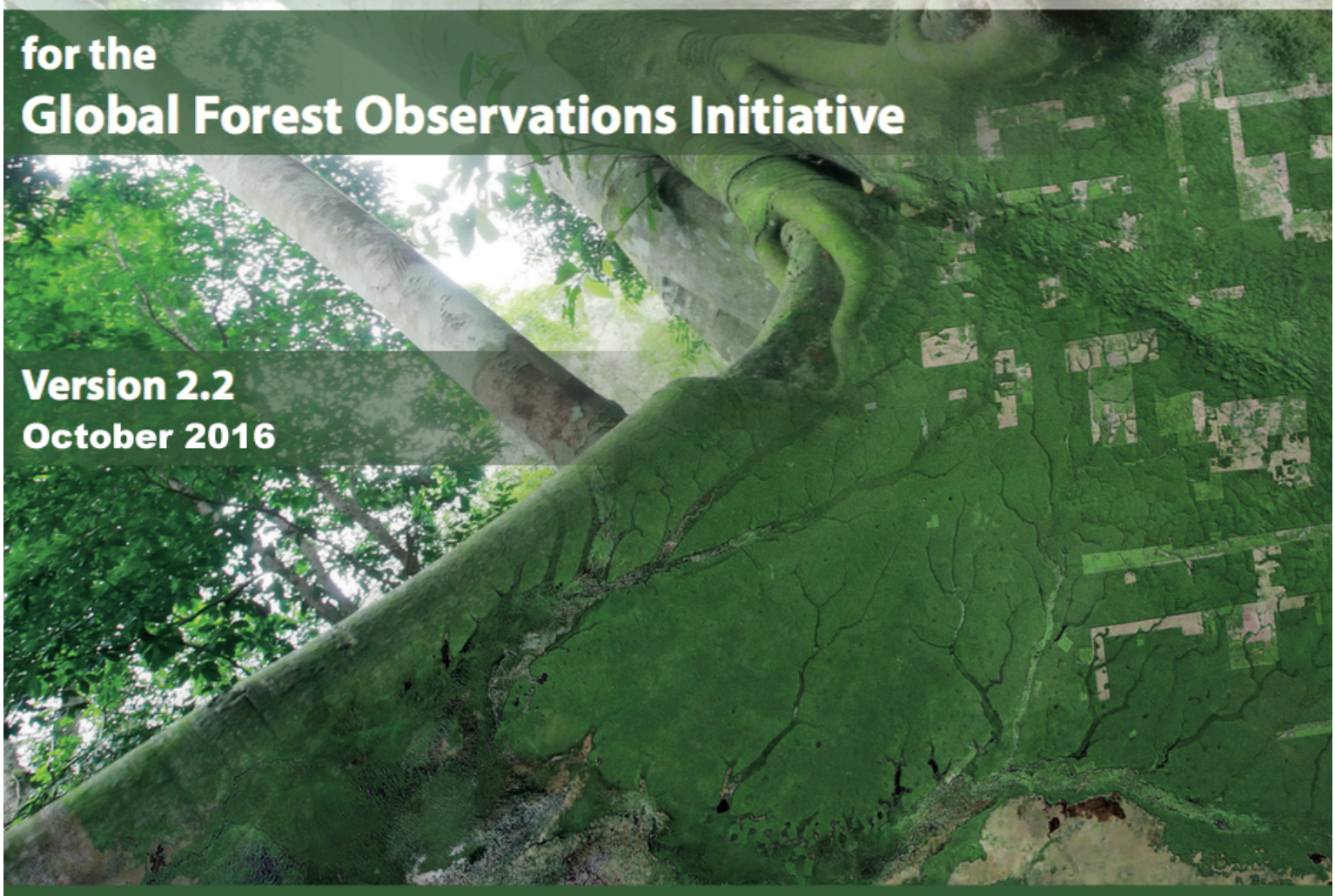
GFOI

Global Forest Observations Initiative

SDCG Element-3 Strategy: Satellite Data in Support of Research & Development (R&D) Activities

for the
Global Forest Observations Initiative



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Committee on Earth Observation Satellites (CEOS)

Space Data Coordination Group (SDCG)

Satellite Data in support of the Global Forest Observations Initiative (GFOI) Research & Development (R&D) Activities

SDCG Element 3

Version 2.2

October 9, 2016

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EXECUTIVE SUMMARY

The **SDCG Element-3 Strategy** is focussed on the acquisition and supply of Earth Observation (EO) data in support of GFOI research and development (R&D) activities. The strategy comprises coordinated observations for acquisition of dense time-series, multi-sensor data (optical and SAR) over a limited number of dedicated study sites to address priority R&D topics as identified by GFOI. With the support of CEOS space agencies, the GFOI research programme will in 2016 continue to provide targeted acquisitions over dedicated study sites and R&D activity that simultaneously addresses several priority R&D topics.

The GFOI R&D programme aims at improving and operationalising EO-based inputs to countries' national forest monitoring and carbon accounting systems (Chapter 1). Specifically this will allow countries to participate effectively in IPCC Tier 3, Approach 3 reporting under the UN REDD+ initiative. Research needs have been identified and prioritised (Chapter 2), after which, a dedicated R&D programme is being initiated with the aim of advancing priority R&D topics towards operational status for inclusion in the GFOI Methods and Guidance Documentation MGD) and ultimately in countries' National Forest Monitoring Systems (NFMS)..

The study sites and satellite data requirements for R&D have been defined during technical expert workshops, country consultation days and former GEO Forest Carbon Tracking (FCT) contacts (Chapter 3). Sites were selected on the basis of ongoing research activity, active collaboration with country representatives, and availability of ground data. The focus of the data provision under the Element-3 strategy is on time-series for accurate change estimates, archive data for baseline generation, and complementary SAR and optical data for exploring the benefits of sensor synergy.

The support of CEOS space agencies is reflected in the Element-3 strategy. Their contribution is by way of providing new acquisitions and archive satellite data over GFOI study sites. Data observation requests, with minimum observation requirements for each sensor have been collated. The extent of space agency support, including data availability and access procedures is outlined (Chapter 4). The context for R&D activity, including background on study sites, research partners and R&D topics is provided (Annex A). The Element-3 Strategy was endorsed by CEOS at SIT-30 (March 31 – April 1, 2015). Provision of satellite data commenced in the second half of 2015. Progress reports will be available to CEOS agencies and presentation of research results is anticipated at an annual science summit as part of the GFOI R&D Coordination component programme.

1 Introduction

1.1 Background and purpose

This document outlines how Committee on Earth Observation Satellites (CEOS) space agencies are coordinating their relevant Earth observing satellite systems to acquire data to support information requirements pertaining to Research and Development (R&D) arising from the Group on Earth Observation's (GEO) Global Forest Observations Initiative (GFOI).

The GFOI (http://www.gfoi.org) The GFOI sets out to facilitate widespread implementation of REDD+. It aims to support countries that are developing and implementing NFMS and associated emissions MRV systems to take full advantage of Earth observation technology, by

- encouraging the use and assuring sustained availability of satellite observations required for forest monitoring by engaging space agencies and satellite data providers;
- developing methods and protocols on the combined utilisation of remotely sensed and ground data for transparent assessment and reporting;
- capacity building programmes to provide sustained assistance and guidance; and,
- promoting directed research and development on high priority topics where further development is needed (e.g. forest degradation, above-ground biomass, satellite data synergy).

CEOS, having effectively coordinated space-based acquisitions in support of Forest Carbon Tracking (FCT) demonstration activities since 2009, has responsibility for coordination of the satellite data contribution to the observations and measurement component of GFOI – the regular and routine (systematic) observations and measurements for effective reporting – ensuring continuity of supply of time series data for consistent reporting.

Recognising the magnitude of the challenge involved in meeting GFOI and requirements, given the global scale and sustained coverage needed, CEOS in 2011 endorsed the three-element "CEOS Space Data Strategy for GFOI" as a framework for its coordination efforts[1].

Element 1: A baseline, coordinated global data acquisition strategy involving a number of space-based *core data streams* that can be utilised and shared free-of-charge for GFOI purposes. This involves systematic and sustained wall-to-wall Earth Observation (EO) acquisitions of forested areas globally and provides the default forest observations data for all countries without specific technical requirements, heritage or data preference. The Element 1 plan was first endorsed in 2013 at CEOS SIT-28.

[1] http://ceos.org/ourwork/ad-hoc-teams/sdcg/

Element 2: A coordinated strategy for national data acquisitions. This aims to accommodate countries that have specific technical requirements, or heritage and experience on working with a particular EO data source or type, as well as the numerous intergovernmental arrangements that may exist or emerge for the supply of certain data to one or more countries. This involves a wider range of satellite data sources, including data that is ordinarily provided on a commercial basis. The Element 2 plan was first endorsed in 2014 at CEOS SIT-29.

Element 3: Data supply in support of GFOI R&D activities, including support of: the science studies assisting the development and evolution of the MGD for GFOI; interoperability studies; and validation activities – typically also involving higher resolution EO data, some of which is provided commercially and is generally beyond the scope of CEOS agency responsibility. The Element 3 plan was endorsed in 2015 at CEOS SIT-30.

1.2 Joint strategy for R&D

CEOS support to the GFOI R&D Coordination component is provided through the SDCG Element 3 plan, which simultaneously addresses several priority R&D topics identified by GFOI. While it is not possible to anticipate all potential user requests, the Element-3 plan is based on sampled user input collected through a limited number of expert workshops, country consultations and previous GEO-FCT contacts.

1.2.1 Contribution from CEOS space agencies

The Element 3 strategy outlines different means for CEOS space agencies to support the GFOI R&D Coordination component:

- Provision of satellite data over GFOI R&D study sites
    - New data acquisitions
    - Historical (archive) data
- Coordinated research announcements (RA) and solicitations
    - RAs targeted at selected GFOI priority R&D topics
    - Coordinated open calls targeted at GFOI support
    - Funding opportunities

Research announcements and opportunities can be posted on the GFOI R&D website (http://www.gfoi.org/rd).

1.2.2 Contribution from GFOI Research and Development teams

In return for the provision of satellite data over GFOI Study Sites, the GFOI R&D teams are responsible for:

- Processing and sharing data
    - Processing satellite imagery and derived map products
    - Share ground data with space agencies

- Communicating results
    - Present results at GFOI Annual Science Meeting (attendance encouraged wherever possible)
    - Contribute to GFOI annual technical report
    - Share any publications arising from R&D

1.3 Document scope

This document focuses on Element 3, satellite data acquisitions and provisions in support of the GFOI R&D Coordination component.

The prime objective of the Element 3 strategy is to provide adequate satellite data required to progress GFOI priority R&D topics to pre-operational or operational status for subsequent inclusion in the GFOI Methods and Guidance Document (MGD).

Following this introductory chapter, this report contains:

- Chapter 2: *The GFOI R&D Coordination component* – outlines the GFOI R&D strategy, supported forest map products, and review of R&D priorities
- Chapter 3: *Collection of user requirements* – summarises user requests arising from technical expert workshops, country consultations and former GEO-FCT National Demonstrator team leads, and lists the GFOI Study Sites.
- Chapter 4: *Coordinated acquisition strategy in support of GFOI R&D* – outlines coordinated acquisition requests for each data stream including archive data.
- Chapter 5: *Governance*: summarises coordinating role of CEOS, SDCG and GFOI, recommendations for advancing the Element-3 Plan, and research announcements.
- Annexes:

  A: *Contributing agencies and missions*

  B: GFOI research partners and R&D topics

1.4 Acknowledgements

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2 Coordination of GFOI R&D activities

2.1 GFOI R&D Coordination (RDC) component

GFOI research activities are coordinated by the **GFOI R&D Coordination (RDC) component**. With funding support from ESA, the GOFC-GOLD Land Cover Office at Wageningen University in The Netherlands is since January 2016 leading the RDC component. R&D coordination was previously led by Norway (2012) and the GFOI Office (2013-2014).

In the GFOI organisational structure (Fig. 2.1), the RDC component has the following main functions:

- Development and implementation of a R&D Plan for GFOI;
- Review user needs for R&D and requirements for space data (Review of GFOI Priority R&D Topics);
- Catalysing Priority R&D Topics through:
  - Organisation of R&D Expert workshops and science meetings;
  - Management of research groups participating in the GFOI R&D programme;
- Liaise with other GFOI components:
  - Integration of new methods into the Methods and Guidance Document;
  - Support GFOI Capacity Building;
  - Work with SDCG to assure availability of relevant space data for R&D (SDCG Element-3)

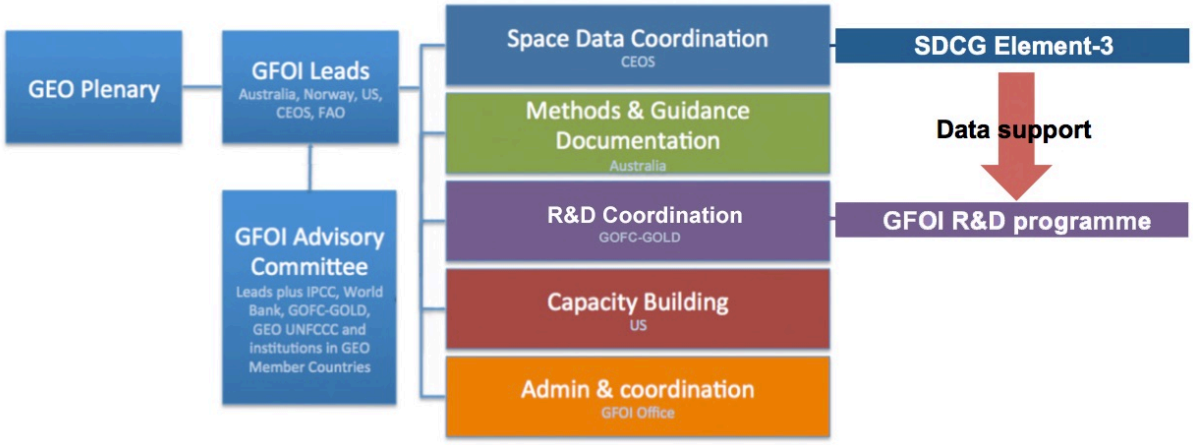

Figure 2.1 – GFOI organisational structure and relationship between SDCG and the GFOI R&D Coordination component

2.2 GFOI R&D framework documents

2.2.1 GFOI R&D Plan

The GFOI R&D Plan [2] identifies priority areas for remote sensing research and development targeted at improving and operationalising of inputs to support emissions estimation and reporting that will facilitate country engagement in IPCC Tier 3, Approach 3 accounting and future REDD+ implementation[3]. It focuses on progressing priority R&D topics to an operational status for integration in future revision and development of the GFOI Methods and Guidance Document (MGD).

The RDC component covers focused R&D actions addressing immediate needs for NFMS, rather than more long-term, basic research activities in the forest monitoring domain. Improvements to those products considered useful for a basic NFMS and non-operational products, either due to lack of regular or cost-effective data access issues or insufficient application across different regions and forest types, will be prioritised for R&D.

R&D is already underway on many topics as countries try to implement their NFMS. GFOI aims to complement these activities by promoting R&D that fills gaps in the existing work. The research needs were prioritised in the *GFOI Review of Priority R&D Topics* [4] to highlight those most urgently needed by countries to implement practical and affordable NFMS that comply with IPCC GPG. As a next step in advancing the R&D programme, a synthesis of R&D tasks and suitable research and partner organisations was completed: The *Landscaping Study* [5] .

Preparations for a dedicated R&D programme for GFOI were initiated in 2014 with the aim to progress the priority R&D topics towards an operational status for incorporation in future revisions of the MGD. With no GFOI budget available to directly fund research groups to undertake dedicated R&D, the approach was instead to capitalise on and catalyse already on-going R&D of relevance to GFOI and to encourage focus on operational status. This was achieved through:

- Dedicated expert workshop series that focus on specific priority topics
- Assessment of R&D needs through GFOI, SDCG and SilvaCarbon country consultations and through experiences from the GEO-FCT National Demonstrators
- Invitation of research groups to participate in a dedicated research programme, and identification of a limited number of dedicated study sites
- Liaison with SDCG to establish a programme for acquisition and provision of relevant space data (i.e. the SDCG Element-3 strategy)
- Follow-up of results and progress through release of regular status reports and organisation of annual science and result presentation meetings.

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[2] GFOI R&D Plan for 2015+. An action plan for advancing priority R&D topics related to the use of Remote Sensing in National Forest Monitoring – February 2015

[3] Baker et al. (2010). Achieving forest carbon information with higher certainty: A five-part plan. *Environmental Science & Policy*, 13: 249-260.

[4] http://www.gfoi.org/sites/default/files/GFOI_ReviewPrioityRDTopics_V1.pdf

[5] Landscaping the Research and Development Situation – DRAFT, July 2014

2.2.2 MGD Recommended Forest Map Products

The RDC component aims to support research required to progress and/or improve methods required for the operational development of the MGD Recommended Forest Map Products. The GFOI MGD defines seven thematic forest map products recommended to enable countries to measure *Forest Area Change* and *Carbon Stock Change Estimates*. Four supplementary forest map products defined in the *GFOI Review of Priority R&D Topics* document (section 2.4 below) are also considered of high relevance to countries, but additional R&D efforts will be required to bring them to an operational or pre-operational stage, and with subsequent inclusion in the MGD**.** Progressing such targeted R&D is a main objective of the GFOI R&D Coordination component.

These eleven products (Table 2.1) determine the data acquisition strategies being developed by CEOS to make satellite data available. It is not the responsibility of CEOS agencies to generate these products, but to make the necessary satellite data available so that countries can generate selected products of their choice to meet their monitoring needs. It should be emphasised that the map products are not end products; rather they represent intermediate information and inputs for GHG emissions estimates that provide improved confidence intervals for country emissions estimates.

The basic requirements of a REDD+ system include estimates of the area and annual rate of land use conversion (i.e., deforestation) and the long term loss and/or gain of carbon (i.e., degradation and/or enhancement of carbon stocks). In Table 2.1, those products with a high priority rating are essential components of the system. Medium priority products can be generated routinely and at reasonable accuracy to assist the inventory, with the exception of degradation type (RD-1). Products considered a low priority may be useful in future REDD+ systems pending the success of R&D.

The perceived operational readiness of each of the forest map products is also indicated in Table 2.1. The logic behind this determination is described in the *GFOI Review of Priority R&D Topics*. All seven recommended forest map products are considered operational when suitable medium resolution optical data are available (the optimal resolution for NFMS). Caveats are associated with certain products, depending on the available technology and satellite data. All four supplementary forest map products are considered to be in an R&D phase.

Code	Name	Overall Inventory priority	Operational Readiness
MGD-1	Forest / Non-Forest	Medium	Operational[(a)]
MGD-2	Forest / Non-Forest Change	Medium	Operational[(a)]
MGD-3	Forest Stratification	High	Operational[(b)]
MGD-4	All Land Use categories	Medium	Operational[(c)]

MGD-5	Land-Use Change between Forests and other Land Uses	High	Operational[c]
MGD-6	Change within Forest Land	High	Operational[b]
MGD-7	Near-Real Time Forest Change Indicators	Medium	Operational[d]
RD-1	Degradation Type map	Medium	R&D
RD-2	Degradation and enhancements of C stocks	High	R&D
RD-3	Above-Ground Biomass (AGB) Estimation	Low	R&D
RD-4	Change in Above-Ground Biomass	Low	R&D

Table 2.1 – GFOI recommended Forest Map Products and Supplementary Forest Map Products

[a] Product considered operational for key optical datasets and L-band SAR, however still in R&D phase for C-band SAR.

[b] Product considered operational for key optical datasets when stratification is limited between primary forest (PF) and planted forest (PlantF), but pre-operational if distinguishing between several sub-strata of natural forest. Product still considered in pre-operational and R&D phase for L-band SAR and C-band SAR respectively.

[c] Product considered operational for key optical datasets, however still in pre-operational and R&D phase for L-band SAR and C-band SAR respectively. Annual mapping of All Land use categories and change at sub-hectare scales is considered technically feasible, but is yet to be implemented for use in greenhouse gas inventories.

[d] Product considered operational for key optical datasets, however still in pre-operational and R&D phase for L-band SAR and C-band SAR respectively.

2.2.3 GFOI Review of Priority R&D Topics

The *GFOI Review of Priority R&D Topics*: *R&D related to the use of Remote Sensing in National Forest Monitoring*[6] is a peer-reviewed study released by the GFOI Office in December 2013. The document (hereafter referred to as the Review) covers those remote sensing derived forest map products needed by countries as they establish a NFMS, deciding if they are operational, pre-operational or are still in an R&D phase, and considering what additional R&D is needed to improve them.

[6] GFOI (2013): *Review of Priority Research & Development Topics: R&D related to the use of Remote Sensing in National Forest Monitoring*. Pub. GEO, Switzerland, 2013 ISBN 978-92-990047-5-3.

The Review identifies current gaps and opportunities for improving NFMS with newly available EO technologies or ground-based measurement methods. The research needs have been prioritised to highlight those most urgently needed by countries to implement practical NFMS that comply with IPCC GPG, and are sustainable and affordable.

The full list of R&D topics identified in the Review (Table 2.2) constitute the drivers for the GFOI R&D plan and forms the basis of the research program to improve NFMS. They also link to the observation requests in the Element-3 plan. The highest priority topics are those that address immediate data needs, including accuracy and stratification according to national requirements, sensor interoperability, data-model integration, and improvements to land use change and forest degradation products. Readers are referred to the Review document (http://gfoi.org/rd) for detailed justification of the R&D topics included.

Forest stratification (MGD-3) is a minimum requirement, with forest types separated on the basis of biomass/carbon densities that can be associated with specific emissions factors. There is increasing interest in the use of SAR and LiDAR for improved discrimination and classification of forest structural types. Further R&D is needed to determine the consistency and transferability of methods across biomes. Improvements to sampling approaches and species distribution modelling would benefit from additional R&D effort.

Satellite sensor interoperability and/or complementarity ("sensor synergy") are cross-cutting topics that address the accuracy and reliability of several products. Current R&D is focused on the consistency, comparability and methods of combining time-series data/products from different satellite sensors, together with the uncertainties involved, in order to derive accurate GHG emissions estimates from forest and land use change. Optimising information extraction from optical and SAR data sources for improved accuracy of the **Land use change** (MGD-5) product is a high priority. R&D is needed on the use of very high resolution (VHR; <5 m) data for calibration and validation (cal/val) of change products.

The technical capacity to monitor forest degradation is lacking. A better understanding of the capabilities and accuracies of remote sensing approaches to fill this gap is needed. R&D on quantitative techniques (utilising SAR and LiDAR technologies) and proxy methods for producing the **degradation/enhancement of Carbon stocks** (RD-2) product is considered a high priority. Where degradation involves the removal of individual trees, the use of VHR data will likely be key. Guidance on best use of VHR and ground data for Cal/Val is needed.

An assessment of soil carbon budget dynamics in peat forests versus other tropical forests is required to better understand the emissions associated with these landscapes.

Continuous improvement of **forest/non-forest** (MGD-1) and **forest/non-forest change** (MGD-2) mapping is possible with the use of multi-sensor data. R&D in these topics is considered a medium priority, and is focussed on an assessment of the achievable accuracies of annual forest area mapping when interspersing some scenes with alternate optical (varying resolution) or SAR data (varying frequency). The research requires access to dense time-series of optical and SAR (in particular, C-band) datasets to determine the temporal imaging requirements and minimum number of observations required to adequately detect change. Improved methods of burned area mapping are also needed.

All land use categories (MGD-4) mapping would benefit from further exploitation of SAR, particularly in cloud-affected regions. Guidance is also needed on the data needs and methods for evaluation of global land use products.

Although not a requirement for REDD+ reporting, there is increasing interest in establishing early warning systems of forest change. R&D is needed to determine the optimal satellite configuration (in terms of resolution and observation frequency) and methods for producing maps of **Near-Real Time forest change indicators** (MGD-7). Further exploitation of SAR wide beam modes and high frequency C- and X-band observations is needed. The development of rapid methods for NRT processing and the data needs and ways of attributing uncertainty in each identified change are required.

Mapping of forest **degradation type** (RD-1) and proxies/indicators is considered a medium priority. Advances in change detection approaches are possible, and mapping methods for regrowth and extracting land use history from time-series optical and/or SAR data are needed.

Estimation of **Above-ground biomass** (AGB) and **change in AGB** (RD-3 and RD-4) at the high accuracies required for emissions reporting are still in the basic R&D domain and therefore considered of lower priority for GFOI. Further R&D is needed on multi-sensor approaches, comprising wall-to-wall optical and/or SAR data and LiDAR, and modelling approaches that integrate repeat coverage. Advances in InSAR and polarimetric InSAR (Pol-InSAR) techniques are needed for canopy height estimation and extending the saturation level for biomass estimation. Additional R&D is needed on robust sampling design and establishing the links between AGB and other carbon pools.

Map Code and Product (if applicable)	R&D Topics	Priority
MGD-3 **Forest stratification**	• SAR texture metrics and polarimetry • Sampling and species distribution models • Consistent methods across biomes • Airborne LiDAR or InSAR structural classification • Forest type mapping from simulated future hyperspectral data	**High**
MGD-5 **Land use change**	• Exploitation of SAR texture and polarimetry for greater class separability • Sensor interoperability and complementarity for improved detection and mapping of land use change • Use of VHR data for calibration/validation of change products	
RD-2 **Degradation/ Enhancement of Carbon stocks**	• Mapping methods for regrowth • Proxy measures • Quantitative measures of degradation • Deriving forest degradation products and field validation from VHR data • Use of SAR data for mapping degradation • Use of airborne LiDAR for deriving biomass/carbon stocks and change • Assessment of the relationship among definitions of degradation, degree of degradation that can be detected, associated accuracies, and useful kinds of remotely sensed data	

General forest mapping method improvements	• Sensor interoperability - Generating similar thematic products from different sensor systems for assembly of time-series • Sensor complementarity for improved information extraction and monitoring • Uncertainty and inference • Assess potential generation of products using simulated future datasets such as (i) Sentinel-1/RCM time-series, (ii) Sentinel-2, and (iii) Hyperspectral (EnMAP) data • Optimising information extraction using dense time-series C-band SAR	
Data-Model integration	• Improved ground data and soil carbon budget models for new forested areas (e.g., peat soils)	
MGD-1 **Forest/Non-forest**	• Investigate alternative non-GFOI data streams for F/NF mapping	**Medium**
MGD-2 **Forest/Non-forest change**	• Improved methods for burned area mapping • Optimising F/NF change mapping using dense time-series C-band SAR	
MGD-4 **All Land use categories**	• Further exploitation of SAR for mapping land use categories • Identify data needs and methods for evaluation of global product accuracy	
MGD-7 **Near-Real Time Forest Change Indicators**	• Test different spectral fractions to identify disturbance pixels in different forest types and regions • Investigate alternative non-GFOI data streams, such as TerraSAR-X and future ALOS-2 ScanSAR • Methods and data for validation of products • Exploiting dense time-series C-band SAR	
RD-1 **Degradation type**	• Methods of extracting land use history (e.g., forest type and age, land use transitions following clearing/re-clearing) from optical time-series • Automated mapping methods • Use of fractional cover and evaluate different spectral indices • Evaluate different change detection approaches	
RD-3 **Above-ground biomass**	• Biomass stock stratification approaches (design- and model-based) • Link between AGB and other carbon pools (e.g., soil carbon) • Transferability of methods from boreal to temperate to tropical forest • Airborne LiDAR or SAR tree height correction • Bi-static SAR for estimating tree height • Integration of ground,- and airborne LiDAR, SAR and optical data • Integration of LiDAR and optical data for calculating past emissions	**Low**
RD-4 **Change in above-ground biomass**	• Modelling approaches using repeat LiDAR • Integration of repeat LiDAR and SAR to estimate biomass change across different forest types • Sampling design options • Transferability of methods to tropical biome	

Table 2.2– Summary of R&D needs identified in the GFOI Review of Priority R&D Topics[4]. [GFOI R&D Review document, Table 3]

2.3 GFOI R&D Expert Workshops

As a means to progress Priority R&D Topics the RDC component is organising a series of technical Expert workshops. The workshop have the following objectives:

- Assessment of existing approaches and current state of the art for the topic in question;
- Identification of obstacles to operational (widespread) use;
- Development of an action plan to progress development;
- Input/recommendations to CEOS and commercial data providers (i.e. SDCG Element-3)

Expert workshop 1 – Sensor interoperability/complementarity (Woods Hole, MA/USA, June 10-11 2014) http://www.gfoi.org/rd/first-rd-expert-workshop/

Expert workshop 2 – Forest degradation (Wageningen, Holland, Oct. 1-3, 2014)

http://www.gfoi.org/rd/second-rd-workshop/

Expert workshop 3 – Approaches to Remote Sensing for Vegetation Biomass Estimation (Brisbane, Australia, Feb. 24-26, 2015)

http://www.gfoi.org/wp-content/uploads/2016/04/GFOI-GOFC_ExpertWorkshop_Feb-2015.pdf

Expert workshop 4 – Global Datasets for National REDD+ Measuring and Monitoring

(Wageningen, The Netherlands, Nov. 9-10, 2015)

http://www.gofcgold.wur.nl/sites/glc4redd-workshop2015.php

Expert workshop 5 – (Joint GFOI / GOFC-GOLD / CONABIO / SilvaCarbon R&D Expert and Capacity Building workshop) – Regional solutions to forest type stratification and characterising the forest state for national forest monitoring and carbon emissions reporting (REDD+ MRV and LULUCF)

(Mexico City, Mexico, June 7-10, 2016)

http://www.gofcgold.wur.nl/sites/gfoiRD_mexico.php

GFOI R&D and GOFC-GOLD LC Science Meeting – First meeting of the GFOI R&D Programme. Organised in coordination with the GOFC-GOLD Land Cover science meeting (The Hague, The Netherlands, 31 Oct – 4 Nov, 2016)

http://www.gofcgold.wur.nl/sites/gofcgold-gfoi_sciencemeeting2016.php

2.4 The GFOI R&D programme

The RDC component is responsible for the coordination of a research programme for GFOI. The programme was first initiated in 2014, in conjunction with the organisation of the Expert Workshops described above. Due to a funding impasse for the RDC component in 2015, the R&D programme was restarted again in early 2016.

Since GFOI does not possess any dedicated budget to support own research activities, the R&D programme instead aims to capitalise on already on-going research, undertaken by external experts and research groups already active in the field of REDD+ and NFMS.

What the GFOI can bring to the table, and which can be used to motivate the R&D groups to focus their activities towards the GFOI Priority R&D Topics, is the provision of satellite data which they currently do not have access to.

Through the Expert workshops, meetings and user consultations described above, contacts have been established with 18 research groups which have expressed interest to participate in and contribute to the GFOI R&D programme. The map in Figure 2.1 shows the locations of the Study Sites where the R&D groups are active.

Figure 2.1 – GFOI R&D Study Sites.

Interactive map at http://www.gfoi.org/rd/study-sites/

The R&D groups and Study Sites are listed below in Table 2.3. The list includes both sites that previously have not been used within GFOI, and well as several of the Validation Sites in the GEO-FCT National Demonstrator countries that still are active, where time-series data have already been collected by CEOS agencies and where good opportunities for change studies exist. The study sites are mostly located in sub/tropical regions, with a few in temperate-boreal biomes to test the transferability of methods across different regions/forest types. The sites are multi-disciplinary and aim to address several of the GFOI priority R&D topics.

Research group	Site Code	Site name	Country	Coordinates	
				lat	long
Group 1	BRA-1	Mato Grosso	Brazil	S11.75	W54.25
Group 2	MLW-1	Mulanje	Malawi	S15.911	E35.640
	GAB-1	Gabon	Gabon	S1.018	E10.729
Group 3	FCT-COL-3	Pacifico-Bajo_Mira	Colombia	N1.65	W78.76
	FCT-COL-4	Amazonia-Tinigua		N2.17	W74.15
	FCT-COL-5	Andes-Antioquia		N7.83	W76.45
	COL-6	Caqueta		N1.4079	W73.5747
	COL-7	La Victoria		N6.26	W74.64
Group 4	ETH-1	Kafa BR	Ethiopia	N7.3	E35.6
	FIJ-1	Lololo & Nakavu	Fiji	S17.3	E177.4
	PER-1	Peru	Peru	S11.1	W74.3
Group 5	GFC-1	GFC Site 1 (FCT)	Guyana	N3.3069	W59.6672
	GFC-2	GFC Site 2’		N5.2671	W59.1066
Group 6	FCT-BOR-3	Mawas	Indonesia	S2.24	E114.48
	FCT-SUM-2	Harapan		S2.20	E103.38
Group 7	FCT-TNZ-5	Amani	Tanzania	S5.13	E38.63
	FCT-TNZ-6	Liwale		S9.50	E38.17
Group 8	PNG-1	Kokoda	Papua New Guinea	S9.184	E147.374
	PNG-2	Milne bay		S10.598	E150.185
Group 9	FCT-MEX-2	Chiapas-1	Mexico	N16.45	W91.40
	MEX-3	Durango		N23.74	W105.49
	FIN-1	Hyytiälä	Finland	N61.85	E24.32
	FIN-2	Sodankylä		N67.48	E26.34

Table 2.3a – GFOI R&D Study Sites (as of June, 2016)

Research group	Site Code	Site name	Country	Coordinates	
				lat	long
Group 10	AU-4 FCT-AU-3	Robson Creek (QLD) Warra (Tasmania)	Australia	S17.119 S43.1046	E145.631 E146.656
Group 11	AU-5	Injune (QLD)	Australia	S25.5	147.7
Group 12	CAN-1 CAN-2 CAN-3	Site 1 NW Territories Site 2 NW Territories Site 3 NW Territories	Canada	N61.4 N62.0 N61.52	W121.3 W116.50 W120.35
Group 13	BRA-2	Novo Progresso	Brazil	S7°02'4.07"	W55°24'1.82"
Group 14	KAL-1	Sebangu N.P. / xMRP	Indonesia	S2°24'	E114°6'30"
	SUM-1	South Sumatra		S2°29'30"	E103°28'30"
Group 15	SUR-1	Klaaskreek	Suriname	N5°12'12.70"	W54°57'4.40"
	KAL-2	Malinau	Indonesia	N3°1'57.23"	E116°36'5.45"
	MAD-1	Kade	Ghana	N6°11'41.14"	W0°56'21.90"
Group 16	SA-1	Lowveld / Kruger N.P.	South Africa	S24°47'	E31°26'
	SA-2	Eastern Cape		S32°50'	E26°06'
	SA-3	KwaZulu-Natal		S28° 19'	E32° 00'
Group 17	DRC-1	Mai Ndombe district	D.R. Congo	S2.70	E18.50
Group 18	MEX-4	Campeche/Kulic	Mexico	N20.3	W90.1
	MEX-5	Marques de Comillas		N16.3	W90.9
	Mex-6	Hidalgo		N20.6	W98.59
	SA-4	Skukuza / Kruger N.P.	South Africa	S25.2	W31.5

Table 2.3b – GFOI R&D Study Sites (as of June, 2016)

3 Space Data in support of GFOI R&D

3.1 Data requirement summary

The table below provides an overview of the space data requirements raised through the GFOI R&D programme, as well as which of the Priority R&D Topics the groups address. Detailed descriptions of the R&D groups, their research, Study Sites and data requirements are provided in Annex A.

Group	Affiliation	Study Site(s) [country]	Sensor data requested									Publicly open & others						R&D topics under investigation							
			SPOT5(Take5)	SPOT 1-5 (archive)	VHR Optical	ALOS-2 PALSAR-2	ALOS-1 PALSAR-1	RADARSAT-2	TerraSAR-X	TanDEM-X	Cosmo-SkyMed	Landsat	Sentinel-1	Sentinel-2	RapidEye	ENVISAT ASAR	Others	Forest type	Forest cover	Deforestation	NRT detection	LC & LLC	Degradation	Biomass/carbon	Interoperability
1	INPE, Brazil	Brazil																					X		X
2	SIRS, France	Malawi																X	X	X			X		X
		Gabon																X	X	X	X		X		X
3	WHRC/BU, USA	Colombia																		X		X	X		X
4	U Wageningen, The Netherlands	Ethiopia																		X	X		X		X
		Fiji																		X	X		X		X
		Peru																		X	X		X		X
5	Guyana Forest Com.	Guyana																					X		X
6	U Wageningen, NL	Indonesia																X		X	X	X	X	X	X
7	U Tromsø, Norway	Tanzania																	X	X				X	X
8	HGC, Malaysia	PNG																		X			X	X	X
9	VTT, Finland	Mexico																	X			X	X	X	X
		Finland																						X	X
10	CSIRO, Australia	Australia																X					X		X
11	UNSW, Australia	Australia																		X		X	X	X	X
12	CFS, Canada	Canada																X	X				X	X	X
13	U Humboldt, Germany	Brazil																		X		X	X	X	X
14	RSS, Germany	Indonesia																		X			X	X	
15	Airbus, Germany	Suriname																X	X	X	X		X	X	
		Indonesia																X	X	X	X		X	X	
		Ghana																X	X	X	X		X	X	
16	CSIR, South Africa	S. Africa																X	X				X	X	X
17	NORUT, Norway	DRC																	X	X					X
18	U Jena, Germany	Mexico																					X		X
		S. Africa																					X		X

*User requirement: Minimum required dataset; Complementary dataset; Available through other sources (not requested through SDCG)

Table 3.1 – GFOI R&D group space data requirement summary and Priority R&D Topics addressed.

3.2 The Element-3 strategy

In response to the requirements above, the proposed Element-3 strategy comprises systematic dense time-series of multi-sensor data (optical, L-, C- and X-band SAR) over the GFOI study sites in order to provide information-rich datasets which fulfil the requirements for experimental analysis. Redundancy is built into the strategy to test the transferability of methods using similar sensors.

Common for all sensors is that dense time-series are required for testing the robustness and consistency of methods of deriving change estimates. Historic (archive) data are needed to extend time series backwards and for baseline generation. Complementary SAR and optical data are needed to assess the benefits of sensor synergy for forest monitoring and degradation assessment. Additional R&D tasks can be added for sites at a later stage.

The section below comprise the data observation requests for each sensor, both new acquisitions and archive, for the GFOI R&D Study Sites. Minimum requirements for are given in case of capacity constraints.

SAR mission agencies are asked to keep the following general considerations in mind:

- Collection of consistent time-series is a key requirement and missed acquisitions and data gaps that inevitably will occur should be re-programmed for fill-in acquisitions the next satellite cycle.
- In order to accommodate SAR-optical interoperability studies, observations in descending pass direction are recommended.
- A key point for each of the SAR sensors is to remain consistent with one single observation mode selected to maximise band sensitivity to forest parameters, and successively build up a uniform and homogeneous multi-temporal coverage over each of the Study Sites. In particular it should be noted that a change in the SAR off-nadir look angle introduces additional uncertainty in time-series analyses and should be avoided.

3.3 Governance

3.3.1 Roles and responsibilities

The R&D activities under GFOI are a partnership between the space agencies – federated under the SDCG Element-3 strategy – the GFOI R&D Coordination component and the GFOI R&D groups. The roles and responsibilities of these various entities are as follows:

GFOI R&D Coordination Component (GOFC-GOLD)

The RDC component is responsible for the following:

- Management of the GFOI R&D programme and coordination of the GFOI R&D groups;
- Act as main interface between SDCG space agencies and GFOI R&D groups;
- Provide mechanism for reporting and feed-back to space agencies and GFOI
- Organisation of R&D Expert workshops and science meetings

SDCG Space Agencies and Data Providers

The space agencies and data providers are responsible for the following with respect to approved projects:

- Review and approve satellite data requests from GFOI R&D groups;
- Ensure lending of processed satellite data addressing the *minimum required datasets* as described in the project forms (Annex A) for approved projects;
- Resources permitting, ensure lending of processed satellite data addressing the *complementary datasets* as described in the project forms (Annex A) for approved projects;
- On a best effort basis, provide technical support for the products supplied.

GFOI R&D Groups

The research groups shall:

- Agree to undertake research focused on one or more of the GFOI Priority R&D Topics;
- Certify that the satellite data provided are used for non-commercial research purposes only;
- Comply with the data policy and data restrictions related to every datasets requested;
- Coordinate the project execution;
    - Provide a project timeline and milestone dates;
    - Ensure, to the best of their ability, that their project has sufficient funding and resources to complete the planned research within the stated timeframe;
    - Publish the results of the research project and appropriately acknowledge the GFOI and the data sources;
    - Submit to GFOI R&D and SDCG, on request, the results and methods used;
    - On a best effort basis, attend annual GFOI R&D science workshops to present results;

3.3.2 Recommendations

To advance the Element-3 Plan, the following recommendations are made:

- The Element-3 plan was endorsed by CEOS at SIT-30 (2015) and SIT-31 (2016). The plan shall be updated on an annual basis.
- Space agencies are encouraged to provide updated lists list of archive data available over GEO-FCT ND verification sites and new study sites (when available).
- In the interests of securing dense time-series and extending previous R&D, space agencies are encouraged to start acquiring data over ND and new study sites as soon as can be accommodated in their acquisition plan.
- GFOI research partners are encouraged to consult the data archives and advise GFOI on specific data requests for R&D.

4 Contributing agencies and missions and corresponding data requests

4.1 ASI

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
COSMO-SkyMed	ASI	Anna Rita Pisani	annarita.pisani@est.asi.it	Research institutional users	http://87.241.31.78/index.php

4.1.1 COSMO-SkyMed

New acquisitions: ASI is currently making significant contributions to the GEO Geohazard Supersites and Natural Laboratories (GSNL) initiative. ASI is interested in supporting R&D activities involving X-band – in particular integration with C-band, L-band and optical data.

Archive data availability: Refer to http://gfoi.org/RD for the COSMO-SkyMed Background Mission on Guyana, Cameroon, Borneo, Tasmania, Peru, Colombia, DRC and Sumatera sites and for the COSMO-SkyMed archive data on GFOI R&D Study Sites.

Data access procedure:

- Access to COSMO-SkyMed data is for research/institutional users;
- Submission of an R&D project to ASI for the exploitation of COSMO-SkyMed data;
- Principal Investigators of accepted proposals have to sign and return to ASI a "COSMO-SkyMed License to use" to obtain the data provision;
- After the approval of the project ASI will provide a COSMO-SkyMed Request Form to order the products.
- Access to the official COSMO-SkyMed archive is possible through the website http://87.241.31.78/index.php by subscription.

4.1.2 Research Announcements

- The "Open Call for Science" started on February 25th, 2015 and is available on the ASI website at: http://www.asi.it/en/agency/bandi_en/calls/cosmoskymed_open_call_for_science
- The Open Call is open to national and international scientific investigators and submission of proposals will be accepted anytime. The selected projects will be supported for two years with a quota of data free-of-charge.
- *Land cover and vegetation* is among the primary application domains.
- ASI is open to exploring the possibility of a coordinated announcement of opportunity (AO) for R&D on GFOI key science questions with CEOS partners.

4.1.3 Requests for COSMO-SkyMed data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 5	GFC-1	Guyana	Jan-Dec	Aug 2016 Aug 2017	Monthly
	GFC-2	Guyana	Jan-Dec	Aug 2016 Aug 2017	Monthly
	GFC-3	Guyana	Jan-Dec	Aug 2016 Aug 2017	Monthly
Group 6	BOR-3 (FCT)	Mawas (Kalimantan), Indonesia	Jan-Dec	Apr2016-2017	Monthly
	SUM-2 (FCT)	Harapan (Sumatra), indonesia	Jan-Dec	Apr2016-2017	Monthly

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 10	FCT-AU-3	Warra (TAS), Australia	Apr-Dec	2015-2016	Monthly
	FCT-AU-4	Robson Creek (QLD), Australia	Apr-Dec	2015-2016	Monthly
Group 11	AU-5	Injune (QLD), Australia	July/Aug 2007 Jan-Dec2015	2007 2015	Monthly

Table 4.1 GFOI R&D Study Sites requested for coverage by X-band SAR.

4.2 CNES

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
SPOT 1 to 5	CNES	Steven Hosford	Steven.hosford@cnes.fr	Non commercial use	www.geostore.com Data access via SWH website (not yet open)
Pléiades	CNES	Steven Hosford	Steven.hosford@cnes.fr	Research use	www.geostore.com Data access via CNES website (not yet open)

4.2.1 SPOT-4 and -5

Archive data availability: Refer to http://www.geostore.com. Archive data available to be processed through SPOT World Heritage programme includes all SPOT 1-5 data at least 5 years old and data acquired in the Congo Basin Initiative. All archive data over GFOI R&D Study Sites will be processed and made available at no cost.

Data access procedure:

- Free and open access via SPOT World Heritage website to all data already processed. User must be identified and non-commercial use licence must be signed.
- One proposal is recommended to cover all GFOI R&D Study Site requests for the SPOT5(Take5) experiment.

4.2.2 PLÉIADES

New acquisitions: Requests for new acquisitions with Very High Resolution Pléiades-1A and -1B is possible. With the current budget available for processing, CNES would be able to provide in the order of a total 25 scenes per year for GFOI.

Archive data availability: Refer to http://www.geostore.com

Data access procedure:

- Registered science users (ISIS programme) can download data from the CNES image database. Registration involves the laboratory signing an agreement with CNES.

4.2.3 Research Announcements

- Offer annual calls for science proposals ("TOSCA"), open to French laboratories in February of each year for funding commencing the following year. Project support is provided for the purchase of data, experimental equipment, travel and temporary (post-doc) positions.
- Coordination with other national/international initiatives is possible, e.g., future research announcements that partly/fully support GFOI.
- CNES is open to exploring the possibility of a coordinated announcement of opportunity (AO) for R&D on GFOI key science questions with CEOS partners.

- CNES is looking for co-funding opportunities to process all SPOT1-5 archive data over GFOI countries through the SPOT World Heritage Programme. The SPOT archive presents a substantial resource for establishing forest baseline information.

4.2.4 Requests for VHR (Pléiades) data

Pléiades VHR (<5 m resolution) data are requested for validation (Table 4.2a and Table 4.2b).

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 2	MLW-1	Malawi	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly
	GAB-1	Gabon	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly
Group 4	ETH-1	Ethiopia	Jan-Dec	2016-2018	1 scene
	PER-1	Peru	Jan-Dec	2016-2018	1 scene
	FIJ-1	Lololo & Nakavu	Jan-Dec	2016-2018	1 scene
Group 5	GFC-1	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
	GFC-2	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
	GFC-3	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
Group 6	FCT-BOR-3	Mawas	Jan-Dec	Apr2016-Mar2017	Monthly
	FCT-SUM-2	Harapan	Jan-Dec	Apr2016-Mar2017	Monthly
Group 7	FCT-TNZ-5	Amani, Tanzania	June-Sept, Jan-Feb	2016-2017	Monthly
	FCT-TNZ-6	Liwale, Tanzania	June-Sept, Jan-Feb	2016-2017	Monthly
Group 8	PNG-1	Kokoda, PNG	Jan-Dec	2015-2017	Monthly
	PNG-2	Milne bay, PNG	Jan-Dec	2015-2017	Monthly
Group 9	FCT-MEX-2	Chiapas, Mexico	Jan-Dec	2007, 2010 , 2013, 2015	Monthly
	MEX-8	Durango, Mexico	June 15 - Aug 31	2010 , 2014, 2015	Monthly
	FIN-1	Hyytiälä, Finland	Jan-Dec	2007, 2010, 2013 2015, 2016	Monthly
	FIN-2	Sodankylä, Finland	Jan-Dec	2007, 2010, 2013 2015, 2016	Monthly
Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	Monthly
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	Monthly
Group 11	AU-5	Injune, QLD, Australia	Jan-Dec	2010 2017	Monthly
Group 13	BRA-2	Novo Progresso, Brazil	entire year	2014 - 2018	weekly
Group 15	SUR-1	Klaaskreek, Suriname	Jan - Dec	2015-2017	2 times / year
	KAL-2	Malinau, Kalimantan	Jan - Dec	2015-2017	2 times / year
	GHA-1	Kade, Ghana	Jan - Dec	2015-2017	2 times / year

Group 17	DRC-1	Mai Ndombe district, DRC	June-Sept Jan-Feb	2016-2017	Monthly
Group 18	MEX-4	Campeche, Mexico	Whole year	2015-2018	Once/year
	MEX-5	Marques de Comilias, Mexico	Whole year	2015-2018	Once/year
	MEX-6	Hiladgo, Mexico	Whole year	2015-2018	Once/year
	SA-4	Skukuza/KNP, South Africa	Whole year	2015-2018	Once/year

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 1	BRA-1	Mato Grosso, Brazil	June-Oct	2016-2017	1 scene
Group 3	FCT-COL-3	Pacifico-Bajo-Mira, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-4	Amazonia-Tinigua, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-5	Andes-Antioquia, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-6	Cacueta, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-7	La Victoria, Colombia	Since launch	Cloud free	Once a year

Table 4.2 GFOI R&D Study Sites requested for coverage by optical VHR sensors (Note: same as Table 4.8)

4.2.5 Requests for SPOT 1-5 (archive) data

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 3	FCT-COL-3	Pacifico-Bajo-Mira, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-4	Amazonia-Tinigua, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-5	Andes-Antioquia, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-6	Cacueta, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-7	La Victoria, Colombia	Since launch	Cloud free	Once a year

Table 4.3 GFOI R&D Study Sites requested for coverage by archive SPOT 1-5

4.3 CSA

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
Radarsat-2	CSA	Yves Crevier	yves.crevier @canada.ca.	Restricted to science support (NEODF)	NEODF-Cat. www.neodf.nrcan. gc.ca
	MDA	MDA Client Service Rep	Clientservices @mdacorporation.com	Commercial	Same as above

The Canadian Space Agency (CSA) overarching objectives in support of the GFOI Element-3 are to support our National Forest community (government, academic and private sectors) and to enable end-users to exploit the large amount of SAR data that is now or will soon be available in support of their programs for forest management, ecosystem protection, carbon accounting, etc.

Due to the commercial nature of the RADARSAT-2 mission, the CSA is restricted to supporting science related activities as identified and endorsed by the GFOI science framework under the Element-3. The CSA is mostly interested in the following topics:

- Use of Synthetic Aperture RADAR (SAR) for the monitoring of forest related attributes;
- Interoperability and complementarity between SAR and optical datasets;
- SAR/SAR mission interoperability;
- Development of SAR-based approaches, algorithms, and methods that are viably sustainable to support local, regional, national, continental and global forest monitoring and carbon accounting.

In this context the CSA is willing to contribute archive data and develop dense time series over punctual sites to support key science and demonstration activities.

4.3.1 New acquisitions: RADARSAT-2

The Canadian Space Agency will contribute data, under the coordinated framework, to projects which will directly contribute to the defined and agreed upon key science questions articulated under the GFOI R&D component. The number of scenes, the preferred sites, and the observation frequency are to be defined and agreed with the project PIs.

The CSA will need to go through a user/data set certification process as planned under the Master Agreement with the owner of the satellite (MDA) and the Canadian remote sensing space system act (RSSSA). Once users and data will be certified, a secured access/open sharing portal hosted in Canada will be put in place. All of the RADARSAT-2 data contributed to the Element-3 component will be open for internal sharing among the list of certified PIs of GFOI. This will include the pertinent dataset acquired under the framework of the FCT project and new dataset acquired in a background mission framework to be defined and agreed under the GFOI.

The CSA will comply to the open sharing principle of the Element-3 and expects, in return, an open sharing of ground data, methods, and derived results. The RADARSAT-2 data will be contributed at no costs to the users. All of the data and processing costs will be covered by the CSA.

In summary, the CSA expects its contribution to GFOI science plan (Element-3 component) to generate better understanding on issues related to SAR only, SAR/SAR and SAR/Optical data interoperability for forest attributes derived information.

It is expected that the key science requirements, articulated in the context of Element-3, represent the position of the Global federated community under GFOI. In addition to our data contribution, the CSA Earth Observation programs (for data, science and demonstration) will remain available to support innovative development of solutions. In this context the CSA is supporting the Canadian Research Team (Group 13).

4.3.2 Archive data: RADARSAT-2

Refer to http://gfoi.org/RD. Full or partial wet and dry coverage was acquired over Mexico, Colombia, Guyana, Cameroon, Tanzania, Indonesia and Tasmania by RADARSAT-2. A total of 727 images were acquired, with 2 national coverages planned. The RADARSAT-1 archive is of limited coherent use for forest monitoring.

4.3.3 Research Announcements

- CSA is open to exploring the possibility of a coordinated announcement of opportunity (AO) for R&D on GFOI key science questions with CEOS partners.

4.3.4 Requests for C-band SAR data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	Monthly
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	Monthly
Group 14	KAL-1	Sebangu N.P. / xMRP	Aug - Oct	2012/2015	4 consecutive acquisitions
	SUM-1	South Sumatra	Aug - Oct	2012/2015	4 consecutive acquisitions

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 1	BRA-1	Mato Grosso, Brazil	June-Oct	2016-2017	1/year
Group 7	FCT-TNZ-5	Amani, Tanzania	June-Sept + Jan	2016-2017	Monthly
Group 18	MEX-4	Campeche, Mexico	Whole year	2015-2018	1 acquisition per month
	MEX-5	Marques de Comilias, Mexico	Whole year	2015-2018	1 acquisition per month
	MEX-6	Hiladgo, Mexico	Whole year	2015-2018	1 acquisition per month
	SA-4	Skukuza/KNP, South Africa	Whole year	2015-2018	1 acquisition per month

Table 4.4 GFOI R&D Study Sites requested for coverag-e by C-band SAR.

4.4 DLR

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
TerraSAR-X	DLR	TerraSAR-X Science Service System	tsx.science @dlr.de	Standard DLR research type. COFUR costs waived for GFOI related proposals	http://terrasar-x-archive.infoterra.de/
TanDEM-X	DLR	TanDEM-X Science Service System	tandemx-science @dlr.de	Standard DLR research type	http://tandemx-science.dlr.de/

4.4.1 TerraSAR-X background mission

DLR is running a background mission since June 2015 to cover the R&D sites systematically based on the centre coordinates supplied by the R&D teams.

- All former Prior 1 siteswere regularly (every 22 days) monitored from an ascending and a descending orbit. All Prio 2 sites were monitored at least monthly. For about half of the Prio 1 sites the regularly acquisitions every 22 days were successful. All other sites have at a minimum 3 successful acquisitions (Status March 2016).
- The Status of acquisitions can be checked by R&D teams via the EOWEB NG tool: https://centaurus.caf.dlr.de:8443/eoweb-ng/template/default/welcome/entryPage.vm
- KML Files of the acquisitions will be provided again to the R&D teams in July 2016.
- A feedback to the DLR GFOI team is a mandatory requirement for the continuation of the background mission till July 2016.

4.4.2 TerraSAR-X new acquisitions

New acquisitions for GFOI R&D Study Sites can be acquired by submitting a research proposal to DLR. All acquisition modes are possible, according to user requests. As a stop-gap solution a background mission was initiated by DLR.

Data access procedure:

- For new acquisitions over GFOI R&D Study Sites a research proposal is required. The primary entry point is the TerraSAR-X Science Service System: http://sss.terrasar-x.dlr.de using the AO for General Proposal Submission. For GFOI R&D groups the usual COFUR costs can be waived for a reasonable amount of data. Therefor the DLR GFOI contact person has to be informed prior to submission of the proposal, the proposal name should include "GFOI" and the scientific GFOI R&D purposes have to be described in the proposal.
- All science proposal submission details are included in http://sss.terrasar-x.dlr.de/pdfs/how_to_submit_a_tsx_proposal.pdf.

4.4.3 TerraSAR-X archive data

TerraSAR-X acquisitions (mostly StripMap) have been acquired and archived since 2008 over selected GEO-FCT and GFOI R&D Study Sites. Detailed search results from the 1Q 2008 to the 1Q 2015 are available at http://gfoi.org/RD. Newer Archive data can be searched via EOWEB: https://centaurus.caf.dlr.de:8443/eoweb-ng/template/default/welcome/entryPage.vm

Archive data access:

- Archived data older than 18 months at the time of ordering from the archive is provided free of charge on request through the AO for the utilization of the TerraSAR-X archive. Entry point is the TerraSAR-X Science Service System: http://sss.terrasar-x.dlr.de. For specific conditions, see http://sss.terrasar-x.dlr.de/pdfs/TSX-Archived-Data-2014-AO-1.0.pdf for archived data requests. It is strongly recommended to check the EOWEB catalogue https://centaurus.caf.dlr.de:8443/eoweb-ng/index2.html for data availability before submitting a proposal.
- Archived data newer than 18 months can be accessed using the AO for General Proposal Submission as described under 4.4.2

4.4.4 Upcoming TerraSAR-X AO's

A new AO for TerraSAR-x Like Products From Tandem-x Pursuit Monostatic Mode was released in April 2016.

4.4.5 TanDEM-X new acquisitions

New acquisitions: The TanDEM-X data acquisition plan will focus on High resolution DEM (HDEM) Demo products acquisitions until the end of 2016. The planning for 2017 is not yet finalised. A discussion forum for new requirements on the scientific data acquisition plan will be organised at the TerraSAR-X/TanDEM-X Science Workshop 17-20 October 2016.

Please note that acquisitions during the HDEM phase are not suitable in all cases:

a) For equatorial regions near and low latitudes the baselines is unsuitable, both ascending and descending

b) Medium and particularly high latitude of the Northern Hemisphere: descending orbits are useful with limitation

c) Medium and particularly high latitude Southern Hemisphere: ascending orbits are useful with limitation

In case b) or c) please contact the Tandem-X Science team tandemx-science@dlr.de before submitting a proposal

4.4.6 TanDEM-X archive data

The TanDEM-X science phase AO (Oct.2014 – Dec. 2015) is already closed. TanDEM-X bistatic and/or polarimetric acquisitions of the science phase may still be acquired on request for GFOI R&D teams and the COFUR costs may be waived for a reasonable amount of data. Please contact the DLR GFOI contact point for further details

The TanDEM-X DEM AO will be launched in Q3 2016. The AO will provide access to final TanDEM-X DEM data and to the Cost that were used for DEM production. There will be a quoted access for the data in the two highest posting classes (12m & 30m), the amount of data will be restricted. Currently, > 90% of the globe's surface is available, 100 % will be reached by 3Q 2016.

TanDEM-X acquisitions have been acquired and archived since 2011 over selected GEO-FCT and GFOI R&D Study sites. Over a few forest super sites a higher amount of data was acquired. The KML's of this super sites will be provided trough the GFOI website. Moreover detailed search results till end 2014 available at http://gfoi.org/RD. Newer archive data can be searched with the EOWEB NG tool:

https://centaurus.caf.dlr.de:8443/eoweb-ng/template/default/welcome/entryPage.vm

Data access procedure:

- A research proposal is required. The primary entry point is the TanDEM-X Science Service System: https://tandemx-science.dlr.de/. All science proposal submission details are included in https://tandemx-science.dlr.de/pdfs/TD-GS-UM-0115-TanDEM-X-Science-Service-System-Manual_V1.0.pdf.

4.4.7 Requests for TerraSAR-X data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 6	FCT-BOR3	Mawas, Borneo	Jan-Dec	2015-2017	Monthly
	FCT-SUM-2	Harapan, Sumatra	Jan-Dec	2015-2017	Monthly
Group 8	PNG-1	Kokoda, PNG	Jan-Dec	2015-2017	Monthly
	PNG-2	Milne bay, PNG	Jan-Dec	2015-2017	Monthly
Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	max
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	max
Group 11	AU-5	Injune, QLD, Australia	Jan-Dec	2015, 2017	Monthly
Group 14	KAL-1	Sebangu N.P. / xMRP	July - Nov	2012/2015	4 consecutive acquisitions
Group 16	SA-1	Lowveld / Kruger N.P.			Monthly
	SA-2	Eastern Cape			Monthly
	SA-3	KwaZulu-Natal			Monthly

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 8	PNG-1	Kokoda, PNG	Jan-Dec	2010-2011 2014	Monthly
	PNG-2	Milne bay, PNG	Jan-Dec	2010-2011 2014	Monthly

Table 4.5 GFOI R&D Study Sites requested for coverage by TerraSAR-X

4.4.8 Requests for TanDEM-X data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 8	PNG-2	Milne bay, PNG	Fixed timeframe	Fixed timeframe	Several interferometric obs.
Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	max
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	max
Group 11	AU-5	Injune, QLD, Australia	Fixed timeframe	2010, 2017	max
Group 12	CAN-1/2/3	NW Territories, Canada	June-Sept	Up to 2015	Once
Group 14	KAL-1	Sebangu N.P. / xMRP	July - Nov	2015	4 consecutive acquisitions

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 7	FCT-TNZ-5	Amani, Tanzania	Fixed timeframe	Fixed timeframe	
	FCT-TNZ-6	Liwale, Tanzania	Fixed timeframe	Fixed timeframe	
Group 8	PNG-2	Milne bay, PNG	Jan-Dec	2011	Several interferometric obs.

Table 4.6 GFOI R&D Study Sites requested for coverage by TanDEM-X.

4.5 ESA

Sensor	Agency	Contact point	Email	Access conditions	Archive and Data search tool
Sentinel-1A	ESA	Frank Martin Seifert	frank.martin.seifert@esa.int	Free and open	https://scihub.esa.int/
ENVISAT ASAR (archive)				One Category-1 proposals	http://earth.esa.int/EOLi/EOLi. Html

4.5.1 Sentinel-1A and Sentinel-2A

Sentinel-1A data in Interferometric Wide-Swath (IWS) mode will be acquired over GFOI R&D Study Sites. The Sentinel-1A observation scenario is available at

https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario/archive

When in full operations, Sentinel-2A will systematically acquire data over land and coastal areas in a band of latitude extending from 56° South to 83° North.

Data access procedure:

- The Sentinel Scientific Data Hub (http://scihub.esa.int) provides free and open access to a rolling archive of Sentinel-1 L0 and L1 products. The latest 2 months of data acquired over specific regions of interest are stored in the archive.
- Data can be downloaded via HTTP.

4.5.2 ENVISAT ASAR

ENVISAT operations were terminated on April 8, 2012. ENVISAT ASAR are provided free of charge by ESA.

ENVISAT ASAR wall-to-wall coverage has been acquired over Guyana, Brazil, Cameroon, Tanzania, Tasmania and additionally Sumatra, DC Congo, Peru and Colombia (from 2010 onwards) in 2009 to 2012. Data acquisitions can be viewed with the EOLi catalogue and ordering tool.

Data access procedure:

- Order preparation within EOLI-SA – download latest version at http://earth.esa.int/EOLi/EOLi.html and save as user set.
- Send processing order to Frank Martin Seifert (frank.martin.seifert@esa.int)
- L1 Processing by ESA

4.6 INPE

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
CBERS-4 CBERS-2B (archive)	INPE	TBC	TBC	Unrestricted use for data acquired by INPE	http://www.dgi.inpe.br/CDSR/

4.6.1 CBERS-4

CBERS-4 was launched in December 2014 with radiometric and geometric commissioning of all four instruments (PAN, MUX, IRS, WFI) commencing in November 2015. The MUX camera is operational (Feb 2016) while the PAN, IRS and WFI instruments are expected to be operational by July 2016.

Data collected during 2015 are archived, but currently no plans for processing.

CBERS-4 data acquired at INPE's ground stations are available open to the public free of charge at http://www.dgi.inpe.br/CDSR/

4.6.2 CBERS-4, CBERS 2B and Landsat TM

Data access procedure:

- INPE will process and distribute, free of charge, via its Image Data Catalogue (www.dgi.inpe.br/CDSR), all CBERS-2B CCD data available over GEO-FCT verification sites in Brazil and Guyana.
- INPE will process and distribute, free of charge, via its Image Data Catalogue (www.dgi.inpe.br/CDSR), all CBERS-2B CCD data available over GEO-FCT verification sites in Brazil and Guyana.
- Similarly, any requested Landsat TM data can be directly downloaded at no cost using the Catalogue.

4.7 JAXA

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
ALOS-2 PALSAR-2 & ALOS PALSAR (archive)	JAXA	Shizu Yabe / Ake Rosenqvist	yabe.shizu@jaxa.jp / ake.rosenqvist @soloEO.com	Special GFOI licence agreement	https://auig2.jaxa.jp/ips/home
				25m mosaic data: Free of charge	http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm
JERS-1 SAR (archive)	JAXA	Shizu Yabe / Ake Rosenqvist	yabe.shizu@jaxa.jp / ake.rosenqvist @soloEO.com	Free of charge	https://www.gportal.jaxa.jp

4.7.1 ALOS-2 PALSAR-2

New acquisitions: New acquisition requests for GFOI cannot be accommodated, however it is anticipated that the ALOS-2 Basic Observation Strategy (BOS), which is fully compliant with SDCG recommendations for L-band SAR will satisfy the requirements for GFOI R&D.

The ALOS-2 BOS plans for past and future acquisitions can be viewed HERE

Ortho-corrected PALSAR-2 mosaics from 2014/2015, and at 25 m pixel spacing, are available for free download at http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm

Data access procedure: Selected GFOI R&D groups can, after signing a dedicated GFOI licence agreement with JAXA, access data at https://auig2.jaxa.jp/ips/home

4.7.2 ALOS PALSAR

Archive data availability: ALOS PALSAR featured a global systematic acquisition strategy through which all land areas on Earth were acquired in stripmap 20 m (HH+HV) and 10 m (HH) mode 3-5 times per year between 2007 and 2011. Consistent time-series over all GFOI R&D sites are available.

Ortho-corrected PALSAR mosaics (2007-2010) at 25 m pixel spacing are available for free download at http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm

Data access procedure: Selected GFOI R&D groups can, after signing a dedicated GFOI licence agreement with JAXA, access data at https://auig2.jaxa.jp/ips/home

4.7.3 JERS-1 SAR

The 1992-1998 archive of JERS-1 data (SAR, VNIR, SWIR) is open to the public free of charge.

Data access procedure:

Data are available from JAXA's G-Portal www (https://www.gportal.jaxa.jp) as well as by direct download through Safe FTP (SFTP). Please refer to the User Manual (section 3) about generating a public key and direct download:

https://www.gportal.jaxa.jp/gportal_file/contents/help/UserManual_en.pdf

Ortho-corrected JERS-1 mosaic from mid-1990's, at 25 m pixel spacing, are available for free download at http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm

4.7.4 Requests for ALOS-2 (FBD) data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 2	MLW-1	Malawi	As available	2014-2018	4 times/year
	GAB-1	Gabon	As available	2014-2018	4 times/year
Group 4	ETH-1	Kafa Biosphere reserve, Ethiopia	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year
	PER-1	Province Satipo and Pasco, Peru	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year
	FIJ-1	Fiji archipelago	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year
Group 7	FCT-TNZ-5	Amani, Tanzania	June-Sept Jan	2016-2017	Monthly
	FCT-TNZ-6	Liwale, Tanzania	June-Sept Jan	2016-2017	Monthly
Group 8	PNG-1	Kokoda, PNG	Jan - Dec	2015-2017	Monthly
	PNG-2	Milne bay, PNG	Jan - Dec	2015-2017	Monthly
Group 9	FCT-MEX-2	Chiapas	Jan - Dec	2015-2016	Bi-monthly
	MEX-8	Durango	Jan - Dec	2014-2016	Bi-monthly
	FIN-1	Hyytiälä	Jan - Dec	2014-2016	Bi-monthly (or once/season)
	FIN-2	Sodankylä	Jan - Dec	2014-2016	Bi-monthly (or once/season)
	RUS-1	Pechora-Ilych	Jan - Dec	2015-2016	Monthly
Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	Monthly
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	Monthly
Group 11	AU-5	Injune, QLD, Australia	Jan - Dec	2015	Bi-monthly
Group 12	CAN-1	NW Territories, Canada	June-Sept	2014-2016	3 / summer
	CAN-2	NW Territories, Canada	June-Sept	2014-2016	3 / summer
	CAN-3	NW Territories, Canada	June-Sept	2014-2016	3 / summer
Group 13	BRA-2	Novo Progresso, Brazil	entire year	2014 - 2018	All 2/3 months
Group 16	SA-1	Lowveld / Kruger N.P.			Bi-monthly
	SA-2	Eastern Cape			Bi-monthly
	SA-3	KwaZulu-Natal			Bi-monthly
Group 17	DRC-1	Mai Ndombe district, DRC	June-Sept Jan	2016-2017	Monthly

Table 4.7a GFOI R&D Study Sites requested for coverage by ALOS-2 PALSAR-2.

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 15	SUR-1	Klaaskreek, Suriname	Jan - Dec	2015-2017	Once / year
	KAL-2	Malinau, Kalimantan	Jan - Dec	2015-2017	Once / year
	GHA-1	Kade, Ghana	Jan - Dec	2015-2017	Once / year

Table 4.7b GFOI R&D Study Sites requested for coverage by ALOS-2 PALSAR-2.

4.8 USGS

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
Landsat 7 & 8	USGS	Eugene Fosnight	Fosnight @usgs.gov	Unrestricted use	http://earthexplorer.usgs.gov

4.8.1 Landsat TM/ETM+/OLI

All Landsat data archived by the US Geological Survey (USGS) is accessible, free of charge to users. The Landsat-8 Long Term Acquisition Plan (LTAP was in December 2014 modified to acquire all descending day-lit land images between 58° N and S latitude. At higher latitudes with more than 50% side lap, the priority is decreased in proportion to the amount of overlap between paths to maintain a 16-day or better revisit period.

Landsat-7 continues to operate within the continental landmass model. Ninety percent of the opportunities are acquired with Landsat-7. No daily limits are set for Landsat-7. All images rejections are due to instrument duty cycle and onboard memory constraints. Investigations are ongoing to reduce these constraints.

New acquisitions: Both missions support special requests that can be used to improve the probability of acquisitions in support of coordinated field measurements. Special requests are more critical to Landsat-7 acquisitions than for Landsat-8 acquisitions.

Archive data availability: The Landsat archive can be accessed through the USGS Global Visualization Viewer (GloVis) at http://glovis.usgs.gov/

Data access procedure:

- Research teams can be directly download Landsat data using Earth Explorer or GloVis. Data are available without restriction, at no cost to users.

4.8.2 Research Announcements

- USGS funds the Landsat Science Term co-chaired by USGS and NASA (landsat.usgs.gov/science_Landsat_Science_Team.php). The current team is funded through 2017. In 2017, a request for proposals for the next Landsat Science Team will be announced.
- NASA publishes open solicitations for Earth Science Data Systems (http://science.nasa.gov/earth-science/earth-science-data/open-solicitations-earth-science-data-systems/)

4.9 Commercial Data providers

4.9.1 Airbus Defence & Space

Sensor	Agency	Contact point(s)	Email	Access conditions	Archive and Data search tool
SPOT 6/7	Airbus D&S	Patrick Houdry	Patrick.Houdry@astrium.eads.net	Special GFOI	

Following a Commercial Provider information session organised in conjunction with SDCG-8 (Sept 2015), ADS have analysed the list of GFOI R&D projects that have requested VHR data, and are ready to support a selection of them with SPOT6/7 HR imagery. More information to be provided.

4.9.2 Requests for VHR data

MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Group	Site code	Location	Time window	Required duration	(Minimum) observation frequency
Group 2	MLW-1	Malawi	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly
	GAB-1	Gabon	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly
Group 4	ETH-1	Ethiopia	Jan-Dec	2016-2018	1 scene
	PER-1	Peru	Jan-Dec	2016-2018	1 scene
	FIJ-1	Lololo & Nakavu	Jan-Dec	2016-2018	1 scene
Group 5	GFC-1	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
	GFC-2	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
	GFC-3	Guyana	Jan-Dec	Aug2016-Aug2017	Monthly
Group 6	FCT-BOR-3	Mawas	Jan-Dec	Apr2016-Mar2017	Monthly
	FCT-SUM-2	Harapan	Jan-Dec	Apr2016-Mar2017	Monthly
Group 7	FCT-TNZ-5	Amani, Tanzania	June-Sept, Jan-Feb	2016-2017	Monthly
	FCT-TNZ-6	Liwale, Tanzania	June-Sept, Jan-Feb	2016-2017	Monthly
Group 8	PNG-1	Kokoda, PNG	Jan-Dec	2015-2017	Monthly
	PNG-2	Milne bay, PNG	Jan-Dec	2015-2017	Monthly
Group 9	FCT-MEX-2	Chiapas, Mexico	Jan-Dec	2007, 2010 , 2013, 2015	Monthly
	MEX-8	Durango, Mexico	June 15 - Aug 31	2010 , 2014, 2015	Monthly
	FIN-1	Hyytiälä, Finland	Jan-Dec	2007, 2010, 2013 2015, 2016	Monthly
	FIN-2	Sodankylä, Finland	Jan-Dec	2007, 2010, 2013 2015, 2016	Monthly

Group 10	AU-4	Robson Creek, QLD, Australia	Apr-Dec	2015-2016	Monthly
	AU-3	Warra, Tasmania, Australia	Apr-Dec	2015-2016	Monthly
Group 11	AU-5	Injune, QLD, Australia	Jan-Dec	2010 2017	Monthly
Group 13	BRA-2	Novo Progresso, Brazil	entire year	2014 - 2018	weekly
Group 15	SUR-1	Klaaskreek, Suriname	Jan - Dec	2015-2017	2 times / year
	KAL-2	Malinau, Kalimantan	Jan - Dec	2015-2017	2 times / year
	GHA-1	Kade, Ghana	Jan - Dec	2015-2017	2 times / year
Group 17	DRC-1	Mai Ndombe district, DRC	June-Sept Jan-Feb	2016-2017	Monthly
Group 18	MEX-4	Campeche, Mexico	Whole year	2015-2018	Once/year
	MEX-5	Marques de Comilias, Mexico	Whole year	2015-2018	Once/year
	MEX-6	Hiladgo, Mexico	Whole year	2015-2018	Once/year
	SA-4	Skukuza/KNP, South Africa	Whole year	2015-2018	Once/year

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Group	Sites	Location	Time window	Required duration	(Minimum) observation frequency
Group 1	BRA-1	Mato Grosso, Brazil	June-Oct	2016-2017	1 scene
Group 3	FCT-COL-3	Pacifico-Bajo-Mira, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-4	Amazonia-Tinigua, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-5	Andes-Antioquia, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-6	Cacueta, Colombia	Since launch	Cloud free	Once a year
	FCT-COL-7	La Victoria, Colombia	Since launch	Cloud free	Once a year

Table 4.8 GFOI R&D Study Sites requested for coverage by VHR data (same as CNES table 4.2)

SDCG Element-3

Annex A

GFOI research partners, Study Sites and R&D topics

Research group	Site Code	Site name	Country	Coordinates	
				lat	long
Group 1	BRA-1	Mato Grosso	Brazil	S11.75	W54.25
Group 2	MLW-1	Mulanje	Malawi	S15.911	E35.640
	GAB-1	Gabon	Gabon	S1.018	E10.729
Group 3	FCT-COL-3	Pacifico-Bajo_Mira	Colombia	N1.65	W78.76
	FCT-COL-4	Amazonia-Tinigua		N2.17	W74.15
	FCT-COL-5	Andes-Antioquia		N7.83	W76.45
	COL-6	Caqueta		N1.4079	W73.5747
	COL-7	La Victoria		N6.26	W74.64
Group 4	ETH-1	Kafa BR	Ethiopia	N7.3	E35.6
	FIJ-1	Lololo & Nakavu	Fiji	S17.3	E177.4
	PER-1	Peru	Peru	S11.1	W74.3
Group 5	GFC-1	GFC Site 1 (FCT)	Guyana	N3.3069	W59.6672
	GFC-2	GFC Site 2′		N5.2671	W59.1066
Group 6	FCT-BOR-3	Mawas	Indonesia	S2.24	E114.48
	FCT-SUM-2	Harapan		S2.20	E103.38
Group 7	FCT-TNZ-5	Amani	Tanzania	S5.13	E38.63
	FCT-TNZ-6	Liwale		S9.50	E38.17
Group 8	PNG-1	Kokoda	Papua New Guinea	S9.184	E147.374
	PNG-2	Milne bay		S10.598	E150.185
Group 9	FCT-MEX-2	Chiapas-1	Mexico	N16.45	W91.40
	MEX-3	Durango		N23.74	W105.49
	FIN-1	Hyytiälä	Finland	N61.85	E24.32
	FIN-2	Sodankylä		N67.48	E26.34
Group 10	AU-4	Robson Creek (QLD)	Australia	S17.119	E145.631
	FCT-AU-3	Warra (Tasmania)		S43.1046	E146.656
Group 11	AU-5	Injune (QLD)	Australia	S25.5	147.7
Group 12	CAN-1	Site 1 NW Territories	Canada	N61.4	W121.3
	CAN-2	Site 2 NW Territories		N62.0	W116.50
	CAN-3	Site 3 NW Territories		N61.52	W120.35
Group 13	BRA-2	Novo Progresso	Brazil	S7°02′4.07″	W55°24′1.82″
Group 14	KAL-1	Central Kalimantan	Indonesia	S2°24′	E114°6′30″
	SUM-1	South Sumatra		S2°29′30″	E103°28′30″
Group 15	SUR-1	Klaaskreek	Suriname	N5°12′12.70″	W54°57′4.40″
	KAL-2	Malinau	Indonesia	N3°1′57.23″	E116°36′5.45″
	MAD-1	Kade	Ghana	N6°11′41.14″	W0°56′21.90″
Group 16	SA-1	Lowveld / Kruger N.P.	South Africa	S24°47′	E31°26′
	SA-2	Eastern Cape		S32°50′	E26°06′
	SA-3	KwaZulu-Natal		S28° 19'	E32° 00'
Group 17	DRC-1	Mai Ndombe district	D.R. Congo	S2.70	E18.50
Group 18	MEX-4	Campeche/Kulic	Mexico	N20.3	W90.1
	MEX-5	Marques de Comillas		N16.3	W90.9
	Mex-6	Hidalgo		N20.6	W98.59
	SA-4	Skukuza / Kruger N.P.	South Africa	S25.2	W31.5

Table A.1 – GFOI R&D Study Sites

ESTIMATING FOREST DEGRADATION IN THE BRAZILIAN AMAZON DUE TO SELECTIVE LOGGING AND FOREST FIRES

GFOI PRIORITY R&D TOPIC(S):
• Forest degradation assessment due to selective logging and forest fires
• SAR/Optical interoperability and complementarity studies

RESEARCH OBJECTIVES:
Develop and apply a semi-automated procedure based on fraction images from multi-temporal data for mapping and differentiating forest degradation caused by selective logging and fires.

OUTCOMES:
1. Algorithm for mapping and characterising forest degraded areas in tropical forest ecosystem by optical data. Report describing the methodology, performance, validation process, and next steps
towards operationalisation.
2. Algorithm for mapping and characterising forest degraded areas in tropical forest ecosystem by optical and SAR data synergy. Report describing the methodology, performance, validation process, and next steps towards operationalisation.

TIME SCHEDULE:
• Progress presentation at GFOI Science meeting [Oct 2016]
• Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
• Progress presentation at 2017 GFOI Science meeting [Q4 2017]
• Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
• Submission to peer-reviewed journal [Mar. 2018]

Group 1

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Project support organisation/programme:
INPE

Project duration:
01/01/2015 – 30/06/2018

Organisation www:
http://www.inpe.br/ingles/

STUDY SITES:
Mato Grosso, Brazil (BRA-1)
Site description: The study area is a subset of a Landsat scene (path/row 226/068) located in the State of Mato Grosso, within the 'Deforestation Arc' of the Brazilian Amazon. This region is showing high deforestation rates since the late 1980s, combined with intense forest degradation activities due to fire and selective logging.
In situ data: Not available.
Centre coord.: S11.75° / W54.25°
Site spatial footprint: 70x60 km^2
ROI: [*BRA-1.kml*]
ROI for VHR sensors: [*BRA-1_VHR.kml*]

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
VHR	GSD < 5m	June-October	2016-2017	Once/year	New	For validation.
RADARSAT-2	Full polarimetric	June-October	2016-2017	Once/year	New	Complementary to Sentinel-1 and ALOS PALSAR.

OTHER DATASETS USED
- Landsat, SPOT
- ALOS PALSAR, Sentinel-1

MAPPING FOREST DISTURBANCE IN DENSE HUMID AND DRY FOREST LANDSCAPES

GFOI PRIORITY R&D TOPIC(S) ADRESSED:
• **Forest degradation** from selective logging, subsistence agriculture and fire
• **Forest type mapping** including humid and dry forest
• **SAR/optical integration** studies

RESEARCH OBJECTIVES:
1. Methodology development for mapping forest types and characterising forest disturbance in complex landscapes (MAL-1).
2. Investigation of near real-time forest disturbance monitoring based on the integration of optical and SAR data streams (GAB-1)

OUTCOMES:
1. Algorithm and processing chain for mapping forest types and disturbance in complex landscape
2. Algorithm for near-real time forest disturbance monitoring based on SAR/optical data synergy

TIME SCHEDULE:
• Progress presentation at GFOI Science meeting [Oct 2016]
• Progress presentation at 2017 GFOI Science meeting [Q4 2017]
• Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
• Submission to peer-reviewed journal [Sep. 2018]

Group 2

Principal Investigator:
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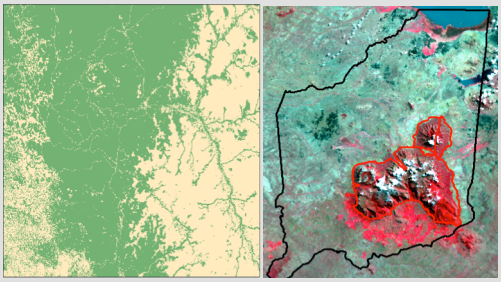
Co-investigators:
GAF AG, JR, CESBIO

Project funding organisation/programme:
H2020 EOMonDis
(previously: FP7 REDDAF and ESA GSE FM REDD Extension project)

Project duration:
1 April 2016 31 March 2019

Organisation www:
http://www.sirs-fr.com/en

Project www (if any):
https://www.eomondis.info/



STUDY SITES:
Mulanje, Malawi (MLW-1)
Site descr.: Biosphere reserve with diverse ecosystem from Miombo woodland to dense humid endemic Mulanje montane forestt with intense human activity.
In situ data.: VHR data, field visits with ground photos located around the Mulanje Mountain conservation area with long-term forest monitoring data.
Centre coord.: S15,911° / E35.640°
Site spatial footprint: 5,000 km^2
ROI: [*MLW-1.kmz*]
ROI for VHR sensors: [*MLW-1_VHR.kmz*]

SITE NAME, Gabon (GAB-1)
Site descr.: Intense degradation and deforestation caused by the establishment of oil palm plantation.
In situ data.: VHR data.
Centre coord.: S1.018° / E10.729°
Site spatial footprint: 35,000 km^2
ROI: [*GAB-1.kmz*]
ROI for VHR sensors: [*GAB-1_VHR.kmz*]

MLW-1
MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
VHR (SPOT-6/7 OR Pleiades)	GSD < 3m	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly	New	VHR key dataset for validation. Required for assessment for Objective 1
ALOS-2 PALSAR-2	Stripmap Fine Beam Dual-pol (10m)	As available	2014-2018	4 times/year	ALOS-2 BOS archive	Key L-band dataset. Sensor synergy assessment not possible

OTHER DATASETS USED – MAL-1
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat, Sentinel 2A, SPOT5
- Sentinel 1A & B,

GAB-1
MINIMUM REQUIRED[1] DATASETS ([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
VHR (SPOT-6/7 OR Pleiades)	GSD < 3m	Jun – Oct & Nov-April	Jun 2016 - Sep 2018	Twice yearly	New	VHR key dataset for validation. Required for assessment for Objective 2
ALOS-2 PALSAR-2	Stripmap Fine Beam Dual-pol (10m)	As available	2014-2018	4 times/year	ALOS-2 BOS archive	Key L-band dataset. Sensor synergy assessment not possible

OTHER DATASETS USED – GAB-1
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat, RapidEye, SPOT
- Sentinel 1A & B,

TIME SERIES-BASED MONITORING OF IPCC LAND CATEGORY CONVERSIONS USING MULTI-SENSOR DATA

GFOI PRIORITY R&D TOPIC(S) ADRESSED:
1. Time-series **SAR/Optical** data for monitoring **forest and land cover change**
2. Time-series **SAR/Optical** methods development for monitoring **degradation**
3. **Optical-optical interoperability**: use of SPOT and Sentinel-2 data to fill gaps in Landsat monitoring
4. **SAR-SAR complementarity**: use Sentinel-1 to complement ALOS-1/2 L-band time series

RESEARCH OBJECTIVES:
1. Time series-based monitoring of IPCC land category conversions using data from multiple sensors. More specifically, we investigate the aspects of time-series fusion of optical (Landsat/Spot/Sentinel-2) and SAR (ALOS ½, Sentinel-1) data for monitoring of forest disturbance and recovery.

OUTCOMES:
1. Refined Alogirthim for SAR/Optical time-series analysis of land cover change (disturbance and regrowth, conversion)
2. Assessment of data needs and acquisition strategies
3. Assessment of uncertainties

TIME SCHEDULE:
• Phase1: Compilation of time-series data
• Phase 2: Compilation of relevant reference data
• Phase 3: Development and Applicaion of joint SAR/optical change detection algorithms
• Phase 4: Assessment of relative merits of SAR/SAR. Optical/optical and SAR/optical combinatios

STUDY SITES:
Colombia: Pacifico-Bajo-Mira (FCT-COL-3), Amazonia-Tinigua (FCT-COL-4), Andes-Antioquia (FCT-COL-5), La Victoria (COL-7)
Site description.: Tropical/Sub-Tropical rainforest.
In situ data.: Partly available.
Centre coord.:
N1.65° / W78.76° (FCT-COL-3)
N2.17° / W74.15° (FCT-COL-4)
N7.83° / W76.45° (FCT-COL-5)
N6.26° / W74.64° (FCT-COL-7)
Site spatial footprints: 2,500 km^2
ROI: COL-3.kml, COL-4.kml, COL-5.kml, COL-7_VHR.kml
ROI for VHR sensors: COL-7_VHR.kml (5x5 km2). Other sites not yet decided

Caqueta, Colombia (COL-6)
Site descr.: Tropical rainforest, deforestation hotspot.
In situ data.: Not available.
Centre coord.: N1.4079° / W73.5747°
Site spatial footprint: 2,500 km^2
ROI: COL-6.kml
ROI for VHR sensors: Not yet decided

GFOI R&D Group 3

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Project funding organisation/programme:
NASA CMS grant, NASA NISAR Science Definition Team grant

Project duration:
01-06-2016-31/5/2019

Organisation www:
http://www.earthbigdata.com/
http://www.bu.edu

COMPLEMENTARY[2] DATASETS ([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
SPOT5(Take5)		All in Archive	Since 2006		Archive	Complement analysis of time series observations
SPOT 1-5		All in Archive	Since 2006		Archive	Complement analysis of time series observations
Pleiades/ Spot-6/7	VHR	Since launch	Cloud free	Once a year	New	La Victoria site – see COL-6_VHR.kml

OTHER DATASETS USED

(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat, Sentinel-2
- ALOS-1/2 PALSAR-1/2, Sentinel-1

COMBINING SAR AND OPTICAL TIME SERIES WITH COMMUNITY BASED ACTIVITY DATA FOR MONITORING TROPICAL FOREST CHANGES

GFOI PRIORITY R&D TOPIC(S):

- Deforestation and degradation monitoring
- SAR/optical integration
- Sensor interoperability
- Community based forest monitoring

RESEARCH OBJECTIVES:

1. Exploit the potential of Sentinel-1 for near-real time forest disturbance monitoring.
2. Expand and improve recently developed SAR-optical time series fusion methods (Reiche et al., 2015a/b) to combine C-band SAR, L-band SAR and optical time series.
3. Exploit synergies between optical & SAR time series and community based activity data (collected through mobile phone technologies) to monitor forest disturbances (in near real-time).

Methods will be developed and tested for three different (and representative) tropical forest environments in order to improve their robustness and applicability.

- PER-1: Evergreen tropical forest with large area changes due to agricultural expansion.
- ETH-1: Seasonal Afromontane forest with small area changes due to smallholder agriculture, fuelwood harvesting.
- FIJ-1: Managed pine plantation with large and well documented changes; regularly affected by landslides.

OUTCOMES:

1. Time series based approach (e.g. adapted version of BFAST) to utilize Sentinel-1 data for near-real time forest disturbance monitoring.
2. Expanded SAR-optical time series fusion approaches of Reiche et al., 2015a/b that allow the integration of multiple time series (e.g. PALSAR-1/2, Sentinel-1 and Landsat).
3. Novel fusion approach to integrate remote sensing time series (SAR and optical) with community-based activity data.

Results of all outcomes to be presented at the annual GFOI R&D science meetings and will potentially be the object of peer reviewed papers.

TIME SCHEDULE:

- Progress presentation at GFOI Science meeting [Oct 2016]
- Outcome 1 and preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Submission to peer-reviewed journal, outcome 1 [June 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1, 2 and 3 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journals, outcome 2 and 3 [June 2018]

Group 4

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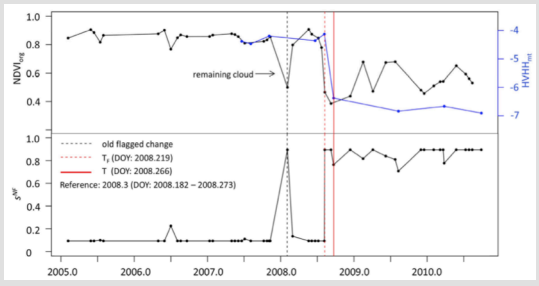
Project support organisation/programme:
Horizon 2020 (BACI); NABU

Project duration:
2016/04/01 – 2018/12/31

Organisation www:
Wageningen University

Project www:
http://baci-h2020.eu/index.php/



STUDY SITES:

UNESCO Kafa Biosphere Reserve, Ethiopia (ETH-1)
Site description: Some of Ethiopia's last remaining Afromontane forests. Deforestation and degradation driven by smallholder agriculture, fuelwood harvesting, highly fragmented forests.
In situ data: Field visits with ground photos, VHR and biodiversity data. Community-based data related to forest change collected by forest rangers with smart phones (since 2011 continuously ongoing; both in situ and input data).
Centre coord.: N7.3 / E35.6
Site spatial footprint: 7000 km²
ROI: ETH-1.kmz
ROI for VHR sensors: ETH-1.kmz

Province Satipo and Pasco, Peru (PER-1)
Site description: The community of Puerto Ocopa is located in the Province of Satipo, Peru. The communities of Loma Linda and San Pedro De Pichanaz are located in the Province of Pasco, Peru. For these provinces, community-based data is already collected at a regular basis (see in situ data below). More communities will be added and monitored within the next years. Deforestation driven by mainly agricultural expansion causing large area changes.
In situ data: Field visits with ground photos. Community-based data related to forest change collected by forest rangers with smart phones (since 2015 continuously ongoing; both in situ and input data).
Centre coord.: S11.1 W74.3
Site spatial footprint: 300 km^2
ROI: PER-1 LomaLinda.kmz, PER-1 PuertoOcopa.kmz, PER-1 SanPedroDePichanaz.kmz
ROI for VHR sensors: PER-1 LomaLinda.kmz, PER-1 PuertoOcopa.kmz, PER-1 SanPedroDePichanaz.kmz

Fiji archipelago (FIJ-1)
Site description: Managed Fiji Pine plantations (Lololo) and its surrounding areas, Viti Levu, Fiji.
In situ data: Field visits with ground photos, VHR-based map, detailed forest harvesting and replantation information.
Centre coord.: S17.3 / E177.4
Site spatial footprint: 1200 km^2
ROI: FIJ-1.kmz
ROI for VHR sensors: FIJ-1.kmz

MINIMUM REQUIRED[1] DATASETS – Site ETH-1
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive OR New	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	Stripmap Fine Beam Dual-pol (20m)	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year	New	Required for Objective 2 and 3. Without new L-band data, it won't be possible to further develop the SAR/optical fusion methods in a way to combine C-band SAR, L-band SAR and optical time series.
ALOS PALSAR	Stripmap Fine Beam Dual-pol (20m)	Jan - Dec	2007-2011	All archived FBD scenes	Archived	Required for Objective 2 and 3. The archived PALSAR data is crucial to understand the historical time series that is continued with PALSAR-2 data. Without the archived PALSAR data it will be difficult to further develop the SAR/optical fusion methods, because the PALSAR-2 time series will be too short (since 2015) to derive sufficient information regarding long term seasonal patterns.
VHR		Jan - Dec	2016-2018			For validation.

OTHER DATASETS USED – Site ETH-1 (Not requested here)
- Sentinel-1A (dual-pol VV/VH)

MINIMUM REQUIRED[1] DATASETS – Site PER-1
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	Stripmap Fine Beam Dual-pol (20m)	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year	New	Required for Objective 2 and 3. Without new L-band data, it won't be possible to further develop the SAR/optical fusion methods in a way to combine C-band SAR, L-band SAR and optical time series.
ALOS PALSAR	Stripmap Fine Beam Dual-pol (20m)	Jan - Dec	2007-2011	All archived FBD scenes	Archived	Required for Objective 2 and 3. The archived PALSAR data is crucial to understand the historical time series that is continued with PALSAR-2 data. Without the archived PALSAR data it will be difficult to further develop the SAR/optical fusion methods, because the PALSAR-2 time series will be too short (since 2015) to derive sufficient information regarding long term seasonal patterns.
VHR		Jan - Dec	2016-2018			For validation.

OTHER DATASETS USED – Site PER-1
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (dual-pol VV/VH)

MINIMUM REQUIRED[1] DATASETS – Site FJI-1
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	Stripmap Fine Beam Dual-pol (20m)	Jan - Dec	2016-2018	As frequent as possible, but at least 3-5 obs./year	New	Required for Objective 2. Without new L-band data, it won't be possible to further develop the SAR/optical fusion methods in a way to combine C-band SAR, L-band SAR and optical time series.
VHR		Jan - Dec	2016-2018			For validation.

OTHER DATASETS USED – Site FIJ-1
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (dual-pol VV/VH)

ADVANCING THE NATIONAL MRV SYSTEM OF GUYANA TO INCLUDE ELEMENTS OF FOREST DEGRADATION

GFOI PRIORITY R&D TOPIC(S) ADRESSED:

1. Methods of detecting and monitoring **forest degradation** arising from mining and shifting agriculture/rotational farming
2. **SAR/Optical interoperability and complementarity** studies

RESEARCH OBJECTIVES:

1. To advance Guyana's national MRV System to include crucial elements of forest degradation monitoring, specifically in the areas of monitoring small scale mining and shifting agriculture
2. Use of VHR data for Cal/Val of products

OUTCOMES:

1. Develop a methodology for more systematic assessment of small-scale degradation activities through the integration of optical and SAR datasets.
2. Study outcomes and recommendations for linking the findings into the National MRV

TIME SCHEDULE:

- Progress report / slides for GFOI / CEOS and SDCG Feb 2017
- Progress report / slides for GFOI meeting (2017)
- Final results provided July 2018

STUDY SITES:

Guyana Forest Commission study sites (GFC-1, & GFC-2')
Site description: Since 2012, Guyana has routinely mapped degradation (>0.25 ha) surrounding all deforestation sites >1 ha and also in 2014 across areas of shifting cultivation >0.25 ha. National coverage of RapidEye imagery is used for detection and monitoring.
In situ data: GFC ground observations for degradation and deforestation. Validation using 0.25 – 0.60 m CIR airborne photography. The detection methods and literature consulted and accuracy of the results are published on the GFC's website at http://www.forestry.gov.gy/publications.html
Centre coord.:
N3.3069° / W-59.6672° (GFC-1)
N5.2671° / W-59.1066° (GFC-2') (shifted soutth from original FCT-GFC-2 location)
Site spatial footprint: 900km^2
ROI: *GFC-1.kmz, GFC-2.kmz*
ROI for VHR sensors: *GFC-1.kmz, GFC-2.kmz*

Group 5

Principal Investigator:
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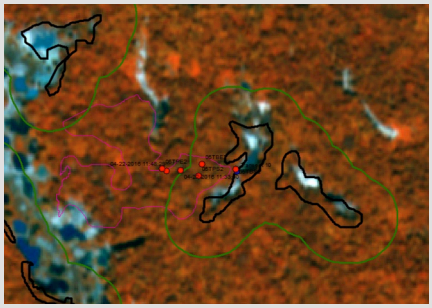
Project support organisation/programme:
Guyana Forestry Commission

Project duration:
2016-08-01 – 2018-06-30

Organisation www:
http://www.forestry.gov.gy/
http://www.indufor-ap.com/

Project www:
GFC & Indufor National Forest Change Mapping and Accuracy Assessments:

- http://www.forestry.gov.gy/Downloads/MRVS_Interim_Measures_Report%20_Year_4_Version_1.pdf
- http://www.forestry.gov.gy/Downloads/MRVS_Interim_Measures_Report_Year_3_Version_3.pdf
- http://www.forestry.gov.gy/Downloads/Guyana_MRVS_Interim_Measures_Report%20_Year_2_Version_3.pdf



MINIMUM REQUIRED[1] DATASETS – GFC-1 (FCT) & GFC-2'
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
COSMO- SkyMed	3m VV	Jan - Dec	Aug 2016 Aug 2017	Monthly	New	Monitoring temporal change
VHR SPOT- 6/7 or Pleiades	GSD <3 m	Jan - Dec	Aug 2016 Aug 2017	Monthly	New	Monitoring temporal change

OTHER DATASETS USED (Not requested here)

- Sentinel A and B, Landsat-8, RapidEye, VHR airborne

MONITORING FOREST DISTURBANCE IN DRYLAND DIPTEROCARP AND PEAT SWAMP FOREST

GFOI PRIORITY R&D TOPIC(S) ADRESSED:
• **Forest degradation** by X-band SAR
• **Sensor synergy** - SAR- and LiDAR-based methods of forest and carbon accounting
• **Above ground biomass**

RESEARCH OBJECTIVES:
Mawas, Kalimantan –
1. Forest degradation, sensor interoperability, above-ground biomass. Study of dense time-series of Sentinel-1 and TerraSAR-X/ COSMO-SkyMed data to monitor degradation processes (related to fire damage, encroachment and illegal logging).
2. Study of improved land cover mapping capability of bi-static TanDEM-X data and utility for improved biomass mapping.
3. Peat swamp hydrology.

Harapan, Sumatra –
4. Forest degradation, sensor interoperability. Study of dense time-series of Sentinel-1 and TerraSAR-X for near-real time highly automated degradation and logging detection.

OUTCOMES:
1. Methodology for mapping legal and illegal selective logging of individual trees and forest degradation using TerraSAR-X and COSMO-SkyMed
2. Near real time monitoring capability at local level (hot spots) using TerraSAR-X and at landscape level using Sentinel-1.
3. Peer reviewed papers

Group 6

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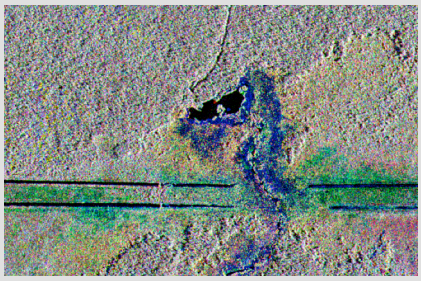
Co-investigators:
N/A

Project funding organisation/programme:
xxx

Project duration:
2010/10/01 2018/06/30

Organisation www:
http://www.wageningenur.nl/en.htm

Project www (if any):
xxx



TIME SCHEDULE:
• Progress presentation at GFOI Science meeting [Oct 2016]
• Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb 2017]
• Progress presentation at 2017 GFOI Science meeting [Q4 2017]
• Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb 2018]
• Submission to peer-reviewed journals [Jun 2016; Mar 2018]

STUDY SITES:
Mawas/Kalimantan, Indonesia (FCT-BOR-3)
Site description: Sites dominated by tropical peat swamp forest types. Former GEO-FCT ND site.
In situ data.: Field data (17 new biomass plots, 2013&2014), aerial photography (2011 and 2014), LiDAR transects (2014).
Centre coord.: S2.24° / E114.48°
Site spatial footprint: 1,000 km^2
ROI: *BOR-3.kml*
ROI for VHR sensors: *BOR-3_VHR.kml*

Harapan/Sumatra, Indonesia (FCT-SUM-2)
Site description: Dryland primary and secondary Dipterocarp forest. Former GEO-FCT ND site.
In situ data.: Field survey reports at regular basis on position and nature of on-going degradation processes.
Centre coord.: S2.20° / E103.38°
Site spatial footprint: 1,000 km^2
ROI: *SUM-2.kml*
ROI for VHR sensors: *SUM-2_VHR.kml*

MINIMUM REQUIRED[1] DATASETS – FCT-BOR-3
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
COSMO-SkyMed	HIMAGE 3m	2015-2017	Apr2016-2017	Monthly	New	Required for objective 1
TerraSAR-X	StripMap 3m	2015-2017	2015-2017	Monthly	Archived	Required for objective 1
VHR (SPOT-6/7 OR Pleiades)	GSD < 3m	2015-2017	Apr2016 – Mar2017	Monthly	New	Required for validation
Sentinel-1	IW VV/VH	2015-2017	2015-2017	Monthly	Archived	Required for objective 1

COMPLEMENTARY[2] DATASETS – FCT-BOR-3 ([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
SPOT5(Take5)	N/A	2015 campaign	2015	All available during campaign	Archive	Complementary to VHR data.

OTHER DATASETS USED – FCT-BOR-3
(Not requested here, e.g. public open data, datasets obtained through other sources)

- LIDAR
- ALOS PALSAR, Sentinel-1

MINIMUM REQUIRED[1] DATASETS – FCT-SUM-2
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
COSMO-SkyMed	HIMAGE 3m	2015-2017	Apr2016-2017	Monthly	New	Required for objective 4
TerraSAR-X	StripMap 3m	2015-2017	2015-2017	Monthly	Archived	Required for objective 1
VHR (SPOT-6/7 OR Pleiades)	GSD < 3m	2015-2017	Apr2016 – Mar2017	Monthly	New	Required for validation
Sentinel-1	IW VV/VH	2015-2018		Monthly		Required for objective 4

COMPLEMENTARY[2] DATASETS – FCT-SUM-2 ([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
SPOT5(Take5)	N/A	2015 campaign	2015	All available during campaign	Archive	Complementary to VHR data.

OTHER DATASETS USED – FCT-SUM-2
(Not requested here, e.g. public open data, datasets obtained through other sources)

- LIDAR
- ALOS PALSAR, Sentinel-2

MONITORING FOREST COVER CHANGE AND CARBON DYNAMICS IN SAVANNAH AND TROPICAL RAINFOREST

GFOI PRIORITY R&D TOPIC(S):

- **Forest aboveground biomass and change estimation**
- **Sensor interoperability/complementarity between optical, C- and L-band SAR**
- **Optimising information extraction using dense time-series C-band SAR for forest monitoring**

RESEARCH OBJECTIVES:

1. Develop methodology for change detection in heterogeneous remote sensing images of forest and other natural environments (i.e., combining different satellite sensors and sensor modes) with the prospect of extending the time series available for change analysis and increasing the temporal resolution of the analysis.
2. Develop methodology for robust and consistent retrieval of biophysical parameters such as aboveground biomass in order to improve the precision of regression analysis with heterogeneous remote sensing data sets as predictor variables (i.e., with satellite data that are recorded under different environmental conditions or with different sensors and sensor modes).

Group 7

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Project duration:
2016-2021

Project funding organisations:
Research Council of Norway 2016–2019
The Arctic University of Norway 2016-2021

OUTCOMES:

1. Algorithms for change detection in heterogeneous remote sensing images. Demonstration of change analysis on repository of forest remote sensing data from Tanzania. Work performed through PhD position funded by the Research Council of Norway from August 2016 – July 2019.
2. Algorithms for robust estimation of biophysical parameters with heterogeneous predictor variables. Demonstration of aboveground biomass estimation and biomass change estimation on repository of forest remote sensing data from Tanzania. Work performed through PhD position funded by UiT The Arctic University of Norway from January 2017 to December 2021.

TIME SCHEDULE:

- Progress presentation at GFOI Science meeting [Nov 2016]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 report to GFOI and CEOS/SDCG [Q1 2018]
- Progress presentation at 2018 GFOI Science meeting [Q4 2018]
- Outcome 1 and 2 report to GFOI and CEOS/SDCG [Q1 2019]
- Progress presentation at 2019 GFOI Science meeting [Q4 2019]
- Outcome 1 final report to GFOI and CEOS/SDCG [Q4 2019]
- Outcome 2 report to GFOI and CEOS/SDCG [Q1 2020]
- Progress presentation at 2020 GFOI Science meeting [Q4 2020]
- Outcome 2 report to GFOI and CEOS/SDGG [Q1 2021]
- Progress presentation at 2021 GFOI Science meeting [Q4 2021]
- Outcome 2 final report to GFOI and CEOS/SDGG [Q4 2021]
- Submission to peer-reviewed journal [2017-2022]

STUDY SITES:

Amani (FCT-TNZ-5)
Site description: Eastern Arc Mountains in NE Tanzania. A global biodiversity hotspot. Characterized by very steep slopes and dense tropical rainforest with an extreme biomass density (max. 1200 t/ha). Large areas of untouched natural forests.
In situ data: Forest inventory plots (180), land cover and vegetation data, destructive harvesting
Centre coord.: S5.13 / E38.63
Site spatial footprint: 80 km^2
ROI: FCT-TNZ-5-Amani.kml
ROI for VHR sensor:

Liwale, Tanzania (FCT-TNZ-6)
Site description: SE Tanzania. Some farmland but mostly Mimbo woodlands, with biomass densities around 50-100 t/ha (max 250 t/ha). Area subject to rapid land conversion and deforestation. Some protected forests (game reserve).
In situ data: Forest inventory plots (613), land cover and vegetation data, destructive harvesting
Centre coord.: S9.50 / E38.17
Site spatial footprint: 1,500 km^2
ROI: FCT-TNZ-6-Liwale.kml
ROI for VHR sensor:

MINIMUM REQUIRED1 DATASETS – Sites FCT-TNZ-5 and FCT-TNZ-6
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD PLR (if avail.)	June-Sept Jan	2016-2019	Annual coverage of complete ROI (FBD) and supersites (PLR)	New	Required for change detection and biomass estimation studies (objective 1 & 2)
VHR (Pleiades)	GSD < 3m	June-Sept Jan-Feb	2016-2019	Annual coverage of supersites	New	Required for validation (objective 1)

COMPLEMENTARY[2] DATASETS – Site FCT-TNZ-5
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
RADARSAT-2	Wide Fine Dual (Liwale complete) Fine Quad / Fine Quad Wide (Amani + supersites in Liwale)	June-Sept Jan	2016-2019	Annual	New	Adds to sensor diversity, which is needed to study relative contribution and complementarity of sensors for objective 1 & 2
Tandem-X	StripMap HH+HV	June-Sept Jan	2016-2019	Annual	New	Adds to sensor diversity, which is needed to study relative contribution and complementarity of sensors for objective 1 & 2

OTHER DATASETS USED – Sites FCT-TNZ-5 and FCT-TNZ-6
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (dual-pol VV/VH)
- Landsat
- RapidEye
- LiDAR
- ALOS-1 PALSAR-1
- ENVISAT ASAR
- TerraSAR-X

DEFORESTATION AND DEGRADATION MONITORING IN PAPUA NEW GUINEA

GFOI PRIORITY R&D TOPIC(S):
- **Deforestation monitoring using SAR**
- **Forest degradation detection using SAR**

RESEARCH OBJECTIVES:
1. Optimising the use of SAR for the detection and monitoring of deforestation and forest degradation.
2. Recovery of forest biophysical parameters.
3. Support the development of an MRV/REDD+ system for PNG

OUTCOMES:
1. SAR-based method for monitoring deforestation. Report on usefulness of C-/X-/L-band SAR for detecting forest area change in natural and managed forests. Report on sensor interoperability and accuracy of forest cover change estimates.
2. Algorithm for detecting forest degradation using dense time-series C-band and high resolution X-band SAR
3. Algorithm to recover tree height information and biomass using TerraSAR-X/TanDEM-X.

Group 8

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Project support organisation/programme:
HGC Internal Funding

Project duration:
Annual Review

TIME SCHEDULE:
- Progress presentation at GFOI Science meeting [Oct 2016]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journal

STUDY SITES:
Kokoda (PNG-1)
Site description: Site of historic significance. Diverse land cover including primary and secondary forests (lowland-upper montane), mangrove, plantations (oil palm, teak, rubber, coconut), grassland and subsistence agriculture.
In situ data: Variable radius plot samples for various strata (Sept 2011), GeoSAR, RapidEye
Centre coord.: S9.184 / E147.374
Site spatial footprint: 25,000 km^2
ROI: *PNG-1.kml*
ROI for VHR sensors: *PNG-1_VHR.kml*

Milne Bay (PNG-2)
Site description: Diverse land cover including mangrove, primary and secondary forest, oil palm plantation, grasslands and subsistence agriculture.
In situ data: Forest sample data, GeoSAR, RapidEye, LiDAR
Centre coord.: S10.598 / E150.185
Site spatial footprint: 700 km^2
ROI: *PNG-2.kml*
ROI for VHR sensors: *PNG-2_VHR.kml*

MINIMUM REQUIRED[1] DATASETS – Sites (PNG-1 and PNG-2)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD	All year	2015-2017	Monthly	New	Required for deforestation detection (objective 1)
TerraSAR-X	Stripmap and Spotlight dual pol (VV+VH)	All year	2015-2017	Monthly	New	Required for degradation method development (objective 1)
VHR (Pleiades)	GSD < 3m	All year	2015-2017	Monthly	New	Required for validation

COMPLEMENTARY[2] DATASETS – Sites (PNG-1 and PNG-2)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
VHR (Pleiades)	GSD < 3m	All year	2010 2014	Monthly	Archive	Required for validation of previous forest cover maps and change estimates (objective 1)
TerraSAR-X	Stripmap and Spotlight dual pol (VV+VH)	All year	2010-2011 2014	Monthly	Archive	Required for historic assessment of degradation (objective 1)

OTHER DATASETS USED – Sites (PNG-1 and PNG-2)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (dual-pol VV/VH) - for construction of high density time-series, ALOS-1 PALSAR-1
- RapidEye, Landsat
- Airborne InSAR

MINIMUM REQUIRED[1] DATASETS – Site (PNG-2 only)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
TanDEM-X	200 m across track baseline	Fixed timeframe	Fixed timeframe	Several interferometric obs	New	Required for height retrieval and carbon estimates (objective 2).

COMPLEMENTARY[2] DATASETS – Site (PNG-2 only)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
TanDEM-X		All year	2011	Several interferometric obs	Archive	Require for historic retrieval of height and biomass (objective 2)

FOREST AND CARBON RESOURCE ASSESSMENT IN TROPICAL AND BOREAL FOREST ECOSYSTEMS

GFOI PRIORITY R&D TOPIC(S):
• Carbon estimation using SAR/Optical/LiDAR
• SAR/Optical integration for forest degradation assessment
• SAR/Optical interoperability and complementarity studies for land use and change monitoring

RESEARCH OBJECTIVES:
- To create and test a novel method for forest area and biomass monitoring by combining earth observation data and modelling to support assessment of forest degradation, national forest inventories and forest management with a special reference to carbon balance (FCT-MEX-2).
- Improve methods to gain knowledge on the biomass and carbon stocks and predicted future growth of Durango state forest (MEX-8).
- To reduce the uncertainty in carbon and water balance assessment with the help of earth observation data and modelling, and provide more accurate up-to-date information on forest parameters (FIN-1, FIN-2).

OUTCOMES:
- Optimised algorithm for retrieval of forest biomass/carbon in different forest types. Report on integration of SAR/Optical/LiDAR data for biomass/carbon estimation and assessment of robustness of methods in tropical and boreal forests (FCT-MEX-2, MEX-8, FIN-1, FIN-2).
- Algorithm for assessing forest degradation through integration of SAR/Optical data (FCT-MEX-2).
- Method of mapping land use and change using SAR and Optical data (FCT-MEX-2, MEX-8).

Group 9

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Project support organisation/programme:
EU/FP7 NorthState

Project duration:
Until end 2016

Organisation www:
http://www.vttresearch.com/services/smart-industry/space-technologies/sensors-imaging-and-data-analysis/earth-observation

Project www (if any):
http://northstatefp7.eu/

TIME SCHEDULE:
- Progress presentation at GFOI Science meeting [Oct 2016]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journal

STUDY SITES:
Chiapas, Mexico (FCT-MEX-2)
Site description: Tropical to subtropical landscape with a strong anthropogenic influence. Mixture of forest and cultivated areas. Shifting cultivation common.
In situ data: Ground plots
Centre coord.: N16.45 / W91.40
Site spatial footprint: km^2
ROI: MEX-2.kml
ROI for VHR sensors: TBD (5x5 km^2**)**

Durango, Mexico (MEX-8)
Site description: Tropical to sub-tropical landscape. Natural and managed forest area.
In situ data: Temporary and permanent plots
Centre coord.: N23.74 / W105.49
Site spatial footprint: km^2
ROI: MEX-3.kml
ROI for VHR sensors: TBD (5x5 km^2**)**

Hyytiälä (FIN-1), Sodankylä (FIN-2), Finland
Site description: Boreal (FIN-1) and northern Boreal conifer dominated managed forest
In situ data: Ground plots and stands
Centre coord.: N61.85 / E24.32 (FIN-1), N67.48 / E26.34 (FIN-2)
Site spatial footprint: km^2
ROI: FIN-1.kml (Hyytiälä) and FIN-2.kml (Sodankylä)
ROI for VHR sensors: HFIN-1_VHR.kml (Hyytiälä)

MINIMUM REQUIRED[1] DATASETS – Site (FCT-MEX-2)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD Stripmap Quad-pol	All year	2015-2016	Bi-monthly	New	Required for forest biomass, interoperability studies, and land cover change monitoring
VHR (Pleiades)	GSD < 3m	All year	2007 2010 2013 2015	Monthly (10 5x5 km images/year)	New	Required for validation of all products

COMPLEMENTARY[2] DATASETS – Site (FCT-MEX-2)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-1 PALSAR-1	FBD Stripmap Quad-pol	All year	2007-2010	Bi-monthly (or once/season)	Archive	To support historic land cover change estimates

OTHER DATASETS USED – Site (FCT-MEX-2)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (IWS, dual pol), RADARSAT-2
- RapidEye, Landsat
- LiDAR

MINIMUM REQUIRED[1] DATASETS – Site (MEX-8)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	Stripmap Dual pol Quad pol	All year	2014-2016	Bi-monthly	New	Required for forest biomass, interoperability studies, and land cover change monitoring
VHR (Pleiades)	GSD < 3m	June 15 -Aug 31	2010 2014 2015	Monthly (10 5x5 km images/year)	New	Required for validation of all products

COMPLEMENTARY[2] DATASETS – Site (MEX-8)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
None						

OTHER DATASETS USED – Sites (MEX-8)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A (IWS, dual pol), RADARSAT-2
- Landsat

MINIMUM REQUIRED[1] DATASETS – Sites (FIN-1), (FIN-2)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	Stripmap Dual pol Quad pol	All year	2014-2016	Bi-monthly (or once/season)	New	Required for forest biomass and interoperability studies
VHR (Pleiades)	GSD < 3m	All year	2007 2010 2013 2015 2016	Monthly (10 5x5 km images/year)	Both	Required for validation of all products

COMPLEMENTARY[2] DATASETS – Sites (FIN-1), (FIN-2)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
SPOT5(Take5)		Fixed timeframe	2015		New	Complement to other optical data. Required for interoperability studies
ALOS-1 PALSAR	Stripmap Dual pol Quad pol (highest priority)	All year	2007-2010	Bi-monthly (or once/season)	Archive	Required for forest biomass and interoperability studies

OTHER DATASETS USED – Sites (FIN-1), (FIN-2)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1A - IWS dual pol
- Landsat
- GeoEye
- Hyperion

FOREST AND CARBON RESOURCE ASSESSMENT IN TROPICAL AND BOREAL FOREST ECOSYSTEMS

GFOI PRIORITY R&D TOPIC(S):
- **Forest disturbance monitoring**
- **SAR-Optical interoperability and complementarity**

RESEARCH OBJECTIVES:
- To examine the potential for retrieving forest canopy profile information from a combination of radar and high resolution optical image data. Success would provide a lower cost alternative to LiDAR data and may enable REDD+ activities to be differentiated.
- Test the potential of methods in a range of forest conditions. Two sites have been identified.
- To evaluate the effect of forest disturbance on soil CO2 fluxes.
- To assess the ecology and long-term impact of management vs. natural disturbance on eucalypt forests.

OUTCOMES:
- Algorithm for retrieving forest canopy profile information through the integration of radar and optical data.
- Report on interoperability and complementarity of SAR and optical systems for retrieval of forest biopshycal parametres and assessment of robustness of methods in different forest types.
- Report on monitoring potential of new method vs. current methods (LiDAR) for REDD+ activities.

Group 10

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Project support organisation/programme:
CSIRO Land & Water, Landscape Int4ensification Programme, Forest Landscape Processes & Risks, Landscape Observation & Simulation

Project duration:
This work is a component of a 3-year post-doctoral proposal commencing July 2016 to June 2019.

Organisation www:
http://my.csiro.au/Business-Units/Land-and-Water-Flagship.aspx

TIME SCHEDULE:
- Progress presentation at GFOI Science meeting [Oct 2016]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journal

STUDY SITES:
Warra, Tasmania, Australia (FCT-AU-3)
Site description: TERN supersite dominated by tall Eucalypt forest. Also comprises areas of moorland, temperate rainforest, riparian and montane conifer forest and scrubs. Established as Long-term Ecological Research (LER) site in 1998. Hub for intensive, multi-disciplinary research to understand the fundamental ecological processes in Eucalypt forests and the long-term effects that management has on those processes in contrast with natural disturbance.
In situ data: Flux tower measurements, hydrology, meteorology, continuous forest inventory plots (CFI), species lists, baseline long-term vegetation monitoring plots, permanently marked plots
Centre coord.: S43.1046, E146.656
Site spatial footprint: km^2
ROI: AU-3.kmz
ROI for VHR sensors: TBD

Robson Creek, Queensland, Australia (AU-4)
Site description: TERN supersite dominated by tropical rainforest. Site of long-term research on monitoring the physical and biological status of rainforests in far north Queensland.
In situ data: Flux tower, forest dynamics plot, tree structural measurements, weather station, soil and water quality sensory, gauging station, logging bore
Centre coord.: S17.119 / E145.631
ROIAU-4.kmz
ROI for VHR sensors: TBD

MINIMUM REQUIRED[1] DATASETS – Sites (FCT-AU-3), (AU-4)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD (HH+HV)	Apr-Dec	2015-2016	Monthly	New	Required for algorithm development to meet objective 1 and SAR/Optical interoperability studies
TerraSAR-X	Stripmap Dual pol (VV+VH) Desc	Apr-Dec	2015-2016	max	New	Required for algorithm development to meet objective 1 and SAR/Optical interoperability studies
TanDEM-X	Default Asc	Apr-Dec	2015-2016	max	New	Required for algorithm development to meet objective 1 and SAR/Optical interoperability studies
RADARSAT-2	Wide Fine Quad pol	Apr-Dec	2015-2016	max	New	Required for algorithm development to meet objective 1 and SAR/Optical interoperability studies
VHR	Default	Apr-Dec	2015-2016	Monthly	New	Required for algorithm development to meet objective 1

COMPLEMENTARY[2] DATASETS – Sites (FCT-AU-3), (AU-4)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
SPOT5(Take5)		Fixed timeframe	2015-2016	max	New	Required for algorithm development to meet objective 1, and interoperability studies with other optical/VHR data
COSMO-SkyMed	Stripmap VV+VH	Apr-Dec	2015-2016	Monthly	New	Complement to TSX data for algorithm development

OTHER DATASETS USED – Sites (FCT-AU-3), (AU-4)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat
- Sentinel-1A - IWS, dual pol

FOREST DISTURBANCE MONITORING AND BIOMASS ESTIMATION IN SAVANNAH WOODLANDS

GFOI PRIORITY R&D TOPIC(S):

• Forest disturbance monitoring methods using time-series SAR, Optical and LiDAR data

• Sensor synergy for improved estimates of Above Ground Biomass (AGB)

RESEARCH OBJECTIVES:

- To extend methods development using SAR and sensor synergy for deforestation and degradation monitoring and retrieving estimates of AGB.
- Use time-series to better understand and quantify ecosystem response to natural and human drivers.

OUTCOMES:

- Optimsed algorithm for retrieving AGB using multi-sensor data. Report on sensor synergy for improved AGB estimates.
- Algorithm for deforestation monitoring using time-series, multi-sensor data.
- Forest degradation mapping method using time-series, multi-sensor data.
- Report on sensor interoperability and complementarity for deforestation monitoring and degradation assessment, and landscape response natural and anthropogenic induced change.

Group 11

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Co-investigators:
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Project support organisation/programme:
TERN Auscover

Project duration:
3 years

Organisation www:
www.unsw.edu.au

Project www (if any):

TIME SCHEDULE:

• Progress presentation at GFOI Science meeting [Oct 2016]
• Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
• Progress presentation at 2017 GFOI Science meeting [Q4 2017]
• Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
• Submission to peer-reviewed journal

STUDY SITES:

Injune, Queensland, Australia (AU-5)

Site description: The Injune Collaborative Landscape Project (ILCP) is an internationally recognised super-site for the development of new ground- and remote sensing based algorithms for retrieving biophysical attributes and detecting change in, for example, biomass and structure, in response to environmental (e.g., drought, wild fire) and anthropogenic (e.g., clearing) change. The landscape is largely comprised of woodlands and open forests.

In situ data: Forest mensuration data including trunk diameters, tree heights, crown sizes. Allometrics for a range of species.

Centre coord.: S25.5 / E147.7

Site spatial footprint: 240 km^2

ROI: AU-5.kml

ROI for VHR sensors: AU-5.kml

MINIMUM REQUIRED[1] DATASETS – Site (AU-5)
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD HH+HV	All year	2015	Bi-monthly	New	Required for methods development for AGB and forest disturbance monitoring and sensor interoperability studies
TerraSAR-X	Stripmap and Spotlight VV+VH	All year	2015/17	Monthly	New	Required for methods development for forest disturbance monitoring and sensor interoperability studies
TanDEM-X	Default	Fixed timeframe	2010 2017	max	Both	Required for retrieval of AGB and sensor interoperability studies
VHR	Default	All year	2010 2017	Monthly	Both	Required for validation of image products and sensor interoperability studies

COMPLEMENTARY[2] DATASETS – Site (AU-5)
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-1 PALSAR-1	FBD HH+HV	All year	2010	Monthly	Archive	Required for historic change analysis and sensor interoperability studies
COSMO-SkyMed	Stripmap and Spotlight VV+VH ping-pong	July/Aug 2007	2007 2015	Monthly	Both	Complement to TSX data. Required for sensor interoperability studies for forest disturbance monitoring.

OTHER DATASETS USED – Site (AU-5)
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat
- Sentinel-1A - IWS, dual pol
- CASI
- Aerial photography
- LiDAR - TLS and airborne
- AIRSAR

MULTI-SOURCE EO MAPPING OF FOREST STRUCTURE AND FIRES IN POORLY INVENTORIED NORTHERN BOREAL FORESTS (Northwest Territories, Canada)

GFOI PRIORITY R&D TOPIC(S):
- Sensor interoperability/complementarity
- Above-ground biomass
- Forest change (fires)

RESEARCH OBJECTIVES:
- Improvements to the mapping and monitoring of northern boreal forests through SAR/SAR & SAR/optical complementarity:
- Regional method development & implementation for improved large area mapping of biomass and fires in poorly inventoried northern boreal forests in the Northwest Territories, Canada, using multi-source EO optical/SAR data (Landsat and improved PALSAR Global Mosaics, PGM) along with ICESAT-GLAS samples and other data (large region including CAN-1/2/3 sites).
- Local method refinement for mapping structural attributes (biomass, height, CAN-1) and fires (CAN-2/3) using short time-series of optical (Landsat) and SAR data (PALSAR-1/2, Rsat-2, Sentinel-1; single TanDEM-X) along with ground plots, ICESAT-GLAS samples and other datasets.

OUTCOMES:
- Compositing algorithm towards optimal exploitation of ALOS-1/2 PGM for large area boreal forest mapping; included in a peer-reviewed paper of national scope and report to GFOI describing method, results, validation, national implementation for biomass mapping and recommendations for best use of PGM in boreal forests.
- Regional methods and maps of biomass and other structural attributes derived from Landsat and composited PGM combined with ICESAT-GLAS samples serving as plot surrogates. Peer-reviewed paper and report to GFOI describing method, results, validation, performance and recommendations for national implementation.
- Refined methods and maps of biomass and fires using varied multi-temporal optical/SAR data; method and map of height derived from TanDEM-X data. Peer-reviewed papers, report to GFOI.

Group 12

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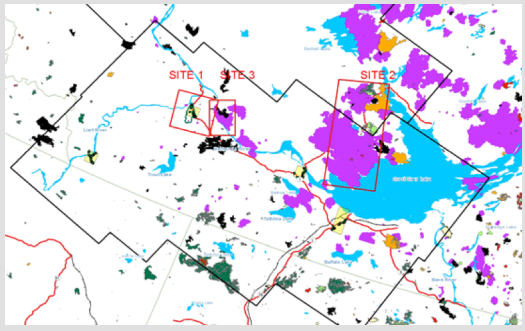
Project support organisation/programme:
Canadian Forest Service, regular program
Canadian Space Agency, GRIP program

Project duration:
2015/04/01 – 2018/03/31

Organisation www:
http://www.nrcan.gc.ca/forests/about/17545

Project www (if any):

Pilot region and sites CAN-1/2/3:



TIME SCHEDULE:
- Progress presentation at GFOI Science meeting, [Oct 2016]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb. 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1,2 and 3 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journals [2017-2018]

STUDY SITES:
Northwest Territories, Canada, CAN-1/2/3 (see figure)
Site description: Large pilot region of poorly inventoried northern boreal forests for Landsat/PALSAR based multi-source vegetation inventory (Objective 1); includes three test-sites for testing refined methods for biomass and height (CAN-1) and fire mapping (CAN-2/3) (Objective 2).
In situ data: Field visits with ground inventory plots, photos; airborne and spaceborne LiDAR data providing surrogate plots; land cover maps, others.

Centre coord.:
CAN-1: N61.40 / W121.30
CAN-2: N62.00 / W116.50 (*Needed minor adjustement, April 2016).*
CAN-3: N61.52 / W120.35
Site spatial footprint:
CAN-1: 3757 km^2
CAN-2: 13509 km^2
CAN-3: 2346 km^2
ROI:
CAN-1.kml
CAN-2.kml
CAN-3.kml

MINIMUM REQUIRED[1] DATASETS – Site CAN-1/2/3
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
TanDEM-X*	CoSSC	June-Sept	Up to 2015	Once	Archived	Required for height estimation in objective 2 for CAN-1, optionally CAN-2/3
ALOS-2 PALSAR*	F2 asc	June-Sept	2014-2016	3 / summer	Archived/New	Required for attribute and fire mapping in objective 2

* *Datasets initially requested through GFOI; now requested or obtained through other sources for various reasons independent of GFOI; see below*.

OTHER DATASETS USED – Site CAN-1/2/3
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Landsat (2007-2016)[1]
- ALOS-1 (2007-2010) and ALOS-2 (2014-2016) yearly 25m PALSAR global mosaics[1]
- ALOS-1/2 PALSAR FBD scenes (2010-2016) [1]
- Radarsat-2 scenes (2010-2016) [1]
- ICESAT-GLAS [1]
- Sentinel-1A (dual-pol VV/VH)

[1]*Critical datasets; mostly all secured.*

SENSE CARBON - SENTINELS SUPPORTING CARBON ESTIMATES AND REDD+

GFOI PRIORITY R&D TOPIC(S) ADRESSED:

- **Forest degradation, deforestation and reforestation**
- **Proxy methods for reporting degradation and/or enhancement of carbon stocks**
- **Satellite sensor interoperability (Landsat, Sentinels, RapidEye, TerraSAR-X, ALOS PALSAR)**

RESEARCH OBJECTIVES:

1. Characterizing land use, land use intensity and post-deforestation dynamics (regrowth, cyclic LU, gradients in LU)
2. Methods for forest degradation, deforestation and reforestation monitoring
3. Methods for enhanced aboveground biomass estimation

OUTCOMES

1. Algorithm for mapping and characterizing forests, land use and land use dynamics by optical and SAR data, and the synergies between both.
2. Assessment of usefulness of optical and SAR data time-series synergy for forest disturbance monitoring in the Brazilian Amazon.
3. Publications describing the methodology, providing mapping results, and evaluating sensor synergies.

GFOI R&D Group 13

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Project support organisation/programme:
German Ministry of Economics and Technology

Project duration:
2013 – 2019

Organisation:
Geomatics Lab, Geography Department, Humboldt-Universität zu Berlin
www.hu-geomatics.de

Project www (if any):
https://www.geographie.hu-berlin.de/en/professorships/geomatics/projects/sensecarbon

TIME SCHEDULE:

2016/06	Presentation at GEO conference Berlin on deforestation and secondary forest dynamics in Para and Mato Grosso, Brazil, using 30+ years of Landsat data
2016/10	Progress presentation at GFOI science meeting
2016 Q4	Peer reviewed publications
2017/02	Outcome 1 & 2 preliminary report to GFOI and CEOS/SDCG
2017 Q1	Report to the German Ministry of Economics and Technology on the synergistic use of radar and optical remote sensing for REDD-related monitoring in Amazonia
2017 Q2	Peer reviewed publications
2018/02	Outcome 1 & 2 final report to preliminary report to GFOI and CEOS/SDCG

STUDY SITES:
Novo Progresso, Brazil (BRA-2)
Site description: Tropical forest site situated on one of the most active deforestation frontiers in the Brazilian Amazon. Land use is dominated by forest clearing and conversion, extensive cattle farming and agriculture. Site generally features high land use dynamic. Due to the relatively long land use history in the site's proximity, extensive areas of secondary and regenerating forests over a wide range of ages exist.
In situ data: Field data collected by Humboldt University and collaborating partners. Publically available forest inventory data and management plans for licensed forest plots where selective timber extraction occurs (AUTEF sites), as well as products of the Brazilian Amazonian forest monitoring programs (DETER, PRODES), post-deforestation land use (TerraClass) and the rural cadastre (CAR).
Centre coord.: 55° 21.424'W, 6° 42.797'S
Site spatial footprint: ~15.000 km^2
ROI: *BRA-2.kml*
ROI for VHR sensors: BRA-2_VHR.kml

BRA-2
MINIMUM REQUIRED[1] DATASETS
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
PALSAR 2	Fine Beam Dual Pol	entire year	2014 - 2018	All 2/3 months	Both	limited fusion capabilities with optical data
Pleiades 1A + 1B	Pan + Multispectral	entire year	2014 - 2018	weekly	Both	limited ground truth verification*
SPOT 6 + 7	Pan + Multispectral (Standard + Off-Nadir observations)	entire year	2014 - 2018	weekly	Both	limited ground truth verification*

* Frequent cloud cover in the study regions demands for high VHR observation frequency to analyse and verify subpixel land use changes.

OTHER DATASETS USED – BRA-2
(Not requested here, e.g. public open data, datasets obtained through other sources)

- RADARSAT-2, TanDEM-X, TerraSAR-X,
- Landsat 7 + 8, Sentinel 1 + 2, CBERS, RapidEye (via RapidEye Science Archive)

FOREST HEIGHT AND ABOVEGROUND BIOMASS ESTIMATION IN TROPICAL FORESTS IN INDONESIA

GFOI PRIORITY R&D TOPIC(S) ADRESSED:
- **Above ground biomass and change**
- **Forest degradation and deforestation**
- **Specific forest types (peat swamp forest)**

RESEARCH OBJECTIVES:
5. Methods for forest height estimation and aboveground biomass estimation

OUTCOMES:
1. Forest height retrieval based on Pol-InSAR X- and C-band data (TerraSAR-X, TanDEM-X, RADARSAT-2, Sentinel-1)
2. Monitoring aboveground biomass varibility and changes in tropical forests

TIME SCHEDULE:
- Preliminary report to GFOI R&D/GOFC-GOLD Land Cover Symposium Wageningen, NL [Nov., 2016]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]

STUDY SITES:
Sebangau National Park and Block B of the Ex-Mega Rice Project (MRP) area, Central Kalimantan, Indonesia (KAL-1)
Site description: Sebangau National Park and Block B of the Ex-Mega Rice Project (MRP) area. The dominant vegetation is tropical peat swamp forest. The underground peat dome can reach up to 20 m depth and constitutes up to ten times the carbon storage of the overlying forest. For the part of the study site located in Sebangau National Park, designated in 2004, a lower amount of change in forest height and biomass is expected. This is in contrast to the Block B area, where intensive illegal harvesting occurs, and thus a large amount of change may be anticipated.
In situ data: Field inventory data (n=250) collected between 2008 and 2014. Next campaign planned for 2016.
Centre coord.: 2° 26.376'S/114° 9.905'E
Site spatial footprint: 1250 km^2
ROI: KAL-1.kml

South Sumatra, Indonesia (SUM-1)
Site description: Site mainly comprises tropical lowland forest, which is the most species-rich ecosystem in Indonesia. These forests are characterized by their upper canopy tree density, consisting mainly of dipterocarps (Dipterocarpaceen) of which cir. 60% are endemic. The tropical lowland rainforest differs from peat swamp forests in that the trees are higher, which are generally 45 m tall but can reach up to 60 m. Peat swamp forests are characterized by tree heights reaching 20-30 m, dependent upon the soil conditions, reaching a maximum of only 45 m.
In situ data: Field inventory was conducted in collaboration with the GIZ (German International Cooperation) within the BIOCLIME (Biodiversity and Clime Change) project.
Centre coord.: 2° 26.517'S/103° 17.921'E
Site spatial footprint: 625 km^2
ROI: SUM-1.kml

GFOI R&D Group 14

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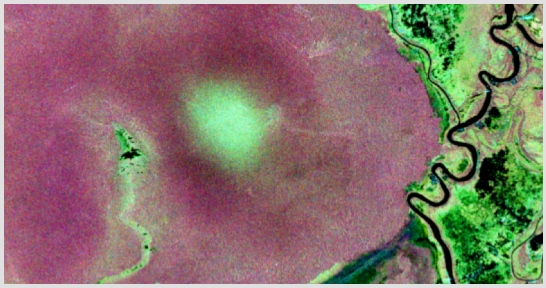
Project support organisation/programme:
DLR – German Space Agency
GIZ – German International Cooperation

Project duration:
2010 – 2018

Organisation www:
http://www.rssgmbh.de/



KAL-1
MINIMUM REQUIRED[1] DATASETS
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
TerraSAR-X	Stripmap HH/HV, HH/VV	July - November	2012/2015	4 consecutive acquisitions	Archive	Objective 1
TanDEM-X	CoSSC HH/HV/VV/VH	July - November	2015	4 consecutive acquisitions	Archive	Objective 1
RADARSAT-2	FQ, MF	August - October	2012/2015	4 consecutive acquisitions	Archive	Objective 1

OTHER DATASETS USED – Site KAL-1

- Sentinel-1 (IW) 4 consecutive acquisitions June-October 2015 (critical dataset)

SUM-1
MINIMUM REQUIRED[1] DATASETS
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
TerraSAR-X	Stripmap HH/HV, HH/VV	July - November	2012/2015	4 consecutive acquisitions	Archive	Objective 1
TanDEM-X	CoSSC HH/HV/VV/VH	July - November	2015	4 consecutive acquisitions	Archive	Objective 1
RADARSAT-2	FQ, MF	August - October	2012/2015	4 consecutive acquisitions	Archive	Objective 1

OTHER DATASETS USED – Site SUM-1

- Sentinel-1 (IW) 4 consecutive acquisitions June-October 2015 (critical dataset)

TIMELY MULTI-SENSOR FOREST DISTURBANCE MONITORING

GFOI PRIORITY R&D TOPIC(S) ADRESSED:
• General forest mapping method improvements (reducing uncertainty)
• Near-Real Time forest change indicators mapping
• Forest stratification
• Degradation/Enhancement of C stocks

RESEARCH OBJECTIVES:
1. Develop a cost efficient concept to monitor deforestation and degradation processes of dense tropical forests at high frequency
2. Analyzing synergy-effects of Sentinel-1/2 and TerraSAR-X/ TanDEM-X for baseline and forest disturbance mapping

OUTCOMES:
1. Methodology and prototype implementation of forest disturbance monitoring tool using VHR SAR data

2. Recommendations in terms of sensor combination for forest deforestation and degradation monitoring

3. Accuracy and limitations of multi-sensor forest monitoring approach

TIME SCHEDULE:
- Progress presentation at GFOI Science meeting [Oct 2016]
- Outcome 1,2 and 3 (depending on reference data quality) final report to GFOI and CEOS/SDCG [Feb. 2017]
- Submission to peer-reviewed journal [Mar. 2017]

GFOI R&D Group 15

Principal Investigator:
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Project funding organisation/programme:
Federal Ministry of Economics and Technology, German Aerospace Center

Project duration:
15.05.2014 – 31.12.2016

Organisation www:
http://www.geo-airbusds.com

Project www (if any):
http://www.intelligence-airbusds.com/en/6239-terrasar-x-based-monitoring-of-forest-degradation-in-ghana

STUDY SITES:
Klaaskreek, Suriname (SUR-1)
Site description: The test site is located in the forestry belt of North-East Suriname, comprising natural forests which are subject to forest management and harvesting activities.
In situ data: Data base of trees logged for commercial use including tree species, time of logging and location of tree.
Centre coord.: 5°12'12.70"N 54°57'4.40"W
Site spatial footprint: 10,000 ha
ROI: *SUR-1.kml*
ROI for VHR sensors: *SUR-1_VHR.kml*

Malinau, Kalimantan, Indonesia (KAL-2)
Site description: Reduced Impact Logging (RIL) and conventional logging (CL) concession areas. Part of Indonesia's Forests and Climate Change Programme (FORCLIME) by the BMZ, GIZ and the Indonesian Ministry of Forestry (KEHMUT). Two test sites have been established in order to compare different logging types (reduced impact logging – RIL, and conventional logging – CL) each one representing one type of logging.
In situ data: Pre- and post-logging inventory data of RIL and CL study sites with a size of +/- 100 ha each. A pre-logging inventory was conducted in March/April 2014.
Centre coord.: 3°1'57.23"N 116°36'5.45"E
Site spatial footprint: 9,100 ha
ROI: *KAL-2.kml*
ROI for VHR sensors: *KAL-2_VHR.kml*

Kade, Ghana (GHA-1)
Site description: The Study area is located in the Eastern Region of Ghana. Remaining contiguous areas of natural forest have the status of forest reserves exhibiting moist semi-deciduous forests. The majority of the area of interest is used for agricultural purposes and covered by oil palm, citrus and cocoa grown under relicts of natural forest. The occurrence of tree crops and natural forest relicts exhibits a fragmented landscape challenging operational baseline mapping techniques.
In situ data: Description and photos from field trip in 2013.
Centre coord.: 6°11'41.14"N, 0°56'21.90"W
Site spatial footprint: 11,500 ha
ROI: *GHA*-1.kml
ROI for VHR sensors: *GHA*-1_VHR.kml

All sites
MINIMUM REQUIRED[1] DATASETS
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
VHR (SPOT6/7 or Pleiades)	GSD < 3m	Jan - Dec	2015-2017	2 times / year	Archive or New	Required for validation

All sites
COMPLEMENTARY[2] DATASETS
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification (**Impact on the project deliverables if dataset not delivered)
PALSAR-2	Stripmap Fine Beam Dual-pol (10m)	Jan - Dec	2015-2017	once / year	Archive or New	Complementary to key X-band acquisitions

OTHER DATASETS USED – All sites
(Not requested here, e.g. public open data, datasets obtained through other sources)

- X-band acquisitions from TerraSAR-X mission (VHR)
- Global TanDEM-X mission archive (VHR bistatic)
- Free Copernicus datasets (Sentinel-1 and Sentinel-2)

STRUCTURAL ATTRIBUTE RETRIEVAL IN SOUTHERN AFRICAN SAVANNAHS, THICKETS AND INDIGENOUS FORESTS

GFOI PRIORITY R&D TOPIC(S):

- Degradation/enhancement of carbon stocks (Use of SAR for mapping degradation / Use of airborne LiDAR for deriving biomass/carbon stocks and changes)
- General forest mapping method improvements (Sensor interoperability / Uncertainty / Optimising information extraction using dense time-series C-band SAR)
- Above-ground biomass (Integration of ground,- and airborne LiDAR / SAR and optical data/ Integration of repeat LiDAR and SAR change across different forest types / Sampling design options)

RESEARCH OBJECTIVES:

- Retrieval of vegetation attributes, including woody plant cover, height, biomass and changes over time due to land management, climate and ecological dynamics, both inside and outside of protected areas, assessment of uncertainties
- Carbon sequestration in thickets, especially in relation to restoration of degraded sites; thicket structural and compositional complexity in relation to the conservation of rare species.

OUTCOMES:

- Algorithm for mapping biomass in South African savannahs and indigenous forests types using field, airborne LiDAR, and SAR imagery. Peer-reviewed publication.
- Assessment of ASAR and Sentinel-1 SAR time-series for mapping biomass. Peer-reviewed-publication.

Group 16

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Project support organisation/programme:
Multiple

Project duration:
2015/06/01 – 2018/05/31

Organisation www:
www.csir.co.za

TIME SCHEDULE:

- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Submission to peer-reviewed journal [May 2018]

STUDY SITES:

Lowveld Savannahs, South Africa (SA-1)
Site description: Kruger National Park and adjacent western populated landscapes
In situ data: Several hundred ground plots, typically ~30x30 m to 100x 100 m, using a variety of methods. Several tens of walked transects, kilometres long, with individual marked trees, repeated every few years. Flux tower operational since 2001. Allometry for key species.
Centre coord.: centre point 24º47'S, 31º26'E (top left 23º53'S, 30º40'E, bottom right 25º35'S, 32º04'E)
Site spatial footprint: 27000 km^2
ROI: SA-1.kml
ROI for VHR sensors: N/A

Eastern Cape Thickets (SA-2), South Africa
Site description: Subtropical thickets at the interface between savannas, arid shrub lands and coastal forests in the area north of Port Elizabeth
In situ data: 150 ground plots, Allometry for key species.
Centre coord.: centre point 32º50'S, 26º06'E (top left 32º16'S, 24º51'E, bottom right 32º20'S, 27º22'E)
Site spatial footprint: 35000 km^2
ROI: SA-2.kml
ROI for VHR sensors: N/A

KwaZulu-Natal Savannahs and Coastal Forests (SA-3), South Africa
Site description: Coastal forests and wetland sites of the iSimangaliso Weltland Park (World Heritage/RaMSAR site), adjacent commercial plantations, and populated landscapes, and the savannahs / woodlands landscape of the Hluhluwe-iMfolozi to the west
In situ data: 30 ground plots woody biomass, typically 100x 100 m. Walked transects including > 300 tagged trees for species mapping.
Centre coord.: centre point 28º19'S, 32º00'E (top left 27º57'S, 30º54'E, bottom right 28º46'S, 33º13'E)
Site spatial footprint: 30000 km^2
ROI: SA-3.kml
ROI for VHR sensors: N/A

MINIMUM REQUIRED[1] DATASETS – Site SA-1, SA-2, SA-3
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	**Observation mode**	**Observation time window**	**Required duration**	**(Minimum) observation frequency**	**Archive data OR New acq.**	**Justification** (Impact on the project deliverables if dataset not delivered)
TerraSAR-X	1. VV+VH 2. Stripmap			Monthly		
ALOS-2 PALSAR-2	1. HH+HV 2. FBD (default)			Bi-monthly		

OTHER DATASETS USED – Site SA-1
(Not requested here, e.g. public open data, datasets obtained through other sources)

- SPOT5, Landsat, Modis, MISR, CAO hyperspectral, repeated national aerial photography (~ 1m GSD, ~ 5 yearly, initially B&W but 4-band colour since ~1980), ALOS PALSAR

OTHER DATASETS USED – Site SA-2

- SPOT5, Landsat, Modis, MISR,

OTHER DATASETS USED – Site SA-3

- SPOT5, Landsat, Modis, MISR, LiDAR

MONITORING FOREST / LAND COVER AND FOREST COVER CHANGE IN TROPICAL RAINFOREST IN DRC

GFOI PRIORITY R&D TOPIC(S):

• Sensor interoperability/complementarity between optical, C- and L-band SAR for forest and forest change monitoring.
• Optimising information extraction using dense time-series C-band SAR and L-band SAR for forest monitoring

RESEARCH OBJECTIVES:

- Investigate SAR/Optical interoperability and complementarity and dense C-band SAR time-series analysis to monitor forest area and change.

OUTCOMES:

- Method of estimating forest area and change. Report on the usefulness of optical and C-/L-band SAR data for forest monitoring.
- Algorithm for improved forest area and change mapping using dense time-series C-band SAR.

TIME SCHEDULE:

- Progress presentation at GFOI Science meeting [Oct 16]
- Outcome 1 and 2 preliminary report to GFOI and CEOS/SDCG [Feb., 2017]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journal

Group 17

Principal Investigator:
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Project support organisation/programme:
ESA DUE Innovator III "SAR for REDD"

Project duration:
March 2015 – March 2017

Organisation www.norut.no
www.osfac.net

STUDY SITES:

Mai Ndombe district (DRC-1)

Site description: Mai-Ndombe district is located in the Bandundu Province in the Democratic Republic of Congo (DRC). The area of Mai-Ndombe is very rich in biodiversity and endemic species (Bonobo). However, for many years this area is facing deforestation and forest degradation. The main causes of this loss of forests are charcoal production for cities, slash and burn agriculture and industrial logging. The Mai-Ndombe district is also the Emission Reductions Program Idea Note area for DRC.
In situ data: 7 forest inventory plots from field work in March 2013, aerial photography from 5 sites, ground photography along route R204 (Selenge to Benye)
Centre coord.: S2.70 / E18.50
Site spatial footprint: 128789 km2
ROI: DRC-1.kml

MINIMUM REQUIRED[1] DATASETS – Sites DRC-1

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD	June-Sept Jan	2016-2017	Monthly	New	Required for sensor interoperbality studies (objective 2)
VHR (Pleiades)	GSD < 3m	June-Sept Jan-Feb	2016-2017	Monthly	New	Required for validation

COMPLEMENTARY[2] DATASETS – Site DRC-1

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
ALOS-2 PALSAR-2	FBD /FBS	Any time	2016-2017	As dense as possible	ALOS-2 PALSAR-2	Desne time series application

OTHER DATASETS USED – Sites DRC-1

- Sentinel-1A (dual-pol VV/VH), Landsat, RapidEye, ALOS-1 PALSAR-1, ENVISAT ASAR

SYNERGISTIC USAGE OF SENTINEL-1 AND SENTINEL-2 DATA TO SUPPORT UNFCCC REDD+ MRV SYSTEMS

GFOI PRIORITY R&D TOPIC(S):
- **Forest degradation and regrowth**
- **SAR/optical integration**

RESEARCH OBJECTIVES:
1. Implementation of high temporal data coverage for more precise and rapid detection of degradation.
2. Achievement of high degree of automation.
3. Achievement of products of sufficient quality for REDD+.

OUTCOMES:
1. Algorithm for detecting forest degradation by optical and SAR data synergy for two pilot regions. Reports describing the methodology, performance, validation process, and next steps towards operationalisation.
2. Forest/non-forest and degradation maps for the two pilot regions.

TIME SCHEDULE:
- Kick-off [June 2016]
- Preliminary report to GFOI R&D/GOFC-GOLD Land Cover Symposium Wageningen, NL [Nov., 2016]
- Progress presentation at 2017 GFOI Science meeting [Q4 2017]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]

Group 18

Principal Investigator:
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Chair of Earth Observation
Friedrich-Schiller-University Jena,
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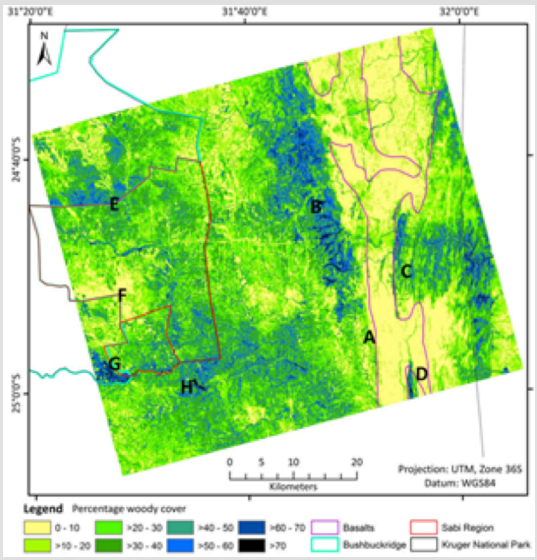
Co-investigators:
-

Project support organisation/programme:
DLR/BMWi

Project duration:
2016/06/01 – 2019/02/28

Organisation www:
http://www.eo.uni-jena.de/



STUDY SITES:
Mexico: Campeche (MEX-4), Marques de Comillas (MEX-5) and Hidalgo (MEX-6)
Site description: Mangrove and tropical rainforest party undisturbed or in different stages of harvest and regeneration. The sites are "supersites" which are featuring a complete LiDAR coverage and more precise field inventory data than for standard forest inventories.
In situ data: Inventory data, field visits with ground photos, VHR, LiDAR.
Centre coord.:
N20.3° / W90.1° (MEX-4)
N16.3° / W90.9° (MEX-5)
N20.6° / W98.59° (MEX-6)
Site spatial footprint:
ROI: MEX-4_Campeche.kmz, MEX-5_Comillas.kmz
ROI for VHR sensors: Mex-6_VHR Hidalgo.kmz, MEX-4_VHR Kulic.kmz .8 images per site (24 in total) with a coverage of ca. 25 km² each.

South Africa: Kruger National Park (Skukuza) and adjacent areas (SA-4)
Site description: Savannah Forest, partly disturbed.
In situ data: TLS for Skukuza, Inventory data, VHR, LiDAR. The site includes a flux tower.
Centre coord.: S25.2° / E31.5°
Site spatial footprint: 4.000 km^2
ROI: SA-1B KNP.kmz
ROI for VHR sensors: SA-1B_VHR.kmz. 8 images per site (24 in total) with a coverage of ca. 25 km² each.

MEX-4, MEX-6, SA-4
MINIMUM REQUIRED[1] DATASETS
([1]Critical: without which the study cannot be completed)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
VHR	GSD < 5m	Whole year	2015-2018	Once/year	New	For validation.

MEX-4, MEX-5, MEX-6, SA-4
COMPLEMENTARY[2] DATASETS
([2]Non-critical but can enhance outcomes)

Mission/ Sensor	Observation mode	Observation time window	Required duration	(Minimum) observation frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
RADARSAT-2	Dual pol	Whole year	2015-2018	1 acquisition per month	both	Complementary to Sentinel-1 if Sentinel-1 data not available

OTHER DATASETS USED
(Not requested here, e.g. public open data, datasets obtained through other sources)

- Sentinel-1 (cross-pol) monthly acquisitions 2015-2018 (critical dataset)
- Sentinel-2 monthly acquisitions 2015-2018 (critical dataset)
- Landsat 8 monthly acquisitions (complementary dataset)
- ALOS PALSAR and ALOS-2 PALSAR-2 25m mosaics (2007-2010 and 2015)
- TerraSAR-X/TanDEM-X (recent data)