

## 1. Publishable summary

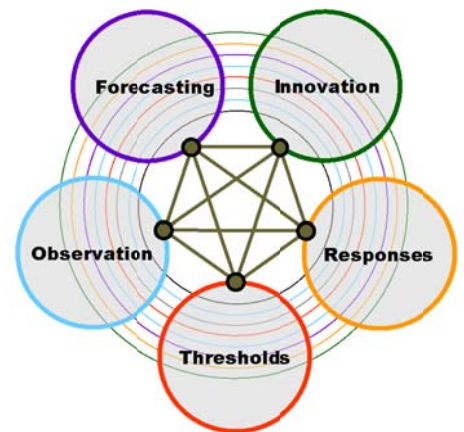
### 1.1 Project Context and Objectives

One of the most fundamental challenges facing humanity at the beginning of the 21<sup>st</sup> century is to respond effectively to the global changes that are increasing pressure on the environment and on human society. This priority is articulated by the International Council for Science (ICSU) as follows:

*“Over the next decade the global scientific community must take on the challenge of delivering to society the knowledge and information necessary to assess the risks humanity is facing from global change and to understand how society can effectively mitigate dangerous changes and cope with the change that we cannot manage. We refer to this field as ‘global sustainability research’.”<sup>1</sup>*

ICSU identified five scientific priorities, or Grand Challenges, in global sustainability research (see Figure 1) through a broad consultation involving over 1000 scientists from 85 countries in 2009-2010. These Grand Challenges include:

1. Developing the **observation** systems needed to manage global and regional environmental change.
2. Improving the usefulness of **forecasts** of future environmental conditions and their consequences for people.
3. Recognizing key **thresholds** or non-linear changes to improve our ability to anticipate, recognize, avoid and adapt to abrupt global environmental change.
4. Determine what institutional, economic and behavioural **responses** can enable effective steps toward global sustainability.
5. Encouraging **innovation** (coupled with sound mechanisms for evaluation) in developing technological, policy, and social responses to achieve global sustainability.



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The increasing importance of linking the scientific effort necessary to underpin the sustainability agenda with innovation and sustainable economic growth is also at the heart of the European Union’s Europe 2020 strategy<sup>2</sup>, focusing on smart, sustainable, and inclusive growth.

The Global Earth Observation System of Systems (GEOSS), envisioned by the group of eight most industrialized countries (G-8) in 2003 and currently half way in its 10-year implementation plan provides the indispensable framework to integrate the earth observation efforts of the 84 GEO-members and 58 participating organisations. A major role of GEOSS is to promote scientific connections and interactions between the observation systems that constitute the system of systems, and address some of the scientific challenges identified by ICSU with a particular focus on nine societal benefit areas<sup>3</sup>. Such interactions also promote the introduction of innovative scientific techniques and technologies in the component observing systems. In this respect therefore the development of GEOSS can make a strategic contribution in delivering the objectives of the Europe 2020 strategy.

For these reasons the European Commission plays a very active role in developing GEOSS. This includes participating and co-chairing GEOSS Committees and the Data Sharing Task Force, and

<sup>1</sup> [http://www.icsu-visioning.org/wp-content/uploads/GrandChallenges\\_Pre-publication.pdf](http://www.icsu-visioning.org/wp-content/uploads/GrandChallenges_Pre-publication.pdf)

<sup>2</sup> COM(2010)2020

<sup>3</sup> Disasters, Health, Energy, Climate, Agriculture, Ecosystems, Biodiversity, Water and Weather

implementing important initiatives to collect and share environmental information for the benefit of the global society: the Infrastructure for Spatial Information in Europe (INSPIRE Directive), the Global Monitoring for Environment and Security (GMES) initiative, and the Shared Environmental Information System (SEIS). The European Commission also contributes to the implementation of the GEOSS Work Programme through research projects like EuroGEOSS, which are funded from its Framework Programme for Research & Development.

## **1.2 Progress and Main Results to Date**

The concept of inter-disciplinary interoperability and the need for it in managing societal issues is central to the addressing the challenges of sustainability research identified by ICSU. With this in mind, EuroGEOSS was launched on May 1<sup>st</sup> 2009 for a three year period with the aim to demonstrate the added value to the scientific community and society of making existing earth observing systems and applications interoperable and used within the GEOSS and INSPIRE frameworks. The project builds an initial operating capability (IOC) in the three strategic areas of Drought, Forestry and Biodiversity, and undertakes the research necessary to develop this further into an advanced operating capability (AOC) that provides access not just to data but also to analytical models made understandable and useable by scientists from different disciplinary domains. To achieve this AOC requires research in advanced modelling from multi-scale heterogeneous data sources, expressing models as workflows of geo-processing components reusable by other communities, and ability to use natural language to interface with the models. The extension of INSPIRE and GEOSS components with concepts emerging in the Web 2.0 communities in respect to user interactions and resource discovery, also supports the increased dialogue between science and society, which is crucial for building consensus on the collective action necessary to address global environmental challenges.

EuroGEOSS has completed the first half of its activities. During these first 18 months of the project, the key objectives were:

- 1) Achieving an Initial Operating Capability, i.e. the development of the services necessary to make it possible to discover view, and access the information resources made available by the partners of the project in the thematic areas of biodiversity, drought, and forestry.
- 2) Registering these resources as GEOSS components.
- 3) Developing the framework for assessing the added value of the project and of GEOSS to the communities of users.

All of these objectives have been achieved: the Initial Operating Capability (IOC) in the fields of biodiversity, drought, and forestry has been established, it has been registered with GEOSS, and a multi-layered framework of surveys and models to assess the longitudinal impact of the project and the benefits of GEOSS have been put in place.

Central to the IOC is the EuroGEOSS broker, which is a component able to read and mediate among the many standards and specifications used by different scientific communities. By building bridges among the practices of these communities, the broker makes it possible to search, and discover the resources available from heterogeneous sources. During this initial phase, the EuroGEOSS broker gives access to over 400 datasets and 26 services, including multiple catalogue services in the three thematic areas. By registering the broker as a GEOSS component, all of the thematic resources of the project are also accessible to the global research community.

The Forestry IOC has been achieved giving priority to the development of federated metadata<sup>4</sup> catalogues and a map viewer, which are then integrated into the EuroGEOSS broker. The IOC Metadata Catalogue was developed based on the open source package GeoNetwork v2.4.3 and populated with spatial and non-spatial metadata from the European Forest Data Centre at JRC.

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<sup>4</sup> Metadata is a description of an information resource, including key elements such as what it is, who is responsible for it, where can it be found, and how it can be accessed.

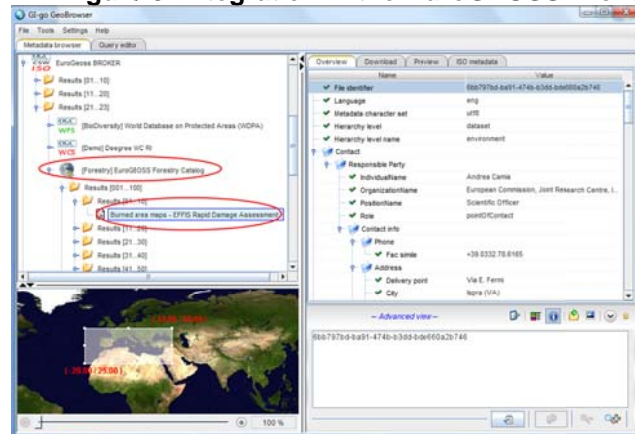
Metadata adjustments have been made to fit Dublin Core elements and ensure compliance with INSPIRE and relevant ISO standards (19115/19119 and 19139). The Metadata Catalogue functionalities and interface have been adjusted to meet the specific forestry theme requirements. As a result the IOC Catalogue provides search, discovery and preview facilities of spatial and non – spatial metadata.

The catalogue successfully harvests metadata from national and local forestry catalogues such as those of the national Spanish spatial data infrastructure (IDEE), and is federated in the EuroGEOSS broker so that its resources are globally accessible and viewable by the GEOSS community.

**Figure 2: The Forestry Catalogue**



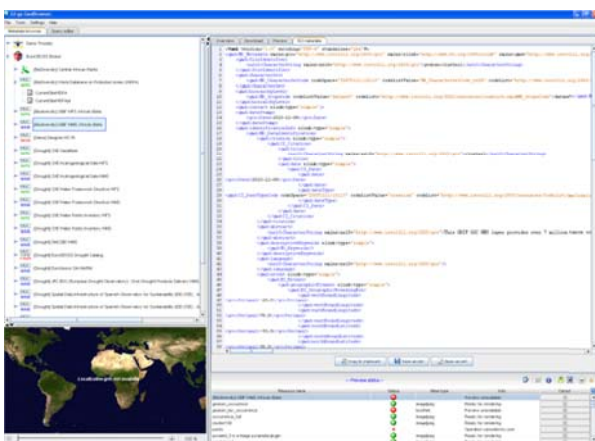
**Figure 3: Integration in the EuroGEOSS Broker**



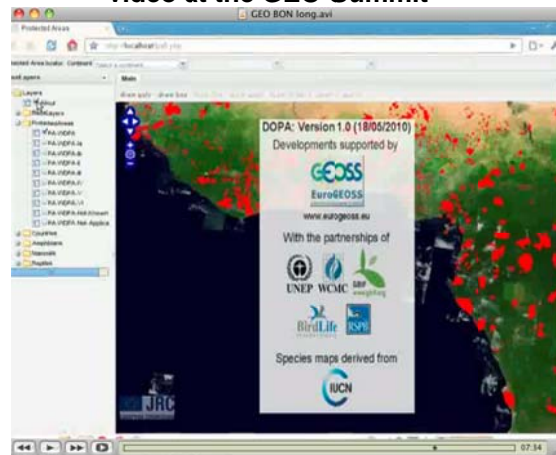
The biodiversity IOC has been achieved by developing a series of metadata catalogues and services at the partners' institutions, and integrating them into the EuroGEOSS broker. A key milestone has been the development of the metadata catalogue for the Global Biodiversity Information Facility (GBIF) with a specialised profile using the Ecological Metadata Language to support better community needs, especially for species names datasets and natural history collections, and for multiple natural languages. A metadata sharing service has been established based on the Open Archive Initiative, harvesting metadata from the participating GBIF catalogues and integrating them into the EuroGEOSS broker.

In parallel to this and related developments at other partners' institutions, significant work has taken place to develop a Digital Observatory for Protected Areas (DOPA) a facility with initial focus on Africa but with a global reach as part of the GEOBON observation network.

**Figure 4: The Biodiversity Catalogue in the EuroGEOSS broker**



**Figure 5: DOPA as a part of the GEOBON video at the GEO Summit**



DOPA will be developed in an iterative way, starting with an information system able to visualise and interact through a single graphical user interface with key datasets hosted by the partners, namely boundaries of protected areas (UNEP-WCMC), species occurrences (GBIF) and maps of bird distributions (Birdlife International and RSPB). Throughout EuroGEOSS, these developments will become more and more web based allowing the integration of information made available in the other thematic areas. Months 1-18 have focused on the setting up of a prototype of DOPA that includes a specialised database, an advanced web client, and the preparation of unique datasets regarding bird distributions that will become available in the form of species occurrences via GBIF and in the form of species distribution maps directly through the DOPA.

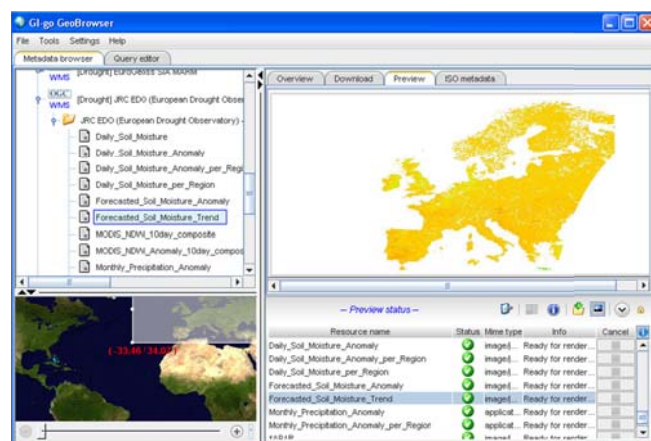
The Drought IOC has been achieved developing a series of web services to discover, view, and access drought data providers from Europe (EC-JRC), South-East Europe (ULBF), and Spain (national level: FGUA-OSE, regional level: CHE. (See Table 1 for acronyms of partners). The goal of connecting drought data providers on the three scale levels (continental, national/international, regional/local) has thus been achieved as an important proof of concept of a nested multi-scale system of systems. All the partners have in place an infrastructure for providing web map services (WMS) and update their services regularly. Some partners (EC-JRC, ULBF) provide also web map services of time series (WMS-T) for accessing data sets of a chosen date or period.

The integration of services from different partners in a common viewer, i.e. the map viewer of the European Drought Observatory, allows the linkage to services from the other thematic areas (e.g. forest) and opens new options for drought data analysis. These options will be further explored in the second half of the project. In addition to the European perspective, an interoperable European Drought Observatory contributes to a future Global Drought Early Warning System under consideration by the World Meteorological Organization (WMO), and GEO/GEOSS. To this end, a prototype Global Drought Monitor has been established as a first building block of the Global Drought Early Warning System in partnership with the North American GEO/GEOSS community, the U.S. National Integrated Drought Information System (NIDIS) and the Princeton African Drought Monitor prototype. A first demonstration pilot of such Global Drought Monitoring System has been achieved and was demonstrated at the GEO Beijing Summit in November 2010.

**Figure 6: The Drought Catalogue**



**Figure 7: Integration in the EuroGEOSS Broker**

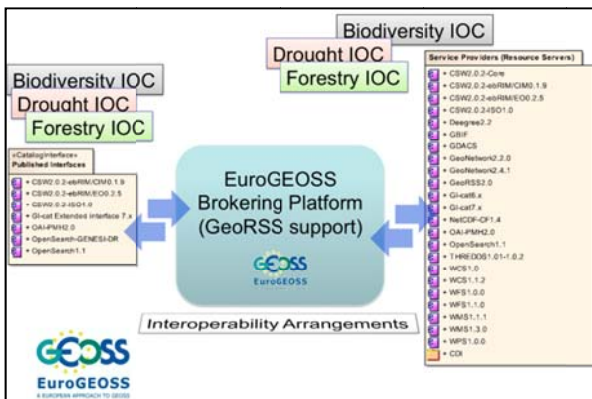


These important thematic developments have been supported by the development of the EuroGEOSS broker which takes the pragmatic approach of building inter-disciplinary interoperability by reaching out to the different communities, their standards and professional practices, and building mediating services that connect them to the broker, rather than assuming that different communities will all adopt a centrally imposed set of standards.

Having supported the development of the IOC in the three thematic areas, work is now developing on three main fronts: the first is the horizontal multi-disciplinary interoperability, i.e. the ability to

access, integrate, and use data from the different thematic areas. This requires developing a series of mediating access services to transform the data so that for example, they have the same coordinate reference system, and projection. The second is the development of semantically-rich annotations of the data so that is possible to search via web of related concepts and terms. Progress in this area has been already achieved in collaboration with the GENESIS project for the Architecture Interoperability Pilots Phase 3 (AIP-3) developed as a contribution to the GEOSS Architecture and Data Committee's activities. The third area of work to reach an Advanced Operating Capability is research in Web2.0 concepts and practices, so that the GEOSS infrastructure can become more accessible and usable by non-experts, and citizens can contribute themselves to the observation of the Earth system.

**Figure 8: Broker supporting multiple practices**



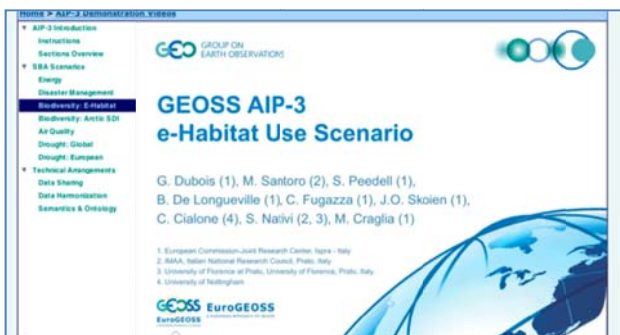
**Figure 9: Semantically Augmented Search**



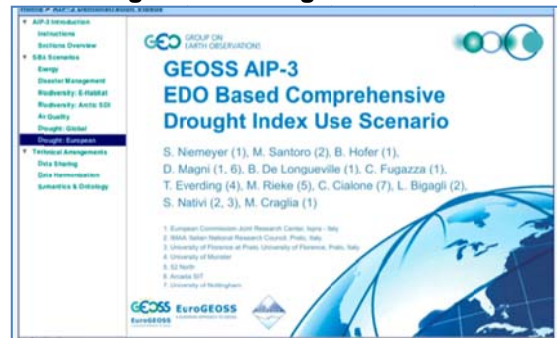
In addition to the activities planned, the project has provided two major contributions to the work of the GEOSS Architecture and Data Committee by:

- Testing the GEOSS Common Infrastructure components (registry, clearinghouses, and geo-portals) as part of the process of streamlining the GCI;
- Participating in two Architecture Interoperability Pilots (AIP-3) on Biodiversity and Drought with outcomes presented at the GEOSS Summit in November 2010 in Beijing. See <http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AIP3/pages/Demo.html>.

**Figure 10: Biodiversity Pilot**



**Figure 11: Drought Pilot**



A dissemination activities of the project have been very substantial in the first 18 months with over 25 papers published, 37 presentations given, 1 major international event organised in the framework of the INSPIRE conference, and multiple posters and videos prepared for international events including the GEO Summit in Beijing in November 2010. The Digital Observatory for Protected Areas and the EuroGEOSS project also featured in a side vent of the 10<sup>th</sup> Conference of the Parties (COP10) of the Convention for Biological Diversity (CBD) in Nagoya in October 2010.

### 1.3 Expected final results and their potential impact and use

During the next 18 months the project will build its Advanced Operating Capability, so that it is possible to access and use not just data across multiple thematic areas but also models and analytical process expressed in workflows and implemented through web-based chains of services. The main expected impact of this development is to make the EuroGEOSS resources accessible and usable not only from specialists in the individual fields, but also from scientists from multiple disciplines that will be able to have a clear picture of how the resources available can be used to address specific questions and how they may be adapted for their specific needs. In addition, the work already started in the project on natural language interfaces and lessons to be learned from Web 2.0 social networks offer the opportunity to expand the use of the EuroGEOSS infrastructure to a much wider audience that transcend scientific disciplines.

Providing quantitative and qualitative evidence of the benefits of multi-disciplinary interoperability in the GEOSS framework is a critical activity of EuroGEOSS that will help sustain the GEOSS efforts beyond its 2015 targets. To deliver these benefits, EuroGEOSS has made from the start a major effort in building outreach and capability building activities so that the experience of the project can be replicated and adapted to different geographical and disciplinary contexts, and thus leverage a multiplier effect for the benefits of global sustainability research.

For further information, and access to all reports, the EuroGEOSS broker, and interactive Forum, see [www.eurogeoss.eu](http://www.eurogeoss.eu). For further information contact Francis Bertrand, BRGM, [f.bertrand@brgm.fr](mailto:f.bertrand@brgm.fr) and Max Craglia, JRC, [massimo.craglia@jrc.ec.europa.eu](mailto:massimo.craglia@jrc.ec.europa.eu)

**Table 1: The EuroGEOSS Partners**

<b>EuroGEOSS Partner Name</b>	<b>Acronym</b>	<b>EuroGEOSS Partner Name</b>	<b>Acronym</b>
Bureau de Recherches Géologiques et Minières	BRGM	Global Biodiversity Information Facility Secretariat	GBIFS
Commission of the European Communities - Directorate General Joint Research Centre - JRC	EC-JRC	United Nations Environment programme	UNEP-WCMC
Consiglio Nazionale delle Ricerche	CNR	Royal Society for the Protection of Birds	RSPB
Internationales Institut fuer Angewandte systemanalyse	IIASA	BirdLife International	BirdLife
Universitat Jaume I de Castellon	UJI	Universitaet Hamburg	UNIHH
The University of Nottingham	UNOTT	Universitaet fuer Bodenkultur Wien	BOKU
Centro Nacional de Información Geográfica	CNIG	Albert-Ludwigs-University Freiburg	ALU-FR
Section française de l'institut des ingénieurs électriciens et électroniciens	IEEE	University of Zaragoza	UZ
Edisoft - Empresa de Serviços e Desenvolvimento de Software, S.A.	EDISOFT	Confederacion Hidrografica del Ebro	CHE
Fundacion General de la Universidad de Alcala	FGUA	Agencia Estatal Consejo Superior de Investigaciones Científicas	CSIC
Univerza v Ljubljani	ULBF	University of Nebraska	NDMC