GFOI

Global Forest Observations Initiative

Global Baseline Data Acquisition Strategy

2014 Update

for the Global Forest Observations Initiative

Version 2.1
for CEOS SIT-29, April 2014

CEOS

Committee on Earth Observation Satellites

GEO

Committee on Earth Observation Satellites (CEOS)

Ad-hoc Space Data Coordination Group (SDCG)

Global Baseline Data Acquisition Strategy for the Global Forest Observations Initiative (GFOI)

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2014 Update

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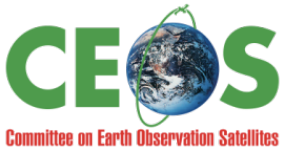

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1 Introduction

1.1 Background and Purpose

This document is to define how Committee on Earth Observation Satellites (CEOS) space agencies will coordinate their relevant Earth observing satellite systems to acquire data to support information requirements arising from the Group on Earth Observation's (GEO) Global Forest Observations Initiative (GFOI). Thus, the primary audience for this document is CEOS.

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 information 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, collaborating with national institutions and international bodies such as the United Nations (UN) Food and Agriculture Organization (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, consistent with and complementary to the work of the Intergovernmental Panel on Climate Change (IPCC);
- 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, GEO will engage with other key users, in particular the FAO.

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

Recognising the magnitude of the challenge involved in meeting GFOI and FCT requirements, given the global scale and sustained coverage needed, CEOS in 2011 defined a three-element strategy as a framework for its coordination efforts:

Element 1: A baseline, coordinated global data acquisition strategy involving a number of space-based *core data streams* that can be utilised and shared free-of-charge for GFOI purposes. This involves systematic and sustained wall-to-wall Earth Observation (EO) acquisitions of forested areas globally and provides the default forest observations data for all countries without specific technical requirements, heritage or data preference (such as for a particular mission or data type [*e.g.*, optical or SAR]). This global baseline data acquisition strategy should guarantee the minimum consistent space data provision necessary for all interested countries to engage in reporting to the relevant UNFCCC under the provisions of a future climate treaty, including the requirements for reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+). To this end, the baseline strategy needs to coordinate with the methodologies described in the January 2014 *Methods and Guidance Document* (MGD) for GFOI.

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

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

Anticipating that the GFOI and FCT data coordination activities would require a significant and sustained effort by CEOS, the 25th CEOS Plenary, in 2011, agreed to the establishment of a dedicated Space Data Coordination Group (SDCG) for GFOI charged with defining and implementing the three-element strategy.

1.2 Scope

This document focuses on Element 1, the global baseline data acquisition strategy. This is the most urgent time-wise and strategically significant element of the overall GFOI data strategy. Element 1 provides evidence that the EO community is committed to the sustained provision of the necessary data flow needed to facilitate wide country participation which is fundamental to the credibility of GFOI, particularly in the REDD+ context of REDD+ (Reduced Emissions from Deforestation and forest Degradation). The UNFCCC and the Kyoto Protocol have not comprehensively included forests in emissions reporting regimes, 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 their monitoring on global scales and in a consistent and comparable manner that will support reporting by national governments to the appropriate frameworks.

Within CEOS and its member space agencies, the document will aim to establish consensus on data requirements associated with the global baseline data acquisition strategy for GFOI, and define how agencies and systems will contribute to its implementation. In the process, gaps and overlaps can be identified and addressed with requests for supplementary data formulated as necessary to donor agencies. Externally, the document will serve to communicate the resolve and technical capacity of CEOS space agencies to coordinate a

sustained supply of EO satellite data in support of GFOI, and also to develop an understanding among countries with an interest in participating in GFOI as to the likely nature of, and sources for, the annual coverage of data for their national territory.

While the full operational status of the global baseline data acquisition strategy Element 1 is planned for by 2016, it is recognised that numerous GFOI target countries have begun their implementation of the necessary monitoring systems and also need immediate support. To accomplish this support, a phased approach towards the global baseline data acquisition strategy is proposed for the years 2013-2015, along with piloting measures for Element 2 (coordinated strategy for national data acquisitions) and Element 3 (Data supply in support of GFOI research and development [R&D] activities).

1.3 Contents

Section 2 defines the **requirements** that determine the design of the global baseline space data acquisition strategy. There are multiple potential applications for the national forest information systems that represent the building blocks of the GFOI, and section 2 identifies those related to the routine reporting of forest-related greenhouse gas emissions and forest carbon stocks to UNFCCC under the anticipated requirements of REDD+. The policy and technical considerations, which have dictated the SDCG approach are discussed, and the resulting satellite data products are described.

Section 3 defines the proposed CEOS **strategy** for EO data acquisitions for an annual global baseline data acquisition strategy for GFOI. It explains the phasing required to establish a sustained annual strategy and the priorities for coverage during the transition years.

Sections 4 through 9 describe how CEOS agencies have, and will, **implement** the strategy and identifies the contribution of individual agencies and satellites. The business as usual (BAU) coverage scenario is explained and the plan for an enhanced coordinated coverage is described. Guidance from the SDCG to each contributing CEOS agency is provided in support of the implementation.

Section 10 discusses **governance** and describes how the SDCG proposes to support the on-going oversight of the strategy in cooperation with the GFOI and CEOS management groups and with the support of individual CEOS agencies.

The ANNEX summarizes potential contributing satellites, including such information as ground resolution, repeat coverage capability, frequencies, and links to further information.

1.4 Acknowledgements

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2 Requirements

2.1 Fundamental Information Requirements for GFOI

The primary purpose of the CEOS global baseline data acquisition strategy for GFOI is to illustrate that national governments can routinely have access to the required amount of satellite data necessary for them to participate in routine reporting of forest-related greenhouse gas emissions and forest carbon stocks to UNFCCC under the REDD+ provisions. The data and methodologies may also be of interest to developed countries for greenhouse gas inventory estimates associated with land use, land-use change and forestry.

The nature of these national reports, and the information required to compile them, determines the requirements for the GFOI and its support for national forest information systems. The policy and scientific requirements for these reports continues to evolve since negotiations under the UNFCCC to establish a new climate treaty are still underway.

It is therefore necessary to make some assumptions as to the future policy landscape related to forests and their reporting in order to develop the GFOI and the data products which it might promote to help ensure consistency and comparability among national forest information systems, and to define the CEOS acquisition strategies for space data.

The following fundamental requirements have been assumed by the SDCG in developing this document:

1. **Countries will report on at least a biennial basis, with annual monitoring.** UNFCCC Annex 1 countries prepare an annual national report, which includes a national greenhouse gas (GHG) inventory and supplementary information related to emissions and removals from land use, land-use change and forestry (LULUCF) activities. Inventory reporting frequency for developing countries is biennial, as decided at the 2011 COP-17 in Durban, South Africa. In order to support all participating countries, and anticipating that market mechanisms may demand more stringent reporting requirements, the GFOI will aim to support the provision of consistent time series observations data with at least an annual frequency, which will support biennial reporting and allow more frequent monitoring, which may be useful for detecting seasonality, for policy purposes, and for institutional continuity.
2. **National monitoring systems are a requirement for full results-based implementation** although sub-national monitoring is acceptable as an interim step. UNFCCC has agreed that national monitoring is required for full results-based participation in REDD+. This would presumably include any participation via market mechanisms. The methodological basis agreed by UNFCCC is the IPCC Good Practice Guidance (GPG) for Land Use, Land-Use Change and Forestry, which - with the subsequent IPCC 2006 Guidelines - is designed to be adaptable for future reporting of greenhouse gas inventories to the UNFCCC. The guidance, with *tiers* (representing different levels of data, data quality and stages of methodological complexity) and *approaches* (representing different methods of land representation), provide methods for estimating national greenhouse gas inventories. The tiers and approaches have been designed so all countries can engage. In anticipation of future requirements around consistency, transparency, comparability, completeness and accuracy (the IPCC GPG reporting principles) in reporting, the GFOI should aim to

support annual national coverage of relevant spatially-explicit data sets for all countries, up to and including the most challenging of the IPCC tiers and approaches. The GFOI MGD aims to describe the optimum use of EO and ground-based data, consistent with the IPCC guidance.

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_2 and other greenhouse gases.** This is to support IPCC GPG, which require measurements be made accurately and consistently. (IPCC has no precision requirement. Lack of bias and time series consistency are requirements). Technical capabilities for derivation of forest/non-forest data products and for forest area change from satellite data are well established. Different forest ecosystems will need to be distinguished. Satellite data represents one of the data sources for the derivation of carbon stock change estimates and emissions and removals of CO_2 and other greenhouse gases, which is more technically challenging.
4. **Spatially explicit national data sets which form the basis for reports may require a spatial resolution better than 30m.** As for the definition of what is regarded as forest, within the limits of any ranges that may be agreed, it is likely to be up to the individual countries to determine which minimum mapping area should be used as the basis for their reporting. However, estimation of change at hectare to sub-hectare basis may be required to establish the relationship with ground-based data, and 30m spatial resolution or finer is assumed to be a requirement of future reporting requirements.
5. **Estimates of forest degradation will be required as an integral part of reporting.** This has been recognized in UNFCCC and IPCC discussions as a priority - given the perceived belief that incentives to reduce deforestation may inadvertently encourage degradation.
6. **REDD+ requirements go beyond deforestation and degradation.** The other activities (conservation, sustainable management of forests and enhancement of forest carbon stocks) also have reporting requirements, which (since no land-use change is involved) may be similar to those for reporting degradation, but may be even more challenging, because proxy indicators (*e.g.,* proximity of transport infrastructure) may be less applicable. There may also be requirements associated with safeguards, e.g. that REDD+ actions should not incentivise conversion of natural forests. Agricultural observations may also be of interest in the context of drivers of REDD+.

The GFOI information products, and therefore the supporting CEOS global baseline data acquisition strategy should be designed to satisfy the most stringent and sophisticated of the reporting tiers and approaches (Tier 3, Approach 3; see section 2.3), so that all participating countries can be supported and the observations component does not become the bottleneck to policy development and satisfying the reporting principles including accuracy, consistency (including in time series), comparability and transparency.

2.2 Policy Considerations

Negotiations, including REDD+ under the UNFCCC, which impact national forest information systems and their requirements, will continue to evolve. Governments will have multiple purposes in mind for their national forest information 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 information 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 Food and Agriculture Organization (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 national and international REDD+ implementation.

The Forest Carbon Partnership Facility (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 to test 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 together and recently conducted a common country needs assessment to complete their REDD+ readiness phases. FAO is also supporting the Capacity Development for REDD+ project (CD-REDD II), which is 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)

As the initial priority for GFOI, the heritage of and prospects for, the policy processes around the definition of, and evolution of, national reporting requirements are of great importance in ensuring that GFOI capabilities., The supporting CEOS space data acquisition strategies, are established in a way which satisfies current and anticipated future requirements.

Following the re-introduction of tropical deforestation onto the agenda in 2005, the UNFCCC agreed at Conference of the Parties (COP)-13 (Bali, 2007) to begin negotiations on further inclusion of tropical forests in post-2012 climate change agreements. The Bali Action Plan Decision 2/CP.13 highlighted the need for international action on forest monitoring. COP-15 (Copenhagen, 2009) made further progress and explicitly cited the need for national forest monitoring systems and for observations in support of these (Decision 4/CP.15), requesting developing country Parties to:

> *"…use the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;*
>
> *…establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:*
>
> *(i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;*

(ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

(iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties; "

After COP-17 in Durban in 2011, there were for two years no specific COP decisions on measurement, reporting and verification (MRV), though via other decisions, Parties have confirmed, amongst other things, that sub-national approaches can be an interim step in the development of national approaches and full results-based implementation requires a national monitoring system. Parties have also indicated in discussion that conservativeness and step-wise approaches may be useful. The expected decision on MRV at COP-18 in Doha was postponed to 2013, where after 8 long years of negotiations (Figure 2.1) on methodological aspects of REDD+ COP-19 decided on the "Warsaw Framework for REDD-plus" (COP-19 in Warsaw, Poland, 11 - 23 November 2013, FCCC/CP/2013/10, par. 44). It consists of seven elements related to both technical and financial aspects of international procedures for REDD+ and formalises REDD+ as a policy process that has achieved an overall consensus among Parties. The decisions provide guidelines on finance; reference levels; measuring, reporting and verification (MRV); safeguards; national forest monitoring systems, institutional arrangements; and addressing drivers of deforestation. The Warsaw Framework for REDD+ is backed by pledges of $US280Mn in financing from the US, Norway and the UK.

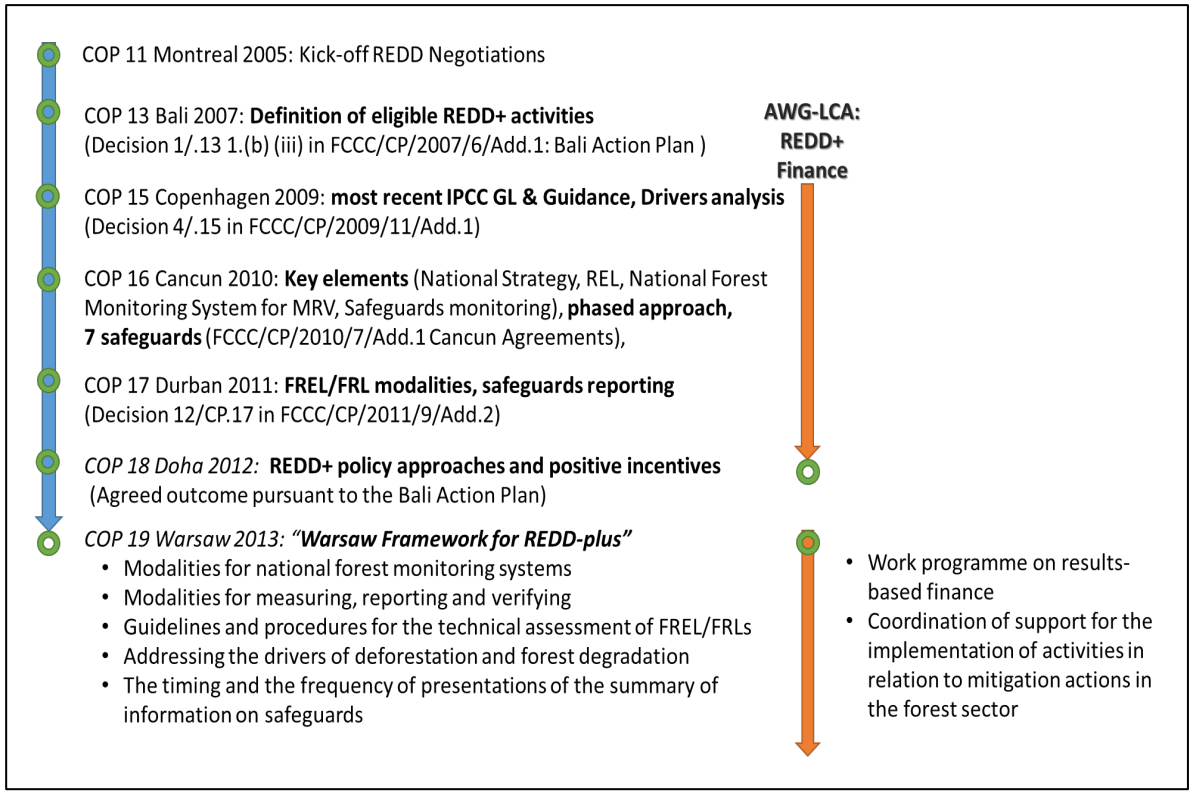

Figure 2.1: Milestone of REDD negotiations at UNFCCC (from GSE Forest Monitoring REDD – technical note GSE-REDD-TN-PD-Ph3 "REDD+ Policy Brief 2013")

2.3 Technical Considerations

As noted in section 2.1, there are two fundamental variables, which the IPCC GPG requires to be measured to estimate greenhouse gas emissions associated with REDD+ activities.

1. Forest Area Change: There are three *Approaches* to land-related data collection to represent land set in the IPCC Guidelines. Countries may use a mix of Approaches for different regions and over time.

- **Approach 1** identifies the total area for each land category—typically from non-spatial country statistics categorized into broad land use types at the time of any land use census or inventory. Information is not provided on the nature and area of conversions between land uses, that is, it only provides ''net'' area changes (for example, deforestation minus afforestation) between two inventories and thus is unlikely to be suitable for any REDD+ policy framework;
- **Approach 2** involves tracking of land conversions between categories, resulting in a non-spatially explicit land-use conversion matrix and hence changes cannot be directly linked to forest carbon maps;
- **Approach 3** extends Approach 2 by using spatially explicit land conversion information, derived from either sampling or wall-to-wall mapping techniques in time series.

While both Approaches 2 and 3 give gross-net changes among land categories, only Approach 3 allows for the estimation of gross-net changes within a category, that is, detection of deforestation followed by afforestation, which is not possible with Approach 2 unless detailed supplementary information is provided. Only Approach 3 can provide spatially explicit tracking of land conversion information.

It is further noted that land area data may need to be stratified by ecosystem type or management practice, as required for greenhouse gas inventory estimates.

2. Carbon Stock Change estimates, or emission factors: IPCC GPG defines different *Tiers* to represent the methodological complexity required to estimate the emissions and removals from a reporting category given its influence on a country's total inventory, data availability and national circumstances. Emissions and removals are usually not directly measured; rather estimates of changes in carbon stocks in the various carbon pools of a forest are converted to emission and removal estimates. Carbon stock or stock change information can be obtained at different Tier levels. Which one selected is in principle independent of the *Approach* to land representation selected (see above), but in practice not all Tiers and Approaches would logically combine.

- **Tier 1** uses IPCC default parameters (for example, biomass in different forest biomes, and carbon fraction);
- **Tier 2** requires some country-specific carbon data (that is, from field inventories and/or permanent plots);
- **Tier 3** uses disaggregated national data of carbon pools and assesses any change in pools through repeated measurements and/or modelling. Moving from Tier 1 to Tier 3 increases the accuracy and precision of the estimates, but usually increases the complexity and the costs of monitoring.

As noted above, the GFOI information products, and therefore any supporting CEOS space data acquisition strategy should be designed to satisfy the most stringent and sophisticated of the reporting tiers and approaches (Tier 3, Approach 3), so that all countries can be supported and that the observations component does not become the bottleneck.

Remote sensing can yield information relevant to biomass estimates, e.g. under some circumstances by use of spectral indices, radar or LiDAR (although no satellite is currently available for this), but these approaches have yet to move systematically from the research to inventory practice, and remote sensing is not so far able to estimate below-ground carbon pools. Furthermore, techniques require calibration or ground truthing, and differentiation of forest types or condition is likely to be more challenging than detection of the presence or absence of forest (so degradation and the other REDD+ activities are much harder than deforestation itself), and emissions of non-CO_2 greenhouse gases cannot yet be incorporated into greenhouse gas inventories by use of remote sensing alone. It is therefore inevitable that remote sensing and ground-based data will need to be used together in making emissions and removal estimates sufficient to support REDD+ participation. This is one of the areas covered in the *Methods and Guidance Document.*

2.4 Recommended Forest Map Products

The GFOI *Methods and Guidance Document*[1] (MGD) was released by the GFOI Project Office at the GEO-X Plenary in January 2014. It defines seven thematic forest map products recommended to enable countries to measure *Forest Area Change* and *Carbon Stock Change Estimates* (Table 2.1).

MGD Recommended Forest Map Products			
Code	**Name**	**Description**	**Purpose**
MGD-1	Forest / Non-Forest	Maps of forest cover through time	Visual appreciation of trends, basis for other products
MGD-2	Forest / Non-Forest Change	Maps of change in the area of forest land	Activity data for deforestation and increase in forest area expressed on a hectare or percentage basis
MGD-3	Forest Stratification	Forest/Non-forest map, but with forest stratified according to Primary Forest, Modified Natural Forest, Planted Forest (or equivalent national stratification), and any sub-stratification	Visual appreciation of forest resources; basis for other products

[1] http://www.gfoi.org/sites/default/files/MGD%20report_V1.pdf

MGD-4	All Land Use categories	Default is UN-FAO Land Cover Classification (LCCS) or an equivalent national classification, allowing aggregation into the six IPCC Land Categories. Forest included using forest/non-forest maps, stratified as in the Forest Stratification map	Visual appreciation of national land use; basis for other products
MGD-5	Land-Use Change between Forests and other Land Uses	Maps of conversions between the six IPCC Land Categories, with forest stratified as described in the Forest Stratification map and the All Land Use Categories map	Activity data for deforestation and enhancement of forest carbon stocks by afforestation / reforestation; activity data if needed for non-forest LULUCF activities
MGD-6	Change within Forest Land	Maps of conversions between forest strata in the Forest Stratification map, and of ongoing activities such as harvesting within categories	Activity data for degradation, sustainable management of forests, enhancement of forest carbon stocks within forest remaining forest, and conservation
MGD-7	Near-Real Time Forest Change Indicators	Not needed for measurement of emissions, but useful for early warning and detection of forest clearing and degradation, therefore may be useful for implementation of REDD+.	Early warning of deforestation and degradation

Table 2.1 – GFOI recommended Forest Map Products.
[GFOI Methods and Guidance Document, Table 6]

Supplementary Forest Map Products			
Code	**Name**	**Description**	**Purpose**
RD-1	Degradation Type map	Map of forest degradation types and proxies/indicators of degradation	For detail on degradation and higher accuracy when calculating emissions
RD-2	Degradation (and enhancements of C stocks)	Mapping of biomass/carbon loss or gain, or change in other vegetation metric relative to a reference year (R&D).	Degradation/Enhancement activity data
RD-3	Above-Ground Biomass (AGB) Estimation	Map showing vegetation biomass estimates that can be used in IPCC reporting following the IPCC Guidelines.	Above-Ground Biomass (AGB) estimation
RD-4	Change in Above-Ground Biomass (AGB)	Map showing changes in vegetation biomass estimates that can be used in IPCC reporting following the IPCC Guidelines	Change in Above-Ground Biomass (AGB)

Table 2.2 – Supplementary Forest Map Products.
[GFOI R&D Review document, Table 7]

Four supplementary forest map products have been defined in the *GFOI Review of Priority R&D Topics* document[2] - herafter referred to as the *GFOI R&D Review document* – which was released by the GFOI Project Office in December, 2013 (Table 2.2). The supplementary products are also considered of high relevance to countries, but additional R&D efforts will be required to bring them to an operational or pre-operational stage, and subsequent inclusion in the MGD. Progressing such targeted R&D is a main objective of the GFOI R&D component.

These eleven products determine the data acquisition strategies being developed by CEOS to make satellite data available. It is not the responsibility of CEOS agencies to generate these products, but to make the necessary satellite data available so that countries can generate selected products of their choice to meet their needs.

2.4.1 MGD Recommended Forest Map products

MGD-1: Forest/Non-Forest product maps can be generated independently or derived by aggregating the Land Use product (MGD-4), if available.

The EO data options for the generation of the MGD-1 product specification include:

- **Optical data**: Can be used stand-alone if cloud-free coverage is obtained. The inclusion of the Short-Wave Infrared (SWIR) band improves class distinction. At least one annual national coverage is necessary, but dual-season (or more frequent) is preferred. Considered operational in the MGD.
- **L-band SAR**: Can be used stand-alone. Dual-polarisation (co- and cross-polarisation) is strongly recommended, as the cross-polarisation channel is sensitive to vegetation structure. At least one annual coverage (dry season) is required, but dual-season (or better) and/or combination with optical and/or other SAR data would provide improved classification accuracy. Considered operational in the MGD.
- **C-band SAR**: Can generally not be used stand-alone as lower vegetation may be confused with forest. Distinction of forest and non-forest with dense time-series coverage is an R&D topic. Dual polarisation (co- and cross-polarisation) is strongly recommended. Considered R&D in the MGD.

MGD-2: Forest/Non-Forest Change. This product specification deals with changes in forest cover - typically to be generated on an annual basis to accommodate reporting of forest losses and gains. MGD-2 can be derived by aggregating the Land Use Change product (MGD-5), if available, or generated using time-series of satellite data. Fire-related changes are important to detect and can be derived from lower resolution products such as NASA Terra & Aqua MODIS burnt area maps.

The EO data options for the generation of the MGD-2 product include:

- **Optical data**: Can be used stand-alone if cloud-free coverage is obtained. Time-series are required, preferably at higher frequency than annual as additional intra-year data improves the classification accuracy. Considered operational in the MGD.

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

- **L-band SAR**: Can be used stand-alone in dual-polarisation. Time-series are required semi-annual or better as additional intra-year data improves classification accuracy.
- **C-band SAR**: Can be used for monitoring of deforestation and logging activities under an existing forest mask (Product MGD-1). Dense time-series (monthly, or more frequent) are required, where dual polarisation (co- and cross-polarisation) is strongly recommended. Considered operational in the MGD.
- A Historical Forest Cover Change map (MGD-2') can be useful to determine past forest cover baselines and assessment of historical change and trends. This product is the same as MGD-2, but is derived from historical (archived) optical satellite data. Considered R&D in the MGD.

MGD-3: Forest Stratification. This product specification is for a map showing relevant forest types, stratified into primary forest, modified natural forest and plantations, and any further sub-stratifications. Forest classes to be included vary between countries and eco regions, including when applicable; regionally significant types *e.g.,* peat swamp forest, mangrove, low-density forest, and secondary/regrowth.

The EO data options for the generation of Product MGD-3 include:

- **Optical data**: Provides the best EO source for forest type distinction and can be used stand-alone if cloud-free coverage is obtained. The inclusion of the SWIR band significantly improves class distinction. Effects of other bands like red-edge on ESA Sentinel-2 need further research. At least one annual national coverage is required, but dual-season coverage (or more frequent) is preferred. Considered operational in the MGD when stratification limited to primary forest and planted forest, but pre-operational if distinguishing between several sub-strata of natural forest.
- **L-band SAR** is generally insufficient on its own for forest type distinction, but in dual-polarisation mode it could compliment optical and C-band data. The combination of dual polarisation L- and C-band data has been demonstrated to allow separation of certain forest types (*e.g.*, Acacia, oil palm, rubber). Dual-season observations would improve class distinction. Considered pre-operational in the MGD.
- **C-band SAR** is similar to L-band, in that it is insufficient on its own for forest type distinction. The combination with dual polarisation L-band data has been demonstrated to allow separation of certain forest types (*e.g,.* Acacia, oil palm, rubber). Dual-polarisation is an absolute requirement. Utilisation in combination with optical data is unknown. Considered R&D in the MGD

MGD-4: Land Use. This is a key product specification required for national baseline mapping. It is for participating countries themselves to decide what level of detail or classification scheme they wish to use, but default is UN-FAO Land Cover Classification (LCCS) or an equivalent national classification, allowing aggregation into the six IPCC Land Categories. Forest included using forest/non-forest maps, stratified as in the Forest Stratification map (MGD-3). Since satellite data observes land cover, supplementary ground-based data may be required to determine land use, where this is a methodological requirement.

EO data options for the generation of product MGD-4 include:

- **Optical data**: Can be used stand-alone if cloud-free coverage is obtained, and provides the most versatile classification. Availability of a SWIR band significantly improves class distinction. At least one annual national coverage would be needed, and dual-season (or more) would be preferred. Considered operational under certain circumstances in the MGD: annual mapping of All Land Use categories and change at sub-hectare scales is considered technically feasible for resolutions around 10 m and better, but is yet to be implemented for use in greenhouse gas inventories.
- **L-band SAR**: L-band SAR can be used stand-alone, if dual season or more frequent data are available. The thematic richness of classifications derived from L-band SAR is inferior to classifications based on optical data, but reaches best results in combination with optical data and/or with other SAR data. Dual-polarisation (co- and cross-polarisation) is preferred as the cross-polarisation channel is sensitive to vegetation structure. Considered pre-operational in the MGD.
- **C-band SAR**: Its capability for land classification is inferior to optical and L-band SAR. C-band SAR can be used for forest/non-forest distinction and timely monitoring of deforestation and logging activities with dense time series, where dual polarisation provides better results. Utility in combination with optical and/or L-band SAR has been proven for improved distinction of certain vegetation classes. Dual-polarisation (including both co- and cross-polarisation) is needed to do this. Considered R&D in the MGD.

MGD-5: Land-Use Change between Forests and other Land Uses. In order to calculate net carbon emissions, countries are required to produce *activity data*, *i.e.*, information about the extent of REDD+ activities. Conventionally, activity data are areas arranged in a land area change matrix, as shown in Table 2.3, sufficiently disaggregated so that they can be associated in an emissions or removal calculation with carbon stock differences or other *emission factors* which are usually expressed per unit area.

Product MGD-5 should characterise conversions between the six IPCC Land Categories, with forest stratified as described in the All Land Use Categories (MGD-4) product. Additional separation into further sub-classes is required for the "Forest-remaining-Forest (FF)" transition class, to map conversions between forest strata in the Forest Stratification map (MGD-3), and of on-going activities such as harvesting within the forest categories.

	Forest land	Grassland	Cropland	Wetlands	Settlements	Other land
Forest land	FF(+)	FG	FC	FW	FS	FO
Grassland	GF	GG	GC	GW	GS	GO
Cropland	CF	CG	CC	CW	CS	CO
Wetlands	WF	WG	WC	WW	WS	WO
Settlements	SF	SG	SC	SW	SS	SO
Other land	OF	OG	OC	OW	OS	OO

Table 2.3 – IPCC Transition Matrix showing the six IPCC land cover categories and associated 36 (theoretical) transitions. Additional subcategories within Forest remaining Forest (FF+) will be required to characterise events such as degradation, enhancements of carbon stocks and transitions from natural forest to plantations.

MGD-6: Change within Forest Land. This product is a sub-category of MGD-5, limited to conversions between forest strata in the Forest Stratification map (MGD-3), and of on-going activities such as harvesting within the forest strata.

The EO data requirements for the generation of the MGD-5 and MGD-6 products are multi-year time-series of the data used for the generation of Product MGD-4. Operational readiness considered in the MGD: operational for optical data around 10m resolution and better, pre-operational for L-band SAR and R&D for C-band SAR.

MGD-7: Near-Real Time Forest Change Indicators. This product specification is intended to provide early warning *indicators* of potential changes in forest cover, such as forest clearing and degradation. It is not required for measurement of emissions, but useful for implementation of REDD+.

The EO data options for the generation of the MGD-7 product include:

- **Optical data**: All optical sensors are potentially useful. Outside of areas with direct ground station downlinks, lower spatial resolution sensors have the potential to fulfil the temporal repetition requirement. 250m resolution NASA Terra and Aqua MODIS data are, for instance, currently used by Brazil within an operational deforestation detection system (DETER) in the Brazilian Legal Amazon. Sensors with a medium/coarse resolution of 50-100m such as CBERS-4 WFI-2 and ResourceSat AWiFS are potentially very useful. High temporal frequency observations (monthly or weekly) would be required. To approach monthly or weekly observations, three-day revisit or better would be needed to increase the probability of cloud-free data. Considered operational in the MGD.
- **L-band SAR**: Wide-beam modes (50-100m GSD) are useful even in single polarisation, but dual-polarisation is preferred. High temporal frequency observations (monthly, or better) would be required. Considered pre-operational in the MGD.
- **C-band SAR** can provide monitoring and indication of deforestation and logging activities under an existing forest mask (Product specification MGD-1). Dense time-series frequency (monthly, or better) would be required, where dual polarisation provides better results (see MGD-2). Considered R&D in the MGD.

2.4.3 Supplementary Forest Map Products

RD-1: Degradation Type Map. Consistent identification and mapping of degradation is of very high priority for REDD+, and identified as a Priority R&D Topic for GFOI. Any potential degradation type, e.g. caused by selective logging, partial fire, pests/diseases, drought and fuel-wood collection, or proxies or indicators such as logging roads, vegetation index changes, and changes in canopy structure, should be taken into consideration and mapped if feasible.

The EO data requirements for the generation of the RD-1 product can be expected to vary depending on the type of degradation (or proxy) but include:

- **Optical data**: High spatial and high temporal observation frequencies are likely to be important. Very high spatial resolution (< 5m) presently is provided only by commercial missions (VHR optical and X-band SAR). For any sensor used, dense time series data can be expected to improve detection, with the temporal frequency depending on degradation type. Amongst the core missions, Sentinel-2 will provide the highest resolution and most spectral bands and dedicated research will be required to assess its potential for degradation mapping.
- **SAR data**: High resolution SAR data can detect some types of forest degradation *e.g.*, suitable schemes to combine degradation indicators with degradation mapping.

Identification and mapping of degradation (or proxies) is in the GFOI R&D Review document considered to be in an R&D phase for all sensor types.

RD-2: Degradation and Enhancements of C Stocks. Map showing biomass/carbon loss or gain, or change in other vegetation metric relative to a reference year. It also include enhancements of carbon stocks resulting from management practices and/or natural causes. e.g. forest management and regrowth. While the Degradation Type product (RD-1) is a qualitative product and a first necessary step towards better understanding of mapping degradation, the RD-2 product concerns quantitative measures of carbon losses and gains. The product is considered to be in an *early* R&D phase in the GFOI R&D Review document.

The EO data options for the generation of Product RD-2 can be expected to be the same as for RD-1, i.e. (dense) time series of Very High Resolution optical and/or SAR data. The product is considered early stage R&D for all sensor types.

RD-3: Above-ground Biomass (AGB) Estimation: This product specification is for a map showing relevant vegetation/land cover classes stratified by above- ground biomass (AGB) that can be used to derive emissions factors for reporting is recommended. The AGB product is distinct from RD-2 product in that AGB is estimated for cover classes additional to forest.

The EO data options for the generation of Product RD-3 include:

- **Optical data**: Not physically related to ABG but can be used interoperably with L-band SAR to increase biomass saturation level, and/or in combination with allometric equations or statistical in-situ measurements, where they provide forest area and type information. Not useful stand-alone.
- **L-band SAR**: Useful as a stand-alone measurement for low biomass (<100 t/ha) forests. Dual polarisation is required. Biomass saturation level can be increased when combined with optical data. Soil moisture affects retrieval accuracy and observations, preferably multiple, should be targeted to dry conditions.
- **C-band SAR**: High temporal density stacking of C-band data have proven useful for estimations of forest above-ground biomass in the boreal zone (<150 t/ha), but this methodology is not suitable in dense tropical forests. Further research is needed for ESA Sentinel-1 for lower biomass forests in the tropical and sub-tropical belts.

The GFOI R&D Review document categorises this product to be in an *early* R&D phase for all sensor types.

RD-4: Change in Above-Ground Biomass: Map showing changes in above-ground biomass in stratified land use/vegetation classes that can be used in emissions reporting following the IPCC Guidelines. Related to RD-3, but tracking changes.

The EO data requirements for product RD-4 can be expected to be the same as for RD-3, but with time-series for all sensors. The GFOI R&D Review document categorises this product to be in an *early* R&D phase for all sensor types.

2.5 Data Strategy Response to GFOI Information Requirements

When in full operation in 2016, the CEOS global baseline data acquisition strategy is foreseen to provide sufficient satellite data availability to accommodate operational or pre-operational generation of all seven of the MGD Forest Map products, and two of the four Supplementary Forest Map products.

In 2014, when the only *core data streams* in operation are expected to be Landsat-7 and Landsat-8 (see 3.2), data needs for six out of the eleven MGD and Supplementary Forest Map products are foreseen:

- Forest/Non-Forest (MGD-1)
- Forest/Non-Forest Change (MGD-2)
- Forest Stratification (MGD-3)
- All Land Use Categories (MGD-4)
- Land Use Change between Forest and other land classes (MGD-5)
- Change within Forest Land (MGD-6)

The products that are not expected to be fully served by *core data streams* in 2014 are:

- Near-Real Time Forest Change Indicators (MGD-7) – requires observations at high temporal revisit frequency. High spatial resolution of less importance. MODIS meets the operational requirement at 250 meter.
- Degradation Types (RD-1) – data requirements to be defined
- Degradation and Enhancements of C stocks (RD-2) – data requirements to be defined
- Above-Ground Biomass Estimation (RD-3) – requires L-band SAR.
- Changes in Above-Ground Biomass (RD-4) – requires L-band SAR.

Product MGD-7 can first be addressed when ESA Sentinel-1 becomes fully operational, limited to a selected number of countries that are supported by dedicated ESA Sentinel-1A observations. When ESA Sentinel-2 becomes fully operational (see 4.2.2. below), product MGD-7 can be expected to be accommodated for all countries, except those with near-permanent cloudiness.

Products RD-1 and RD-2 are considered a priority research topic for GFOI and the data requirements for the generation of a degradation-type product are at present yet to be defined.

Products RD-3 and RD-4 are also a labelled a priority research topic for GFOI, where L-band SAR constitutes the sensor type with best sensitivity to above-ground biomass. CONAE/ASI SAOCOM-1 is the only mission of the *core data streams* carrying an L-band SAR and baseline observations supporting generation of MGD-7 products can be expected in 2016.

3 Strategy for Global Baseline Coverage

3.1 Basic Strategy

In 2011, the 26th CEOS Plenary endorsed the development of a CEOS data strategy for GFOI, which addresses both:

- Sustained global observations required in support of the GFOI as it evolves in the coming years in support of policy developments; and
- Technical support activities on-going within the GFOI, including continuation of the GEO-FCT National Demonstrators (NDs), and science questions in support of the *Methods and Guidance Document* development and challenges, such as data interoperability.

The agreed strategy comprises three elements:

1. **A baseline, coordinated global data acquisition strategy** involving a number of core data streams that can be shared openly and acquired free-of-charge for GFOI purposes. This will involve systematic and sustained wall-to-wall acquisitions of forested areas, globally repeated on timescales consistent with national reporting commitments and the requirements of national forest information systems – which are to be determined but anticipated to require at least annual monitoring in support of biennial reporting for developing countries under REDD+ provisions. This would provide the default forest observations data for all countries without specific technical requirements, heritage or data preference such as for a particular mission or type of optical or SAR data.

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

3. **Data supply in support of GFOI R&D activities**, including support to the science studies assisting the evolution of the MGD for GFOI, interoperability studies, and validation activities – typically also involving higher resolution EO data, some of which is provided commercially and is generally beyond the scope of CEOS agency responsibility.

The first element is the subject of this document. The CEOS global baseline data acquisition strategy for GFOI can be characterised as:

- Aiming to illustrate the minimum space data provision necessary for all interested countries to engage in reporting to the relevant UNFCCC frameworks, such as REDD+;
- Based on acquisitions undertaken by a number of core data streams (see 3.2 below) - which will allow free-of-charge access to the resulting data archives by countries for national forest information systems;

- Phased – recognising that sufficient and sustained global coverage by these *core data streams* will not be feasible for several years, and anticipating the launch of a number of key satellites within the next few years, having started in 2013; national REDD+ requirements and policy considerations have been taken into account so far as possible in designing the evolution of this strategy (see 3.3 below);
- Adaptive to changes in requirements, MGD development and to space agency supply plans; the global baseline data acquisition strategy is a living plan which will serve as the basis for SDCG's on-going communication with, and coordination of, the CEOS agencies providing core data streams or other mission data (see 3.4 below and section 10 on Governance). It will be revised on an annual basis.

3.2 Core Data and Contributing Data Streams and their Roles

The global baseline data acquisition strategy involves coordination of a number of *core data streams* that satisfy key criteria consistent with the principles for implementation of the GFOI:

- *Core data streams* provide data, at 30m resolution or finer, free-of-charge and openly shareable for GFOI purposes, consistent with being available in support of any country's information requirements;
- *Core data stream* systems have a sustained and long-term capacity in coverage, processing and distribution which is consistent with the large (global) scale data requirements of the GFOI.

Discussions among CEOS agencies active within the FCT Task for several years have resulted in consensus on a working list of CEOS agency satellite missions that represent the *GFOI Core Data Streams* – based on available information regarding known or expected data policies and mission capacities. These include:

- Landsat-7 and -8 (optical) – USGS/NASA;
- Sentinel-1 series (C-band SAR) – ESA/EU;
- Sentinel-2 series (optical) – ESA/EU;
- CBERS-4 (optical) – INPE/CRESDA;
- RADARSAT Constellation Mission (C-band SAR) – CSA.

Sentinel-1 and -2 satellite series are part of the Copernicus Space Component under ESA responsibility. Copernicus, previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation.

CONAE and ASI are considering the possibility of including the L-band SAR SAOCOM-1 series of satellites as a core data stream candidate. Further CEOS agency missions that satisfy these criteria are encouraged for inclusion in the list of core data streams and the SDCG will actively pursue inclusion of additional missions. For the time being, it is assumed that coordination of the global baseline data acquisition strategy will involve CRESDA, CSA, ESA, INPE, USGS/NASA and perhaps CONAE and ASI.

3.2.1 Individual Roles of the Core Data Streams

The requirements outlined in Section 2 above are assumed to be achieved for most countries through a baseline coverage data set derived from optical data, which is the easiest for most countries to handle and analyse. The assumption is that a combination of **Landsat-7,**

Landsat-8, and Sentinel-2A will provide more than adequate frequency of coverage for GFOI requirements when space and ground segments are fully operational in 2016, for all regions of the world other than those most affected by persistent cloud cover. Prior to availability of the ESA Sentinel-2A data stream, there is a strong dependence on USGS/NASA Landsat-7 and Landsat-8 in the transition to global coverage.

INPE/CRESDA CBERS-4 is foreseen as having a significant regional role dictated by its ground station network in Brazil, China, and when fully developed, central Africa. It can also play a role in supporting global coverage needs through to the simultaneous operation of Landsat-7, Landsat-8, and Sentinel-2A, as well as performing a gap-filling role.

Sentinel-1A offers the first prospect of a radar core data stream, from mid 2014, and its C-band data will in the 9 months ramp-up phase be focused on provision of time series data in heavily clouded areas in the tropical and subtropical regions.

The **CSA RADARSAT Constellation Mission** is being planned to provide synergies and interoperability with the ESA Sentinel-1 series and will provide continuity of gap-filling capabilities for GFOI.

The **SAOCOM-1** series will operate in L-band frequency. L-band SAR is due to its relatively long wavelength sensitive to forest and vegetation structure and this makes the SAOCOM-1 data an important contribution (see 2.4), in particular in very cloudy regions where sufficient optical cannot be obtained.

3.2.2 GFOI Contributing Data Streams

Whilst few CEOS agency missions may currently satisfy the criteria to be classified as a *GFOI Core Data Stream*, other Public-Private Partnership (PPP) and commercial missions will be able to contribute to systematic national, regional, and global coverage – and thereby to the three Elements of the CEOS Baseline Global Data Strategy for GFOI. These include optical high-resolution missions, (such as the SPOT series and RapidEye), as well as other radar missions (such as ALOS-2, Radarsat-2, TerraSAR-X and TanDEM-X). The data from these further missions can also support validation and technical studies and be needed to satisfy reporting requirements in terms of detection thresholds, secure or enhanced frequency and reliability of cloud-free coverage. They will also be critical in supporting global coverage during the transition period of the core data streams in the early years of the strategy, mainly until 2015.

3.2.3 Special Core Data Sets by Contributing missions

Certain data sets from some missions in the Contributing Data category are of relevance for GFOI and can be considered special case Core Data Sets.

CNES SPOT World Heritage (SWH) data. CNES offers through the SWH programme access to ortho-rectified SPOT-1 through -5 data that were captured more than 5 years ago (rolling limit) for non-commercial uses. All data available from the SWH archive, operated by CNES, are free of charge. Also SPOT data acquired within the **SPOT Congo Basin Initiative** SPOT data are publicly available through a special user agreement for REDD+ purposes, and can be used by GFOI countries in the region.

JAXA ALOS-2 Global Mosaic data. JAXA are planning the generation of 25 m resolution global mosaics based on ALOS-2 PALSAR-2 L-band SAR on an annual basis starting from 2014. Such mosaics have been generated for the years 2007-2010 using ALOS PALSAR data, and are since January 2014 available free of charge at 50m pixel spacing. Release of 25m resolution versions of both ALOS and ALOS-2 mosaics is under consideration.

3.3 Phased Implementation

It is assumed that a new climate treaty with REDD+ provisions will be agreed in 2015 and that there will be a requirement for historical data for setting reference levels.

The GFOI Implementation Plan calls for the key components (including Observations & Measurement) to be operational by the end of 2015. As far as possible, timing of the CEOS Baseline Global Data Acquisition Strategy for GFOI should reflect and support the schedule indicated in the GFOI Implementation Plan. In practical terms, the failure of a number of key data streams in recent years (CBERS-2 and CBERS-3, ALOS, ENVISAT, and Landsat-5), and delays to the operational availability of many of their replacements will limit the ability of contributing CEOS agencies to guarantee sustained global coverage consistent with national reporting requirements, until 2016 – which is planned to be the first year for formal accomplishment of full global space data available in support of GFOI requirements.

A phased approach is used by SDCG to:

- Allow the establishment of the necessary coordination processes with contributing agencies;
- Reflect the schedule of gradually increasing availability of the anticipated core data streams between now and 2016;
- Reflect priorities set by the policy context and readiness of individual countries to participate in REDD+ development;
- Take into account the need for continuity of coverage of the existing National Demonstrator countries established under the GEO-FCT Task as a precursor to GFOI.

Table 3.1 indicates the schedule for the establishment of the global baseline data acquisition strategy for GFOI by 2016 – consistent with the above considerations:

Year	Coverage added	No. countries*	Area* (Mkm^2)	Total Area* (Mkm^2)
2013	GEO-FCT National Demonstrator countries GFOI Participating Countries	15	20.5	20.5
2014	UN-REDD National Programme Countries WB-FCPF Participating Countries CD-REDD Project Countries (BMU)	36	18.5	39.0
2015	UN-REDD Partner Countries WB-FCPF Partner Countries Other Pan-Tropical Countries	17	9.0	48.0
2016	Global	127	84.8	132.8

Table 3.1 – Proposed schedule for the establishment of the global baseline data acquisitions for GFOI.
(the number of countries and areas exclude overlap between the groups)*

The phasing of the strategy applies to coordination of the necessary satellite data acquisitions consistent with national reporting requirements. The strategy is:

- Working to ensure continuity of coverage of the (former) FCT National Demonstrator countries and adds a priority to those countries that have been seeking active participation in GFOI and have engaged in related capacity building activities;
- Dependent on the core data streams presently in operation:
    - USGS/NASA Landsat-7 and -8
- Dependent on the launch of the core data streams anticipated between 2014 and 2016 and generally consistent with their acquisition capacities; these are:
    - CBERS-4 (December 2014);
    - Sentinel-1A and -1B (April 2014, late 2015);
    - Sentinel-2A and -2B (Spring 2015, 2016);
    - SAOCOM-1A and -1B (2015, 2016)
- Consistent with the goal of supporting countries that have ambitions to participate in the REDD+ frameworks – seeking to provide those countries that have demonstrated readiness with the required wall-to-wall coverage as soon as capacity is available;
- Prioritising tropical and sub-tropical forest coverage, consistent with the policy considerations; and
- Reflecting engagement of different countries using priorities agreed with the GFOI Advisory Committee and the GFOI Project Office.
- The strategy is built around *core data streams*, which as a part of their designation feature free and open data distribution policies. However, there is a data distribution and delivery service which needs to be added on top of this strategy to ensure countries are able to leverage the data acquired. That service is defined in the Space Data Services Strategy for GFOI (Element 2).

Year	Country	GEO-FCT ND	GFOI Part'ip.	UN-REDD Nat.Prog	UN-REDD Partner	WB FCPF Particip.	WB FCPF Candid.	GIZ CD-REDD
2013	Brazil	√						
	Cameroon	√			√	√		
	Colombia	√		√		√		√
	Democratic Rep. of Congo	√		√		√		
	Guyana	√			√	√		
	Indonesia	√		√		√		
	Mexico	√			√	√		
	Nepal	√			√	√		
	Peru	√			√	√		√
	United Republic of Tanzania	√		√		√		
	Cambodia		√	√		√		
	Costa Rica		√		√	√		
	Ecuador		√	√				
	Panama		√	√		√		
	Viet Nam		√	√		√		

Table 3.2 – GFOI priority countries in 2013. The table indicates country involvement in the GEO-FCT, WB FCPF, UN-REDD and GIZ[3] CD-REDD processes.

[3] Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for Int'l Cooperation)

Year	Country	GEO-FCT ND	GFOI Part'ip.	UN-REDD Nat. Prog.	UN-REDD Partner	WB FCPF Particip.	WB FCPF Candid.	GIZ CD-REDD
2014	Bolivia (Plurinational State)			√		√		
	Congo			√		√		
	Nigeria			√		√		
	Papua New Guinea			√		√		
	Paraguay			√		√		
	Zambia			√				√
	Philippines			√			√	√
	Solomon Islands			√				
	Sri Lanka			√			√	
	Argentina				√	√		√
	Bhutan				√	√		√
	Chile				√	√		√
	Ghana				√	√		√
	Lao People's Democr. Rep.				√	√		√
	Mozambique					√		√
	Thailand					√		√
	Central African Republic				√	√		
	El Salvador					√		
	Ethiopia				√	√		
	Gabon				√	√		
	Guatemala				√	√		
	Honduras				√	√		
	Kenya				√	√		
	Liberia					√		
	Madagascar				√	√		
	Nicaragua					√		
	Suriname				√	√		
	Uganda				√	√		
	Vanuatu					√		
	Algeria							√
	Kyrgyzstan							√
	Morocco				√			√
	South Africa							√
	Tajikistan							√
	Tunisia				√			√
	Uruguay						√	√
2015	Bangladesh			√				
	Belize						√	
	Benin				√			
	Burkina Faso					√		
	Burundi						√	
	Chad						√	
	Côte d'Ivoire				√	√		
	Dominican Republic					√		
	Fiji					√		
	Jamaica						√	
	Malawi				√			
	Malaysia				√			
	Mongolia				√			
	Myanmar				√			
	Pakistan				√	√		
	South Sudan				√		√	
	Sudan				√		√	
	Togo					√		
	Zimbabwe				√			
2016	Remaining Global							

Table 3.3 – GFOI priority countries in 2014-2016.

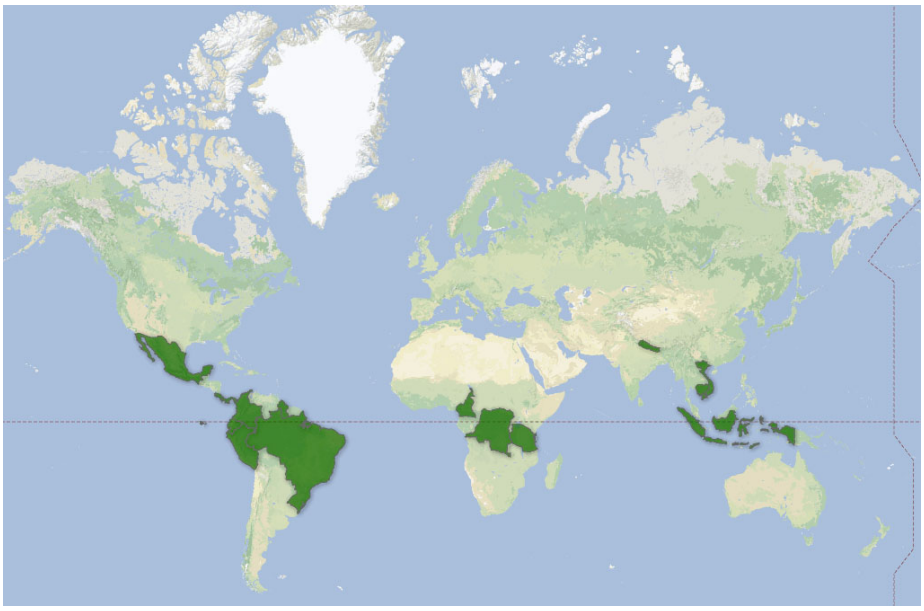

Figure 3.1 – GFOI priority countries in 2013

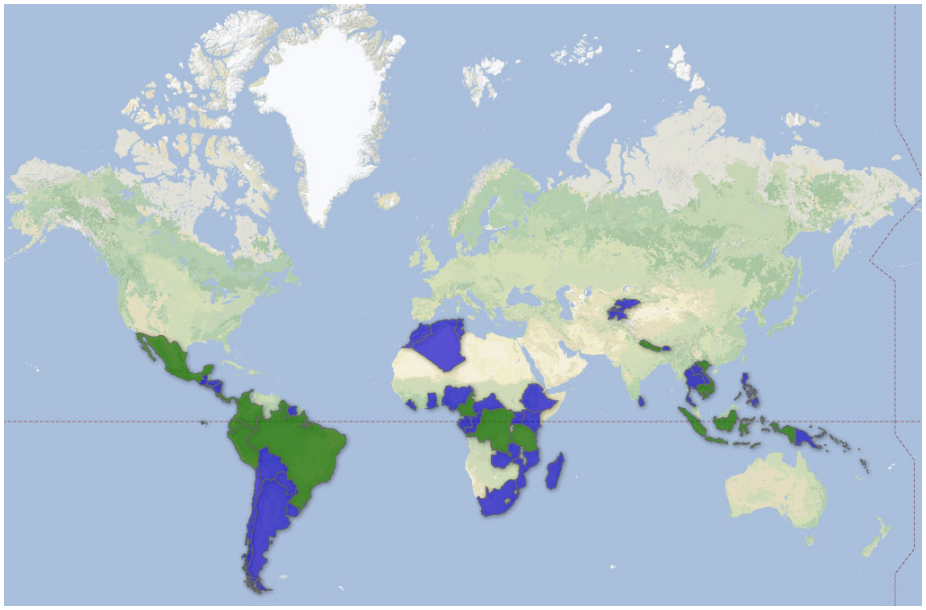

Figure 3.2 – Expansion Scenario: 2014

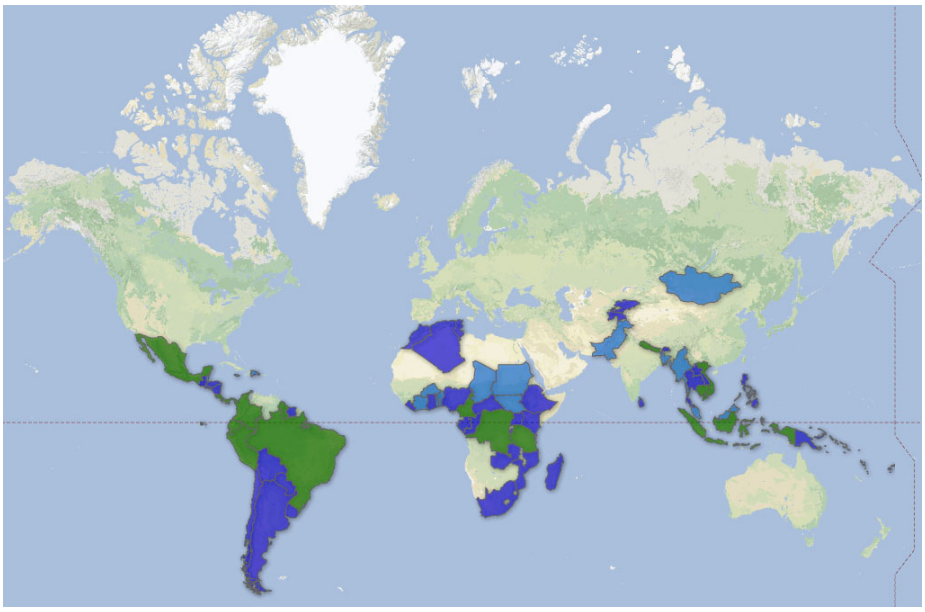

Figure 3.3 – Expansion Scenario: 2015

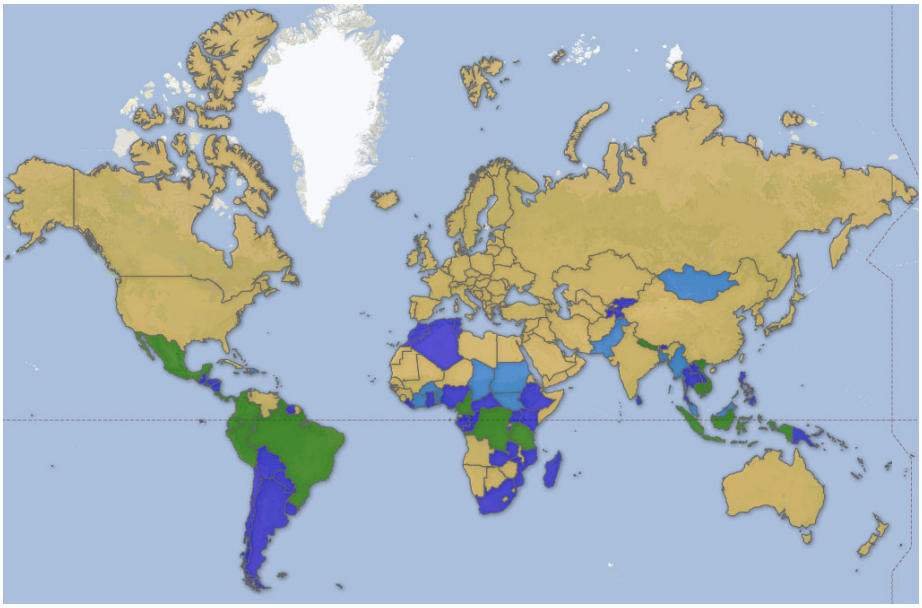

Figure 3.4 – Expansion Scenario: 2016

3.4 Strategy Maintenance

The requirements for the global baseline data acquisition strategy can be anticipated to evolve continuously as the policy and methodological framework around REDD+ develop, and as individual countries determine positions and engage with FCPF, UN-REDD and GFOI. The acquisition capacity can also be expected to change as satellite schedules are altered and national data policies and acquisition strategies evolve.

The global baseline data acquisition strategy will continue to be maintained, in the first instance by the SDCG, as a means of managing expectations of the policy community and of individual countries as to space data availability, and for on-going coordination of the implementation efforts of the contributing space agencies. SDCG proposes to update the global baseline data acquisition strategy at least annually for review at its meetings, endorsement at the annual CEOS Strategic Implementation Team (SIT) meeting and approval by the *core data stream* agencies. Governance issues are discussed in Section 10 and include continued direction from the GFOI Steering Committee (on evolution of the requirements and policy context) and interaction with the CEOS SIT (for coordination of implementation matters).

4 Approach to Implementation

4.1 Introduction and Overview

This section outlines the implementation steps required to address the requirements that were defined in Section 2 following the strategy defined in Section 3. It is intended to give guidance to satellite operators and EO data providers.

The implementation is characterised and assessed by:

- Summarising the combined *core data streams* "business as usual" (BAU) coverage plans;
- Assessing the capacity of the combined BAU plans against the anticipated impact of clouds;
- Suggesting recommendations to the BAU plans to better meet GFOI data requirements;
- Provide early input to mission teams of key future systems; and
- Provide general suggestions on how *Contributing Data Streams* could be employed to augment or fill critical data gaps.

The guidance to *core data stream* satellite operators is characterised by the roles outlined in Section 4.2, including global baseline coverage, regional focus, and gap filling. These roles are based on the data requirements as described in Section 2.4 and summarised in Table 1. In essence, the product requirements can be met for a given area with: cloud free optical coverage; L-band SAR coverage; or, high frequency C-band SAR coverage in combination with baseline optical or L-band SAR coverage.

Global Coverage	Regional Focus and Gap Filling
Landsat-7/-8 [2012+] Sentinel-2A/-2B [2015+] Sentinel-1A/-1B [2014+] RCM [2018+]	CBERS-4 [2015+] *South America, South- and Southeast Asia, and Africa* SAOCOM-1A/-1B [2016+] *Pan-tropical*

Table 4.1 – Roles foreseen for the Core Data Streams [year of start of operations]

4.2 Global Baseline Coverage

The technical characteristics and global scale capacity of the Landsat and Sentinel-2 systems make them key data streams for the GFOI. An indication of their relevance relative to the GFOI forest information target products (see 2.4) is given in Table 4.2 below:

	F/NF MGD-1	F/NF C MGD-2	F type MGD-3	LU MGD-4	LUC MGD-5	FC MGD-6	EW MGD-7	Degr RD-1-2	ABG RD-3-4
Landsat 7 & 8	O	O	Δ	O	O	Δ	Δ	R&D	R&D
Sentinel 2A & 2B	O	O	Δ	O	O	Δ	O	R&D	R&D

Table 4.2 – Sensor relevance to GFOI target products
(O: can be used stand-alone; Δ: can provide partial or complementary information when in combination with another core sensor, or under other certain circumstances; R&D)

4.2.1 USGS/NASA Landsat

BAU: Landsat and the Landsat Long Term Acquisition Plan

Acquisitions by the Landsat-7 and Landsat-8 missions are guided by Long Term Acquisition Plans (LTAP). The plans are used to set priorities for the acquisition of Landsat images as a function of seasonality; land definition; time since last successful acquisition, forecasted cloud cover; cloud climatology; and sun angle. Each day the opportunities are ranked by their priorities and images are acquired up to the daily limit. Physical constraints such as duty cycle, maneuvers, on-board memory and downlink opportunities may dictate acquisition opportunities.

Landsat-7 and -8 are managed as a constellation. As of November 2013, Landsat-7 is managed as a continental mission. Open ocean, islands and Antarctica are no longer routinely imaged with Landsat-7. The focus of Landsat-7 on continental land masses will increase the average number of daily images from 375 to 434 (90.5% of 479 opportunities), while at the same time reducing the number of times the sensor needs to be power cycled. Between June and August 2013, the average increased from 392 to 470 images per day (85.5% of 550 opportunities). Between December 2013 and February 2014, the average increased from 354 to 357 images per day (99% of 358 opportunities). The 20% missing data in the Landsat-7 images results in a no-data rate similar to 20% cloud cover. However, cloud-free Landsat-7 data is preferred to 20% cloud cover, since cloud contamination and cloud shadow will have effects beyond the areas identified as clouds.

Landsat-8's increased dynamic range, new bands, and fewer physical constraints make it the preferred sensor for water, islands, snow/ice and night imaging. Landsat 8 has acquired 550 images per day since commissioning. A further increase is under investigation to establish a new baseline. The expectation is the sustainable level will be greater than 550. However, the baseline specification continues to be 400 images/day.

BAU: Landsat Capacity Assessment

Together, the Landsat-7 and Landsat-8 missions offer an 8-day revisit time, with each individual satellite revisiting every 16 days. Data are acquired during every opportunity

over U.S. territory, and within the Brazilian and Australian ground station masks. Globally, the LTAP aims at achieving at least four seasonal global land coverages each year optimized for cloud cover. Although the LTAP is not adjusted to accommodate the needs of specific user communities, suggestions for optimisation are always welcome. For documented persistently cloudy scenes and scenes where the LTAP is not performing optimally, special requests to increase the probability of acquisitions will be considered.

An 8-day revisit time is not sufficient to create annual cloud-free mosaics in regions with persistent cloud cover. The change to a Landsat-7 continental model and the proposed increase in Landsat-8 acquisitions increases the probability of acquiring cloud-free images and helps compensate for the missing data caused by the scan line corrector failure on Landsat-7. Multiple acquisitions will often be necessary to provide annual complete data coverage to compensate for persistent clouds and Landsat-7 missing data. The analysis of these persistently cloudy regions in GFOI countries provides information needed for understanding and improving LTAP.

4.2.2 ESA Sentinel-2

BAU: Plans for Sentinel-2 acquisitions

The ESA Sentinel High Level Operation Plan (HLOP) identifies the main constraints, limitations and potential conflicts, describes the strategy and provides high-level exploitation (for details see Sentinel-1 under 4.2.3).

The Sentinel-2 instrument has been designed to cover systematically all land surfaces between 56° South latitude (Cape Horn in South America) and 84° North latitude (north of Greenland) including major islands (greater than 100 km^2 size), EU islands and all the other small islands located at less than 20 km from the coastline, the whole Mediterranean Sea as well as all inland water bodies and closed seas.

The ESA Sentinel-2 satellites will have a repeat cycle of 5 days for the 2-satellite constellation (Sentinel-2A and -2B), where each satellite has a revisit time of 10 days. ESA Sentinel-2 will use the same core ground station network and the European Data Relay System (EDRS – ready for launch in 2016) in the Payload Data Ground Segment (PDGS) as ESA Sentinel-1.

BAU: ESA Sentinel-2 Capacity Assessment

The PDGS is expected to become available through a phased period of approximately 12 months beginning with the launch of ESA Sentinel-2A (second quarter of 2015). ESA Sentinel-2A's ramping-up is under development and foresees after the 3-month commissioning phase a stepwise approach to global monitoring: first 3-4 months coverage of Europe, Africa and Asia, and rest of global land mass in the following 4-5 months (Figure 4.1). ESA Sentinel-2B launch target is 2016.

From 2015 to 2016 ESA Sentinel-2A will be relied upon with a gradual ramping-up of coverage areas, repetitiveness and ground station capabilities. Once the full operational PDGS setup is attained, ESA Sentinel-2A and -2B will systematically cover all land masses between S56 and N84 latitude (5-day combined revisit, or maximum of 73 observations/year). The average duty cycle of the multispectral instrument is 17 minutes, allowing peak performance up to 32 minutes per orbit.

The standard user product from the PDGS is Level 1C ortho-rectified Top of Atmosphere reflectance, which is archived systematically and provided as 100kmx100km tiles (~ 500Mb). This product includes the parameters for reflectance to radiance conversion.

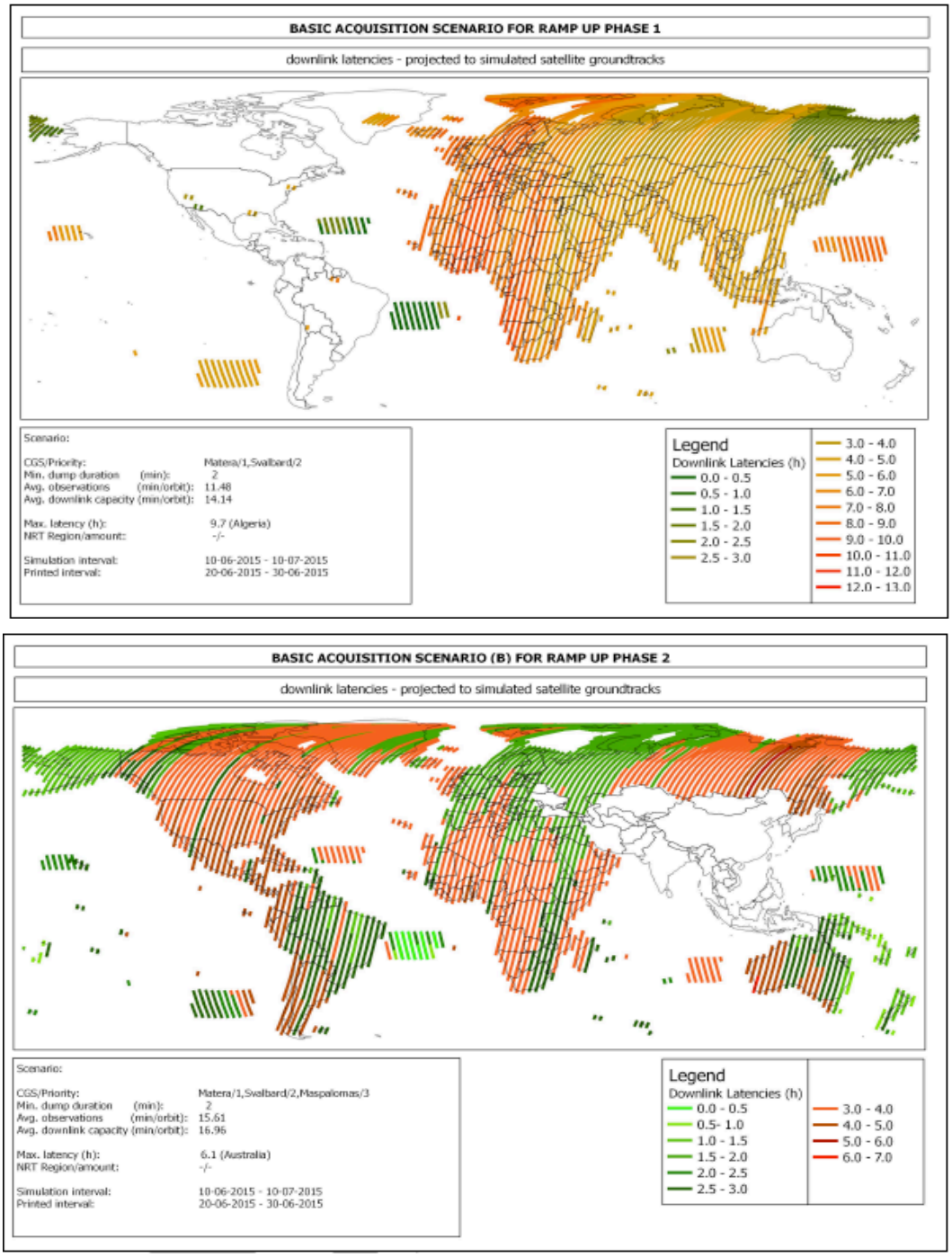

Figure 4.1 – Two-phased approach of the basic acquisition scenario during the 9 months ramp-up phase with downlink latencies projected to simulated satellite groundtracks.

4.2.3 ESA Sentinel-1

Observations with high temporal repeat are likely to be required in order to optimise usefulness of C-band SAR for GFOI, it must therefore be determined how an efficient global-scale observation pattern for Sentinel-1 can be implemented. It is proposed to start using the capacities of the two missions to focus on tropical and subtropical areas with very frequent cloud coverage. An indication of the relevance of Sentinel-1 to the GFOI forest information target products (see 2.4) is given in Table 4.3 below:

	F/NF MGD-1	F/NF C MGD-2	F type MGD-3	LU MGD-4	LUC MGD-5	FC MGD-6	EW MGD-7	Degr RD-1-2	ABG RD-3-4
Sentinel 1A & 1B	R&D	Δ	R&D	Δ	R&D	-	O	R&D	-
RCM	R&D	Δ	R&D	Δ	R&D	-	O	R&D	-

Table 4.3 – Sensor relevance to GFOI target products
(O: can be used stand-alone; Δ: can provide partial or complementary information when in combination with another core sensor, or under other certain circumstances; R&D)

BAU: Plans for Sentinel-1 Acquisitions

The Sentinel High Level Operation Plan (HLOP) identifies the main constraints, limitations and potential conflicts related to the high level operations of the Sentinel missions. The HLOP describes the measures and the strategy to cope with these constraints and to allocate Sentinel resources with the goal of reducing the potential conflicts during operations and providing a high level exploitation of the Sentinel Operations.

The implementation of a pre-defined observation strategy for the Sentinel-1 and Sentinel-2 missions is based on a careful analysis of the user needs and optimisation of the related space and ground resources. This is necessary due to the various constraints related to these missions.

The 9-month ramp-up phase of Sentinel-1 starts at completion of the 3-month commissioning commissioning phase that follows the launch of Sentinel-1A (April 2014), and continues until the full operational capacity is reached with the constellation of the Sentinel-1A and -1B.

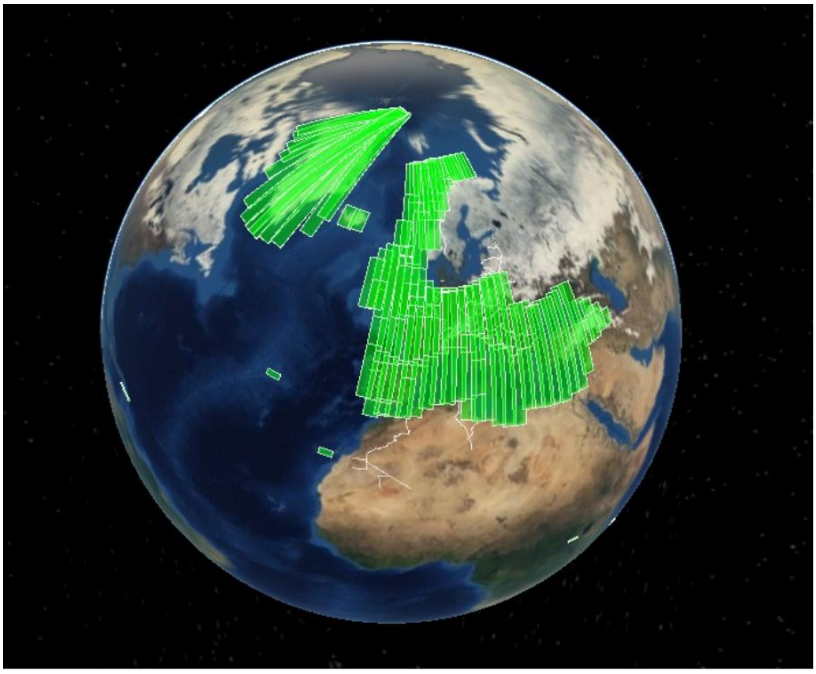

Figure 4.2 – Sentinel-1 acquisitions (simulation) over parts of Europe and surrounding waters. IWS mode, descending orbits over a 12-day repeat cycle

Once the full operational setup is reached, Sentinel-1A and -1B are planned to regularly cover the world, where the default mode over land is the Interferometric Wide-Swath (IWS) mode. The respective polarisation mode (single vs. dual polarisation) depends on mission and application requirements, as well as the overall system capacity; in particular the data download constraints.

BAU: Sentinel-1 Capacity Assessment

A preliminary and indicative observation scenario for the first 6 months of the Sentinel-1 exploitation phase is being defined. Highest priority is given to Copernicus services and use, as well as to national services and use by ESA/EU Member States. Coverage of Europe, European waters, and North Pole remain the priority areas for Sentinel-1 operations. Outside of Europe operations, a campaign to support forest monitoring international activities is foreseen.

Taking into account mission constraints during the ramp-up phase, three regions of tropical rain forest identified by GFOI have been considered for early acquisitions; Colombia, Ecuador, Peru in South America (Figure 4.3), Tanzania in Africa and, Indonesia/Sumatra and Vietnam in Southeast Asia.

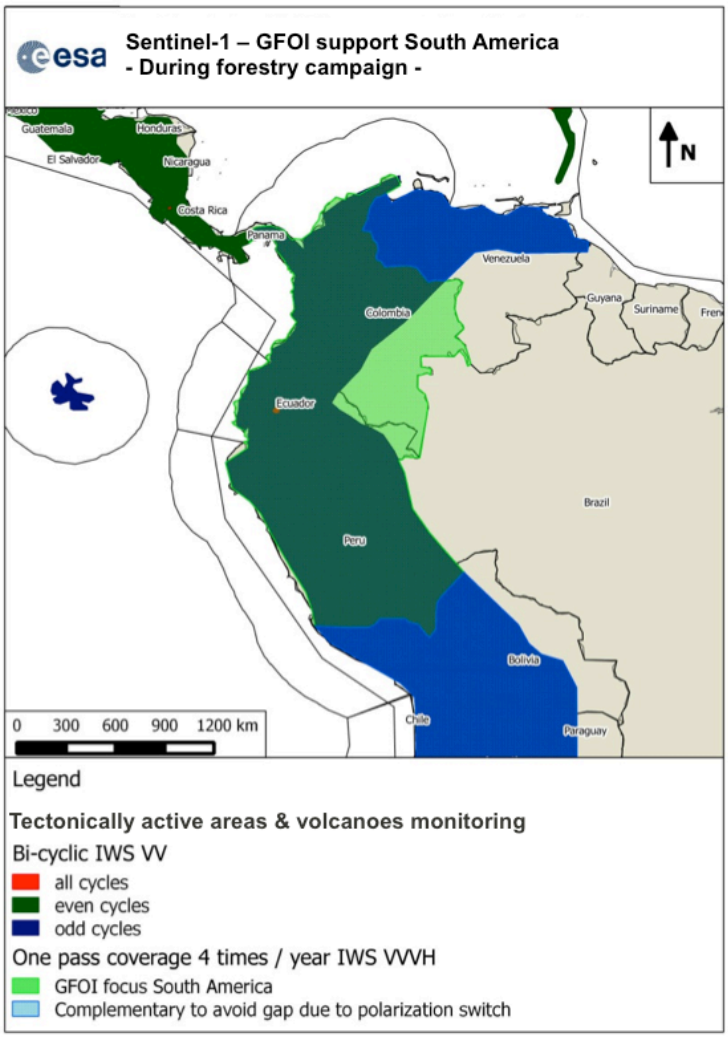

Figure 4.3 – Sentinel-1 forestry campaign during ramp-up phase in South-America in synergy with mapping of tectonic areas.

With full operational capacity, the ESA Sentinel-1 resources are expected to allow a substantial amount of data relevant to global forest monitoring. The design of the related global acquisition plan is still under consideration by ESA.

The potential for interoperable use of C-band SAR with other SAR systems should be highlighted also here. C-band frequency is complementary to both L- and X-band and as mentioned above, synergetic use of C-band and L-band SAR has for instance demonstrated the potential for improved distinction of key forest types such as rubber, oil palm and acacia.

4.2.4 CSA RADARSAT Constellation Mission

Canada's RADARSAT Constellation Mission (RCM) and ESA's Sentinel-1 will have comparable configurations and the anticipated roles for the two missions pertaining to GFOI can be expected to be similar. The high level of complementarity between the missions allows for a high level of coordination in the acquisition planning for GFOI, similar to that of RADARSAT-2 and ENVISAT ASAR within the GEO Forest Carbon Tracking Task.

RCM will feature largely pre-programmed acquisitions to meet clearly defined user needs. CSA is currently conducting capacity assessments for domestic use, which will help determine capacities to support campaigns like the GFOI. Prelaunch requests from the SDCG in support of GFOI may be possible to integrate with the concept of operations currently under development.

4.3 Regional Focus and Gap-filling

The INPE/CRESDA CBERS-4 and CONAE/ASI SAOCOM-1 missions may not be intended for full global-scale operations, but do have the capacity to fulfil regional/semi-continental scale observations consistent with GFOI objectives.

	F/NF MGD-1	F/NF C MGD-2	F type MGD-3	LU MGD-4	LUC MGD-5	FC MGD-6	EW MGD-7	Degr RD-1-2	ABG RD-3-4
CBERS-4 (MUXCAM, PanMUX, IRS)	O	O	Δ	O	O	Δ	Δ	R&D	–
SAOCOM 1A & 1B	O	O	Δ	Δ	Δ	Δ	-	-	O

Table 4.4 – Sensor relevance to GFOI target products
(O: can be used stand-alone; Δ: can provide partial or complementary information when in combination with another core sensor, or under other certain circumstances; R&D)

4.3.1 INPE/CRESDA CBERS-4

BAU: Plans for CBERS-4 acquisitions

After the launch failure of CBERS-3 in December 2013, the identical CBERS-4 is planned to be launched in December 2014. While Brazil (INPE) and China (CRESDA) home country geographic areas are the first priority for the CBERS-4 mission, every cycle observations are planned within the entire coverage areas of the INPE (Cuiaba[4]) and the CRESDA (Miyun, Sanya and Kashi[5]) ground stations. As shown in Figure 4.4, the stations cover most of tropical South America, and South- and Southeast Asia. It is anticipated that all data acquired will be processed and made available through the INPE and CRESDA catalogues.

[4] *The Cuiaba ground station covers in full: Brazil, Bolivia, Paraguay, Surinam and Uruguay, and in part: Guyana, Venezuela, Colombia, Peru, Chile and Argentina.*

[5] *The Miyun, Sanya and Kashi ground stations cover in full in South and Southeast Asia: China, Pakistan, Nepal, Bhutan, Bangladesh, Burma, Thailand, Malaysia, Brunei, Laos, Cambodia, Vietnam, Philippines and Singapore, and in part: Indonesia (Kalimantan and north and central Sumatra) and India.*

CBERS for Africa is an on-going initiative by INPE to establish a network of CBERS ground stations in Africa (Maspalomas/Spain, Aswan/Egypt, Libreville/Gabon, Malindi/Kenya, Hartebeesthoek/South Africa). The schedule for the remaining African ground station upgrades is not currently available, but once in operations, the stations will cover the whole African continent.

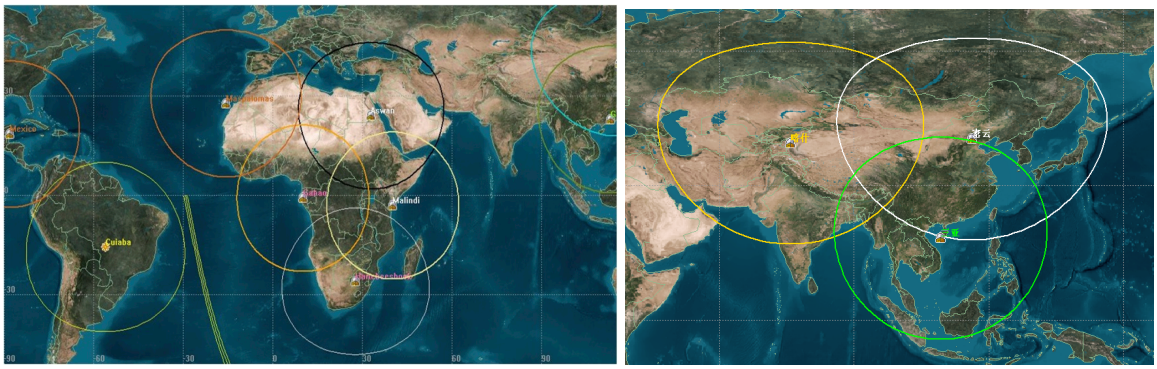

Figure 4.4 – CBERS-4 ground station coverages for INPE (left) and for CRESDA (right). The ground station network over Africa is presently under establishment.

BAU: CBERS-4 Capacity Assessment

During routine operations, data from all four instruments on CBERS-4 (MUXCam, PanMUX, IRS, WFI) are planned to be acquired simultaneously. The combined data rate for the four instruments is about 300 mbps, which is within the capacity for the X-band downlink. The system duty cycle is approximately 15 minutes per orbit for CBERS-4 satellite.

INPE and CRESDA have not (yet) developed plans for systematic observations outside the CBERS ground station network, but capacity exists to extend observations also to other areas by use of the On-Board Recorder (OBR) in support of GFOI.

4.3.2 Argentine-Italian SAOCOM-1

BAU: Plans for Pan-tropical Observations

The CONAE/ASI SAOCOM-1A and -1B mission will be operating in L-band frequency. L-band SAR is due to its relatively long wavelength sensitive to forest and vegetation structure and SAOCOM-1 data can therefore be expected to constitute an important contribution to the development of several of the GFOI target forest information product specifications (see 2.4).

The potential of sensor interoperability should also be highlighted, as both C- and X-band SAR are complementary to the L-band frequency. Synergetic use of L-band and C-band has for instance demonstrated the potential for improved distinction of forest plantations from natural forest.

The first priority for SAOCOM-1 is acquisitions over Argentina and Europe, within the framework of the SIASGE[6] System, which is composed by Argentine-Italian SAOCOM Constellation and the Italian COSMO SkyMed Constellation. A Global Background Mission strategy has been developed for the remaining capacity. Its objective is to foresee acquisitions of certain valuable data to generate a database useful for future uses, according to the available resources. In particular, pan-tropical coverage utilising the dual-polarisation mode two to three times per year might receive priority and is under consideration. With launch of SAOCOM-1A scheduled for late 2015, the first pan-tropical coverage can be expected in 2016. SAOCOM-1B is scheduled for launch 6 months after 1A.

BAU: SAOCOM Capacity Assessment

Ground stations in Cordoba (Argentina), Matera (Italy) will be used for direct downlink and playback of onboard recorder data. Also, Fairbanks (Alaska) is under consideration to be used for data downlink but the corresponding agreements are still under negotiation. The possibility of using Svalbard (Norway) is also under consideration.

The average duty cycle for SAOCOM-1 is about 15 minutes per orbit (for each satellite). The on-board recorder capacity is 256 Gbits, which corresponds to 14-17 minutes of recorded data, depending on the observation mode used. Data will be downlinked at a constant data rate (310 mbps).

[6] SIASGE: Sistema Italo-Argentino de satélites para beneficio de la Sociedad Gestión de las emergencias y desarrollo Económico (Italo-Argentine satellite System for Social benefit, emergency Management and Economic development)

5 Roles for Other Contributing Data Streams

The approach to implementation of a global baseline data acquisition strategy for GFOI relies on *core data streams* as outlined in Section 3.2. However, there are a number of important other contributing data streams that can make very valuable contributions to GFOI.

As mentioned above under 3.2, certain data sets from *contributing data streams* fulfil some of the requirements for Core Data, and can be considered **Special Core Data Sets** for GFOI.

Contributing data streams can also provide coverage complementary to the *core data streams*, either as gap-filling observations in areas or times where core data are insufficient, or provide thematic information not available on the core missions. In may cases, this will be national level coverage and therefore will be implemented under the *Space Data Services Strategy* (Element 2), or local scale coverage over specific research sites under the Element 3 strategy to support GFOI R&D activities.

The *contributing data streams* are of potential relevance to all MGD Recommended and Supplementary Forest Map products. In particular, some contributing missions provide capacity of observations at very high spatial resolution (5m and better) and thus add potential to support the development of degradation-related products (RD-1, RD-2).

	F/NF MGD-1	F/NF C MGD-2	F type MGD-3	LU MGD-4	LUC MGD-5	FC MGD-6	EW MGD-7	Degr RD-1-2	ABG RD-3-4
SPOT	O	O	Δ	O	O	Δ	O	O	R&D
ALOS-2	O	O	Δ	Δ	Δ	Δ	O	-	O
RapidEye	O	O	Δ	O	O	Δ	O	O	–
RADARSAT-2	R&D	Δ	R&D	Δ	R&D	–	O	R&D	–
TerraSAR-X	R&D	Δ	R&D	Δ	R&D	–	–	Δ	–
TanDEM-X	Δ	–	R&D	Δ	R&D	–	–	Δ	R&D
ResourceSat	O	O	Δ	O	O	Δ	O	–	–

Table 5.1 – Contributing missions potential relevance to GFOI target products (O: can be used stand-alone; Δ: can provide partial or complementary information when in combination with another core sensor, or under other certain circumstances; R&D)

5.1 SPOT

SPOT is operated as a Public-Private Partnership (PPP) between CNES and Airbus Defence and Space (formerly Astrium). SPOT-4 was decommissioned in 2013 and SPOT-5 is planned to be decommissioned in late 2014 or 2015 (dates to be confirmed). SPOT-6 and -7 are operated solely by Airbus Defence and Space.

Optical data from the SPOT systems are of potential relevance to all of the GFOI target products (Table 5.1).

Historical data from SPOT-1 through -5 constitute, together with Landsat, key sources of historical data for the establishment of reference baselines of forest cover and analysis of historical trends. While no global systematic acquisition plans were implemented for SPOT-1 through -5, and the spatial and temporal completeness of the archive therefore can be expected to vary between geographical regions, the SPOT archive is extensive and stretches back almost three decades.

As mentioned above under 3.2.3, certain data sets from SPOT fulfil some of the requirements for core data, and can be considered **Special Core Data Sets** for GFOI:

- Historical data from the SPOT archive are available though the **SPOT World Heritage (SWH) Programme**, which offers access to ortho-rectified SPOT-1 through -5 for non-commercial uses. All data available from the SWH archive, operated by CNES, are free of charge. CNES will cover the reprocessing costs of the first 100,000 scenes, out of which 50,000 covering France and a further 50,000 scenes yet to be allocated. A part of this second quota of 50,000 scenes could potentially be allocated to GFOI priorities. Users can obtain access to further data by covering a reprocessing cost, after which the scenes will be added to the common, free SWH archive. The first set of SWH ortho-rectified images will be available by the end of 2014.
- **SPOT Congo Basin Initiative.** Since 2010, SPOT-4 and -5 have been used to undertake systematic annual observations over the Congo Basin and Madagascar in support of REDD+ activities in the regions, through an initiative by the French government. The coverage area was initially strictly focused on tropical rainforests, but has now been extended to cover other areas. A 2010 reference data set covers data acquired between 2008 and 2012. The compilation of a new 2015 data set using SPOT-5 and (fully commercial) SPOT-6 imagery was started in 2013 and will continue until 2017. The Congo Basin data are publicly available through a special user agreement for REDD+ purposes.

5.2 ALOS-2

JAXA ALOS-2 is scheduled for launch in May 2014. It will be the only L-band SAR in operation until the planned launch of SAOCOM-1A. With L-band sensitivity to vegetation structure, ALOS-2 has potential to support several of the MGD target products, in particular in countries with severe cloud cover and those with past experience of L-band SAR. The potential for interoperable use of L-band SAR with both optical and other SAR systems should be noted also here.

Forest monitoring defined as one of key objectives for ALOS-2 and a global acquisition strategy – the Basic Observation Scenario (BOS) – has been developed to maintain continuity with ALOS-1 PALSAR global acquisitions. The ALOS-2 BOS comprises fine resolution observations (10m) over the global land areas twice per year, and six times per year observations over the pan-tropical belt. For rapid deforestation monitoring, coarser resolution (100m) ScanSAR observations are planned nine times per year over the tropical forest areas.

The ALOS-2 mission is fully owned and operated by JAXA. JAXA will distribute limited amount of data for a marginal cost or free-of-charge to governmental users, international cooperations and Research Announcement (RA) users under cooperative agreement, which encompass initiatives such as GFOI. For genereral users, a private distributor will disseminate data on commercial basis.

Similar to that for SPOT above, certain data sets generated by JAXA fulfil the requirements for Core Data, and thus can be considered **Special Core Data Sets** for GFOI:

- **L-band SAR Global Mosaic Data Sets** at 25m resolution have been generated by JAXA for the years 2007, 2008, 2009 and 2010 using ALOS (-1) PALSAR dual-polarisation data, and for the mid 1990's using JERS-1 SAR single-pol data. Each mosaic comprises about 70,000 scenes. The mosaics are ortho-rectified and provided in 1x1 degree tiles to enable direct import into standard GIS software and analysis by users without prior knowledge of SAR processing. Mosaics at 50m pixel spacing are (since January 2014) available for direct download free of charge by JAXA. Mosaic generation is planned to continue with ALOS-2 PALSAR-2 dual-polarisation data on an annual basis, starting from 2014. Open release of 25m resolution versions of both ALOS and ALOS-2 mosaics is under consideration by JAXA.

	F/NF MGD-1	F/NF C MGD-2	F type MGD-3	LU MGD-4	LUC MGD-5	FC MGD-6	EW MGD-7	Degr RD-1-2	ABG RD-3-4
SPOT SWH Data Set	Historical baselines and trends			Historical baselines and trends			–	–	–
ALOS-2 Global 25m Mosaic Data Set	O	O	Δ	Δ	Δ	Δ	-	-	Δ

Table 5.2 – Special Core Data Set relevance to GFOI target products.
(O: can be used stand-alone; Δ: can provide partial or complementary information when in combination with another core sensor, or under other certain circumstances)

5.3 RapidEye

RapidEye is a commercial endeavour of BlackBridge (formerly RapidEye), where DLR closely collaborates with Blackbridge, e.g. in terms of scientific exploitation of RapidEye data. RapidEye is a constellation of five satellites used to facilitate frequent observations and reduction of the impact of cloud cover. It features a strategic acquisition plan with a priority over forested areas. The specific details of the plan (temporal repeat, regional focus areas) depend on actual user needs and orders.

With the high revisit frequency together with a spatial resolution of 6.5 metres, RapidEye has the technical potential to support generation of all the GFOI target products, including important contributions to degradation (RD-1, RD-2).

BlackBridge/RapidEye have previously provided data for GEO-FCT research activities and are encouraged to continue acquisition of data for GFOI R&D activities.

5.4 RADARSAT-2

CSA RADARSAT-2 has been used to undertake dedicated acquisitions over selected GEO FCT National Demonstrator countries between 2009 and 2012. The observations were coordinated with ESA ENVISAT ASAR and were used to progress development of forest-related applications for C-band SAR. It was amongst others demonstrated in the GEO-FCT

research programme that dense time series of C-band SAR data could be used to monitor changes in forest area and to detect degradation related features such as logging roads.

In accordance with actions at the 2nd SDCG meeting (Sept 2012), CSA/MDA were encouraged to consider the outcome of the SDCG gap analysis in their acquisition planning, and to consider continued RADARSAT-2 data provision for GFOI R&D activities. It was recommended that the SDCG (via KSAT) initiate discussions with CSA and MDA within the context of the discussion framework to access commercial data sets required to meet the GFOI objectives.

5.5 TerraSAR-X and TanDEM-X

TerraSAR-X and TanDEM-X are operated in a PPP between DLR and Airbus Defence and Space (formerly Astrium). TerraSAR-X operates in X-band, which due to its high frequency can yield higher spatial ground resolution than L-band or C-band SAR systems. DLR TerraSAR-X data at 1 and 3 m resolution have demonstrated the potential to detect degradation related features, such as logging roads, changes in canopy cover and removal of individual trees, at high precision. DLR TerraSAR-X data acquisitions are primarily order-based, , excess capacities beyond orders and the DLR TanDEM-X mission requirements are coordinated in background missions, such as for the GEO FCT validation sites in place between 2008 and present. The potential for synergetic use of X-band with C- or L-band over national scales should also be noted.

The DLR TanDEM-X system – achieved by two DLR TerraSAR-X spacecraft in close formation – has been designed for collection of two global single-pol coverages of X-band SAR data at 12m resolution within the 2011-2013 time period for the generation of a global Digital Elevation Model.

TanDEM-X bistatic X-band data have been collected systematically to cover the full globe up to four times between 2011 and 2013 within the DLR TanDEM-X mission as part of its global DEM project. TanDEM-X has proven useful for classifying land cover and forest structure using bistatic information. In particular, interferometric coherence improves the accuracy of land cover and forest structure information. While TanDEM-X, maintaining the formation flight, will continue with collecting data for filling gaps for the global DEM during 2014, a number of scientific campaigns, including addressing forest monitoring, are planned during 2014-2015.

DLR is open for a joint approach to GFOI R&D, and noted that in the past DLR has performed validation for FCT sites, and facilitated access to data. For scientific purposes, DLR can facilitate access for scientific use of data through the DLR Service to Science programme.

Data for operational scenarios will need to be requested through the commercial partner – Airbus Defence and Space – possibly through the development of a specific GFOI license.

5.6 ResourceSat-2

The Indian Space Research Organisation's (ISRO) ResourceSat-2 carries three multispectral instruments: LISS-3, LISS-4 and the Advanced Wide Field Sensor (AWiFS), with ground resolutions at 5.8m, 23.5m, and 56m, respectively. ResourceSat-2 data are available from ISRO on a commercial basis.

6 2013 Implementation Summary

The 2013 implementation results are documented in Annex B, the *2013 SDCG Implementation Report*. The report is available at http://www.ceos.org/sdcg.

In brief summary, with only with Landsat-7 and -8 in operations of the *core data streams* in 2013 –and with Landsat-8 operational only a part of the year (since May 30, 2013) – performance exceeded expectations. With an 8-day revisit period for the two satellites, approximately 90% of the scenes covering the 2013 GFOI priority countries had less than 10% could cover.

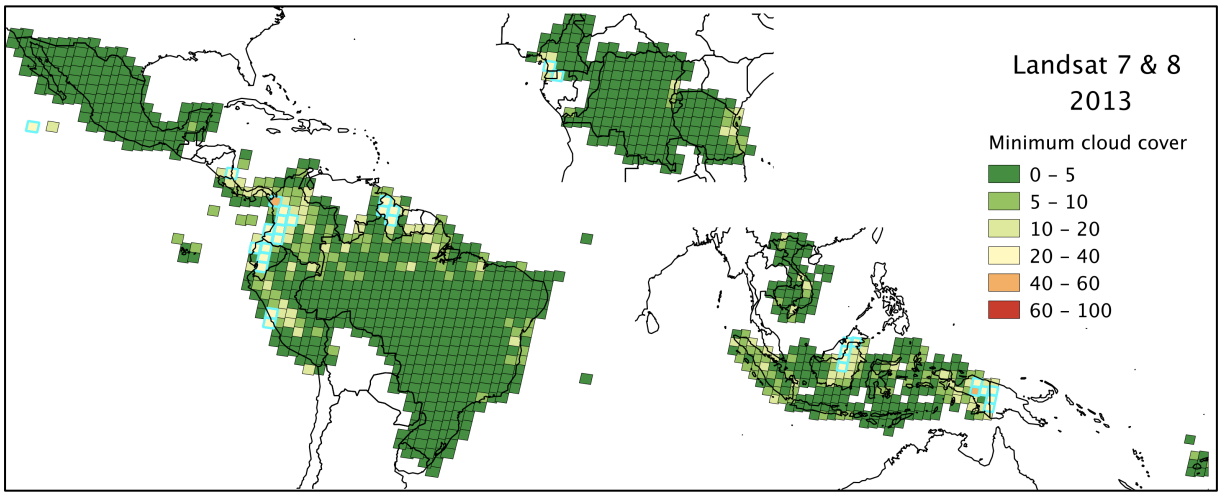

Figure 6.1 – Distribution of the best cloud-free images over the 2013 GFOI priority countries. Scenes with a best cloud cover greater than 20% are highlighted in cyan.

Persistently cloudy images, particularly those highlighted in Figure 6.1 will require more than one image to provide acceptable coverage. Other sources of information will needed to supplement the *core data streams* for some of these scenes.

7 2014 Implementation Plan

Sections 7, 8, and 9 of this strategy outline the steps being suggested by the SDCG to implement the Element 1 strategy in 2014, 2015, and 2016 and beyond. The implementation steps for 2014 are most specific, while the level of detail decreases for 2015 and again for 2016 and beyond, reflecting increasing uncertainty further into the future. The years 2015 and 2016 and beyond are documented and described based on best knowledge at the time.

7.1 Landsat-7 and -8

In the 2014 time frame, Landsat will continue to be the only *core data stream* for moderate resolution optical data. Two major changes in the Landsat acquisition plans were implemented to permit more complete coverage of global day-lit land. The new Landsat 7 continental LTAP and the proposed increase in Landsat 8 acquisitions were described in Section 4.2.1. If Landsat 8 is able to acquire 650 images for the remainder of the year, Figure 5.1 shows the distribution of images given a nominal model year. The model shows that during the northern growing season, most images/day most mid latitude images would be acquired.

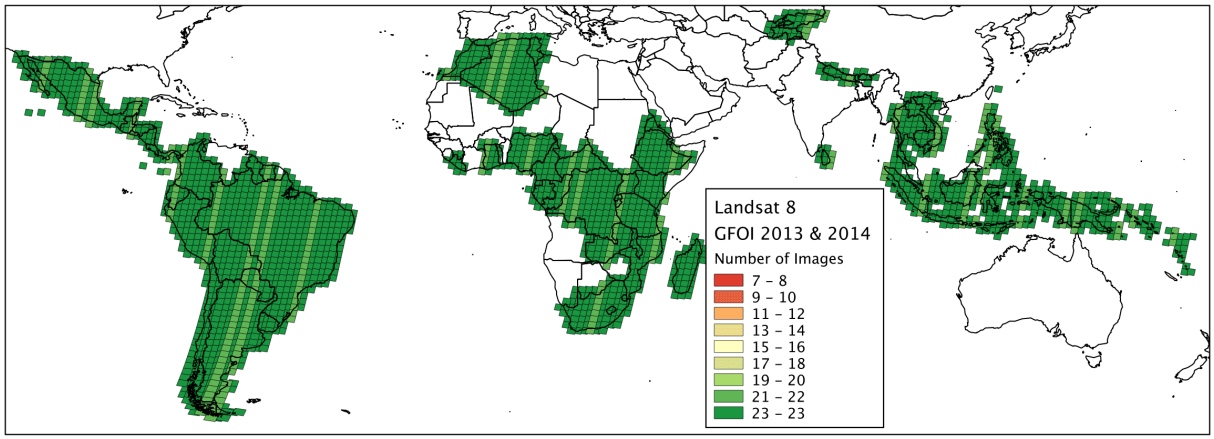

Figure 7.1: – Map of the number of Landsat 8 images acquired for the 2013 and 2014 GFOI priority countries.

The patterns of minimum cloud cover data shown in Figure 7.2, are similar those in the as acquired map shown in Figure 6.1. Northwest South America, the western part of Central Africa, and Southeast Asia continue to show persistently clouds. The inclusion of CBERS-4 and Sentinel-2 data will increase the probability of cloud-free data, but optical data in these regions will likely need to continue to be supplemented by SAR data.

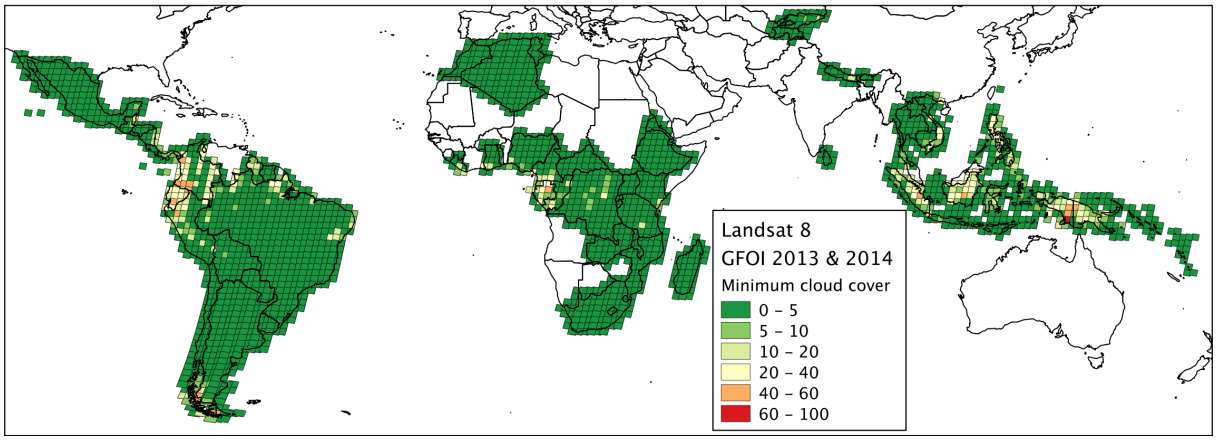

Figure 7.2 – The percentage cloud cover of the best Landsat-8 image for each path row acquired for the 2013 and 2014 GFOI priority *countries.*

Landsat 7 has no daily limit constraint. The limits are a function of on-board Solid State Recorder (SSR) capacity, ETM+ duty cycle constraints and sun elevation. Cloud avoidance is used to optimise acquisitions within those constraints. It is critical that a good mix of download stations exists. The download ground stations are carefully selected to optimise SSR management and to minimise costs. During periods when download stations are not available, SSR capacity constraints come into play.

ETM+ duty cycle constraints are worst in the western part of Central Africa and Southeast Asia. A side effect of the continental model is that many island nations are no longer cover by Landsat 7. GFOI 2013 and 2014 countries affected are Papua New Guinea, Vanuatu, Solomon Islands, and Sri Lanka.

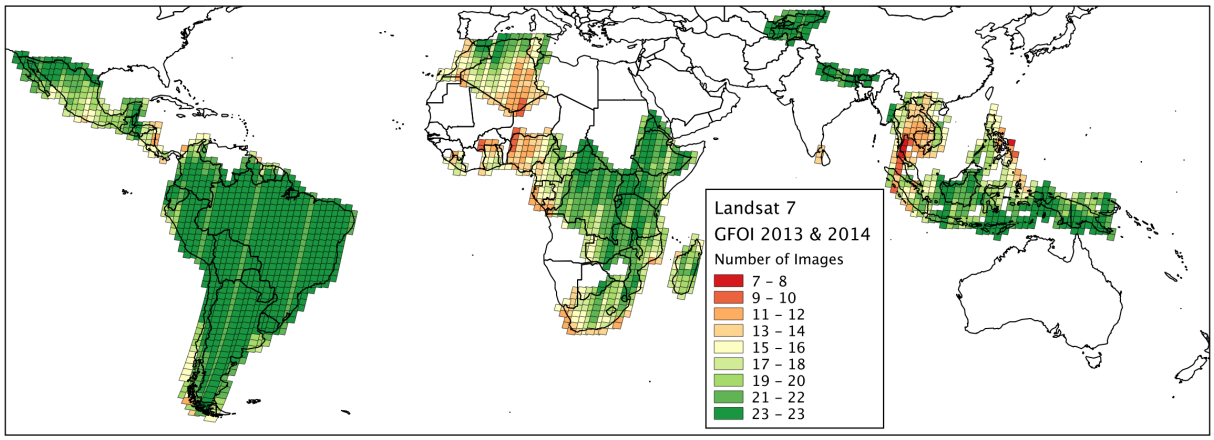

Figure 7.3 – Map of the number of Landsat 8 images acquired for the 2013 and 2014 GFOI priority countries. The cloud cover patterns seen in 2013 and in 2014 for Landsat 8 continue to persist (Figure 7.4).

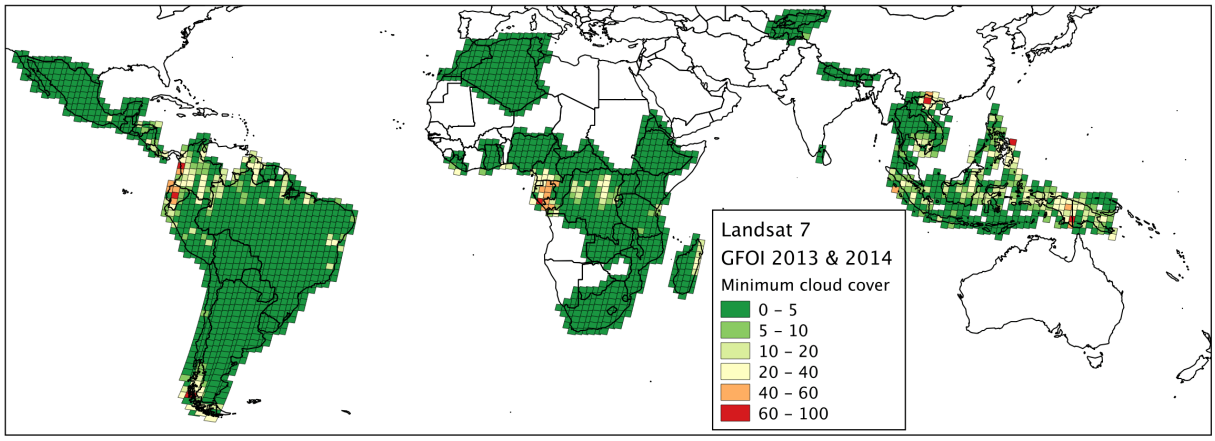

Figure 7.4 – The percentage cloud cover of the best Landsat 8 image for each path row acquired for the 2013 and 2014 GFOI priority countries.

These model results use MODIS cloud fraction data for a nominal year to simulate Landsat cloud cover assessments to predict the affect of the new acquisition plans. The Landsat 8 model is an optimistic model. If it is determined that Landsat 8 cannot acquire beyond 550 images/day without incurring risk to the mission, the 550 images/day acquired in 2013 will continue. The current daily limit is considerable more than the at launch specification of 400 images/day.

SDCG actions:

SDCG-2014-1	**USGS/NASA / Landsat-7 Landsat-8**	**Continue to optimise the USGS/NASA Landsat-7 and Landsat-8 acquisition strategies in 2014, boosting the number of acquisitions globally, to the benefit of GFOI and many other initiatives.**
SDCG-2014-2	**USGS/NASA / Landsat**	**Continue to pursue the development of Global WELD products as a potential source of cloud free mosaics for both historical, and future coverage for GFOI countries.**

7.2 Sentinel-1A

Sentinel-1A is scheduled to launch in April 2014. Following 3-month commissioning phase, Sentinel-1A will enter a 9-month ramp-up phase where observation capacity is gradually increased. The ramp-up phase scenario is focused on coverage over European and Arctic regions, but some limited observations in support of GFOI will be accommodated in the acquisition plan by ESA. This includes tropical rain forest areas in Colombia, Ecuador, Peru, Tanzania, Sumatra/Indonesia and Vietnam, in accordance with the GFOI acquisitions expansion scenario for 2013 defined in Section 3.3.

Countries should not expect to utilise data from Sentinel-1A operationally in 2014. However, the data acquired will be available for initial analysis, and R&D, and the initialisation of this data flow represents an important milestone for Copernicus support to GFOI. Based on present information, Sentinel-1 is expected to provide an operational data flow once it reaches steady-state operations sometime in 2015.

SDCG actions:

SDCG-2014-3	**ESA / Sentinel-1**	**To the extent that launch timing, checkout and calibration, and the ramp-up acquisition strategy allow, focus Sentinel-1 acquisitions in support of GFOI on Colombia, Ecuador, Peru, Tanzania, Sumatra/Indonesia, and Vietnam.**

7.3 Contributing Missions

Amongst the optical *contributing data streams* mentioned above, SPOT-5, SPOT-6, RapidEye and ResourceSat-2 are expected to remain in operations during all of 2014.

Amongst the contributing SAR missions, RADARSAT-2, TerraSAR-X and TanDEM-X are also anticipated to continue operations.

ALOS-2 is expected to be launched in May 2014, and begin acquiring global data immediately after the 3-month commissioning phase. Acquisitions for sensor calibration and validation will have first priority during the Cal/Val phase, but the systematic acquisition plan (ALOS-2 BOS) will commence in parallel where resources permit. The operational phase is expected to begin i in October 2014.

Contributing Data Streams have a valuable role to play in the coordination of national coverage and data sets, the likes of which are described in the *Space Data Services Strategy for GFOI* (Element 2). In 2014, pilots of the *Space Data Services* are going to be developed, and operators of Contributing Data Streams are encouraged to review that *Strategy*, and identify areas for potential coordination.

8 2015 Implementation Plan

8.1 Landsat-7 and -8

Landsat-7 and -8 will continue to remain the only optical *core data streams* in operations until at least mid 2014 when CBERS-4 should become available for the persistently cloudy northwestern part of South America and mid 2015, when Sentinel-2A is expected to begin its ramp-up operations.

Once Landsat-7 reaches its end of mission (no later than early 2018), there is a risk to the continuity of Landsat thermal data streams. The loss of Landsat-7 will leave only Landsat-8 with a thermal sensor, and the TIRS sensor has a 3-year design life. Options for thermal continuity are currently being considered, and may be advanced in the 2015 timeframe.

8.2 Sentinel-2A

The launch of Sentinel-2A is anticipated in the second quarter of 2015, with Sentinel-2B planned for launch about a year later. As mentioned in Section 4.2.2, the Sentinel-2A ramp-up plans are under development by ESA but a stepwise approach to global monitoring is foreseen in the first year of operations. The first 3-4 months coverage will focus on Europe, Africa and Asia, expanding to the rest of the global landmass in the following 4-5 months. Presuming a Q2 2015 launch, this would mean Sentinel-2A reaches operations in late 2015.

8.3 CBERS-4

While the cause for the launch failure of CBERS-3 is being investigated, CBERS-4 remains scheduled for launch in December 2014. If the schedule holds, the mission may be in operation in mid 2015. As outlined in Section 4.3, once operational, CBERS-4 should focus on providing regional coverage as well as gap filling where capacity allows. Specific regions of interest are expected to be South America, Asia, and Africa. Expected increases in CBERS ground station coverage will mean that the system can offer greatly expanded capacity over Africa.

An estimate of the expected optical coverage for the 2015 time frame is shown in Figure 8.1. The observation frequency over Europe and over the regions covered by the INPE and CRESDA ground stations will be improved, while the limited number of coverages over large parts of Africa, Central America and parts of South America and, to a lesser extent, over southern Indonesia and Oceania, remain.

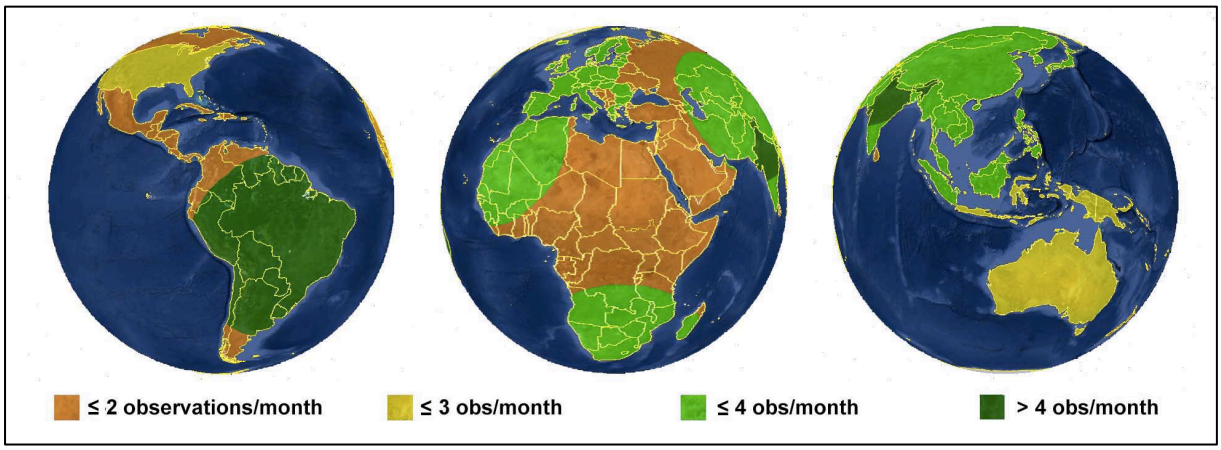

Figure 8.1 – Estimated average number of monthly observations foreseen by Landsat-7 and -8, CBERS-4, and Sentinel-2A in 2015.

8.4 Sentinel-1A and -1B

Sentinel-1A will have completed its ramp-up phase in early 2015, and it is anticipated that at that stage it will provide an operational forest monitoring data flow. The related global acquisition plan is still under development by ESA, but four observations per year over global forest areas is being considered (dual pol. VV/HV, IWS mode).

Sentinel-1B is scheduled for launch in late 2015 and will not be able to add any capacity for GFOI in 2015.

8.5 SAOCOM-1A

SAOCOM-1A is scheduled for launch in late 2015 and will not be able to add any capacity for GFOI in 2015.

8.6 Contributing Missions

Amongst the optical *contributing data streams* mentioned above, SPOT-5, SPOT-6, RapidEye and ResourceSat-2 are expected to remain in operations during all of 2014.

Amongst the contributing SAR missions, RADARSAT-2, TerraSAR-X and TanDEM-X are also anticipated to continue operations.

The iterative development of the nationally focused *Space Data Services Strategy for GFOI* (Element-2) will continue in 2015, and Contributing data stream providers should pay particular attention to how that *Strategy* develops.

9 2016+ Implementation Plan

Full coverage of all global land areas six times per month can be expected in mid 2016, when Landsat-7 and -8, CBERS-4 and Sentinel-2A, -2B are foreseen to be in full operations, including even for the least covered regions. The most frequently covered region (central part of South America) may be covered more than 10 times per month, or some 120 times in a year.

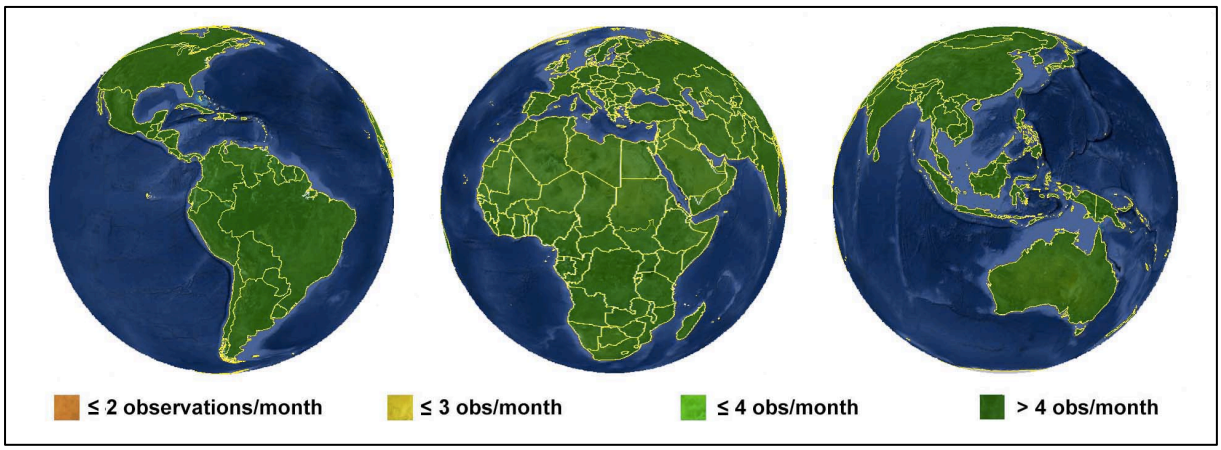

Figure 9.1 – Average number of monthly observations foreseen by Landsat-7 and -8, CBERS-3 and -4, and Sentinel-2A and -2B in 2016. All land areas are foreseen to be covered more than 8 times per month.

In addition to the optical missions, both Sentinel-1A and -1B are also expected to be fully operational, potentially providing worldwide C-band radar observations at least four times per year.

SAOCOM-1A is also expected to become operational in 2016, with the launch of SAOCOM-1B scheduled later the same year. CONAE 's Global Background Mission (GBM) is expected provide pan-tropical coverage two to three times per year for the constellation.

As outlined earlier in Section 3.3, the expansion plan for 2016 calls for worldwide coverage of all land areas. With the fleet of optical and radar satellite missions expected to be in operation in 2016, the coverage requirements for GFOI can be foreseen to be adequately met.

The launch of the CSA RADARSAT Constellation Mission (RCM) is planned for 2018. While the data policy for GFOI remains to be confirmed, RCM is currently considered a *core data stream*. This three-satellite constellation has great potential to complement ESA Sentinel-1's role, and increase the capacity and reliability of C-band data streams.

10 Governance

10.1 Institutional Arrangements

The GFOI Space Data Coordination Group (SDCG) was established by CEOS for the purpose of developing and managing a CEOS data acquisition strategy for GEO's GFOI. The SDCG is an *ad hoc* group of CEOS and its existence is reviewed and approved on an annual basis by CEOS Plenary. The GFOI Implementation Plan foresees the establishment of an institutional home for GFOI in a relevant organisation (such as FAO) with full-time staff assigned to the execution of the various operational functions in due course. These functions will include the coordination of the space data acquisitions and delivery since operational activities are beyond of the scope of CEOS responsibilities. We can anticipate some on-going need for the kind of activities which have been initiated by the SDCG, in interfacing with CEOS data provider agencies, particularly in monitoring the annual progress towards data acquisition targets and adapting acquisition strategies accordingly to guarantee that these targets are met. The scale and scope of the space data supply needs of GFOI is so huge 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. The optimal organisational arrangements and interfaces will be determined by CEOS at its annual Plenary and SIT meetings as the GFOI structure matures. For the time being, the assumption is that an *ad hoc* SDCG will continue to develop and manage the CEOS data strategy for GFOI.

10.2 Strategy Management and Roles

The SDCG proposes to update the GFOI data strategy on at least an annual basis and to present the updated strategy to CEOS SIT for endorsement – with an emphasis on the implementation plan for the coming year and the actions required of contributing CEOS agencies. SIT is the forum for securing commitment at a senior level within CEOS agencies with regards to satellite mission implementation matters.

The GFOI Advisory Committee, on which CEOS is represented, has the responsibility of ensuring 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 Steering Committee meetings through the CEOS representative.

In early 2013, the landscape began to change with the arrival of the first of the staff for the GFOI Project Office. The Project Office is working to establish itself as a hub for engagement of GEO Member governments in the GFOI activity and has a stake in the dialogue with countries, including around the arrangements for the space data acquisitions and supply in support of national forest information systems and carbon accounting ambitions.

10.3 Next Steps

The next steps for the SDCG are to:

1. Seek endorsement of this first updated revision of the *Global Baseline Data Acquisition Strategy* at the next CEOS SIT meeting (April 2014), and in particular by the Core data stream CEOS provider agencies; particular emphasis will be given to buy-in of CEOS provider agencies for the *Global Baseline Data Acquisition Strategy* for the year ahead (setting the model for the future annual engagement in the same way between SDCG and SIT);
2. Coordinate the continuing implementation of the *Global Baseline Data Acquisition Strategy* in 2014 with the CEOS agencies concerned - overseeing the progress towards realisation of the expanded 2014 coverage targets;
3. Submit the second Element of the CEOS data strategy for GFOI for endorsement alongside this updated global baseline strategy at next CEOS SIT meeting (April 2014) – **GFOI Space Data Services**. This strategy is described in detail in a separate document entitled *Space Data Services Strategy for The Global Forest Observations Initiative (GFOI)*. Consistent with the desire to demonstrate outcomes for GEO governments prior to the 2015 GEOSS implementation target date, the SDCG will begin the process of piloting the *Services* with a few countries during 2014.
4. Manage the annual update (for early 2015) to the *Global Baseline Data Acquisition Strategy* to reflect changes in the policy drivers or data stream availability.
5. ESA Sentinel-1A: Launch is planned for early-April 2014, with a 9-12 month ramp-up period to follow. Sentinel-1A represents the first of the Copernicus satellites, and as such represents an important opportunity to begin to integrate the first non-Landsat Core data stream. The SDCG should work closely with ESA and the Sentinel-1A mission management to ensure good coordination, and to establish work flows, and data discovery and access tools consistent with the *Space Data Services Strategy for The Global Forest Observations Initiative (GFOI)*.

Annex A – Mission Summaries

Anticipated Core optical missions.

Agency	Mission	Launch	Resolution	Swath	Revisit	Duration	Duty Cycle
USGS/NASA	Landsat-7	1999	15m, 30m	185 km	16 days	5 years	380 images per day (~10 minutes/revolution)
USGS/NASA	Landsat-8	2013	15m, 30m	185 km	16 days	5 years	550 images per day (~15 min/rev)
INPE/CRESDA	CBERS-4	2014	5m 10m, 20m, 40m, 64m	60-866 km	26 days	3 years	~15 min/rev
ESA	Sentinel-2A	2015	10m, 20m, 60m	290 km	10 days	7 years	~17 min/rev avg.
ESA	Sentinel-2B	2016	10m, 20m, 60m	290 km	10 days	7 years	~17 min/rev avg.

For additional information see CEOS MIM site at http://database.eohandbook.com

Anticipated Core SAR missions.

Agency	Mission	Launch	Band	Polarization	Resol.	Revisit	Duration	Duty Cycle
ESA	Sentinel 1-A	2014	C	Single-, Dual-polarisation	9 m, 20 m, 50 m	12 days	7 years	~25 min/rev
ESA	Sentinel 1-B	2015	C	Single-, Dual-polarisation	9 m, 20 m, 50 m	12 days	7 years	~25 min/rev
CSA	RADARSAT Constellation Mission (3 satellites)	2018	C	Single-, Dual-, Full-polarisation	1 m, 3 m, 5 m, 16 m, 50 m, 100 m	12 days	7 years	~12 min/rev per satellite
CONAE and ASI	SAOCOM-1A	2015	L	Single-, Dual-, Full-polarisation	10 m, 30 m, 50 m, 100 m	16 days	5 years	~15 min/rev
CONAE and ASI	SAOCOM-1B	2016	L	Single-, Dual-, Full-polarisation	10 m, 30 m, 50 m, 100 m	16 days	5 years	~15 min/rev

For additional information see CEOS MIM site at http://database.eohandbook.com

Additional optical missions of interest.

Agency	Mission	Launch	Res	Swath	Revisit	Duration	Duty Cycle
CNES	SPOT-5	2002	2.5 m, 5 m, 10 m, 20 m	60 km	26 days	Planned to be decommissioned in 2014	TBC
CNES	Pleiades 1A,1B	2011 and 2012	0.7m and 2m	20km	26 days	5 years	TBC
DLR/ Public-Private Partnership	RapidEye	2008	5 m, 6,5 m	77 km	5.5 days (daily off-nadir)	Through 2019 according to latest info from RapidEye	4 million km²/day from the combined 5 satellites
INPE	Amazonia-1	TBC	40 m	740 km	26 days	3 years	TBC
ISRO	ResourceSat-2 AWiFS	2012	56 m	740 km	26 days	3 years	TBC
Airbus D&S	SPOT-6/7	2012 and 2014	1.5m and 8m	60km	26 days	10 years	TBC

For additional information see CEOS MIM site at http://database.eohandbook.com

Additional SAR missions of interest.

Agency	Mission	Launch	Band	Polarization	Res	Revisit	Duration	Duty Cycle
CSA	RADARSAT -1	1996	C	HH	8 m, 25 m, 30 m, 35 m, 50 m, 100 m	24 days	5 years	TBC
CSA	RADARSAT-2	2007	C	HH, VV, HV, VH	3 m, 5 m, 8 m, 10 m, 25m	24 days	7 years	TBC
DLR	TerraSAR-X	2007	X	HH, VV, HV, VH	1 m, 3 m, 16 m	11 days	8 years	18 %[7] (~18 min/rev)
DLR	TanDEM-X	2010	X	HH, VV, HV, VH	1 m, 3 m, 16 m	11 days	8 years	~3 min/rev, max ~12 min/day[8]
JAXA	ALOS-2	2014	L	HH, VV, HV, HH+HV, VV+VH, HH+HV +VH+VV	3 m, 6 m, 10 m, 60 m, 100 m	14 days	5-7 years	~50 min/rev

For additional information see CEOS MIM site at http://database.eohandbook.com

[7] A typical actual scenario is: 1= 60 sec Stripmap/ScanSAR + 220 sec Spotlight with option (according to current orders) to do 600 sec Data Takes.

[8] 1.000 km swath length per orbit and a total of 5.000 km per day (with swath width=3D30km)

Annex B – 2013 Implementation Report

Available at http://www.ceos.org/sdcg