GROUP ON EARTH OBSERVATIONS

GSNL
GEO Geohazards Supersites and Natural Laboratories

Geohazard Supersites and Natural Laboratories 2.0 GEO Initiative GI-08

2017-2019 GSNL Implementation plan

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ACRONYMS

Acronym	Meaning
CEOS	Committee on Earth Observation Satellites

DCT	Data Coordination Team (of the CEOS)
DMP	GEO Data Management Principles
DOW	Document of Work
DP	Data Policy
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EPOS	European Plate Observing System
FDSN	Federation of Digital Seismic Network
GEOSS GCI	GEOSS Common Infrastructure
GEP	Geohazards Exploitation Platform
GFDRR	Global Facility for Disaster Reduction and Recovery
GNSS	Global Navigation Satellite System
GODI	Global Open Data Initiative
GPS	Global Positioning System
GSAC	Geodetic Seamless Archive Centers
HDDS	Hazard Data Distribution System (of USGS)
InSAR	SAR interferometry
IPRs	Intellectual Property Rights
IRIS	Incorporated Research Institutions for Seismology
IT	Information Technology
OpenDRI	Open Data for Resilience Initiative
RDA	Research Data Alliance
SAC	Scientific Advisory Committee of GSNL
SAR	Synthetic Aperture Radar
SB	Small Baseline
SSARA	Seamless SAR Archive
TBC	To Be Confirmed
TBD	To Be Defined
UNAVCO	University NAVSTAR Consortium
UNISDR	United Nations office for Disaster Risk Reduction
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
VRE	Virtual Research Environment
WG	Working Group
WOVO	World Organization of Volcano Observatories
WP	Work Package

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GSNL GEO Geohazards Supersites and Natural Laboratories

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1. Executive summary

The Geohazard Supersites and Natural Laboratory initiative (GSNL) is a voluntary international partnership ***aiming to improve, through an Open Science approach, geophysical scientific research and geohazard assessment in support of Disaster Risk Reduction***.

The GSNL goal is pursued promoting broad international scientific collaboration and open access to a variety of space- and ground-based data, focusing on areas with scientific knowledge gaps and high risk levels: the Supersites and the Natural Laboratories. For these areas a joint effort is carried out: the space agencies provide satellite imagery at no cost for scientific use, the monitoring agencies provide access to ground-based data, the global scientific community exploits these data to generate state of the art scientific results. The coordination of each Supersite is normally attributed to local geohazard scientific institutions and researchers which are already operationally providing authoritative geohazard information to support the decision makers. This process ensures that the new knowledge generated by the wider scientific community is rapidly taken up by the stakeholders to benefit hazard assessment, disaster monitoring and response actions.

The specific ***objectives*** of GSNL for the period 2017-2019 are:

1. *to enable the global scientific community open, full and easy access to a variety of space- and ground-based data, focusing over selected, high risk areas of the world: the Supersites and the Natural Laboratories;*
2. *to promote advancements in geohazard science over the selected sites;*
3. *to report scientific results relevant to geohazard assessment to authoritative bodies and other DRR stakeholders, supporting informed decision-making in Disaster Risk Management activities;*
4. *to innovate technologies, processes, and communication models, enhancing data sharing, global scientific collaboration, and capacity building in geohazard science;*

To reach these goals, in the period 2017-2019 the GSNL initiative will build on its past successes, increasing the number of Supersites (from 7 to 12-13) and improving several management and IT aspects, strengthening the way the Supersite scientists collaborate and generate new science.

Organization

The GSNL initiative is a network of communities which is governed by the scientific community and the data providers (space agencies and in situ monitoring agencies). The single Supersites are managed by scientific and monitoring institutes (e.g. USGS, INGV, GSN Science, IMO, etc.) which have a national mandate to provide geohazard scientific support to government agencies for DRM. This ensures the rapid uptake of scientific results by decision makers.

Implementation

The first 5 years of the initiative allowed to demonstrate the validity of the Supersite concept, showing that improved access to EO and in situ data is able to stimulate new science which can directly benefit the society. The process by which decision makers made direct use of the information produced and communicated by the scientific community was straightforward for some Supersites (e.g. Hawai'I, Iceland, Campi Flegrei, Ecuador). However much work will be done in the next three years to establish the conditions by which the same process can be applied on a more routine basis to all Supersites.

Given the networking character of the initiative, the planned activities are divided in two main groups: global level tasks, and Supersite level tasks.

The tasks to be carried out at the level of the global network concern the General management, the Networking, the Data provision and the Outreach and dissemination activities. These activities will be carried out by the SAC and CEOS DCT, supported by the single Supersite Coordinators, and concern routine duties, as review of Supersite progress, evaluation of new Supersite proposals, coordination and communication with other initiatives and projects, etc., but also targeted tasks as definition of a GSNL data policy, refurbishment of the website, development of a Virtual Research Environment for the communities, etc.

The tasks to be carried out at the single Supersite level concern the Management, the Community building, the Infrastructure development, the Outreach and dissemination activities. The Coordinators and the scientific community of the Supersites will carry out routine management and reporting activities, but will also work to increase participation, improve the level of collaboration, promote the open sharing of research results, establish better connections with local stakeholders, increase the visibility of their Supersite, establish clear procedures for in situ data access, etc.

Societal benefits

GSNL has succeeded so far to improve data access (EO and in situ) over the Supersites. This has benefited the quality of scientific results obtained by the scientific community, and in turn, for the Supersites where scientific support is operationally provided within a national framework, it has generated a positive impact on the prevention and response activities of the DRM users.

We will transfer the positive experiences and service models from the more mature Supersites to the less advanced ones, exploiting the role of the local community in the provision of scientific information services to local End-users. We will demonstrate the societal benefits of an Open Science approach to Geohazards and their related disasters, by exploiting a streamlined process by which research results from the global scientific community are operationally provided as consensus scientific information to the decision makers for direct use in DRR activities. Moreover, we will implement a process allowing the End-users to propose specific priority objectives to the global scientific community, promoting a more effective geohazard assessment, and ultimately improving the DRM actions taken at local level.

Resources

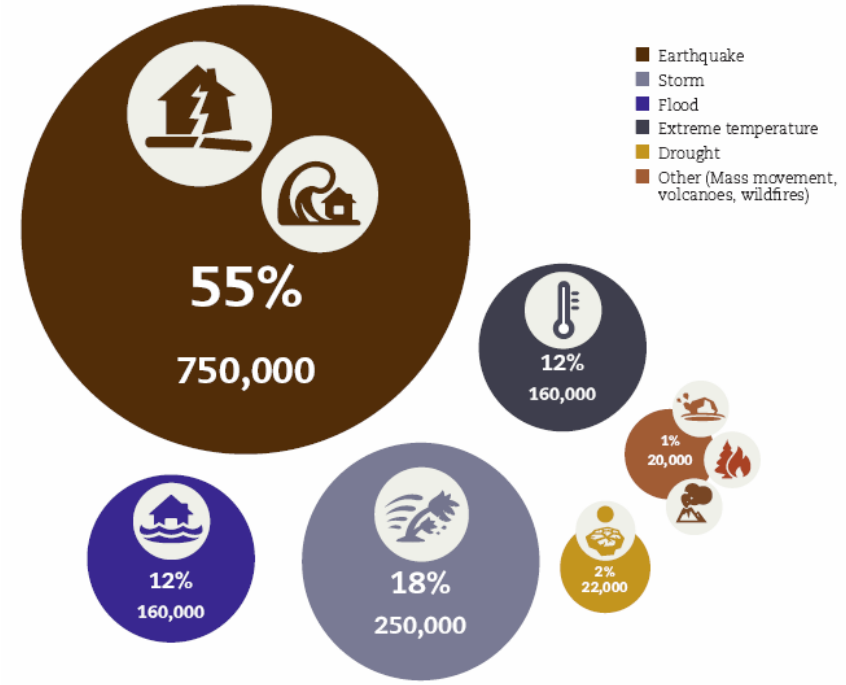
Since its inception the GSNL initiative was mainly based on voluntary contributions (data, efforts infrastructures) from the various partners. Only the European Supersites benefited from large EC funding (~6 M€ each), which allowed to further develop the monitoring and ICT infrastructures. We expect that in-kind support from the participants will remain the baseline funding model for 2017-2019, even for the Supersites providing operational services, which are part of public institutional service agreements at national level.

In addition, we expect that direct cash-funding for Supersite-specific tasks (e.g. for developing data infrastructures, monitoring networks, capacity building) will be obtained through national or international competitive calls.

The total resources (direct and in-kind) available for this 2017-2019 IP through contributions from the partnership, i.e. the CEOS agencies (including EO data and infrastructures as the ESA GEP), the monitoring agencies (in situ data and infrastructures), and the scientific community (management, research, dissemination), is estimated to be ~5.8 M€/year (of which 4.4 M€/year of commercial EO data costs).

2. Synopsis of objectives and benefits

Geophysical phenomena such as earthquakes, volcanic eruptions and landslides unfold as natural disasters when they meet with vulnerability of the human environment. While representing only 13% of the annual number of disasters, they are by far the deadliest type. In the last 20 years, they claimed over 770.000 lives, i.e. 56% of the total disaster-related deaths, causing huge economic damages (787 billion dollars/year) and affecting over 135 million people and 25 million homes, most of which in lower-income countries (CRED, 2015).



Number of deaths by disaster type in the period 1994-2013, CRED, 2015

The basic foundation of effective Disaster Risk Reduction is the accurate estimate of the relevant hazard (i.e. the probability of occurrence of the adverse effect in a certain area over a given time period). In the case of seismic and volcanic hazards the assessment requires continuous scientific investigations, since their causative processes are not completely understood (Rundle et al., 2003). The scale at which these phenomena and their preparatory processes are best studied, and at which most Disaster Risk Management actions are carried out, is the regional scale (up to 100s of km).

The Geohazard Supersites and Natural Laboratories initiative (GSNL) was started in GEO in 2010 to improve scientific knowledge on Seismic and Volcanic hazards in specific regions of the world.

The GSNL goal was to promote open and more complete access to a variety of space- and ground-based data needed for the generation of new science, focusing on zones with scientific knowledge gaps and high risk levels: the Supersites. On each Supersite a partnership among the space agencies (as satellite image providers), the national monitoring agencies (as ground data providers), and the global scientific community, was established through a peer review community process.

By 2015 the GSNL initiative proved to be very successful. In fact the Supersites demonstrated not only to be able to generate new science, but through the improved data access and monitoring capacities they also promoted the use of geohazard knowledge by DRM users.

In 2015 a process of revision began, to lead the initiative towards the generation of more direct and rapid societal benefits by improving the uptake process of new scientific results by decision makers. The revision process is still ongoing, and is bringing the new GSNL 2.0 initiative towards full compliance with the new GEO Strategic Plan, and with the role of science as envisioned in the Sendai Framework for Disaster Risk Reduction 2015-2030.

The specific objectives of GSNL 2.0 are:

1. to enable the global scientific community open, full and easy access to a variety of space- and ground-based data, focusing over selected, high risk areas of the world: the Supersites and the Natural Laboratories;
2. to promote the conditions by which state of the art geohazard science is generated by the global scientific community over the selected sites;
3. to communicate scientific results useful for geohazard assessment to authoritative bodies and other stakeholders, supporting informed decision making in Disaster Risk Management activities at the selected sites;
4. to promote innovation in the development and testing of technologies, processes, and communication models, to enhance data sharing, global scientific collaboration, knowledge transfer and capacity building in geohazard science and applications;

How these objectives are pursued is explained in Sections 5, 7, 8.

We stress that the GSNL 2.0 objectives are fully compliant with the GEO Strategic Objectives:

1. **Advocacy** of Earth observation. Thanks to the partnership with CEOS, GSNL is able to provide larger and more open accessibility to satellite imagery for DRR. The involvement of in situ monitoring agencies ensures that the ground data are also openly shared and used by a wider scientific community.
2. **Engagement** with stakeholders. The GSNL 2.0 model is based on a well-structured end-to-end engagement model including the data providers, the global scientific community and the local scientific community which acts as final service provider for the end-users. Through the Supersite, the local end-users will be able to make explicit their needs for new knowledge to the global scientific community, stimulating focused research of more direct societal benefit.
3. **Delivery** of useful products and services. The Supersites coordinators are part of the national authoritative frameworks for DRM, and their role is to ensure that the research products generated by the international community are effectively used for science-based decision-making at the local scale.

GSNL 2.0 will build on the successes of GSNL 1.0 (see Section 4), and is expected to generate the following outcomes and benefits:

- provide better EO and in situ data availability in developing countries, eventually benefit geohazard assessment and DRR activities;
- increase the type and quantity of satellite and ground data made available to the scientific community and DRR stakeholders, benefitting the quality of scientific results and of the information support to decision-makers;

- improve the international collaboration among scientists and geohazard stakeholders, testing in the Supersites procedures and approaches which could benefit geohazard stakeholders all over the world;
- contribute to reduce the impact of disasters providing international scientific support to local Prevention and Response actions.

Definition of GSNL 2.0 in the GEO Work Plan 2017-2019: Initiative or Flagship?

The GSNL 2.0 initiative is a network of communities. GSNL by itself does not have a formal policy mandate from international organisations, however the scientific and monitoring institutes coordinating the single Supersites (e.g. USGS, INGV, GSN Science, IMO, etc.) do have a mandate defined by national laws or regulations, to provide scientific support to government agencies for DRM.

In fact, for these scientific institutes one of the main reasons for committing to establish and maintain a Supersite on a given area is to develop better services for their DRM agencies of reference.

In most cases the relationship between the Supersite coordinator institution and its national government is truly operational, involving for instance formally ruled, continuous, 24/7 provision of services during emergency response. While such operational commitments are independent of the existence of the Supersite, the collaborative framework arising from the Supersite status allows the global scientific community to contribute in a more proactive and direct way to the generation of significant advances in geohazard science. According to the new GSNL 2.0 vision, the authoritative role of the coordinator within its national DRM value chain ensures that the improved scientific knowledge is effectively used to support the local hazard assessment for Prevention and Response.

At present the improved data access and the increased international collaboration has been used by most Supersites to provide operational services of high scientific quality. The baseline sustainability of the latter is achieved by the Coordinator through national resources, with additional specific project funding used for technological innovations. The international scientific community is generally funding its contributions through R&D projects.

We expect that in some less developed countries, due to the characteristics of the national DRM value chains (i.e. too fragmented or with loose science/government relationships), a Supersite may not be able to immediately provide well defined, continuous operational services to support DRM. In these cases the Supersite concept is still implemented, but with loosened initial requirements, with the mid-term goal to help the national service providers to eventually implement the full concept.

In summary, GSNL is a bottom-up global networking initiative governing the establishment and the support of local collaborative frameworks, most of which provide operational geohazard information services to national governments regulated by explicit national mandates.

GSNL cannot be easily classified within the present GEO Implementation mechanisms schematic description; we request the GEO Program Board to clarify the placement of the GSNL initiative in the 2017-2019 Work Plan.

3. Relationship to previous developments and results

This plan aims to continue and expand the 5-year developments of the GSNL initiative; at the end of 2015 the GSNL initiative was composed of 7 Supersites:

Permanent/Candidate* **Supersite**	**Coordinator**	**Coordinator institution**	**Date established**	**Available funding**
Hawaiian volcanoes	Michael Poland	USGS, Hawai`I, USA	October 2012	Internal USGS funding, project funding
Icelandic volcanoes	Freysteinn Sigmundsson, Kristin Vogfjord	University of Iceland and IMO Reykjavik, Iceland	November 2013	~6 M€ EC project 2013-2016, futurevolc.hi.is
Mt.Etna volcano	Giuseppe Puglisi	INGV, Catania, Italy	April 2014	~6 M€ EC project 2013-2016, http://med-suv.eu/
Campi Flegrei & Vesuvius volcano	Sven Borgstrom	INGV Naples, Italy	April 2014	
Marmara Fault	Semih Ergintav, Nurcan Meral Ozel	KOERI, Istanbul, Turkey	April 2014	~6 M€ EC project 2013-2016, http://marsite.eu/
Ecuadorian volcanoes	Patricia Mothes	IGEPN, Quito, Ecuador	October 2014	Internal IGEPN funding
Taupo volcanic zone, NZ	Nico Fournier, Ian Hamling	GNS Science, Lower Hutt, New Zealand	October 2014	Internal GNS funding,

* A candidate Supersite can become Permanent after the evaluation of its initial 2-year period.

Over 10 Event Supersites were also established in the period 2010-2015; for them the data provision was guaranteed only for ~one year after the event.

By the end of 2015, the two biennial reports for the Hawai'I and Iceland Supersites, provided evidence of the important results achieved. Other reports are expected in July 2016 (section 7).

The most important achievements of the initiative, and the challenges of GSNL 2.0 are:

Main achievements

- provision of open access to in-situ geophysical data for the Supersites;
- provision of thousands of satellite images to the Supersite scientific communities;
- generation of new scientific results over the Supersites, based on the open data;
- establishment of DLR Supersite data portal in support of GSNL and the CEOS Pilots;
- establishment of UNAVCO Seamless SAR archive (SSARA) for SAR data sharing;
- establishment of the ESA Supersites Exploitation Platform, now Geohazards Exploitation Platform (GEP), and the underlying Virtual Archive;
- provision of scientific monitoring information to DRM decision makers, to support volcanic unrest management in Hawai'I, Iceland, Campi Flegrei, Ecuador Supersites.

Challenges

- establish the SE Asia Natural Laboratory (see Task 1.3 in section 5);
- adapt the open data policy to the conditions in specific countries, ensuring that local scientists and data producers can benefit from the international collaboration;
- establish Supersites in regions with high risk levels and less research capacities;
- improve open sharing of further data types, research products and software;
- promote international collaboration and capacity building;
- fully implement an Open Science approach in the GSNL initiative.

4. Participants/contributors

The list of participants for each Supersite is provided in Annex C.
The institutions contributing to the GSNL initiative are listed below.

Agencies/institutes contributing governance support:

Organization	Type
Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy	Public monitoring/research institute
Incorporated research Institutions for Seismology (IRIS), USA	Non-profit university consortium
Division of Marine Geology and Geophysics (MGG) University of Miami, USA	Academia
European Plate Observing System (EPOS)	Consortium of research infrastructures
Swiss Seismological Service (SED) at Zurich ETH, Switzerland	Public monitoring/research institute
Institut de Physique du Globe de Paris, France	Public monitoring/research institute
UNAVCO, USA	Non-profit university consortium
WEGENER, EU	Voluntary research initiative

Agencies contributing satellite EO data:

Organization	Type
United States Geological Survey - USGS, USA	Public monitoring/research institute
Agenzia Spaziale Italiana - ASI, Italy	National space agency
Centre national d'études spatiales - CNES, France	National space agency
Canadian Space Agency - CSA, Canada	National space agency
Deutsches Zentrum für Luft- und Raumfahrt - DLR, Germany	National space agency
European Space Agency - ESA, Europe	International space agency
National Aeronautics and Space Administration - NASA, USA	National space agency
National Oceanic and Atmospheric Administration - NOAA, USA	Public scientific agency

Agencies/institutes contributing in-situ data:

Organization	Type
US Geological Survey – Hawaiian Volcano Observatory, United States	Public monitoring/research institute
Institute of Earth Sciences, University of Iceland	Academia
Iceland Meteorological Office, Iceland	Public monitoring/research institute
Istituto Nazionale di Geofisica e Vulcanologia, Italy	Public monitoring/research institute
Kandilli Observatory Earthquake Research Institute, Boğaziçi University, Turkey	Public monitoring/research institute
Instituto Geofísico - Escuela Politécnica Nacional, Ecuador	Public monitoring/research institute
GNS Science, New Zealand	Public monitoring/research institute

Other contributions:

Organization	Type of contribution
European Commission (through FP7 and Horizon 2020 programs)	Funding of research and infrastructural projects
European Space Agency	Satellite data. Research processing environment including storage, hosted processing chains and e-collaboration functions
Committee of Earth Observation Satellites - CEOS	Coordination of space agencies contributions. Disaster observation strategy and disaster pilots

Relationship with other GEO initiatives.

The 2017-2019 period will be important to consolidate the GSNL 2.0 concept and increase the number of scientists involved in active research at each Supersite. We will establish relationships with the regional GEO initiatives as AmeriGEOSS and AfriGEOSS, to stimulate their community to contribute to GSNL. Presently there are two Supersites in the Americas but none in Africa. Collaboration with these initiatives will be exploited also to coordinate more technical activities related to regional data sharing within GEOSS.

Capacity building will also be a strong theme for this IP. The Geohazard Supersites will increasingly promote the involvement of local scientists in international research, according to the GSNL 2.0 concept that transnational scientific collaboration is instrumental to provide better scientific support to local DRR activities at each Supersite. International collaboration is also the most important way to improve scientific capacities where they are less developed, ensuring that in the long term, the sustainability of the scientific support services for local Disaster Risk Management actions will rely on the local scientific community.

5. Description of activities

The overall planning of activities is divided in two main task groups:

1. Implementation and management of the initiative at the global level.
2. Implementation and management of existing and future Supersites at the local level.

5.1. Implementation and management of the initiative at the global level

Planned tasks:

Task	Task name	Description	Lead Participants
1.1	Management	Reform of the governance structure and rules to improve representativeness of the global geohazard scientific community. Invite some observer/adviser from the community of stakeholders. Periodically revise the Supersite requirements and proposal templates. Review Supersite progress through periodic reporting (annual/biennial). Request to all Supersites that the periodic reports contain specific statements by the Supersite end-users, evaluating the scientific support they received in terms of quality, timeliness, completeness. Research on an appropriate metrics to assess the results of Supersites to improve scientific research and societal benefits. Work with the CEOS WG Disasters to coordinate GSNL and other CEOS initiatives on Disasters, as the CEOS Disaster pilots, the GEO-DARMA initiative and the Recovery Observatory. Address with Space Agencies the issue of EO data access for Supersite scientists. Review and approve Event and Permanent Supersite proposals. Request more formal commitments from the GSNL participants as regards their support to the initiative, including resource allocation. Organize yearly meetings of the GSNL community at main geophysical conferences, as AGU and EGU.	**SAC Chair,** SAC members, CEOS DCT members
1.2	Networking activities	Establish a Natural Laboratory including different hazard sources. Improve the communication links and the collaboration with other international initiatives, and infrastructures, on Open Data (e.g. EPOS, EarthCube, Research Data Alliance, the World Bank's Open Data initiative, the Global Open Data Initiative, OpenDRI of GFDRR, WOWO and WOVOdat, etc.). Collaborate an strengthen the relationships between GSNL and the providers of data processing services, as the ESA Geohazard Platform, UNAVCO Plug & Play GPS project, the DLR TSX/TDX processing services, to improve the processing capacities of the single Supersites. Further increase the communication links and the collaboration with other DRR global/regional initiatives, as the Charter on Space and Major Disasters, UNISDR, UNSPIDER, WB/GFDRR, Sentinel Asia, CEOS Disaster Pilots, GEO-DARMA, AmeriGEOSS, AfriGEoss, etc. Establish contacts with development funding agencies to explore the possibility to support the establishment of Supersite in less developed countries. Improve collaboration with other scientific, user-oriented initiatives as the Global Earthquake Model and the Global Volcano Model.	**SAC Chair,** SAC members, CEOS WG Disaster members, Supersite Coordinators
1.3	Data	Promote the adoption of the GEO Data Management Principles by the	**SAC Chair,**

	provision	entire partnership, exploiting coordination with global/regional data infrastructures. Prepare a reference document on the compliance to DMP for each Supersite; request to Supersite coordinators to implement actions for alignment to DMP. Continue to pursue, as a priority for 2016, the establishment of the SE Asia Natural Laboratory (or an initially more limited Supersite). Discuss and publish a formal GSNL Data Policy document, base on the GEOSS data sharing principles. The document will provide a baseline DP, which can be adapted to local conditions. Implement e-collaboration services for the GSNL Supersite scientific network through the GEP and its R&D synergic EVER-EST project. Perform a survey on the research infrastructures used by each Supersite, assess the interoperability issues, provide a report and recommendations for a common approach. In collaboration with the CEOS WG Disasters, collect EO data needs from the Supersite scientific community and advocate for image quota allocation with the CEOS space agencies. In particular, pursue JAXA support for the initiative, to obtain L-band ALOS 2 data, explore the possibility to obtain Staring Spotlight mode TSX data and TanDemX DEM data. Provide support with licensing issues and verify quota consumption. Maintain web documents describing data access procedures. Promote within the Supersite community the data access services developed by existing data sharing infrastructures as for instance, EPOS, IRIS, UNAVCO GSAC/SSARA, and the Geohazard Exploitation Platform. Promote the use of GEOSS for data and product dissemination.	SAC members, CEOS DCT members, Supersite Coordinators
1.4	Dissemination & Outreach	Refurbish the present GSNL web pages now hosted on the GEO website, transforming them into a front-end portal to the various Supersite websites. Provide a graphical layout for adoption by the Supersites, to enhance the common visual branding of the GSNL initiative. Improve the graphical design of the website and provide more direct evidence of Supersite results and activities. Provide also web based services to promote virtual collaboration among scientists. Implement a publication repository for the scientific results generated within the Supersites. Collaborate with the GEOSS CDI team to ensure that all Supersite data and products are visible through a uniformed data discovery interface, at least for EO data/products. Investigate if it is possible to establish agreements with the main scientific publishers to get the permission to provide open access to all Supersite publications.	**SAC Chair,** SAC members, CEOS WG Disaster members,

5.2. Implementation and management of existing and future Supersites at the local level

Planned tasks:

Task	Task name	Description	Lead Participants
2.1	Supersite management	The Supersite Coordinator will periodically report to the SAC on the progresses and results of the Supersite. Synthetic reports will be provided every year, while a detailed report will be provided every two years.	**Supersite Coordinators,** Scientific community

		Coordinators will manage the licensing process for EO data, and ensure proper tasking of satellite image acquisition, if needed. Within the Supersite community, most scientists will likely have their own research projects, funded by national/international agencies, to which they have their own commitments and financial obligations. Thus the role of the Supersite Coordinator is mainly to coordinate the communication and the provision of services to the scientific community, to maintain a lively exchange of ideas and results, and to ensure that the research results are discussed and eventually reach the DRM users in a proper form. In the period 2017-2019 the Supersite management should improve to follow the planned changes to the GSNL initiative. The management activities will be more oriented to enlarge the community, improve the knowledge exchange and the sharing of research results in digital format, to ensure the proper attribution of IPRs, to promote the Supersite activities and seek national resources for sustainability of the Supersite infrastructure. To make the operational character of the scientific monitoring and research more evident, and create a framework for future sustainability, the Coordinator should oversee that the national DRM users explicitly acknowledge the existence of the Supersite and its advantages for the local/regional hazard assessment. Create a logo for each Supersite, reflecting in the logo graphics the GEO/GSNL membership. Cross reference the GSNL initiative in the Coordinator's institution web site. Organize yearly meetings of the Supersite community at main geophysical conferences, as AGU and EGU; report on the Supersite results in dedicated scientific sessions at geophysical and EO meetings (AGU, EGU, FRINGE, IGARSS; Living Planet, etc.).	
2.2	Supersite community building	For some Supersites, especially in less developed countries, the community building must be supported at least initially by capacity building. The latter should be organized in collaboration with existing initiatives in GEO and in the CEOS (e.g. WGCAPD). In this respect, we plan to share scientific codes for data processing among scientists, and to provide remote processing services. Supersite scientists will be asked to organize webinars to help the sharing of new knowledge and improve the coordination. Special student support programs will be requested to national and international funding agencies, with the help and coordination of the GSNL governance bodies. DRM stakeholders will be invited as observers into the community, with the following tasks: examine the scientific results provided by the Supersite, suggest priority scientific needs for hazard assessment, evaluate the use of the scientific information in their fields and provide suggestions for better communication procedures between the scientific and DRM communities.	**Supersite Coordinators,** Scientific community
2.3	Supersite infrastructure maintenance & development	The Supersite coordinators will implement actions to align the data and product management of their Supersite to the GEO Data Management Principles. This Task includes the generation of new scientific information and its release to local end-users for DRR activities. The different types of research products are described later in this section. This Task includes also the routine dissemination of EO and in-situ data for the Supersite. For those Supersites which do not yet provide web services for in situ data access, the Coordinator will define a clear road map to this aim. As a short term solution the Coordinator should use the opportunities provided by existing research infrastructures as UNAVCO,	**Supersite Coordinators,** In situ data providers, Scientific community

		IRIS, EPOS, etc. We will also invite Supersites to share Real Time GNSS data and products via streaming. For EO data access the community will use the specific portals developed by the CEOS agencies, providing feedbacks on their capacities. The Supersites should further take advantage of the ESA Geohazards Exploitation Platform (see Annex A) for EO data access, processing and pre-operations to improve the collaboration and effectiveness of scientific research. By 2017 further e-collaboration services will be available to the GSNL Supersite network from the EVER-EST VRE. Each Supersite community will be invited to test them. The Supersite Coordinator will promote the sharing of digital research products within the community, adopting the GSNL rules for proper IPR attributions as defined in the GSNL Data Policy. This should be done in a coordinated way with other international initiatives, adopting common metadata structures and ensuring long term data/product preservation and referencing them using also innovative tools as the Research Objects. Each Supersite should develop a unified web interface to facilitate discovery and access of the data and scientific products to the scientific users and to the public. Moreover Supersite coordinators will facilitate the interaction between data providers and GEOSS technical team to ensure that all the Supersite data could be discovered through the GEOSS GCI.	
2.4	Supersite dissemination /outreach	Collection of the scientific community contributions (presentations, publications, reports) within specific Supersite repositories. Prepare dissemination material for the public and DRM community, emphasizing the value of international collaboration and focused scientific research for hazard assessment and social benefits at the local scale. Obtain from Supersite end-users a periodic assessment of the scientific support they received, in terms of quality, timeliness, completeness. Create a website or specific web pages for the communication to the public of Supersite activities and results.	**Supersite Coordinators,** Scientific community

Specific products and services to be generated for the Supersites

As described in section 6 the single Supersites are normally coordinated by public research institutions which are part of the national Disaster Risk Management framework. This ensures that any scientific information generated by the Supersite community will be disseminated to the right end-users. The latter in turn are able to provide specific requirements to the Supersite coordinators for new research products which may be needed.

The table below shows the most common scientific products which are generated for the Supersites, divided in the two main phases of DRM. These products are generated (and periodically updated) by different research groups in an asynchronous way, and then disseminated to the end-user by the Supersite coordinator. Annex E shows some examples of Supersite products.

Science products to support Hazard Assessment and Risk Prevention	***Science products to support Disaster Response***
Ground deformation maps for seismic and volcanic areas (mean ground velocity over many years)	Ground deformation maps for earthquakes and volcanic eruptions and associated gravitational mass movements (ground displacement related to a single event, or displacement time series during or after the crisis)

Strain rate maps	Precise earthquake locations
Identification of active faults (mapping) and characterization of their kinematics	Regional Moment Tensor solutions
Models of active faults and estimates of fault slip rates, maximum expected event, recurrence intervals, and other parameters of fault activity	Coulomb stress transfer analysis maps
Earthquake hazard and damage scenarios	Maps and parameters of phenomena induced by earthquakes on the natural environment: fault scarps, soil liquefactions, ground fractures, triggered landslides, drainage network changes, etc.
Models and estimates of parameters for volcano plumbing systems	Maps and parameters of earthquake effects on the built environment: classification of building and infrastructure damage at different resolutions
Volcanic hazard scenarios, for lava flows, flank collapses, lahars, ash fall, ash clouds, etc.	Identification and characterization of magma chambers and plumbing systems during eruptions
Topographic maps (periodical updates)	Models of maximum deviatoric shear stress caused by ground deformation episodes during volcano unrest.
Land use and exposure maps (periodical updates)	Maps and parameters of the effects of volcanic eruptions, as fractures, collapses, pyroclastic flows, lahars, lava flows, lava domes, ash falls, ash clouds, etc. and their interaction with the natural and built environments
Others	Near real time scenarios for mass eruption rate, plume heights, ash fall, etc.
	Others

6. Involvement of end-users

There are three main types of stakeholders involved in the GSNL initiative:

1. **The data providers** (for in situ and EO data). They are mostly contributors to the initiative, however they also use GSNL to promote their activities, demonstrating the societal benefits of the data they produce.
2. **The global geohazard scientific community**. Scientists use the initiative to obtain an easier and open access to a large quantity of EO data, plus in situ data which may not be easily accessible outside of the Supersite framework. They are motivated by the scientific research, by the possibility to improve their capacities through a focused collaboration, and by the possibility to contribute with their work to generate direct societal benefits in DRR.
3. **The final users of the geohazard scientific information**. This category includes policy makers and decision makers at international/national/regional scales, the industry sector, the responders, the general public. These are what we call **End-users**.

When the GSNL initiative was originally started in 2010 as a direct agreement between the first two stakeholder categories, the main users of the Supersite data were the researchers.

In the first 5 years of activity it became clear that the End-users were in most cases the final recipients of the scientific results of most Permanent Supersites, thanks to the well established relationships between the local researchers and the national/regional decision-makers. Given the existence of national security issues in all disaster-related activities, all public and government End-users formally accept scientific support on DRM only if delivered through national authoritative bodies. As mentioned in the previous sections the Coordinators of the existing Supersites belong to such authoritative bodies, which caused the communication link between the scientific community and the end-users to be fully open and working well.

This successful proof-of-concept obtained for the initial Supersites stimulated the changes which are being formally implemented in GSNL 2.0. In fact, starting November 2015, the new requirements for a Permanent Supersite request coordination with the national DRM end-user community, and an explicit commitment of the international scientific community (not just the local one) to support the end-users' uptake of the science products generated for the Supersite.

At present one of the main challenges of GSNL 2.0 is promoting efforts by the global scientific community in providing support to local DRM actions and decisions. This is especially important for Supersites in less developed countries, where local capacities may be limited.

A precondition to solve this issue is to recognize the central role of the local scientific institutes as official providers of scientific information services to the local end-users, especially where this is regulated in a formal operational framework. With these premises we plan to implement a process by which the results obtained by all scientists are shared and discussed within the community under the Coordinator supervision, eventually establishing consensus on a final outcome. The Coordinator can then use its institutional channels to convey the scientific information to the decision makers. Such information will be provided as a report explaining in a

clear way all the uncertainties arising from the different points of view of the wider scientific community.

We expect that the DRM actions taken at local level will considerably benefit from this process.

The end-users presently receiving scientific support information conveyed through the Supersite Coordinators are listed below:

Permanent Supersite	End-user
Hawaiian volcanoes, USA	Hawai'I County Civil Defense, Hawai'I Volcanoes National Park
Icelandic volcanoes	Icelandic Police - Dep.t of Civil Protection and Emergency Management, Environmental Agency of Iceland, Directorate of Health
Mt.Etna volcano, Italy	National Department of Civil Protection, Regional Civil Defense
Campi Flegrei & Vesuvius volcano, Italy	National Department of Civil Protection, Regional Civil Defense
Marmara Fault, Turkey	Istanbul municipality
Ecuadorian volcanoes	Secretariat for Risk Management, Regional governments, Municipalities
Taupo volcanic zone, New Zealand	End users include: Ministry of Civil Defence and Emergency Management, Department of Conservation, Regional councils, MetService

Assessment of impact on DRR activities

The actual impact of scientific support products in the DRR activities carried out by end-users depends on a quantity of factors, e.g. on the quality of the products, the timeliness of delivery, the capacity of users to understand and fully use the scientific information, the contingent situation in which the actions are carried out, and many others.

The easiest, albeit not necessarily most accurate, way to assess the impact of the scientific support products in DRR activities is to ask the end-user themselves. However, since the end-users are part of the value-adding process to this information, through their independent decisions, they may not be necessarily objective evaluators. In some cases it may be expected that the assessment of the impact of the scientific information they receive be influenced by the rate of success of their own decisions even when the latter is due to other factors.

Notwithstanding these weaknesses this is the most direct way by which the scientific community can get important feedbacks on their work. Thus the GSNL SAC will request that the periodic Supersite reports contain specific statements by the Supersite end-users, evaluating the scientific support they received in terms of quality, timeliness, completeness (Tasks 1.1 and 2.4).

7. Planning of implementation and related issues

Resources for implementation

The Tasks described in this implementation plan will be carried out by the SAC, the CEOS space agencies, the Supersite Coordinators and the participants listed in Annex C. The actual specific partner contributions for each of the tasks listed in section 5 (and any other which may be needed during implementation) cannot be exactly defined here, since most of them are provided through in-kind resources which are committed by each partner on a yearly base.

Beyond the use of in-kind contributions, the GSNL partnership will be seeking specific cash-funding for the implementation of the planned tasks. In the period 2013-2016 the activities of four European Supersites (Mt. Etna, Campi Flegrei/Vesuvius, Marmara and Iceland) were supported by large funding resources obtained through EC FP7 projects. These projects resulted in the improvement of the monitoring networks and ICT data infrastructures on those Supersites. Similar proposal will be submitted in future competitive calls to support GSNL.

In general the success of any Supersite implementation depends on two main correlated factors: **observational capacity**, i.e. capacity to generate enough observations to monitor and model the phenomena and their associated hazards, and **scientific capacity** of the Supersite community to generate new science able to ultimately reduce the risk.

The observational capacity can be highly variable, especially in terms of quantity and density of instruments and collected data, and depends from the local situation for the in situ data and from the space agencies' priorities (some also commercial) of covering the area. In the ideal conditions we expect that the Supersites have already well developed in situ monitoring networks which are upgraded and maintained on national funding. In less developed countries the situation is often much less than ideal and cash-funding for the optimal development of the in situ monitoring networks need to be obtained at international level, leveraging on the GEO Supersite framework. For the satellite data the GSNL partnership is instead able to improve the areal coverage by all satellite platforms (including the commercial ones), mobilizing large quantities of in-kind resources from the CEOS space agencies (see section 11).

The scientific capacity is constrained by the amount and quality of the available observations, but is also largely depending on international resources for collaborative activities as knowledge sharing, capacity building, networking, dissemination, ICT data and processing infrastructures, etc. These resources are provided in-kind by some of the participants (e.g. the ESA Geohazard platform, see Annex A) but will also be obtained through competitive calls or institutional block funding (e.g. from the Supersite Coordinating institutions).

As reported in section 11, the only active R&D project providing some direct (cash) funding for part of the activities in Tasks 1.3, 1.4 and 2.3, 2.4 is the EVER-EST project (EC H2020 program). The GSNL SAC Chair and three Supersite Coordinators are involved in EVER-EST (which is managed by ESA) and its activities are perfectly aligned with this implementation plan. EVER-EST will develop a Virtual Research Environment (VRE) for the GSNL scientific community, to be completed in October 2018; this is thus a formal milestone for this IP.

The EVER-EST VRE is designed to provide a variety of collaboration services aimed at improving the scientific interactions and productivity in the Supersite and its technical solutions will be possibly exploited in the ESA-GEP. EVER-EST will be fully compliant to the GEOSS GCI, and

interoperable with data infrastructures which are providing in-kind support to GSNL, as the UNAVCO GSAC/SSARA and EPOS.

The Geohazards Exploitation Platform of ESA will continue to provide in-kind support to GSNL in the form of storage, processing and collaborative services (see Annex A). The GEP is supporting also the geohazard community of the CEOS WG Disasters and other international activities. The GEP is potentially one of the most important assets to improve the scientific capacity of the GSNL community for EO data processing/analysis. The long term sustainability of the GEP and of its support to GSNL is envisioned through new approaches based on virtualization and federation of EO based capabilities and linking them to research network such as the European EPOS Research Infrastructure. However the formal commitment of ESA concerns development and pre-operations up to the end of 2017.

UNAVCO is also providing in-kind resources to GSNL activities mostly in terms data storage and data/processing services, but is also providing technical and management support. The UNAVCO Seamless Geodetic and SAR archives (GSAC/SSARA) are extensively used by Supersite scientists globally. UNAVCO services are presently being extended to research products, and are fully interoperable, so it is expected that the GSNL community will continue to exploit them in the future. UNAVCO is also providing processing capabilities within its Plug & Play GPS project. Long term sustainability is ensured by internal in-kind support.

EPOS is presently developing an European infrastructure to provide interoperable data and product services to the Earth Science community; its services will be gradually available to the Supersites according to the EPOS implementation plan schedule.

For optical satellite imagery and derived products, the USGS will provide data hosting services for its Supersites on the Hazards Data Distribution System (http://hddsexplorer.usgs.gov).

Reporting on implementation

As already mentioned the GSNL governance requires periodic reporting of the Supersite activities by the Coordinators: synthetic reports every 12 months and detailed reports every 24 months after Supersite establishment. These reports are assessed also by the CEOS supporting agencies during the CEOS WG Disaster meetings and their periodicity is considered reasonable.

The schedule of the next biennial reports is shown below.

Supersite	Biennial report 1	Biennial report 2	Biennial report 3
Hawai'I	Available here	25-Oct-16	25-Oct-18
Iceland	Available here	5-Nov-17	5-Nov-19
Etna	9-Jul-16	9-Apr-18	8-Apr-20
Campi Flegrei	9-Jul-16	9-Apr-18	8-Apr-20
Marmara	9-Jul-16	9-Apr-18	8-Apr-20
Ecuador	29-Oct-16	29-Oct-18	28-Oct-20
Taupo	29-Oct-16	29-Oct-18	28-Oct-20

For improved monitoring of the implementation, starting from this Implementation plan, the SAC will request specific reporting on the single Tasks every 12 months (or when needed) to provide to GEO evidence of the progresses.

Implementation schedule and milestones

The temporal planning for the tasks described in section 7 is shown in the following chart:

		2017			2018			2019		
Task	**Description**	**Q1**	**Q2**	**Q3**	**Q1**	**Q2**	**Q3**	**Q1**	**Q2**	**Q3**
1.1	Management									
1.2	Networking activities									
1.3	Data provision									
1.4	Dissemination/ Outreach									
2.1	Supersite management									
2.2	Supersite community building									
2.3	Supersite infrastructure development									
2.4	Supersite dissemination/ outreach									

For several of the sub-tasks in 1.1, 1.2, 2.1, 2.2 the proposed temporal planning is based on voluntary contributions, which makes it difficult to identify rigorous milestones. The latter can be identified with good confidence only in connection with the milestones of projects supporting GSNL either with funding or with in-kind resources, as follows.

The green line shows the February 2017 milestone marking the availability of the improved integrated services of the ESA-GEP.

The blue line shows the October 2017 milestone marking the availability of EO-based Level 1 products from the EPOS RI (to be disseminated through the ESA-GEP).

The red line shows the October 2018 milestone marking the availability of the GSNL VRE e-collaboration services from the R&D EVER-EST project, and the availability of Level2-3 products from the EPOS TCS 12.

8. Data management & data policy

The core datasets for the GSNL initiative are satellite EO data and in-situ data.

The main satellite EO data used by the community to date are:

Type of data	Data provider	How to access	Type of access
ENVISAT	*ESA*	*http://eo-virtual-archive4.esa.int*	*registered public*
RADARSAT-1	*CSA*	*FTP access*	*GSNL scientists*
TerraSAR-X	*DLR*	*https://supersites.eoc.dlr.de/ UNAVCO*	*registered public*
Cosmo-SkyMed	*ASI*	*Via the ESA-GEP portal, UNAVCO SSARA*	*GSNL scientists*
RADARSAT-2	*CSA*	*Via UNAVCO, ESA-GEP or FTP access*	*GSNL scientists*
Sentinel-1	*ESA*	*https://scihub.esa.int/dhus/*	*registered public*
Pleiades/SPOT 5	*CNES*	*Tbd*	*registered public*
Landsat	*USGS*	*http://hddsexplorer.usgs.gov*	*Registered public*

The main in situ data used by the community (not all types are provided by each Supersite):

Type of data	Data provider	How to access	Type of access
GPS/GNSS	*Supersite communities*	*UNAVCO, Iceland catalogue, Mt.Etna catalogue, FTP and streaming data and product access*	*unregistered or registered public*
Seismic	*Supersite communities*	*IRIS, Italian catalogue, Iceland catalogue, FTP access*	*unregistered public*
Gas Emission analysis	*Supersite communities*	*Text Reports, FTP access*	*GSNL scientists*
Gravity	*Supersite communities*	*Text Reports, FTP access*	*GSNL scientists*
Tilt, levelling	*Supersite communities*	*Text Reports, FTP access*	*GSNL scientists*
Camera	*Supersite communities*	*Web links or Text Reports, FTP access*	*GSNL scientists*
Strain	*Supersite communities*	*Text Reports, FTP access*	*GSNL scientists*
Geological data	*Supersite communities*	*Text Reports, FTP access*	*GSNL scientists*
Ground-based radar	*Supersite communities*	*Iceland catalogue, FTP access*	*unregistered public or GSNL scientists*
Infrasonic data	*Supersite communities*	*Iceland catalogue, FTP access*	*GSNL scientists*
VNIR/TIR video camera data	*Supersite communities*	*Iceland catalogue, FTP access*	*GSNL scientists*

GSNL promotes the adoption of the GEO Data Management Principles by all the Supersite communities. The Annex D describes the status of adherence to the GEO DMP of the present GSNL data management practices. A more detailed analysis of the level of compliance to the DMPs for each Supersite will be carried out in Task 1.3, at the beginning of the implementation period, to develop a reference document based on which actions for alignment should be put in place by each Supersite (in Task 2.3).

During the evaluation stage of the initial proposal, Supersites are assigned a quota of EO data by each space agency, up to several hundreds of images/year. These values may be increased through time, based on the evidences of Supersite success. The EO data are presently discoverable and accessible through web services, with the exception of Radarsat 2 datasets.

The in-situ data for some older Supersites are distributed mostly through web services and web-based infrastructures (e.g. UNAVCO SSARA/GSAC, IRIS, EIDA), but there are Supersites for which a data infrastructure is not yet in placee. Task 2.3 will address this issue. Moreover, whereas seismic data are provided by file and streaming access, GNSS data are usually only provided as 15 second sampled daily files via FTP service. For geohazards applications, however, there is a strong movement toward providing real-time high rate (1 second sampled) GNSS data and derived positions time series as streams. The International GNSS Services (IGS) has taken the lead in this effort and now has 175 globally distributed stations contributing streaming data to the IGS Real-time Service (http://www.igs.org/rts).

Most of the data are already discoverable through GEOSS, although for the actual data access in some cases login credentials are needed. Task 1.3 will address a better integration with the GEOSS GCI, and ensure that all Supersite datasets become part of the GEOSS Data Core.

It should be noted that the requirement to use login credentials, obtained through a registration process, is not in contrast with the GEO principle of Open data sharing. The data access is still open (with the exceptions listed below) for those who register; this further step is mainly needed to monitor the usage of the data. However there might be limitations to this principle due to sensitivity of the data (e.g. during initial emergency response), or to specific local situations. For example, in Indonesia the open sharing of geohazard monitoring data is limited by national regulations and the data sharing needs to be ruled within a bilateral MoU with the data provider. The GEO-GSNL initiative provides a useful framework to increase data accessibility to a larger scientific community.

Starting from 2015, GSNL 2.0 is requesting the Supersite communities to provide open access also to scientific products in digital format (e.g. maps, models, simulations, etc.), not just raw data. The sharing of products requires further developments, as the definition of metadata and formats, management of IPRs and proper attribution through Persistent Identifiers and licensing. GSNL will exploit the activities carried out in this field by UNAVCO and EPOS, and will test different options in the EVER-EST VRE (Tasks 1.3 and 2.3).

Since the inception of the GSNL initiative, our data policy has always been aligned to the pre-2015 GEO Data Sharing principles. The experience gained in the establishment of 7 Supersites in different countries, and the discussions undertaken with prospective Supersite communities in further countries (e. Indonesia, Philippines, Iran, China) have clearly shown that the fully open data policy is not applicable in some contexts. Rather than excluding these countries and their populations from the benefits of the Supersite initiative, we believe that partial limitations to the fully open data sharing principle could be accepted if at least the open access to the scientific community is granted. In fact, the post-2015 GEOSS Data Sharing Principles, recognize

the need to accept the national limitations as a way to encourage and promote in the mid-term the adoption of really open data policies. Thus GSNL 2.0 totally supports the new Data Sharing Principles and will acknowledge them in a formal Data Policy document to be adopted by all Supersites.

9. Risk assessment

The main risks in the implementation of the foreseen Tasks arise from the difficulties in planning activities based for a large part on voluntary contributions and in-kind support. These resources are often committed on a yearly base, and might be subject to fluctuations (decrements or increments) during the Implementation Plan period.
As a mitigation, the GSNL governance will request at the beginning of each year, a support plan to all contributing partners asking to commit specific resources to the single sub-tasks.
If a specific activity loses support the Task will be re-evaluated and the activity re-assigned or put on hold.
We do not foresee any risk able to put a halt to the entire initiative.
Risks at the single Supersite level may consist in the difficulty to keep at a high level the interest of the research community to investigate new scientific problems. We expect that, given the slow dynamics of the phenomena of interest, especially for interseismic periods between earthquakes there could be periods of slower scientific advancements. However this is a typical feature of the progress of seismological and volcanological research and in fact the Supersite status may even reduce this problem, due to its capacity to attract international collaboration.

10.Management and governance

The GSNL initiative is presently managed at central level by the Scientific Advisory Committee, which works in close collaboration with the CEOS Data Coordination Team. The activities of the SAC are supported by their respective organizations as in-kind contributions.

The composition of the Scientific Advisory Committee is as follows:

Name	Role	Affiliation
Stefano Salvi	SAC Chair	Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy
Tim Ahern	Member	Incorporated research Institutions for Seismology (IRIS), USA
Falk Amelung	Member	Division of Marine Geology and Geophysics (MGG) University of Miami, USA
Massimo Cocco	Member	INGV and European Plate Observing System (EPOS)
Florian Haslinger	Member	Swiss Seismological Service (SED) at Zurich ETH, Switzerland
Yann Klinger	Member	Institut de Physique du Globe de Paris, France
Chuck Meertens	Member	UNAVCO, USA
Susanna Zerbini	Member	WEGENER, EU

The composition of the CEOS Data Coordination Team is as follows:

Name	Role	Affiliation
Brenda Jones	DCT Chair	United States Geological Survey - USGS, USA
Simona Zoffoli	Member	Agenzia Spaziale Italiana - ASI, Italy
Steven Hosford	Member	Centre national d'études spatiales - CNES, France
Christine Giguère	Member	Canadian Space Agency - CSA, Canada
Jens Danzeglocke	Member	Deutsches Zentrum für Luft- und Raumfahrt - DLR, Germany
Ivan Petiteville	Member	European Space Agency - ESA, Europe
Chu Ishida	Member	Japan Aerospace eXploration Agency - JAXA, Japan
Frank Lindsay	Member	National Aeronautics and Space Administration - NASA, USA
Bob Kuligowski	Member	National Oceanic and Atmospheric Administration - NOAA, USA

Secretarial support is given by GEO Secretariat, although at the time of writing no stable point of contact in GEOSec has been identified for the Disaster resilience SBA.

Each Supersite is managed by a Coordinator (they are listed in section 6). The Coordinators take autonomous decision but they have to respect the commitments declared in the initial proposals, and the general rules of the initiative. This is demonstrated through periodic reporting.

Intermediate summary reports are requested about once per year to each Supersite Coordinator by the SAC Chair. The latter presents the intermediate results to the governing bodies of GSNL during SAC meetings, and during the meetings of the CEOS Working Group on Disasters, twice per year.

Communication with the wider GSNL community is carried out through the GSNL website (to be refurbished in 2017), through mailing lists, and through face to face meetings (at least once a year) organized during large geophysical/geoscience conferences (AGU meeting in the USA and EGU meeting in EU).

Several presentations per year on the initiative and its accomplishments are done, mostly by the SAC Chair and the Supersite Coordinators, at scientific or stakeholder meetings.

It should be noted that a new governance model has been requested by the SAC, and is under study, to be likely implemented in Q1 2017.

11. Summary of committed resources

As mentioned in section 9 the majority of the resources supporting the GSNL initiative are provided in-kind by the participants. It is difficult to provide an accurate value assessment of in-kind resources provided by such a complex partnership. The contribution of the CEOS agencies is clear, since it is expressed in satellite data products. We value in the table below only the commercial satellite data acquired on demand for the Supersite needs.

The operation of in-situ instrument networks occurs for the most part independently of Supersite existence, but in GSNL there are specific resources dedicated to management, data integration, service interoperability and dissemination (Task 2.3).

The table below shows an estimate of the resources available to GSNL for 2017-2019. There is an inherent uncertainty in the in-kind resources allocation, given the voluntary nature of the initiative, and because they are in many cases identified on a yearly basis. Starting 2017 we will request more formal commitments from the participants, including for resource allocation (Task 1.1). For these reasons we cannot provide a detailed annual budget.

Task	Source	Amount/year
1.1 Management	In-kind: INGV, ETH, UNAVCO, IRIS, Univ. of Miami, Univ. Bologna, IPGP	Total in-kind ~105 K€
1.2 Networking activities	In-kind: INGV, ETH, UNAVCO, IRIS, ESA, USGS, NASA	Total in-kind ~80 K€
1.3 Data provision	In-kind for in-situ data: INGV, ETH, UNAVCO, IRIS, USGS, EPOS, ESA In-kind for commercial satellite data: ASI, DLR, CSA	Total in-kind ~200 K€ Total in-kind: 4400K€
1.4 Dissemination & Outreach	Cash: EVER-EST project In-kind: INGV, UNAVCO, ESA, USGS	Total cash ~40 K€ Total in-kind ~95 K€
2.1 Supersite management	In-kind: INGV, USGS, Univ. of Iceland, IMO, KOERI, GNS Science, IGEPN	Total in-kind ~215 K€
2.2 Supersite community building	In-kind: INGV, USGS, Univ. of Iceland, IMO, KOERI, GNS Science, IGEPN	Total in-kind ~35 K€
2.3 Supersite infrastructure maintenance & development	Cash: EVER-EST project In-kind: UNAVCO, INGV, USGS, Univ. of Iceland, IMO, KOERI, GNS Science, IGEPN, ESA-GEP	Total cash ~175 K€ Total in-kind ~385 K€
2.4 Supersite dissemination & outreach	Cash: EVER-EST project In-kind: INGV, USGS, Univ. of Iceland, IMO, KOERI, GNS Science, IGEPN	Total cash ~50 K€ Total in-kind ~30 K€

Annual planned income from in-kind resources: 5545 K€. Annual planned income from cash resources (intended as funding directly assigned to GSNL activities identified in this IP): 265 K€.

There is clearly need for additional resources, in particular at the level of the Supersite, for technological improvements of monitoring networks, data management, capacity and community building. Normally, the local data and service providers are supported by national research programs and institutional funding. However, to increase the number of Supersites in less developed countries, further funding opportunities should be sought. Since one of the main

objectives of a Supersite 2.0 is to provide scientific support to DRR activities of local users for both Prevention and Response, there should be the possibility to develop and support the local Supersite infrastructure through development funding. We will explore these new funding opportunities through direct contacts with development aid agencies and development banks, and through a close collaboration with the new GEO-DARMA initiative, which is also aiming to stimulate the provision of products and services for DRR, although not limited to geophysical disasters. These actions will be carried out by the GSNL management (Task 1.2) in strict collaboration with Supersite coordinators, even at the proposal stage.

12. ANNEXES

A. Technical Annex

The contribution of the ESA - Geohazards Thematic Exploitation Platform

Description provided by ESA

The Geohazards Exploitation Platform (GEP) is a contribution from ESA to support the GSNL initiative, the CEOS WG Disasters and its Pilots and the broader geohazards community.

The Geohazards Exploitation Platform or Geohazards TEP (https://geohazards-tep.eo.esa.int) is an ESA originated R&D activity on the EO ground segment to demonstrate the benefit of new technologies for large scale processing of EO data. The platform was expanded to support the geohazards community's objectives as defined in the context of the International Forum on Satellite EO and Geohazards organised by ESA and GEO in Santorini in 2012. The GEP is a follow on to the Supersites Exploitation Platform (SSEP) an ESA initiative to support the Geohazards Supersites & Natural Laboratories initiative (GSNL).

The Platform allows both on demand processing for specific user needs and systematic processing to address common information needs of the geohazards community as a whole, as well as massive processing on multi-tenant computing resources on the Cloud that will address the challenges of monitoring tectonic areas on a global basis, and of studying a range of geohazards. To exploit the geo-information generated using the Platform, the GEP will leverage open APIs for the integration of interactive processing and post-processing services.

The GEP follows a model for partnership and community building that is user driven. Fundamentally the current prototype has been designed working on requirements from users of the geohazards community in the context of the Geohazards Supersite initiative (GSNL) and the CEOS Disasters Working Group. Both the GSNL and the CEOS WG Disasters are a Task of the Disaster Societal Benefit Area of the intergovernmental Group on Earth Observations (GEO). The CEOS WG Disasters is running Pilots including a Volcano Pilot and a Seismic Pilot with a range of expert users globally (30 organisations from 12 countries as of Q2 2016).

In particular the GEP supports users and Supersites of the GSNL initiative directly and through the CEOS Seismic Pilot Objective B, for EO data exploitation with hosted processing of ESA and non ESA EO data, using processing chains from the geohazards scientific community or commercial software.

The costs associated to the GEP can be split into the following components:

- **Expert Users Support:** Help thematic service owners in integrating algorithms, publish results, interconnect existing services within GEP

- **Infrastructure:** ICT resources for data storage and computing. It does not include commercial data/software fees
- **Platform Evolution:** Development of new or updated capabilities, including both minor and major updates and bug-fixing
- **Platform Operations:** Basic operational tasks (making sure the platform is up and running, adding/removing users, etc…), support to final users, outreach (including travels), costs for minimum hardware infrastructure and commercial data/software fees

The cost associated to the Geohazards platform exploitation in the framework of GSNL, CEOS and EPOS are based on new models associated to virtualized and federated assets integrated and operated as an on line marketplace.

Committed resources over the 2011-2017 period:

- Storage on Virtual Archive 2 to support GSNL (task in the context of GEO): ~50K industrial cost.
- SuperSites Exploitation Platform (SSEP, processing environment and storage, task in the context of GEO) : 300K industrial cost.
- TEP Quick Win (continuation of SSEP): 500K industrial cost (in the context of CEOS DRM).
- GEP (scaling up SSEP in the framework of GSNL and CEOS WG Disasters : 925k euro.
  Sub total: 1.775 MEuro industrial cost, summing the ESA contracts to develop the GEP and its precursors.
  Consolidated Sub total: 2.1 MEuro counting ESA internal costs (i.e. staff/facilities) as in-kind contribution.
  Revised total: 700 kEuro, counting that about one third of the total costs are associated to directly support the GSNL activities. In average, up to 2017, the annual cost associated to the GEP capability is around 400kEuro/yr of which 100kEuro/yr concern support dedicated to GSNL activities.

The resources provided through the GEP are used to support a range of activities such as:

- Data provision
- Networking
- Data processing/modeling
- Dissemination & Outreach
- Geohazards community building
- Supersite infrastructure maintenance & development

B. CV of SAC Chair

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Authored/co-authored peer reviewed journal papers in the last 5 years:

Tolomei C., Salvi S., Merryman Boncori J. P., Pezzo G., InSAR measurement of crustal deformation transients during the earthquake preparation processes: a review, Bollettino di Geofisica Teorica ed Applicata, Vol.56,n.2, doi:10.4430/bgta0143, 2015.

Atzori, S., Antonioli, A., Salvi, S. and Baer, G., 2015. InSAR - based modeling and analysis of sinkholes along the Dead Sea coastline. Geophysical Research Letters, 42(20), pp.8383-8390.

De Santis, A., De Franceschi, G., Spogli, L., Perrone, L., Alfonsi, L., Qamili, E., ... & Tao, D. (2015). Geospace perturbations induced by the Earth: the state of the art and future trends. Physics and Chemistry of the Earth, Parts A/B/C.

Boncori, J. P. M., Papoutsis, I., Pezzo, G., Tolomei, C., Atzori, S., Ganas, A., ... & Antonioli, A. (2015). The February 2014 Cephalonia Earthquake (Greece): 3D Deformation Field and Source Modeling from Multiple SAR Techniques. Seismological Research Letters, 86(1), 124-137.

Pezzo, G., Boncori, J.P.M., Atzori, S., Antonioli, A. and Salvi, S., (2014). Deformation of the western Indian Plate boundary: insights from differential and multi-aperture InSAR data inversion for the 2008 Baluchistan (Western Pakistan) seismic sequence. Geophysical Journal International, 198(1), pp.25-39.

Atzori S., Salvi S., 2014, SAR data analysis in Solid Earth Geophysics: from science to risk management, In: Land Applications of Radar Remote Sensing, Edited by F. Holecz, P. Pasquali, N. Milisavljevic and D. Closson, InTech, ISBN 980-953-307-1017-3

Tolomei, C., Taramelli, A., Moro, M., Saroli, M., Aringoli, D., & Salvi, S. (2013). Analysis of the deep-seated gravitational slope deformations over Mt. Frascare (Central Italy) with geomorphological assessment and DInSAR approaches. Geomorphology, 201, 281-292.

Ran N. Nof, Gidon Baer, Alon Ziv, Eli Raz, Simone Atzori, and Stefano Salvi, 2013, Sinkhole precursors along the Dead Sea, Israel, revealed by SAR interferometry, Geology, doi: 10.1130/G34505.1

M. Moro, S. Gori, E. Falcucci, M. Saroli, F. Galadini, S. Salvi, 2013, Historical earthquakes and variable kinematic behaviour of the 2009 L'Aquila seismic event (central Italy) causative fault, revealed by paleoseismological investigations, Tectonophysics, Volume 583, Pages 131-144, ISSN 0040-1951, 10.1016/j.tecto.2012.10.036.

Emergeo Working Group: Liquefaction phenomena associated with the Emilia earthquake sequence of May–June 2012 (Northern Italy), Nat. Hazards Earth Syst. Sci., 13, 935-947, doi:10.5194/nhess-13-935-2013, 2013

G. Pezzo, J.P. Merryman Boncori, C. Tolomei, S. Salvi, S. Atzori, A. Antonioli, E. Trasatti, F. Novali, E. Serpelloni, L. Candela and R. Giuliani, 2013 Coseismic deformation and source modeling of the May 2012 Emilia (northern Italy) earthquakes. Seismological Research Letters(August 2013), 84(4):645-655

Salvi, S., Tolomei, C., Merryman Boncori, J., Pezzo, G., Atzori, S., Antonioli, A., Trasatti, E., Giuliani, R., Zoffoli, S., & Coletta, A. (2012). Activation of the SIGRIS monitoring system for ground deformation mapping during the Emilia 2012 seismic sequence, using COSMO-SkyMed InSAR data. Annals Of Geophysics, 55(4). doi:10.4401/ag-6181

S. Gori, E. Falcucci, S. Atzori, M. Chini, M. Moro, E. Serpelloni, G. Fubelli, M. Saroli, R. Devoti, S. Stramondo, F. Galadini, S. Salvi 2012, Constraining primary surface rupture length along the Paganica fault (2009 L'Aquila earthquake) with geological and geodetic (DInSAR and GPS) evidence. Ital. J. Geosci., 131, 359-372. doi: 10.3301/IJG.2012.21.

S. Atzori, C. Tolomei, A. Antonioli, J.P. Merryman Boncori, S. Bannister, E. Trasatti, P. Pasquali & S. Salvi, (2012) The 2010-2011 Canterbury, New Zealand, seismic sequence: multiple source analysis from InSAR data and modeling. Journal of Geophysical Research.Volume 117, Issue B8, DOI: 10.1029/2012JB009178

G. Pezzo, C. Tolomei, S. Atzori, S. Salvi, E. Shabanian, O. Bellier and Y. Farbod, (2012) New kinematic constraints of the western Doruneh fault, north-eastern Iran, from interseismic deformation analysis. Geophysical Journal International, 190, 1, 622-628, DOI: 10.1111/j.1365-246X.2012.05509.x

Fornaro G., Atzori S., F. Calò, D. Reale, Salvi S., (2012), "Inversion of Wrapped Differential Interferometric SAR Data for Fault Dislocation Modeling", IEEE Trans. Geosci. Remote Sens., DOI 10.1109/TGRS.2011.2173584

S. Salvi, S. Stramondo, A. Ferretti, G. J. Funning, F. Sarti, A. Mouratidis (2012) The Sentinel-1 mission for the improvement of the scientific understanding and the operational monitoring of the seismic cycle, Remote Sensing of Environment, vol. 120, 164-174, DOI:10.1016/j.rse.2011.09.029

F. Canova, C. Tolomei, S. Salvi, G.Toscani, S.Seno, (2012) Land subsidence along the Ionian coast of SE Sicily (Italy), detection and analysis via Small Baseline Subset (SBAS) multitemporal differential SAR interferometry. Earth Surface Processes and Landforms, 37, 3, pp 273–286 DOI: 10.1002/esp.2238

S. Salvi, S. Atzori, J. P. Merryman Boncori, C. Tolomei, S. Zoffoli, (2011) Observing the great Tohoku earthquake by the COSMO-SkyMed operational satellites, Space Research Today, Volume 181, 25-27, doi:10.1016/j.srt.2011.07.008

S. Stramondo, M. Chini, C. Bignami, S. Salvi, S. Atzori, (2011) "X-, C-, and L-band DInSAR investigation of the April 6, 2009, Abruzzi earthquake". IEEE Geosciences and Remote Sensing Letters, Vol. 8, No. 1, pp. 49-53.

M. Moro, M. Chini, M. Saroli, S. Atzori, S. Stramondo, S. Salvi, "Analysis of large, seismically induced, gravitational deformations imaged by high resolution COSMO-SkyMed SAR". Geology, Vol. 39, No. 6, pp. 527-530, June 2011.

GROUP ON EARTH OBSERVATIONS

GSNL GEO Geohazards Supersites and Natural Laboratories

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D. Compliance to the GEO Data Management Principles

The GEOSS Data Management Principles are provided as guidelines to all GEO contributors, to ensure an optimal level of discovery, accessibility, usability, preservation, and curation of the resources made available through GEOSS.

In this section we provide a general description of the status of compliance of the Geohazard Supersites to the DMP, and of the GSNL future activities in this field. A more detailed analysis of the compliance levels to the DMPs for each Supersite will be carried out in Task 1.3, at the beginning of the implementation period, to develop a reference document based on which actions for alignment should be put in place by each Supersite (in Task 2.3).

DMP-1: Metadata for Discovery

For some data types (e.g. raw seismic and geodetic data) internationally recognised standards for metadata exist, and are used by the majority of Supersites, since seismologists and geodesists in general distribute their data (not necessarily open access) using coordinated distributed data infrastructures as IRIS or ORFEUS - EIDA for seismologists or UNAVCO for geodesist, or in the future EPOS for all types of geophysical data. Three members of the GSNL SAC have lead roles in IRIS, UNAVCO and EPOS, and actively collaborate in a joint project (COOPEUS, now COOP+) to harmonise standards for data distribution and promote interoperability of catalogues at a global scale.

Satellite image metadata structures are also well established and used by all space agencies, making it easy to discover satellite data through the specific catalogues used by GSNL (Sentinel-Hub, GEP, DLR-Supersite portal).

Some data types do not have internationally agreed metadata structures (e.g. gravity data, geochemical data), but in general the metadata structures developed at regional scales include most of the items indicated in the DMP.

On the other hand, for scientific products, the situation is much more backward. For standard seismic and GPS products (hypocenters, focal mechanisms, site velocities) recognised metadata structures do exist, but so fare there have been few attempts to harmonise the metadata for less standard geophysical scientific products, as for instance source models or InSAR time series analyses. Some attempts are under way; UNAVCO has proposed a metadata structure for InSAR time series products, EPOS is working on one, but there is still much work to be done. Since one of the main objectives of a Supersite is to provide scientific products to users, metadata standardization of scientific products is very important for GSNL and we will promote coordinated community efforts in this issue.

DMP-2: Online Access

Most of the data provided by the partnership for each Supersite can be accessed online. Nearly all online access methods envisioned in the DMP are used, although not for all data types. For instance for the Sentinel and TerraSAR X data, and for seismic and geodetic data, direct web service access is provided to allow automatic machine-download through APIs. For many CEOS satellite datasets, the Geohazard Exploitation Platform of ESA provides access and remote

processing through virtual machines hosting a variety of processors. Some other portals provide services for map browsing, data/product visualization and download (e.g. GEP, UNAVCO-SSARA, IRIS, ORFEUS).

Online data discovery and access through GEOSS is still not fully implemented for all Supersites data, and this is one of the priorities of the next three years (Task 2.3).

While most Supersite data can be accessed through the online resources of the single providers or through distributed data portals, In most cases there is still a lack of dedicated portals where Supersite users can directly browse and access all data available for the site.

GSNL has always been requesting a strong effort to each Supersite as regards the provision of EO and in situ data through unified online means. However due to the sometime limited resources available to the Supersites, this has been more or less successful, and presently only the Mt. Etna, Campi Flegrei, and Iceland Supersites have developed dedicated data access portals with unique interfaces. The present Implementation Plan aims at improving this situation (Task 1.3).

DMP-3: Data Encoding

The issues related to schematic and syntactic interoperability have been successfully addressed by the geophysical community, but mostly for those data types which for their nature, are of more global interest, as geologic, seismic and geodetic data. For other data types of more local use (e.g. geochemical or paleoseismological observations) standardized encoding needs much development. GSNL is not planning any specific activity in this field, which is of a more general interest of the larger geological/geophysical community.

DMP-4: Data Documentation

Ensuring that data are properly documented is one of the main goals of GSNL, since it is the basis for a correct re-use of the data. Again, there is a long tradition in good documentation of seismic and geodetic data (and EO data), but for other data types there is much work to do. Task 2.3 will address this issue, promoting the implementation of the DMP guidelines in this subject.

DMP-5: Data Traceability

Same as DMP-4.

DMP-6: Data Quality-Control

Normally quality checks are referred to in the metadata of most geophysical data which are well documented. For past data collections, in case a quality control had not been performed (or was less stringent than at present), the datasets were reviewed to provide the best possible quality, providing additional benefits to the data provider itself.

DMP-7: Data Preservation

Long term data preservation is extremely important in earth Sciences, and each Supersite should have a strategy for data and product preservation to enable new science in the future.

Up to now, this has not been a specific requirement for establishing a Supersite, since it is normally already a concern of the data providers. However, not all aspects of data preservation are dealt with the same detail by the local communities, and GSNL will act to promote the adoption of the DMP guidelines in all Supersites.

DMP-8: Data and Metadata Verification

As for DMP-6 and 7, GSNL will promote the adoption of the GEOSS guidelines in all Supersites.

DMP-9: Data Review and Reprocessing

Reanalysis and review of past data collections for management purposes is not common in the geophysical community. Where relevant, GSNL will promote the adoption of the GEOSS guidelines in all Supersites.

DMP-10: Persistent and Resolvable Identifiers

Use of attribution identifiers is being increasingly used by the geophysical community, thanks also to new community services for persistent identifier management. Various data distribution consortia (e.g. UNAVCO, FDSN) already implement DOI attribution to networks and geophysical datasets (mostly seismic and geodetic), and they are used by the Supersites data providers. One further step still in its earlier phases, is the attribution of DOIs to research products generated within the Supersite context, to ensure their open sharing and eventual dissemination to end-users. This is a very important pillar for the success of GSNL, and it is one of the goals of the EC EVER-EST project, which is an active contribution to the GSNL initiative within this IP.

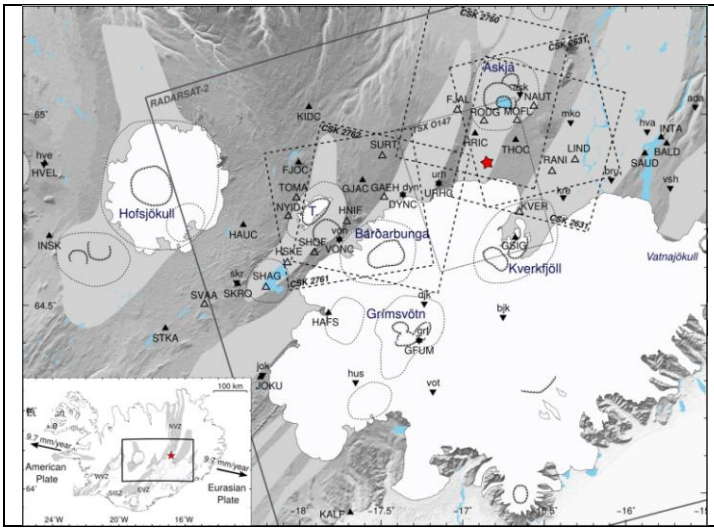
E. Examples of science products generated for Supersites

Scientific products to support Emergency Management during the Bardabunga, Iceland, eruption

The Bardabunga volcano erupted in 2014, in the area covered by the Iceland Supersite. Thanks to the Supersite framework, three radar satellites were constantly monitoring the area: Radasat 2 of the Canadian space agency, CSA; TerraSAR X of the German space agency, DLR; and COSMO-SkyMed of the Italian space agency, ASI.

The SAR images provided by these satellites were used to generate constantly updated maps of the ground deformation in the volcanic area. This information was integrated with precise GPS measurements collected on the ground, and with seismological and geological data, to generate models of the volcanic plumbing system which allowed to closely monitor the evolution of the eruption.

This eruption also shows the use of Supersite scientific products in the decision making process of end-users, as explained in the figures below provided by the FUTUREVOLC EC project, supporting the Supersite.

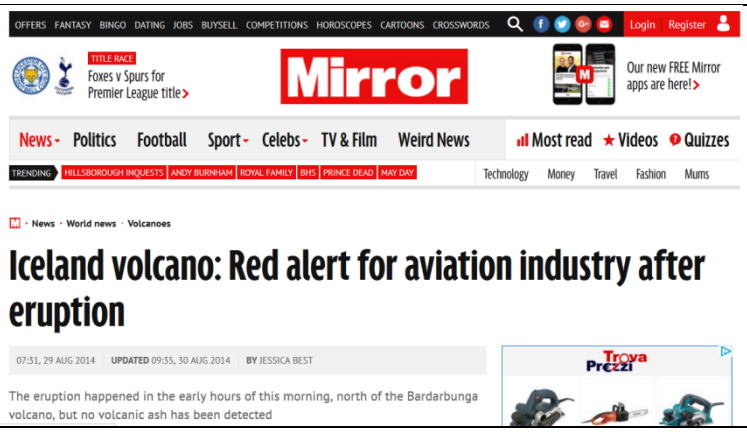


The Bardabunga volcano (caldera) is located underneath the 800-m think Vatnajökull ice cap (white area in the figure).

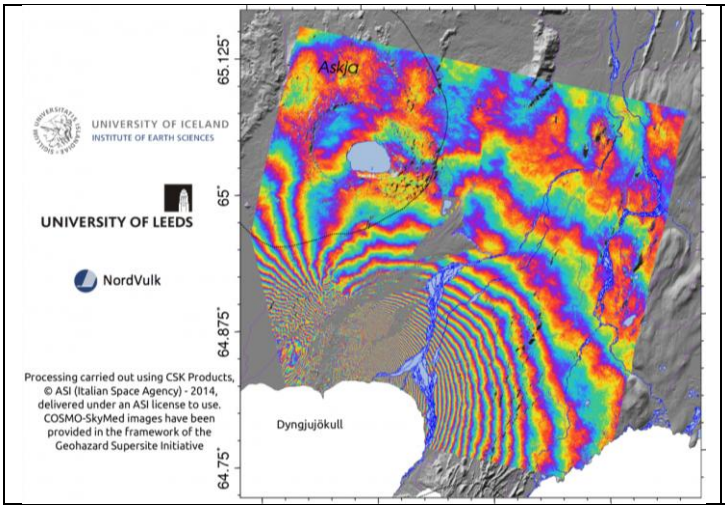
The rectangles show the extent of the X and C band SAR images used to monitor the area. The Supersite receives over 700 of these images per year.

The eruption started August 16, 2014. The worst scenario prompted for strong magma/water interaction, important explosive activity and emission of >10-km high volcanic ash cloud.

FUTUREVOLC

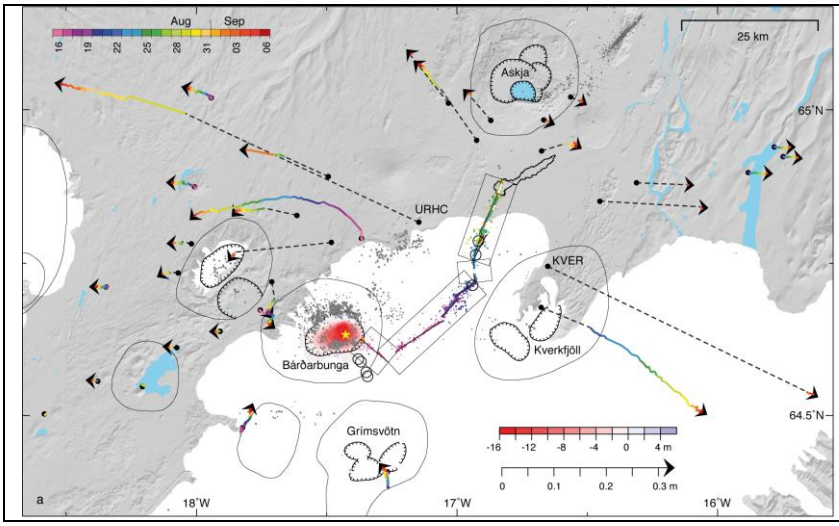


On August 29 a Red alert was issued for commercial air flights. This immediately raised much concern in the international media, for fear of a possible doublet of the 2010 eruption effects of Eyjafjallajökull, which caused global losses of over one billion dollar.



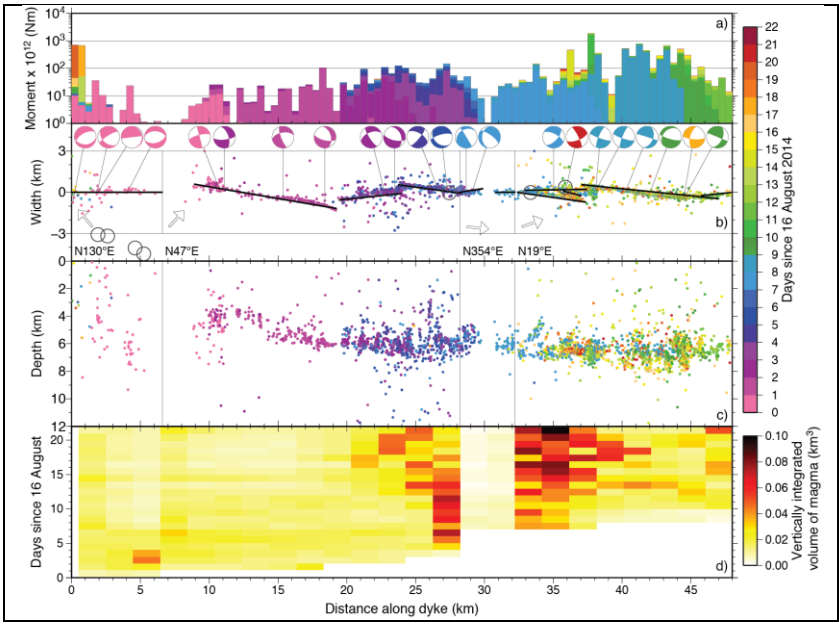
SAR Interferograms generated using the Supersite satellite imagery were used to monitor the ground deformation occurring in the area. These products were generated by a research group including scientists from Iceland, UK, and Norway.
The delivered product consisted of the ground displacement in the considered interval, for each coherent pixel.

FUTUREVOLC



In situ measurements of ground deformation were collected using GPS by Iceland scientists and integrated with InSAR results to provide very precise information on the movements of magmatic masses in the system.
The delivered products consisted of the station positions in the three cartesian components for the different measurement epochs.

FUTUREVOLC



The international research group analysed satellite and in situ data to monitor the evolution of the eruption and observed the migration of magma from the Bardabunga caldera to a location outside of the ice cap, 40 km to the north.
The delivered products consisted of the model parameters and of the inferred information.

FUTUREVOLC

NATIONAL COMMISSIONER OF THE ICELANDIC POLICE
DEPARTMENT OF CIVIL PROTECTION AND EMERGENCY MANAGEMENT

THE SCIENTIFIC ADVISORY BOARD OF THE ICELANDIC CIVIL PROTECTION		
Date: 03.12.2014	Time: 09:30	Location: Crisis Coordination Centre, Skogarhlid.
Regarding: Volcanic activity in the Bardarbunga system.		
Attending: Scientists from Icelandic Met Office and the Institute of Earth Sciences University of Iceland along with representatives from the Icelandic Civil Protection, the Environmental Agency of Iceland, Vatnajokull National Park and the Directorate of Health.		

Main points
• An overview of the activity in Bardarbunga and the volcanic eruption in Holuhraun
• Air quality
• Scenarios

Notes

- Today the Scientific Advisory Board of the Icelandic Civil Protection reviewed data about the development of events in Bardarbunga and the volcanic eruption in Holuhraun, from the beginning of the unrest until the present day. Most of the data show a decline in the subsidence of the Bardarbunga caldera and the volcanic eruption on Holuhraun. Earthquake activity is though still strong and the flow of lave great in comparison to volcanic eruptions in Iceland for over the last 100 years. The findings of the meetings are as follows:
  - **Earthquakes in Bardarbunga:** Seismic activity has been very strong since mid-august. The activity peaked in first half of September, it has slowly decreased since then, but activity remains intense. The period of seismic unrest is one of the largest ever recorded in a volcano globally.
  - **Earthquakes in the dyke from Bardarbunga to Holuhraun:** Strong seismic activity coincided with the progression of the dyke in the second half of August, but it decreased after the volcanic eruption began on Holuhraun. Earthquakes are still detected in the dyke but they are small and relatively few.
  - **Subsidence of the Bardarbunga caldera:** In the days following the onset of the seismic unrest, the ice-covered base of the caldera began to subsidence up-to 80 cm a day, but the subsidence has since slowed and it is now around 25 cm per day. The subsidence is in the shape of a bowl and it is greatest in the centre of the caldera, about 50 m, but smaller to the edges.
  - **Crustal deformation:** Extensive ground deformation Major was recorded while the dyke was forming, signalling the progression of the dyke and subsidence towards Bardarbunga. Interpretation of GPS data and analysis of satellite interferograms indicates that the volume of the magma in the dyke is about 0.5 cubic kilometres, and that it was fully formed by the beginning of the volcanic eruption. After the eruption started the subsidence has been steady, but slowly decreasing, towards Bardarbunga.
  - **The volcanic eruption in Holuhraun:** The volcanic eruption that began on Holuhraun on 31 of August is characterised by a large and unusually steady flow of lava. The magma that comes up is a rather primitive basalt, with a chemical composition typical of the Bardarbunga volcanic system. The petrology analysis of the magma suggests that it stabilised at 9-20 km depth, meaning that it could not have resided at a shallower depth in the crust. The lava field is now 76 square kilometres in area.

The scientific products generated by the different research groups **were periodically delivered to the Civil Protection authority,** under the responsibility of the Supersite coordinator institutions.

The scientific products **helped take many decisions during the emergency,** eventually lowering the red alert to orange when the data showed that the eruption was not going to happen under the ice cap but well outside of it, in Holuhraun.

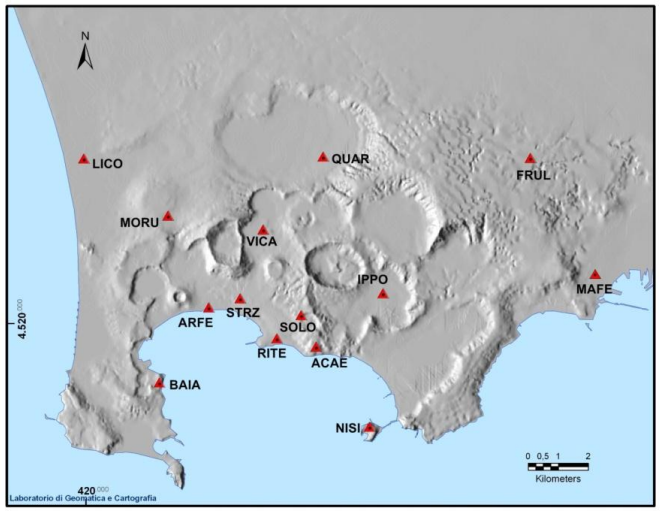
Scientific products to monitor unrest in Campi Flegrei Supersite, Italy

The Campi Flegrei caldera is a quiescent volcano where over 1.5 million people are exposed to high volcanic risk. The area is subject to periodic ground deformation episodes, due to magma and fluid migration in the shallow plumbing system.

These episodes are closely monitored using a variety of in situ data: seismic, geodetic, geochemical. Through the Supersite framework over 500 commercial SAR satellite images per year are received from the Italian, German and Canadian space agencies and openly shared. They are used by the scientific community to generate continuously updated ground deformation maps, which are integrated with ground data to model the causative sources.

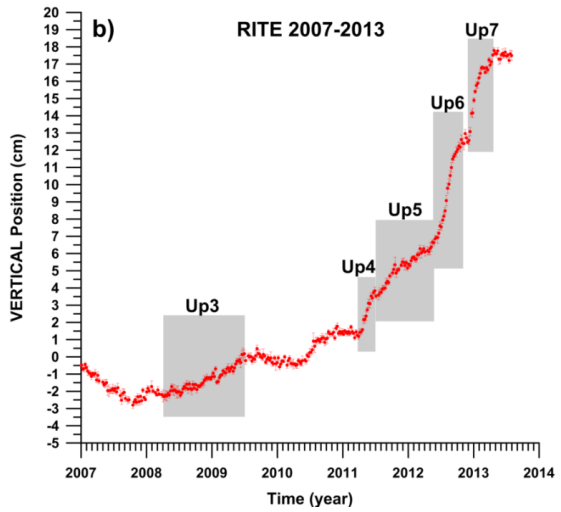
During the period 2011-2013 ground motion accelerated from 1-2 cm/yr up to 7-8 cm/yr. This episode was closely monitored using ground GPS measurements and InSAR time series data. This information was then used, together with seismic data, to model the magmatic source. The analysis of the ground deformation information **prompted the decision by the Civil Protection authority, to raise the volcano attention level from Yellow to Orange**. In 2014 the ground deformation rates (and the attention level) went back to normal.

The information below was provided by the MEDSUV EC project, supporting the Supersite.



The Campi Flegrei caldera is partly located under water in the Pozzuoli gulf, and it is dotted by many craters of different age.

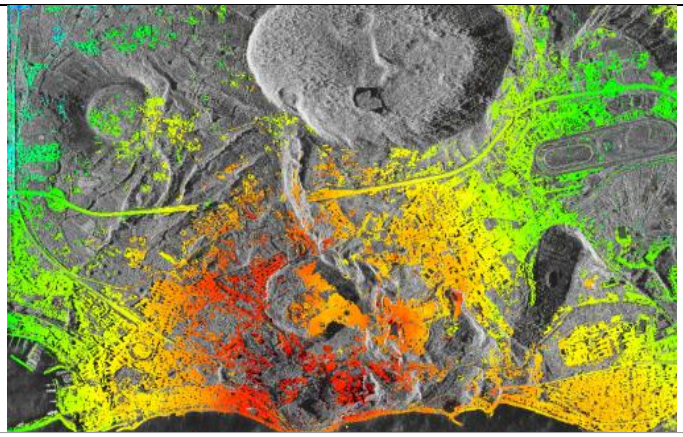
The figure shows the network of permanent GPS stations, whose data are available through the Supersite initiative.

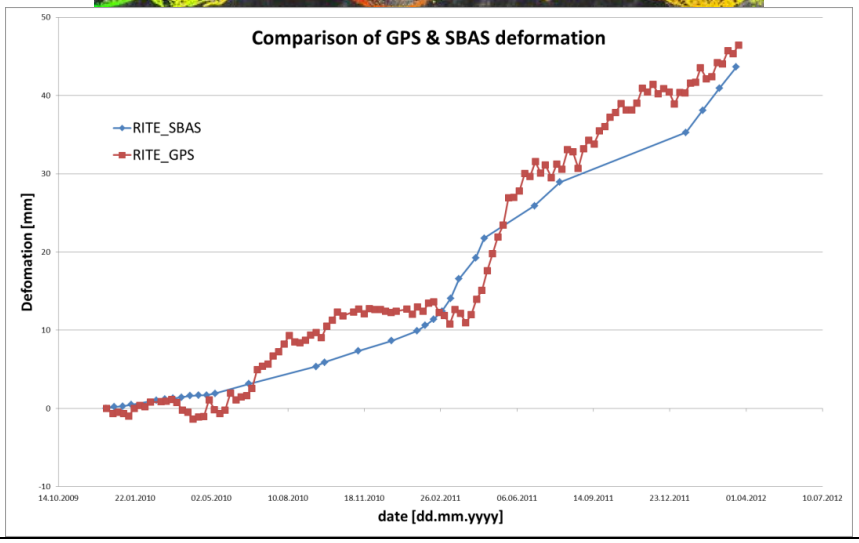


The time series of the vertical position of the RITE GPS station, in the center of the caldera, shows several Uplift episodes, depicting a strong increase of average uplift velocity starting in early 2011.

The delivered products consists of the mean station velocities in the three cartesian components for the considered period, and the station position time series.

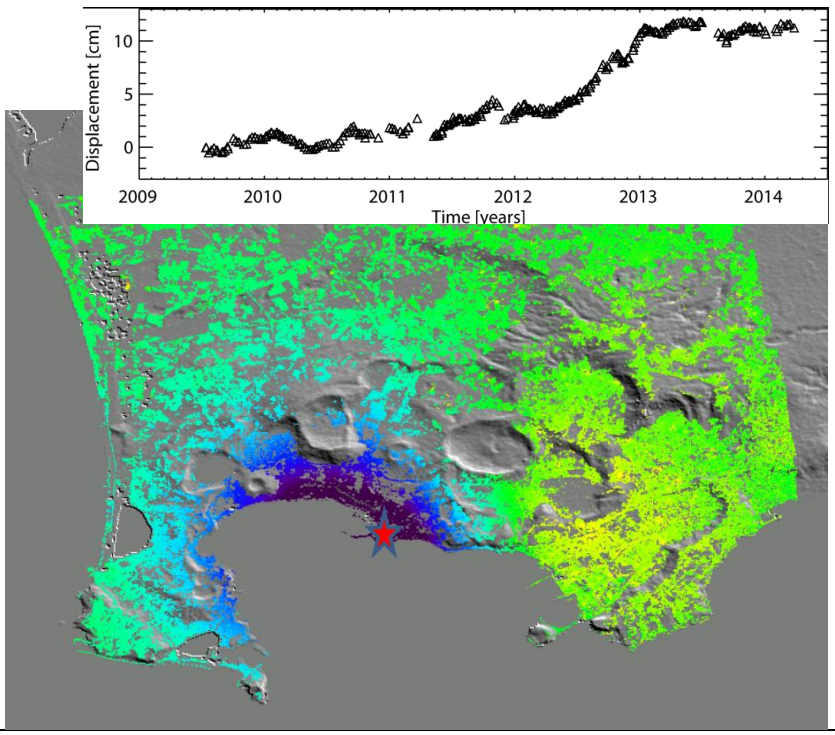
Source: De Martino et al., 2014





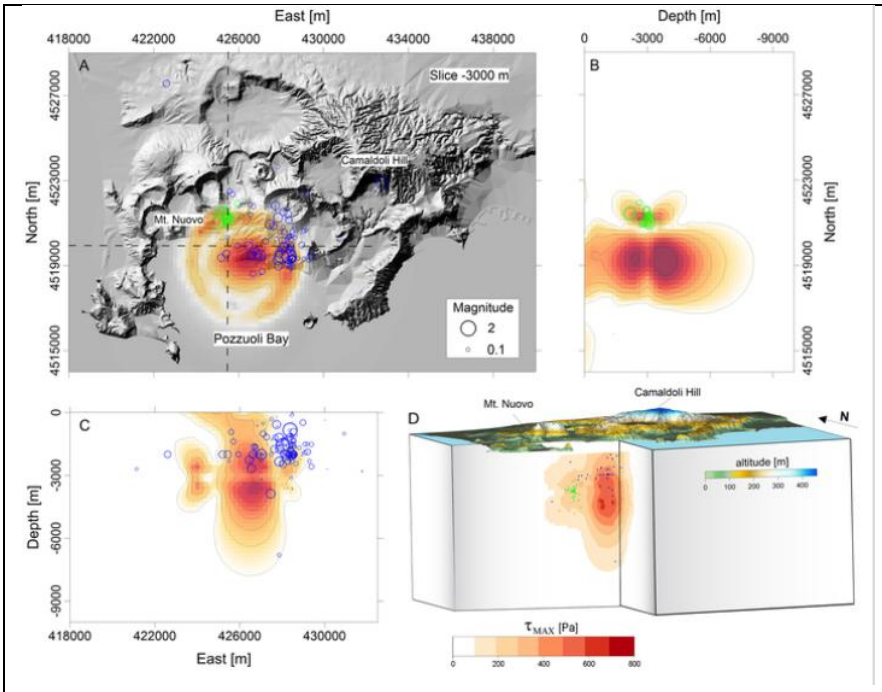
TerraSAR X data show the increase of uplift velocity.
The upper figure shows the mean velocity in the 2009-2012 period obteined through multitemporal InSAR data processing.
The figure below shows the InSAR Line of Sight displacement time series compared to the vertical displacement of the RITE GPS station.
The delivered products consist of the mean ground velocity in the considered period, and the stack of displacement time series for each coherent pixel.

Source: Minet et al., 2012



COSMO-SkyMed InSAR data also show the ground deformation increase. The lower figure shows the mean Line of Sight velocity measured using nearly 300 COSMO-SkyMed images in the period 2009-2014.
The graph shows the displacement time series, which were validated using the in situ data from GPS and leveling measurements.
The delivered products consist of the mean ground velocity in the considered period, and the stack of displacement time series for each coherent pixel.

Source: IREA-CNR, MEDSUV project

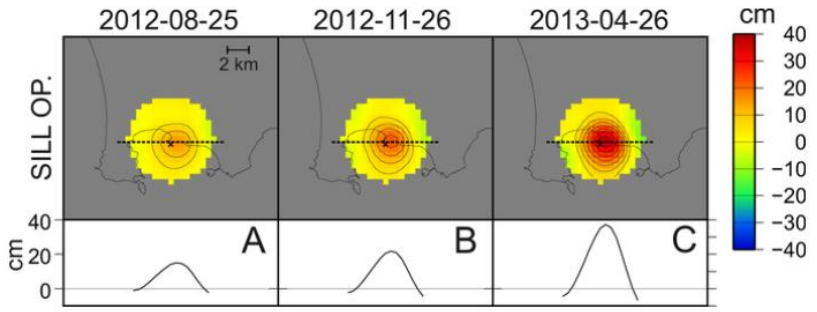


The inception of the ground deformation episode was accompanied by a shear stress increase which triggered a short-lived local seismic sequence.

The figure shows that the seismicity occurred in an area where high levels of deviatoric shear stress are modeled using the deformation data.

The delivered products consist of the modeled shear stress, the high resolution seismicity, and the inferred information.

Source: D'Auria et al., 2015



The final scientific product is the source model, accounting for all observations, which attributes the unrest episode to the injection of a volume of 0.004 km^3 of magma inside a sill (horizontal circular fracture) located at 3 km depth.

The delivered products consist of the source model and its parameters.

Source: D'Auria et al., 2015