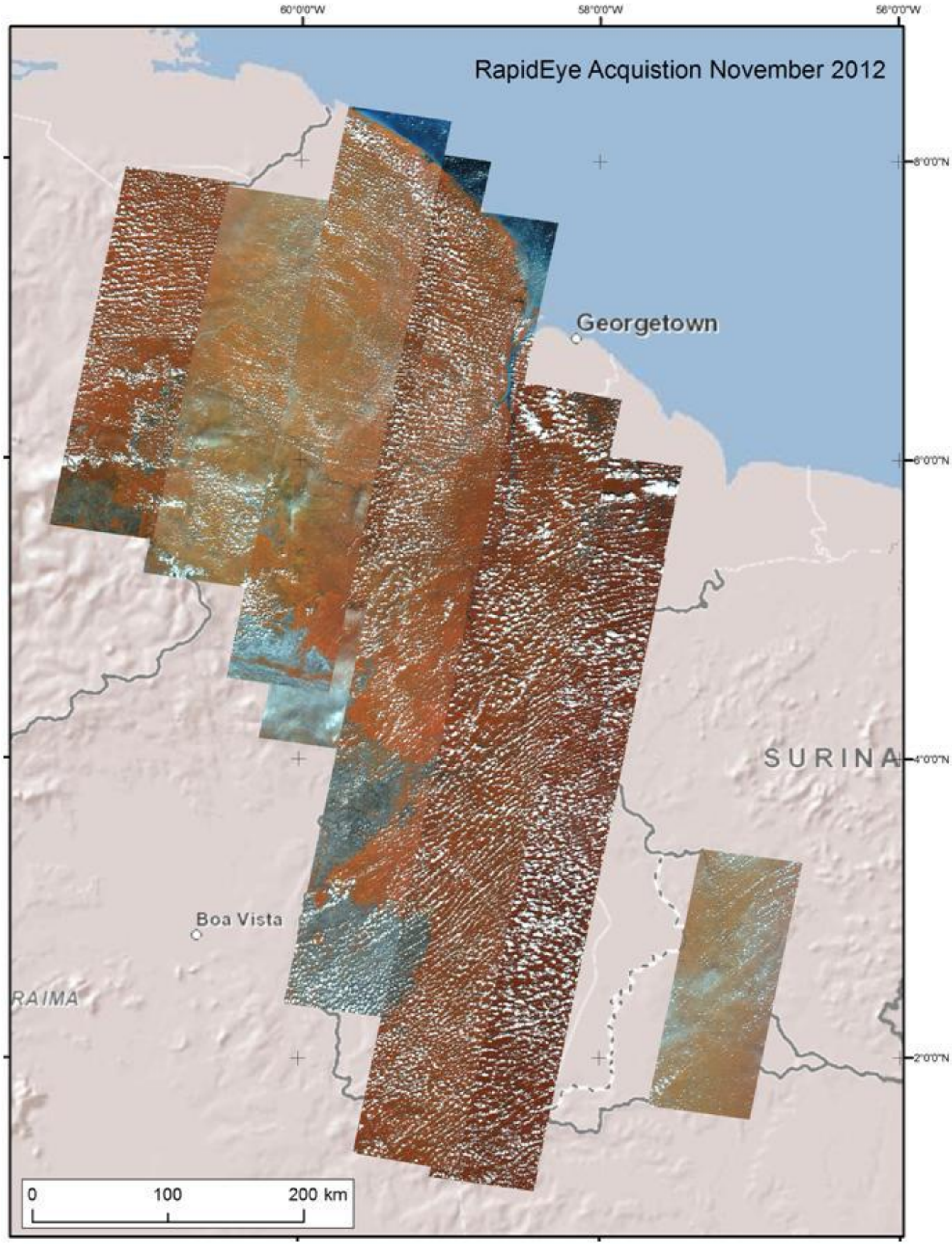
Feature Class	Feature Dataset	Created / Update freq	Layer Description
Administrative	GY_Boundary_2009	August 2010	Updated country boundary for Guyana as at August 2010
	GY_Boundary_2012	January 2012	Updated country boundary for Guyana as at January 2012 (from hi-res imagery)
	GY_Regions	January 2012	Regional Boundary representation for each of the 10 regions of Guyana
	GY_protected_areas	December 2012	Representation of all legally protected areas in Guyana as provided by the PAC.
Agricultural Leases	Year_1_Agricultural_Leases	August 2010	Agricultural lease areas as provided by GL&SC
Amerindian Areas	Year_1_Amerindian_areas	December 2010	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
	Year_2_Amerindian_areas	December 2011	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
	Year_3_Amerindian_areas	December 2012	Titled Amerindian areas in Guyana. Divided into administrative regions. From GL&SC.
FIRMS	Historical_Fire_Locations	August 2010	Historical point locations of fires as derived from the MODIS based FIRMS dataset.
	Year1_Fire_Locations	August 2011	Point fire locations for year 1analysisfromOctober 2009–October 2010
	Year2_Fire_Locations	January 2012	Point fire locations for year 2analysisfromOctober 2010– December2011
	Year3_Fire_Locations	December2013	Point fire locations for year 3analysisfromDecember 2011–December 2012
Hydro	Waterbody	August 2010	Waterbody layer, digitised from geo-corrected Landsat imagery.
Forest Stratification	Year1_Forest_strata_map	January 2011	Forest Stratification map generated after year 1 change detection analysis.
GGMC Mining Areas	Year1_LRG_Scale_Concessions	January 2011	Large scale concessions areas for Year 1 provided by GGMC
	Year1_MED_Scale_concessions	January 2011	Medium scale concession areas for Year 1 provided by GGMC
	Year2_AllClosedProjectAreas	January 2012	Year 2 analysis of project areas that are no longer in operation
	Year2_Auction_Areas_current_region	January 2012	Areas that were auctioned in the current regions for year 2 analysis
	Year2_Claim_licence_Recommended	January 2012	Areas where Claim licences were recommended for year 2 analysis
	Year2_GGMC_Reserved_Area	January 2012	Areas set aside by GGMC for year 2 analysis
	Year2_Large_scale_min_prop_region		Areas where large scale mining occur
	Year2_Mineral_licences_region	January 2012	areas where licences were allocated for mineral mining according to region for year 2 analysis
	Year2_Reconnaissance_Area_region	January 2012	Prospecting areas that may eventually be mined for year 2 analysis
	Year2_Special_mining_permit_region	January 2012	Areas where special mining permits are allocated for year 2 analysis
	Year3_Claim_Licences_jan2013_wgs8421N	January 2013	Areas where licences were issued by GGMC to conduct mining for year 3 analysis
	Year3_Mineral_Licence_jan2013_wgs8421N	January 2013	Areas where licences were allocated for mineral mining by region for year 3 analysis
	Year3_Prospecting_Licence_jan2013_wgs8421N	January 2013	Areas where licences were issued by GGMC for prospecting mining areas for year 3 analysis

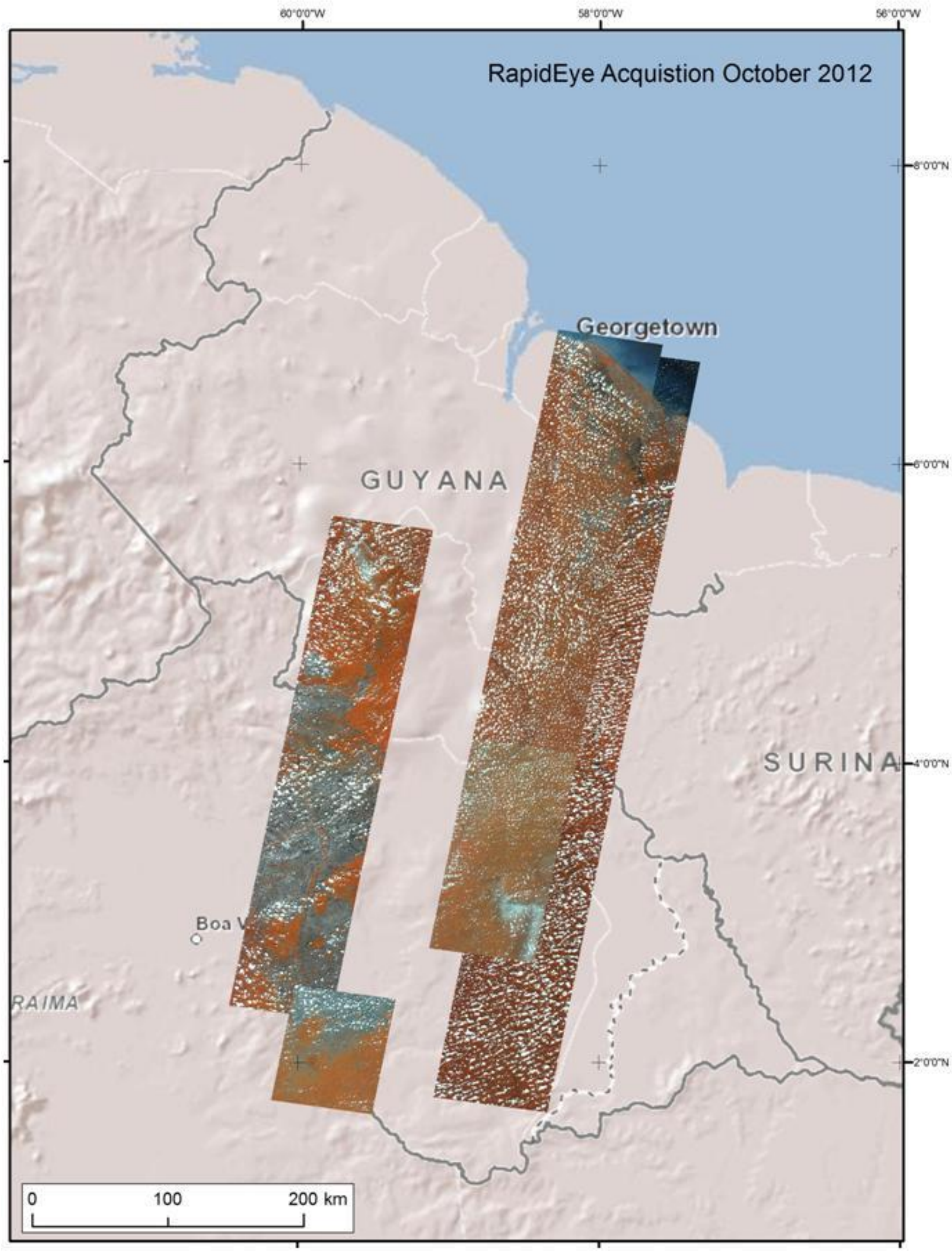
Feature Class	Feature Dataset	Created / Update freq	Layer Description
	Year3_Special_mining_permit_jan2013_wgs8421N	January 2013	Areas where special mining permits were allocated for year 3 analysis
Managed Forest Areas	State_Forest_2006	2006	Layer showing state forest boundary.
	TSA_WCL_Merged	6monthly	A merged layer showing all activeTSA"s and Wood Cutting Leases (WCL) (large forest concessions)
	activeSFEP_Merged	6monthly	A merged layer of all active State Forest Exploratory Permits.
	activeSFPs_Merged	6months	Active State Forest Permits (small forest concessions). By Division–Demerara, Essequibo, Berbice, NorthWest
	logging_Camps	NA	Point location of logging campsites, based on the Annual Operating plan.
	harvest_Areas	NA	Polygons showing extent of harvest activities (pre 2008,2008 & 2009)
Population	Municipalities	Aug2010	Polygon file showing area covered by the municipalities of Guyana
	Placenames		Point file showing places of interest
Roads	gpsroads_dd	3-6months	All GPS roads and trails as at August 2010.
Soil & Vegetation	soil_data	1960s	National Soil map of Guyana. Produced by NARI.
	GY_Vegetation_Map	2001	National vegetation map of Guyana. Produced by Dr. ter Steege.

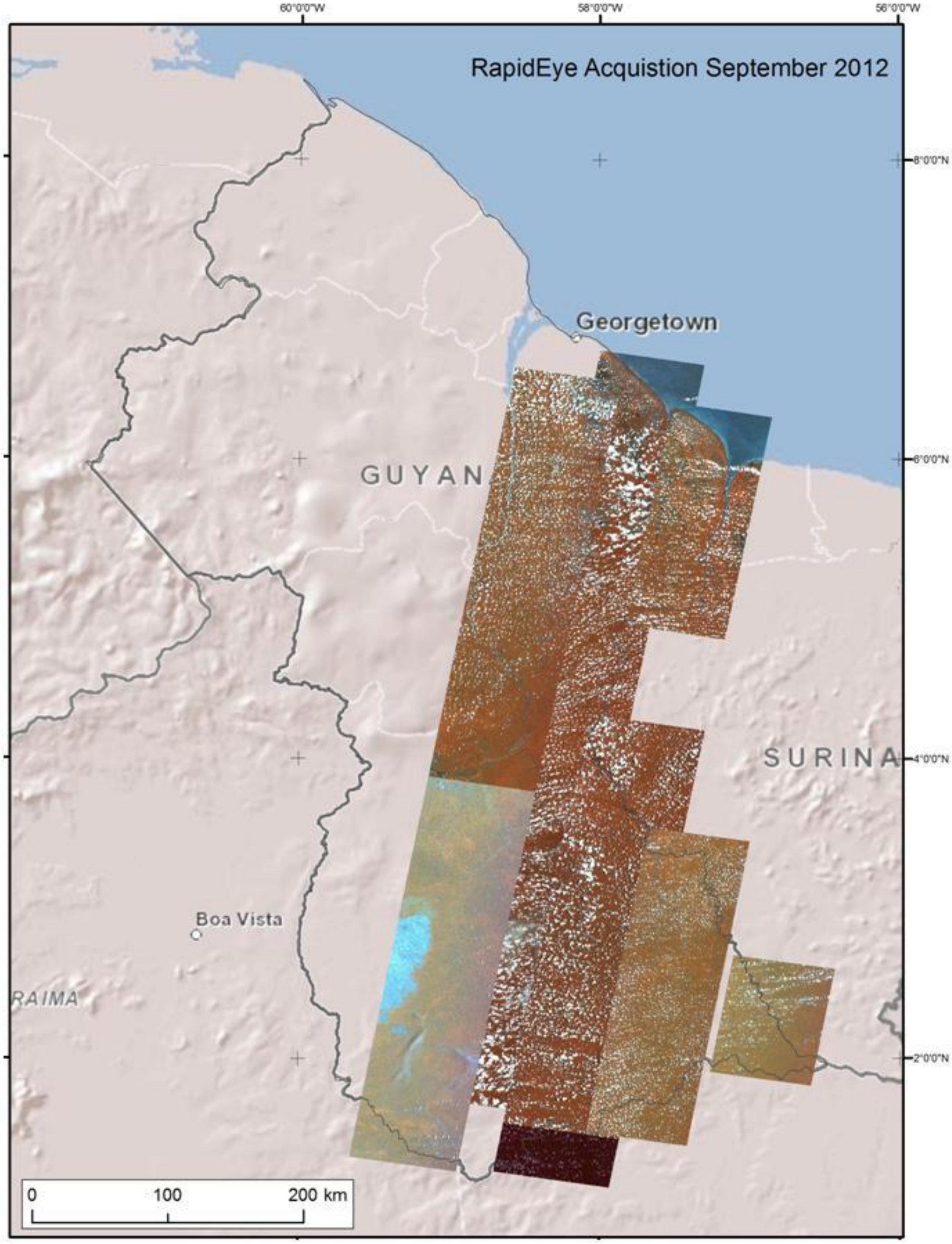
Appendix 6

Monthly RapidEye Acquisitions


RapidEye Acquistion December 2012
60°0'0"W
58°0'0"W
56°0'0"W
8°0'0"N
6°0'0"N
4°0'0"N
2°0'0"N
Georgetown
GUYANA
SURINA
Boa Vista
RAIMA
0
100
200 km


RapidEye Acquistion November 2012
60°0'0"W
58°0'0"W
56°0'0"W
8°0'0"N
6°0'0"N
4°0'0"N
2°0'0"N
Georgetown
SURINA
Boa Vista
RAIMA
0
100
200 km


60°0'0"W
58°0'0"W
56°0'0"W
RapidEye Acquistion October 2012
8°0'0"N
Georgetown
6°0'0"N
GUYANA
SURINA
4°0'0"N
Boa V
RAIMA
2°0'0"N
0
100
200 km


60°0'0"W
58°0'0"W
56°0'0"W
RapidEye Acquistion September 2012
8°0'0"N
6°0'0"N
4°0'0"N
2°0'0"N
Georgetown
GUYAN
SURINA
Boa Vista
RAIMA
0
100
200 km

Appendix 7

Land use Classes

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	2010 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[37], 7.1, 7.2. 8.1	Class 6
	Plantations	Locations in GFC's GIS	Area insignificant
Grassland	Savannah <30% cover	Non forest classes grouped and not mapped out individually	
	Grassland		
Cropland	Cropland		
	Shifting Agriculture		
Wetland	Wetland open water		
	Herbaceous wetland		
Settlements	Settlements		
Other land	Other land		

Previous 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.

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

- 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.
- 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 in to the National Map on the basis of the regional FIDS maps. In other cases large forest areas classified to be wet forest were reclassified into mixed forest in accordance with FIDS coverage.
- In the South West 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[38]. 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).

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

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

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 Shrub 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, either 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* 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.

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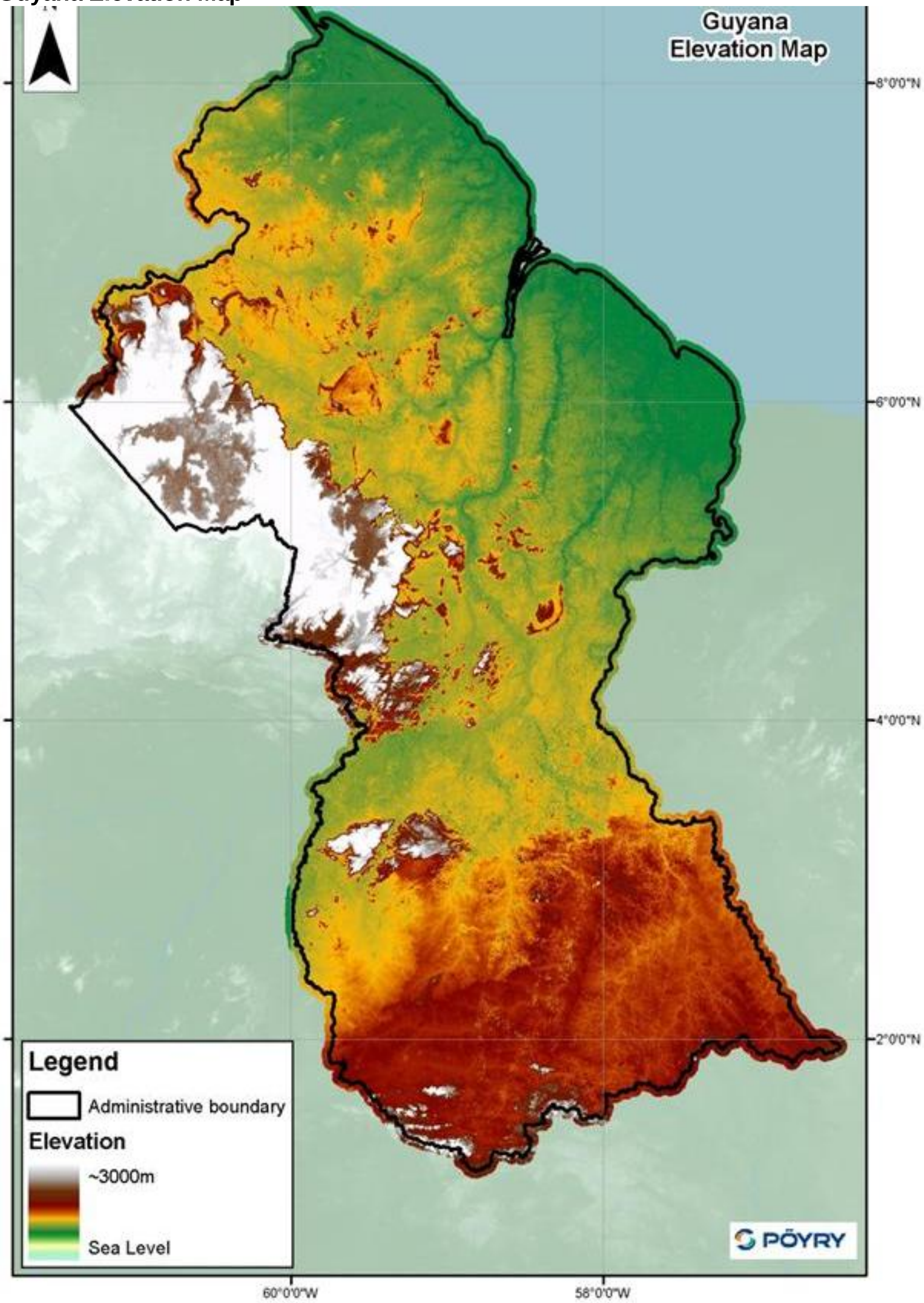
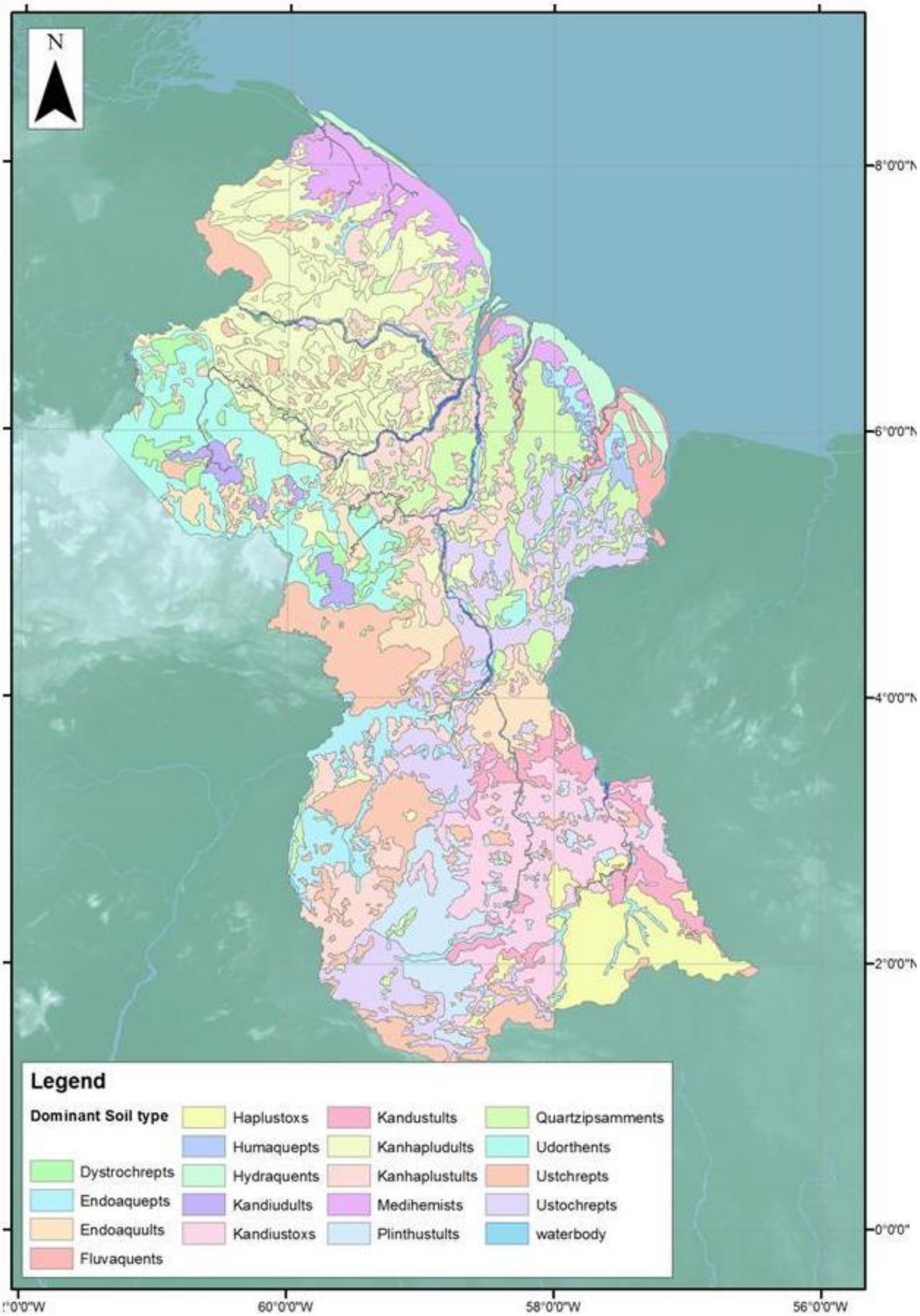
Appendix 8

National Datasets

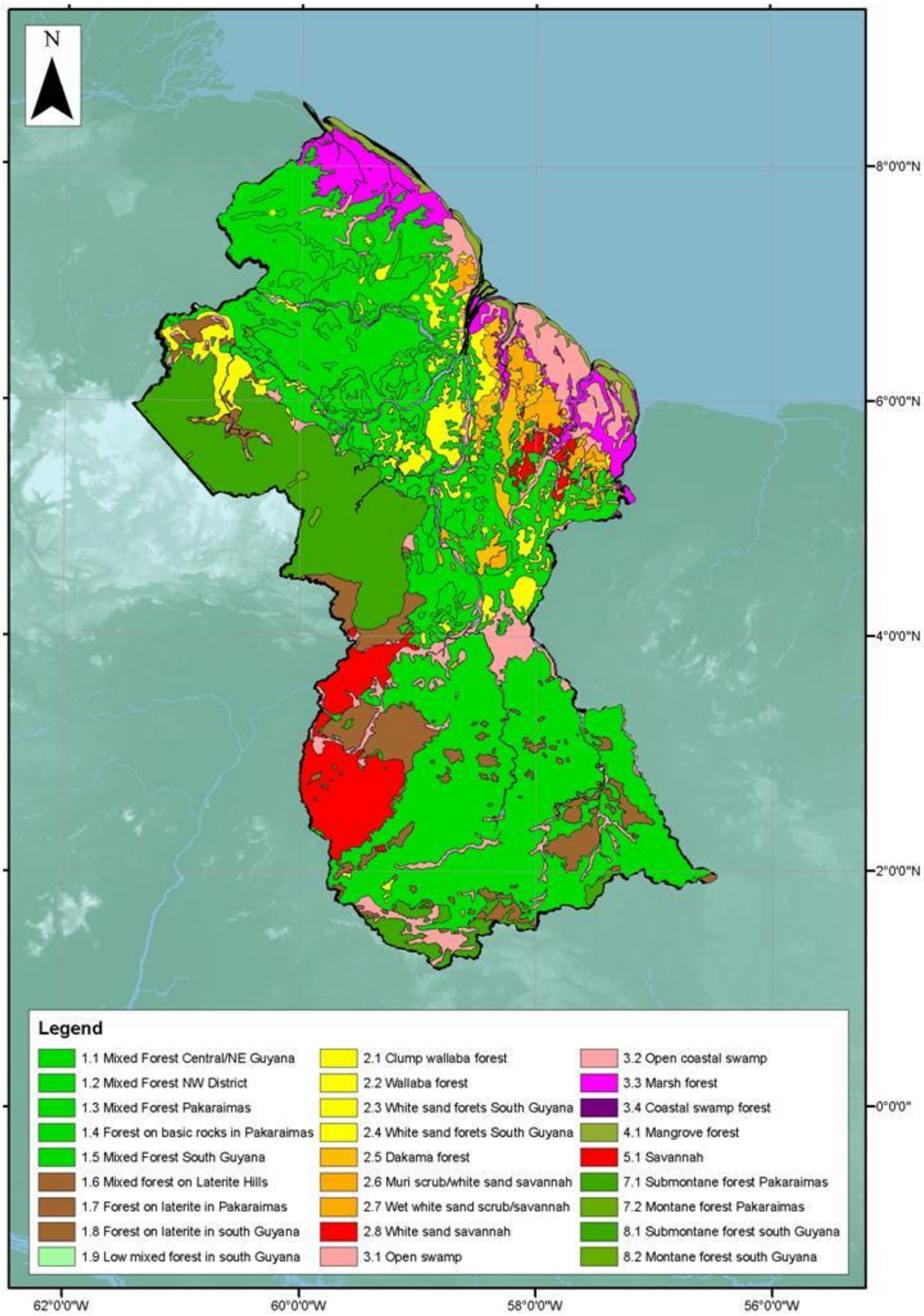
Guyana Elevation Map



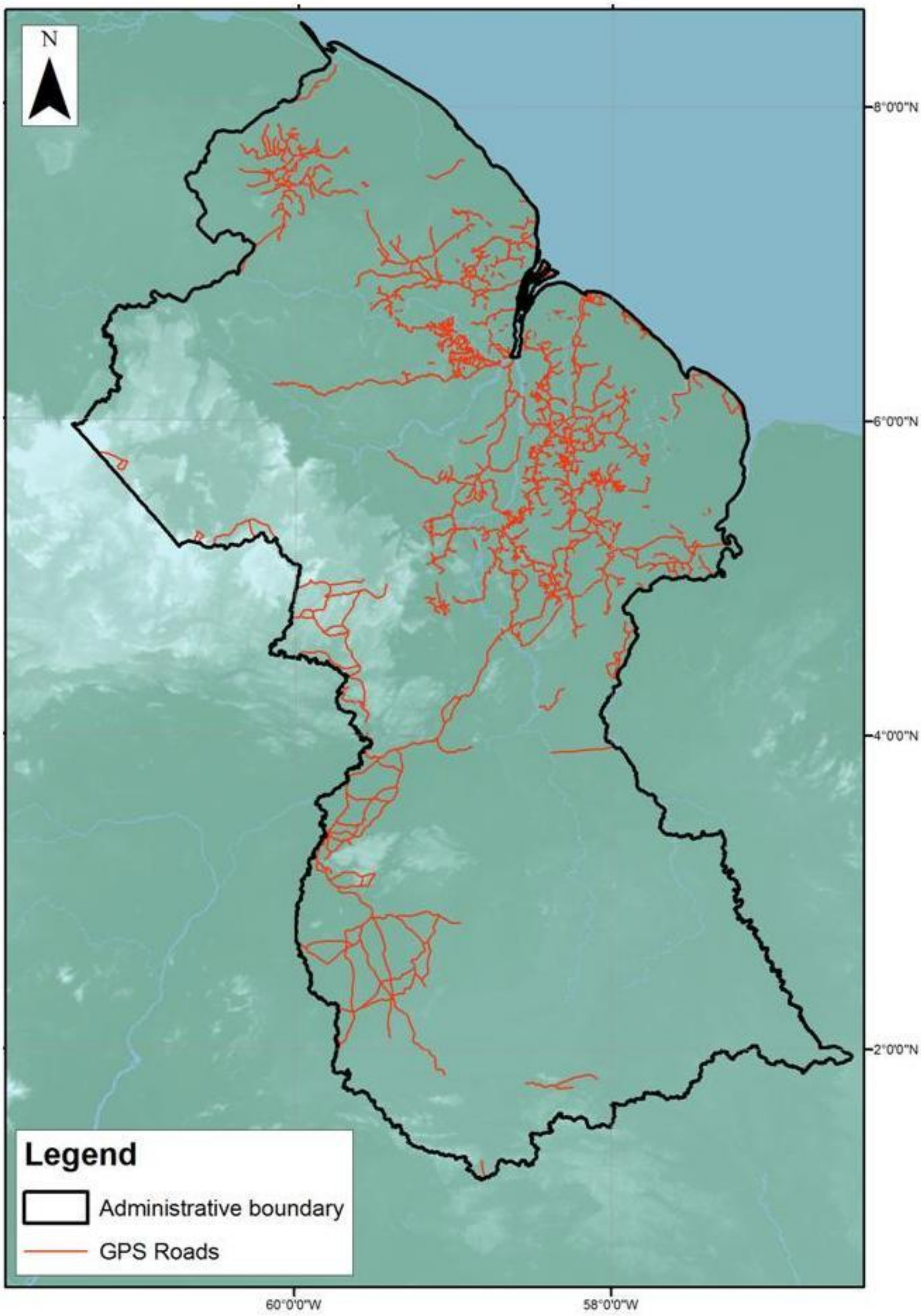
Guyana Soil Types Map



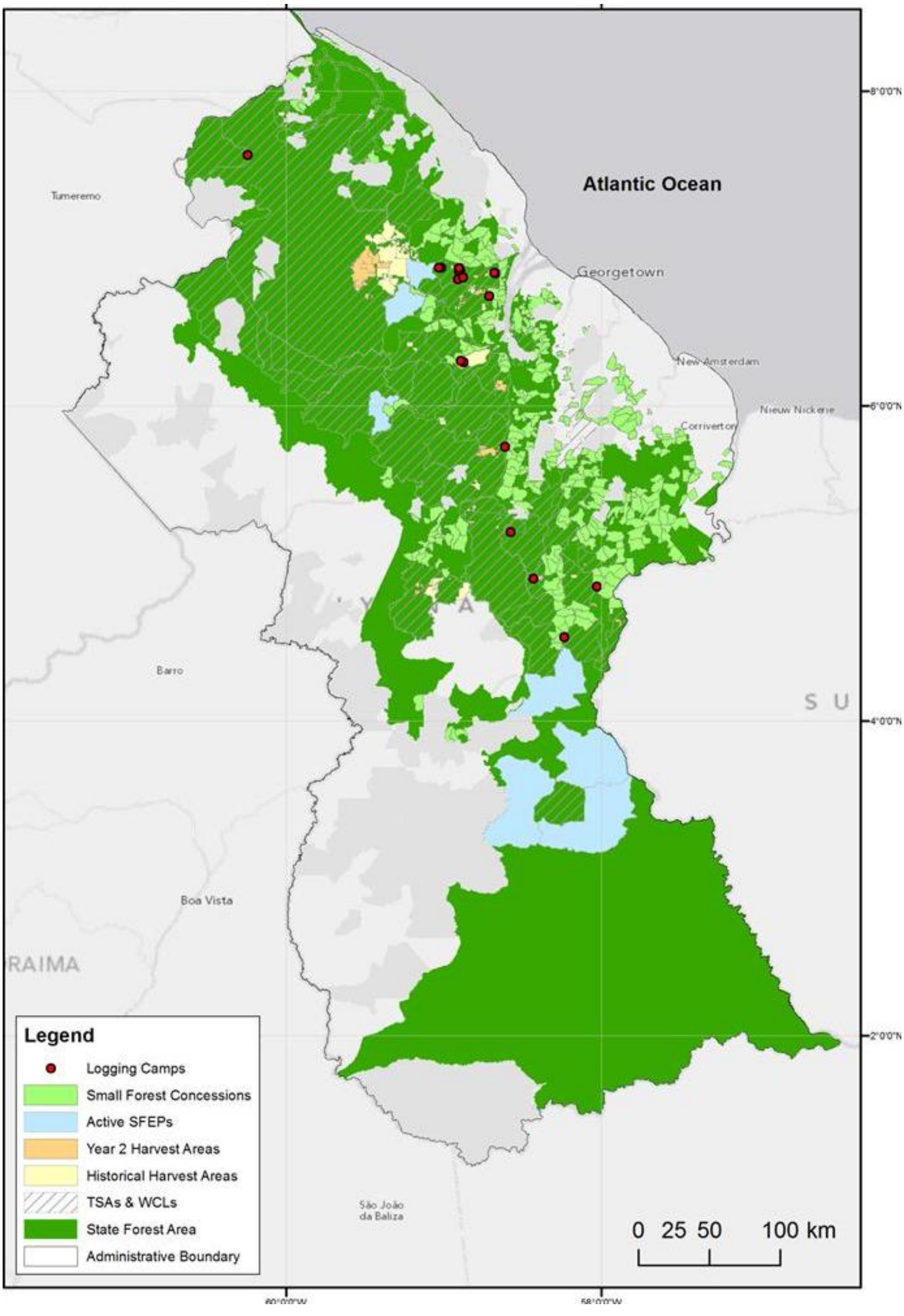
Guyana Vegetation Map



GPS Roads Layer



Managed Forest Areas



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