INPUT PAPER

Prepared for the Global Assessment Report on Disaster Risk Reduction 2015

In response to the Indicator 'RA 2, PFA3/CI1'

GEO DISASTER TASK DI-01

GEO's global coordination of observing and information systems to support all phases of the risk management cycle associated with hazards (mitigation and preparedness, early warning, response, and recovery)

Francesco Gaetani, GEO Secretariat, Lead Author
Falk Amelung, Univ. Of Miami
Bill de Groot, NRCan-Canadian Forest Service
Stuart Frye, NASA
Francis Lindsay, NASA
Stuart Marsh, GHCP
Ivan Petiteville, ESA
Hans Peter-Plag, GHCP
Guy Seguin, International Space Consultant

January, 2014

Table of Contents

1) Introduction

This paper has been prepared for the Global Assessment Report on Disaster Risk Reduction 2015 in response to the Indicator 'RA 2, PFA3/CI1' "Relevant information on disasters is available and accessible at all levels, to all stakeholders (through networks, development of information sharing systems etc)". The paper describes the contributions of the of the Group on Earth Observations (GEO)[1] Work Plan Task DI-01 "Informing Risk Management and Disaster Reduction" and the Geohazards Community of Practice (GHCP) to this indicator since the creation of GEO in 2005.

Earth observations (Eos) and information, derived both from space and surface networks, have demonstrated not only their maturity, but their critical role in supporting first responders and risk managers by providing effective tools to rapidly map damages and impacts during rescue operations.

GEO through its 160-plus partners comprised of 90 Governments, UN Organizations including UNISDR, and international scientific organizations, is working to expand the use of satellite imagery and surface data for managing risks posed by fires, floods, earthquakes and other hazards.

The vision for GEO is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information. The purpose of GEO is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behavior of the Earth system. GEO will meet the need for timely, quality long-term global information as a basis for sound decision-making, and will enhance delivery of benefits to society. Crisis management faced by governments due to high-frequency natural and human-induced extreme events requires EO capacities that generally cannot be provided by one country alone; effective response requires regional/international collaboration and coordination.

GEOS's signature initiative, the Global Earth Observation System of Systems (GEOSS) represents the collective effort of hundreds of governments and organizations, and thousands of individuals, to monitor the Earth system, share and exchange Earth system data, and deliver useful information to society. GEOSS has enabled many countries to access information and thereby provide essential services to address challenges which otherwise would not have been met.

GEO, through its Disaster Task is coordinating the efforts of several organizations including the Committee of Earth Observation Satellites (CEOS) which enhances the use of Satellite data by conducting multi-risk pilot projects and by supporting geohazards Supersites, UNEP which produces a Global Risk data platform, SERVIR, Global Wildfire Information System, the Universal Access to the International Charter Space and Major Disasters, the development of a volcanic ash monitoring system and the development of a Global Earthquake Model., and

[1] http://www.earthobservations.org

the design and development of a Global Geohazards Information System for Disaster Risk Reduction (GGIS-DRR).

Despite significant progress in recent years and evidence of utilization of the systems put in place under GEO leadership, there remains substantial work to achieve the target of the GEO Disaster Task.

2) Background

Over the past several decades, EOs both from *in situ* platforms and satellites have monitored natural hazards and their impacts on humanity and the environment. A number of programs and studies have underlined the importance of an integrated observing strategy for a hazards monitoring system (e.g., Marsh et al., 2004).

Despite the significant effort of international and national organizations to preserve and increase the quality and quantity of observed data in many regions of the world, the *in situ* platforms for collecting data and related systems for managing information related to hazard and risk are inadequate, and are often deteriorating. Where these capabilities do exist, there are frequently no quality assurance and control standards applied to the instruments, data reduction methods, and procedures.

On the other hand, the number and the quality of data and products provided through remote sensing from space has rapidly evolved from an early period of limited satellite programs with mission-specific reviews to the interdisciplinary coordination of multi-mission programs. In 1984, the assembled representatives of international and national spaceborne Earth observation systems agreed to coordinate informally their current and planned systems for Eo from space by organizing the Committee on Earth observation Satellites (CEOS). Since 1984, CEOS has evolved significantly from an organization focusing on the harmonization of data standards and information services to a more strategic organization supporting the creation of an Integrated Global Observing Strategy (IGOS) to provide a comprehensive framework to harmonize the common interests of the major space-based and *in situ* systems for global observation of the Earth. IGOS was developed as an over-arching strategy for conducting observations relating to climate and atmosphere, oceans and coasts, the land surface and the Earth's interior. The IGOS Partnership brought together a wide range of organizations committed to strengthening space-based and *in situ* Earth observations. In 2005, with the emergence of GEO with its high-level political mandate, the IGOS Partners decided to transition the IGOS Themes into GEO, thus broadening international collaboration on the GEOSS

3) Development of GEO and GEOSS (2005-2015)

GEO is coordinating international efforts to build a fully operational Global Earth Observation System of Systems (GEOSS), a global public infrastructure for EOs consisting of a flexible and distributed network of content providers.

GEO was established in 2005 by the Third Earth Observation Summit with the mandate to implement the GEOSS 10-Year Implementation Plan (10YIP; GEO, 2005a). It was launched in response to calls for action by the 2002 World Summit on Sustainable Development and the Group of Eight (G8) leading industrialized countries. These high-level meetings recognized that international collaboration is essential for exploiting the growing potential of EOs to support decision making in an increasingly complex and environmentally stressed world.

GEO is a voluntary partnership of governments and international organizations, which provides a framework within which these partners can develop new projects and coordinate their strategies and investments. As of January 2014 GEO's membership includes 89 Governments and the European Commission; in addition, 77 intergovernmental, international and regional organizations with a mandate in EO or related issues have been recognized as Participating Organizations (POs). This partnership collaborates to interlink environmental monitoring systems, coordinate observation strategies and investments, and share environmental data, information and know-how.

Based on this cooperation, the GEO community is generating information products and services that decision makers can use to confront global challenges, from addressing natural disasters and health epidemics to reducing biodiversity loss and carbon emissions. Because the sheer costs and logistics of expanding EO infrastructure would be daunting for any single nation, GEOSS makes the production of comprehensive Earth observations more sustainable by leveraging investments from a wide range of partners, ensuring that EO remains a global public good accessible to all. Technological advances have made GEOSS possible, while the expanding requirements of users have made it necessary.

4) Review of EO for DRR information systems

The GEO Work Plan provides the framework for implementing the GEOSS 10-Year Implementation Plan (2005-2015). In its current version, the Work Plan gathers 26 practical Tasks based on the inputs of the GEO community and builds on activities which correspond to outcomes identified as being necessary to meet the Strategic Targets identified by the Implementation Plan. The Disasters Task (DI-01)[2] has been designed to improve the use of EO and related information systems in support of the whole risk management cycle associated with hazards (i.e., mitigation and preparedness, early warning, response, and recovery). Twenty-plus governmental bodies and international organizations active in Disaster Risk Reduction and Management (DRRM) are coordinated by CEOS, and supported by GHCP in the implementation of the Task DI-01. The task has been structured around five components to address the Strategic Target for the Disasters Societal Benefit Area, namely

> *«Enable the global coordination of observing and information systems to support all phases of the risk management cycle associated with hazards (mitigation and preparedness, early warning, response, and recovery). (GEOSS Strategic Targets Document 12(Rev1) As accepted at GEO-VI)»*

In particular, the five components of Task DI-01, focus on providing support to operational systems, enabling and informing risk and vulnerability analyses, conducting regional end-to-end pilots with a focus on building institutional relationships, and conducting gap analyses to identify missing data, system gaps and capacity gaps.

[2] http://www.earthobservations.org/geoss_imp.php?t=di-01

Component 1: Disaster Management Systems

The first Component aims to improve access to information produced through key Disaster Management Systems, develop best practice guidelines for technical and procedural cooperation in satellite-based emergency mapping and, finally, review global and regional disaster risk management systems. Space agencies, *in situ* observing agencies and other partners work together to expand the use of Eo and related products to manage disaster risk. Among other sources of data, satellites have a uniquely valuable vantage point to monitor a broad range of disasters, including tropical storms, floods, wildfires, volcanoes, earthquakes and tsunamis. One or more remote sensing satellites can oftentimes capture conditions on the land shortly after a disaster occurs. By comparing to pre-existing conditions, these data can be used to create maps and provide actionable information concerning hazard impacts and identification of damaged areas. As an example, space borne imagery proved invaluable in providing rapid information to responders coping with the effects of Super Typhoon Haiyan (Yolanda) in the central Philippines in November 2013.

The International Charter Space & Major Disasters is a key system that provides rapid access to crisis data. Through the Charter, 15 space agencies around the world deliver space-based data to aid civil protection agencies and humanitarian organisations responding to natural and man-made disasters.

Image 1 : Satellite imagery proved invaluable in providing rapid information to responders coping with the effects of Super Typhoon Haiyan (or Yolanda) in the Philippines in November 2013

In 2012, based on an earlier request by GEO, the Charter Board adopted the principle of 'Universal Access' permitting any national disaster management authority to become an Authorized User, provided a proper admission process is followed, thereby allowing it to request assistance in the event of a major disaster. Since 2009, GEO has been collaborating with the Charter to increase awareness of the Charter among disaster management officials in GEO Member States, as well as helping to identify methods to improve broader access to the Charter. Both the Charter and GEO expect this collaboration to continue to grow over the coming years.

Component 2: Geohazards Monitoring, Alert and Risk Assessment

This component supports the implementation of a fully integrated approach to geohazards monitoring, alert and risk assessment. The activities are based on collaboration among existing networks and international initiatives (e.g., the Global Earthquake Model), and stimulate new initiatives to increase cooperation between space and ground-based (subsurface) data providers and user communities.

One of the main activities underpinning this Component is the establishment of a network of GEO Geohazard Supersites and Natural Laboratories (GSNL)[3]. The Geohazard Supersites partnership pool and coordinate the existing space-based and ground-based observation resources of GEO to better estimate the hazards. This information can then be used by local government agencies for risk reduction, i.e. to mitigate and to improve the preparedness for geologic disasters

The overall objective is to advance scientific understanding of potential hazards by improving and integrating space-based and *in situ* monitoring. To achieve this objective the initiative pursues two broadly defined aims. The first is to broaden the expert community by establishing an open access data infrastructure of *in situ* and space-based observations. The second is to establish direct links between the geohazard monitoring agencies and the space agencies, facilitating the use of Eo for routine Geohazard monitoring.

Supersites are sites in which active single or multiple geological hazards (earthquakes, volcanic eruptions, landslides) pose a threat to human population and/or critical facilities. Research on Supersites focuses on compiling geophysical data sets that lead to a better scientific understanding of the geological processes, narrowing down the uncertainty in hazard assessment. Supersites provide open and full access to data acquired by *in situ* and satellite EO systems.

[3] http://www.earthobservations.org/gsnl.php

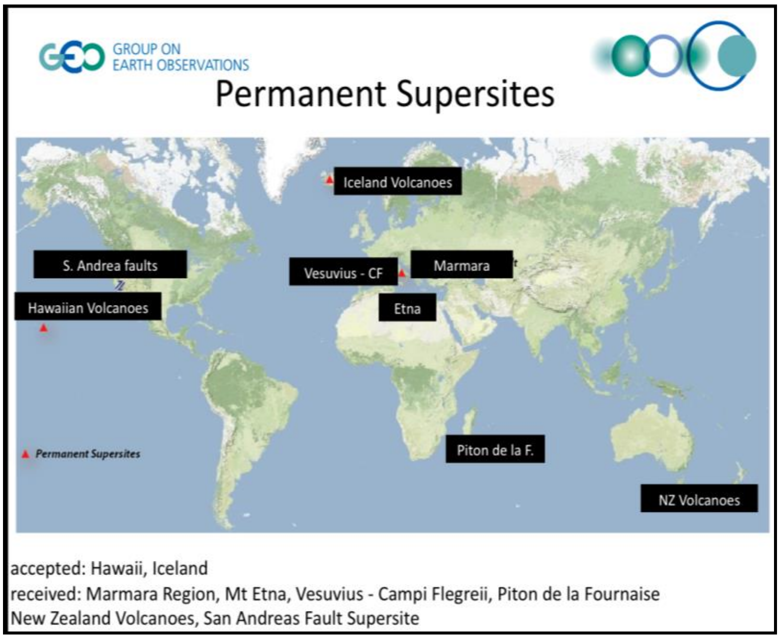


Image 2 : Permanent Supersites include volcanoes in Hawaii, Iceland and Italy and a geological fault in Turkey. Candidate Supersites are volcanoes on Reunion Island and in New Zealand and the San Andreas Fault

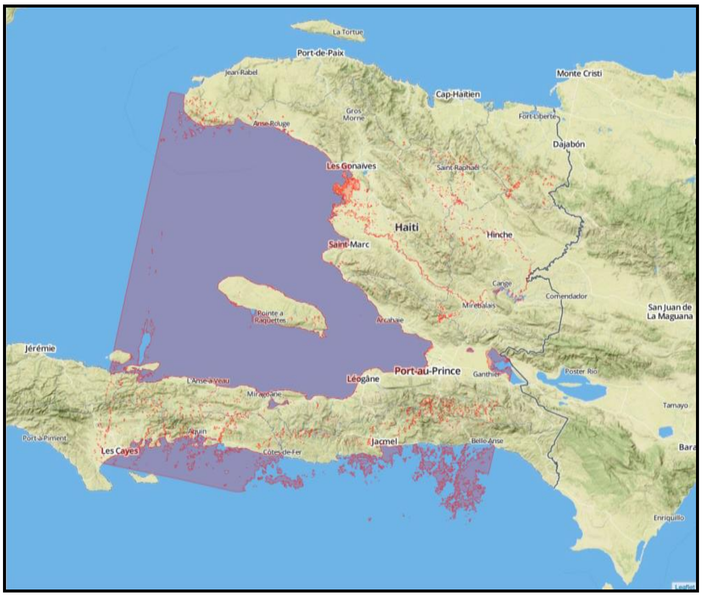
Most data are accessible through the GSNL data portal but are physically located elsewhere. This e-infrastructure supports collaborative research activities of a broad international research community. It provides the unique potential of making scientific progress and providing information to policymakers in geohazards endangered areas. The Supersites concept proved itself following the disastrous Haiti and Tohoku-oki earthquakes of January 2010 and March 2011 events respectively. Within a very short time, Supersites were established and multi-satellite RADAR data, and results and interpretations drawn from the data were openly available to all stakeholders through this cyber-infrastructure, advancing knowledge for potential future threats. The Haiti earthquake has provided the proof of concept that freely available large data sets across disciplines (satellite, seismology and geotechnical engineering), in combination with a cyber-infrastructure can lead to substantial progress in observing, measuring and modeling geohazards (Hayes et al., 2010; Calais et al., 2010). It has further proven that synergetic exploitation of globally available resources (data and knowledge) provides significant return on the individual investments.

The next step is to further broaden the network of Supersites and Natural Laboratories. A top priority is the establishment of the Japan and Southeast Asia Natural Laboratories. The Japan Natural Laboratory will expose a larger community to Japan’s advanced on- and off-shore *in situ* monitoring systems and facilitate comparative research projects with regions in similar tectonic settings. At the same time, it will provide the Japanese research community and monitoring agencies with RADAR observations from international satellites. The Southeast Asia Natural Laboratory will lead to a satellite-based monitoring system for the volcanoes in Indonesia and the Philippines, which account for 15% of the world’s volcanoes and are responsible for some of the largest known historic eruptions.

Component 3 "Regional end-to-end Systems"

This Component focuses on implementing regional and cross-cutting end-to-end projects and applications supporting the full cycle of disaster management. As outlined in a road map developed by the GHCP (2011), the GGIS-DRR promoted by the GHCP provides a cyber infrastructure for the end-to-end projects. The GEO Caribbean Satellite Disaster Pilot (CSDP) and the Southern African Flood and Health Pilot (SAFHP) are developing a coordinated, timely and needs-based approach to the utilization of Eo for multi-hazard disaster management. The scope is the full cycle of disaster management from an "end-to-end" approach (from data collection to analysis, product generation and service delivery) across all hazard types. CSDP (Alleyne, et al., 2012) provides customized disaster management through satellite-tasking, data processing and product delivery. CSDP work responds to a diverse range of disasters. Partners include Regional Centers of Excellence and national agencies from Barbados, Grenada, Jamaica, Saint Lucia and the Virgin Islands. Other CSDP participants include Jamaica (University of West Indies (UWI)), the Caribbean Disaster and Emergency Management Agency (CDEMA), the Caribbean Institute for Meteorology and Hydrology (CIMH) and the Water Center for the Humid Tropics of Central America and the Caribbean (CATHALAC).

Since 2009, during the hurricane seasons, CSDP produces a range of image maps for use by regional and national agencies in affected regions before, during and after disasters. These maps helped to identify susceptible areas, support the need to release or retract evacuation notices, facilitate post-event response and recovery, and justify improvements in response protocols. Satellite images also provide newsworthy pictures viewed on television and in newspapers by thousands of people. CSDP also provides training and conducts regular workshops. Capacity-building is conducted in conjunction with the GEOSS AIP[4] Capacity-Building Working Group and the CEOS Working Group for Capacity-Building and Data Democracy.



[4] http://www.ogcnetwork.net/AIpilot

Image 3 : Resulting OpenStreetMap product developed by CSDP over Haiti followinghurricane Isaac (Aug., 2012).

The Southern African Flood and Health Pilot (SAFHP), formerly Namibian Flood Pilot project is conducted under the auspices of the Namibian Ministry of Agriculture Water and Forestry (MAWF), CEOS and originally moderated by the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). The effort began by identifying and prototyping technologies which enabled the rapid gathering and dissemination of both space-based and ground sensor data and data products for the purpose of flood disaster management. This was followed by an international collaboration to build small portions of the identified system. The system was prototyped over the past few years during the 2010-2011 flood seasons, with further prototyping during 2012 and 2013. The pilot has been fostered by CEOS to facilitate international efforts to promote satellite sensor data interoperability. In particular, the group has been using of a technology effort called SensorWeb, being developed at NASA, which leverages Open Geospatial Consortium (OGC) Sensor Web Enablement (SWE) standards to facilitate various satellite and ground sensor interoperability. The group has made use of satellites data together with various ground sensors, including river gauges in Namibia and models such as Global Disaster Alert and Coordination System (GDACS) from European Commission Joint Research Center (JRC). Finally, the group has been experimenting with integrating a large cloud computing service provided by the Open Cloud Consortium (OCC) with the SensorWeb to provide management of large datasets and their distribution to emergency workers.

Component 4 "Global Wildland Fire Information System"

The Component is coordinating efforts to establish a beta GWIS web portal and network of major national and regional fire information providers. The establishment of GWIS builds on the initial activities of the Global Observation of Forest Cover and Global Observation of Land cover Dynamics (GOFC-GOLD) Fire Implementation Team and the integration of regional data wildfire information sources. A Global Wildland Fire Early Warning System (EWS-Fire) is being developed by GOFC-GOLD in the frame of the Component. The global EWS-Fire uses ground-based and remotely sensed data to prepare early warning products. Global fire danger (or hazard) is calculated using extended fire weather forecasts from advanced numerical weather models, and fire danger maps are supplemented with current MODIS hot spot data for visual comparison with current fire activity. The Global EWS-Fire is one component of *A Strategy to Enhance International Cooperation in Fire Management* (FAO, 2006). The system supports and builds on existing national and regional fire management programs by providing new longer term predictions of fire danger; common global fire danger metrics to support international fire management cooperation, including resource-sharing during times of fire disaster; and a fire danger rating system for the many countries that do not have a national system in place (de Groot and Goldammer 2013). Early warning of extreme fire danger conditions are critical to mitigating or preventing wildfire disaster and will be increasingly important as climate change progresses (de Groot and Flannigan, 2014).

Component 5 Foster utilization of Earth observations remote sensing data for all phases of Disaster Risk Management

Through CEOS - the space coordination arm of GEO – space agencies have created a Disaster Working Group to help improve disaster risk management (DRM) on a global basis, for all phases of disaster management. An Observation Strategy has been produced by the WG as a response to a collection of observation requirements from the user community to enable the delivery of three coordinated pilots over the period 2014-2016. Each of these thematic pilots (floods, seismic risk and volcanoes) aims to serve as a showcase for the international DRM community to demonstrate benefits of closer ties to users and ease of access to data and potential for increased roles of space agencies in DRM beyond the current Hyogo Framework for Action.

The Floods pilot is developing a Global Flood Dashboard (single access for multiple existing systems) and build on three regional (sub) pilots showcasing end user benefit of frequent high spatial resolution observations (Caribbean, Southern Africa, Mekong/Java). The Seismic Risks pilot will develop a demonstrator for an EO-based global strain map (main focus on Alpine-Himalayan Belt). Additional activities include an Exploitation platform for large data set analysis (strain map, supersites) and the implementation of rapid scientific products for 4 to 6 (large) earthquakes per year (>M5.8). Finally, the Volcanoes Pilot aims to demonstrate the feasibility of systematic global monitoring in regional arc (Latin America), while developing new EO-based monitoring products to feed GSNL and performing real-time in-depth monitoring of one '100-year' category major eruption.

5) Patterns of use of EO information for decision making

In 2008-2009, the CEOS Disasters SBA Team and the United Nations Office for Outer Space Affairs (UNOOSA) under the umbrella of GEO, led a major international effort to identify satellite data user requirements for risk management. The resulting report was used as a starting point for several disaster-specific initiatives, such as the GEOSS Architecture Implementation Pilot (AIP-2) Disaster demonstration and CEOS DRM initiative (see Component 5 in the previous Section). In addition, the CEOS Disasters SBA Team began similar work on architecture requirements – aiming to match specific existing and new satellite missions with user requirements and analyzing priorities for disaster-management information, as well as gaps in existing and planned mission coverage.

In parallel, the GHCP populated the GEOSS User Requirements Registry (URR) with needs related to users, applications, observations, research, technology and infrastructure in the broad area of risk assessment and reduction. The URR provides links among similar needs in all other GEO Societal Benefit Areas and to carry out a gap analysis.

The report produced by CEOS began as a GEO effort to identify the needs of disaster managers across all phases of disaster management. An initial assessment of user requirements across all phases concluded that each phase required a specific approach. The phases are addressed by different actors and are using satellite data to varying degrees. For example, the International Disaster Charter provides access to a wide range of satellite data for disaster response, but the data is not easily available for other phases of disaster management. Disaster mitigation, which represents the greatest opportunity to save lives and protect property, also presents some of the greatest challenges. The large areas to be covered require very large volumes of data. Typically, budgets available for mitigation are the smallest of any phase, even though the needs are greatest.

Recognizing the limits imposed by financial constraints, participants in this exercise were asked to identify those areas where information was more important to obtain. Most participants agreed that criteria to judge relative importance could be a combination of frequency of disaster, severity of disaster (economic impact) and number of people affected. Ultimately, those involved in the study felt that an objective third-party source should be used as a starting point for geographic consideration of user needs. This source ultimately became the World Bank for a number of disaster types, as it presented a comprehensive analysis of disasters and their impacts over 15-25 years, using the well-established CRED data base on disaster impacts at the *Universite Catholique de Louvain* in Belgium.

In order to establish a common set of characteristics for user requirements, the following approach was used for each disaster type and phase:

Identify region of interest (priority areas)

Identify target characteristics (what do we want to see?)

Identify temporal revisit period

Establish timeliness/latency requirements

Identify end use for data by intermediate user (application, service, etc)

Once the approach was approved by the participating organizations, the user requirements were defined in a tabular format and circulated to the entire group for review. These were then refined to obtain the existing, validated requirements. Organizations included in this validation process included end user groups such as civil defence agencies, meteorological agencies, national and regional disaster response agencies, international aid organizations and others involved in the supply of information, such as space agencies.

Identifying the interests of disaster managers was one of the most complex decisions of the user needs compilation process. Needs vary on the phase of disaster. During the warning and response phases, the information needed covers only the area threatened by the disaster. Even for large scale events, this area is typically limited in scope and can be readily imaged by satellites, with the exception of droughts and some floods. In the mitigation phase, the area of interest is much more difficult to resolve. In fact, when one considers multiple hazards, almost every inhabited area is at risk, to some extent, for some type of disaster. Even uninhabited areas are of interest because of their interaction with inhabited areas, particularly for approaching windstorms over the ocean, flooding, or the spread of wildfires.

It is currently not economically feasible to image the entire world at a high resolution using different types of satellites on a frequent basis. This is what would be required if a comprehensive mitigation program were to be conducted. In addition, the imagery would need to be processed and integrated into comparative value added products that provide specific information about specific types of disasters.

As an intermediate step, it was decided to work on mitigation in areas that represent the highest degree of risk of disaster in terms of both likelihood, and the potential for the largest loss of life and economic impact.

The World Bank and Columbia University conducted a similar analysis several years ago and identified, on a global basis the most vulnerable areas of the world for a number of different disaster types. It was decided to use these maps as a starting point to limit the amount of data required and thus prioritize user needs during the mitigation phase according to international priorities.

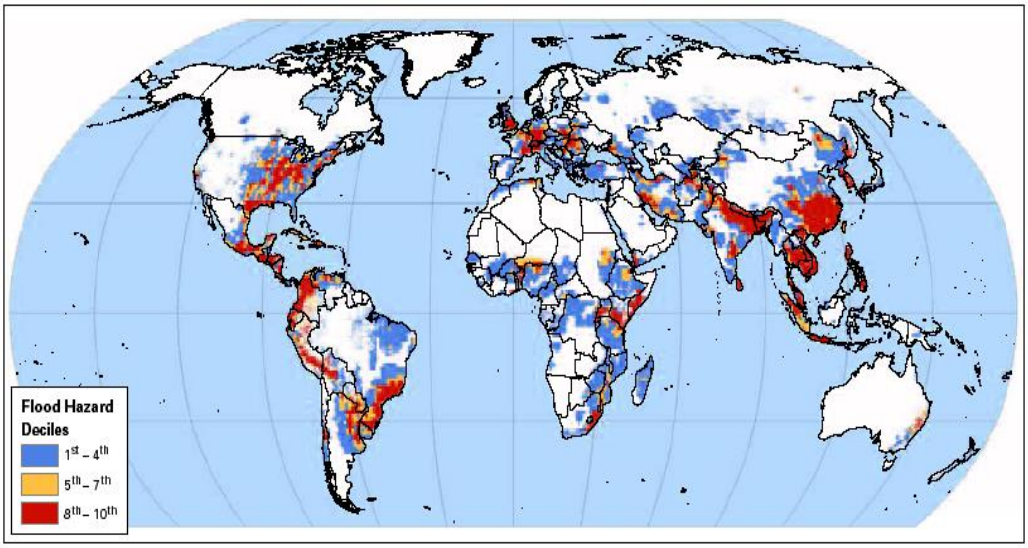


Image 4 Areas of the world most affected by flooding (The World Bank – Natural Disaster Hotspots: A Global Risk Analysis)

Once these areas were identified, it was necessary to analyze for each risk and during each phase the type of information required.

The outputs of such an analysis was used for regional end-to-end demonstrations, particularly in the Caribbean and in Africa, as described under Component 3 in section 4.

To help define the strategic gap analyses process and the information required, the CEOS Disasters Societal Benefit Area (SBA) team in cooperation with the CEOS Systems Engineering Office (SEO) has performed a detailed gap analysis of Earth remote sensing support of floods observations (CEOS, 2013)5. The SEO has used a comprehensive systems framework to allow the definition and traceability of requirements and the assessment of critical gaps. This framework links the key decisions regarding disaster flooding with their required informational products, science models, space-based measurements and the

[5] Available for download at: http://ceos.org/images/Floods_Analysis_030713.pdf

necessary instruments and missions. This analysis was intended for CEOS agencies to understand floods observational gaps, and for disaster support networks to understand requirements and capabilities of CEOS missions. This analysis included a background discussion of floods observation techniques, a section dedicated to flood products and models, and requirements and mission capabilities. It also included new mission concepts and a detailed discussion of solution options.

This work has provided a model to follow not only to refine the conclusion as the development of new satellites progress but also for application to different type of disaster risks.

6) Networks and knowledge management

We are entering an era of increasing global risks and new opportunities where policy and management decisions must be based on the near-real-time environmental monitoring of the entire Earth system. This need for decision-support tools by a wide range of user groups is the driving force behind the development of GEOSS. The 10YIP identifies nine distinct groups of users and uses, which are denoted as "Societal Benefit Areas" (SBAs). The nine SBAs are Disasters, Health, Energy, Climate, Water, Weather, Ecosystems, Agriculture and Biodiversity. Although the user groups in each SBA have their own distinctive features and needs, the SBAs are mutually interdependent and cannot be addressed in isolation.

Interlinking observation systems requires common standards for architecture and data sharing, but usually the architecture of an EO system refers to the way in which its components are designed so that they function as a whole. Each GEOSS component must be configured so that it can communicate with the other participating systems. In addition, each contributor to GEOSS subscribes to the GEO data-sharing principles, which aim to ensure the full and open exchange of data, metadata and products.

The GEOSS Common Infrastructure (GCI) allows EO users to access search and use the data, information, tools and services available through GEOSS. A major component of the GCI is the GEOSS Portal[6] a single Internet gateway to the comprehensive and near-real-time data produced by GEOSS. The GEO Portal is integrating diverse data sets, identifying relevant data and portals of contributing systems, and provides access to models and other decision-support tools. In addition, the GEOSS Data Access Broker (DAB) is the engine that drives the entire system, connecting directly to the various GEOSS components and services, collecting and searching their information and distributing data and services via the Portal to the user. Finally, the Components and Services Registry and the Standards and Interoperability Registry of the GCI provide a formal listing and description of all the Earth observation systems, data sets, models and other services and tools that together constitute GEOSS along with information about standards and other interoperability arrangements relevant to the implementation and operation of GEOSS.

[6] http://www.geoportal.org/

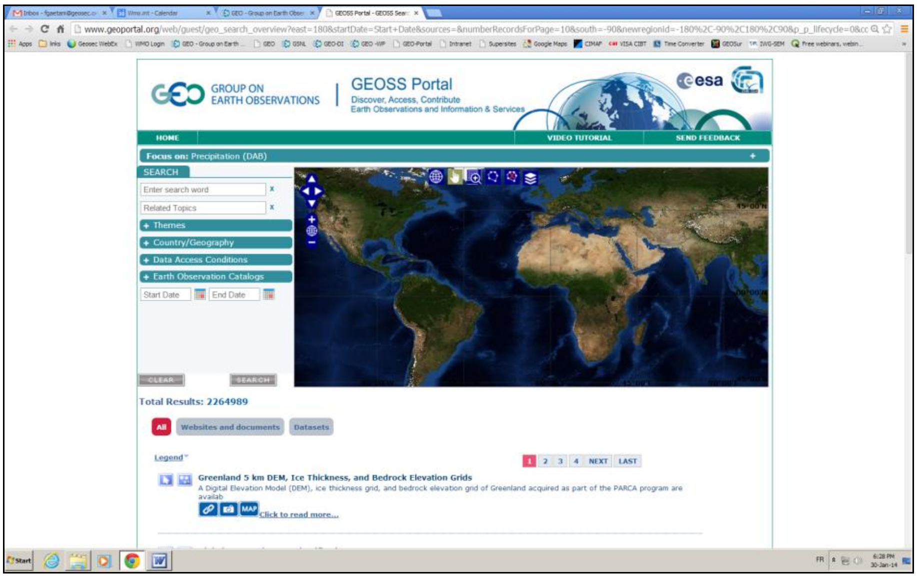


Image 4 : Data products, Services and Earth observations Systems are available through the GEOSS portal. The recent integration of CEOS WGISS Integrated Catalog (CWIC) and NASA's Global Change Master Directory (GCMD) greatly contributed to the dramatic increase of EO data connected.

For users without good access to high-speed internet, GEO has established GEONETCast[7] a 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 diverse communities. GEONETCast is led by three regional infrastructure providers: EUMETSAT in Europe (EUMETCAST), Chinese Meteorological Administration (CMA) in the Asia-Pacific region (FengYunCast), and NOAA in the Western Hemisphere (GEONETCast Americas). This user-driven, user-friendly and low-cost information dissemination service aims to provide global information as a basis for sound decision-making in the Disasters Societal Benefit Area. GEONETCast receiving technology is based on using widespread and off-the-shelf components allowing for widespread adoption of the service at low cost

7) Future of EO IKM for Disaster Risk Reduction

Earth observations continue to play an increasingly important role in helping societies address challenges to food, water, and energy security, and in making societies more resilient to natural hazards and more adaptive to climate change. The global challenges currently facing the international community as addressed in the Disasters Societal Benefit Area of GEO, increasingly demand broad and timely access to high-quality, integrated and sustained Earth observation data and related information. Moreover, Earth observation data and information are owned by many entities around the world, and no country is able to acquire the comprehensive data and tools it needs to inform policy in these critical domains. Specifically, crisis management faced by governments due to high-frequency natural and human-induced extreme events requires Earth observation capacities that generally cannot be provided by one country alone; effective response requires regional/international collaboration and coordination so that, when such events occur, the flow of data from various countries, as well as the international organizations in which they are represented, works smoothly.

---

[7] http://www.earthobservations.org/geonetcast.shtml

In this framework, it is important to recognize the role that science plays in Disaster Risk Reduction (DRR), since a more resilient community is also a community where science is successful in providing stakeholders and citizens with unambiguous and detailed information on risks (Béquignon *et al.*, 2010). GEO is committed to facilitate dialogue between science and civil society; encourage the adoption and use of quantitative and qualitative tools to measure risk; and create mechanisms and guidelines to communicate and understand risk and uncertainty. Objective and reliable information on hazard, vulnerability and exposure, presented through an analysis of expected impacts for given Risk Scenarios, is instrumental for triggering and, more importantly, sustaining the political will and economic strength needed to achieve adaptation and mitigation. In this regard, the role EOs can play is invaluable because of their contribution to the representation of complex dynamics and processes through detailed, unbiased and up-to-date risk maps.

Sharing data and information and making these resources readily accessible and usable by a large community of users is still a major challenge for the Disaster Task team of GEO. Technological and economic barriers to online access to data pose a real issue in a sector where IT development is evolving at ever greater speeds, driven by the increasing computational power of personal computers and personal devices and the growing popularity of technology-based applications for geocoding and location information. For GEO, it is of paramount importance to support the establishment of large, multi-sectoral and meshed data infrastructure at national, regional and global levels. Data infrastructures (or cyber-infrastructures) are critical to promoting an integrated use of data and the development of new data products, and the development of e-infrastructures to integrate observations through novel ICT solutions. This is key when managing data relevant to: the measure of 3D deformation in volcanic and tectonic areas; areas prone to flooding or landslides; and monitoring and understanding of pre-eruptive processes, ash emission, seismicity patterns, earthquake ground shaking maps, etc.

The development of federated data infrastructures can address the specific requirements of both *in situ* and satellite data providers. This would allow the implementation of coherent stakeholder interaction strategies to foster and disseminate progress in science, to address risk communication and, eventually, to adopt effective plans for long-term sustainability of the research infrastructures (such as the Supersites) in terms of financial and human resources.

GEOSS represents the collective effort of hundreds of governments and organizations, and thousands of individuals to monitor the Earth system, share and exchange Earth system data, and deliver useful information to society. GEOSS has enabled many countries to access information and thereby provide essential services to address challenges which otherwise would not have been met. Despite significant progress in recent years, there remain substantial gaps in ongoing national, regional, and global efforts to address these challenges. GEO has demonstrated it can play a key role in addressing these gaps in an effective and long-term manner through coordination and networking among its major stakeholders, and by working together with other key international environmental mechanisms.

References

Alleyne, N., Eddy, A., Frye, S., Saulnier J.F., Aube, G., Seguin, G., Capellaere, P. Caribbean Satellite Disaster Pilot: 2012. A CEOS Activity for GEO in support of GEOSS; proceedings from IEEE International Geoscience and Remote Sensing Symposium (IGARSS), 22-27 July, 2012, Munich, Germany.

Béquignon, J., Caughey, J., Cramer, W., Fellous, J.-L., Heip, C., Justice, C., Key, J. R., Koike, T., Lacaux, J.-P., Lafaye, M., Lafeuille, J., Mathieu, P.-P., Ranchin, T., Scholes, B. and Schroedter-Homscheidt, M., Edited by Fellous, J.-L. and Béquignon, J. 2010. GEO and Science. A report prepared in the framework of the GEO Science and Technology Committee in support of the GEO 2009-2011 Work Plan's Task ST-09-01 "Catalyzing Research and Development (R&D) Resources for GEOSS", pp.50, European Space Agency, EU.

Calais, E., Freed, A., Mattioli, G., Jonsson , S., Amelung, F., Jansma, P., Hong, S.H., Dixon, T., Prepetit, C., and Momplaisir, R. 2010. Transpressional rupture of an unmapped fault during the 2010 Haiti earthquake, doi 10.1038/NGEO992, Nature Geosciences.

CEOS, Strategic Gap Analysis for Earth Remote Sensing in Support of Floods Disasters, 2013.

de Groot, W.J., and Goldammer, J.G. 2013. The Global Early Warning System for Wildland Fire. Pages 277-284 in Vegetation Fires and Global Change - Challenges for Concerted International Action. A White Paper directed to the United Nations and International Organizations (J.G. Goldammer, ed., Global Fire Monitoring Center). Kessel Publishing House, Remagen-Oberwinter, Germany. ISBN: 978-3-941300-78-1

de Groot, W.J., and Flannigan, M.D. 2014. Climate change and early warning systems for wildland fire. In Preventing Disaster: Early Warning Systems for Climate Change (A. Singh and Z. Zommers, eds.) Springer, New York (in press)

FAO, 2006. Fire management review: international cooperation. Fire Management Working Paper 18. Food and Agriculture Organization, United Nations. Rome.

GEO, Group on Earth Observations. 2005. GEOSS 10-year Implementation Plan, 40 p., GEO Secretariat, Geneva (CH).

GEO, Group on Earth Observations. 2014. GEO 2012-2015 Work Plan, Revision-1, 82 p., GEO Secretariat, Geneva (CH).

GHCP, 2013. A Roadmap for the Geohazards Community of Practice of the Group on Earth Observations. Available at http://www.geohazcop.org/.

Hayes, G.P., Briggs, R.W., Sladen, A., Fielding, E.J., Prentice, C., Hudnut, K.,Mann, P., Taylor, F.W., Crone, A.J., Gold, R., Ito, T., and Simons, R. 2010. Complex rupture during the 12 January 2010 Haiti earthquake, Nature Geoscience 3, 800-805 (2010) doi:10.1038/ngeo977

Marsh, S., and the Geohazards Theme Team. 2004. Geohazards Theme Report, Integrated Global Observing Strategy Partnership. Available at http://www.geohazcop.org.