



# Space Data Services Strategy

for the  
**Global Forest Observations Initiative**

Version 1.1  
for CEOS SIT-29, April 2014

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# 1 Introduction

## 1.1 Background and Purpose

This document defines how CEOS space agencies will support the space data needs of individual governments supported by the Group on Earth Observation's (GEO) Global Forest Observations Initiative (GFOI). The three-element data strategy, of which this document describes 'Element 2', was agreed by CEOS for GFOI in late 2011 and is outlined below.

The GFOI (<http://www.gfoi.org>) has been developed in the context of significant investments by national governments to reduce greenhouse gas emissions from deforestation, forest degradation, and associated land use change. National forest information systems are recognised to be essential for effective participation in and reporting to international agreements and forest carbon incentive mechanisms. GFOI supports governments that are establishing national forest monitoring systems by:

- fostering the sustained availability of space-based observations for national forest monitoring systems and assisting countries to make the best use of these observations;
- providing assistance and guidance on utilising space-based observations while collaborating with national institutions and international bodies such as the United Nations (UN) Food and Agriculture Organisation (FAO) to ensure that countries are able to utilise the available data;
- developing Methods and Guidance Documentation (MGD) on the acquisition and use of data for national forest monitoring systems that is consistent with and complementary to the work of the Intergovernmental Panel on Climate Change (IPCC); and
- promoting on-going research and development – GFOI supports continuous improvements in the use of space-based observations and the uptake of current forest carbon science.

The GFOI aims to support long-term space-based observation needs emerging from the discussions within the UN Framework Convention on Climate Change (UNFCCC). To realise the mission of the GFOI, the Group on Earth Observations (GEO) will engage with other key users, particularly the FAO.

CEOS has effectively coordinated space-based acquisitions since 2009 in support of Forest Carbon Tracking (FCT) demonstration activities. Based on the FCT experience, CEOS has accepted responsibility for coordination of the satellite data contribution to the observations and measurement component of GFOI to ensure the regular and systematic observations and measurements for effective reporting. This will ensure continuity of data supply for maintenance of time series and consistent reporting.

Recognising the magnitude of the challenge involved in meeting the requirements of the countries, given the global scale and sustained coverage needed, and the need for significant and sustained effort, CEOS at the 25<sup>th</sup> CEOS Plenary, in 2011, agreed to the establishment of a dedicated Space Data Coordination Group (SDCG) for GFOI charged with defining and implementing a three-element strategy as a framework for its coordination efforts:

**Element 1: A coordinated global baseline data strategy for EO data acquisition** involving a number of space-based ‘core’ data that can be used 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 (such as for a particular mission or data type [e.g. optical or synthetic aperture radar - SAR]). This global baseline data strategy should guarantee the minimum consistent space data provision necessary for all interested countries to engage in reporting to the relevant UNFCCC guidelines under the provisions of a future climate treaty. This includes the requirements for Reducing Emissions from Deforestation and Forest Degradation in developing countries (REDD+) and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries. To this end, the baseline strategy needs to coordinate with the methodologies described in the Methods & Guidance Documentation (MGD).

**Element 2: A coordinated strategy for national data acquisitions** will accommodate countries that have specific technical requirements or heritage and experience on working with a particular EO data source or type. It will also accommodate the numerous intergovernmental arrangements that may exist or emerge for the supply of certain data to one or more countries. This will involve a wider range of satellite data sources, including data that are ordinarily provided on a commercial basis.

**Element 3: Data supply in support of GFOI R&D activities.** This includes support for: science studies assisting the development and evolution of the MGD for GFOI; satellite sensor interoperability; time series consistency; forest degradation; and validation activities. Many R&D activities will also need satellite data that, for operational purposes, is provided commercially. Many of those missions are, however, developed in cooperation with CEOS agencies - giving the agencies the right to support R&D projects with data free of charge.

## 1.2 Scope

In 2013, CEOS endorsed the Element 1 Global Baseline Strategy - providing an important statement of technical capability and organisational intent that the CEOS space agencies are willing and able to undertake the required annual global coverage. This evidence that the EO community is committed to the sustained provision of the necessary data flow needed to facilitate country participation is fundamental to the credibility of GFOI, particularly in the REDD+ context. The UNFCCC has not comprehensively included forests in emissions reporting regimes in the Kyoto Protocol, partly due to concerns about monitoring. Recognising the significant role of forests in global carbon emissions and the climate system, GFOI seeks to ensure that the technical and institutional means exist for forest monitoring on global scales and in a consistent and comparable manner that will support reporting by national governments to the appropriate frameworks.

The Element 1 Global Baseline coverage and the core data sensors that provide it will continue to be the working assumption within GFOI as the default data available to countries. However, experience working with FCT and GFOI has demonstrated that, for many reasons, many countries will need more dedicated and customised support to be able to determine the space data needs associated with their national requirements and to manage the discovery, retrieval, handling, and processing of the space data in a way which is consistent with IPCC guidelines.

Element 2 (national data acquisitions) of the overall CEOS strategy for GFOI aims to provide the necessary support around the space data needs and ambitions of these countries. The SDCG is characterising this support as the GFOI Space Data Services available to national

governments. The Services will typically be provided through organisations with substantial in-country activities in place, namely FAO (UN-REDD, in particular) and World Bank (Forest Carbon Partnership Facility – FCPF, in particular). This document has been developed for internal CEOS use as the basis for endorsement by CEOS agencies at the 29<sup>th</sup> Meeting of the CEOS Strategic Implementation Team (SIT-29). Like the Element 1 (Global Baseline) Strategy, the implementation plan will be updated annually by SDCG for information and endorsement by CEOS. A companion document, which describes and promotes the ‘GFOI Space Data Services’ to governments, has been developed for external communication purposes.

### **1.3 Contents & acknowledgements**

Section 2 explains the requirements for the GFOI Space Data Services, and Section 3 outlines the strategy proposed by SDCG to define and develop the Services. Section 4 explains the three-year Work Plan laid out by SDCG for implementation of the Strategy, and Section 5 focuses on what to expect during 2014. The plan for 2015 and beyond is briefly discussed in Section 6. Overall governance issues within GFOI and CEOS are explained in Section 7.

SDCG acknowledges the authorship of S. Ward, G. Dyke, E. Fosnight, B. Killough, A. Rosenqvist & F.M. Seifert and the review contributions of K. Keith, M. Steventon, P.E. Skrovseth, S. Hosford, S. Wilson amongst others.

## 2 Requirements

### 2.1 Fundamental Information Requirements for GFOI

The Global Baseline Strategy for GFOI made some assumptions regarding the fundamental information requirements of governments in relation to their routine reporting of forest-related greenhouse gas emissions and forest carbon stocks to UNFCCC under the REDD+ provisions. These assumptions drive the definition of the GFOI Space Data Services and are summarised below:

1. Countries will report on at least a biennial basis with annual monitoring.
2. National monitoring systems are a long-term requirement for full, results-based implementation.
3. The fundamental variables that need to be measured for REDD+ include Forest Area Change (the transitions to, from, and within the Forest land use category class - forest-related activity data), associated carbon stock changes, and emissions and removals of CO<sub>2</sub> and other greenhouse gases.
4. Spatially-explicit national datasets, which form the basis for reports, may require a spatial resolution better than 30m.
5. Estimates of forest degradation will be required as an integral part of reporting.
6. REDD+ requirements go beyond deforestation and degradation.

The fundamental information requirements of governments, and therefore the supporting CEOS space data strategy, must satisfy the most stringent and sophisticated of the IPCC/UNFCCC reporting tiers and approaches, ensuring that all participating countries can be supported. The observations component must not become the bottleneck to policy development or satisfying the reporting principles, to include accuracy, consistency, comparability, and transparency. The Global Baseline Strategy document of CEOS (March, 2013) specifies the range of GFOI information products to be derived from space data.

The GFOI MGD (January 2014) is intended for governments developing national forest monitoring systems consistent with IPCC guidelines and emerging UNFCCC requirements for National Forest Monitoring Systems (NFMS) to support Measurement, Reporting, and Verification (MRV) associated with REDD+ activities.

The MGD is the second “deliverable” of GFOI (after the space data acquisitions) that can be provided to governments as a tangible outcome of the GFOI activity and provides important guidance around the application of the space data consistent with decisions taken at COP 19 in Warsaw November 2013. Among the Space Data Services offered must be explicit examples implementing the guidance documented in the MGD and countries are to adopt consistent and comparable methods in the application of the space data.

## 2.2 Policy Considerations

Negotiations, including REDD+ under the UNFCCC, which impact national forest monitoring systems and their requirements, will continue to evolve. Governments will have multiple purposes in mind for their national forest monitoring systems, including in relation to forest resource management, biodiversity, national reporting, and other issues. Although the priority for the GFOI is to support consistent and comparable reporting by these national forest monitoring systems in the REDD+ context, the need is also to support a wide range of requirements of different national governments.

The UN-REDD Programme is the United Nations collaborative initiative on REDD+ in developing countries, established by the FAO, the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP). It supports nationally led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in their national and international REDD+ implementation efforts.

The FCPF is a global partnership, housed within the World Bank's Carbon Finance Unit. It provides technical assistance and supports developing countries with forest stocks in their efforts to develop national strategies and systems for REDD+. The FCPF further assists countries with testing approaches that can demonstrate that REDD+ can work and provides them with performance-based payments for emission reductions programs.

UN-REDD and FCPF are cooperating closely and recently conducted an assessment of common country needs for completing their REDD+ readiness phases. FAO is also supporting the Capacity Development for REDD+ project (CD-REDD II), which is a partnership led by the Coalition for Rainforest Nations (CfRN) and Thünen Institute of Forest Ecosystems in Germany, funded by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ - the German development aid agency).

Both FAO/UN-REDD and World Bank have developed significant networks of in-country contacts and capacity. SDCG will leverage this heritage and experience wherever possible when liaising with national governments to ensure consistency with existing activities. The capacity building activities and relationships of the other Leads will also be used where appropriate to support engagement of the relevant national institutions and programmes.

## 2.3 Data Types

The Global Baseline Strategy of CEOS is necessarily built around free and open data – known as the 'core' data – so that accessibility of the data is guaranteed for all countries at all times for GFOI purposes.

SDCG's consultation with many countries has confirmed that a much broader range of data must be considered when defining the strategy for national data acquisitions. Although the core data will be promoted as the default option for the countries, both GFOI contributing data and commercial data are already of interest to, and are being used by, a large number of countries. The Space Data Services being proposed by SDCG will address all of these data and provide impartial guidance to governments as to how to satisfy their space data needs. SDCG will also accommodate connections between the governments and the data suppliers.

The relevant satellite sources for core and contributing data are summarised in the figures on the following page.

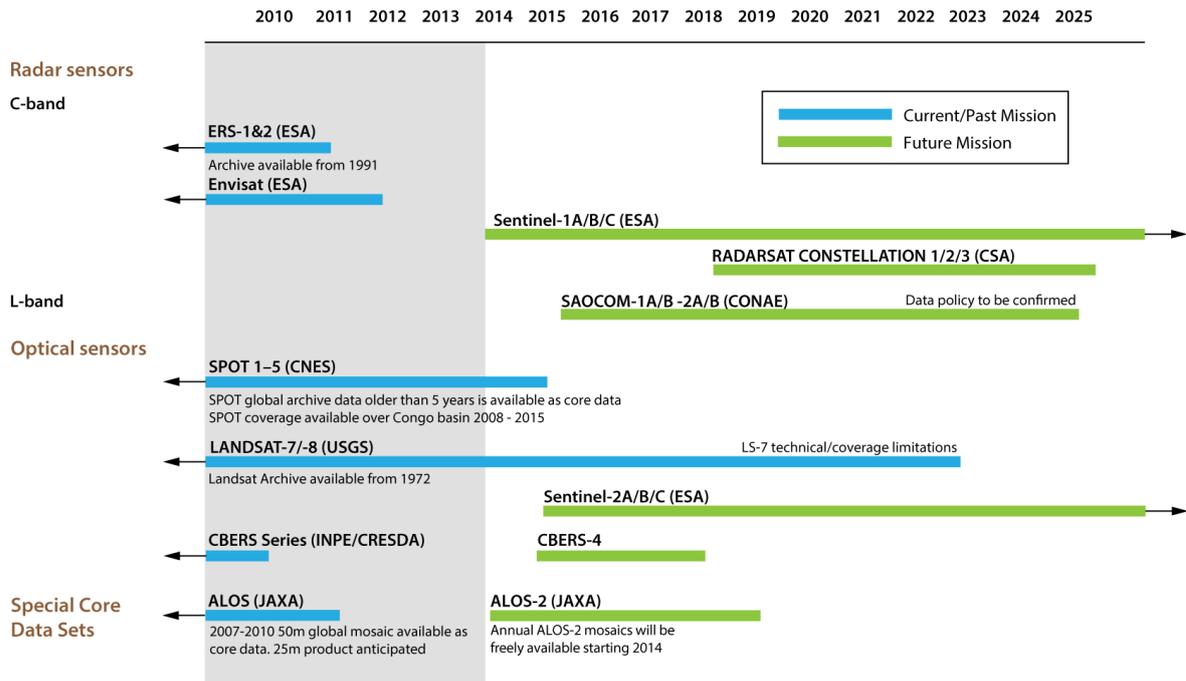
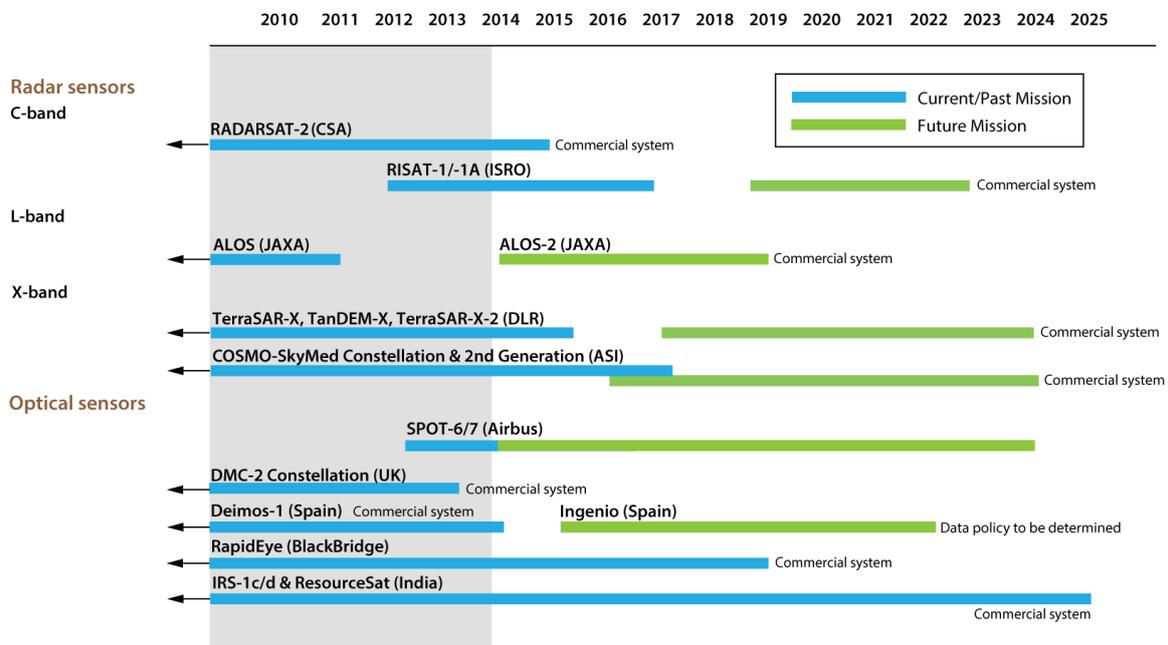


Figure 1: Core Data for GFOI



There are also numerous missions in planning by several countries that may be of value - including many high resolution missions of interest for validation. Few datastreams will have the capacity to provide routine global coverage. But many more will be able to contribute to national and regional coverages.

Figure 2: Contributing & Commercial Data for GFOI

## 2.4 Country Consultation

SDCG has undertaken a series of consultations with interested countries in order to develop a comprehensive understanding of their status, capacities, and ambitions in relation to their national forest monitoring systems and participation in REDD+. GFOI Country Days were included in the SDCG-4 meeting in Pasadena (September 2013) for Latin American countries and at FAO in Rome (February 2014) for African participants. Bilateral efforts undertaken by Norway and Australia in Indonesia were broadened to engage more South-East Asian countries in a preparatory workshop of the US programme SilvaCarbon in Chiang Mai (January 2014). UN-REDD has been consulted in order to obtain their assessment of the needs of countries for the GFOI Space Data Services and to ensure priorities are consistent with on-going activities related to REDD+. Finally, SDCG has ensured consistency with the Space Data Management System (SDMS) prototype being developed by NASA's CEOS Systems Engineering Office (SEO) and Norway for FAO to support UN-REDD.

Meeting	Participating Countries
<b>SDCG-4 (Pasadena)</b>	Mexico, Colombia, Ecuador, Peru, Guyana, Honduras
<b>SDCG-5 (Rome)</b>	Uganda, Tanzania, Kenya, Democratic Republic of Congo
<b>SilvaCarbon Asia (Chiang Mai)</b>	Thailand, Vietnam, Cambodia, Laos, Philippines, Nepal, Indonesia

*Table 1: Countries Consulted to Date*

An upcoming SilvaCarbon workshop in Cameroon in May 2014 will be an opportunity to consult central African countries on their space data needs.

## 3 GFOI Space Data Services Strategy

### 3.1 Strategy Features

Ensuring sustained satellite data supply is one of the four pillars of GFOI implementation, and the first step to supplying data is data acquisition. In 2012, the SDCG developed Element 1 of the CEOS space data strategy for GFOI, the Global Baseline Strategy for GFOI that outlines a phased plan for global coverage using satellites with free and open data policies. This strategy was endorsed by CEOS at SIT-28 (March 2013).

The next SDCG step toward ensuring the satellite data supply is to provide country specific GFOI Space Data Services, Element 2 of the CEOS space data strategy for GFOI. The objective of these services is to provide more country specific support, based on national needs as well as existing/planned capacities and relationships. The Element 2 Strategy focuses on direct support to individual countries, typically in cooperation with FAO/UN-REDD and World Bank's FCPF, in relation to their Space Data Service needs. This focus is different from that of Element 1, the Global Baseline Strategy, which focuses on data acquisitions and is largely undertaken in isolation from external stakeholders through the long-term acquisition plans of the core data providers.

Based on the countries' requirements, the Element 2 strategy will focus on prototype GFOI Space Data Services during 2014, 2015, and 2016 while GFOI takes shape and develops capacity. Consistent with the founding principles of GFOI, the Element 2 strategy will accommodate the connections and develop the capabilities and technical interfaces that will facilitate the operational phase of GFOI and the working relationships among governments, in-country capacity-building programmes like UN-REDD and FCPF, and the main data suppliers.

Based on SDCG's consultation with countries and stakeholders and on the context in which the Element 2 strategy must operate, the following basic features of the strategy are proposed. The Element 2 strategy will:

1. Provide a GFOI Space Data Services 'menu' for countries to choose from in support of their national forest monitoring systems' needs; the services in the menu will be defined according to the wide variety of capacities and ambitions of the relevant countries, building on data types, methodologies and requirements outlined in the MGD.
2. Offer an impartial assessment of national data needs for countries in support of their space data strategies - taking advantage of the Global Baseline Acquisition Strategy and products as the default solution for all countries to ensure consistency, comparability, and cost-efficiency, and lead to the adoption of their national MRV baseline.
3. Provide services as they are requested by national governments, directly or through FAO and the SDMS initiative, with priorities guided by UN-REDD and FCPF relevance and available capacity.
4. Accommodate connections between countries and the data suppliers to establish the links and technical interfaces needed for data acquisitions. SDCG will work via the in-country relationships and capacities developed by UN-REDD and World Bank to ensure consistency with existing activities.

5. Investigate the SDMS for space data discovery, access, cloud storage, assembly, processing, and information product development. The SDMS and Space Data Services will assist countries meet the formal MRV requirements with an emphasis on assisting countries with limited domestic capacity.
6. Be supported by all core data providers and have endorsement of FAO/UN-REDD and World Bank.
7. Be consistent with and support the MGD of GFOI – promoting its uptake by countries to ensure that the space data are being applied in a way that is consistent with IPCC guidelines and GFOI objectives.
8. Ensure consistency with the R&D and Capacity Building Components of GFOI, including through delivery of Regional Space Data Workshops.

## 3.2 GFOI Space Data Services

### 3.2.1 Service Menu

The proposed GFOI Space Data Services include:

1. **Regional GFOI Space Data Workshops** – including leveraging the substantial contribution of SilvaCarbon 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 (Element 1) 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 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.

Each is explained in turn in the following sub-sections.

### **3.2.2 Regional Space Data Workshops**

SDCG has identified the need to establish stronger regional coordination around capacity building related to understanding and applying space data in support of national MRV and REDD+ ambitions. SDCG will support existing plans for SilvaCarbon, and seek to assist UN-REDD and FCPF regional workshops and to augment these events with dedicated sessions and workshops focused on the space data aspects of this coordination and capacity building. The first GFOI Regional Workshop in Southeast Asia, led and funded by SilvaCarbon, was held in Thailand in January 2014, and is an example of the workshops to be supported by SDCG.

### **3.2.3 Impartial National Space Data Needs Assessments**

It can be difficult for government agencies unfamiliar with the application of satellite data to determine their requirements related to their national MRV strategies and to assess the suitability of the many different sources available (radar, optical, various bands and spatial resolutions) for satisfying those requirements.

In collaboration with the GFOI Project Office, the National GFOI Contact, and, when appropriate FAO/UN-REDD and World Bank/FCPF, SDCG will provide a short assessment report to governments based on their status, capacity, specific requirements or unique factors, donor arrangements, and opportunities. This report will stress the aim of GFOI to achieve consistent and comparable national systems through the use of the baseline global coverage by core data as the default for most countries. However, it will also highlight possible variations from this default recommendation based on specific national needs, such as cloud cover, a heritage with a particular data type, or a specific donor arrangement. The report will provide the information necessary to progress with the national space data acquisition strategy, take advantage of the follow-on GFOI Space Data Services such as coverage support, and accommodate connections with related data suppliers of all types.

### **3.2.4 National Historical Coverage Reports**

The SDCG will work with the GFOI MGD authors and 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 and the relative quality of that data (e.g., processing level or cloudiness). It is expected that this service will support efforts to establish a baseline year for national MRV systems and assessment of trends in forest coverage changes. SDCG will directly support this service for the core data (see Figure 1).

For contributing data (i.e. those not included in the core data, Figure 2), historical coverage characterisation will rely on the resources of the supplier of the data – this might include the associated CEOS agency and/or the private sector. SDCG agencies have indicated that they will consider archive search support for RADARSAT (Canadian Space Agency, CSA), TerraSAR-X and TanDEM-X (DLR), and SPOT and Pleiades (CNES), as well as support from Blackbridge for RapidEye (details yet to be coordinated).

The service will provide guidance and tools to enable countries to discover archive contents. This will help to empower countries, allowing them to engage and take ownership of the data required to support national reporting. It should be developed in coordination with FAO, in particular, which supports a number of countries in the execution of forest monitoring initiatives such as REDD+.

The CEOS SEO has started to develop the tools and processes to support this service. This includes leveraging existing CEOS groups and activities, (e.g. the Working Group in Information Systems and Services (WGISS) and their OpenSearch activity) as well as the CEOS Visualization Environment (COVE) tool and its Coverage Analyser function.

### 3.2.5 Ensured On-going Coverage

**Core Coverage Tracking:** The first step in ensuring acquisitions of core data for engaged 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 countries should expand in sync with the phasing of the global acquisition strategy. Both spatial (e.g. map) and statistical (e.g. percent coverage at sub-national scales) summary information should be made available at least annually, and more frequently if possible. In addition, assessments of cloud cover and the quality of the data should be addressed, whenever possible.

**Ensuring Future Acquisitions:** The next step in ensuring acquisitions of core data will be pro-active, including targeted acquisition requests to satellite operators to minimise coverage gaps. Limitations in coordination, processing, and satellite capacity may reduce SDCG's ability to deliver this service to all countries in the initial phases of implementation. When limitations arise, priority will be given to countries that have shown significant engagement and progress towards realising national MRV and have the institutional arrangements and resources in place.

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

### 3.2.6 Satellite Data Discovery, Assembly and Delivery

The baseline assumption is that core data at a processing level specified by the country (e.g. standard level, terrain corrected, etc.) will be available for direct download via the internet. However, it is recognised that some countries and agencies within countries may not be able to download the data directly. Further, delivery of data on media direct from multiple CEOS space agencies and/or commercial sources to multiple country agencies is not sustainable or efficient. So SDCG seeks to implement an efficient discovery and data assembly/hosting mechanism, where national agencies can discover data from multiple sources and have support on the assembly of the data to a collection point for delivery over the "last mile".

In cases where countries are unable to download core data themselves, CEOS GFOI will seek alternate solutions to facilitate delivery via physical media or alternate delivery channels. Resources to support this coordinated delivery should leverage agency resources to the extent possible, as well as the activities of sponsors like SilvaCarbon, the Australian Government, and the Norwegian Space Centre (NSC). In addition to direct delivery, remote regions may consider other data delivery options for data downlinks of new datasets.

### 3.2.7 Cloud Storage and Processing of Satellite Data

SDCG will collaborate and/or coordinate the definition and development of several data services pilot projects to support GFOI. These pilot projects currently include data services for Kenya and Colombia and the FAO SDMS for Ecuador, Tanzania and Uganda. All of these pilot projects will develop and demonstrate an architecture for:

1. Selection and secure storage of land imaging scenes on dedicated servers.
2. Pre-processing of imagery using cloud-based servers with existing algorithms/tools.
3. Analysis of imagery using existing tools or new tools (e.g. The CEOS Visualization Environment – COVE, Google Earth Engine).
4. Analysis of historical coverage archive records, including assessments of image quality (e.g. processing level, cloud cover).
5. Distribution of data and analysis results to pilot countries for testing and evaluation.

- Investigation of alternative approaches to data distribution for remote regions with poor infrastructure (e.g. a modular computer populated with archived data) and/or the use of non-traditional delivery mechanisms for future data downloads.

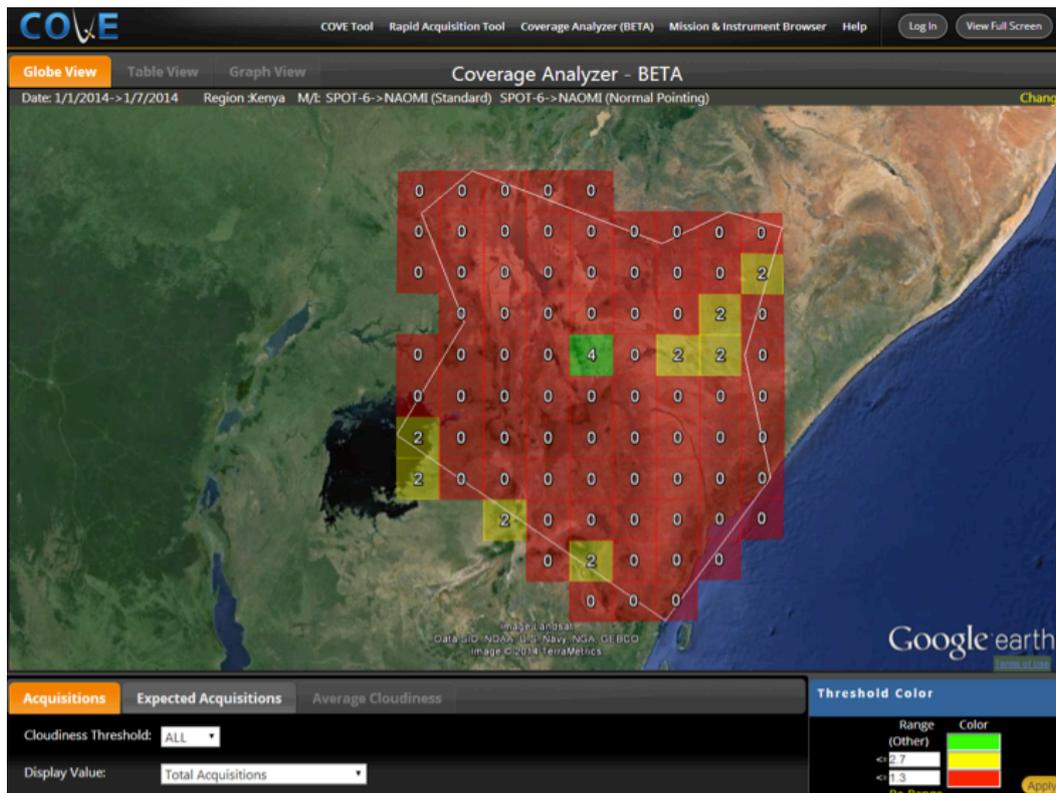


Figure 3: Mock-up of the SDMS

This centralized data management system will significantly improve access to multiple mission datasets for countries with limited resources and limited knowledge of mission data ordering systems and processing methods. The consultation process which SDCG has undertaken with countries has highlighted that the lack of infrastructure and capacity for the handling and processing of large volumes of space data associated with wall to wall coverage, is a major obstacle to the uptake of space data in support of national MRV. Remote capabilities which overcome this obstacle but guarantee national sovereignty of the data, its handling and subsequent reporting will be an essential feature of the GFOI initiative and crucial to its uptake in countries around the world.

It may be more efficient for the heavy-lifting of data handling and processing to create standard 'GFOI products' to be undertaken close to the big data systems of the core data suppliers so long as countries feel ownership of the resulting information products. This is the capability that the SDMS seeks to demonstrate.

### 3.3 Strategy Maintenance

The requirements for the CEOS strategy for supporting national space data needs related to GFOI (known as Element 2 and characterised in this document as the GFOI Space Data Services) can be anticipated to evolve continuously as the policy and methodological framework around REDD+ develops and as individual countries determine positions and engage with FCPF, UN-REDD, and GFOI. SDCG's initial definition of the Space Data Services is based on consultation with a broad range of different countries, but this definition can be expected to evolve with the needs of these countries – including national data policies and acquisition strategies, satellite schedules, understanding and capacity around

the role for satellite data in national MRV. Progress on the pilot projects will also have influence on the Space Data Services implementation, and success in that direction would likely put greater emphasis on its application to as many countries as practical.

The Element 2 strategy will continue to be maintained, in the first instance by the SDCG, as a means of managing expectations of the policy community and individual countries regarding the support available from GFOI and CEOS in relation to the space data aspects of GFOI. SDCG proposes to update this strategy at least annually for review at its meetings and endorsement at the CEOS SIT meetings.

Governance issues are discussed in Section 7 and include continued direction from the GFOI Advisory Committee (on evolution of the requirements and policy context) and interaction with the CEOS SIT (for coordination of implementation matters relating to the Space Data Services).

## 4 Implementation Approach

### 4.1 Introduction and Overview

The development and prototyping of Space Data Services for countries will be an exploratory and iterative process, and the following approach to Element 2 implementation is proposed by SDCG to ensure a sustainable outcome for GFOI:

1. SDCG will provide and coordinate the initial capacity and technical capabilities, and systems to seed pilot versions of the GFOI Space Data Services. It will in all cases be seeking to establish operational responsibilities and leadership from among the agencies and stakeholders active within GFOI to ensure that a sustained arrangement for service delivery is considered from the outset. Some of the services may continue to be provided by SDCG for the foreseeable future, whilst others will evolve to leadership by relevant agencies.
2. Particular emphasis will be given upfront on dialogue with representatives of individual governments to develop a thorough understanding of the nature and diversity of requirements and to specify outcomes that are known from the outset to be relevant to country needs. These requirements will be defined in coordination with FAO and World Bank, the key in-country agents for support of governments. These organisations will often be responsible for dialogue with governments and for establishing the relationship with GFOI and the request for Space Data Services support.
3. The data services pilot projects proposed for the provision of cloud-based storage and services may ultimately have many different users, purposes, and applications. The SDCG approach will be to ensure the development of these pilot projects are fully in compliance with both the MGD and the IPCC guidelines, such that we can be confident that it will support consistent and comparable country reporting to UNFCCC, while respecting sovereign ownership of information.
4. SDCG will seek to ensure that implementation is supportive of, and consistent with, other CEOS initiatives that use land surface imaging observations, notably the GEO Global Agricultural Monitoring Initiative (GEOGLAM).
5. Because of its dependence on the funding and capacity of its member agencies, the SDCG approach to implementation will be influenced significantly by the ability to secure sponsorship and leadership for each of the services and the supporting manpower and technology. The funding contributions of Norway, USA, and others will be crucial in realising the Space Data Services.

SDCG has outlined a three-year Work Plan for implementation of the Space Data Services that is designed to allow the maturation of the different Services and the establishment of an engaged community of countries that will expand to include all countries with an active interest in participating in REDD+. Section 4.2 details the plan for development and implementation of each of the Services in 2014, 2015, and 2016. Special attention is given to the SDMS in Section 4.3, given its role in the delivery of several data services for several countries in support of UN-REDD.

## 4.2 Three-Year Work Plan

A summary of the evolution of each of the Services during 2014-2016 is shown in Table 2, with the lead(s) indicated in brackets.

Service	2014	2015	2016
<b>Regional GFOI Space Data Workshops</b>	<ul style="list-style-type: none"> <li>* SDCG-5 Country Day: Four pilot countries engaged (Democratic Republic of Congo, Tanzania, Kenya and Uganda) [SDCG]</li> <li>* 3 workshops in Southeast Asia [SilvaCarbon]</li> <li>* 3 workshops in South America [SilvaCarbon]</li> <li>* 2 workshops in Africa [SilvaCarbon]</li> </ul>	<ul style="list-style-type: none"> <li>* Continued SilvaCarbon workshops planned in Southeast Asia, South America, and Africa [SilvaCarbon]</li> <li>* Continued SDCG meetings [SDCG]</li> </ul>	<ul style="list-style-type: none"> <li>* Planning and budget horizon for workshops currently extends only to 2015</li> </ul>
<b>National space data needs assessments</b>	<ul style="list-style-type: none"> <li>* Pilot process with pilot countries to follow up SDCG-4 &amp; SDCG-5 engagement and as part of SDMS requirements definition [SDCG-SEO]</li> </ul>	<ul style="list-style-type: none"> <li>* More comprehensive and custom reports, including all core data and offered to all countries engaging with GFOI through meetings or SDMS [SDCG-SEO/core data agencies]</li> </ul>	<ul style="list-style-type: none"> <li>* Continued provision of comprehensive and custom reports, including all core data and offered to all countries engaging with GFOI through meetings or SDMS [SDCG-SEO/core data agencies]</li> </ul>
<b>National historical coverage reports</b>	<ul style="list-style-type: none"> <li>* Sample Landsat coverage reports provided to countries attending SDCG-5 and -6 as part of an Assessment Report [SDCG-SEO]</li> <li>* Development of a tool to semi-automate historical core data coverage reports for countries, potentially as a part of the SDMS or stand-alone, with the objective of empowering countries to perform their own discovery [SDCG-SEO]</li> </ul>	<ul style="list-style-type: none"> <li>* Support to countries performing their own historical core data coverage assessment using SDCG/SEO tools [SDCG-SEO]</li> <li>* Development of process/tools to semi-automate the generation of comprehensive coverage reports provided for all years of interest to concerned countries; includes all missions of interest, including commercial [SDCG-SEO/ agencies and companies]</li> </ul>	<ul style="list-style-type: none"> <li>* Support to countries performing their own historical core data coverage assessment using SDCG/SEO tools [SDCG-SEO/TBD Operator]</li> <li>* Support to countries performing their own historical comprehensive data coverage assessment using SDCG/SEO tools and methods [SDCG-SEO/agencies and companies/TBD Operator]</li> </ul>
<b>Ensured on-going coverage</b>	<ul style="list-style-type: none"> <li>* Adjustments to Landsat-7 and -8 LTAP sought for engaged countries (having attended SDCG or workshops) [SDCG/USGS]</li> <li>* Coordination with Sentinel-1 mission management on the ramp-up of coverage to optimise for GFOI applications [SDCG/ESA]</li> <li>* Engagement and support for all countries engaging with GFOI through meetings or SDMS [SDCG]</li> </ul>	<ul style="list-style-type: none"> <li>* On-going optimisation of Landsat coverage [SDCG/USGS]</li> <li>* Stabilisation of Sentinel-1 acquisitions and on-going optimisation [SDCG/ESA]</li> <li>* Coordination with Sentinel-2 mission management on the ramp up of coverage to optimise for GFOI applications [SDCG/ESA]</li> <li>* Engagement and support for all countries engaging with GFOI through meetings or SDMS [SDCG]</li> </ul>	<ul style="list-style-type: none"> <li>* On-going optimisation of Landsat coverage, coordination with Sentinel-2 [SDCG/USGS/ESA]</li> <li>* On-going optimisation of Sentinel-1 coverage [SDCG/ESA]</li> <li>* Stabilisation of Sentinel-2 acquisitions and on-going optimisation [SDCG/ESA]</li> <li>* Coordination with CBERS-4 mission management on the ramp up of coverage to optimise for GFOI applications [SDCG/INPE]</li> <li>* Coordination with SAOCOM-1A mission management on the coverage to optimise for GFOI applications [SDCG/CONAE]</li> <li>* Engagement and support for all countries engaging with GFOI through meetings or SDMS [SDCG]</li> </ul>

<p><b>Core data discovery, assembly &amp; delivery</b></p>	<ul style="list-style-type: none"> <li>* Physical HDD delivery of Landsat coverage for 2013 is being provided to: Costa Rica, Ecuador, Panama, Vietnam, Argentina, Zambia [USGS]</li> <li>* SDMS pilot delivery of core data delivery (via download and investigation of physical delivery, if required) [SDCG-SEO, Norway, FAO]</li> <li>* Develop scheme for the delivery of value-added core data, e.g. the generation of cloud-free mosaics via Global WELD or Google Earth Engine [SDCG-SEO/USGS/NASA]</li> <li>* Provision of ALOS PALSAR mosaics (2007-2010) [JAXA]</li> <li>* Provision of historical SPOT 1-5 data (before 2009) on request [CNES]</li> <li>* Provision of SPOT 5 and 6 acquisitions over the Congo Basin [CNES, AFD]</li> </ul>	<ul style="list-style-type: none"> <li>* Expand core data delivery via SDMS, aiming to reflect Global Baseline Strategy coverage aspirations [SDCG-SEO/TBD data delivery]</li> <li>* On-going delivery of global WELD and/or Google Earth Engine products [SDCG-SEO/USGS/NASA]</li> <li>* Provision of ALOS-2 PALSAR-2 mosaics from 2014 [JAXA]</li> <li>* Provision of historical SPOT 1-5 data (before 2010) on request [CNES]</li> <li>* Provision of SPOT 5 and 6 acquisitions over the Congo Basin [CNES, AFD]</li> </ul>	<ul style="list-style-type: none"> <li>* Grow core data delivery via SDMS reflecting Global Baseline Strategy coverage aspirations [SDCG-SEO/TBD data delivery]</li> <li>* Development of Sentinel-2 value added core data, including the generation of cloud-free mosaics [ESA]</li> <li>* Provision of historical SPOT 1-5 data (before 2011) on request [CNES]</li> </ul>
<p><b>Cloud storage, processing &amp; analysis</b></p>	<ul style="list-style-type: none"> <li>* Pilot version of GFOI SDMS developed in collaboration with four countries and UN-REDD, targeting delivery of L1T equivalent products and cloud-free mosaics — stopping short of delivering forest thematic products [SDCG-SEO, Norway, FAO]</li> <li>* Incorporation of FAO's open thematic product tools in the pilot SDMS, supporting country development of their own forest thematic products [SDCG-SEO, Norway, FAO]</li> <li>* Investigating pilot capacity for the SDMS to facilitate the generation of cloud-free mosaics of core data, augmented with commercial data where required [SDCG-SEO]</li> </ul>	<ul style="list-style-type: none"> <li>* Beta version of the SDMS based on the outcomes of the pilot phase and discussion with stakeholders including FAO, countries, and data providers; aiming to provide country space data capacity bootstrapping support [SDCG-SEO, Norway, FAO]</li> </ul>	<ul style="list-style-type: none"> <li>* Operational version of the SDMS, building on the beta phase, to provide country space data capacity bootstrapping support. [SDCG, FAO]</li> </ul>

*Table 2: Summary of Element 2 Three-Year Work Plan*

### 4.3 Space Data Management System (SDMS)

As described in previous sections, the SDMS is a mechanism to facilitate access to space datasets and analysis tools to support country-based reporting and decision-making. The key features of the SDMS are listed below:

- Web-based User Interface (UI) that is sensitive to low bandwidth.
- Modular development approach to allow expansion for new countries, new datasets, and new processing and analysis tools.
- Secure access and segmented storage for individual countries to ensure protection of country-level data and products and to meet the requirements of any dataset End User License Agreements.
- Dedicated storage of images and related datasets (e.g., global cloud-free mosaics, ground-based data from countries) with consideration for automated updates to stored mission archives as new data become available.
- Ability for user to upload and download datasets, add processing tools, and upload and download reports.
- Access to a suite of data processing tools (e.g., OpenForis) for user-based processing of images using a cloud computing architecture for enhanced performance.
- Access to a suite of analysis tools for reviewing data archives (i.e. COVE, Coverage Analyser) and generating cloud-free mosaics (e.g., Google Earth Engine).
- Design flexibility to allow consideration of a desktop version for regions without sufficient internet bandwidth and alternative data delivery approaches for incremental data updates.
- Training and support to ensure countries can operate and use the system for value-added purposes in support of national reporting.

The SDMS described above will be developed over a period of years with the intention that its operational phase will be transitioned to another organization (such as the GFOI Project Office, FAO). The SEO will develop prototypes of the SDMS that include increasing support for countries and increasing capability. This development approach will continue to seek feedback from both the user community and the supporting management organizations to ensure the operational product meets the intended requirements, including helping adoption of the GFOI MGD by countries.

## 5 2014 Implementation Plan

### 5.1 Outcomes

Sections 3, and 4 of this document outline the steps being suggested by the SDCG to implement the GFOI Space Data Services strategy in 2014, 2015, 2016, and beyond. The level of detail decreases for 2015 and 2016, reflecting increasing uncertainty further into the future. The 2015 update of the Element 2 strategy will feature more detail on the years ahead.

SDCG has defined the following outcomes for the implementation of the Element 2 strategy for 2014:

1. Endorsement of the Element 2 strategy and its 2014 implementation plan by the CEOS SIT in April 2014.
2. Development of prototypes for each of the six GFOI Space Data Services and prototyping of their value with a number of countries, including those attending SDCG and SilvaCarbon meetings and those engaged in the SDMS. In depth engagement with 2-3 countries, focused on trialling the delivery of the Services, in the months before SDCG-6. Inclusion in a country day at SDCG-6 seeking feedback on the pilot services, and detailed follow-up from SDCG-6 on pilot service delivery and optimisation.
3. A pilot version of a Space Data Management System developed in collaboration with FAO and UN-REDD to prototype the relevance and effectiveness of a data services system for the National Forest Monitoring Systems of the pilot countries (Uganda, Tanzania, DR Congo). In addition, other pilot projects will test data services systems for Kenya and Colombia.

### 5.2 Implementation Roles

Roles have been identified for a number of the groups contributing resources and support to the realisation of these outcomes in 2014.

**SDCG:** On-going coordination of the development of the GFOI Space Data Services, providing the linkage between: CEOS agencies and leadership such as the Plenary and SIT Chairs; CEOS contributors such as the SEO; the GFOI Leads and Office and the implementation of the GFOI Space Data Component; country coordination organisations such as FAO and the World Bank; and consultations with the community (including countries) on the development of the Services.

**CEOS SEO:** Leadership of the development of the Space Data Management System and other pilot projects, in coordination with SDCG, as well as key stakeholders such as FAO/UN-REDD and the pilot countries. Continuing support on historical coverage assessments for countries engaging with SDCG through the “country days”, and further development of self-service tools that will automate the generation of these assessments to the greatest extent possible. Continuing engagement with contributing data providers in support of national needs assessments and historical archive searches. Possible engagement with Google Earth Engine in relation to SDMS implementation.

**SilvaCarbon:** On-going coordination of SilvaCarbon workshops in the Americas, Asia, and Africa with GFOI. These workshops provide opportunities for GFOI and the SDCG to engage countries on the development and delivery of the GFOI Space Data Services, as well as the promotion of GFOI MGD and R&D activities and needs.

SilvaCarbon also implement country based activities in selected countries including Colombia, Ecuador, Peru, Vietnam and Gabon to support the implementation of the MRV systems. These activities include larger mapping efforts where the interaction and collaboration from SDGS are needed in order to order to contribute to data flow.

**GFOI Leads and Office:** On-going over-arching coordination between the Components of GFOI (Space Data, MGD, R&D, Capacity Building). Providing strategic guidance to CEOS via the SDCG on the development and delivery of the Services. Supporting SDCG in the management of the interfaces between countries and country service provider agencies.

**FAO/UN-REDD and World Bank/FCPF:** Using in-country capacity and heritage to provide SDCG with feedback on the development and delivery of the Services. Providing opportunities to seek feedback from end users, consolidate and summarise that feedback, and serve as a representative of the user community. Advise SDCG on the suitability of the Services being developed and delivered.

**Countries:** Defining their requirements and providing SDCG with feedback on the development and delivery of the Services. Furnishing active national points of contact, with clear linkages to national government MRV systems, to coordinate the various needs assessment, assured coverage, and data delivery Services being delivered.

**Core Data Providers:** Providing free and open access to data via standard delivery channels. Coordinate assured coverage as specified in the Global Baseline Strategy (Element 1). Work with the CEOS SEO on the automation and development of archive access and historical coverage assessment tools.

**Contributing Data Providers:** To the extent that data access and commercial arrangements allow, work with the CEOS SEO on the automation and development of archive access and historical coverage assessment tools and on the preparation of national reports and needs assessments. Provide low- or no-cost trial data to the extent possible to support the development of national MRV systems. In addition, investigate the ability to securely store and distribute purchased data for individual countries via the SDMS and other relevant pilot projects, within the guidelines of End User License Agreements.

For the sake of tracking and reporting progress, SDCG proposes to appoint a Lead for each of the six GFOI Space Data Services. It is anticipated that the Service Leads will change over time as the Services mature and become operational, but the identification of these Leads at all times will help management of the strategy by SDCG and help share the burden of effort across the groups.

### 5.3 Milestones

**SDCG-5, February, 2014:** Confirmation of the pilot GFOI Space Data Services and the required resources and support for implementation. Consultation with countries and key provider agencies (e.g. UN/FAO) seeking feedback on the Services proposed.

**SIT-29, April, 2014:** Endorsement of the Element 2 (GFOI Space Data Services) strategy by CEOS SIT, including confirmation of resources by supporting CEOS agencies.

**July 2014: GFOI Leads Meeting to review the Space Data Services architecture and approach under development by the SEO to support several prototype projects**

**May-September 2014:** Identification of, and engagement with 2-3 countries on a detailed piloting of the Services. Countries should be identified by way of pro-active country expression of interest, and the Services should be mapped to at least one current issue with their nation MRV development that the Services can address.

**SDCG-6, October, 2014:** Review of the implementation status of the pilot Space Data Services through both reporting from CEOS SEO and UN/FAO. Reviewing lessons learned to date on the pilot implementation of the Services during a country day with the 2-3 countries identified for detailed engagement and follow-up.

**2014 CEOS Plenary, October, 2014:** Presentation of the implementation status of the GFOI Space Data Services, seeking more broad feedback from CEOS, and key CEOS implementing agencies in particular, on the implementation of the Services. Seeking confirmation of the continuing mandate of SDCG.

## 6 2015+ Implementation Plan

As noted in Section 4.1, the approach to implementation of the Element 2 strategy will necessarily be iterative – and therefore the detailed plans for 2015 and beyond will depend on outcomes of the development of the pilot services in 2014. This will necessitate continued review by stakeholders (CEOS, GFOI, FAO, World Bank, SilvaCarbon, etc.) with the overall goal of an operational system.

The review of 2014 activities, and planning for 2015 implementation will be carried out in the preparations for the SDCG-7 meeting, nominally scheduled for the first quarter of 2015. This will include a review of lessons learned from the 2014 pilot implementation of the GFOI Space Data Services, and the pilot implementation of the SDMS. This will culminate in the presentation for information and endorsement of the 2015 Element 2 implementation plan at SIT-30 in the first half of 2015.

While the 2014 implementation is focused on the development of the initial six services, the review of lessons learned in preparation for 2015 implementation may conclude that the makeup of the services should be revised, either by removing services that didn't prove useful, merging of services where there was significant overlap, or the possible addition of services to meet a need not originally identified.

The approach to the development of the 2015 implementation will be confirmed at the SDCG-6 meeting, planned for October 2014.

## 7 Governance

### 7.1 Institutional Arrangements

CEOS is a voluntary group and its resources are the combined contributions of its individual space agencies, which provide the capacity to progress initiatives such as GFOI. This constraint has been confirmed in the recent strategic planning exercise of CEOS and documented in the relevant strategic documents. At the same time, CEOS has recognised the need for flagship initiatives of GEO – such as GFOI and GEOGLAM – to have a much more hands-on space data coordination and supply role for CEOS, including interaction with the user groups, and for this coordination to be sustained in support of the on-going services and societal outcomes that these tasks strive toward. To date CEOS has responded extremely positively to the increasing demands imposed by the GFOI data strategy. The SDCG has been pioneering this new level of specificity and engagement for CEOS in support of GFOI, and the Element 2 strategy has been defined in terms of user-focused Services that the SDCG proposes to support. The voluntary nature of CEOS activities continues to apply, but the SDCG is looking to establish operational responsibilities and uptake of the Services in a sustained way by one or more of the GFOI stakeholders.

Institutionalisation of the Space Data Services is essential for their sustained availability and to be able to scale up the pilot Services being pioneered by SDCG, in cooperation with the GFOI Leads. The in-country capacity and expertise of FAO/UN-REDD and World Bank/FCPF has been recognised by the GFOI Leads as the most effective channels for the application and uptake of GFOI deliverables. The SDCG will therefore seek to embed the Space Data Services within the in-country programmes of UN-REDD and FCPF and to support their leadership of the delivery of the Services to the relevant government agencies. The scale and scope of the space data supply needs of GFOI is so huge, however, and the resource implications for CEOS agencies so correspondingly large, that CEOS and its agencies will need continued assurance that its resources and data continue to be optimised and consistent with their policies and priorities. Although an ad-hoc body that requires annual renewal from CEOS, SDCG sees a continuing role for its function in the Space Data Services for the foreseeable future – a role that CEOS must commit to if operational monitoring capabilities of forests are to be realised through GFOI.

### 7.2 Strategy Management and Roles

The Element 2 strategy for provision of the GFOI Space Data Services will continue to be maintained by SDCG, in response to the evolving understanding of requirements – as country feedback is provided, experience is gained in applying the core data and the MGD of GFOI, and changes emerge in the policy environment.

Space Data Service Leads will be responsible for overall stewardship and progress of the definition and implementation of that Service and for reporting to SDCG and other meetings, as needed. Leadership of the Services should reflect ambitions for future operationalization of the Service.

Annual endorsement by SIT will emphasise the implementation plan for the coming year (this document is structured accordingly to support ease of update annually) and the actions required of contributing CEOS agencies.

The GFOI Advisory Committee, on which CEOS is represented, has the responsibility of ensuring that the strategy is informed by the latest policy developments and requirements and may make special requests of CEOS as these factors evolve. The SDCG reports to all GFOI Advisory Committee meetings through the CEOS representative.

The geometry has begun to change with the arrival of the first of the staff for the GFOI Project Office. The Project Office is expected to become a hub for engagement of GEO governments in the GFOI activity and will have a future stake in the dialogue with countries, including around the arrangements for the space data acquisitions and supply.

### 7.3 Next Steps

Noting the Milestones in Section 5, the next steps for the SDCG are to:

1. Seek endorsement of this strategy for GFOI Space Data Services at the next CEOS SIT meeting (April, 2014) and in particular by the CEOS core data provider agencies; particular emphasis will be given to getting buy-in from CEOS provider agencies for the year ahead (setting the model for the future annual engagement in the same way between SDCG and SIT);
2. Coordinate implementation of the strategy in 2014 with the CEOS agencies and GFOI stakeholders and countries concerned – overseeing the progress toward realisation of the 2014 Work Plan targets, including development of a pilot SDMS with FAO;
3. Manage the annual update (for early 2015) to the GFOI Space Data Services to reflect necessary changes and communicate on-going activity for endorsement by future SIT meetings.

# GFOI

