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2009-2011 Work Plan Progress Report

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2009-2011 Work Plan Progress Report

This Report describes how the GEO 2009-2011 Work Plan has advanced the GEOSS 10-Year Implementation Plan since the GEO-VII Plenary meeting. It highlights key outputs and activities and provides an overall summary of the progress made in each cross-cutting and Societal Benefit Area. Consistent with the Work Plan structure, the Progress report is organized around Overarching Tasks to help: (i) highlight key lines of GEOSS implementation; (ii) showcase progress and coordination at the overarching level; and (iii) support the monitoring and evaluation of GEOSS implementation.

As with previous Work Plan Progress Reports, the present document includes an annex featuring an “at-a-glance” summary table. To help the reader more easily evaluate overall progress, the table has been color-coded to assess the progress made in each Task. Readers interested in greater detail about specific Tasks are referred to the main body of the report and to the Task Sheets, which are available at http://www.earthobservations.org/geoss_imp.shtml.

HIGHLIGHTS

In 2010, the focus of the Work Plan shifted towards building GEOSS – developing the GEO Portal, connecting various observing, prediction and information systems, and making environmental data, products and services available to society. In 2011, this trend continued with numerous new products and information contributed to GEOSS and major data-sharing and capacity-building efforts bearing fruit. Examples of how GEO Members and Participating Organizations have advanced GEOSS implementation are highlighted below.

The GEO Portal

Following the 2010 selection process, the USGS clearinghouse was selected as the single GCI (GEOSS Common Infrastructure) Clearinghouse and the ESA/FAO portal as the single GEO Portal. The selection was based on three main criteria: sustainability, functionality and usability.

As of September 2011, 302 components (including data sets, systems, and portals) have been registered in the GEOSS Common Infrastructure, providing access to over 99’600 resource descriptions. A “Sprint to Plenary” effort has been launched to increase the usability of the GEOSS Common Infrastructure. The main goal is to improve the search and retrieval functionalities of the GEOSS Common Infrastructure. This effort is supported by the 4th GEOSS Architecture Implementation Pilot; see AR-09-01
New GEOSS Products and Information

A range of new information and products was developed and contributed to GEOSS since the GEO-VII Plenary. This is now available to the entire GEO community either through the GEO Portal or through community portals that will soon be connected to the GEO Portal:

- In response to the 11 March earthquake in Japan, the International Charter on Space and Disasters was activated and a Supersite website was created. More than 63 images were captured by the Charter satellites in the first 48 hours, and ground-displacement measurements were released through the Supersite website in the first 24 hours. The Supersite website had as many ca. 4,500 visitors a day in the first two weeks following the earthquake; see DI-06-09 and DI-09-01
- The Global Earthquake Model initiative was contributed to GEOSS. The initiative is a public-private partnership that aims to calculate/communicate earthquake risk worldwide; see DI-09-01
- A prototype global early warning system for wildland fires was made operational. *Fire-potential maps* were produced for northern Europe and the Commonwealth of Independent States (Eurasia) through the integration of daily weather data from more than 400 stations; see DI-09-03
- A project was launched to develop a global operational *volcanic-ash alert-system* for aviation hazard avoidance. The new system should take into account atmospheric composition and increase the relevance of volcanic-ash alerts; see AR-09-02
- An open-source software was developed to collect *epidemics data worldwide*; the software was validated by the World Health Organization. Innovative risk-maps for Rift Valley fever were produced using satellite imagery, and then validated by local partners. New *pollen* shedding models were developed to better forecast the release, distribution and health impact of allergenic pollen in Europe; see HE-09-01 and US-09-03
- Over 3200 *human-settlement maps* were produced for cities with populations over 1 million (274 cities) and over 100 thousands (about 3000 cities). Maps are based on high-resolution satellite images; see DA-09-03
- Over 20 years of *solar radiation data* were released for public use. This includes over 200 parameters available globally at high-resolution for the period 1983-2006. The data provide valuable information for electricity production in Africa and the Mediterranean; see EN-07-01
- Monthly precipitation data from 190 countries (in-situ measurements at about 85,000 stations) were integrated into a global precipitation climatology. The data were extensively quality-controlled to produce next generation precipitation products; see CL-06-01 and WA-08-01
- A flood information dashboard was developed as part of an early flood-warning pilot for Southern African regions. The information helped the Namibian Government to issue flood warnings to local populations; see DI-09-02
- Measurements from GRACE satellites were used to quantify underground water-storage – a key development towards detecting *water-cycle acceleration* under a changing climate. A number of tools were refined for global groundwater assessment; see WA-08-01
- A web-based information system was developed to integrate, analyze, and archive Earth observation data from 20 Asian countries (Asian Water Cycle Initiative). Tools were developed for applying remote-sensing data to water management and showing the value of Earth observation in the Latin and Caribbean Americas (GEOSS in the Americas); see WA-06-07
- A web-based application (NASA Giovanni) was developed to visualize, analyze, and download vast amounts of Earth remote-sensing data. The application directly supports research on tropical convection for improved *seasonal forecasting*; see CL-09-01
The overall completion rate of the Global Ocean Observing System reached over 60%, while the global Argo float and ship measurement components were being maintained at 100%. Sustainability of global observing systems depends on clearly demonstrating their value to society across Societal Benefit Areas; see AR-09-03.

New carbon datasets were released: the FLUXNET CO\(_2\) fluxes dataset, and the TCCON CO\(_2\) and CH4 dataset. These datasets are vital for the validation and calibration of satellite measurements. A European project was launched for the development of an operational global integrated carbon observation system (GEOCARBON); see CL-09-03.

The US SilvaCarbon program and four European REDD-related projects were contributed to GEO Forest Carbon Tracking activities. Nepal was included as a new National Demonstrator joining Australia (Tasmania), Brazil, Cameroon, Colombia, Democratic Republic of Congo, Guyana, Indonesia (Borneo, Sumatra), Mexico, Peru and Tanzania; see CL-09-03.

New tools were developed to improve the quality of global land-cover maps. A major land-spotting project was launched to collect land-cover information via gaming. New Geo-Wiki portals were set up for cropland, forest and biomass; see US-09-02.

Global terrestrial ecosystem mapping was initiated for Central America, China, Europe, Indonesia, and Australia (over 50% complete). Mapping data were made available through a Rapid Data Distribution System; see EC-09-01.

An ecosystem database was developed to provide (i) time-series of satellite images for all protected areas over 10 sq km; and (ii) assessments of protected-area management effectiveness; see EC-09-01.

Two new Brazilian pilot-sites were proposed for the GEO-JECAM (Joint Experiment on Crop Assessment and Monitoring). These come in addition to the seven existing pilot-sites in Argentina, Canada, China, Europe, and Mexico. Data requests were submitted to CEOS for access considerations; see AG-07-03.

GEO BON became a key contributor to the Convention on Biological Diversity (CBD). A mandate was given to GEO BON to prepare an evaluation of existing observation capabilities relevant to the CBD’s targets for protecting biodiversity by 2020. The Global Invasive Species Information Network created country-level dynamic maps of native and invasive species; see BI-07-01.
More Data Sharing and Capacity to Use GEOSS Information

Numerous initiatives were undertaken by GEO Members and Participating Organizations to enhance data-sharing, build capacity and foster the use of GEOSS products and services throughout the world:

- Actions were launched in support of the "GEOSS Data Collection of Open Resources for Everyone" (GEOSS Data-CORE). Data-sharing initiatives were announced by a number of countries and organizations including Brazil, China, Japan, South Africa, Spain, and ESA. All Synthetic Aperture Radar (SAR) data acquired by ESA since 1991 were made freely available through the GEO Supersites portal; see [DA-06-01](#) and [DI-09-01](#).

- Formal actions were undertaken by Europe and Africa to improve authorized access to the International Charter on Space and Major Disasters. Thirteen meetings were organized with the disaster-management authorities of Mali, Niger, Uganda, South Africa, Burkina Faso, Ethiopia, Mozambique, Namibia, Zambia, Senegal, Democratic Republic of Congo, Tanzania, and Kenya; see [DI-06-09](#).

- CMACast was updated to a new multimedia dissemination system, thereby improving interoperability with EUMETCast and GEONETCast Americas. Calls were issued to expand the GEONETCast broadcast footprint over the Pacific region to address the low availability of information in the region; see [AR-09-04](#).

- High-resolution images (LANDSAT tiles) were disseminated to Africa via GEONETCast. A new CBERS (INPE) product was also disseminated to Africa via GEONETCast. The latter can be seen as a pioneer to the large-scale distribution of CBERS data in Africa. 70% of the CBERS data is currently available through the South African online catalogue; see [AR-09-04](#) and [CB-09-05](#).

- Ground stations were upgraded to receive and process CBERS-2B imagery. New Memoranda of Understanding were signed with Spain and South Africa for CBERS-3 reception. CBERS-3 is due for launch in the first quarter of 2012; see [AR-09-04](#) and [CB-09-05](#).

- China (CMA) joined the USA (NOAA) and EUMETSAT in creating a GEONETCast training channel. Training channels are now in operation for EUMETCast, GEONETCast Americas, and CMACast covering most of Europe, Africa, the Americas and Asia; see [CB-09-02](#).

- Training on tropical forest monitoring was provided in three different languages (English, Spanish, Portuguese) using a Brazilian open-source system. Over 60 people were trained from 18 countries. Results were directly applied by the Democratic Republic of Congo; see [CB-09-02](#).

- The GEO Agricultural Monitoring Community of Practice responded to a request from the G20 to develop a proposal for improved crop monitoring and reduced price volatility over the world. The initial proposal was adopted by the G20 Agriculture Ministers; see [AG-07-03](#).

- A Memorandum of Understanding was signed between Korea and the “Intergovernmental Authority on Development Climate Prediction and Applications Centre” to support east African countries in adapting to climate variability and change. Two projects were launched to support the establishment of robust climate information services, national and regional weather and climate monitoring systems, and assistance to the agriculture and health sectors; see [WE-09-01](#).

- An analysis was undertaken to identify Earth observation priorities across GEOSS Societal Benefit Areas. Results show that the 3 highest-ranked observations are precipitation, soil moisture and surface air temperature. A gap analysis was initiated to assess availability of these observations over the next 15 years; see [US-09-01](#).

- A European project (EGIDA) was launched to support the implementation of the GEO Science and Technology Road Map. The project builds on many ongoing initiatives such as the OECD Governance of International Co-operation on Science, Technology and Innovation for Global Challenges (STIG); see [ST-09-01](#).
TABLE OF CONTENTS

1 BUILDING AN INTEGRATED GEOSS .......................................................................................................................... 6

1.1 ARCHITECTURE ......................................................................................................................................................... 6
   AR-09-01: GEOSS Common Infrastructure (GCI) ................................................................................................. 6
   AR-09-02: Interoperable System for GEOSS .............................................................................................................. 7
   AR-09-03: Advocating for Sustained Observing Systems .......................................................................................... 8
   AR-09-04: Dissemination and Distribution Networks ............................................................................................... 10
   AR-06-11: Radio Frequency Protection ..................................................................................................................... 11

1.2 DATA MANAGEMENT ................................................................................................................................................ 13
   DA-06-01: GEOSS Data Sharing Principles .............................................................................................................. 13
   DA-09-01: Data Management .................................................................................................................................. 14
   DA-09-02: Data Integration and Analysis .................................................................................................................. 15
   DA-09-03: Global Data Sets ....................................................................................................................................... 15

1.3 CAPACITY BUILDING ................................................................................................................................................. 17
   CB-09-01: Resource Mobilization (Seville Roadmap) .............................................................................................. 17
   CB-09-02: Building Individual Capacity in Earth Observations ............................................................................... 18
   CB-09-03: Building Institutional Capacity to Use Earth observation ...................................................................... 19
   CB-09-04: Capacity Building Needs and Gap Assessment ......................................................................................... 19
   CB-09-05: Infrastructure Development and Technology Transfer for Information Access ........................................ 20
   CB-10-01: Building Capacity through Outreach and Awareness Raising ................................................................. 22

1.4 SCIENCE AND TECHNOLOGY ...................................................................................................................................... 23
   ST-09-01: Catalyzing R&D Funding for GEOSS ...................................................................................................... 23
   ST-09-02: Promoting Awareness and Benefits of GEO .......................................................................................... 24

1.5 USER ENGAGEMENT .................................................................................................................................................... 25
   US-09-01: User Engagement ..................................................................................................................................... 25
   US-09-02: Socio-Economic Indicators ...................................................................................................................... 26
   US-09-03: Cross-Cutting Products and Services .................................................................................................... 26

2 THE 9 GEOSS SOCIETAL BENEFIT AREAS .................................................................................................................. 28

2.1 DISASTERS .................................................................................................................................................................. 28
   DI-06-09: Use of Satellites for Risk Management ................................................................................................... 28
   DI-09-01: Monitoring for Geohazards Risk Assessment ................................................................................................. 29
   DI-09-02: Multi-Risk Management and Regional Applications .................................................................................... 31
   DI-09-03: Warning Systems for Disasters .................................................................................................................. 33

2.2 HEALTH ....................................................................................................................................................................... 35
   HE-09-01: Information Systems for Health .................................................................................................................... 35
   HE-09-02: Monitoring and Prediction Systems for Health .............................................................................................. 36
   HE-09-03: End to End Projects for Health .................................................................................................................. 38

2.3 ENERGY ........................................................................................................................................................................ 41
   EN-07-01: Management of Energy Sources .................................................................................................................. 41
   EN-07-02: Energy Environmental Impact Monitoring ................................................................................................ 43
   EN-07-03: Energy Policy Planning ............................................................................................................................... 43

2.4 CLIMATE ........................................................................................................................................................................ 45
   CL-09-01: A Climate Record for Assessing Variability and Change ........................................................................... 45
   CL-09-02: Accelerating the Implementation of the Global Climate Observing System ...................................................... 49
   CL-09-03: A Global Carbon Observation and Analysis System ...................................................................................... 50

2.5 WATER ........................................................................................................................................................................ 53
   WA-06-02: Droughts, Floods and Water Resource Management .................................................................................. 53
   WA-06-07: Capacity Building for Water Resource Management .................................................................................. 54
   WA-08-01: Integrated Products for Water Resource Management and Research ..................................................... 56

2.6 WEATHER ...................................................................................................................................................................... 58
   WE-06-03: TIGGE and the Development of a Global Interactive Forecast System for Weather ..................................... 58
   WE-09-01: Capacity Building for High-Impact Weather Prediction .................................................................................. 59

2.7 ECOSYSTEMS ................................................................................................................................................................. 61
   EC-09-01: Ecosystem Observation and Monitoring Network (GEO EcoNet) ................................................................. 61
   EC-09-02: Ecosystem Vulnerability to Global Change .................................................................................................. 63

2.8 AGRICULTURE .............................................................................................................................................................. 65
   AG-06-02: Data Utilization in Fisheries and Aquaculture ............................................................................................... 65
   AG-07-03: Global Agricultural Monitoring .................................................................................................................. 66

2.9 BIODIVERSITY ............................................................................................................................................................... 68
   BI-07-01: Developing a Biodiversity Observation Network ............................................................................................. 68

APPENDIX A: PROGRESS TABLE ........................................................................................................................................ 70
APPENDIX B: LIST OF ACRONYMS .............................................................................................................................. 72
1 BUILDING AN INTEGRATED GEOSS

1.1 ARCHITECTURE

The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference given to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such systems have interfaces to the shared architecture.

GEOSS 10-Year Implementation Plan, Section 5.3

AR-09-01: GEOSS Common Infrastructure (GCI)

A “Sprint to Plenary” effort was launched to increase the usability of the GEOSS Common Infrastructure. The USGS clearinghouse was selected as the single GEOSS Common Infrastructure (GCI) Clearinghouse and the ESA/FAO portal as the single GEO Portal. The selection was based on three main criteria: sustainability, functionality and usability. As of September 2011, 302 components (including data sets, systems, and portals) had been registered in the GCI, providing access to over 99’600 resource descriptions. However, many missing datasets are still missing. It remains crucial for GEO Members and Participating Organizations to register their components with sufficiently detailed metadata.

Following the 2010 selection process, the US Geological Survey (USGS) clearinghouse was selected as the single GCI Clearinghouse Component Provider and the European Space Agency/UN Food and Agriculture Organization portal as the single GCI Web Portal Component Provider. The decision was presented to the GEO-VII Plenary in Beijing for information. GCI demonstrations were given as part of the main GEO-VII exhibition in Beijing.

As of 22 September 2011, 302 components (including data sets, systems, and portals) and 177 internet interface services have been registered in the GEOSS Common Infrastructure. This implies that over 99’600 resource descriptions may be searched through the Clearinghouse. Advanced integrative applications are under development to discover, access and use these resources across GEOSS Societal Benefit Areas. One example is the EuroGEOSS infrastructure that focuses on European-contributed data and services across the biodiversity, drought, and forestry domains.

The GEO Architecture and Data Committee initiated a coordination effort to increase the usability of the GEOSS Common Infrastructure (GCI). The main purpose is to improve the search and retrieval functionalities of the GCI. The first step is to demonstrate improved access to selected datasets at the GEO-VIII Plenary in November 2011. This will require adapting both the GCI and the data handling systems of the data providers. Providers will be selected on the basis of (i) ‘Critical Earth Observation Priorities’ identified through the work of the User Interface Committee (see Task US-09-01); and (ii) contributions to the GEOSS Data-CORE. The USA (USGS) and ESA/FAO (as providers of the GCI Clearinghouse and Web Portal) are fully engaged in this activity referred to as “Sprint to Plenary”.

The fourth GEOSS Architecture Implementation Pilot (AIP-4; http://www.ogcnetwork.net/AIP), led by the Open Geospatial Consortium (OGC), fully supported the “Sprint to Plenary” initiative (the call for participation in AIP-4 resulted in 23 responses so far). Also ontology activities, led by Japan (University of Tokyo), ESA and IEEE, realigned to deliver a controlled vocabulary that helped discover priority datasets through searches and concept browsing.

Prior to AIP-4, the third GEOSS Architecture Implementation Pilot (AIP-3) helped incorporate new components into the GCI – consistent with the GEOSS architecture and interoperability
arrangements. AIP-3 lasted from March to October 2010 (http://www.ogcnetwork.net/node/635) and demonstrated capabilities in numerous areas, including disaster management, biodiversity, air quality, water quality and drought, and energy. Outcomes of AIP-3 were captured in a series of videos presented at the Beijing Summit (http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AIP3/pages/AIP-3_ER.html). All AIP-3 videos were registered as Best Practices in the Best Practices Wiki. AIP activities rely on contributions from the Open Geospatial Consortium (OGC), USA (USGS/FGDC, NASA), ESA, the European Commission, and Northrop Grumman.

CEOS convened a worldwide webinar tutorial on GEOSS registration practices. GEOSS registration videos were saved into a downloadable format to encourage more uptakes into GCI. Registration figures steadily increased over the past year. However, there are still gaps and missing data sets in the GCI. It remains vital for all GEO Members and Participating Organizations to register their components in the GEOSS Common Infrastructure with sufficiently detailed metadata (see http://geossregistries.info/holdings.htm).

An analysis of the Best Practices Wiki – an educational resource developed by IEEE for the GEO community – revealed that usage and submissions were low. The tool, operational since 2008 (http://wiki.ieee-earth.org/), is under-used by the GEO community. Collaborative work through the Architecture Implementation Pilot and GEO Committees should help to improve the situation.

Japan (University of Tokyo) developed a Wiki-based terminology registry, data search functions, and visualization functionalities using Reverse Dictionary. The functions were demonstrated as part of AIP-3, and implemented into the web-based Data Integration and Analysis System (DIAS). New visualization tools were also developed such as the GEOSS Target & Task Graphic Tool (http://geoss.iis.u-tokyo.ac.jp/geoss/). In the Target and Task Tool, all Work Plan Task information is treated as ontological information (including inter-Task relationships).

**AR-09-02: Interoperable System for GEOSS**

Interoperability among GEOSS observing, modelling and information systems progressed on a number of fronts, including land-surface imaging and atmospheric composition (volcanic ash). A proposal for the creation of a 7th virtual constellation on Sea-Surface Temperature was endorsed by CEOS. Data integration was improved in the framework of Sensor Web. New projects were launched to develop a dynamic modelling infrastructure and integrate environmental models in the area of water and land use.

The Committee on Earth Observation Satellites (CEOS) continued to develop virtual constellations to merge and integrate data and information in six different fields: Land Surface Imaging; Atmospheric Composition; Ocean Colour Radiometry; Ocean Surface Topography; Ocean Surface Vector Wind; and Precipitation. All derived data were registered into the GEOSS Common Infrastructure supporting numerous Societal Benefit Areas including Climate, Water, Ecosystems and Agriculture.

The Land Surface Imaging (LSI) Constellation Working Group on Information System and Services (WGISS) improved the existing LSI portal designed to collect and distribute satellite imagery of the Earth’s land surface (http://wgiss.ceos.org/lsip). New functionalities include (i) a cross-system search and data retrieval which ensures map-based query and direct-data download capabilities using CWIC (CEOS WGISS Integrated Catalog); and (ii) new data types (such as MODIS) and descriptive information (link to Working Group on CAL/VAL portal and others). Users are able to access images from 28 satellites across CEOS space agencies via the LSI portal (see “The CEOS-Land Surface Imaging Constellation Portal for GEOSS”: http://www.earthzine.org/category/sections/articles/).

The Atmospheric Composition (AC) team, including the USA (EPA, NASA, NOAA), ESA and EUMETSAT, launched an AC portal (http://wdc.dlr.de/acp) to provide access to atmospheric composition forecasts, tools and services. The portal contributes to the GEO Architecture
Implementation Pilot and adheres to OGC standards. A white paper for a geostationary air-quality constellation is under preparation.

The AC team also worked on the development of a global operational volcanic-ash alert-system for aviation hazard avoidance. Completion of two 14-month demonstration phases is planned for January 2012 (see http://www.esa.int/esaCP/SEM8HJNSNNG_index_0.html).

The Ocean Surface Topography (OST) and Ocean Surface Vector Wind (OVW) constellations helped coordinate satellite observations and capacity building. They also encouraged the participation of the China marine remote-sensing satellite series (HY-2A & 2B) in the constellations. A dedicated OVW and Satellite Wave Height portal was developed.

A proposal for the creation of a 7th virtual constellation on Sea-Surface Temperature was endorsed by CEOS member agencies over the 26th Strategic Implementation Team meeting (Frascati, Italy, 24-25 May 2011). A final proposal is now in preparation. This new constellation will build upon the work of the Group for High-Resolution Sea-Surface Temperature.

WMO members continued to gradually implement the WMO Information System (WIS). 13 Global Information System Centres and about 110 Data Collection/Production Centres were proposed. A clearinghouse interface was built to reach GCI-WIS interoperability. This allows WIS Global Information System Centres to search the GEOSS Clearinghouse and conversely, the WIS catalogs to be searched through the GEOSS Clearinghouse.

South Africa (CSIR) supported the development of Sensor web technologies. A Sensor Web working group was established within CEOS WGISS (Working Group on Information Systems and Services of the CEOS) ensuring satellite and in-situ observation interoperability. Best practices for Sensor Web were developed such as the African weather services standardized RESTful SOS interfaces (to be registered in the GEOSS Common Infrastructure). The African fire service and other SOS services also developed best practices. Training and workshop activities for Sensor Web were planned for 2011-2012. A Sensor Web thread should be part of the Architecture Implementation Pilot 4 (AIP-4).

The European Commission, USA (NASA) and IEEE further developed a dynamic modelling infrastructure – Model Web – to serve researchers, managers, policy makers and the general public. The European project UncertWeb (2010-2013; http://www.uncertweb.org/) continued to make progress on quantifying uncertainty in chained models. The Composition as a Service (CaaS) approach was investigated and a prototype was developed to work on model chaining and uncertainty. An Advisory Group meeting was planned for September 2011.

The EuroGEOSS project developed a Brokering framework which is able to implement most of the mediation functionalities required by the Model Web to access complex resources like models and ingest datasets. A variety of information and outreach activities took place or were planned. A paper entitled “Environmental Model Access and Interoperability: the GEO Model Web Initiative” was submitted to the journal Environmental Modelling and Software. A session was planned at the Fall American Geophysical Union conference entitled “Ecological Models: Coordination, Access, and Sharing”.

**AR-09-03: Advocating for Sustained Observing Systems**

Terrestrial Essential Climate Variables (ECVs) were prioritized according to their urgency and feasibility for standardization. Overall completion rate for the Global Ocean Observing System stood at 62% while the global drifting buoy, Argo float and volunteer ship measurement component arrays were maintained at 100%. An implementation strategy for the Global Cryosphere Watch was approved by the 16th World Meteorological Congress. Approximately 30 space geodesy ground stations were identified as necessary to define and maintain the International Terrestrial Reference Frame. Concerns remain about the overall strengthening and sustainability of global observing systems that underpin products and services across all GEOSS Societal Benefit Areas.
The Global Terrestrial Observations System (GTOS) developed a plan for “A Framework for Terrestrial Climate-Related Observations and the Development of Standards for the Terrestrial Essential Climate Variables” (http://www.fao.org/gtos/doc/pub77.pdf). This report prioritizes a list of Essential Climate Variables (ECVs) according to their urgency, importance, and readiness and feasibility for standardization. These ECVs are: Biomass, Glaciers and Ice Caps, Land Cover, Permafrost and Soil Moisture. The standardisation process was encouraged by SBSTA30 and COP-15 Decision 9.

With regard to standardization, a Memorandum of Understanding (MoU) was signed between ISO (International Organization for Standardization) and the UN-agencies sponsoring GTOS (FAO, UNEP, UNESCO, WMO). The MoU defines the organization and operation of a framework for observational standards, protocols and reporting guidelines for terrestrial ECVs. The standardisation process will be handled under different ISO-Technical Committees according to the different ECVs. Efforts have been initiated for land-cover. Details are available on the following websites: www.fao.org/gtos/topcFRAME.html and www.fao.org/gtos/topcECV.html.

The Global Ocean Observing System (GOOS) continued to develop. Implementation levels for the in-situ global networks were successfully sustained above 60%. As of September 2011, the overall system completion rate stood at 62% while the global drifting buoy, Argo float and volunteer ship measurement component arrays were being maintained at 100%. This level of implementation was stagnant for several years. Success will still depend on clearly demonstrating that the system not only serves research aims, but also underpins a wide variety of readily available products and services useful to society, across all of the GEOSS Societal Benefit Areas.

The Intergovernmental Oceanographic Commission strengthened and streamlined the governance of GOOS at its 26th Assembly in June 2011. GOOS is now aligned to a Framework for ocean observing developed after the OceanObs'09 conference (21-25 September 2009, Venice, Italy), which seeks to serve a larger number of societal issues and benefit areas, and an expanding number of
Essential Ocean Variables. It will seek with the many international and regional partners in building a Global Ocean Observing System to align existing structures and identify new needed structures to animate Framework processes in setting requirements for societal benefit areas, coordinate observing networks and data management arrangements, and evaluate if ocean data products are fit for their purpose.

The Polar Observations, Research and Services (PORS) group defined a set of tasks to move the WMO Global Cryosphere Watch (GCW) forward. The CGW will help meet most of the data and information requirements on the cryosphere – building upon the legacy of the International Polar Year (IPY). Promotion of the GCW is ongoing: A major IPY Report was completed, which discusses IPY legacy issues. Also an Implementation Strategy for the GCW was approved by the 16th World Meteorological Congress in May 2011.

A Vision for the WMO Global Observing System (GOS) in 2025 was developed, approved and communicated to GOS partner organizations. All data from GOS comply with GEOSS interoperability arrangements and Data Sharing Principles, and will be accessible through the WMO Information System (WIS).

The International Association of Geodesy (IAG) completed a simulation-study to scope the size, distribution, and performance of geodetic ground-networks required for the development of global geodetic reference frames. The study shows that approximately 30 globally well-distributed space geodesy ground stations are needed to define and maintain the International Terrestrial Reference Frame with an accuracy of 1 mm and a stability of 0.1 mm/year. The International Association for Geodesy started preparing a call for participation in support of an improved Global Unified Height System.

AR-09-04: Dissemination and Distribution Networks

GEONETCast further improved capabilities. The dissemination of high-resolution images to users in Africa was initiated. International Charter data was sent over the GEONETCast Americas system. Preparation was made for the large-scale dissemination to Africa and South & Central America of CBERS products. The development of GEONET – a global communication network of interconnected networks – was launched. Calls were issued to expand the GEONETCast broadcast footprint over the Pacific region. Users were requested to provide feedbacks on GEONETCast Training and Alert Channels.

China (CMA), USA (NOAA) and EUMETSAT continued to develop GEONETCast – a low-cost dissemination system for GEOSS data. GEONETCast is fully interoperable with the GEOSS Common Infrastructure and provides near-global coverage through data exchange between 3 regional Network Centers: EUMETSAT (EUMETCast, over Europe, Africa, and Americas), NOAA (GEONETCast Americas, over the Americas and Caribbean), and CMA (CMACast, over Asia and part of the Pacific).

CMACast was updated to a multimedia dissemination system based on second-generation Digital Video Broadcast (DVB-S2) technology with both file and multimedia transmission capability. CMACast enhanced user management and improved interoperability with EUMETCast and GEONETCast Americas. Discussions with Russia (Roshydromet) regarding its potential involvement as a GEONETCast infrastructure provider continued. Practical work on integrating the Multiaddress Information Transmission (MITRA) system into GEONETCast was initiated.

The dissemination of high-resolution images (LANDSAT tiles) to users in Africa was initiated in support of the “International Charter on Space and Major Disasters” and the “Observatoire Satellital des Forêts d’Afrique Centrale” (OSFAC). EUMETCast successfully completed the proof of concept test-activities for LANDSAT Africa activities (EUMETCast is now awaiting a request from the data provider/originator to establish a service).
The DevCoCast project prepared for the dissemination to Africa and South & Central America of numerous products, including a **new CBERS product** from INPE. The latter is composed of one scene per day over Africa and one scene per day over South America. The spatial resolution is roughly 27x27km (average). This can be seen as a “pioneer” or forerunner to the larger-scale distributions of CBERS through direct reception in Africa (see Task CB-09-05).

Another “proof of concept” demonstration took place in Argentina. On 26 January 2011, *International Charter data was sent over the GEONETCast Americas* system. Four image files were sent in under 2 hours. The files were successfully received in Argentina (CONAE and RANET program). During the GEO-VII Plenary, DevCoCast partner Denmark (DMI), together with China (CMA) demonstrated how GEONETCast data exchange (EUMETCast-CMACast) can support oceanographic end-user information systems in Asia.

Calls were issued to further expand the GEONETCast broadcast footprint over the Pacific region to address the low availability of environmental information in the region. GEO could assist in securing funding for the expansion of GEONETCast into this region.

ESA, DANTE, IEEE and Japan worked towards the establishment of GEONET – a global communication network of interconnected networks – through which GEOSS-related data, products and information can be distributed. A preliminary inventory of candidate networks for “data access, exchange and dissemination” was initiated. This inventory includes existing ESA Earth Observation Wide Area Network and DDS (Data Dissemination System), GEONETCast, Global Telecommunication System (GTS), CEOSnet and other potential contributing networks. The inventory also benefits from ESA’s cooperation with the EC Info Society on the European Internet, GEANT. A report on GEONET inventory including “World Wide Connectivity of the Research and Education Networks” is being finalized and will be available soon. The analysis of mobile network utilization within GEOSS was initiated and GEONET mobile scenarios were defined.

Questionnaires were drafted to collect **requirements** from GEOSS users and data providers, and initial contact was established with the User Interface Committee to cover the nine Societal Benefit Areas. Technical communication between GEONETCast and GEONET was consolidated through the work of Architecture and Data Committee. Finally, the GEONET project website was setup.

**AR-06-11: Radio Frequency Protection**

Consistent progress was made on radio frequency protection. The ITU-R report on “The essential role and global importance of radio-spectrum use for Earth observations and for related applications” was adopted. The report represents the response to Resolution 673 on “Radiocommunications use for Earth observation applications” which was adopted at the ITU-R World Radiocommunication Conference 2007 (WRC-07). The promotion of radio frequency protection remains a long-term effort that requires strong political support. GEO Members can make a difference in influencing country representative positions in radio-communication fora.

The Telecommunication Union Radiocommunications Sector (ITU-R) Study Group 7 together with WMO adopted a report on “The essential role and global importance of radio spectrum use for Earth observations and for related applications”. The report describes the considerable **socio-economic benefits of spectrum-use for Earth observation**. Part A, in particular, is a major step towards the improved recognition of radio-frequency applications for GEOSS. The report will be an important reference in future radio-frequency discussions, either at international or national levels. Both documents are available on the ITU website. [http://www.itu.int/pub/R-REP-RS](http://www.itu.int/pub/R-REP-RS)

WMO and the International Telecommunication Union (ITU) collaborate on better using radio frequency for Earth observation. Whilst WMO focuses on meeting the needs for environmental information and corresponding radio frequency spectrum resources, ITU allocates the radio-frequencies needed for interference-free operations of radio-based applications and
radiocommunication systems (e.g. terrestrial and space systems used for climate monitoring and prediction, weather forecasting and disaster early warning).

Radio-frequency protection is a **long-term effort** that requires strong political support. It is of benefit to all users of GEOSS information. GEO Members can make a difference in influencing country-representative positions in radiocommunication fora.
1.2 DATA MANAGEMENT

In the implementation of GEOSS, increased sharing of methods for modelling and analysis needed to transform data into useful products will be advocated. The implementation of GEOSS will facilitate, within 6 years, data-management approaches that encompass a broad perspective of the observation-data life cycle, from input through processing, archiving, and dissemination, including reprocessing, analysis and visualization of large volumes and diverse types of data. The implementation of GEOSS will establish, within 6 years, international information sharing and dissemination drawing on existing capabilities through appropriate technologies, including, but not limited to, Internet-based services.

GEOSS 10-Year Implementation Plan, Section 5.1 & 5.2

DA-06-01: GEOSS Data Sharing Principles

The action on the creation of a "GEOSS Data Collection of Open Resources for Everyone" (GEOSS Data-CORE) was accepted by Ministers in Beijing. A related call for contribution was sent to the GEO Community. Efforts are ongoing to integrate the Data-CORE into the GEOSS Common Infrastructure to ensure discovery of, and access to, contributed datasets. Intellectual property rights rules and regulations were examined. In addition, numerous actions were undertaken at the national and regional level in support of data sharing, for instance by Brazil, China, Japan, South Africa, Spain, ESA and EEA.

The Action Plan proposed for the implementation of the GEOSS Data Sharing Principles was accepted by the GEO-VII Plenary in Beijing in 2010. This Action Plan is in response to the Cape Town Ministerial Declaration supporting the establishment of a process to reach consensus on the implementation of the Data Sharing Principles for GEOSS. One key action from the Plan was included in the Beijing Declaration and accepted by Ministers over the Beijing Ministerial Summit. This action called for the establishment of a "GEOSS Data Collection of Open Resources for Everyone" (GEOSS Data-CORE): a distributed pool of documented datasets contributed by the GEO community on the basis of full and open exchange (at no more than the cost of reproduction and distribution) and unrestricted access.

In 2011, the Data Sharing Task Force focused on the implementation of the GEOSS Data-CORE, working mainly on: (i) Developing a list of datasets contributed by GEO Members and Participating Organizations; (ii) Integrating the Data-CORE into the GEOSS Common Infrastructure (together with Common Infrastructure component providers); (iii) Examining intellectual property rights rules and regulations that apply to data providers; and (iv) Identifying licenses that are compliant with the definition of the Data-CORE.

A call was sent to the GEO Community in June to further information on individual datasets contributed to the GEOSS Data-CORE. Issues such as user registration, data tagging and legal liability were also explored. A subgroup of the Data Sharing Task Force drafted a white paper on “Legal Options for the Exchange of Data through the GEOSS Data-CORE”. The paper identified possible legal options for data providers (such as “statutory public domain”) and recommendations for licenses that would be compatible with the GEOSS Data-CORE. The findings and recommendations will be submitted to the GEO community for consideration.

In addition to the Data-CORE, numerous actions are ongoing at the national and regional level in support of the implementation of the GEOSS Data Sharing Principles. For example: Brazil is maintaining a free and open data policy for its Earth observation satellites, including for the China Brazil Earth Resources Satellite (CBERS). China is offering data from the CBERS-02B satellite free of charge to African countries (China also contributed receiving equipment and ground stations to download the data). Japan is providing data and maps from its Advanced Land Observing Satellite (ALOS) in support of major disasters (up to April 2011). South Africa is distributing free Earth
observation data, including CBERS data, via its Earth observation portal and Earth observation data center. Spain is granting free access to, and use of, the AEMET datasets – including radar and lightning images, numerical weather predictions, and climate series (see www.aemet.es).

The European Space Agency (ESA) Member States recently approved an open and free data policy for the ENVISAT and ERS missions, and ESA’s Earth Explorers data policy is free and open. The Eye on Earth database maintained by the European Environment Agency (EEA) is completely open to the public. EUMETSAT is working to improve access to key information on the state of the planet collected by its satellites. OneGeology-Europe is making geological map data freely available. The International Council for Science (ICSU) is contributing its new World Data System and its long-term stewardship of quality-assessed data and services as a key service to GEOSS.

**DA-09-01: Data Management**

Momentum is building in data quality-assurance, harmonization and long-term preservation. Outreach for activities was strong which resulted in broader consensus, albeit within a community that is still a fraction of the GEO community. Funding for the long-term preservation of data remains difficult to locate. There is a strong need for a common GEO strategy – to build reference datasets and ensure coherence within Earth Science.

A team of experts led by the Committee on Earth Observation Satellites (CEOS) promoted and improved the Framework for Quality Assurance for Earth Observation (QA4EO; http://qa4eo.org). A one-page summary was produced describing key principles against which compliance with quality assurance should be assessed. Detailed guidelines (based on best practices) were generated to provide guidance across GEO communities. These guidelines, originally derived from best-practices of satellite communities, were broadened to include best practices of in-situ sampling communities. The QA4EO team participated in the 3rd Architecture Implementation Pilot (AIP-3) and coordinated international inter-comparison campaigns for land-surface reflectance, surface brightness, Radar C-Band radiometric characterisation and infra-red reflection distribution. Activities from the European FP7 project GEOVIQUA were also integrated (http://www.geoviqua.org/). A GEO Quality Assurance workshop was held from 18 to 20 October 2011 to bring together all communities concerned by quality assurance. Interaction began with the Earth Science Information Partners (ESIP) to connect and unite the ongoing earth observation quality efforts of both initiatives.

The European Space Agency (ESA), Canada (CSA), France (CNES), Germany (DLR) and Italy (ASI) consolidated the GEO approach to long-term preservation of Earth observation data, inviting more partners to join in. As a first step, requirements for data preservation were collected within each Societal Benefit Area. Moreover a broad user-consultation was held and a first version of preservation guidelines for satellite-based datasets was reviewed in May 2011.

The objective is to guarantee the preservation of all Earth observation data for an unlimited time-span, ensuring and facilitating access and usability through the implementation of a harmonized collective approach among Earth observation data owners. The preservation of Earth observation space data and associated knowledge is a long-term responsibility of space operators. As a result, funding is often difficult to locate. There is a strong need for a common GEO strategy – to build reference datasets and ensure coherence within Earth Science.

The USA (NOAA) and GSDI worked towards data, metadata and products harmonization – establishing connections with projects such as EuroGEOSS (integration of data discovery, access and use across the drought, biodiversity and forest areas). Contributions from GMES and the Infrastructure for Spatial Information in Europe (INSPIRE) initiative were strengthened. Data and products registered in the GEOSS Common Infrastructure were scrutinized for harmonization and metadata was analyzed in connection with the QA4EO.
DA-09-02: Data Integration and Analysis

Data integration made progress through the connection of important water data-centers across the world. A Memorandum of Understanding was signed to effectively link data management systems such as GENESI-DR, GIOVANNI, and DIAS. A team was formed to assess the benefits of applying ensemble techniques in the ocean domain. A new geodetic International Terrestrial Reference Frame was delivered.

Canada (University of Manitoba), Japan (University of Tokyo), USA (NASA) and ESA formed a Water Cycle Data-Centre Alliance to link GENESI-DR, GIOVANNI, DIAS and the 5th Grid projects. A Memorandum of Understanding was signed to that effect. Two inventories of water-cycle data-centres were completed, with a questionnaire distributed to over 75 global, regional and national water data centres. Collaboration with ICSU to facilitate data exchange is underway.

The United Kingdom (Met Office) formed a new dedicated inter-comparison team to confront ensemble analyses of sea-surface temperature. Initial contacts were established with the ocean community to assess the benefits of applying ensemble techniques in the ocean domain.

The International Association of Geodesy (IAG) worked to strengthen the Global Geodetic Observing System (GGOS) and develop intergovernmental agreements for planning and maintaining geodetic infrastructure and operations. A new International Terrestrial Reference Frame, suitable for positioning and Earth science applications, was delivered. France (MEDDTL) contributed resources in support of a request for the establishment of an ISO standard for the International Terrestrial Reference Standard.

DA-09-03: Global Data Sets

International collaboration was initiated on high-resolution land-cover products. A partnership was launched with the European Marine Observation and Data Network to enhance access to European seas’ data. An information server was made available to compare Digital Elevation Models from different sources. Over 3200 urban areas were mapped extracting human settlement information from high-resolution satellite images. Further progress is required on the interoperability, validation and preservation of global datasets.

GTOS (GOFC-GOLD), CEOS and the USA (USGS) collaborated on the harmonisation and standardisation of global land-cover characterisation in order to improve the quality of global land-cover products at medium resolution. International collaboration was initiated on high-resolution land-cover products. Ongoing projects include a 3-year project by China (SBSM) to produce global land-cover data at 30m resolution as well as numerous terrestrial parameters. Plans are to provide validated moderate-resolution land-cover maps and eventually land-cover change maps at high-resolution.

The OneGeology project continued to build momentum around the development of a dynamic digital geological map of the world (http://www.onegeology.org). The number of full and open datasets grew to 197. More and more users were granted access to data in a usable and editable format (as opposed to simple image files presented by map servers). Collaboration was initiated with the European Marine Observation and Data Network (EMODNET) to enhance access to European seas’ data. The first OneGeology training course was held in Columbia for an audience of ten countries in South/Central America and the Caribbean. Significant advances at the regional level were made possible by funding obtained through OneGeology-Europe (EC) and Geoscience Information Network (NSF) projects. Interaction between OneGeology and GlobalSoilMap.net was initiated.

The Committee on Earth Observation Satellites (CEOS) performed inter-comparisons of digital elevation models and verifications of the ASTER GDEM (Global Digital Elevation Model). An information server was made available to compare DEMs from different sources. The USA (USGS)

Japan (AIST) developed new datasets by extracting human settlement information from high-resolution satellite images. Products relate to cities with populations of over 1 million (274 cities) and cities with populations of over 100 thousands (3734 cities). In total, over 3200 urban areas were mapped. A software to extract road vectors from satellite images was also evaluated as a Web GIS tool. The Global Roads Open Access Dataset (gROADS) was submitted for review in the framework of CODATA.
1.3 CAPACITY BUILDING

The GEO capacity-building strategy follows the World Summit on Sustainable Development concept of a global partnership between those whose capacity needs development and those who are able to assist in the process, recognizing that activities have intertwined social, environmental, and economic impacts. The GEO capacity-building strategy will be based on best practices derived from studying successful and less-successful approaches.

*GEOSS 10-Year Implementation Plan, Section 5.6*

**CB-09-01: Resource Mobilization (Seville Roadmap)**

GEO efforts are ongoing to identify resources for individual, institutional and infrastructure capacity building. Practical examples of solutions provided by Earth observation applications were gathered in the form of success stories. A support team was established to identify and contact potential funding organizations for GEO proposals, however progress on implementation was slow.

Actions to mobilize resources were undertaken in the framework of the European FP7 project GEONetCab (**GEO Network for Capacity Building**). GEONetCab aims to improve the effectiveness and efficiency of GEO-related capacity-building activities and to broker support for capacity-building projects and activities. The project puts a special emphasis on developing countries, new EU member states and EU neighboring states, and addresses all GEOSS Societal Benefit Areas (with a particular focus on climate monitoring).

Practical examples of solutions provided by Earth observation applications were gathered in the form of **success stories**. Success stories target an audience that is not necessarily familiar with Earth observations and their potential. They are therefore written in a non-technical language and are very brief (2 pages) and illustrated. Success stories will be disseminated in various ways, including through the capacity-building web. The latter will provide examples of applications (such as the success stories) and information on where to find affordable training and low-cost or free software solutions.

A great deal of time and effort has been dedicated to building the theoretical framework and business model of the capacity-building web. The web facility is now almost ready to go live and will be linked to the **GEO Portal** as an integral part of that portal.

Promotional activities have started, and a **promotional toolkit** is being developed. Visits to the World Bank, the Inter-American Development Bank, International Food and Policy Research Institute, World Resources Institute and Organization for Economic Cooperation and Development have been undertaken. The focus is on building partnerships in general, but the topics of water and food security have thus far received special attention.

GEO issued a Call for Proposals (CFP) in February 2009 inviting organizations to propose **projects that apply Earth observations to decision-support activities**. The CFP was co-managed by the Capacity Building Committee (CBC), the User Interface Committee (UIC) and the GEO Secretariat. The CFP focused on projects in 4 Societal Benefit Areas with 72 full proposals submitted by September 2010: 18 in Agriculture, 2 in Energy, 13 in Health, and 39 in Water.

The final selection of proposals was announced on 1 October 2010. A support team consisting of User Interface Committee and Capacity Building Committee members and GEO Secretariat staff was established to identify potential funding organizations for the selected proposals. Preparations are being made to hire a donor coordinator to **match proposals with potential funding** organizations and help broker connections. Information sheets are being created for each proposal as part of a dossier that can be presented to funding organizations. A GEO CFP website is being created to provide links to the selected proposals.
CB-09-02: Building Individual Capacity in Earth Observations

Regional training activities were conducted on (i) tropical forest monitoring in three languages (Spanish, English and French) using an open-source system; (ii) disaster management & emergency response; and (iii) climate change/variability & health. A GEONETCast training channel was created for Asia (CMACast). However the usage of GEONETCast training channels remains low. GEO Members and Participating Organizations are invited to define their needs for GEONETCast training, and take advantage of GEONETCast global broadcast capability.

The Brazilian center in Belém do Pará (Amazon region) advanced its operations to become the world reference center in the monitoring of tropical forests, focusing on capacity building. INPE Amazonia offered training on tropical forest monitoring in three different languages (English, Spanish, and Portuguese), using the open-source system TerraAmazon: the Amazon rainforest monitoring system of the Brazilian PRODES project.

Training activities included: (i) 3 courses in English, 37 people trained from: France, Guyana, USA, Mexico, Ecuador, Papua New Guinea, Democratic Republic of Congo, Vietnam, Thailand, Indonesia, Cambodia; (ii) 1 course in Portuguese, 12 people trained from: Paraguay, Mozambique, Angola; (iii) 1 course in Spanish, 12 people trained from: Peru, Ecuador, Guatemala, Colombia. Following these sessions, the Democratic Republic of Congo (DRC) decided to adopt the technology developed by INPE for a satellite-based forest monitoring system. The goal of the DRC is to use this system for designing and implementing national forest policies.

Cooperation agreements were signed with France’s IRD (Research Institute for Development), the Japanese International Cooperation Agency (JICA), the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), the Food and Agriculture Organization (FAO), the Constellation of small Satellites for the Mediterranean basin Observation (COSMO-SkyMed), and the Brazilian Agricultural Research Corporation (Embrapa).

UNOOSA supported regional training and capacity building programs related to disaster management and emergency response. The main focus is on developing individual capacity in drought, desertification, landslides and earthquake management, and establishing regional network of practitioners in Latin America. Following a first workshop held in Brazil in 2008, Spring Schools were held in 2009 and 2010. Further schools are scheduled on Landslides and Earthquakes in 2011/2012.

The USA (International Research Institute for Climate and Society (IRI), Center for International Earth Science Information Network (CIESIN) and the Mailman School of Public Health) organized a “Summer Institute on Climate Information for Public Health” (16 May – 27 May 2011, New York, USA). The 2011 course exposed participants to data, methods and tools for integrating climate considerations into public health decision-making processes. It included hands-on experience with decision tools and targeted professionals who play a role in public health-care planning.

China (CMA) joined the USA (NOAA) and EUMETSAT in creating a GEONETCast training channel. Training channels are now in operation for EUMETCast, GEONETCast Americas, and CMACast covering most of Europe, Africa, the Americas and Asia. However the usage of training channels remains low. The GEONETCast community needs input from GEO Members and Participating Organizations to (i) define user-needs in training and capacity building; (ii) suggest or provide training materials for broadcast over the system; and (iii) take advantage of the global broadcast capability to add capacity to regional and national capacity-building activities.
CB-09-03: Building Institutional Capacity to Use Earth observation

The GEONETCast Toolbox was further improved to offer open and real-time access to GEONETCast data streams. Distance education courses were organized in Africa using GEOSS components and demonstrating the relevance of Earth observations through training and awareness-raising. Coastal forecasting systems continued to develop for Africa and Latin America.

The Netherlands (ITC) further developed an essential tool for international capacity-building networks: the GEONETCast Toolbox. Coupled to an open source data handling and analysis system, the Toolbox permits open, direct and real-time access to GEONETCast data. Online since June 2009 (http://www.itc.nl; keyword “GEONETCast”), the Toolbox was made available as open source (http://52north.org/communities/earth-observation). The Toolbox also became operational in several educational and research institutions in Europe and African countries such as Kenya, Rwanda, South Africa, Ethiopia, Uganda and Tunisia.

ITC and partners also focused on developing distance education courses using GEOSS components and demonstrating the relevance of Earth observations through training and awareness-raising. Outputs include two e-learning courses (for resp. 40 and 65 people) organized for (i) AMESD project partners in Southern Africa; and for (ii) ITC network partner RCRMD in East Africa. Numerous institutions supported and benefited from those courses. These include the: Institut de Recherches Agronomiques, Tunisia; University of Maidaguri, Nigeria; University of Makerere, Uganda; Universities of Addis Ababa, Ethiopia; Center for Training and Integrated Research, Kenya and University of Zimbabwe. Further network partners across Africa, Asia and Latin America should join in 2011/2012.

Further networking activities relate to (i) the Europe-funded DEVCOCast project to build a GEONETCast user network in Africa and Latin America, (ii) the AMESD project (a pan-African partnership and networking for the monitoring of the environment for sustainable development in Africa funded by the EC), (iii) the TIGER-2 project (an ESA initiative on Earth observation, climate and water resources for Africa), and (iii) the SERVIR project network extension.

Plans were initiated for a Bio-energy Atlas of Africa (see also EN-07-01). The atlas will allow policy-makers and other stakeholders to visualize which initiatives hold the greatest potential over time, and which are the impacts on the continent’s sustainability. Space-based and in-situ Earth observations will be integrated with ground surveys, historical records and market information, and assimilated with geographic information systems (GIS) analytical tools to forecast short- and long-term trends of bio-energy demand and supply at regional and local scales. A draft project plan (with outputs and milestones) is under development in the framework of EnerGEO with support of RCMRD, South Africa (CSIR) and Brazil (INPE).

The global network of operational oceanography continued to develop, involving major operational and research centers worldwide. International cooperation progressed among (i) China-Korea-Denmark on the Western Pacific forecasting System, (ii) Chile-France-USA on the Latin America coastal forecasting system, (iii) South Africa-Norway on the African coastal forecasting system, and (iv) the EU on GMES Marine Core Services. Products and applications were developed and openly shared for research.

CB-09-04: Capacity Building Needs and Gap Assessment

Engaging users in capacity-building activities remains a priority. Efforts to identify user-needs are proceeding with new projects such as the GEO Network for Capacity Building (GEONetCab) and GEO Capacity Building Initiative in Central Asia (SEOCA).
The GEO Network for Capacity Building (GEONetCab) project started creating conditions for the improvement and expansion of GEO capacity-building activities. A first analysis of opportunities and bottlenecks in Earth observation applications was conducted, resulting in the report “Marketing of Earth Observation Products and Services, Part 1”. The study describes the different categories of Earth observation products and services and how they relate to the business process of organizations and to the various GEOSS Societal Benefit Areas. The maturity of these products and services and the regional spread of applications are then considered, leading to advice on the optimum marketing mix of capacity building and brokerage for promoting the use of earth observation solutions.

In addition, four regional studies were carried out in the Czech Republic, Poland, Southern Africa and French-speaking Africa. Each study describes the situation with respect to applications of Earth observations and the level of capacity, combined with an analysis of bottlenecks and opportunities. The case studies are extremely valuable, not only for their emphasis on particular regions, but also in terms of providing practical examples of problems and solutions.

GEONetCab is a European FP7 project aimed at: (i) analyzing the current situation in Earth observation applications across the GEO themes; (ii) providing a capacity-building approach that takes “quick win projects” as a starting point; and (iii) carrying out awareness and dissemination activities to create a strong global basis for supporting GEO’s capacity building operations. Another project is the GEO Capacity Building Initiative in Central Asia (SEOCA). SEOCA follows a similar approach to GEONetCab however focused on Central Asia and Europe.

Morocco (Centre National de Recherches Météorologiques) led efforts to develop reliable and widely accepted qualitative and quantitative metrics for measuring (i) the efficacy of Earth observation capacity-building programs, and (ii) the implementation of GEO capacity-building strategy. Recent outputs include capacity building indicators compiled from the 119 Task Sheets of the GEO Work Plan. Indicators are now being used to assess the links between the Capacity Building Strategic Target and the efficacy of the GEO capacity building process. The report resulting from this assessment was presented for validation during the 13th Capacity Building Committee meeting in March 2011. The report is now finalized and there is work on the development of a new set of performance indicators more focused on quantitative information to be implemented for the new 2012-2015 GEO Work Plan.

**CB-09-05: Infrastructure Development and Technology Transfer for Information Access**

| Efforts are underway to establish and upgrade ground stations for CBERS imagery. Pre-processing systems were adjusted to receive CBERS-2B images and new Memoranda of Understanding were signed for CBERS 3 reception. Final results for AEGOS (African-European Geo-resources Observation System) were presented to national and regional stakeholders, emphasizing the need for transparent, shared and interoperable systems of public geoscientific information for decision makers. The Data Democracy initiative (for unhindered access to Earth observation information) requires strong support from the GEO community. |

Brazil (INPE), China (CRESDA) and South Africa (SANSA) established and upgraded ground stations to receive, process, store and distribute CBERS imagery. The Hartebeeshoek station, near Pretoria, turned fully operational with assistance and funding from China. The pre-processing system was adjusted to receive CBERS-2B images. A new Memorandum of Understanding was signed with SANSA for CBERS-3 reception in December 2010. Currently 70% of the data can be ordered through the online catalogue at http://catalogue.sansa.org.za/. Efforts are underway to fill the CBERS-2B gaps in the South Africa Data Center with similar data from the INPE catalogue – to evaluate the feasibility of developing image mosaics over some selected countries covered by the station footprint. Gaps will still be expected after this exercise.
Progress was also made on the ground station of Maspalomas, operated by the Spain National Institute for Space Technology (INTA). A Memorandum of Understanding was signed on June 2, 2011 for CBERS 3 reception. The CBERS image catalog in Maspalomas is operational and images can be obtained at the website: http://crepad-cbers.ccc.inta.es/catalogo/. A field survey was conducted in Gabon to define the appropriate location for a future CBERS antenna in the Congo Basin. Discussions are ongoing with China (CRESDA) and Italy (ASI, University of Rome) to enable the reception of CBERS-3 and CBERS-4 images at the Malindi station in Kenya. The Aswan station in Egypt will require major investments for receiving CBERS-3 and CBERS-4 images, including the acquisition of a new antenna. Negotiations between INPE and NASRS are ongoing. The CBERS2-B operations ended in April 2010. CBERS-3 is due for launch in the first quarter of 2012.

Brazil (INPE) and the Committee on Earth Observation Satellites (CEOS) progressed on the implementation of the “Data Democracy” initiative and related activities (open-source solutions and CBERS capacity building). Data Democracy is to strengthen the Earth observation data-utilization cycle by: (i) Broadening in-situ data/information access; (ii) Increasing data dissemination capabilities; (iii) Sharing software tools; and (iv) Transferring technology to end-users. Moreover Data Democracy is about unhindered access to Earth observation information; open-source software and open systems; adequate dissemination models that reflect the realities of bandwidth in developing countries; and locally initiated cross-border projects and intensive capacity-building programmes.

AEGOS (African-European Geo-resources Observation System) broadcasted geoscience data via GEONETCast. The last AEGOS Phase 1 technical meeting, steering committee and public conference were held on 14-19 April 2011 in Dakar, Senegal. Final results were presented to the national and regional stakeholders as well as the way forward for AEGOS subsequent development and implementation through a second phase. Discussions were held with representatives from UNESCO/International Hydrology Programme, ICSU-Regional Office for Africa, EuroGeoSurveys, Organisation of African Geological Surveys, Geological Society of Africa, ACP (African, Caribbean and Pacific Group of States) Secretariat, African Union/Human Resources, and UN Economic Commission for Africa.

AEGOS final results were further presented in regional meetings organized by the ACP Secretariat and the UN Economic Commission for Africa: First meeting of ACP Ministers in charge of the development of mining resources; (Brussels, Belgium); and Second meeting of the Committee on Development Information Science and Technology-CODIST-II (Addis Ababa, Ethiopia). Resolutions from the meetings emphasize the need to develop transparent, shared and interoperable systems of public geoscientific information for decision makers, investors, education, research, national and international institutions. Development partners should support the operationalization of systems such as AEGOS and associated transfer of know-how, in synergy with comparable platform for public data and georesources information sharing.

Funded by the European Commission (FP7) and implemented mainly by European and African geological surveys, AEGOS aimed to design a pan-African spatial data infrastructure for the sustainable use of geo-resources in Africa (http://www.aegos-project.org/). AEGOS organized a set of thematic workshops involving end-users on: (i) Hardware and software components and data flow specification related to required system functionality; (ii) User-oriented products and services, review and tests; (iii) Review of spin-off projects based on AEGOS, preparation of road map for AEGOS test beds; and (iv) Training infrastructure and organization: final decisions for content and implementation.
CB-10-01: Building Capacity through Outreach and Awareness Raising

A number of initiatives helped develop GEO outreach including the IEEE Workshop series and the Earthzine website. Earthzine receives about 7500 visitors per month from more than 120 countries.

IEEE and various partners furthered efforts to organize GEOSS outreach workshops in all Societal Benefit Areas. **5 user-oriented workshops were planned for 2011** from April to December (see www.earthobservations.org or www.ieee-earth.org/category/events/featured/workshops). Workshops typically expose regional and local stakeholders to best practices in capacity-building and to the benefits of using the GEONETCast dissemination system in combination with open-source applications. 2011 themes focused on drought, hydrology, oceans, climate, and sensor web/rural communications. The workshop originally planned in Sendai, Japan was relocated to Vancouver BC, Canada and conducted in July.

Through the **Earthzine website** (http://www.Earthzine.org), IEEE published articles, essays and interviews covering the nine Societal Benefit Areas. In January 2011, Earthzine hired two new part-time staff to support operations and editorial throughput, and to expand readership and contributor base. WWW.Earthzine.org is an on-line, open-access outreach media dedicated to (i) increasing interest in Earth science, Earth sensing and information technologies, (ii) expand the public’s understanding of the role Earth observation plays in improving our knowledge of Earth, (iii) increase participation of citizen scientists through open invitation to post articles, reviews and opinion essays, and (iv) engage public discussion of the benefits of utilizing Earth information in decision making through Earthzine’s open access blog. Earthzine’s readership has doubled approximately every year since its inception in November 2007. Earthzine presently attracts an international audience of about 7500 readers per month in more than 120 countries.
1.4 SCIENCE AND TECHNOLOGY

ST-09-01: Catalyzing R&D Funding for GEOSS

An international effort was launched to support the implementation of the GEO Science and Technology Road Map and improve the coordination of resources for large multinational Research & Development projects. This involves the coherent networking of national/regional projects and initiatives related to the EC, ICSU, IGFA, and the OECD (among others). A Science & Technology review was conducted for Agriculture, taking to six, the number of Societal Benefit Areas reviewed by the Science and Technology Committee (with Disasters, Health, Water, Biodiversity and Ecosystems).

The FP7 European EGIDA project was launched to support the implementation of the GEO Science and Technology Road Map and improve the coordination of resources for large multinational R&D projects. A National Use Cases Workshop was held (ISPRA, Rome, Italy, 18-19 April 2011) in order to analyze national GEOSS implementation across Europe and assemble a portfolio of “use cases” demonstrating how these national/regional initiatives show "GEOSS at work". Best practices were identified within the use cases for replication elsewhere in Europe and beyond, as well as gaps to be filled at national and/or regional level. More information on the selected use cases may be found on the EGIDA website (http://www.egida-project.eu/).

The 1st Joint Workshop of the EGIDA "Stakeholder Network and Advisory Board: Connecting GEOSS and its Stakeholders in Science and Technology” was held (Bonn, Germany, 9-11 May 2011) to develop a process for matching research funding with research teams. Contributions included the OECD Governance of International Co-operation on Science, Technology and Innovation for Global Challenges (STIG) project, which aims to explore new governance mechanisms to meet the most pressing global issues facing society.

Further contributions related to a new alliance comprised of the International Council for Science (ICSU), the Belmont Forum of the International Group of Funding Agencies for Global Change Research (IGFA) and International Social Science Council (ISSC). These important actors of the Global Environmental Change (GEC) community have joined forces to develop a 10-year program called Earth System Research for Global Sustainability (ESRGS) which will, among other things, focus on aligning resources and funding opportunities with international partnerships which seek to respond to the Belmont “Challenge.”

Resource mechanisms reviewed over the EGIDA Workshop included the European Commission 7th Framework Programme, ERA-Net (European instrument for coordinating resources for large multinational R&D projects), and ESFRI (European strategy for funding research infrastructures to develop the scientific integration of Europe and strengthen its international outreach).

At the 16th meeting of the Science & Technology Committee (STC) (Sydney, Australia, 14-15 April 2011), the Committee reviewed the Tasks of the Agriculture Societal Benefit Area (SBA). It noted the great amount of work accomplished, particularly with respect to Joint the Experiment for Crop Assessment and Monitoring (JECAM). However, it also observed that the only truly active subtask seem to be AG-07-03a on agricultural monitoring. The Committee further noted the need for enhancing the scientific interest in the SBA rather than its operational applications.

The STC stressed the importance of the Agriculture SBA as a strategic area for GEO, in which its direct and indirect effects on all the other SBAs (Energy, Climate, Ecosystems, Water, Disasters and Health) are apparent. Following the review, the STC recommended increased consideration be given to the impacts that agriculture and production have on society and economy and vice-versa, and recommended that the Food and Agriculture Organization become more engaged in Work Plan activities.
ST-09-02: Promoting Awareness and Benefits of GEO

Progress was achieved in showing GEO at work and making GEO and GEOSS better acknowledged within the Science and Technology community. A GEOSS citation standard was developed to increase the attractiveness of GEO and GEOSS for scientists and ensure that data used to create new products is acknowledged and appropriately credited. A “GEO label” draft concept was prepared. A GEOSS Portfolio for Science and Technology was developed. Dedicated workshops were organized to focus research networks on GEOSS issues.

Five main Activities underpin the implementation of Task ST-09-02:

With regard to Activity 1 (“Links with major scientific research enterprises”), a preliminary target list was compiled (inventory; prioritization; integration). With regard to Activity 2 (“Encourage scientists and technical experts to contribute to GEOSS”), a citation-standard consistent with the Federation of Earth Science Information Partners was developed and presented during the 16th meeting of the Science and Technology Committee. The Committee accepted the standard and now seeks to promote its use within GEO. The citation standard was further presented to the 22nd GEO Executive Committee in July 2011. The guidelines for the citation-standard were adapted from the International Polar Year (IPY) Data Information Service. The IPY provided a citation model upon which to build as it synthesized different approaches agreed to by many international data centers.

Also a “GEO label” draft concept was prepared and elaborated. Current ideas include a voluntary label that would be both, qualitative (based on user feedback) and quantitative (based on peer-review). The recognition of value that the GEO label would provide would also encourage scientists and researchers to contribute data and systems to GEOSS.

With regard to Activity 3 (“Outreach to diverse scientific and technological communities in order to make GEOSS more visible and attractive”), a GEOSS Portfolio for Science and Technology was developed (http://www.geo-tasks.org/geoss_portfolio/). The Portfolio currently features seven "compelling examples". With regard to Activity 4 (“Specific efforts to contact universities and research laboratories with the goal to involve them in GEOSS activities”), dedicated workshops were organized to focus research networks on GEOSS issues.

Finally with regard to Activity 5 (“Presence of GEO at major symposia and other meetings on different levels”), a Union Session on GEOSS was organized at the Fall American Geophysical Union (AGU) meeting (December 13-17, 2010, San Francisco, USA), convened by NASA, University of Nevada, and the GEO Secretariat. The session, “Understanding and Predicting Water and Energy Cycle Changes Using Multisensor Heterogeneous Data for Energy and Water Cycle Research”, featured examples of how GEOSS is contributing to research in hydrology.

At the European Geosciences Union (EGU) meeting (April 3-8, 2011, Vienna, Austria), a Session on “Hydrometeorological modeling and Earth observations under extremes: issues of scale, dependence and robust frameworks for collective risk assessment” was convened by Italy (CIMA Foundation) and the GEO Secretariat, and GEO presentations were given as part of the Session on “Geodesy and natural and induced hazards: Progress during 30 years of the WEGENER initiative.”
1.5 USER ENGAGEMENT

The needs of users, and the technical solutions to those needs, change with time. GEO will organize regular GEOSS User Fora among and within Societal Benefit Areas or sub-areas, making use of user communities where they exist and catalyzing the formation of new ones where they do not. It will also create an appropriate mechanism for coordinating user requirements across Societal Benefit Areas. The function of the User Fora will be to document and review user requirements, assess the extent to which they are being met, and make recommendations to GEO with the objective of improving the delivery of information appropriate to user needs.

GEOSS 10-Year Implementation Plan, Section 4.2

US-09-01: User Engagement

Users were actively engaged in reviewing and assessing requirements for Earth observation data, products and services. Earth observations priorities were identified across Societal Benefit Areas – showing that the three highest-ranked Earth observations are precipitation, soil moisture and surface air temperature. Follow-up activities were launched to assess the availability of highly-ranked observations over the next 15 years and to enhance the functionalities of the GEOSS Common Infrastructure. Partnerships were fostered across and within Societal Benefit Areas and Communities of Practice continued to develop with the support of the User Interface Committee.

The USA (NASA, EPA), IAG and IEEE led a GEO effort to identify critical Earth observation priorities common to many Societal Benefit Areas (SBAs). A cross-SBA analysis was undertaken showing that the 20 highest-ranked observations are common to, at least, four SBAs. The 3 highest-ranked observations were precipitation, soil moisture and surface air temperature (see full report at www.earthobservations.org/documents/committees/uic/201011_us0901a_sba_report.pdf). Analysts and advisory groups were identified in each SBA to harvest information from publicly available documents. Altogether, activities involved over 130 people in the advisory groups, and the analysts examined over 1500 documents. Final reports were completed for all Societal Benefit Areas (an update is underway for Biodiversity).

As a follow up, a gap analysis was initiated for the 30-35 highest-ranked observations to assess their potential availability over the next 15 years. Initial focus was set on temporal/geographic gaps in satellite observations, using the CEOS database as a primary source. Detailed information was also gathered for 5 of the top 10 parameters (precipitation, soil moisture, surface air temperature, vegetation cover, NDVI). A preliminary list of users, purposes, and required characteristics was prepared for “precipitation” – the highest-ranked observation. This could be extended to other observations such as soil moisture or land cover.

The foregoing analyses have multiple applications, including: (i) support satellite mission planning; (ii) identify key gaps in current and planned observation networks; (iii) target access to high-priority observations; and (iv) serve users’ needs across Societal Benefit Areas. They will also serve to enhance the functionalities of the GEOSS Common Infrastructure and determine which parameters will be available first (see Sprint to Plenary Initiative; AR-09-01).

Communities of Practice (CoP) continued to develop with the support of the User Interface Committee. They undertook numerous actions in support of Work Plan implementation including coordinating activities within/across Tasks and developing websites and newsletters. A comprehensive brochure on “GEO Communities of Practice” was developed and circulated in print in Beijing (see www.earthobservations.org/documents/cop/201011_CoP_brochure.pdf).

Communities of Practice reported to the User Interface Committee meetings in Vienna and Sydney in 2011, and contributed to the workshop “Building a User-driven GEOSS: Methods to Capture, Analyze and Prioritize User Needs” held at the ISRSE Symposium in April. A presentation was given on
“Communities of Practice: Implementation & Users”. The presentation reviewed the CoP concept and progress in actually linking users with providers of observations and information. The presentation built upon contributions from numerous Communities of Practice including Biodiversity (GEOBON), Forest, Integrated Global Water Cycle Observation, Energy, Geohazards, and Coastal Zone (see the workshop website for details: http://www.geo-tasks.org/workshops/2011_Sydney/).

US-09-02: Socio-Economic Indicators

The Geo-Wiki tool for improving the quality of land-cover maps developed new applications for cropland, forest and biomass. Integrated benefit assessments and interoperable databases were developed in 3 key areas: forestry, drought and biodiversity. Progress for registering socio-economic data in the GEOSS Common Infrastructure remained slow.

IIASA developed a number of new functionalities for the Geo-Wiki (http://www.geo-wiki.org), a tool to improve the quality of global land-cover maps. A seasonal profile was added helping to differentiate between evergreen and broadleaved forest (for every pixel, a 5-year average NDVI vegetation profile was provided). An agriculture.geo-wiki.org was set up for cropland and a biomass.geo-wiki.org was set up for forest and biomass. In addition, a major land-spotting project was launched to collect land-cover information via gaming. Tutorials were developed to help users learn how to do validation and to help IIASA understand how good users were (users were given a test to see how well they performed). Users were then classified as expert validators or novices – helping to address issues of validation quality.

Through the Geo-Wiki, volunteers review hotspot maps of global land-cover disagreement and determine, based on what they actually see in Google Earth and/or their local knowledge, whether land-cover maps are correct or incorrect. Their input is recorded in a database, along with uploaded photos, to be used in the future for the creation of a new and improved global land cover map. The Geo-Wiki is registered in the GEOSS Common Infrastructure (GCI) as an information service.

EUROGEOSS (Tools and Application of Benefit Assessment), a European FP7 project, progressed in developing methodologies and tools for assessing the societal benefits of GEOSS in 3 thematic areas (Forestry, Drought and Biodiversity). EUROGEOSS is for the integrated benefit assessment of the value of improved global land-cover information. Interoperable databases were developed and a system-dynamics model (the Felix model) was used to assess the benefit streams of GEO and GEOSS.

A workshop on the Socio-economic Benefits of Earth observations was hosted by the European Commission (Joint Research Centre) in July 2011 in Ispra, Italy. The purpose of the workshop was to identify a “program of activities” for the 2011-2014 time period to determine, document, and quantify the socioeconomic benefits of Earth observations – including the benefits of GEO and GEOSS.

The Organization for Economic Co-operation and Development (OECD) opened to GEO all its documents published in the framework of the OECD Space Forum (see www.oecd.org/futures/ space). The OECD also agreed to get its freely available socio-economic data registered in the GEOSS Common Infrastructure.

US-09-03: Cross-Cutting Products and Services

Plans were made for the development of a Global Map of larger-scale (1:250,000). Needs and feasibility are under examination. Pollen shedding models were developed to better forecast the release, distribution and health impact of allergenic pollen in Europe. A plant phenological database was developed by European networks and plant monitoring protocols were finalized for ~225 species. Observational phenological guidelines were unified throughout Europe.
Japan (GSI) and other members of the International Steering Committee for Global Mapping (ISCGM) made plans for the development of a **Global Map of larger-scale** (1:250,000), to be implemented between 2013 and 2017. Questionnaires were sent to National Mapping Organizations to identify the needs for a larger-scale Global Map and assess feasibility. Discussions were held at ISCGM (Winchester, UK, June 2011). A web-service is being developed to make Global Map available and enable applications aligned with Societal Benefit Areas.

With regard to phenology, the EUMETNET project PEP725, chaired by Austria (Central Institute for Meteorology and Geodynamics; ZAMG) and the USA (National Phenology Network; USA-NPN) coordinated efforts to build an International Phenology Network. New pollen shedding models were developed to better forecast the release, distribution and **health impact of allergenic pollen** in Europe.

A European plant **phenological database** was developed and plant monitoring protocols were finalized for ~225 species; a new animal phenology program was introduced by the USA-NPN in spring 2010. A mechanism was developed to bring standardization to the collection of ecosystem-parameters and expand networks throughout the world. Observational phenological guidelines were unified throughout Europe and many scientific publications were issued including a set of “Guidelines for plant phenological observations”.

2 THE 9 GEOSS SOCIETAL BENEFIT AREAS

2.1 DISASTERS

Disaster-induced losses can be reduced through observations relating to hazards such as: wildland fires, volcanic eruptions, earthquakes, tsunamis, subsidence, landslides, avalanches, ice, floods, extreme weather, and pollution events. GEOSS implementation will bring a more timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.

*GEOSS 10-Year Implementation Plan, Section 4.1.1*

**DI-06-09: Use of Satellites for Risk Management**

Images from more than a dozen satellites informed the response to the Japanese crisis. More than 63 satellite observations were made in the first 48 hours following the quake in the framework of the International Charter on Space and Disasters. A metadata catalog was released to support the discovery, browsing, and download of images produced by the International Charter so far. A major action was launched to improve Charter access in Africa, involving thirteen African countries.

The International Charter on Space and Disasters was activated in response to the **earthquake in Japan on March 11th** 2011. Charter images from more than a dozen satellites informed the response to the Japanese crisis. More than 63 satellite observations were made in the first 48 hours following the quake. Numerous mapping products were produced by a range of value-adders based on different satellite data. The March 11th quake was the largest ever recorded in Japan and is the world's fourth largest earthquake to strike since 1900, according to the US Geological Survey. The epicenter of the earthquake was 231 miles (373 kilometers) northeast of Tokyo and 80 miles (130 km) east of Sendai on Honshu, Japan's main island. The activation was requested by the Japan Aerospace Exploration Agency (JAXA). The Asian Institute of Technology (AIT) took over the Project Management.

Since 11 March 2011, the **Charter was activated seven times** (as of late August 2011) to mitigate the impact of flooding in Colombia, Japan, Namibia, USA; wildfires in Canada; landslides in Korea; and volcano eruptions in Chile. As of today, the Charter has responded to over 330 calls acquiring over 3000 images by around 20 different imaging satellites (over 30 activations in the period September, 2010-August 2011). Metadata related to these activations is available through the **Charter metadata catalog** at http://www.disasterschartercatalog.org. The catalog was released to provide a user-friendly interface for discovery and browsing of these metadata.

Following a GEO formal request, the Board of the **International Charter on Space and Major Disasters** unanimously endorsed the principle of “universal access” to the Charter by GEO Members. The Board then reviewed Charter access on a region-by-region basis and initiated a series of actions to ensure that non-Charter countries have a ready-means to access satellite data for disaster response. Initial focus was set on Africa and the Asia-Pacific region.

In particular, ESA visited several African countries to consolidate requirements. Thirteen meetings were held between 2009 and 2011 with the disaster-management authorities of the following countries: **Mali, Niger, Uganda, South Africa, Burkina Faso** (GEO Members) and **Ethiopia, Mozambique, Namibia, Zambia, Senegal, Democratic Republic of Congo, Tanzania, and Kenya** (non GEO Members). Most GEO principals participated in the formal meetings and were very supportive. In Kenya, this support was reinforced by the Regional Center for Mapping of Resources for Development (RCMRD). In South Africa, the Charter was also introduced to the Board of the European project Garnet-e. The countries considered showed strong interest in the Charter (although most national authorities were unaware of the Charter).
The gap analysis for “satellite Earth observation data supporting disaster managers” was reviewed on the occasion of the June 2011 CEOS Disaster Team meeting. As a follow-up, a case study will be initiated to compile satellite requirements for wide-area flooding management, building upon reports on global risk and vulnerabilities from CIESIN and the World Bank. The case study should focus on major areas affected by flooding such as Southern Africa, South-East Asia. Statistical data from the Sensor Web or the Charter would also be added.

**DI-09-01: Monitoring for Geohazards Risk Assessment**

The GEO Supersites initiative consolidated its critical role in providing rapid access to seismic information to scientists and end-users. A new Supersites website was launched in response to the 11 March earthquake in Japan that had about 4,500 visitors a day in the first two weeks following the quake. Focus was also set on three main natural laboratories: South-East Asia, Central America and the Caribbean. A white paper and strategic plan were drafted to pave the way for a global Supersites consortium of universities, research institutions, national agencies, and satellite-data providers. The latter would establish an operational global network and develop multi-sensor SAR planning and data access tools. The Global Earthquake Model was contributed to GEOSS – an initiative to calculate and communicate earthquake risk worldwide.

In response to the 11 March earthquake, offshore northern Japan, the Supersites initiative went into rapid action to collect Synthetic Aperture Radar (SAR) imagery (see below) as well as GPS and seismic data. As a result, the Tohoku-oki Supersite website had as many as 4,500 visitors a day in the first two weeks following the earthquake. During the month of March it served about 34,000 unique IP addresses, 6% of which were from Japan (see http://supersites.earthobservations.org/sendai.php).

The first GPS-measured ground displacement field produced by Japan (Geospatial Information Authority) was made available on the Supersite website on the very day of the earthquake. The Supersites website also provided an overview of ongoing research in the quake and related tsunami through links to relevant research institutions such as the Earthquake Research Institute (University of Tokyo) and the Japanese Space Agency’s Research and Application project.

*Interferogram from Japan ALOS-Palsar published through the GEO Tohoku-oki Supersite website. One color cycle represents 11.8 cm of motion in the radar line of sight (approximately east at 38 degrees from the vertical). Time spans of the interferometric pair is 2011/03/03 - 2011/04/18*
SAR imagery was also provided, granting access to images captured by European (Envisat and ERS-2), Japanese (ALOS-Palsar) and German (TerraSAR-X) satellites. ESA SAR satellites were tasked to perform systematic observations of Japan. Dissemination of this data was enabled by the ESA’s Virtual Archive, a cloud-based cyber-infrastructure that ensures rapid online access anywhere in the world. All the ESA SAR data acquired since 1991 were made freely available on-line through the GEO Supersites portal.

The Geohazards Supersites initiative was launched within GEO in 2009 to provide high-quality data to researchers and managers worldwide. Since 2009, the website has received about 17’000 visits from 120 countries. It now focuses on three main natural laboratories: (i) South-East Asia, coordinated by Indonesia (Institute of Technology Bandung, Volcanological Survey of Indonesia), Japan (Earthquake Research Institute at the University of Tokyo), and Philippines (Institute of Volcanology and Seismology), with the USA (USGS’s Volcano Disaster Assistance Program) and Singapore (Earth Observatory) as advisors; (ii) Central America, coordinated by the USA (University of Miami) in collaboration with the Latin American Volcanological Association (LAVA) and the World Organization of Volcano Observatories (WOVO); and (iii) the Caribbean (Hispaniola), coordinated by the United Nations Development Program (UNDP) and the USA (Purdue University, University of Miami).

ESA in partnership with EPOS (European Plate Observing System; http://www.epos-eu.org/) promoted a Supersites Initiative for Europe to improve coordination between satellite and in-situ Earth observations. A European Supersites Coordination Team was formed, with representatives from ESA, EPOS, British Geological Survey, German Research Centre for Geosciences (GFZ) Istituto Nazionale di Geofisica e Vulcanologia (INGV), Institut de Physique du Globe de Paris (IPGP), and the Swiss Federal Institute of Technology (ETHZ). The Team attempted to secure funding for the European Initiative through participation in European Commission and/or national project calls, also identifying a list of possible supersites in Europe.

CEOS set up a team of experts to stimulate the use and combination of Interferometric Synthetic Aperture Radar (InSAR) data and optical satellite data for measuring significant surface displacement when radar data loses coherence (e.g. during an earthquake).

Discussion on the establishment of a global Supersites consortium of universities, research institutions, national agencies, and satellite-data providers is advancing well, building upon national and regional initiatives such as the Supersites Initiative for Europe. A new version of the Supersites white paper is being prepared along with a Supersites strategic plan, whose first draft was circulated among interested parties early this year. The plan, issued for space and ground components separately, pursues the establishment of additional Supersites and new natural laboratories. The main aim is to establish an operational global network and to develop multi-sensor SAR planning and data access tools.

Italy (EUCENTRE) developed a “vulnerability and risk mapping” methodology for urban settlements based on the joint use of optical and radar data. The data were fed into a physical vulnerability model (SP-BELA) capable of estimating damage probability levels. A method was also developed relying on Very High Resolution (VHR) radar data for estimating the damage level aggregated at the size of a city block. Two case studies were completed for L’Aquila (Italy, 2009) and Port au Prince (Haiti, 2010), and two were initiated for Padang (Indonesia, 2009), and Guan Xian (China, 2008) where the main challenge remains access to reliable ground reference data.

The mapping product, provisionally termed BASeDaLe (Block-Aggregated Seismic Damage Level) was developed in the framework of the GMES SAFER project and in cooperation with the Italian Civil Protection Department. BASeDaLe was operationally validated by the German Aerospace Agency (DLR), scientifically validated by the European Joint Research Centre (JRC), and accepted for inclusion into the SAFER portfolio of Emergency Products. Cooperation with ESA was initiated to enlarge the set of usable satellite data in case of emergency, and to transfer the computationally-heavy procedure to a grid-computing system.
A ground survey in L'Aquila, Italy, in cooperation with the Italian Istituto Nazionale di Geofisica e Vulcanologia was organized in June 2011, with the participation of Japan (Chiba University). Access to the restricted Red Zone was allowed, and roughly one thousand geo-referenced pictures were taken, in order to collect damage evidence and build a better set of ground reference data.

The Global Earthquake Model initiative (GEM, www.globalquakemodel.org) was contributed to GEOSS. The initiative aims to establish uniform and open standards to calculate and communicate earthquake risk worldwide, by developing a global, state-of-the-art and dynamic earthquake risk model, together with the communities exposed to this risk.

**DI-09-02: Multi-Risk Management and Regional Applications**

Regional end-to-end applications continued to develop through major international initiatives such as the Caribbean Satellite Disaster Pilot and the Namibian Early Flood-Warning SensorWeb Pilot. The Pilots address the full cycle of disaster management (from mitigation to recovery) from an end-to-end approach (from data collection, to analysis, product generation and service delivery). A flood dashboard was developed and major results were obtained in the use of radar images for flood mapping, and access and use of satellite images. With regard to activities on multi-risk management, progress remained difficult to assess due to limited reporting.

Numerous countries and organizations jointly initiated projects to demonstrate data and service integration for regional end-to-end applications. These include Canada, France, Germany, Italy, Japan, Portugal, South Africa, USA, Cathalac (Water Center for the Humid Tropics of Latin America & the Caribbean), CEOS, UNOOSA, the World Bank and WMO. Moreover several space agencies including the Canadian Space Agency (CSA), the Italian Space Agency (ASI), NASA and ESA expressed interest in contributing data to ensure that near-real-time information is available on floods and landslides.

In this context, the GEO Caribbean Satellite Disaster Pilot continued to develop a coordinated, timely and needs-based approach to the utilization of Earth Observation data for disaster management. The scope was the full cycle of disaster management (from mitigation to warning, response and recovery) from an “end-to-end” approach (from data collection, to analysis, product generation and service delivery). Five projects were defined in close cooperation with National Partners: Barbados, British Virgin Islands, Grenada, Jamaica; and Saint-Lucia.

In 2011, the Pilot redefined the project activities along two related thrusts, in order to simplify the project structure and facilitate participation of local and national partners: 1) Near-real time warning and response (lead: USA (NASA), key partners: Canada (CSA) and Caribbean Institute for Meteorology and Hydrology); and 2) Risk mitigation and preparedness (lead: Canada (CSA)).

Discussions were launched with the UNDP “Enhancing Resilience to Reduce Vulnerability in the Caribbean” project. As a result, the Caribbean Institute for Meteorology and Hydrology (CIMH) agreed to provide the CSDP community with the web interface currently used for ground data collection and storage in the framework of the UNDP project. This will pave the way for a regional web portal that will provide access to both spatial and ground observed data.

The Caribbean Disaster Pilot was run for an initial period of two-years. Funding was on a best efforts basis and mostly supplied by satellite agencies, universities, disaster response agencies and meteorological agencies. The Pilot builds on feedbacks from end-users such as the Caribbean Disaster and Emergency Management Agency (CDEMA) and Caribbean Institute for Meteorology and Hydrology. CDEMA worked to define user requirements and assist in developing tools that address those requirements for the entire region. Activities were structured to allow demonstration across a number of variables including disaster phases, relative capacity development (some countries have significant GIS capacity, others little), and technologies. User requirements identified in DI-06-09 were critical to establishing a baseline for this work and setting activities in motion.
A Namibian sensor web was launched as an experimental/demonstration tool during the Namibian flood of January-April 2011. The **Namibian Early Flood-Warning Sensor-Web Pilot** aims to develop an operational flood management system for Southern African regions, and to provide flood and waterborne-disease forecasting tools for local decision-makers. Efforts consist in identifying and prototyping technology which enables the rapid gathering and dissemination of both space-based and ground-sensor data, and data products. The Namibian Pilot is an international partnership between the USA (NASA), UN-Spider, Namibia (Department of Hydrology), Canada (Space Agency), Ukraine (Space Research Institute), Germany (DLR), and others.

The User Interface of the Namibian Early Flood-Warning Sensor-Web Pilot

A **Flood Dashboard** was developed where key information could be readily accessed and made available to interested parties (see http://matsu.opencloudconsortium.org/namibiaflood). Major results were also obtained in the use of radar images for flood mapping, access and use of satellite images in hydrological models, and access to the International Charter on Space and major Disasters. As a result of the Pilot, the Namibian Government was able to issue flood warnings to local populations.

Progress on the “implementation of a multi-risk management approach” remained difficult to assess due to limited reporting.
DI-09-03: Warning Systems for Disasters

A prototype global early warning system for wildland fires was made fully operational online. 1-7 day forecasts of Fire Weather Index were produced and early warning products were enhanced using satellite data. Weather data from more than 400 weather stations were processed daily to produce fire weather and fire potential maps. A regional fire system for southern Africa started developing. Contact was established with the German Indonesian Tsunami Early Warning System (GITEWS) to reinforce tsunami activities.

The GEO wildfire team, led by GOFC/GOLD and UNISDR, continued to develop the Global Early Warning System for Wildland Fires. A prototype for the Early Warning System was made fully operational online (see http://www.fire.uni-freiburg.de/gwfews/forecast_ews.html). 1-7 day forecasts of global Fire Weather Index were produced using the US NCEP Global Forecast System and Canadian Forest Fire Danger Rating System. Early warning products were enhanced using satellite data such as global hotspots (indicating current fire activity and used for local calibration of fire ignition models) and land-cover data to interpret vegetation and fuels.

The “Global Fire Danger Forecast” web interface of the Global Early Warning System (EWS) for Wildland fires
The Global Early Warning System aims to provide targeted information from local to global scales and to integrate individual efforts in fire management and fire danger rating. The system was designed as a distributed and autonomous *network of systems* to (i) complement national fire danger rating systems where they exist, (ii) provide fire danger and early warning where national systems do not exist, and (iii) enhance warnings generated at the local community level. The architecture and concept of the System were presented at the 5th International Wildland Fire Conference (Sun City, South Africa, May 2011).

Canada, Russia, and Germany developed methodologies for gathering electronically daily fire-danger and large-fire occurrence data for large portions of northern Europe and the Commonwealth of Independent States (Eurasia). Weather data from more than 400 weather stations were processed daily to produce fire weather and fire potential maps using the Canadian Forest Fire Danger Rating System (CFFDRS). Maps were displayed by the Global Fire Monitoring Center (GFMC). The CFFDRS outputs are applicable to boreal forests with moderate to deep forest floor layers and, therefore, well suited for use across the Eurasian region (http://www.fire.uni-freiburg.de/fwf/eurasia1.htm).

South Africa (CSIR), via GOFC-GOLD SAfnet and UN Afri firenet, started developing a regional fire system for southern Africa (to include western Africa in the future). EC (JRC) started a summary document of fire danger rating systems around the world, and started a pilot study to produce a set of global fire danger/early warning products using the ECMWF forecast model. Discussions were initiated with the Comisión Nacional Forestal (CONAFOR) and the Comisión nacional para el conocimiento y uso de la biodiversidad (CONABIO) in Mexico to set up a regional wildfire system for Central and South America.

With regard to tsunami early warning, contact was established with Germany (GFZ, DLR) and the German Indonesian Tsunami Early Warning System (GITEWS). GITEWS, a project funded by the German Government for the reconstruction of the tsunami-prone region of the Indian Ocean, is coordinating efforts toward the establishment of a fully operational system based on dedicated in-situ platforms (seismometers, GPS stations, tide gauge, and buoys) and satellite data. The system was recently handed over to Indonesian Authorities and will serve as “national centre for risk assessment and early warning” in close coordination with IOC. Germany will continue to support operations, in particular through the education and training of the Indonesian warning-centre operators.
2.2 HEALTH

Health issues with Earth-observation needs include: airborne, marine, and water pollution; stratospheric ozone depletion; persistent organic pollutants; nutrition; and monitoring weather-related disease vectors. GEOSS will improve the flow of appropriate environmental data and health statistics to the health community, promoting a focus on prevention and contributing to continued improvements in human health worldwide.

GEOSS 10-Year Implementation Plan, Section 4.1.2

HE-09-01: Information Systems for Health

The GEOSS information system for health made progress through the contribution of two main projects: EPIDEFENDER (to collect epidemics data) and AdaptFVR (to produce forecasts of “zones at risk” for mosquitoes). Discussions were initiated to connect the WHO “Global Information Management System on Environmental Health” to GEOSS. New activities were developed through the Health Community of Practice on water-borne diseases and vector-borne and zoonotic diseases, both integrated in the current 2009-2011 Work Plan and future 2012-2015 Work Plan.

France (CNES, Institute for Space Medicine and Physiology) contributed tools and projects to the GEOSS information system for health. The first contribution was EPIDEFENDER, an open-source software for collecting epidemics data, made available in December 2010. The EPIDEFENDER software was developed and validated by the World Health Organization during the implementation of an epidemics data-collecting system for Georgia.

Another contribution was the AdaptFVR project to study the impacts of climate change on the emergence of Rift Valley Fever vectors in Senegal, and develop adaptation strategies for better management of pastoralism in the Sahel. The project provided health-users with information bulletins and forecasts of “zones at risk” for Rift Valley fever mosquitoes (see figure). Innovative risk-maps were produced using satellite imagery and then validated by local partners. Discussions with users were initiated, for instance with Directorates for Veterinary Services, to integrate this information into decision-making systems. The project is supported by the research program ´Management and Impacts of Climate Change´ (GICC) managed by France (Ministry of Ecology, MEEDDM).
A new point of contact from WHO was identified and discussions were initiated to connect the GIMS (Global Information Management System on Environmental Health) to GEOSS. GIMS is a comprehensive, wiki-style data management system that was launched at the OECD World Forum in 2009. It aims to enable data sharing with interested parties, and incrementally develop an early-warning system for water-borne diseases. The system would rely on a platform linking environmental determinants with socio-economic indicators (water access/quality) and health.

The Health and Environment Community of Practice continued to develop. New activities were included in the 2009-2011 Work Plan making the GEO Health Societal Benefit Area more comprehensive and holistic. A Community of Practice workshop was held (29-31 March 2011, Geneva, Switzerland, ca. 40 participants) to discuss existing projects and develop new proposals. New proposals mainly related to aeroallergens, emerging space applications, and environmental modelling (e.g. European FP7 project EO2HEAVEN – Earth Observation and ENVironmental modelling for the mitigation of HEAlth risks). In addition, the Community of Practice developed background papers for each of the new proposal and reported on progress to the whole GEO community during the Work Plan Symposium (4-6 May, Geneva, Switzerland).

HE-09-02: Monitoring and Prediction Systems for Health

Activities supporting the development of monitoring and prediction systems for Health made progress on a variety of fronts: An interoperable architecture started developing for global mercury observation and monitoring. AIRNow International extended its demonstrations of real-time air-quality information delivery to provinces in China, also exploring options for demonstrations in Brazil. A project was launched for estimating and forecasting influenza outbreaks based on environmental factors. International action was agreed to put widely-used pesticides on course for elimination by 2012. Despite progress, there is still room for bringing the weather, health and ecosystem communities closer, and sharing health-relevant observations (e.g. aerosols) in real-time.

Italy (CNR-IIA) launched the implementation of the Global Mercury Observation System (GMOS; www.GMOS.eu). The European FP7 project officially started on 1 November 2010 with a budget of 9 M€ over 5 years (2011-2015). Standard operating procedures (SOPs) were developed for monitoring mercury at ground-based sites. The GMOS Interoperable Architecture started developing along with the SDI (Spatial Data Infrastructure). The protocol for real-time data acquisition and quality assurance analysis from all sites was the first step during 2011. SOPs for ambient and marine measurement programs were established and all GMOS new ground based sites were made operational. First cruises were also performed in the Mediterranean Sea, the Atlantic and Indian Oceans.

GMOS involves 23 leading research institutions and universities worldwide. It builds upon existing mercury monitoring systems and atmospheric monitoring programs such as EMEP, AMNet, NADP, and MercNet; ground-based observation systems; oceanographic observation programs (including cruises over the Pacific Ocean, the Atlantic Ocean, and the Mediterranean and North/Baltic Seas); aircraft programs (including intercontinental flights in the upper-troposphere/lower-stratosphere). Eventually maps of mercury concentrations and deposition fluxes will be produced and GMOS data will be used to validate regional- and global-scale atmospheric mercury models.

The USA (Environmental Protection Agency) further developed AIRNow International. AIRNow International is a portable software system currently managing and delivering real-time air quality information to 300 US cities. It is largely open-source and distributed free-of-charge. AirNow was further demonstrated in China following the 2010 World Expo demonstration in Shanghai. A workshop was held in the Yangtze River Delta region (January 2011) that was well attended by all provinces in the region. A more technical follow-up training opportunity was planned for September 2011, in order to train Zhejiang and Jiangsu Province experts on AIRNow-International.
In addition, the USA (EPA) funded a scoping mission to Brazil to explore options for real-time data AIRNow International projects there. Meetings were tentatively scheduled in Brazil in Fall 2011. The USA (EPA) also worked with the European Environment Agency (EEA) on the development of the “Eye on Earth” database – providing US real-time data and web services that may eventually be included. Further collaboration is underway with EEA’s AirWatch, the European projects GMES-MACC and GEOMON, China’s AMFIC, and Mexico’s Instituto Nacional de Ecologia.

The Air Quality Community of Practice (http://geo-aq-cop.org/) focused on the “Networking of Air Quality Data Systems” over its last workshop in Croatia in August 2011. The 3-day workshop was attended by 26 participants, representing major air quality data hubs in Europe and the US. Commitments were made towards expanding the Air Quality Data Network; adding more datasets to the shared data pool; broadening the metadata support and linking the AQ Community Catalog to other catalogs.

The USA (NASA, NOAA) and France (CNES) initiated a project on Surveillance and Prediction of Seasonal Influenza and Early Detection of Pandemic Influenza. Preliminary capabilities were identified for estimating and forecasting influenza-cases on the basis of environmental factors (derived from satellite measurements and ground observations). Influenza databases started developing for certain regions or countries in Central America, building upon publicly-available data. Work was initiated to develop influenza models and decision-support tools with national public health organizations in Central America. Additional multilateral collaborations were pursued with public health organizations outside Central America. Workshops and training sessions for technology transfer were held in Central America.

In particular, the USA (NASA, CDC) held a Climate and Influenza Circulation Workshop in Guatemala in September 2011. The goal was to demonstrate to public health stakeholders in Central America (e.g. from Guatemala, Panama and El Salvador) how remote sensing data may be used for estimating influenza risks. First versions of working influenza models were developed. The USA (NASA, CDC), WHO, and national health agencies launched a study on the influence of climatic, meteorological and environmental factors on influenza circulation in Europe.

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Passive air samplers for Persistent Organic Pollutants (POPs)
Representatives from 127 governments agreed to add “endosulfan” – an off-patent organochlorine insecticide and acaricide – to the list of Persistent Organic Pollutants to be eliminated worldwide. The action puts the widely-used pesticide on course for elimination from the global market by 2012. Representatives met in Geneva in April 2011 at the 5th meeting of the Conference of the Parties (COP-5) to the Stockholm Convention on Persistent Organic Pollutants (POPs).

The Stockholm Convention is a 2004 global treaty to protect humans and the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release and storage. Monitoring activities help identify changes in POP levels over time and provide information on regional and global environmental transport. A revised “Global Monitoring Plan” guidance document was accepted by COP-5, including new sampling and analyzing methods and new POPs to be monitored in air, human milk and blood (and other media). The 5th round of UNEP/WHO milk survey was completed (and accepted by COP-5). A global review of the impacts of climate variation and change on POPs and related policy implications was produced (and also accepted to COP-5).

COP-5 agreed on a budget for the implementation of the Global Monitoring Plan for POPs, which is in its second phase of implementation (2010-2015). The budget supports the work of the Stockholm Convention Secretariat (US$ 530,000 plus human resources in 2011), and relies on contributions from partners such as RECETOX, the South-East Asia Monitoring Programme, UNEP DTIE/Chemicals Branch, WHO, and a GEF medium size project (2011-2012; US$ 700,000; started in July 2011).

Various POPs capacity building activities were organized and planned, including: (i) regional projects in Western and Eastern/Southern African countries, Latin America and the Caribbean, and the Pacific (to continue until September 2011), and (ii) the 7th Summer School of Environmental Chemistry and Ecotoxicology, organized in June-July 2011 by the Czech Republic.

The World Meteorological Organization (WMO) helped advance the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Two operational regional nodes were established: the Northern Africa/Middle East/Europe SDS-WAS node operated by Spain (AEMET/BCS) and the Asian node operated by China (CMA). Web-portals were developed for both nodes to share observations (remote sensing, ground-based) and model outputs (www.bsc.es/sds-was).

A WMO SDS-WAS/GESAMP (Group of Experts on Scientific Aspects of Marine Environmental Protection) Expert Workshop on “Modelling and Observing the Impacts of Dust Transport and Deposition on Marine Productivity” was held in March 2011. The SDS-WAS supported the MERIT project (HE-09-03) by conducting a study of dust occurrence over multi-decadal periods – investigating a potential link between dust storms and meningitis outbreaks.

HE-09-03: End to End Projects for Health

Meningitis prevention gradually made progress through targeted environmental monitoring. Efforts were aligned with WHO information needs for reactive and preventive vaccination. Research on the West Nile Virus helped establish links between ecosystems and disease transmission. Efforts to develop monitoring and early-warning systems for vector-borne diseases (e.g. malaria, dengue, Rift Valley fever) and water-borne diseases (e.g. cholera, leptospirosis) are underway through a number of international initiatives.

The Heath and Climate Foundation (HCF), the International Research Institute for Climate and Society (IRI) and ACMAD, in collaboration with WHO and research health communities, coordinated efforts around the development of Meningitis Environmental Risk Information Technologies (MERIT). The IRI Data Library Meningitis map-room was assembled (http://iridl.ldeo.columbia.edu), and the SERVIR/IRI Data Library was integrated in the WHO OpenHealth mapping tool. A data sharing strategy was discussed in order to effectively share the MERIT data and products.
Near real-time experimental monitoring was conducted of the environmental conditions and **epidemic situation at the regional/meningitis-belt level**. The localization and intensity of meningitis outbreaks was considered in parallel with **climate and environmental information** (e.g. sea surface temperature, humidity, wind convergence, and dust conditions). In an Ethiopian case-study, detailed proposals were developed to determine which factors (epidemiological, population-related or climate) were most influential.

A number of activities surrounding the MERIT project were launched (called “mini-MERIT groups”) and efforts were geared up to support the introduction of the new conjugate vaccine. In particular, the MERIT Steering Committee met twice in 2011 (in January in Geneva, Switzerland, and in May in New York, USA) to refocus MERIT activities in light of the deployment of the new conjugate vaccination. WHO issued a “Perspective on MERIT Research and Modelling Activities” to help MERIT align with WHO information needs for **reactive and preventive vaccination**. The next MERIT technical meeting is planned to be held in Geneva in November 2011.

The USA (NOAA) launched actions to develop an early-warning system for **reducing health risk from water-borne diseases**. Related actions included: (i) Developing a Global Initiative for an Integrated Cholera Early-Warning System; (ii) Mapping environmental factors affecting the distribution of Leptospirosis; (iii) Determining the impact of climate variability, climate change and extreme events on the vulnerability of water sanitation systems; and (iv) Assessing coastal-ecosystem health and impact on vibrios, harmful algal blooms, and contaminants.

The **Cholera Early-Warning System** initiative started by determining public-health needs, establishing a specific community with WHO, and planning an initial pilot in Bangladesh. A US pilot project was launched with the State Health Department, NASA, NOAA, FDA and the private sector to build on existing operational NASA forecasts for cholera in the Gulf of Mexico.

The WHO started a project on **leptospirosis**, which adopts a “MERIT approach” – bringing together a group of partners and starting with identifying public health needs. Urban outbreaks of leptospirosis linked to natural catastrophes were set as a priority. The team drafted a technical framework document summarizing the current situation and the first research tracks to explore. This will be the basis for discussions in the second workshop planned later in 2011. The project group will eventually agree on first recommendations for outbreak response and on main directions for operational research.

*Multispectral satellite image (Resourcesat) showing regions of high (blue dots) and low (green dots) malaria endemicity, in Tumkur, India*
With regard to coastal-ecosystem health and impact on vibrios, harmful algae blooms and contaminants, a community of public health, environmental and marine scientists was created to foster the use of Earth observations in reducing risks related to seafood and aquaculture.

The USA (NOAA) and France (CNES) took leadership in developing a requirement-based system for vector-borne disease monitoring. The system relies on the use of satellite and in situ data for monitoring environmental conditions conductive to the spread of vector-borne and zoonotic diseases such as malaria, dengue and Rift Valley fever. Studies were launched to explore (i) the relationship between rainfall and malaria in western India (see figure), and (ii) the potential of an irrigated-area vegetation index for predicting malaria 1-2 months in advance. A long-term study on the effects of climate change on malaria and dengue was started. Also a system for Climatic-Weather Alert for Dengue Prevention started developing in Brazil. Discussions were initiated to better relate the models and remote-sensing applications used in the different projects.

The USA (EPA) worked to develop decision-support tools linking aspects of ecosystems, biodiversity and human health. The USA (EPA) funded research on the role of anthropogenic stressors in the transmission of the West Nile Virus (WNV), a mosquito-transmitting disease causing human illness and sometimes death. As a result of this research, vector-control agencies started locating abandoned swimming pools and standing water sources, including storm and waste-water drainage infrastructure in high-risk communities. The research may also help alert healthcare providers to areas of higher West Nile virus incidence, thereby informing allocation of resources; see http://newsroom.ucla.edu/portal/ucla/west-nile-virus-more-prevalent-178717.aspx).

The US group on “Biodiversity, Landscape Change, and Human Health” also worked to connect researchers on tick- and mosquito-borne disease transmission with decision-makers in high-risk areas. The group encouraged land-use planning and landscape architecture communities to share disease prevention strategies at the household, community, and regional scales, and to put these into practice.
2.3 ENERGY

GEOSS outcomes in the energy area will support: environmentally responsible and equitable energy management; better matching of energy supply and demand; reduction of risks to energy infrastructure; more accurate inventories of greenhouse gases and pollutants; and a better understanding of renewable energy potential.

GEOSS 10-Year Implementation Plan, Section 4.1.3

EN-07-01: Management of Energy Sources

The SoDa Service released over 20 years of data on surface solar radiation (1985 to 2005) producing maps of high relevance for Africa, the Mediterranean Basin, and the Central Atlantic. SoDa combined national datasets to make over 200 parameters available at high-resolution globally. These can be downloaded in the form of plots, enabling non-specialists to easily view and manipulate data. A GEO initiative was launched to develop a Bioenergy Atlas of Africa. The goal is to allow policy-makers to visualize existing and potential bioenergy resources and improve local energy policies. Progress is slow however.

The SoDa Service, a major player in disseminating data and services on solar radiation, released the HelioClim-1 database containing 21 years of data on surface solar radiation (1985 to 2005, approx. 20 km spatial resolution, see http://www.soda-is.com/eng/services/services_radiation_free_eng.php). The database produced by France (MINES ParisTech) with funding from the European Union, use observations from geostationary meteorological satellites from Europe, Japan, and the USA to produce maps of surface solar radiation. These maps provide information for many applications (e.g. electricity production) and are of major interest to Africa, the Mediterranean Basin, and the Central Atlantic Ocean.

![Yearly average of daily sums of global horizontal irradiation](http://www.soda-is.com/eng/services/services_radiation_free_eng.php)
The SoDa Service combined HelioClim-1 with the Surface Meteorology and Solar Energy (SSE) database developed by the USA (NASA); a dataset derived from multiple space-based measurements, climatologies, and reanalyses. As a result, **200 parameters relating to solar-energy resource-assessment**, cloud cover, and meteorological conditions became available globally on a 1°x1° latitude/longitude grid for a 22-year period (1983-2006). These data became available in ASCII format and through graphical plots, enabling non-specialists to easily view and manipulate the data.

France (MINES ParisTech) initiated the development of an HelioClim-3 database covering Europe from 2004. HelioClim-3 is based on the advanced capabilities of the Météosat Second Generation satellites and the EUMETCAST program, and will result in much **enhanced spatial and temporal resolutions** of surface solar radiation data, products and services.


South Africa (CSIR) and the Regional Center for Mapping of Resources for Development (RCMRD) supported a GEO initiative towards developing a Bioenergy Atlas of Africa. The goal is to allow planners to **visualize existing and potential bioenergy resources**, and to determine which technologies are viable solutions at national or regional scales. The Bioenergy Atlas should enable policy-makers and other stakeholders to visualize which initiatives hold the greatest potential over time and what their potential effects may be on the continent’s sustainability. It should combine layers of data (land-use, hydrology, soils, demography, infrastructures, etc) with analysis tools.

A related GEO workshop was organized during the 8th Conference of the African Association of Remote Sensing of the Environment (AARSE, October 2010, Addis Ababa, Ethiopia). Aimed at experts in **energy planning**, remote sensing, geoinformatics, and related fields from Africa and abroad, the workshop sought to compile an inventory of on-going bioenergy initiatives in Africa and to draft a project plan for developing an atlas of bioenergy resources for the continent.

Recent publications on Energy include an article from ESA on “Sustainable development using Earth observations” focusing on **forestry, hydropower, and mining** (in Imaging Notes); and an article on “CEOS contributions to informing energy management and policy decision-making using space-based Earth observations” (in Applied Energy (2011), doi:10.1016/j.apenergy.2011.03.001).

Collaboration is underway within the Federation of Earth Science Information Partners (ESIP) to promote **access to Earth science data** and information relevant to energy management.
EN-07-02: Energy Environmental Impact Monitoring

EnerGEO moved into the implementation phase of wind, solar, biofuels and fossil-fuels pilot projects. Data inventories, software and environmental impact-models were developed. Norway established contacts with organizations involved in Carbon Capture and Sequestration (CCS) monitoring.

EnerGEO moved into the implementation phase of wind, solar, biofuels and fossil-fuels pilots. Extensive analyses and data inventories were conducted, and software and energy/environmental impact-models were developed. A first EnerGEO Summer School was organized on the theme “Energy Resources - Demand & supply and the impact on biodiversity and ecosystems” (Salzburg, Austria, 7-15 Sept 2011).

The GEOSS approach is considered by EnerGEO as the best way to integrate data from different Earth observation sensors and models, and also to make EnerGEO data and results available to the entire community through the GEO Portal. EnerGEO is now gearing up to achieve its first milestone: the 18-month evaluation and reporting event.

EnerGEO will deliver a prototype distributed-system compliant with GEO standards and architecture also enabling the collection of, and access to, data concerning the impact of energy use on the environment and ecosystems. The system will make it possible to plan energy strategies and quantify the environmental costs of energy exploitation (see http://www.energeo-project.eu/). Moreover, EnerGEO will develop tools for making a global assessment of the current and future impact of the exploitation of energy resources on the environment. The project – funded by the European Commission under the 7th Framework Programme (FP7) – will last for 4 years with final results expected by 2013.

Norway established contacts with organizations involved in Carbon Capture and Sequestration (CCS) monitoring, including ESA (ESRIN project led by SciSys Ltd, UK) and others applying InSAR and hyperspectral imagery to CCS monitoring. Discussions were initiated on the use of gravimetry for the monitoring of CO2 storage site.

The European Space Agency (ESA) conducted a pilot project with GDF SUEZ, Tractebel Engineering and Tractebel Energia, to explore how Earth observation-based indicators can help to assess the impact of large hydropower plants on the environment.

EN-07-03: Energy Policy Planning

A European project was launched to develop downstream services in renewable energy. A high-resolution solar atlas was released for the south-eastern part of France. Together with the 20-year Helioclim-1 database and the SoDA service, this represents valuable information for energy-policy and investment planning. The SoDA service ensures free and open access to surface solar radiation and will become part of the GEOSS DataCORE.

A European project for the development of downstream services in renewable energy was launched in the framework of the Global Monitoring for Environment and Security (GMES) in January 2011. The user-driven project (called ENDORSE) builds on GMES Core Services such as MACC, SAFER and Geoland 2. It addresses (i) energy sources such as the sun, wind and biomass; (ii) electricity grid management; and (iii) building engineering through daylighting in buildings. Users are part of the implementation team to ensure sustainable and transferable downstream services.

The European Renewable Energy Research Centres Agency (EUREC) submitted a request to become a GEO Participating Organization.
France (MINES ParisTech) produced and released a **regional solar atlas** for the **French region of Alpes Côte d'Azur** (http://www.atlas-solaire.org in French, soon to be available in English). The atlas features **200m resolution maps** (see figure) based on the integration of three datasets: (i) in-situ measurements (one full year), (ii) solar radiation data from the Helioclim-3 database (see EN-07-01), and (iii) relief data derived from the SRTM database. Maps also provide annual Global Horizontal Irradiation (GHI) values, accessible through a Web service at http://www.atlas-solaire.org/Web-Map-Service.

Together with the Helioclim-1 databases and the SoDA service (see EN-07-01), the regional solar atlas directly supports **energy policy-planning** through applications ranging from electricity production to climate studies. The SoDA service ensures free and open access to multiple surface solar radiation datasets and will become part of the GEOSS Data-CORE (see DA-06-01).
2.4 CLIMATE

The climate has impacts in each of the other eight Societal Benefit Areas. Coping with climate change and variability demands good scientific understanding based on sufficient and reliable observations. GEOSS outcomes will enhance the capacity to model, mitigate, and adapt to climate change and variability. Better understanding of the climate and its impacts on the Earth system, including its human and economic aspects, will contribute to improved climate prediction and facilitate sustainable development while avoiding dangerous perturbations to the climate system. 

GEOSS 10-Year Implementation Plan, Section 4.1.4

CL-06-01: A Climate Record for Assessing Variability and Change

Good progress continued on the extension of the climate record through reanalysis, reprocessing and reconstruction. New reanalysis data were produced using improved models and observations (in-situ and remotely-sensed). The global precipitation database (85,000 stations world-wide) was quality controlled to serve as a basis for a 20th century precipitation reanalysis (1901-2009). The new MACC project (Monitoring Atmospheric Composition and Climate) started producing reanalysis fields of atmospheric composition such as CO2 and CH4 for the period 2003-2010. The paleo-climate record of the past centuries was extended with new analyses of temperature and precipitation variability over South America.

Japan (JMA) progressed in the production of JRA-55 – the new Japanese reanalysis project covering the period 1958-2012. JRA-55 should be completed and released to the public by 2013. Early evaluation shows improvements on the known problems of the JRA-25 dataset, such as cold biases in the lower stratosphere, unnatural jumps in time series of mean temperature associated with changes of satellite, and a dry bias in the Amazon basin.

The GPCC (Global Precipitation Climatology Centre) received, processed and integrated monthly precipitation data from 190 countries. The database (in-situ observed precipitation at about 85,000 stations world-wide) is continuously expanding with improved spatial and temporal coverage. It is also intensively quality controlled in the context of the preparation of the new 2010 GPCC products: the Global monthly precipitation climatology and the Full Data Reanalysis Version 5 for the period 1901-2009.

The European Centre for Medium-Range Weather Forecasts (ECMWF) further progressed on ERA-Interim and ERA-CLIM. With respect to ERA-Interim, a production stream was run for the period 1979-1988 – the period for which there is comprehensive coverage of satellite data, and products produced by recent reanalyses. The data are available on the ECMWF Data Server (http://data-portal.ecmwf.int/). ECMWF reanalysis activities shifted focus towards the collection and preparation of input observations, boundary conditions, and atmospheric forcing data for a comprehensive atmospheric reanalysis of the entire 20th century: the ERA-CLIM project.

The MACC (Monitoring Atmospheric Composition and Climate) project was also launched to succeed the GEMS project (a short-period reanalysis of atmospheric composition coupled with meteorology covering the period 2003-2007). MACC extended the GEMS reanalysis into 2009, and initiated a second reanalysis covering the period 2003-2010 (see figure). This new reanalysis differs from the GEMS reanalysis in terms of assimilation of additional data on composition, use of new emission fields, improvements to the model and analysis schemes for composition, higher model resolution (now the same as ERA-Interim) and newer (2010) ECMWF meteorological components. Satellite data from various sensors are used to constrain CO2, CH4, O3, CO, NO2, and aerosol, while SO2 and HCHO are also carried as variables within the assimilating meteorological model. Many other chemical species are provided from a coupled chemical transport model.
The USA (NOAA) initiated the production of a new reanalysis dataset: the NCEP Climate Forecast System Reanalysis-Lite (CFSRL), which is a low resolution version of the Climate Forecast System Reanalysis and Reforecast (CFSRR). CFSRL is planned to be run in 2 stages, first 1979-2010, and then 1948-1978. CFSRL will serve as a replacement for the original NCEP/NCAR Reanalysis. CFSRL was originally proposed to resolve numerical issues in the deep ocean, the deep land, and the stratosphere. CFSRL will benefit from having MERRA, ERA-40 and ERA-Interim (ECMWF) for comparison and monitoring.

IGBP (Past Global Changes Project; PAGES) further extended the paleo-climate record. Analyses of temperature and precipitation variability were produced for South America over the past centuries. Results were published in two main articles: “Multi-centennial summer and winter precipitation variability in southern South America (Neukom, R. et al., 2010a, Geophysical Research Letters), and “Multiproxy summer and winter surface air temperature field reconstructions for southern South America covering the past centuries (Neukom, R. et al., 2010b, Climate Dynamics).
Additional results were published in the PAGES newsletter (http://www.pages-igbp.org/download/docs/NL2011-1_lowres.pdf), showing for instance that solar activity highs and lows coincide with the Medieval Climate Anomaly and the Little Ice Age, respectively. Regional PAGES workshops were held to examine paleo-climate change over the last 2000 years on all continents (Africa, Asia, Australia, North/South America and Antarctic Peninsula, Europe and the Mediterranean, and Arctic).

![China locations of proxy temperature series (five defined climate regions), and examples of the longest temperature series from four climate zones (from Quansheng Ge and Wenxiang Wu, PAGES news, March 2011)](image)

Two new PAGES Working Groups will be created to further support activities: One on “Sea Ice Proxies” to critically assess and compare proxies in order to make recommendations about their reliability and applicability in the Arctic and Antarctic; and one on “Solar Forcing” to bring together scientists from the solar physics, climate modeling, and palaeoclimate-reconstruction communities, and achieve closer collaboration.
CL-09-01: Environmental Information for Decision-making, Risk Management and Adaptation

Efforts to coordinate and develop climate services are underway. Research on monsoons and tropical cyclones is making progress, offering new prospects of reliable seasonal prediction. A NASA Giovanni System was completed, providing new data and visualization tools for tropical convection research. An African Climate Policy Centre was created in Ethiopia to address the policy component of the ClimDev Africa project. However, overall progress on ClimDev Africa is slow.

In support of the Earth-System Prediction initiative, WMO (WWRP-THORPEX) and WCRP coordinated the implementation of YOTC (the Year of coordinated observing, modeling and forecasting of organized tropical convection and its influences on predictability; http://www.ucar.edu/yotc). The USA (NASA) completed the development of a YOTC Giovanni System (YOTC-GS) to provide data and visualization for parameters relevant to the research and investigation of tropical convection (see figure and http://gdata2.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=YOTC).

Two beta Giovanni prototypes were released: “YOTC-GS L3” to explore Level 3 data products (e.g. MODIS Terra, Aqua AIRS, AMSR-E, TRMM), and “YOTC-GS L2” to explore Level 2 data products (e.g. TRMM, AIRS, Merged IR, QuikSCAT, AMSR-E). Currently, 14 parameters can be viewed as atmospheric profiles and 60 parameters can be viewed in satellite swath format.

Atmospheric model inter-comparison projects were launched to enhance seasonal predictability. YOTC includes the production of databases for operational seasonal forecasts and a strategy for coordination of polar prediction. YOTC databases are freely available to the community subject to minimal acknowledgement.
More than 100 scientists and graduate students met for the 1st YOTC International Science Symposium (16-19 May 2011 Beijing, China) to discuss progress and new directions in understanding, simulating and approximating the multiple scales and phenomena associated with tropical convection.

The three African partners of ClimDev Africa formally launched the ClimDev Africa Programme at the 7th African Development in Addis Ababa, Ethiopia in October 2010. However, a mechanism for submitting and approving project proposals has not yet been developed. The newly created African Climate Policy Centre (ACPC) in Addis Ababa, Ethiopia, will address the policy component of ClimDev Africa. It will also house the Secretariat for ClimDev Africa. A newly formed ClimDev Africa Programme Steering Committee will also form. The ClimDev Africa Programme represents a major opportunity to improve climate observations in Africa in the course of the next five to ten years.

**CL-09-02: Accelerating the Implementation of the Global Climate Observing System**

The 2010 update of the GCOS Implementation Plan identified 138 measurable actions to guide the implementation of GCOS on a 5-10 year timescale. An update of the Systematic Observation Requirements for the Satellite-based Products for Climate document was also drafted. A Progress Report was submitted to the UNFCCC on the 59 climate actions required to meet the needs of the GCOS Implementation Plan. CEOS created a new Working Group on Climate to coordinate and encourage collaborative activities in the area of climate monitoring.

The 2010 update of the GCOS Implementation Plan (in support of the UNFCCC) identified **138 measurable actions to guide the implementation of GCOS** on a 5-10 year timescale. Sustained support for the GCOS system components (WMO GOS/GAW, GOOS, GTOS, research networks) is critical for the success of GCOS. An update of the “Systematic Observation Requirements for the Satellite-based Products for Climate” document was also drafted by the GCOS Secretariat and a group of experts in January 2011. Final release of the document was planned for late 2011.

The GCOS/WCRP Observation and Assimilation Panel (WOAP) held, in collaboration with ESA, a workshop on the ‘Evaluation of Satellite-Related Global Climate Datasets’ (Frascati, Italy, 18-20 April 2011). The objective was to promote the inter-comparison of satellite and in-situ datasets suitable for climate studies and to assess a number of key climate datasets against the GCOS guidelines. Outcomes of the workshop include: (i) a framework for performing an inventory of all ECV datasets including indices of maturity and uncertainty; and (ii) a set of best practices for evaluating and inter-comparing global climate datasets.

With regard to key climate data from satellite systems, the Committee on Earth Observation Satellites (CEOS) sustained efforts to develop plans and respond to actions in accordance with the **needs of climate communities**. CEOS provided a 2010 Progress Report to the UNFCCC on the 59 climate actions developed in response to the needs expressed in the GCOS Implementation Plan. During the 24th CEOS Plenary (October 2010, Rio, Brazil), top priority activities were identified, including Forest Carbon Tracking, Global Monitoring of Greenhouse Gases from Space, Data Democracy, and Climate Change.

In particular, CEOS created a new Working Group on Climate (WGClimate) to coordinate and encourage collaborative activities between the world’s major space agencies in the area of climate monitoring. WGClimate will facilitate the development and exploitation of **Essential Climate Variable (ECV) time-series**. In particular, WGClimate will (i) conduct a CEOS agency meta-analysis to identify current capabilities for producing ECVs; (ii) build a link to the IPCC modeling community to facilitate inter-comparison of model outputs and data; and (iii) develop an ECV-by-ECV implementation strategy.
Efforts to coordinate carbon monitoring systems are underway under the auspice of the GEO Carbon Community of Practice. Integrated systems started developing web-portals and data providers started delivering high-quality satellite data for estimating regional CO2 and CH4 sources and sinks. A European project was approved in support of an operational global carbon observation and analysis system. With regard to forest carbon tracking, European and US projects were contributed to the GEO initiative. Satellite data acquisitions, in-situ measurements, and data processing continued for the National Demonstrator countries. Nepal joined as a new National Demonstrator. An Implementation Plan was developed for the Global Forest Observations Initiative (GFOI).

Efforts to coordinate carbon monitoring systems are underway under the auspice of the GEO Carbon Community of Practice (CCoP). The Europe-funded ICOS (Integrated Carbon Observing System) and COCOS (Coordination Action Carbon Observation System) started developing carbon web-portals following recommendations of the CCoP. Global carbon data was also shared among the community: The FLUXNET network released CO2 fluxes data (http://www.fluxnet.ornl.gov/fluxnet/index.cfm), and the TCCON (Total Carbon Column Observing Network) provided ground-based remote sensing measurements of CO2 and CH4 with high-accuracy and precision. The ground-based data are vital for the validation and calibration of satellite measurements and provides complementary information to the in-situ measurements.

A new project funded by the European Commission (GEOCARBON, 2011-2014, 6.5 mio €) will support the coordination and development of an operational global integrated carbon observation and analysis system. The project will start in late 2011 and build upon related projects worldwide. Main objectives include: (i) Provide harmonized global carbon data information (integrating the land, ocean, atmosphere and human dimension); (ii) Provide improved regional carbon budgets (including annual sources and sinks of CO2); and (iii) Strengthen the effectiveness of the European and global carbon community participation in the GEO system.

With regard to greenhouse-gas monitoring from space, a new project was launched by ESA (GHG-CCI: Green House Gases Climate Change Initiative; http://www.esa-ghg-cci.org/) to deliver high-quality satellite data for estimating regional CO2 and CH4 sources and sinks. The satellite data include column-averaged CO2 and CH4 retrieved from the SCIAMACHY (ENVISAT) and TANSO (GOSAT) instruments (see figure). Initial comparison between CO2 SCIAMACHY and TANSO products shows significant differences, leading to further algorithm development.
With regard to GOSAT retrieval and data analysis, next steps were planned in the framework of the “SWIR Carbon Observation Retrieval Model Inter-comparison Project” (SCORE-MIP, http://sites.google.com/site/scoremip/). Meetings were held to reinforce international collaboration: “The 7th International Workshop on Greenhouse Gas Observations from Space” (Edinburgh, UK, 16-18 May 2011, https://sites.google.com/site/iwggms7hq).

Forest Carbon Tracking (FCT) activities continued to grow under the co-leadership of Australia (CSIRO and Department of Climate Change), Japan (JAXA), Norway (NSC), Canada (CSA and Forest Service), USA (USGS, USDA/Forest Service), CEOS (ESA), and FAO. The USA (USGS, USDA/Forest Service) joined as a new co-lead and contributed the SilvaCarbon program – to build capacity worldwide to monitor and manage forest and terrestrial carbon, drawing on the expertise of the US scientific and technical community.

The European Commission consolidated its contribution through 4 new REDD-related FP7 projects (RECOVER, REDDAF, REDD-FLAME, REDDINESS), providing direct support to several FCT National Demonstrators. A European coordination meeting was held (Brussels in May 2011) to convene the 4 REDD project coordinators, all EC directorates involved and the GEO FCT Team. Other co-leads ensured continuity in their contributions so that activities were able to progress.

Nepal was included in June as a new National Demonstrator (ND), bringing the total number of National Demonstrators to 11 countries (Australia-Tasmania, Brazil, Cameroon, Colombia, Democratic Republic of Congo, Guyana, Indonesia-Borneo and -Sumatra, Mexico, Nepal, Peru and Tanzania). The Cameroon Minister for Environment and Protection of Nature renewed its commitment to the GEO FCT initiative. As requested by Cameroon, a comprehensive plan of FCT activities was initiated for the country.
Satellite data acquisitions, in-situ measurements, data processing, and product development continued in 2011 for the **National Demonstrator countries** (see figure). Coordinated satellite data acquisition started over Nepal in June and continued for the other countries according to the CEOS agencies decisions in May (CEOS Strategic Integration Team meeting), where the “GEO FCT 2011 Data Requirements for National Demonstrators for the Period May-December 2011” was approved.

The operations of the Advanced Land Observing Satellite (ALOS) were terminated by Japan (JAXA) on 23 April 2011 due to malfunctioning solar power generation. ALOS data play an important role in many application fields and in many GEO tasks, starting with Forest Carbon Tracking. Although new data will not be available, the huge ALOS archive is deemed to be of great importance for a number of applications. The good news is that the follow-on satellite is already being built and that JAXA is making its best to accelerate the development of **ALOS-2** (now only with PALSAR-2) in order to launch the satellite by the first half of 2013.

Three important Forest Carbon Tracking reviews took place in early February 2011: (i) the 1st National Demonstrator Summit, attended by all National Demonstrator representatives, to build closer links between country authorities & product development teams, and to plan FCT related activities in each country for 2011-2012; (ii) the 2nd Science Data Summit, to review progress on satellite product development, identify key remote-sensing science questions, and improve synergies and visibility of GEO-FCT within UNREDD - FAO and UNFCCC (see www.fao.org/forestry/fra/68164/en/); and (iii) the 4th Space Data Coordination, to review 2010 acquisitions and consolidate plans for 2011. The meeting was attended by commercial providers who confirmed, in general, their willingness to contribute to FCT demonstrations.

**FCT outreach** products were developed and displayed at the GEO-VII Plenary and Ministerial Summit Exhibition in Beijing, as well as at the Forest Day 4 Exhibition in Cancun, the latter in connection with the UNFCCC COP16.

A program of **training workshops** was designed for South America in the 2011-2012 timeframe. The first Workshop took place in Peru on 15-19 August, three more are planned to be held in US-Sioux Falls end of August, Mexico and Colombia in the October-November timeframe.

The FCT team met twice in April-May 2011 (back to back to the ISRSE34 in Sydney, Australia, and to the CEOS SIT meeting in Frascati, Italy) to review progress and consolidate plans for 2011. Following upon the GEO-VII Plenary request to conduct in 2011 a **Global Forest Observations Initiative** (GFOI) planning phase, an Implementation Plan was developed by a Planning Team (under the direction of a Task Force). The Plan will be presented to GEO-VIII Plenary for endorsement. The Plan was developed through close interaction between the Planning Team and the Task Force with the support of the GEO Secretariat.
2.5 WATER

Water-related issues addressed by GEOSS will include: precipitation; soil moisture; streamflow; lake and reservoir levels; snow cover; glaciers and ice; evaporation and transpiration; groundwater; and water quality and water use. GEOSS implementation will improve integrated water-resource management by bringing together observations, prediction, and decision-support systems and by creating better linkages to climate and other data. In situ networks and the automation of data collection will be consolidated, and the capacity to collect and use hydrological observations will be built where it is lacking.

*GEOSS 10-Year Implementation Plan, Section 4.1.5*

**WA-06-02: Droughts, Floods and Water Resource Management**

Progress continued in drought and flood management. The development of a prototype global drought monitoring portal was initiated, building upon existing North American, European, and African drought monitors. New data and services for assessing climate impacts on the quantity and quality of water were developed and made available through the GEO Portal. Flood forecasts for Europe became routinely available up to 10 days in advance. Consensus was reached on the use and definition of a precipitation index to characterize meteorological droughts. One issue of concern remains communication and the extent to which research results eventually guide policy-planning.

The USA (National Integrated Drought Information System; NIDIS) started developing a prototype Global Drought Monitoring web portal (GDMP; see figure). The GDMP will be made interoperable with GEOSS by utilizing Open Geospatial Consortium (OGC) Web Mapping Services (WMS). Other web services will also be used to exchange drought maps (and other information) among existing continental and regional drought monitoring efforts, including the North American Drought Monitor, the European Drought Observatory, and the Princeton University African Drought Monitor.
The Global Drought Monitoring Portal will be (i) partly a web-based, real-time, geographic information system; and (ii) partly a system of algorithms for reconstructing surface hydrologic conditions relative to a historical climatology (to rank water scarcity conditions relative to a common drought severity ranking standard). Additional components that will be added with time include a Global Drought Early Warning Framework, where early warning tools, standards and best practices will be contributed to the GDMP, and a Global Drought Impacts Monitor. Links have already been established with the Agricultural Community of Practice for collaboration on a global index for agricultural drought.

With regard to **drought monitoring and impact assessment**, recommendations were provided to the World Meteorological Organization (WMO) in January 2011 regarding specific characteristics for calculating the Standardized Precipitation Index (SPI). This follows a consensus reached among drought experts that the SPI should be used to characterize meteorological droughts by all National Meteorological and Hydrological Services around the world. The guidelines feed into the Global Drought Clearinghouse, established in late 2010, by producing consistent SPI values around the world that can be used for characterizing and comparing meteorological drought.

The ACQWA (Assessing Climate Impacts on the Quantity and quality of Water) project worked on improving statistical downscaling of Regional Climate Models (RCMs) in the Alpine region. A "smart" metadata catalogue of all data being used in the project was assembled (e.g. in-situ and remotely-sensed water data). All significant outputs in terms of data (climatology, hydrology, environment, socio-economics) were made available through the GEO Portal, including services developed to feed the ACQWA portal (currently under development, http://acqwa.grid.unep.ch/).

One issue of concern for ACQWA is the extent to which European projects outcomes eventually guide or influence policy. “There is an overwhelming feeling by numerous project scientists and coordinators that there is still a large gap between science and policy, and that this may be due to problems of communicating in an appropriate manner the key research results that would be of use to policy-relevant strategies” (ACQWA Newsletter).

The European Commission Joint-Research-Centre (JRC) further improved the European Flood Alert System (EFAS). **Flood forecasts became routinely available up to 10 days** in advance based on projections from both the German Weather Service (DWD) and ECMWF. JRC also pursued the development of a pan-African flood early warning system, using the same principles as for EFAS and making use of a pilot study of Eastern Africa.

In the context of the Hydrologic Ensemble Prediction Experiment (HEPEX; http://www.hepex.org/), the USA (NOAA) and the Netherlands (Deltares) initiated the development of a Community Hydrologic Prediction System (CHPS).

**WA-06-07: Capacity Building for Water Resource Management**

Efforts are underway to build capacity for water-resource management around the globe. Key regional initiatives include GEOSS in the Americas, and the African and Asian Water Cycle Coordination Initiatives. 17 African nations contributed to the implementation plan for the African Initiative. Initial demonstration projects on hydrological modeling were conducted for the Volta and Niger river basins. With more than 60 trans-boundary river basins in Africa, efficient water governance and cooperation remain a challenge.

As part of the “**GEOSS in the Americas**” initiative, the “CIEHLYC” program developed tools for applying remote-sensing data to water management and showing the value of Earth observation in the Latin and Caribbean Americas. A dynamic webpage was implemented, hosted by Peru (CONIDA), featuring a list of data services and projects for the region (http://watercycleforum.com/ciehlc/). A Latin American & Caribbean Water Cycle Capacity Building Workshop was planned for late November in Cartagena, Colombia. The objective is to enhance the use of Earth observations across North, Central, and South America, and the Caribbean. The workshop is oriented towards providing a
“hands-on” demonstration of near real-time data and services available through GEOSS, for both freshwater and ocean monitoring and management.

The Asian Water Cycle Initiative (AWCI) continued to (i) link prediction systems with decision-support tools; (ii) coordinate the needs of science researchers, space agencies and decisions makers; (iii) build human and institutional capacity for using global data sets for local purposes; and (iv) establish policies on data-sharing and common formats. A web-based data archiving and integration system was developed to upload, quality control, integrate, analyze, and archive Earth observation data from the 20 countries participating in the AWCI (see figure). All data products, information and standards were registered in the GEOSS Common Infrastructure.

![Status of the “Asian Water Cycle Initiative” archiving and integration system](image)

**The African Water Cycle Coordination Initiative** (AfWCCI) organized the 2nd GEOSS African Water Cycle Symposium (23-25 February 2011, Addis Ababa, Ethiopia). 70 participants from 23 countries, including 17 African nations, contributed to the implementation plan for the AfWCCI, including a white-paper analyzing the scope of “African needs for enhanced use of Earth observations in the realm of water management”. The white paper addressed issues such as data sharing, interoperability, and standards for water data and water quality.

In addition, Symposium participants drafted a summary paper on the AfWCCI for submission to the Rio+20 Regional Workshop for Africa (30 May–1 June 2011, Pretoria), in anticipation of full adoption at the Rio+20 Regional Conference slated for November 2011. Once the AfWCCI has been established, a “workbench” will be set whereby scientists and professionals can work together to elaborate and validate tools, and make them freely available for informed water-resource planning. The workbench, will implement pilot projects within specific transboundary basins as a first step towards improved cooperation and data sharing. With more than 60 trans-boundary river basins in Africa, efficient water resource governance and cooperation remain problematic. River systems represent major infrastructure, drinking water, and irrigation resources for the continent’s populations.

A GEO-UNESCO Joint Workshop on “Earth Observations and Capacity Development for IWRM (Integrated Water Resources Management) at River Basins in Africa” is being planned for January 2012 in Kenya. Representatives of 11 river basin authorities across Africa should participate to provide an overview of water resource issues. Space and development agencies should also participate. In addition, specific issues to be addressed under the GEO framework should be identified, such as current use of data in decision-making in the basin, and plans for sustainable development. Demonstration projects involving hydrological modeling of the Volta and Niger river basins using remotely-sensed and in-situ data were conducted by Japan (University of Tokyo).
Since the beginning of the TIGER II projects, ESA installed **16 Data Dissemination Systems in Africa** to support African partner institutions in accessing data (by-passing the sometimes challenging internet infrastructure in Africa). In parallel, on-the-job training was organized in Europe (funded by ESA and organized by Netherlands (ITC, University of Delft) and Portugal (University of Lisbon)) to allow over 30 African technicians to collaborate closely with European experts. Also within the context of TIGER, ESA and the World Bank launched a small demonstration project investigating how Earth observation technology may support Word Bank investments in the Zambezi river basin.

ESA is planning a new TIGER activity, “TIGER NET” (1.5 Mio Euro), that will focus on major trans-boundary basins in Africa. Canada (CSA) launched the SOAR-Africa initiative, a partnership for exploring the enhanced capabilities of RADARSAT-2 in the context of TIGER projects.

The IEEE selected a proposal for “Rainwater Harvesting in Africa” from among 16 proposed pilot projects as top candidate for **water discovery** implementation. Progress on this proposal was evaluated at the 2nd African Water Cycle Coordination Initiative Symposium (23-25 February 2011, Addis Ababa, Ethiopia).

**WA-08-01: Integrated Products for Water Resource Management and Research**

The International Soil Moisture Network contributed in-situ soil moisture measurements to the ESA SMOS calibration/validation campaign. Measurements from GRACE satellites were used to quantify underground water-storage – a key development towards detecting water-cycle acceleration under a warming climate. Activities of the Integrated Global Water-Cycle Community of Practice continued to (i) engage hundreds of people in discussions about GEO; (ii) bring research funds to advance issues/products of interest to GEO; and (iii) lead to the registration of numerous products and services in the GEOSS Common Infrastructure. However support for GEO water activities in universities and research institutes independent from GEO Member agencies often remain precarious.

The International Soil Moisture Network (ISMN, http://www.ipf.tuwien.ac.at/insitu/) contributed to the ESA SMOS CAL/VAL campaign as the sole in-situ soil moisture measurements database. Long term continuation for the ISMN is top priority and an institutional host for the ISMN is being sought. ISMN is currently operated by the Technical University of Vienna through ESA funding in the framework of the SMOS (Soil Moisture Ocean Salinity) Project. The identification of candidate soil moisture networks and establishment of institutional data collection are ongoing though the Global Terrestrial Network – Hydrology (GTN-H).

The USA (NASA Energy and Water-cycle Study) developed a new approach to the quantification of underground water-storage. This approach based on measurements from the GRACE satellites contrasts with traditional methods based on flux-based estimates. This is a key development towards **detecting water cycle acceleration under a warming climate**. Work also advanced on the Global Groundwater Monitoring Network (GGMN), spearheaded by the International Groundwater Resource Assessment Centre (IGRAC), a GTN-H network partner. IGRAC refined a number of tools for global groundwater assessment, such as the Global Groundwater Information System (GGIS) (http://www.igrac.nl/).

New (quasi-)global long-record precipitation datasets were produced and made available online, including the National Climate Prediction Center Morphing Technique (CMORPH) datasets (2003-present); the National Climate Data Center (NCDC) 20th Century Reanalysis Project (Version 2, 1871-present); the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS) monthly and twice-daily datasets (1987-2005); and the University of Maryland Cooperative Institute of Climate Studies (CICS) Oceanic Precipitation Reconstruction (1900-2006).

Moreover, all US (NASA) TRMM precipitation datasets were upgraded to Version 7, with uniformly processed data available from the start of TRMM (late 1997) to the present. The TRMM Multi-satellite Precipitation Analysis products are in process. The GPCP (Global Precipitation Climatology Project)
monthly precipitation datasets were upgraded to Version 2.2 and extended to the present (see figure), delayed by about two months for processing. The companion GPCP One-Degree Daily datasets are in process.

1979-2010 precipitation average from GPCP (Global Precipitation Climatology Project) Now at version 2.2 extended through December 2010

The Global Runoff Data Centre (GRDC) continued to provide updated time series of daily and/or monthly river discharge data from more than 7800 stations across 157 countries, comprising around 310,000 station-years with an average time series length of about 40 years. The GRDC maintains project-related services including the provision of an information infrastructure called European Terrestrial Network for River Discharge (ETN-R), for the automated collection, quality control and redistribution of near real-time river discharge and water level data from 30 European national and trans-boundary river basins in support of the European Flood Alert System (EFAS).

A GRDC reference dataset was assembled that can serve as input into Global Climate Models and together with the data providers a network of climate sensitive stations with minimal anthropogenic impact started developing. The interoperability of hydrological observing systems is crucial to provide global hydrological monitoring including water levels and discharge. Therefore the GRDC is engaged with the Open Geospatial Consortium to work towards the definition of standards and protocols for hydrological observation networks.

A CEOS (JAXA) water-cycle portal was opened for evaluation (http://waterportal.restec.or.jp). The portal builds on the Coordinated Energy and water cycle Observations Project (CEOP) and the Data Integration and Analysis System (DIAS). CEOP set up common archive centers at the US National Center for Atmospheric Research (NCAR), the World Data Center Climate (WDCC), and the German Max Planck Institute (MPI). Interoperability arrangements were made to allow for a well-organized approach to collecting, processing, storing, and disseminating shared data and metadata.

The Integrated Global Water Cycle (IGWCO) Community of Practice reviewed all GEO Water activities and explored possible linkages with Agriculture, Energy, Disasters and Health activities. A 16-page brochure entitled “Introduction to the IGWCO Community of Practice” was developed for distribution at the GEO Plenary, providing detailed information on all IGWCO activities and strategy (http://www.earthobservations.org/documents/igwco/2010_igwco_brochure.pdf). Overall, activities of the IGCWO have (i) engaged hundreds of people in discussions about GEO; (ii) brought research funds to advance issues/products of interest to GEO; and (iii) led to the registration of over 240 resources (products and services) in the GEOSS Common Infrastructure.
2.6 WEATHER

The weather observations encompassed by GEOSS are based on the requirements for timely short- and medium-term forecasts. GEOSS can help fill critical gaps in the observation of, for example, wind and humidity profiles, precipitation, and data collection over ocean areas; extend the use of dynamic sampling methods globally; improve the initialization of forecasts; and increase the capacity in developing countries to deliver essential observations and use forecast products. Every country will have the severe-weather-event information needed to mitigate loss of life and reduce property damage. Access to weather data for the other Societal Benefit Areas will be facilitated.

GEOSS 10-Year Implementation Plan, Section 4.1.6

WE-06-03: TIGGE and the Development of a Global Interactive Forecast System for Weather

Global weather forecasts from numerical centers around the world are available through the TIGGE database in standard format with minimum time delay. Action is ongoing to ensure the TIGGE archive is documented using meta-data information and that any missing fields are reinstated. The database currently archives over 500 global predictions per day from 10 global weather forecasting centres. TIGGE has over 750 user-institutions registered worldwide. The Global Interactive Forecasting System (GIFS) for improved high-impact weather prediction is making progress. Prototype forecasting products for tropical cyclones, heavy rainfall, and strong winds, have been developed using numerical prediction data from TIGGE, and the products will be evaluated in conjunction with regional forecast demonstration projects. A new European project was launched to support this activity (GEOWOW Weather component).

The WMO World Weather Research Programme (WWRP) further developed TIGGE (THORPEX Interactive Grand Global Ensemble) – a standardized, user-friendly database of ensemble weather forecasts for improved predictions of high-impact weather events on the one-day to two-week timescale. Actions were undertaken to improve documentation of the data set by updating metadata information and enhancing the information available on the TIGGE project website (http://tigge.ecmwf.int). Efforts have also been made to deliver missing data fields to minimize gaps in the archive record.

The database currently archives over 500 global predictions per day from 10 global weather forecasting centres (Australia (BOM), Brazil (CPTEC), Canada (CMC), China (CMA), France (MétéoFrance), Japan (JMA), Korea (KMA), UK (UKMO), USA (NCEP) and ECMWF). The 3 archiving centres are ECMWF, China (CMA), and USA (NCAR). The ensemble predictions are available with a 48-hour delay for research purposes via web portals hosted by NCAR (USA), ECMWF (Europe) and CMA (China). Over the past year, several of the data providers have made improvements to their ensemble prediction systems, including enhanced resolution and improved representation of uncertainty in forecast initial conditions and better representation of the effect of model error on forecast uncertainties. The archive centres are being enhanced, notably with the introduction of a model validation portal at NCAR.

TIGGE has over 750 user-institutions registered worldwide. Promotion of the TIGGE database is underway in the realms of ecosystem management, water-resource engineering, early warning, hazards and associated impact research.

The next step for TIGGE is to become part of a Global Interactive Forecasting System (GIFS). This includes the development and evaluation of prototype products for tropical cyclone prediction. These products will focus on improving prediction of tropical cyclone track, and landfall. GIFS is developing prototype products to improve warnings of heavy rainfall, strong wind and other events of
high priority related for instance to food security. The benefits of the GIFS products will be evaluated in specific regions in conjunction with the WMO/CBS Severe Weather Forecast Demonstration Project (SWFDP).

Occurrence probability of extreme 24-hr precipitation
Valid: 2011012912UTC +4–5days

Prototype heavy-rainfall product based on TIGGE ensemble forecasts. The four panels on the right show the forecast probabilities of heavy rainfall based on predictions from 4 global Numerical Weather Prediction centres. The area of heavy rain in North-East Australia is associated with the tropical cyclone Yasi (courtesy of Mio Matsueda, JAMSTEC, Japan)

Significant new funding is required for the successful demonstration of GIFS services in conjunction with the SWFDP and related regional pilot projects. The European FP7 GEOWOW project started in September 2011. The weather component of GEOWOW will provide some funding support for the development and evaluation of GIFS, and for the enhancement of the TIGGE data portal. The project will also ensure that the TIGGE data are available through the GEOSS Common Infrastructure.

WE-09-01: Capacity Building for High-Impact Weather Prediction

A roadmap was developed for the establishment of flood forecasting and warning systems in the Philippines. Two major projects progressed in Africa: (i) Regional Climate Framework in Eastern Africa; and (ii) Weather and Climate Impact on Community Health and Public Health Services. A Memorandum of Understanding was signed by Korea and the Intergovernmental Authority on Development Climate Prediction and Applications Centre to enhance east African countries’ ability to adapt to climate variability and change. Funding support is required to further implement THORPEX Africa activities and enhance the capacity of African weather research and operational communities.
The Korean Metrological Administration (KMA) strengthened efforts to develop Numerical Weather Prediction (NWP) infrastructure in Asia. A roadmap was developed for the establishment of **flood forecasting and warning systems in the Philippines**. A project was launched under the auspice of KOICA (Korea International Cooperation Agency) to establish an Early Warning and Response System for Disaster Mitigation in Metro Manila (Pasig-Marikina River Basin).

Two KOICA projects also progressed in Africa with the support of WMO: (i) Regional Climate Framework in Eastern Africa to Support Adaptation to Climate Change; and (ii) Weather and Climate Impact on Community Health and Public Health Services. These projects aim to advance the economic and social development of the countries concerned by supporting the establishment of (i) robust climate information services; (ii) national and regional weather and climate monitoring systems; and (iii) weather forecasting and assistance to the agriculture, health and other economic sectors. KMA signed a Memorandum of Understanding with the Intergovernmental Authority on Development Climate Prediction and Applications Centre (ICPAC) to **support east African countries in adapting to climate variability and change**.

KMA conducted a series of **training courses** and workshops to build capacity and capability for Numerical Weather Prediction (NWP) in Asian and African developing countries. KMA also planned a 2011 training event for women scientists and a forum on climate change for Africa using KOAFEC fund. KMA and KOICA (Korea International Cooperation Agency) identified financial and human resources to work with WMO and major NWP centers.

Under the framework of TIGGE (WE-06-3) and THORPEX-Africa, the intention is to provide improved forecasts and applications designed to address severe weather prediction in Africa. A workshop should be organized in Africa during 2012 to specify prototype products and set up arrangements for assessment and evaluation. **Support is requested from GEO** to help secure the additional resources required to implement this programme of work.
2.7 ECOSYSTEMS

Observations are needed on the area, condition, and natural-resource stock levels of ecosystems such as forests, rangelands, and oceans. GEOSS implementation will seek to ensure that methodologies and observations are available on a global basis to detect and predict changes in ecosystem condition and to define resource potentials and limits. Ecosystem observations will be better harmonized and shared, spatial and topical gaps will be filled, and in situ data will be better integrated with space-based observations. Continuity of observations for monitoring wild fisheries, the carbon and nitrogen cycles, canopy properties, ocean colour, and temperature will be set in place.

GEOSS 10-Year Implementation Plan, Section 4.1.7

EC-09-01: Ecosystem Observation and Monitoring Network (GEO EcoNet)

Global standardized ecosystem mapping made progress for Central America, China, Europe, Australia, and Indonesia. An online tool for non-specialists was created to provide easy access to satellite images for all protected areas over 10 km². Two key products were developed for forest mapping and change monitoring. The status of the seven ChloroGIN regional nodes was reviewed for expansion. An international initiative was launched for a Global Urban Observation and Analysis System. However linkages with GEOBON should be reinforced and an overarching cooperation among ecosystem monitoring networks should be developed. Efforts were made in the framework of the new 2012-2015 Work Plan development to address these issues.

The US Geological Survey (USGS) made further progress on global ecosystem mapping (see figure):

Status of GEO global terrestrial ecosystem mapping activities

The USA (USGS) made further progress on global ecosystem mapping: Mapping was completed for the conterminous United States, South America and the sub-Saharan Africa region. Mapping was initiated for Central America, China, Europe, Indonesia, and Australia (over 50% complete). The GEOSS Australia ecosystems mapping effort developed most requisite input datalayers (isobioclimates, biogeographic regions, geology), and progressed on the landforms layer derived from the 30m SRTM Digital Elevation Model (DEM). Discussions also proceeded on the development of a national ecosystems classification derived from aggregated NVIS (National Vegetation Information System) units. For Indonesia, a new 90m landforms datalayer was derived from the 30m SRTM DEM. Isobioclimates mapping also commenced.
Mapping data were made available through a Rapid Data Distribution System (RDDS) on a USGS server (http://rmgsc.cr.usgs.gov/ecosystems/). The overall objective is to develop a standardized, robust and practical classification and map of global ecosystems for terrestrial, marine, and freshwater environments. The resulting map(s) can serve as a framework for a wide range of studies and applications.

In support of Protected-areas Assessment and Monitoring, UNEP (WCMC) worked on a collaborative project to upgrade a protected-area online tool for non specialists. The user-friendly tool allows to measure change in and around protected areas. The project relies on citizen science to look at land-cover change and uses updated data from the World Database of Protected Areas (WDPA) (www.wdpa.org). WCMC created a readily accessible global database providing (i) time-series of geo-referenced satellite images for all protected areas over 10 sq km; and (ii) assessments of protected-area management effectiveness and change.

The FAO coordinated efforts of partners, including the EC (Joint Research Centre) with input from over 120 countries, to get the most comprehensive and detailed assessment of loss and gain in world’s forests done so far. The objective is to obtain a globally consistent detection of forest cover and estimates of changes in forest area over time. Two key products are being developed: 1) global & regional change in forest area; and 2) a global tree-cover map based on MODIS Vegetation Continuous Field (VCF) analysis at 250 m resolution. New results will be released in late 2011 and 2012.

For the change in forest area, nearly 14,000 samples of Landsat imagery from 1990, 2000, and 2005 were analyzed to detect changes in forested area at 25m resolution which is the most detailed level ever done for such a large global assessment. There is online data portal access to Landsat imagery and auxiliary information (http://www.fao.org/forestry/fraremotesensing/en/). The project processed satellite imagery into draft Land-cover data, making it easier for countries to access and use. The project engaged more than 120 national experts through 16 workshop in the past 2 years. Sample locations were shared with GEO Forest Carbon Tracking activities to enable technical cooperation and encourage consistency.
The ChloroGIN (Chlorophyll Global Integrated Network) enhanced access to near-real time and archived measurements of ocean-colour and sea-surface temperature for South America, Africa and the Indian Ocean. ChloroGIN regional nodes include ChloroGIN-Europe, ChloroGIN-Indian Ocean, ChloroGIN-Antares, ChloroGIN-Africa, ChloroGIN-Canada, ChloroGIN-SE Asia and ChloroGIN-NE Asia (as well as Global ChloroGIN). The status of the seven ChloroGIN nodes was reviewed over the ChloroGIN plenary meeting (Halifax, Canada, 9-11 August 2011).

The expansion of the ChloroGIN network to new countries (such as the Philippines) and other regions of the globe was discussed. Proposed ChloroGIN lakes initiative, related GEO/GOOS initiatives and relevant ESA initiatives were also discussed. The group also considered: i) Development of Southeast Asia node; ii) Further development of ChloroGIN Africa; iii) Future development of Antares; iv) Improving in situ data availability and sharing; v) How to improve the ChloroGIN website.

A Handbook of Satellite Remote Sensing Image Interpretation (293 pages) was published featuring many case studies (see IOCCG Report Series). A new international Secretariat for the ChloroGIN activities was established to facilitate execution of the activities. Development of a new website is underway, which will build on the new Fisheries Applications of Remotely Sensed Ocean Colour (FARO) initiative and serve to integrate the SAFARI (Task AG-06-02) and ChoroGIN websites, without removing their separate identities.

New activities started developing on urban ecosystems. Activities seek to fill gaps in the integration of data required to characterize urban ecosystems (such as built environment, air quality and carbon emissions) with indicators of population density, environmental quality, and quality of life. An international initiative was launched for a Global Urban Observation and Analysis System. The initiative should help coordinate global coverage and data accuracy of urban observing systems through integrating satellite data of different sources, resolutions, and sensors with in situ field measurements. It should further contribute to topics such as urban transformations, energy consumption and efficiency, and the water cycle. Partners include the USA (Indiana State University), China, and Germany (DLR).

EC-09-02: Ecosystem Vulnerability to Global Change

An observation and assessment system was designed to improve environmental management in the Black Sea region. Data gaps were filled through new contributions from Russia and Turkey. A new system started developing to collect and distribute information in mountain areas and improve resource management in local mountain communities. The system is supported by a high-altitude observing network operational in Europe, Asia, and Africa. A 3-year programme was launched to assess the impact of climate change on tourism development in the Mediterranean region. New activities started developing on Arctic ecosystems. No activities were reported on the impact of transport infrastructure on ecosystems.

The EC, Switzerland (University of Geneva) and UNEP coordinated efforts to develop a Black Sea basin observation and assessment system – EnviroGRIDS (gridded management system for environmental sustainability and vulnerability; see www.envirogrids.net). Environmental datasets covering the Black Sea catchment area were registered in the GEOSS Common Infrastructure through an EnviroGRIDS component and different types of web services. A data gap analysis was conducted, showing a lack of access to data in Turkey and Russia. New partners from these countries joined the consortium in 2011 to fill these gaps.

A first policy brief covering GEOSS, GMES and INSPIRE was published and two baseline reports were finalised: one on “data availability and quality for hydrological simulation” and one on “grid services supporting massive data management”. A series of hands-on workshops (“Bringing GEOSS Services to Practice”) was conducted in Romania and Georgia, and others were organized in 2011 around the Black Sea. EnviroGRIDS targeted the needs of the Black Sea Commission (BSC) and the
International Commission for the Protection of the Danube River (ICPDR) to help bridge the gap between science and policy.

Italy (Ev-K2-CNR) and WCRP (CEOP-HE) further developed an international **mountain climate and environment monitoring network**, starting with the existing SHARE (Stations at High Altitude for Research on the Environment) network that aims to provide high-quality, reliable, long-term data to the scientific community and decision-makers. The SHARE network is already **operational in Europe, Asia, and Africa** (with extension to South America as the next step), and supports the ongoing monitoring of glaciers in the Himalaya to understand the complex relationship between climate and debris-covered glaciers, and the glaciers’ response to climate change. Some SHARE stations provide data and products through individual websites (e.g. http://www.isac.cnr.it/cimone/, http://evk2.isac.cnr.it/realtime.html). These are not yet registered into the GEOSS Common Infrastructure, however efforts are underway.

A SHARE Information System started developing (in collaboration with UNEP Vienna) to collect and distribute available information in mountain areas and improve capabilities in **mountain natural-resources management**. The network is involving **local populations** in technical activities, including training 8 technicians in Nepal, 3 in Pakistan and 2 in Uganda. A SHARE website (http://www.share.ev2.cnrs.org) was launched to provide information on the SHARE operational structure, monitoring stations, pilot sub-projects and relevant scientific publications.

Greece (National Observatory of Athens) started implementing a 3-year research programme called **XENIOS - Climate Change Impacts on the Touristic Development of Sensitive Areas**. The main goal is the observation and understanding of the environment and microclimate in areas where rapid tourism development is expected. Climate-change related processes are being investigated and the reduction of environmental impact as a result of innovative-bioclimatic construction is being assessed. Activities are focused on the Messinia area – a region of integrated tourism.

New activities started developing on **Arctic ecosystems**. The Arctic monitoring activity (proposed by Canada) will engage users and northern communities involved in Arctic ecosystems stewardship. It will focus on the use of Earth observation technologies for the monitoring of land, coastal and marine ecosystems towards the definition of ecosystem services and benefits.
2.8 AGRICULTURE

Issues addressed by GEOSS will include: crop production; livestock, aquaculture and fishery statistics; food security and drought projections; nutrient balances; farming systems; land use and land-cover change; and changes in the extent and severity of land degradation and desertification. GEOSS implementation will address the continuity of critical data, such as high-resolution observation data from satellites. A truly global mapping and information service, integrating spatially explicit socio-economic data with agricultural, forest, and aquaculture data will be feasible, with applications in poverty and food monitoring, international planning, and sustainable development.

GEOSS 10-Year Implementation Plan, Section 4.1.8

AG-06-02: Data Utilization in Fisheries and Aquaculture

Activities were undertaken to accelerate the integration of Earth observation into fisheries research and management. A two-year project started establishing connections with ongoing ecosystems projects (such as ChloroGIN) to optimize results. Activities require institutional support from operational organizations to ensure an effective transition from research to operation.

Canada (CSA, Bedford Institute of Oceanography) and the USA (NOAA) further led the implementation of the SAFARI project (Societal Applications in Fisheries and Aquaculture using Remote Sensing). SAFARI aims to build capacity at research-level and operational-level, and facilitate the application of rapidly-evolving satellite technology to fishery management. Details of progress are available on the SAFARI website (http://www.geosafari.org/index.html). Outreach material was prepared including a Handbook of Satellite Remote Sensing Image Interpretation (with many case studies, 293 pages). Work also began on a multi-authored textbook on remote sensing in biological oceanography.

A national workshop was organized with scientists, policy-makers and stakeholders (5-6 January, 2011, Toronto, Canada) to address some of the obstacles that lie in the way of the operational use of satellite data, and suggest actions that could facilitate its broader application (see workshop recommendations at http://www.geosafari.org/documents/Recommendations.pdf). The SAFARI team started planning for the second international symposium on remote sensing and fisheries (provisional venue, Mar del Plata, Argentina).

The SAFARI team worked as advisory group member within Task US-09-01a to identify Earth observations priorities in fishery and aquaculture. The draft report is now available online (http://sbageotask.larc.nasa.gov/). In addition, a full proposal was submitted to the GEO Call for Proposals, making synergies with (i) AR-09-02a (Virtual Constellation on Ocean Colour Radiometry), and (ii) EC-09-01c (ChloroGIN).

The FARO (Fisheries Applications in Remotely-sensed Ocean colour) programme, funded by Canada, continued to develop SAFARI and support the related ChloroGIN (Chlorophyll Global Integrated Network) project. Outputs of the project relate to marine ecosystems and ocean biogeochemistry for near-surface global ocean and coastal waters. A secretariat is operational at the Bedford Institute of Oceanography (Canada) to support the coordination of FARO/SAFARI and ChloroGIN activities.

Cross-linkages between SAFARI and ChloroGIN include the: (i) establishment and development of in-situ time-series stations in Latin American and Indian Ocean waters; (ii) global set of synoptic, calibrated, consistent satellite data in coastal waters of developing countries; (iii) extension of ChloroGIN to lakes; (iv) training course in India and in Africa; and (v) development of low-cost bio-optical instrumentation for the ChloroGIN Network. Further linkages will be established with WA-08-01g (Global Water Quality Monitoring) and CB-09-03d (Building Capacity for Operational Oceanography) activities in the framework of the new 2012-2015 Work Plan.
AG-07-03: Global Agricultural Monitoring

The GEO Agricultural Monitoring Community of Practice, in partnership with R&D stakeholders and key institutions, responded to a request from the French Presidency of the G20 to develop a proposal for improved crop monitoring and reduced price volatility over the world. Two new pilot sites were identified by Brazil in support of the Joint Experiment on Crop Assessment and Monitoring (GEO-JECAM), complementing seven existing sites in Argentina, Canada, China, Europe and Mexico. Related satellite and in-situ data acquisition was initiated through CEOS. Training on crop monitoring in Africa was initiated. However, strong support is still required from GEO Members and Participating Organizations for a mainstream development of crop monitoring systems in developing countries.


Prior to the June Ministerial Meeting, the GEO GLAM technical proposal was discussed in a preparatory meeting of the deputies of the G20 (May 11, Paris, France). Following the Meeting, a more detailed proposal including programme and budget will be developed by the Community of Practice and partners to be submitted to the G20 Plenary in Paris in November 2011.

In addition to this new initiative, the Global Agricultural Monitoring (GLAM) Community of Practice progressed on the implementation of two near-term projects (5 years): The GEO Joint Experiment on Crop Assessment and Monitoring (GEO-JECAM) and the Multi-source Production, Acreage and Yield (PAY) database. The main objective of PAY is to (i) enable the objective assessment of food security and risk management planning, and (ii) facilitate inter-comparison and convergence of estimation methods.

The main objective of GEO-JECAM is the inter-comparison of modeling and monitoring methods for agricultural monitoring using multi-source satellite and in-situ data (see JECAM website at www.umanioba.ca/outreach/aesb-jecam/). Seven JECAM pilot sites were identified in 2010 (Argentina, Canada, China, Europe and Mexico) and two more were identified in 2011 in Brazil (XVth Brazilian Symposium on Remote Sensing, Curitiba, 2-5 May). The Agricultural Monitoring Community of Practice also met over the Symposium to seek more global representation on GEO activities.

Two more JECAM pilot sites were proposed by Brazil in 2011, complementing the seven pilot sites proposed by Argentina, Canada, China, Europe and Mexico in 2010.
Data requests for GEO-JECAM were submitted to CEOS for access considerations. Technical discussions were held between GEO-JECAM and CEOS agencies over CEOS Action Workshops (Feb 2011, Washington DC, USA; June 2011, Ottawa, Canada). Objectives were to initiate a documented, coordinated plan for the acquisition of remotely-sensed data in support of the GEO-JECAM initiative, in particular to: (i) Set the stage for a common understanding of GEO-JECAM, its objectives and plans; (ii) Present GEO-JECAM data requirements; (iii) Allow space agencies and commercial data providers to present their capabilities in response to the GEO-JECAM Charter, Science Plan and User Requirements document; (iv) Coordinate efforts to collectively respond to the data requirements; and (v) Agree on a documented, coordinated plan to collectively acquire the required data. The final report was due for September 2011.

With regard to capacity building, India (ISRO) offered opportunities to get training on crop monitoring with remote sensing. Candidates from South Africa, Sudan and Uganda were selected and got started in the spring. Workshops were also organized in Kazakhstan, Hong-Kong and Austria covering issues of land-cover mapping and validation. These workshops helped the GLAM community establish links with other programmes as well as maximize gains from global efforts.

China provided training courses and PhD fellowships to Thai scientists to transfer CropWatch technology to Thailand and enhance the use of Chinese and Thai satellite data in crop monitoring and land suitability assessment.

China (IRSA) and USA (University of Maryland) will seek funding as part of the CropWatch project to help Uganda set up a crop monitoring system and in-situ observation site for ecosystem services assessment.


The University of Maryland led the development of the Global Agricultural Community of Practice (see webpage at www.earthobservations.org/cop_ag_gams.shtml) with support from the US Department of Agriculture (USDA), EC Joint Research Center (JRC), Chinese Academy of Sciences (CAS), and the Indian Space Research Organization.

The Community of Practice worked to expand activities to agricultural risk assessment and drought management (in collaboration with WA-06-02). New activities were also initiated on “cropland mapping”, and “rangeland and pasture monitoring”, following related workshops hosted by IIASA (Austria) in June 2011 and by CSIRO (Australia) in April 2011. Activities will for instance help bring the community together to produce a best available global cropland map, as well as validations of existing products.
2.9 BIODIVERSITY

Issues in this area include the condition and extent of ecosystems, distribution and status of species, and genetic diversity in key populations. Implementing GEOSS will unify many disparate biodiversity-observing systems and create a platform to integrate biodiversity data with other types of information. Taxonomic and spatial gaps will be filled, and the pace of information collection and dissemination will be increased.

*GEOSS 10-Year Implementation Plan, Section 4.1.9*

BI-07-01: Developing a Biodiversity Observation Network

The GEO Biodiversity Observation Network (GEO BON) continued to make progress towards developing an “integrated network on biodiversity”. GEOBON was given a mandate by the Convention on Biological Diversity (CBD) to prepare an evaluation of existing observation capabilities relevant to the CBD’s targets for protecting biodiversity by 2020. A draft report was completed and circulated for review. The Global Invasive Species Network created country-level dynamic maps of native and invasive species. Limitations to GEOBON’s expansion relate to varying degrees of resources available.

GEO BON became a key participant in the primary international forum for biodiversity: the Convention on Biological Diversity (CBD). At the 10th Conference of the Parties to the Convention on Biological Diversity, GEO BON was given a mandate to prepare an evaluation of existing observation capabilities relevant to the CBD’s targets for protecting biodiversity by 2020. In response, GEO BON convened an International Expert Meeting (1-3 March 2011, Wageningen, Netherlands) to prepare an “Assessment of the Adequacy of Existing Observation Capabilities for the CBD 2020 Targets”.

As a result, a draft report on the status of current observations for each of the 20 ‘Aichi targets’ defined by the Convention on Biological Diversity was completed and circulated for review (see www.earthobservations.org/documents/cop/bi_geobon/2011_cbd_adequacy_report.pdf). The report will be presented to an Ad Hoc Technical Expert Group (AHTEG) to be convened by the CBD and will subsequently be presented to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) in November. In addition, policy documents were drafted for Engaging National Governments as well as Membership and Guidelines for Regional Biodiversity Observation Networks. There are currently under review.

GEO BON continued to develop activities at the gene level (e.g., creating maps of phylogenetic diversity), species level (e.g., abundance and distribution for a large assemblage of species), and ecosystem level (e.g. promoting methods and data for biennial ecosystem service accounts at national scales). GEO BON also planned a technical coordination-capability which will (i) review existing data provider networks, (ii) establish partnerships, (iii) design an information architecture, (iv) build the necessary components, (v) register data and services, and (vi) provide helpdesk facilities, training and outreach.

With regard to early-products, GEO BON was approached by the Ramsar Convention to take the lead in the development of a Global Wetlands Observatory System (GWOS). GEOBON also continued to support protected-area monitoring in Africa. Products include a Web Feature Service (WFS) of the (i) World Database on Protected Areas (WDPA) from UNEP-WCMC (see EC-09-01), (ii) important bird-areas from BirdLife International, and (iii) red-list species occurrences from the Global Biodiversity Information Facility (GBIF). Alert services from the African protected-area unit of the EC Joint Research Centre (JRC) were also included.
With regard to invasive species, the USA (NBII) and partners expanded the Global Invasive Species Information Network (GISIN). Several improvements were made including the ability to edit online, establish project-level security and produce country-level dynamic maps of native and invasive species, and a redesign of the GISIN web portal (www.gisin.org). Additional features were added to facilitate data transfers.

GISIN now has 7 providers and over 1,000,000 records cached. It enables searches across databases, improves access to global data, and integrates invasive and alien species data with other biodiversity data from GBIF. It can be linked with inventory data from GEO-BON. GISIN also supports the Global Register of Invasive Species (GRIS) which was created by the IUCN Invasive Species Specialist Group with funding from Defenders of Wildlife, as a tool to produce a reference list of known invasive-species. If adequately funded, this resource will provide online information-support for pre-screening of proposed imports, and risk-assessments.

Barriers remain to the further expansion of GISIN, such as a comprehensive system for globally unique (and persistent) identifiers and taxonomic name resolution (still under development by partner organizations), and a lack of long-term funding and support.

In late 2010, GEO BON held side events at both the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-14) in Nairobi, Kenya, and the CBD-COP10 in Nagoya, Japan, and presented a showcase at the GEO-VII Plenary.
**APPENDIX A: PROGRESS TABLE**

*Green:* Overarching Task progress judged to be very good to excellent (if any sub-tasks, progress judged to be very good to excellent for most sub-tasks; see corresponding text for details)

*Yellow:* Overarching Task is progressing but more effort is required (if any sub-tasks, more effort is required on most sub-tasks; see corresponding text for details)

*Red:* Overarching Task is inactive (no reported progress) or progress judged insufficient (if any sub-tasks, progress judged insufficient for most sub-tasks; see corresponding text for details)

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<tr>
<th>Tasks</th>
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<td><strong>ARCHITECTURE</strong></td>
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<td>AR-09-01 GEOSS Common Infrastructure (GCI)</td>
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<td>AR-09-02 Interoperable Systems for GEOSS</td>
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<td>AR-09-03 Advocating for Sustained Observing Systems</td>
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<td>AR-09-04 Dissemination and Distribution Networks</td>
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<td>AR-06-11 Radio Frequency Protection</td>
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<td><strong>DATA MANAGEMENT</strong></td>
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<td>DA-06-01 GEOSS Data Sharing Principles</td>
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<td>DA-09-03 Global Data Sets</td>
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<td><strong>CAPACITY BUILDING</strong></td>
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<td>CB-09-01 Resource Mobilization (Seville Roadmap)</td>
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<td>CB-09-02 Building Individual Capacity in EO</td>
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<td>CB-09-03 Building Institutional Capacity to Use EO</td>
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<td>CB-09-04 Capacity Building Needs and Gap Assessment</td>
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<td>CB-09-05 Infrastructure Development and Technology Transfer for Information Access</td>
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<td>CB-10-01 Building CB through Outreach and Awareness Raising</td>
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<td><strong>SCIENCE AND TECHNOLOGY</strong></td>
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<td>ST-09-01 Catalyzing R&amp;D Funding for GEOSS</td>
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<td>ST-09-02 Promoting Awareness and Benefits of GEO in the S&amp;T Community</td>
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<td><strong>USER ENGAGEMENT</strong></td>
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<td>US-09-01 User Engagement</td>
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<td>US-09-02 Socio-Economic Indicators</td>
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<td>US-09-03 Cross-Cutting Products and Services</td>
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### THE 9 GEOSS SOCIETAL BENEFIT AREAS

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<td>DI-09-01</td>
<td>Systematic Monitoring for Geohazards Risk Assessment</td>
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<td>DI-09-02</td>
<td>Multi-Risk Management and Regional Applications</td>
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<td>DI-09-03</td>
<td>Warning Systems for Disasters</td>
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<td>HE-09-01</td>
<td>Information Systems for Health</td>
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<td>HE-09-02</td>
<td>Monitoring and Prediction Systems for Health</td>
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<td>HE-09-03</td>
<td>End-to-End Projects for Health</td>
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<td>ENERGY</td>
<td>EN-07-01</td>
<td>Management of Energy Sources</td>
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<td></td>
<td>EN-07-02</td>
<td>Energy Environmental Impact Monitoring</td>
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<td>EN-07-03</td>
<td>Energy Policy Planning</td>
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<td>CLIMATE</td>
<td>CL-06-01</td>
<td>A Climate Record for Assessing Climate Variability and Change</td>
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<td></td>
<td>CL-09-01</td>
<td>Environmental Information for Decision-making and Adaptation</td>
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<td>CL-09-02</td>
<td>Accelerating the Implementation of GCOS</td>
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<td></td>
<td>CL-09-03</td>
<td>Global Carbon Observation and Analysis System</td>
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<td>WATER</td>
<td>WA-06-02</td>
<td>Droughts, Floods and Water Resource Management</td>
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<td>WA-06-07</td>
<td>Capacity Building for Water Resource Management</td>
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<td></td>
<td>WA-08-01</td>
<td>Integrated Products for Water Resource Management and Research</td>
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<td>WEATHER</td>
<td>WE-06-03</td>
<td>TIGGE and the Development of GIFS</td>
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<td>WE-09-01</td>
<td>Capacity Building for High-impact Weather Prediction</td>
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<td>ECOSYSTEMS</td>
<td>EC-09-01</td>
<td>Ecosystem Observation and Monitoring Network (GEO EcoNet)</td>
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<td></td>
<td>EC-09-02</td>
<td>Ecosystem Vulnerability to Global Change</td>
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<td>AGRICULTURE</td>
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<td></td>
<td>AG-07-03</td>
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<td>BIODIVERSITY</td>
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<td>Developing a Biodiversity Observation Network</td>
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### APPENDIX B: LIST OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AARSE</td>
<td>African Association of Remote Sensing of the Environment</td>
</tr>
<tr>
<td>ACQWA</td>
<td>Assessing Climatic change and impacts on the Quantity and quality of Water</td>
</tr>
<tr>
<td>ADC</td>
<td>Architecture and Data Committee</td>
</tr>
<tr>
<td>AeroCOM</td>
<td>Aerosol Comparisons between Observations and Models</td>
</tr>
<tr>
<td>AG</td>
<td>Agriculture</td>
</tr>
<tr>
<td>AIT</td>
<td>Asian Institute of Technology</td>
</tr>
<tr>
<td>AMDAR</td>
<td>Aircraft Meteorological Data Relay</td>
</tr>
<tr>
<td>AMESD</td>
<td>African Monitoring of the Environment for Sustainable Development</td>
</tr>
<tr>
<td>ANTARES</td>
<td>A Network for the Enhancement of the Education and Scientific Research</td>
</tr>
<tr>
<td>APEC</td>
<td>Asia-Pacific Economic Cooperation</td>
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<tr>
<td>APFM</td>
<td>Associated Programme on Flood Management</td>
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<tr>
<td>APN</td>
<td>Asian Pacific Network for Climate Change Research</td>
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<tr>
<td>AR</td>
<td>Architecture</td>
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<tr>
<td>ASCOPE</td>
<td>ESA Active LIDAR</td>
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<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
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<td>ASI</td>
<td>Italian Space Agency</td>
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<tr>
<td>ASSENSDS</td>
<td>NASA Active LIDAR</td>
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<td>AVHRR</td>
<td>Advanced Very High Resolution Radiometer</td>
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<tr>
<td>AWCI</td>
<td>Asian Water Cycle Initiative</td>
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<tr>
<td>B08FDP</td>
<td>Beijing 2008 Olympic Games Forecasting Demonstration Project</td>
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<tr>
<td>B08RDP</td>
<td>Beijing 2008 Olympic Games Research and Development Project</td>
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<td>BGR</td>
<td>German Geological Survey</td>
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<tr>
<td>BI</td>
<td>Biodiversity</td>
</tr>
<tr>
<td>BIOMASS</td>
<td>ESA p-band radar for above-ground biomass</td>
</tr>
<tr>
<td>BIOSTRAT</td>
<td>Specific Support Action (SSA) funded by the EU Sixth Framework Programme and aims to further develop the EU Biodiversity Research Strategy</td>
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<tr>
<td>BRGM</td>
<td>French Geological Survey</td>
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<tr>
<td>CASTOR</td>
<td>Capture and geological STORage of CO₂</td>
</tr>
<tr>
<td>CATHALAC</td>
<td>Water Centre for the Humid Tropics of Latin America and the Caribbean</td>
</tr>
<tr>
<td>CB</td>
<td>Capacity Building</td>
</tr>
<tr>
<td>CBC</td>
<td>Capacity Building Committee</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CBERS</td>
<td>China-Brazil Earth Resources Satellite</td>
</tr>
<tr>
<td>CEOP</td>
<td>Coordinated Energy and Water Cycle Observations Project</td>
</tr>
<tr>
<td>CEOS</td>
<td>Committee on Earth Observation Satellites</td>
</tr>
<tr>
<td>CFP</td>
<td>Call for Participation</td>
</tr>
<tr>
<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
</tr>
<tr>
<td>CGMS</td>
<td>Coordination Group for Meteorological Satellites</td>
</tr>
<tr>
<td>ChloroGIN</td>
<td>Chlorophyll Ocean Globally Integrated Network</td>
</tr>
<tr>
<td>CIESIN</td>
<td>Center for International Earth Science Information Network, Columbia University, USA</td>
</tr>
<tr>
<td>CIMA</td>
<td>(CIMA Foundation) International Center of Environmental Monitoring</td>
</tr>
<tr>
<td>CIMO</td>
<td>Joint Commission for Instruments and Methods of Observation</td>
</tr>
<tr>
<td>CL</td>
<td>Climate</td>
</tr>
<tr>
<td>CMAP</td>
<td>Merged Analysis of Precipitation</td>
</tr>
<tr>
<td>CNES</td>
<td>French Space Agency</td>
</tr>
<tr>
<td>CO2GeoNET</td>
<td>European Network of Excellence on the geological storage of CO₂</td>
</tr>
<tr>
<td>CO2ReMoVe</td>
<td>Research into Monitoring and Verifying Carbon Dioxide geological storage</td>
</tr>
<tr>
<td>CoP</td>
<td>Community of Practice</td>
</tr>
<tr>
<td>CPC</td>
<td>Climate Prediction Center</td>
</tr>
<tr>
<td>CSIR</td>
<td>Council for Scientific and Industrial Research, South Africa</td>
</tr>
<tr>
<td>CUAHSI</td>
<td>Consortium of Universities for Advancement of Hydrologic Science</td>
</tr>
<tr>
<td>DA</td>
<td>Data Management</td>
</tr>
<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
</tr>
<tr>
<td>DevCoCast</td>
<td>Provides processed land and ocean satellite data and value-added products in Developing Countries</td>
</tr>
</tbody>
</table>
DI Disasters
DIVERSITAS An international programme of biodiversity science
DLR German Aerospace Center
EARS Dutch Remote-Sensing Company
EBONE European Biodiversity Observation Network
EC Ecosystems
EC European Commission
ECDC European Center for Disease Prevention and Control
ECMWF European Centre for Medium-range Weather Forecasts
ECV Essential Climate Variables
EDEN Emerging Diseases in a changing European Environment
EEA European Environmental Agency
EN Energy
EnerGEO Earth observation for monitoring and assessment of the environmental impact of energy use
EO Earth Observations
EPS Ensemble Prediction System
ERSL Environmental Remote Sensing and Image Processing Laboratory
ESA European Space Agency
ESRI Environmental Systems Research Institute
EUMETSAT European Organisation for the Exploitation of Meteorological Satellites
FAO Food and Agriculture Organization
FAPAR Fraction of Absorbed Photosynthetically Active Radiation
FDPs Forecast Demonstration Projects
FDSN International Federation of Digital Seismograph Networks
FLUXNET Network of Regional Networks Integrating Worldwide CO₂ Flux Measurements
FOSS4G Free and Open Source Software for Geospatial
FP6 European Commission funded projects
FP7 European Union 7th Framework Programme
FPAR Fraction Photosynthetically Available Radiation
FRA Forest Resource Assessment
GAW Global Atmosphere Watch
GBIF Global Biodiversity Information Facility
GBRDS Global Biodiversity Resources Discovery System
GC1 GEOSS Common Infrastructure
GCOS Global Climate Observing System
GDEWS Global Drought Early Warning Systems
GEMS Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data
GEO Group on Earth Observations
GEO BON Group on Earth Observations Biodiversity Observation Network
GEOBENE Global Earth Observation Benefit Estimation: Now, Next and Emerging
GeoCapacity Assessing European Capacity for geological storage of Carbon Dioxide
GeoHazData Interoperable and distributed metadata system for inventorying hazard maps
GEONETCast Near real time, Global Network of Satellite-based Data Dissemination Systems designed to distribute space-based, air-borne and in situ data, metadata and products to low-cost receiving stations maintained by users
GEOSCHEM Goddard Earth Observing System-CHEMistry
GEOS Global Earth Observation System of Systems
GEWEX Global Energy and Water Cycle Experiment
GFMC Global Fire Monitoring Center
GFZ German National Research Center for Earth Sciences
GGMN Global Groundwater Monitoring Network
GGOS Global Geodetic Observing System
GIFS Global Interactive Forecast System
GIS Geographical Information System
GISIN Global Invasive Species Information Network
GLOBCARBON ESA Global Land Products for Carbon Model Assimilation
GLOBCOLOUR ESA Node for Global Ocean Colour
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>GLOBCOVER</td>
<td>ESA Global Land Cover Service</td>
</tr>
<tr>
<td>GMES</td>
<td>Global Monitoring for Environment and Security</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<tr>
<td>GOF-C-GOLD</td>
<td>Global Observation of Forest and Land Cover Dynamics</td>
</tr>
<tr>
<td>GOOS</td>
<td>Global Ocean Observing System</td>
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<tr>
<td>GOS</td>
<td>Global Observing System</td>
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<tr>
<td>GOSAT</td>
<td>Greenhouse Gases Observing Satellite</td>
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<tr>
<td>GPCC</td>
<td>Global Precipitation Climatology Centre</td>
</tr>
<tr>
<td>GPM</td>
<td>Global Precipitation Measurement</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>GRIB</td>
<td>GRidded Binary</td>
</tr>
<tr>
<td>GRUAN</td>
<td>GCOS Reference Upper Air Network</td>
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<tr>
<td>GSICS</td>
<td>Global Space-based Inter-Calibration System</td>
</tr>
<tr>
<td>GSN</td>
<td>Global Seismographic Network</td>
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<tr>
<td>GTOS</td>
<td>Global Terrestrial Observing System</td>
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<tr>
<td>HARON</td>
<td>Hydrological Applications and Run-Off Network</td>
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<tr>
<td>HE</td>
<td>Health</td>
</tr>
<tr>
<td>HEPEX</td>
<td>Hydrological Ensemble Prediction Experiment</td>
</tr>
<tr>
<td>IAG</td>
<td>International Association of Geodesy</td>
</tr>
<tr>
<td>IAS</td>
<td>Invasive Alien Species</td>
</tr>
<tr>
<td>ICSU</td>
<td>International Council for Science</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IGACO</td>
<td>International Global Atmospheric Chemistry Observations</td>
</tr>
<tr>
<td>IGAC-SPARC</td>
<td>International Global Atmospheric Chemistry - Stratospheric Processes And Their Role in Climate</td>
</tr>
<tr>
<td>IGBP</td>
<td>International Geosphere-Biosphere Programme</td>
</tr>
<tr>
<td>IGCO</td>
<td>Integrated Global Carbon Observation</td>
</tr>
<tr>
<td>IGOS</td>
<td>Integrated Global Observing Strategy</td>
</tr>
<tr>
<td>IGRAC</td>
<td>International Groundwater Resources Assessment Centre</td>
</tr>
<tr>
<td>IGWCO</td>
<td>Integrated Global Water Cycle Observations (former IGOS Water Theme)</td>
</tr>
<tr>
<td>IIASA</td>
<td>International Institute for Applied Systems Analysis</td>
</tr>
<tr>
<td>ILTER</td>
<td>International Long Term Ecological Research network</td>
</tr>
<tr>
<td>ILWIS</td>
<td>Integrated Land and Water Information System</td>
</tr>
<tr>
<td>INPE</td>
<td>Brazilian National Institute for Space Research</td>
</tr>
<tr>
<td>InSAR</td>
<td>Interferometric Synthetic Aperture Radar</td>
</tr>
<tr>
<td>INTA</td>
<td>Instituto Nacional de Técnica Aeroespacial, Spain</td>
</tr>
<tr>
<td>IOC</td>
<td>Initial Operating Capability</td>
</tr>
<tr>
<td>IOC</td>
<td>Intergovernmental Oceanographic Commission</td>
</tr>
<tr>
<td>IOCCG</td>
<td>International Ocean Colour Coordinating Group</td>
</tr>
<tr>
<td>IP3</td>
<td>GEOSS Interoperability Process Pilot Projects</td>
</tr>
<tr>
<td>IPT</td>
<td>Integrated Provider Toolkit</td>
</tr>
<tr>
<td>IPWG</td>
<td>International Precipitation Working Group</td>
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<tr>
<td>IPY</td>
<td>International Polar Year</td>
</tr>
<tr>
<td>IRI</td>
<td>International Research Institute for Climate and Society</td>
</tr>
<tr>
<td>IRIS</td>
<td>Incorporates Research Institutions for Seismology</td>
</tr>
<tr>
<td>ISC</td>
<td>International Seismological Centre</td>
</tr>
<tr>
<td>ISCGM</td>
<td>International Steering Committee for Global Mapping</td>
</tr>
<tr>
<td>ISDR</td>
<td>International Strategy for Disaster Reduction</td>
</tr>
<tr>
<td>ISLSCP</td>
<td>International Satellite Land-Surface Climatology Project</td>
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<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>ISSGS</td>
<td>IUCN/SSC Invasive Species Specialist Group</td>
</tr>
<tr>
<td>ITC</td>
<td>International Institute for Geo-Information Science and Earth Observation</td>
</tr>
<tr>
<td>ITC</td>
<td>International Training Centre</td>
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<tr>
<td>ITU</td>
<td>International Telecommunication Union</td>
</tr>
<tr>
<td>IUCAF</td>
<td>Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature and Natural Resources (World Conservation Union)</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>SPOT-VGT</td>
<td>SPOT Vegetation</td>
</tr>
<tr>
<td>SSC</td>
<td>Species Survival Commission</td>
</tr>
<tr>
<td>SST</td>
<td>Sea Surface Temperature</td>
</tr>
<tr>
<td>STC</td>
<td>Science and Technology Committee</td>
</tr>
<tr>
<td>TerraLib</td>
<td>Open source GIS software library</td>
</tr>
<tr>
<td>TerraView</td>
<td>GIS application built on the TerraLib GIS library</td>
</tr>
<tr>
<td>THORPEX</td>
<td>The Observing-system Research and Predictability Experiment</td>
</tr>
<tr>
<td>TIGER</td>
<td>ESA-launched initiative focusing on the use of space technology for water</td>
</tr>
<tr>
<td>TIGGE</td>
<td>THORPEX Interactive Global Grand Ensemble</td>
</tr>
<tr>
<td>TOVS</td>
<td>NOOA TIROS (Television Infrared Observation Satellite) Operational Vertical Sounder</td>
</tr>
<tr>
<td>T-PARC</td>
<td>THORPEX Pacific Asian Regional Campaign</td>
</tr>
<tr>
<td>UIC</td>
<td>User Interface Committee</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNECA</td>
<td>United Nations Economic Commission for Africa</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNESCO-IHE</td>
<td>Institute for Water Education</td>
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<tr>
<td>UNOOSA</td>
<td>United Nations Office for Outer Space Affairs</td>
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<tr>
<td>UNOSAT</td>
<td>United Nations Operational Satellite Applications Programme</td>
</tr>
<tr>
<td>US</td>
<td>User Engagement</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>USOFDA</td>
<td>US Office of Foreign Disaster Assistance Project Management</td>
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<tr>
<td>VENUS</td>
<td>Victoria Experimental Network Under the Sea</td>
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<tr>
<td>VI</td>
<td>Vegetation Index</td>
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<tr>
<td>WA</td>
<td>Water</td>
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<tr>
<td>WCRP</td>
<td>World Climate Research Programme</td>
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<tr>
<td>WDC</td>
<td>World Data Center</td>
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<tr>
<td>WE</td>
<td>Weather</td>
</tr>
<tr>
<td>WFPHA</td>
<td>World Federation of Public Health Association</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WIGOS</td>
<td>WMO Integrated Global Observing System</td>
</tr>
<tr>
<td>WIKI</td>
<td>Page or Collection of Web pages designed to enable anyone who accesses it to contribute or modify content, using a simplified markup language</td>
</tr>
<tr>
<td>WIREC</td>
<td>Washington International Renewable Energy Conference</td>
</tr>
<tr>
<td>WIS</td>
<td>WMO Information System</td>
</tr>
<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
</tr>
<tr>
<td>WWRP</td>
<td>World Weather Research Programme</td>
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</tbody>
</table>