

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

**for the
Global Forest Observations Initiative**

**Version 4.1
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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

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Table of Contents

EXECUTIVE SUMMARY	3
1 Introduction	4
1.1 Background and purpose	4
1.2 Joint strategy for R&D	5
1.3 Document scope.....	6
1.4 Acknowledgements.....	6
2 Coordination of GFOI R&D activities	7
2.1 GFOI R&D Coordination (RDC) component	7
2.2 GFOI R&D framework documents.....	7
2.3 GFOI R&D Expert Workshops	11
2.4 The GFOI R&D programme.....	12
3 Space Data in support of GFOI R&D	16
3.1 Data requirement summary	16
3.2 The Element-3 strategy	16
3.3 Governance.....	17
4 Contributing agencies and missions and corresponding data requests	18
4.1 ASI.....	18
4.2 CNES	20
4.3 CSA	23
4.4 DLR	25
4.5 ESA	28
4.6 INPE	30
4.7 JAXA.....	31
4.8 USGS	33
4.9 Commercial Data providers	34
Annex A: GFOI R&D Study Sites, research partners and R&D topics	

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 2018 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 first endorsed in 2015 by CEOS at SIT-30 and subsequently SIT-31, and thereafter submitted for information at SIT-32 and SIT-33 (this document).

Provision of satellite data by CEOS agencies started in the second half of 2015 and is currently ongoing (as of April 2018). Progress reports are provided to CEOS agencies on an annual basis (prior to SIT). Presentation of research results is anticipated in 2018/2019 at a science meeting 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 efforts¹.

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/>

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

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 first 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 GOF-C-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).

2.2 GFOI R&D framework documents

2.2.1 GFOI R&D Plan

The GFOI R&D Plan² 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+ implementation³. 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

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_ReviewPriorityRDTTopics_V1.pdf

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

- 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.

2.2.2 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.

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 2.1) 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.

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.

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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Improved ground data and soil carbon budget models for new forested areas (e.g., peat soils) 	
MGD-1 Forest/Non-forest	<ul style="list-style-type: none"> Investigate alternative non-GFOI data streams for F/NF mapping 	Medium
MGD-2 Forest/Non-forest change	<ul style="list-style-type: none"> Improved methods for burned area mapping Optimising F/NF change mapping using dense time-series C-band SAR 	
MGD-4 All Land use categories	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 2.1 – Summary of R&D needs identified in the GFOI Review of Priority R&D Topics⁴.
[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.



Figure 2.1 – GFOI R&D Study Sites.

Interactive map at www.gfoi.org/RD/study-sites/

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.

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
	BOL-1	Santa Cruz	Bolivia	S18.4	W62.4
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 April, 2018)

Research group	Site Code	Site name	Country	Coordinates	
				lat	long
Group 10	AU-4	Robson Creek (QLD)	Australia	S17.119	E145.631
	FCT-AU-3	Warra (Tasmania)		S43.1046	E146.656
Group 11	-	-	-	-	-
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	Sebangu N.P. / xMRP	Indonesia	S2°24'	E114°6'30"
	SUM-1	South Sumatra		S2°29'30"	E103°28'30"
Group 15	GUF-1	Regina, Cayenne	French Guiana	N4°13'44.38	W52°9'21.46"
	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	Kulic	Mexico	N20.09	W89.53
	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 April, 2017)

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								
			SPOT-5(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
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	
4	U Wageningen, The Netherlands	Ethiopia																	X	X		X		X
		Fiji																	X	X		X		X
		Bolivia																	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
8	HGC, Malaysia	PNG																	X			X	X	X
9	VTT, Finland	Mexico																			X	X	X	X
		Finland																X				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 D&S, Germany	F. Guiana															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	FSU Jena, Germany	Mexico																				X		X
		S. Africa																				X		X

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

Table 3.1 – GFOI R&D group space data requirement summary and Priority R&D Topics addressed (as of April 10, 2018). Group 11 withdrawn - no data provided.

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.

Data observation requests for each sensor, both new acquisitions and archive, for the GFOI R&D Study Sites are provided in section 4 below. Minimum requirements for are given in case of capacity constraints.

3.3 Governance

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;

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

New acquisitions: ASI is currently making significant contributions to the CEOS DRM Pilot projects and 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 available 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 REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
5	Guyana Forest Commission (Guyana)	Guyana	OK	Ongoing	
6	Wageningen Univ (Hoekman) (The Netherlands)	Indonesia	OK	Ongoing	

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
10	CSIRO (Australia)	Australia	Not yet	Not yet	

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	Delphine Fontannaz	Delphine.fontannaz@cnes.fr	Non commercial use	theia-landsat.cnes.fr
Pléiades	CNES	Delphine Fontannaz	Delphine.fontannaz@cnes.fr	Research use	www.geostore.com Data access manual via CNES

4.2.1 SPOT-4 and -5

Archive data availability: Refer to theia-landsat.cnes.fr and <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 10000km² per year for GFOI.

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

Data access procedure:

- All GFOI R&D users having signed an agreement with CNES can request access to any GFOI data by emailing isis-pleiades@cnes.fr.

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.

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 REQUIRED¹ DATASETS – Non-commercial groups

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
4	Wageningen Univ (Reiche) (The Netherlands)	Ethiopia, Fiji	OK	Completed	
5	Guyana Forest Commission (Guyana)	Guyana	OK	Completed for 1 South site	Cloud cover limiting factor (North site)
6	Wageningen Univ (Hoekman) (The Netherlands)	Indonesia	OK	Ongoing (no acquisitions in 2016)	Cloud cover limiting factor
7	Tromsø Univ (Norway)	Tanzania	No response from R&D team	No response from R&D team	
10	CSIRO (Australia)	Australia	No response from R&D team	No response from R&D team	
13	Humboldt Univ (Germany)	Brazil	OK	Ongoing	
16	CSIR (South Africa)	South Africa	No response from R&D team	No response from R&D team	NEW REQUEST
17	NORUT (Norway)	D. R. Congo	OK	Completed	
18	FSU-Jena (Germany)	Mexico, South Africa	OK	Ongoing	

(¹Critical: without which the study cannot be completed)

COMPLEMENTARY² DATASETS – Non-commercial groups (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
1	INPE (Brazil)	Brazil	No response from R&D team	No response from R&D team	
3	Boston U./Woods Hole Research Center (USA)	Colombia	No response from R&D team	No response from R&D team	

Table 4.2a Non-commercial GFOI R&D groups requesting optical VHR sensors

MINIMUM REQUIRED¹ DATASETS – Groups with commercial affiliation

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
2	SIRS (France)	Malawi, Gabon			Group not approved.
8	Horizon Geoscience (Malaysia)	Papua New Guinea			Group not approved.
9	VTT (Finland)	Finland, Mexico			Group not approved.

Table 4.2b GFOI R&D with commercial affiliations requesting coverage by optical VHR sensors

4.2.5 Requests for SPOT 1-5 (archive) data

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
3	Boston U./Woods Hole Research Center (USA)	Colombia	Not yet	Not yet	

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 RADARSAT-2 data

MINIMUM REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
10	CSIRO (Australia)	Australia			
14	Remote Sensing Solutions (Germany)	Indonesia			

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
1	INPE (Brazil)	Brazil			
7	Tromsø Univ (Norway)	Tanzania			
16	CSIR (South Africa)	South Africa			
18	FSU-Jena (Germany)	Mexico, South Africa			

Table 4.4 GFOI R&D groups requesting RADARSAT-2

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 ¹	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/

¹ For GFOI R&D groups the usual COFUR costs may be waived for a reasonable amount of data. The DLR GFOI contact person should 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.

4.4.1 TerraSAR-X background mission

DLR carried out background mission from June 2015 to May 2018 covering the R&D sites systematically based on the centre coordinates supplied by the R&D teams. KML Files of the acquisitions were provided to the R&D teams in July 2016. From June 2018 on the background mission will only continued on special request of a R&D team.

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>.

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.

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](#).
- 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 Requests for TerraSAR-X data

MINIMUM REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
6	Wageningen Univ (Hoekman) (The Netherlands)	Indonesia			
8	Horizon Geoscience (Malaysia)	Papua New Guinea			
10	CSIRO (Australia)	Australia			
14	Remote Sensing Solutions (Germany)	Indonesia			

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
16	CSIR (South Africa)	South Africa			Previously "Minimum Required"

Table 4.5 GFOI R&D groups requesting coverage by TerraSAR-X

4.4.5 TanDEM-X acquisition planning

After finalisation of the Global DEM the TanDEM-X mission continues its bi-static formation. The acquisition plan from Sept. 2016 to Sept. 2017 includes e.g. additional CoSSCs coverages in the boreal and the tropics to support forest monitoring. New acquisition include French-Guayana, Nicaragua, Costa Rica, Panama, Colombia, Peru, parts of Brazil, Sumatra, Borneo, Gabu and Nigeria. From 2018 onwards the main mission objective is a ChangeDEM.

4.4.6 TanDEM-X archive data

The TanDEM-X DEM AO provided access to final Global TanDEM-X DEM data. As the AO is already closed TanDEM-X data can only be requested by using the General Proposal Submission procedure.

TanDEM-X data have been acquired 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 are available on request. 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. The primary entry point is the TanDEM-X Science Service System: <https://tandemx-science.dlr.de/> using the AO for General Proposal Submission.
- 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 TanDEM-X data

MINIMUM REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
7	Tromsø Univ (Norway)	Tanzania			
8	Horizon Geoscience (Malaysia)	Papua New Guinea			
10	CSIRO (Australia)	Australia			
12	Canadian Forest Service (Canada)	Canada			
14	Remote Sensing Solutions (Germany)	Indonesia			

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
7	Tromsø Univ (Norway)	Tanzania			Previously "Minimum Required"

Table 4.6 GFOI R&D groups requesting 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-1

The Sentinel-1 mission comprises a constellation of two polar-orbiting satellites, operating day and night performing C-band synthetic aperture radar imaging, enabling them to acquire imagery regardless of the weather. Sentinel-1A and -1B data routinely provided to Copernicus Services and users worldwide. Over land, including the GFOI study sites, Sentinel-1 is operated mainly in interferometric wide swath mode (IWS) with a repeat time of 6 or 12 days. The operational scenario implements a baseline predefined mission. Find more information on the operational scenario with the repeat cycle and the polarisation at <https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/observation-scenario>

4.5.2 Sentinel-2

Sentinel-2 is a European wide-swath, high-resolution, multi-spectral imaging mission. The full mission comprises a constellation of two polar-orbiting satellites, designed to give a high revisit frequency of 5 days at the Equator. The mission is fully operational since February 2018 providing systematic coverage of continental land surfaces (including inland waters) between latitudes 56° south and 84° north and all coastal waters up to 20 km from the shore. More information on the acquisition scenario can be found at <https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-2-msi/revisit-coverage>

4.5.3 ESA Earth observation missions data

Since May 2010 the revised ESA Earth Observation Data Policy applies to the ESA missions ERS-1, ERS-2, Envisat, GOCE, SMOS, CryoSat and future Earth Explorer missions. The policy defines two classes of ESA datasets:

- The free dataset includes the collections available online, and requires only a minimal fast registration through this site
- The restrained dataset includes sets not available online – on demand products, on-demand data acquisition, some archived data etc. The data is provided free of charge in most cases, and requires the submission of a Project Proposal.

More information can be found on the webpage “How to access ESA Data”:

<https://earth.esa.int/web/guest/data-access/how-to-access-esa-data>

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 <http://earth.esa.int/EOLi/EOLi.html>.

4.5.4 Permanent Open Call

Under the Earth Observation Science for Society permanent Open Call ESA opens a framework to rapidly respond to new innovative ideas. Since September 2017 proposals, which are restricted to bidders from ESA member states, can be submitted at any time, but are expected to be limited in size and duration. Taken into account the need for rapid implementation any individual contract will be limited to a Firm Fixed Price of up to 150K Euro and to a maximum duration of 12 months. More information can be found at ESA's tendering system EMITS <http://emits.sso.esa.int/> under AO9101.

4.6 INPE

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

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.

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	Ake Rosenqvist	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	Ake Rosenqvist	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 (2015, 2016, 2017) 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, 2008, 2009, 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) (<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 PALSAR-2 (FBD) data

MINIMUM REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Data provision
2	SIRS (France)	Malawi, Gabon	OK	Ongoing
4	Wageningen Univ (The Netherlands)	Ethiopia, Fiji, Bolivia	OK	Ongoing
7	Tromsø Univ (Norway)	Tanzania	OK	Ongoing
9	VTT (Finland)	Finland, Mexico	OK	Ongoing
10	CSIRO (Australia)	Australia	OK	Ongoing
12	Canadian Forest Service (Canada)	Canada	OK	Ongoing
13	Humboldt Univ (Germany)	Brazil	OK	Ongoing
16	CSIR (South Africa)	South Africa	OK	Ongoing
17	NORUT (Norway)	D. R. Congo	OK	Ongoing

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision
15	Airbis D&S (Germany)	French Guiana, Indonesia, Ghana	OK	Ongoing

Table 4.7a (top) and 45.7b (bottom). GFOI R&D groups requesting coverage by ALOS-2 PALSAR-2.

4.7.5 Requests for ALOS PALSAR (FBD) data

MINIMUM REQUIRED¹ DATASETS (¹Critical: without which the study cannot be completed)

Group #	Affiliation	Study site location(s)	User agreement	Data provision
4	Wageningen Univ (The Netherlands)	Fiji	OK	Ongoing

COMPLEMENTARY² DATASETS (²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision
9	VTT (Finland)	Finland, Mexico	OK	Ongoing

Table 4.7c (top) and 45.7d (bottom). GFOI R&D groups requesting 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	-	-	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 Team 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 Commercial data providers

No commercial data providers are currently providing support to the GFOI R&D programme.

4.9.2 Requests for Very High Resolution optical data

MINIMUM REQUIRED¹ DATASETS – Non-commercial groups served by CNES (Pléiades)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
4	Wageningen Univ (Reiche) (The Netherlands)	Ethiopia, Fiji			Pléiades OK by CNES
5	Guyana Forest Commission (Guyana)	Guyana			Pléiades OK by CNES
6	Wageningen Univ (Hoekman) (The Netherlands)	Indonesia			Pléiades OK by CNES
7	Tromsø Univ (Norway)	Tanzania			Pléiades OK by CNES
10	CSIRO (Australia)	Australia			Pléiades OK by CNES
13	Humboldt Univ (Germany)	Brazil			Pléiades OK by CNES
16	CSIR (South Africa)	South Africa			NEW REQUEST 2017
17	NORUT (Norway)	D. R. Congo			Pléiades OK by CNES
18	FSU-Jena (Germany)	Mexico, South Africa			Pléiades OK by CNES

(¹Critical: without which the study cannot be completed)

COMPLEMENTARY² DATASETS – Non-commercial groups served by CNES (Pléiades)

(²Non-critical but can enhance outcomes)

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
1	INPE (Brazil)	Brazil			Pléiades OK by CNES
3	Boston U./Woods Hole Research Center (USA)	Colombia			Pléiades OK by CNES

Table 4.8a Non-commercial GFOI R&D groups requesting optical VHR sensors

MINIMUM REQUIRED¹ DATASETS – Groups with commercial affiliation **NOT served by CNES**

Group #	Affiliation	Study site location(s)	User agreement	Tasking/data provision	Notes
2	SIRS (France)	Malawi, Gabon			
8	Horizon Geoscience (Malaysia)	Papua New Guinea			
9	VTT (Finland)	Finland, Mexico			

Table 4.8b GFOI R&D groups with commercial affiliation requesting optical VHR sensors.

SDCG Element-3

Annex A

GFOI research partners, Study Sites and R&D topics

Annex A

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
	BOL-1	Santa Cruz	Bolivia	S18.4	W62.4
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 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	GUF-1	Regina, Cayenne	French Guiana	N4°13'44.38	W52°9'21.46"
	KAL-2	Malinau, Kalimantan	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	Kiuic	Mexico	N20.09	W89.53
	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]

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: Fieldwork information acquired in July/August 2017.

Centre coord.: S11.75° / W54.25°

Site spatial footprint: 70x60 km²

ROI: [BRA-1.kmI]

ROI for VHR sensors: [BRA-1_VHR.kmI]

COMPLEMENTARY² DATASETS (²Non-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 < 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

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/>

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]

STUDY SITES:

Mulanje, Malawi (MLW-1)

Site descr.: Biosphere reserve with diverse ecosystem from Miombo woodland to dense humid endemic Mulanje montane forest 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 km²

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 km²

ROI: [GAB-1.kmz]

ROI for VHR sensors: [GAB-1_VHR.kmz]

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/>

MLW-1**MINIMUM REQUIRED¹ DATASETS** (¹Critical: 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 REQUIRED¹ DATASETS** (¹Critical: 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 1/2, Sentinel-1) data for monitoring of forest disturbance and recovery.

OUTCOMES:

1. Refined Algorithm 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:

- Phase 1: Compilation of time-series data
- Phase 2: Compilation of relevant reference data
- Phase 3: Development and Application of joint SAR/optical change detection algorithms
- Phase 4: Assessment of relative merits of SAR/SAR. Optical/optical and SAR/optical combinations

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 km²

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 km²

ROI: COL-6.kml

ROI for VHR sensors: Not yet decided

GFOI R&D Group 3

Principal Investigator:

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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>

COMPLEMENTARY² DATASETS (²Non-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 PALSAR-1
- ALOS-2 PALSAR-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, and possible integration with active fire alerts
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.

- 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.
- BOL-1: Dry tropical forest strongly affected by large area commercial deforestation
- SUM-3: Natural (dry and evergreen) and plantation forest affected by large-scale forest cover loss due to agricultural expansion and fires.

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.
4. New approach to integrate dense Sentinel-1 alerts with active fire alerts.
5. Characterization of forest disturbance alerts using machine learning on TerraSAR-X SpotLight data to describe extent, severity and cause of forest change. The goal is to integrate Sentinel-based forest change alerting with VHR TSX data to provide near real-time decision support (jointly with Group 15).

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.

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](http://www.wageningenur.nl)

Project www:

<http://baci-h2020.eu/index.php/>

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]
- Publication in peer-reviewed journal, outcome 1 [Jan 2018]
- Outcome 1, reported to GFOI and CEOS/SDCG [March. 2018]
- MSC thesis submission, outcome 2 and 3 [June 2018]
- Submission to peer-reviewed journals, outcome 4 [June 2018]
- Outcome 2,3 and 4 reported to GFOI and CEOS/SDCG [Feb. 2019]

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

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 km²

ROI: FIJ-1.kmz

ROI for VHR sensors: FIJ-1.kmz

Province of Santa Cruz, Bolivia (BOL-1)

Site description: Dry tropical forest strongly affected by large area commercial deforestation, southeast of the province of Santa Cruz, Bolivia. Being one of the wettest regions of Bolivia, this area is characterized by a humid tropical climate with distinct wet (~October – May) and dry seasons (~June – September). The change from wet and dry seasons is associated with a strong change in photosynthetic activity of the forest. Deforestation in the area is mainly caused by large-scale industrial logging and agricultural expansion, resulting into visible patches of land cleared from forests.

In situ data: VHR-based map.

Centre coord.: S18.4 / W62.4

Site spatial footprint: 10 000 km²

ROI: BOL-1.kmz

Province of Riau, Indonesia (SUM-3)

Site description: The province of Riau is located in central Sumatra, Indonesia (centered at Lat. 1°N, Lon. 102°W), and covers about 9 million ha land area with elevations up to 1200 m. The dry season commonly ranges from April to Primary and secondary dryland, swamp and mangrove forest dominate the natural forest in Riau. Riau has the highest forest cover loss rates in Indonesia driven by mainly expansion and conversion to oil palm, arcacia, coconut and rubber plantations

In situ data: VHR-based map.

Centre coord.: N1 / W102

Site spatial footprint: 90 000 km²

ROI: SUM-2.kmz

MINIMUM REQUIRED¹ DATASETS – Site ETH-1

(¹Critical: 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 (Pleiades)		Jan - Dec	2016-2018			For validation.

OTHER DATASETS USED – Site ETH-1 (Not requested here)

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

MINIMUM REQUIRED¹ DATASETS – Site FJI-1

(¹Critical: 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 (Pleiades)		Jan - Dec	2016-2018			For validation.

OTHER DATASETS USED – Site FIJ-1

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

MINIMUM REQUIRED¹ DATASETS – Site BOL-1

(¹Critical: 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.

OTHER DATASETS USED – Site BOL-1

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

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

OTHER DATASETS USED – Site SUM-3

- 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 south from original FCT-GFC-2 location)

Site spatial footprint: 900km²

ROI: GFC-1.kmz, GFC-2.kmz

ROI for VHR sensors: GFC-1.kmz, GFC-2.kmz

MINIMUM REQUIRED¹ DATASETS – GFC-1 (FCT) & GFC-2'

(¹Critical: 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

Group 5

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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%20Year_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%20Year_2_Version_3.pdf

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

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 [Sep 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 km²

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 km²

ROI: SUM-2.kml

ROI for VHR sensors: SUM-2_VHR.kml

Calha Norte, Brazil (non-GFOI)

Site description: Dryland primary forest

Group 6

Principal Investigator:

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Co-investigators:

N/A

Project funding organisation/programme:

SarVision (Starling)

Project duration:

2010/10/01 2019/06/30

Organisation www:

<http://www.wageningenur.nl/en.htm>

MINIMUM REQUIRED¹ DATASETS – FCT-BOR-3⁽¹Critical: 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

COMPLEMENTARY² DATASETS – FCT-BOR-3 ⁽²Non-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 REQUIRED¹ DATASETS – FCT-SUM-2⁽¹Critical: 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

COMPLEMENTARY² DATASETS – FCT-SUM-2 ⁽²Non-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).

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]
- Two papers submitted to peer-reviewed journals [Q2 2018]
- Progress presentation at 2018 GFOI Science meeting [Q4 2018]
- One paper submitted to peer-reviewed journal [Q4 2019]
- Outcome 1 and 2 report to GFOI and CEOS/SDCG [Q1 2019]
- Two papers submitted to peer-reviewed journals [Q2 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]
- One paper submitted to peer-reviewed journal [Q2 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]

Group 7

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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 km²

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 km²

ROI: FCT-TNZ-6-Liwale.kml

ROI for VHR sensor:

MINIMUM REQUIRED¹ DATASETS – Sites FCT-TNZ-5 and FCT-TNZ-6

(¹Critical: 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)

COMPLEMENTARY² DATASETS – Site FCT-TNZ-5

(²Non-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)

- Landsat
- RapidEye
- LiDAR
- Sentinel-1A (dual-pol VV/VH)
- 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.

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 km²

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 km²

ROI: PNG-2.kml

ROI for VHR sensors: PNG-2_VHR.kml

Group 8

Principal Investigator:

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Project support organisation/programme:

HGC Internal Funding

Project duration:

Annual Review

MINIMUM REQUIRED¹ 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	GSD < 3m	All year	2015-2017	Monthly	New	Required for validation

COMPLEMENTARY² 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 REQUIRED¹ 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).

COMPLEMENTARY² 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).

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: km²

ROI: MEX-2.kml

ROI for VHR sensors: TBD (5x5 km²)

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: km²

ROI: MEX-3.kml

ROI for VHR sensors: TBD (5x5 km²)

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/>

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: km²

ROI: FIN-1.kml (Hyytiälä) and FIN-2.kml (Sodankylä)

ROI for VHR sensors: HFIN-1_VHR.kml (Hyytiälä)

MINIMUM REQUIRED¹ DATASETS – Site (FCT-MEX-2)

(¹Critical: 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	GSD < 3m	All year	2007 2010 2013 2015	Monthly (10 5x5 km images/year)	New	Required for validation of all products

COMPLEMENTARY² DATASETS – Site (FCT-MEX-2)

(²Non-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 REQUIRED¹ DATASETS – Site (MEX-8)

(¹Critical: 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	GSD < 3m	June 15 -Aug 31	2010 2014 2015	Monthly (10 5x5 km images/year)	New	Required for validation of all products

COMPLEMENTARY² DATASETS – Site (MEX-8)

(²Non-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 REQUIRED¹ 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	GSD < 3m	All year	2007 2010 2013 2015 2016	Monthly (10 5x5 km images/year)	Both	Required for validation of all products

COMPLEMENTARY² 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/Journal paper on interoperability and complementarity of SAR and optical systems for retrieval of forest biophysical parameters, assessment of robustness of methods in different forest type, comparison of monitoring potential of radar versus LiDAR for REDD+ activities.

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 [Dec. 2018]
- Submission to peer-reviewed journal (Dec. 2018)

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: km²

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

ROI AU-4.kmz

ROI for VHR sensors: TBD

Group 10

Principal Investigator:

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Project support organisation/programme:

CSIRO Land & Water, Landscape
Int4ensification Programme, Forest
Landscape Processes & Risks,
Landscape Observation & Simulation

Project duration:

Field work will be conducted between July 2017 and December 2017. Publication to be completed by December 2018.

Organisation www:

<http://my.csiro.au/Business-Units/Land-and-Water-Flagship.aspx>

MINIMUM REQUIRED¹ 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

COMPLEMENTARY² 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
- Sentinel 2 MSI
- Terrestrial Lidar (collected via in-house Compact Biomass Lidar instrument (or Dual Wavelength Echidna Lidar if available)

FOREST DISTURBANCE MONITORING AND BIOMASS ESTIMATION IN SAVANNAH WOODLANDS

Group withdrawn due to lack of funding.

No data have been obtained.

Group 11

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Laboratory)

Project support organisation/programme:

TERN Auscover

Project duration:

3 years

Organisation www:

www.unsw.edu.au

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

GFOI PRIORITY R&D TOPIC(S):

- Sensor interoperability/complementarity
- Above-ground biomass
- Forest change (wildfires)

RESEARCH OBJECTIVES:

- **Overall objective:** improvements to the mapping and monitoring of northern boreal forests through SAR/optical complementarity:
- **Objective 1:** Regional method development & implementation for improved large area mapping of biomass and wildfires 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).
- **Objective 2:** Local methods for mapping height from TanDEM-X (CAN-1) and wildfires from short time-series of optical (Landsat) and SAR data (PALSAR-1/2, Rsat-2, Sentinel-1; single TanDEM-X) along with various datasets (extended CAN-2/3 sites).

OUTCOMES:

- Compositing method 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-scale methods and improved 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.
- Local-scale methods and maps of wildfires using varied multi-temporal optical/SAR data including polarimetric SAR; method and map of height derived from TanDEM-X data. Peer-reviewed papers, report to GFOI.

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 progress report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journals [2018-2019]

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 (MVI) (Objective 1); includes three test-sites for testing refined methods for biomass and height (CAN-1) and fire mapping (CAN-2/3) lately extended to a broader area including ground plots in burned areas (Objective 2).

In situ data: Field visits with ground inventory plots, photos; airborne and spaceborne LiDAR data providing surrogate plots; land cover maps, others.

Group 12

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Natural Resources Canada, Canadian Forest Service, Canada

Project support organisation/programme:

Canadian Forest Service, regular program
Canadian Space Agency, GRIP program

Project duration:

2015/04/01 – 2019/03/31

Organisation www:

<http://www.nrcan.gc.ca/forests/about/17545>

Project www (if any):

[Pilot region and sites CAN-1/2/3:](#)

Centre coord.:

CAN-1: N61.40 / W121.30

CAN-2: N62.00 / W116.50

(Main site for fire mapping investigations; was further extended in Dec. 2016 to include 63 ground plots established in 2015 by CFS within six wildfires) .

CAN-3: N61.52 / W120.35: this site, next to CAN-1 site, won't be ground-truthed but is still relevant as a complement to site CAN-2 for fire mapping investigation.

Site spatial footprint:CAN-1: 3757 km²

CAN-2: 13509 km² → extended to 62 800 km² without requiring additional datasets from GFOI beyond the latest PALSAR-2 allocation (Jan. 2017). This extension was necessary to include scattered clusters of ground plots established within six 2014 wildfires.

CAN-3: 2346 km²**ROI:**

CAN-1.kml

CAN-2.kml

CAN-3.kml

MINIMUM REQUIRED¹ DATASETS – Site CAN-1/2/3

(¹Critical: without which the study cannot be completed)

Mission/ Sensor	Obs 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 obj 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
ALOS-2 PALSAR**	FP	June-Sept	2015-2016	1 / summer	Archived	Required for testing fire mapping using polarimetric vs dual-pol PALSAR-2

* Datasets initially requested through GFOI; they were mostly requested or obtained through other sources for various reasons independent of GFOI.

** Recent allocation of 15 PALSAR scenes (Jan, 2017) through GFOI to better cover the extended site CAN-2 and acquire polarimetric datasets. 9 out of 15 scenes were downloaded.

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 (2015-2016) yearly 25m PALSAR global mosaics¹
- ALOS-1/2 PALSAR FBD scenes (2010-2016)¹: 25 PALSAR-2 scenes were obtained through a JAXA-CSA MOU on the theme of disaster management.
- Radarsat-2 scenes (2016-2017)¹: 142 scenes acquired through CSA.
- ICESAT-GLAS¹
- Sentinel-1A (VV/VH): complementary SAR imagery partly investigated within the timeframe of the project.

¹Critical datasets; 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.

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
2017/02	Outcome 1 & 2 preliminary report to GFOI and CEOS/SDCG
2017 Q2	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
2017 Q4	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 km²

ROI: BRA-2.kml

ROI for VHR sensors: BRA-2_VHR.kml

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>

BRA-2**MINIMUM REQUIRED¹ DATASETS**

(¹Critical: 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, 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 variability 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 km²

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 (Dipterocarpaceae) 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 Climate Change) project.

Centre coord.: 2° 26.517'S/103° 17.921'E

Site spatial footprint: 625 km²

ROI: SUM-1.kml

GFOI R&D Group 14

Principal Investigator:

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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 REQUIRED¹ DATASETS**

(¹Critical: 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 REQUIRED¹ DATASETS**

(¹Critical: 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:

- Near-Real Time forest change indicators mapping
- Assess changes in dense tropical forests to monitor forest degradation and regrowth
- Forest stratification

RESEARCH OBJECTIVES:

1. Analyzing synergy-effects of Sentinel-2, SPOT 6/7 and TerraSAR-X/ TanDEM-X for baseline and forest disturbance mapping
2. Characterization of forest disturbance alerts using machine learning on TerraSAR-X SpotLight data to describe extent, severity and cause of forest change. The goal is to integrate Sentinel-based forest change alerting with VHR TSX data to provide near real-time decision support (jointly with Group 4).

OUTCOMES:

1. Methodology and prototype implementation of forest disturbance monitoring tool using VHR SAR and optical data.
2. Computer vision and machine learning techniques to exploit information content of VHR X band SAR data to characterize forest change alerts in near real time.

TIME SCHEDULE:

- Progress presentation at GFOI Science meeting
- Project 2:2018 – Project definition, fund raising
2019 – Project Kick-off
- Submission to peer-reviewed journal [TBD]

STUDY SITES:

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]

French Guiana (GUF-1)

Site description: The study area is located in the Régina commune (arrondissement Cayenne) of French Guiana. The area is primarily covered by tropical forest and subject to legal exploitation.

In situ data: Logging data from ONF

Centre coord: 4°13'44.38"N, 52°9'21.46"W

Site spatial footprint: 7,500 ha

ROI for VHR sensors: [GHA-1_VHR.kml]

GFOI R&D Group 15

Principal Investigator:

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Project funding

organisation/programme:

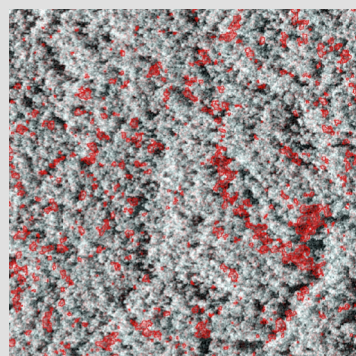
Federal Ministry of Economics and
Technology, German Aerospace Center

Project duration:

01.01.2018 – 31.12.2021

Organisation www:

<http://www.geo-airbusds.com>



All sites**MINIMUM REQUIRED¹ DATASETS**

(¹Critical: 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

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)

RETRIEVAL OF STRUCTURAL ATTRIBUTES AND CARBON STOCKS 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:

- Methods for retrieval of woody vegetation attributes (cover, height, biomass, carbon), changes over time due to land management, climate and ecological dynamics, both inside and outside of protected areas, and 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 woody cover, height and biomass in South African savannahs and indigenous forests types using field, airborne LiDAR, and optical/SAR imagery. Peer-reviewed publication.
- Assessment of ASAR and Sentinel-1 SAR time-series for mapping biomass. Peer-reviewed-publication.

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.: 24°47'S, 31°26'E (top left 23°53'S, 30°40'E, bottom right 25°35'S, 32°04'E)

Site spatial footprint: 27000 km²

ROI: SA-1.kml (VHR ROI 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.: 32°50'S, 26°06'E (top left 32°16'S, 24°51'E, bottom right 32°20'S, 27°22'E)

Site spatial footprint: 35000 km²

ROI: SA-2.kml (VHR ROI N/A)

Group 16

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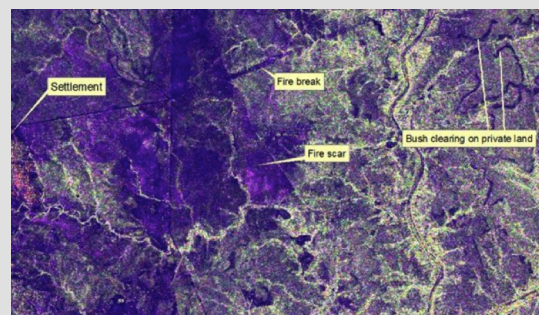
Multiple

Project duration:

2015/06/01 – 2018/05/31

Organisation www:

www.csir.co.za



KwaZulu-Natal Savannas and Coastal Forests (SA-3), South Africa

Site description: Coastal forests and wetland sites of the iSimangaliso Wetland Park (World Heritage/Ramsar site), adjacent commercial plantations, and populated landscapes, and the savannas / 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. LiDAR tracks

Centre coord.: 28°19'S, 32°00'E (top left 27°57'S, 30°54'E, bottom right 28°46'S, 33°13'E)

Site spatial footprint: 30000 km²

ROI: SA-3.kml (VHR ROI N/A)

MINIMUM REQUIRED¹ DATASETS – Site SA-1, SA-2, SA-3

(¹Critical: without which the study cannot be completed)

Mission/ Sensor	Obs 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		1 st prio: summer – leaf-on (Dec-March) 2 nd prio: winter leaf-off (June-Sept)	2016-17	1 interfero- metric pair per season	New	Required for objective 1 (mapping height)
ALOS-2 PALSAR-2	1. HH+HV 2. FBD (default)	1 st priority winter – dry (June-Sep) 2 nd prio: summer –wet (Dec-Mar)	2015- 2018	Monthly	ALOS-2 BOS archive	Required for objective 1 (mapping biomass and cover)
VHR (Pleiades)	GSD < 2m	Autumn (April- May) / Spring (October- November)	2016-17	Cloud-free, once per season (i.e. 2 coverage)	New	Validation, GSD critical for assessing cover and biomass in open forests

COMPLEMENTARY² DATASETS – Site SA-1 only

(²Non-critical but can enhance outcomes)

Mission/ Sensor	Observat ion 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	Staring SpotLight High Res SpotLight	1 st prio: summer – leaf-on (Dec-March) 2 nd prio: winter leaf-off (June-Sept)	2016-17	2-4 scenes per seasons	New	Complementary to TandemX data, assessment height with multi-image stereoscopic SAR

COMPLEMENTARY² DATASETS – Site SA-1, SA-2, SA-3²(Non-critical but can enhance outcomes)

Mission/ Sensor	Obs mode	Observation time window	Required duration	(Minimum) observatio n frequency	Archive data OR New acq.	Justification (Impact on the project deliverables if dataset not delivered)
RADARSAT-2	Full Pol	1 st priority winter – dry (June-Sep) 2 nd prio: summer –wet (Dec-Mar)	2016- 2018	2-4 scenes /season	New	Complementary to Sentinel-1 & ALOS PALSAR. Enables full-pol / time series assessment for Objective 1
SPOT5(Take5)	N/A	Season winter (June-August) – spring (September- November), summer (December- February), autumn (April	2016-17	1-2 scenes per season	New	Complementary to VHR data, assessment multi-season optical

OTHER DATASETS USED – Site SA-1, SA-2, SA-3

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

- ALOS-1 PALSAR-1
- Landsat ETM+ / 8
- MODIS/MISR
- ENVISAT ASAR WSM VV/HH
- Sentinel-1A dual-pol (HH, VH)
- Sentinel-2A
- LiDAR tracks (SA-1 and SA-3 only)

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:

- Improved method of estimating forest area and forest change with C-/L-band SAR data/time series.
- Validation report on C-/L-band SAR data based forest and forest change mapping with VHR optical data and comparison with GFC results.

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 GFOI sessions at ISRSE in South Africa (May 2017)
- Final report of ESA DUE Innovator III "SAR for REDD" (Dec. 2017)
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Feb. 2018]
- Submission to peer-reviewed journal

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:

- From fieldwork in March 2013 along the route R204 (Selenge to Benye): 7 forest inventory plots, aerial photography from 5 sites, ground photography along route R204 especially from forest/non-forest transitions,
- From fieldwork in September 2016 in the Kwamouth region along the road from Masia-Mbio to Kwamouth: aerial photography from 14 sites, ground photography and GPS positions collection along the road, especially from forest/non-forest transitions. Some tree height and tree count measurements.

Centre coord.: S2.70 / E18.50

Site spatial footprint: 128789 km²

ROI: DRC-1.kml

Group 17

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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
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MINIMUM REQUIRED¹ 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	June-Sept Jan	2016-2017	Monthly	New	Required for sensor interoperability studies (objective 2)
VHR (Pleiades)	GSD < 3m	June-Sept Jan-Feb	2016-2017	Monthly	New	Required for validation

COMPLEMENTARY² 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	Dense 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]
- Capacity Building Workshop South Africa [May 2017]
- Intermediate Results [Feb 2018]
- Progress presentation at GFOI Science Meeting 2018
- Progress presentation at ForestSAT 2018
- Capacity Building Workshop Mexico [late 2018]
- Outcome 1 and 2 final report to GFOI and CEOS/SDCG [Dec. 2019]

STUDY SITES:

Mexico: Kiuic (MEX-4) and Hidalgo (MEX-6)

Site description: Tropical and temperate forests partly 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.:

N20.09 / W89.53 (MEX-4)

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.: S25.02 / E31.5

Site spatial footprint: 4.000 km²

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.

Group 18

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DLR/BMWi

Project duration:

2016/06/01 – 2019/12/31

Organisation www:

<http://www.eo.uni-jena.de/>

MEX-4, MEX-6, SA-4**MINIMUM REQUIRED¹ DATASETS**

(¹Critical: 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-6, SA-4**COMPLEMENTARY² DATASETS**

(²Non-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)