

# **GFOI Space Data Services**

**Support for GFOI Participating Countries**

**Version 0.1  
Draft for country consultation**

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## 1 Introduction and Context

This paper describes a collection of **Space Data Services** being developed by the CEOS Space Data Coordination Group (SDCG) for GFOI. It forms the basis for a dialogue with the community, with the goal of ensuring the services proposed are relevant and well targeted at the needs of countries.

Ensuring sustained satellite data supply is one of the four pillars of GFOI implementation, and the first step to supply is acquisitions. In 2012, the SDCG developed a global data acquisition strategy for GFOI outlining a phased plan utilising satellites with free and open data policies (i.e. “Core data streams”, see Figure 1). This strategy has been endorsed by CEOS, and will scale to provide global acquisition coverage for countries participating in GFOI as mission capacity is added.

The SDCG is now looking at the next step in ensuring the satellite data supply in the form of a strategy for **GFOI Space Data Services**. The objective of these services is to provide more targeted country support, based on national needs, and existing and planned capacities and relationships.

The **GFOI Space Data Services** being considered can be divided into five broad categories.

- **Historical Coverage Characterisation:** support to discover which data exists for a given country for past years;
- **Ensured Ongoing Coverage:** more tailored support to ensure ongoing national acquisitions are ensured pro-actively;
- **Core Data Delivery:** support for physical delivery of data;
- **Core Data Value Adding:** enhanced core data products, including the generation of cloud-free mosaics; and
- **Data Processing:** capacity to generate inputs to forest information products.

The intention is that the SDCG will work with the pilot countries to scope and scale each of these services in order to optimise their utility, determine what assets and capabilities exist for their development, and what further resources may be needed.

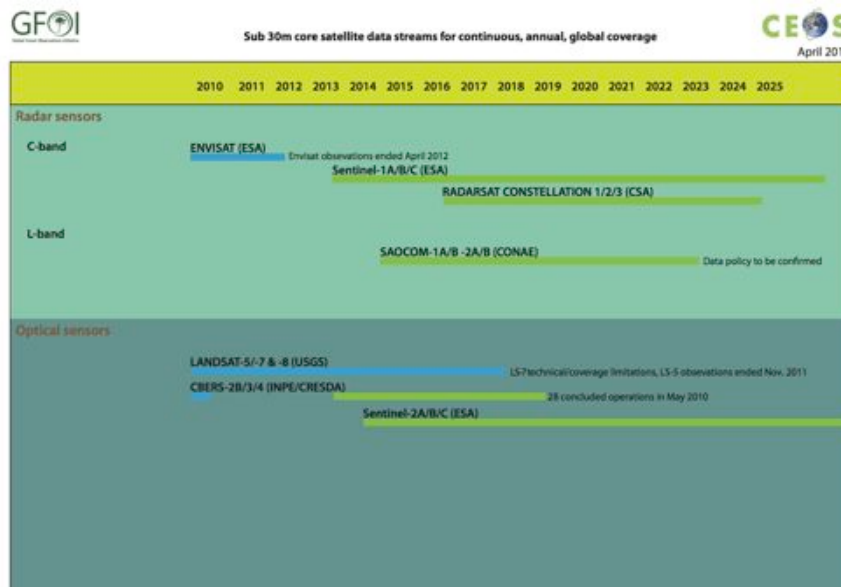


Figure 1 Core Data Streams for GFOI

## 2 GFOI Operational Scenario

The **GFOI Space Data Services** will be delivered in the context of the *GFOI Operational scenario for satellite data acquisition, archiving, processing and delivery*. The development of this operational scenario will be led by the GFOI Office.

Under this operational scenario, the GFOI Office will serve as the main point of contact and coordination for the interaction with countries. In order to best leverage existing resources, it is expected that the GFOI Office will work in close coordination with groups such as SilvaCarbon, FAO, UN-REDD, and others.

## 3 Historical Coverage Characterisation

The SDCG will work with the GFOI Methods and Guidance authors and GFOI countries, to develop a historical coverage characterisation service. The objective of this service will be to help countries determine what satellite data exists in the archives. It is expected this service will support efforts to establish a baseline year for national Measurement Reporting and Verification (MRV) systems, and assessment of trends in forest coverage changes. SDCG will directly support this service for the Core data streams (Figure 1).

For Contributing data streams (i.e. those not included in the Core data streams), historical coverage characterisation will rely on the resources of the operator of the data stream – this might include the associated CEOS agency and/or the private sector. SDCG agencies have indicated they will consider archive search support for RADARSAT (CSA), TerraSAR-X (DLR), and SPOT (CNES) – though the details remain to be coordinated.

The service will provide guidance and tools to enable countries to discover archive contents themselves. This will help to empower countries, allowing them to engage and take ownership. It should be developed in coordination with FAO,

which supports a number of countries in the execution of forest monitoring initiatives such as REDD+.

In addition, the CEOS Systems Engineering Office (SEO) has started to develop the tools and process to support these services. This includes leveraging existing CEOS groups and activities, for example the Working Group in Information Systems and Services (WGISS) and their OpenSearch activity.

## 4 Ensured Future Acquisitions Service

### 4.1 Core Coverage Tracking

The first step in ensuring acquisitions by Core data streams for engaged GFOI countries will be spatially explicit reporting. The objective of this reporting is to assure countries that the imagery they require has been acquired for all regions of interest.

Coverage tracking for engaged GFOI countries should expand in sync with the phasing of the global acquisitions strategy. Both qualitative (i.e. map) and quantitative (i.e. percent coverage at sub-national scales) coverage information should be made available at least annually, and more frequently if information allows.

### 4.2 Ensuring Future Core Data Stream Acquisitions

The next step in ensuring acquisitions by Core data streams will be pro-active, including targeted acquisition requests to satellite operators to minimise coverage gaps. Limitations in coordination, processing, and satellite capacity mean that SDCG may not be able to deliver this service to all countries in the initial phases of implementation. This means that priority would be given to countries that have shown significant engagement and progress towards realising national MRV, and have the institutional arrangements and resources in place.

### 4.3 Augmenting Core Coverage

Countries may wish to augment coverage beyond the Core data streams. In cases where SDCG agencies are willing and able to support, they may be able to work with a particular country on an augmentation request. This might include direct coordination, passing that request onto another government organisation (e.g. national foreign aid body), and/or a national industrial partner.

## 5 Core Data Delivery

The baseline assumption is that terrain corrected Core data will be available for direct download via internet. However, it is recognised that both technical capacity and internet bandwidth concerns may mean that some countries are unable to download the data directly.

In cases where countries are unable to download Core data themselves, the operating agencies might be able to facilitate delivery, for example via physical media or alternate delivery channels. Resources to support this coordinated delivery should leverage agency resources to the extent possible (e.g. USGS has

limited resources to deliver Landsat data), as well as the activities of sponsors like SilvaCarbon, the Australian Government, and the Norwegian Space Centre (NSC).

## 6 Core Data Value Adding: Cloud-Free Mosaics

Persistent cloudy conditions make it difficult to achieve coverage of many tropical countries. Several initiatives are under development to enable the systematic generation of cloud-free mosaics of optical imagery.

### 6.1 Web Enabled Landsat Data (WELD)

WELD is currently available over the lower 48 states of the US, plus Alaska (i.e. CONUS). This service leverages the Landsat archive, generating weekly, monthly, and annual cloud-free mosaics which can be downloaded by interested users and processed. WELD products are based on terrain corrected Landsat data (i.e. L1T), and also include several data layers which may be of interest to GFOI countries (e.g. NDVI\_TOA, DT\_Cloud\_State, etc.).

It is anticipated that WELD products will be available globally during 2014. Currently WELD products only utilise Landsat-7 imagery, covering 2003 – 2012, though the plan is to extend WELD coverage back through the complete Landsat archive.

### 6.2 Norway Cloud-Free Mosaic Service for GFOI

The NSC is considering an effort to develop an open-source service for cloud-free mosaic compositing and pixel-level cloud analysis at KSAT in Tromsø, in collaboration with Aberystwyth University and Curtis Woodcock's group at Boston University. The service is initially targeted at supporting Norway collaboration with Tanzania, while the longer term goal is to provide support to any GFOI country, possibly as a part of a "Norwegian processing hub". Landsat and RapidEye are initially targeted, but other data sources (e.g. Sentinel-2, CBERS, SAR) are also foreseen to be included.

## 7 Data Processing Services

Whilst all data provided for national MRV would ideally be made physically available to governments, it may be possible that data processing is conducted outside the countries concerned. Conventionally, this may mean a "processing hub", for example at a supporting regional remote sensing centre or university, or with close collaboration between countries (e.g. Indonesia and Australia).

Increasingly, improvements in IT are enabling options for virtualised "cloud computing", supporting offsite processing and generation of products. This means that only the final products are delivered to the end user, and can be delivered in a more compact format minimising bandwidth requirements.

This approach could help address the issue of data delivery, and may also help address deficiencies or a total lack of national computing infrastructure to handle satellite data. Simply put, these solutions have the potential to change the game, contributing capacity to countries with little or no heritage of satellite data processing.

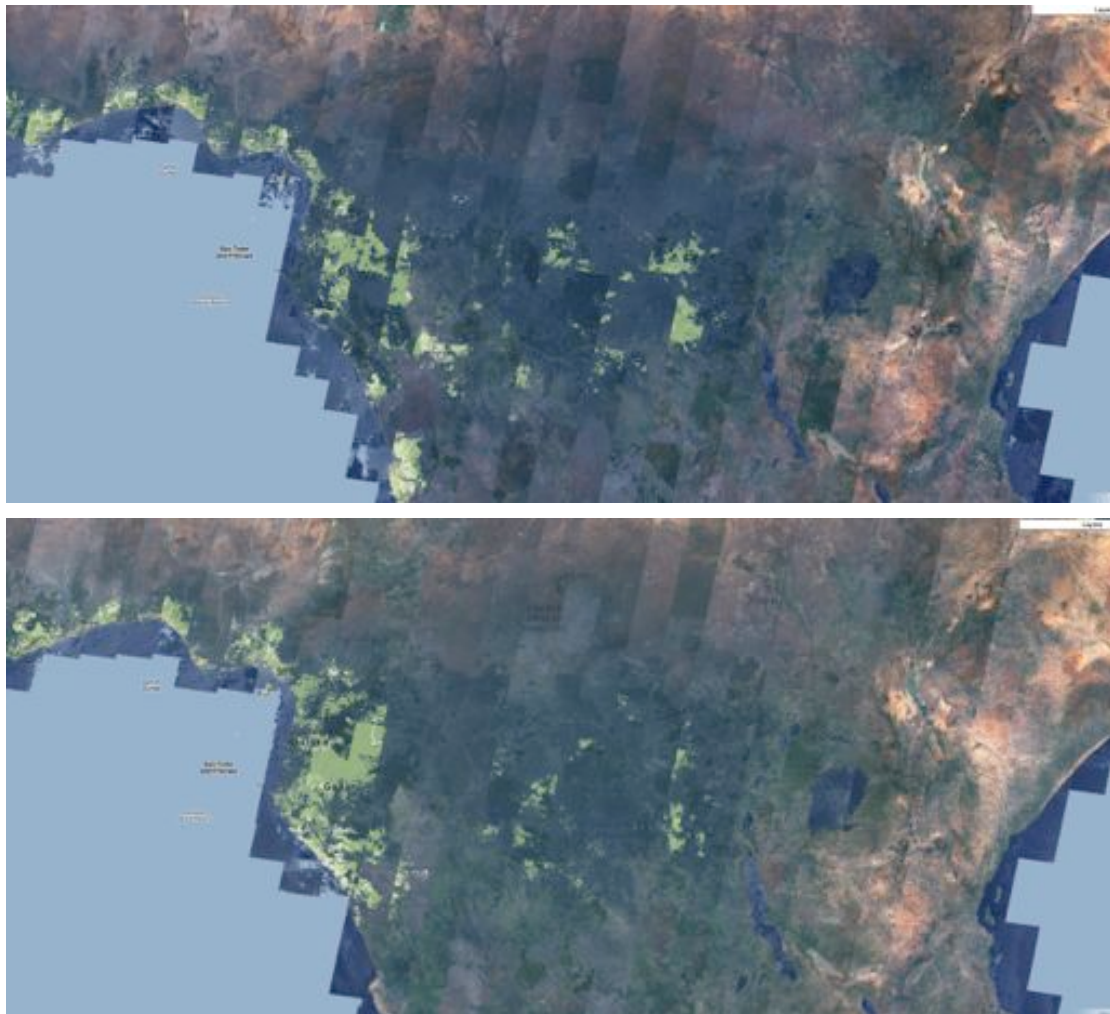
Several cloud computing options are currently being developed – some by space agencies, and some by private industry.

### 7.1 Google Earth Engine

Google Earth Engine works by dividing multi-temporal satellite data into individual “pixel stacks” and distributing processing of those stacks across computing infrastructure. The data is stored in an archive hosted on Google infrastructure, which means that data sets can be accessed quickly and seamlessly.

Users may upload their own data for processing. And the Earth Engine team also maintains its own copy of the Landsat and MODIS archives. Consideration is also being given to ingesting other data streams such as the Sentinels, and VIIRS – which may enable cloud free mosaicking algorithms and methods like WELD to be applied to these data streams.

A number of GFOI-linked researchers are investigating Google’s Earth Engine platform. These activities will help assess its potential to support GFOI countries as a study tool, or as a tool for countries to generate forest information products.



**Figure 1 Example Mosaics of Cloud Free of 2011 and 2012 Landsat-7 Computed by Earth Engine**  
 Cloud masking based on a basic NDSI/NDVI test, HOT Zhang et al. (2002), and a spectral test Irish (2000).  
 Images: Google Earth Engine

## 7.2 Global Forest Watch 2.0

“Global Forest Watch 2.0 is a powerful near real-time forest monitoring system that unites satellite technology, data sharing, and human networks around the world to fight deforestation.” This initiative is being developed by the World Resources Institute, who participated in the SDS-4 meeting in Sydney, presenting on the plans and potential for this activity. The application is being developed based on the Google Earth Engine platform, and there is some potential for GFOI to consider leveraging its outputs.

## 8 Next Steps

This paper will be shared with SDCG stakeholders, including a selection of countries willing to serve as pilots for the services during the development process. It will be revised in consultation with these stakeholders, and will serve as the basis for developing the full version of Element 2 of the *CEOS Baseline Global Acquisition Strategy for The Global Forest Observations Initiative*, a.k.a. **GFOI Space Data Services**.

There are several key milestones planned for the development of the Element 2 strategy:

- May – August 2013: Community consultation, outline, and initial drafting.
- September 2013: SDCG-4 meeting (CalTech, Pasadena, CA, TBC).
- October 2013 – March 2014: Intensive strategy drafting, including community consultation, stakeholder engagement, and SDCG-5 (TBC).
- April 2014: Presentation of the Element 2 Strategy to CEOS SIT-29 (Toulouse, France, TBC).

In addition, several other lines of investigation should be pursued to inform the development of the Element 2 strategy:

- A logic/flow diagram of the Element 2 services should be developed for discussion in the lead-up to, and at SDCG-4.
- Mock-ups and/or examples of the proposed information tools and products should be developed for discussion in the lead-up to, and at SDCG-4.
- Work with the WELD development team to understand the expected completeness of global WELD mosaics based on the underlying global Landsat archive.
- Work with the WELD development team to understand the prospects for future *operational* funding support for Global WELD, beyond the MEaSUREs supported research activity.
- The dialogue with other potential providers of mosaicking and/or “cloud computing” providers such as NSC’s open-source service, Google Earth Engine, Global Forest Watch 2.0, and others should be pursued.