



CEOS Contribution to GFOI





Committee on Earth Observation Satellites

Peak coordination body for space agencies operating civil satellite EO programs

55 Agencies operating 112 satellites

Members provide all free and open core data streams

Landsat, Sentinel-1 and -2, plus many others and PPP support

Major contributor to GEO with members providing



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Major contributor to GEO, with members providing virtually all space-based data



\$ billions invested in space infrastructure...

Context and Overview

GFOI aims to provide...

A platform for the coordination of forest observations

Assistance and guidance on the utilisation of those observations

Support to governments in the development of their national systems

... via ...

*fostering the availability of **Space Data***

Methods and Guidance

Capacity Building and Promotion of R&D

CEOS Contributing to GFOI

Space Data Component Lead, and established the SDCG through agency participation

GFOI R&D Plan contributing resources, expertise, and data to developing key enabling elements

Capacity Building participating in workshops run by SilvaCarbon providing space data support

MGD providing linkages to the space data needs outlined and via MGD 2.0 / Portal

Individual space agencies sponsor a number of forestry related activities inline with national priorities and mandates, including technology development, infrastructure, and foreign aid

Space Data Component History

2009 - 2010: Support to GFOI Precursor GEO-FCT

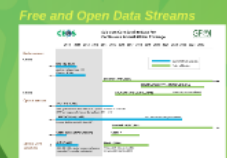
Space agency foundational investment in GFOI

2010 - 2011: GFOI Formation, CEOS Strategy for GFOI Endorsed

Space agency policy statement in support of global forest monitoring

2012 - 2013: Global Coverage Assured by 2016

Global Baseline Data Acquisition Strategy



2014: Tailored National Space Data Services

Space Data Services for GFOI Strategy

A diagram titled "Space Data Services" showing a list of services and their descriptions. It includes a small globe icon and text detailing the scope and goals of the services.

Free and Open Data Streams



Sub-30m Core Satellite Data For Continuous, Annual, Global Coverage



2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

Radar sensors

C-band

← **ERS-1&2 (ESA)**
Archive available from 1991

← **Envisat (ESA)**

Sentinel-1A/B/C (ESA)

RADARSAT CONSTELLATION 1/2/3 (CSA)

L-band

SAOCOM-1A/B -2A/B (CONAE)

Data policy to be confirmed

Optical sensors

← **SPOT 1-5 (CNES)**
SPOT global archive data older than 5 years is available as core data
SPOT coverage available over Congo basin 2008 - 2015

← **LANDSAT-7/-8 (USGS)**
Landsat Archive available from 1972

LS-7 technical/coverage limitations

Sentinel-2A/B/C (ESA)

← **CBERS Series (INPE/CRESDA)**

CBERS-4

Special Core Data Sets

← **ALOS (JAXA)**
2007-2010 50m global mosaic available as core data. 25m product anticipated

ALOS-2 (JAXA)
Annual ALOS-2 mosaics will be freely available starting 2014

Current/Past Mission

Future Mission

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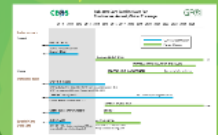
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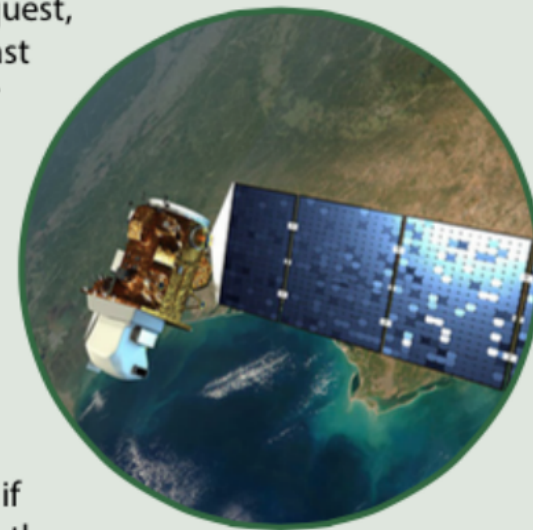
Space Data Services for GFOI Strategy

Space Data Services

2015+: Implementation of Baseline and Services

Space Data Services

1. **Regional GFOI Space Data Workshops** — including leveraging the substantial contribution of existing GFOI capacity building efforts in Africa, South America and Southeast Asia, to build relationships and determine requirements and priorities.
2. **Impartial National Space Data Needs Assessments** — as a service to individual governments seeking to establish their MRV strategies and the role of space data therein; SDCG will help determine their capacity and requirements for all kinds of space data including core, contributing, and commercial data.
3. **National Historical Coverage Reports** — to assess, on request, what satellite data exist for a given country or region for past years, including that in support of setting reference levels for national reporting obligations under UNFCCC.
4. **Ensured On-going Coverage** — tailored support to ensure that on-going national baseline acquisitions are included in the long-term acquisition strategies of all supporting data.
5. **Satellite Data Discovery, Assembly & Delivery** — support for the fundamental tasks around identifying and, if necessary, delivering data (or derived products) supplied by the core data supply agencies for national coverage.
6. **Cloud Storage, Processing, and Analysis of Satellite Data** — via the Space Data Management System (SDMS) and other GFOI Space Data Services prototypes for countries whose spatial data infrastructure necessitates a virtual national capability for GFOI. This system will be developed in close cooperation with FAO and will ensure compliance with the MGD and IPCC guidelines for the national reporting obligations.



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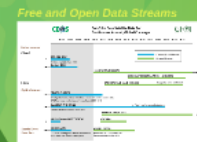
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Space Data Services for GFOI Strategy



**2015+: Implementation of Baseline and Services
Data Provision to R&D**

SDCG 3-Year Work Plan 2015 - 2017

Space Data Coordination Group Role and Outcomes

*Direct influence on global acquisition strategies at
USGS and ESA*

Landsat-8 image request increase from 550 to 725 per day

*Sentinel-1A+B (C-band SAR) forested areas increased in
acquisition plan priority*

Sentinel-2A+B operational plans including full forest coverage

Advocacy for open data availability

*Willingness to rally around clearly expressed space data
requirements*

Space Data Coordination Group Role and Outcomes

Space Data Management Support from SEO

Data search/discovery, archive assessment and acquisition planning - development of links to archives for search

Development of Space Data Management System (SDMS) prototypes and development of systems engineering tools

FAO Prototype delivered in November 2014

Colombia Prototype delivered in December 2014 - high-resolution TanDEM-X data provided by DLR

Kenya Prototype under development supporting SLEEK - leveraging Data Cube provided by Geoscience Australia

Helping countries understand and access space data and services they require

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CEOS SEO (NASA funds) country assessments and support

Working to address FAO, World Bank, and SilvaCarbon priorities

In 2014 USGS delivered Landsat data on physical media to 20 GFOI countries (including Kenya via SEO)

Ongoing Activities

Development of SDCG 3-Year Work Plan

Providing continuity for 2015 - 2017

Designed to communicate plans with the GFOI Leads, other GFOI components, CEOS, space agencies, countries, stakeholders

Global Baseline Data Acquisitions

Landsat-7 and Landsat-8, Sentinel-1A, CBERS-4, soon to be joined by Sentinel-2A

Coordination role continuing to grow with new data streams - programming influence

R&D support

Many space agencies providing significant support

GFOI-specific acquisition strategy ready, but need direction and structure from GFOI Leads



Space Data Services

3 Year Vision

Development of
scalable tools and
sustained
capabilities based
on the prototypes
and pilots that
SDCG has been
exploring

Space Data Services

Service Definition

Collaboration with FAO, WB, MGD, and SilvaCarbon

Regional Workshops

National space data needs for GFOI priority countries

Ensured Coverage

Archives, tools, customisation for GFOI priority countries

Discovery Tools

Interoperable tools for core data via single access point

Space Data Services

Services
3 Year Vision

Development of scalable tools and sustained capabilities based on the prototypes and pilots that SDCG has been exploring

Assembly Delivery

Core data, existing portals, through Capacity Building

MGD Integration

Derivation of GFOI standard products using space data

Cloud Computing

Pilots supporting national MRV implementation via MGD

Model Country

Incorporating lessons learned from pilots, including SDMS



Space Data Services

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Cloud Computing

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Country Engagement

Ad hoc coordination with SilvaCarbon at GFOI meetings

Addressing bilateral priorities and needs opportunistically (e.g. Kenya)



Needs direction from the Leads

Overall strategy, better links to FAO and World Bank, priority countries, trajectory and roles

Priorities needed for data acquisition

19 Countries to Date

SDCG-4

September 2013:
Colombia*,
Peru*,
Ecuador*,
Mexico*,
Guyana,
Honduras

SDCG-6

October 2014:
Bangladesh,
Indonesia*,
Nepal*,
Philippines*

SC Thai.

February 2014:
Thailand*,
Vietnam*,
Cambodia*,
Laos,
Philippines,
Nepal*,
Indonesia*

SC Colombia

September 2014:
Colombia*,
Nepal*, Laos*,
Cambodia*,
Vietnam*,
Bangladesh*,
Ecuador*,
Peru*, Mexico*

SDCG-5

February 2014: Uganda,
Zambia, DRC,
Tanzania,
Kenya*,
Colombia*

SDCG-7

March 2015:
Kenya*,
Cambodia*,
Colombia*

Addressing bilateral priorities and needs opportunistically (e.g. Kenya)

Needs direction from the Leads

Overall strategy, better links to FAO and World Bank, priority countries, trajectory and roles

Priorities needed for data acquisition and management, including tailored products (e.g. data cubes)

MGD Links

3-Year Work Plan Vision:

SDCG acting to promote and provide linkages and improve integration with the other components ...

Including Methods and Guidance via MGD 2.0 / Portal

R&D Acquisitions

Support through the GFOI R&D Plan

Focus on filling gaps in R&D; enabling

*Data contributed from Italy, France,
Germany, Japan, Canada*

*GFOI R&D governance issues to be
addressed*

Examples of Direct Agency Contributions to Forestry



Congo Basin Initiative (SPOT archive processing/distribution)

National R&D Projects on large area monitoring for REDD, degradation, and biomass

X-band research into canopy structure, degradation, land use

Forestry acquisitions included in RS-2 background mission

Kyoto & Carbon Global Forest/Non-Forest Products



Funding of Global Forest Cover Change (GFCC) Project (Matt Hansen)

Funding development of global WELD (Landsat) cloud free mosaics

SERVIR support to forestry



Development of LCMAP project enabling generalised land cover change detection with Landsat



Sentinel-1 for GFOI



Several areas have been acquired during the Sentinel-1 ramp-up phase for GFOI (overall / dual-pol):

- Colombia 521 / 21 scenes
- Ecuador 236 / 0 scenes
- Peru 574 / 5 scenes
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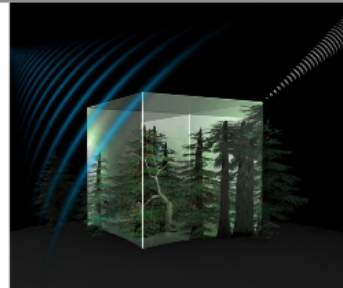
European Space Agency

Earth Explorer BIOMASS



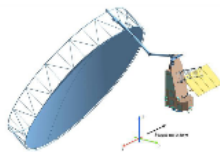
BIOMASS will be the **7th Earth Explorer**

- Selected by ESA's Earth Observation Programme Board in 2013 and confirmed in February 2015
- Biomass based on global interferometric and polarimetric P-Band Radar observations
- Essential to understand the Earth's carbon cycle
- To be launched in 2020



EE7 BIOMASS products

- Above ground forest biomass
- Upper canopy height
- Areas of forest clearing



Spot-5 / Take-5 Experiment



- **Spot-5 will deorbit** from April to August 2015;
- CNES and ESA have decided to repeat the **Take5 R&D activity** with the Spot 5 satellite to put it in a 5-days repeat mode, similar to Sentinel-2A/B;
- covers a larger part of the **vegetation period** in the Northern hemisphere;
- have an **improved** **Input to R&D operability, forest degradation and biomass estimation** variety of modes wrt Spot4/Take5 (1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10 → 11 → 12 → 13 → 14 → 15 → 16 → 17 → 18 → 19 → 20 → 21 → 22 → 23 → 24 → 25 → 26 → 27 → 28 → 29 → 30 → 31 → 32 → 33 → 34 → 35 → 36 → 37 → 38 → 39 → 40 → 41 → 42 → 43 → 44 → 45 → 46 → 47 → 48 → 49 → 50 → 51 → 52 → 53 → 54 → 55 → 56 → 57 → 58 → 59 → 60 → 61 → 62 → 63 → 64 → 65 → 66 → 67 → 68 → 69 → 70 → 71 → 72 → 73 → 74 → 75 → 76 → 77 → 78 → 79 → 80 → 81 → 82 → 83 → 84 → 85 → 86 → 87 → 88 → 89 → 90 → 91 → 92 → 93 → 94 → 95 → 96 → 97 → 98 → 99 → 100 → 101 → 102 → 103 → 104 → 105 → 106 → 107 → 108 → 109 → 110 → 111 → 112 → 113 → 114 → 115 → 116 → 117 → 118 → 119 → 120 → 121 → 122 → 123 → 124 → 125 → 126 → 127 → 128 → 129 → 130 → 131 → 132 → 133 → 134 → 135 → 136 → 137 → 138 → 139 → 140 → 141 → 142 → 143 → 144 → 145 → 146 → 147 → 148 → 149 → 150 → 151 → 152 → 153 → 154 → 155 → 156 → 157 → 158 → 159 → 160 → 161 → 162 → 163 → 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→ 997 → 998 → 999 → 1000
- assuming a 5-day repeat cycle, thus resulting **~ 30 images per site**;
- Dedicated **GFOI input** during 2nd R&D Expert workshop on forest degradation and open call by ESA resulting in **28 forest related sites** globally.

European Space Agency

Tropforest



GOFC-GOLD REDD+ Sourcebook





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Growing REDD Experiences in Africa

1. REDD Pilot Cameroon (2007-2009)
2. REDD Extension in Rep. of Congo and Gabon with AFD
3. REDD for Africa Cameroon and CAR
4. Additional Mapping in Rep. of Congo and Gabon with AFD
5. REDD+ MIV for SADC with AFD
6. GSE REDD+ by Forest Mapping in Malawi, Zambia and Zimbabwe

DUE Innovators for GFOI

Objective: Respond to the Research & Development Agenda of major international initiatives e.g. GFOI, GEOGLAM, GEOBON, GCOSS

Project Activities:

1. Perform the necessary R&D preparatory work to exploit the most innovative aspects of Sentinel-1 and Sentinel-2 for REDD+ activities
2. Develop a user community in Southern Africa for Sentinel 2
3. Improve accuracy of forest cover change maps and statistics for REDD reporting
4. Technology transfer to new user community (i.e. capacity building)

ROI: March 2015
Budget: € 200,000
Duration: 2 years

GSE FM REDD – Dry Forests

Adaptation of current GSE FM processing chains for dry forest mapping needed:

- Methods for utilization of frequent multi-seasonal images (i.e. simulation of Sentinel 2 data for improving dry forest mapping)
- Development of standardised processing protocols to utilise existing and improved mapping systems
- Expansion of GSE FM portfolio to meet SADC REDD+ requirements

Outcomes:

- Prepared user community in Southern Africa for Sentinel 2
- Improved accuracy of forest cover change maps and statistics for REDD reporting
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Earth Explorer BIOMASS

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- covers a larger part of the world in the Northern hemisphere;
- have an improved portfolio of modes wrt Spot4/Take5
- assuming a 5-day revisit frequency, this resulting ~ 30 images per site;
- Dedicated GFOI implementation 2nd R&D Expert workshop on forest degradation and deforestation call by ESA resulting in 28 forest related sites globally.

Forest Mapping in support of World Bank activities

Objective: Provide an independent expert opinion on the accuracy of various remote RS based assessments and aerial photographs and to map overlap of various types of land alterations.

Results: Over the last several Forest Management Conferences (FMC) have been working with existing Member Countries and Agricultural Conferences, and associated work.

Follow-up activity in 2014 to map ALL of the Republic of Liberia, constant dataset.

Financed by the Forestry Development Authority using a WFP GFP grant for REDD+ readiness preparation.

DUE GlobBiomass

Objective: Provide the user communities with a better characterization of the distribution and changes, and an improved quantification of regional and global biomass.

Project Activities:

1. Improve above ground biomass for 2010, and stock and change in 2005, 2010 and 2014
 - Better geometric resolution
 - Improved accuracy
 - Validation (discrepancy, error statistics)
2. Platform for data sharing and validation
3. Better analysis of landscape (forest typologies)
4. Standardization of maps

Prime: University of Jena, Germany
c.schulze@uni-jena.de

ROI: Jan 2015
Budget: €1,200,000
Committed users: 14
Duration: 3 years

GSE Forest Monitoring REDD in Gabon

Forest cover change map 2010-2013

Forest cover change map between 2010 and 2013 for Gabon

Tropforest

Principal Objective: Establish a database of ortho-rectified satellite imagery for monitoring deforestation and assessing carbon emissions in the tropics for the years 2009 and 2010.

Users:

- JRC TR3ES-3
- FAO with P&A and UN-REDD

	Sampling Interval		TOTAL
	3x1 day	3x3 day	
Latin America	1,230	302	1,532
South/Southeast Asia	743	179	922
TOTAL	1,973	481	2,454

ROI: 2009-2010
Budget: 1.5M
Duration: 2 years

GFOC-GOLD REDD+ Sourcebook

Complementary GFOI Method and Validation Document

A sourcebook of procedures for monitoring and reporting on greenhouse gas emissions and removals associated with deforestation, peat and losses of carbon stocks in forests remaining forests, and forestlands

http://www.gfoi.org/wu-ri/redd

BIOMASAR: Pan-boreal GSV

Growing Stock Volume (GSV) in m³ha obtained with BIOMASAR algorithm for all vegetated areas

Reference year: 2010

Map projection: geographic coordinates

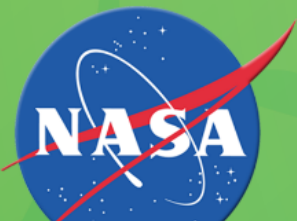
Pixel size: 0.01 degree (~1 km)

ESA EO Thematic Exploitation Platforms

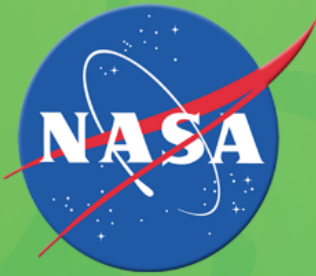
Facilitate effective and economically sustainable use of computing infrastructures and ground segment capabilities by European scientific communities and industry:

- Thematic – addressing thematic domains of possible applications
- Scientific – aiming at the scientific community
- EO data
- Exploitation platform – offering a development, data exploitation and data access, etc.
- Thematic Coastal, Forestry, Hydrology, Polar, Urban, Geohazard

ROI: March 2015
Budget: €1,000,000
Committed users: 5
Duration: 3 years



Funding of Global Forest Cover Change (GFCC) Project (Matt



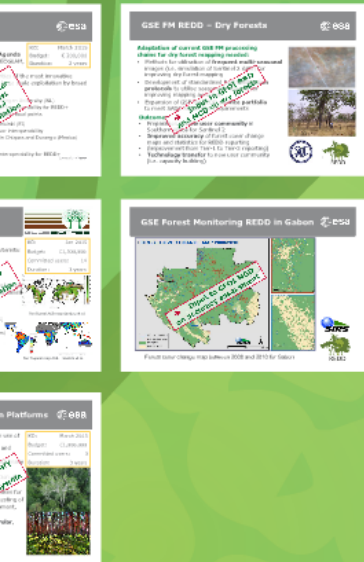
Funding of Global Forest Cover Change (GFCC) Project (Matt Hansen)

Funding development of global WELD (Landsat) cloud free mosaics

SERVIR support to forestry

Development of LCMAP project enabling generalised land cover change detection with Landsat





Congo Basin Initiative
(SPOT archive
processing/distribution)



National R&D Projects
on large area
monitoring for REDD,
degradation, and
biomass



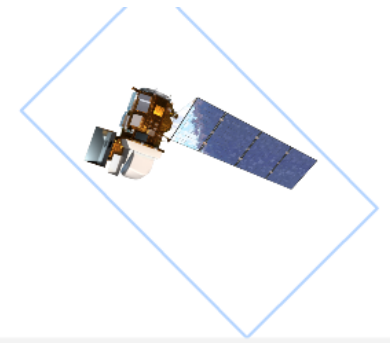
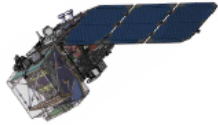
X-band research into
canopy structure,
degradation, land use



Forestry acquisitions
included in RS-2
background mission



Kyoto & Carbon Global
Forest/Non-Forest
Products



CEOS integral and supportive Lead for GEO/FCT and GFOI since inception

Significant specific support to GFOI reach

Billions invested in space infrastructure

Providing space data services support – helping countries navigate and access space data

Pilots like SDMS and Data Cube removing obstacles to application of Space Data in national MRV

Guaranteeing minimum coverage in support of future climate treaties and performance-based mechanisms

Continued strong support from key space agencies

Landsat - USGS
Sentinel - ESA/EC
CBERS-4 - INPE

Asking CEOS to endorse 3-Year Work Plan later in March