In the Supersites endeavour, Earth Observation (EO) is a key contribution with many national and European missions, with an important research contribution in the operable frame of GMES/Copernicus. Although the projects are incubators with the data and the geo-information they use or generate, they provide resources of key value to users for both response and prevention purposes. In particular, a given Supersite will use or generate monitoring data and information that includes unique capabilities (e.g. precise terrain deformation measurements of seismic or volcanic hazards). Users are encouraged to provide requirements and feedback in these incubation activities. While the three EC Supersites projects are R&D-related and the Supersites users primarily are science users, there is a need to identify operational requirements that will be the targets of the projects.

As far as European activities are concerned, it was made clear during the discussions that there is a broad range of cross-cutting issues and there are commonalities between the three FP7 EC Supersites projects (hereby EC Supersites projects) and between them and other relevant projects in the domain of Geohazards. From the comments received, it was made clear that the setting up of some sort of coordination mechanism would be helpful. Beyond the planned achievements of the GEO Supersites initiative, it apperas that a horizontal activity such as the establishment of a ‘European Geohazard office’ would be of great help to fertilize results and pave the way for R&D priorities concerning EO and Geohazards. This coordination between the EC Supersites projects and between these projects and others with similar mandate, would help to crossfertilize R&D and innovation aspects between projects overall, including emergency-response (e.g. the Copernicus EMS, the International Charter Space & Major Disasters, etc). This coordination can be proved to be usefull in other phases of the Risk Management cycle such as that of prevention and preparedness, with projects such as the various FP7 projects originated by the Unit I4 in Directorate I in DG RTD as indicated in the catalogue provided at the meeting. It was explained,
however, by DG RTD, that such coordination mechanism has to be carefully examined in relation to whether if goes beyond the legal scope of their programmes of work.

Thematically it has been suggested that the Supersites might also expand in terms of the types of hazard addressed. To date, Geohazards Supersites and Natural Laboratories (GNSL) are focusing only on geological risks (volcanoes and seismic risk). However, there is a clear message from Session 1 of the Workshop, that Supersites should possibly cover all the different kinds of Geohazards events including landslides, subsidence, tsunamis and, in a near future, not only geological but other type of hazards (i.e. glaciers, wildfires, floods). This is in line with the concept of Supersites as was initially drafted by IGOS in 2004 and with the vision set in the Roadmap for the Geohazards Community of Practice of the Group on Earth Observations (GEO) to develop a global network of carefully selected core sites addressing all the relevant phases of the risk management cycle. For example, landslides were presented as a theme that would be pertinent with activities already suggested to the Geohazard Supersites & Natural Laboratories (GSNL) partners, for instance concerning landslides in Slovenia.

Overall and in relation to the European activities on Supersites, the following recommendations were put forward:

i) address links between the three projects and with other relevant projects,

ii) support the transfer from knowledge (R&D) to mature applications by identifying priorities (e.g. link to VAACs for aviation safety) and address new R&D topics well in scope but not in the original work programme of the Supersites (some examples were already identified in the Q&A session)

iii) help the different users understand what capability or service is offered in Europe by these activities by simply informing and promoting what is available.

Session 2: “Data requirements for Supersites”

Rapporteur Massimo Cocco

Session 1, represented a valuable opportunity to discuss the impact and the added value of the three EC Supersites projects. An issue that raised a lot of interest during the discussions was the relevance of promoting an integrated use of data (concerning for instance measuring 3D deformation in volcanic and tectonic areas, monitoring and understanding pre-eruptive processes, ash emission, seismicity patterns, etc.), which can foster the developing of new data products. This, of course, is of great relevance for the Space Agencies, and for this reason the EC Supersites projects can represent an important collaborative framework between different components of solid Earth science.

The inclusion of vulnerability data to allow risk mitigation was also extensively discussed. The societal impact of these projects was recognized as well as their potential relevance for risk assessment in tectonic and volcanic areas. The possible link with GEM, GVM and CEOS DRM was pointed out.
As pointed out at a keynote presentation, the International Forum on Satellite Earth Observations (EO) and Geohazards, a precursor to the Supersites projects, represents a reference concerning the long term (5-10 years) needs of users and practitioners and what they require from EO systems. The 3 EC Supersites projects do not have the goal to deliver operational services but rather developing R&D with the aim to improve monitoring and better understand hazards based on reference sites. As it has been indicated in a keynote presentation, the Supersites initiative (GSNL) is one of the three objectives of the newly started CEOS activity on Disaster Risk Management (CEOS DRM). A pilot is under definition concerning seismic hazards and will provide access to data and an exploitation platform based on the current SSEP platform for data storage, processing and dissemination.

In relation to data integration, the discussions revolved around the key role that the European Supersites can play in providing full and open access for the establishment of coherent multidisciplinary datasets. In this frame, Supersites can potentially be instrumental in leveraging multi-disciplinary collaboration for integration of data and parameters observed by different sensors and to develop novel data processing approaches for networked sensors. This would be beneficial not just for a better satellite / in-situ integration, but also for a more robust and operational multi sensors approach for Geohazards monitoring and risk assessment including high-end technology such as very broad band seismic sensors including tilt meters in boreholes. As far as the building of an e-infrastructure for Supersites is concerned, one of the most important goals towards the establishment of the European Supersites concept is to build a data infrastructure. This e-infrastructure will enable for sharing data observed on these sites (and related products) among the global community of Geohazards’ scientists and stakeholders.

The discussion also addressed issues related to e-science and ICT innovation. In particular, it has been pointed out the importance to foster a shared vision for developing web services for all projects through a federated IT approach. During the Workshop, several existing web-services were presented or mentioned in presentations, which provided an important reference model for IT implementation.

The exchange of views promoted by this workshop and the stimulating debate during Session 2 allowed the identification of the following crucial issues which might determine the success of the Supersites projects:

- Data Policy
- Coherent ICT Architectures (interoperability)
- Metadata structure (EPOS design, compliant with GEOSS)
- Identification of end-users: scientists, stakeholders and decision-makers (communication strategy)
- Science and Risk Communications
- Clear distinction of services to decision makers
- Exploitation of existing web-services
In order to manage the risks associated with the above critical issues, coordination among the three EC Supersites projects and with other initiatives that are dealing with similar problems for national or regional research infrastructures (e.g. EPOS) has been recommended as a valuable solution. This coordination should also include a report on the existing procedures for Risk Communication as well as on the procedures in place in the different sites to deliver information, products and alert to decision-makers and civil defence agencies. The question of providing access to real-time data has also been addressed. This involves the data policy and access rules to data issue, but coordination on possible choices on this matter has been suggested.

Another issue that has been identified to be included in the report on the status of the three EC Supersites projects concerns the existing available IT resources both within the projects (e.g. storage, processing facilities) and outside the projects (e.g. grid, cloud, computational resources, ESA exploitation platform).

Finally, coordination on outreach and dissemination has been also recommended as well as on sharing best practices for operational forecasting. A remark on the possibility to involve other disciplines within environmental sciences interested in Supersites activities (e.g. land use, biodiversity, atmospheric sciences, ecosystems) was also voiced during the conclusive discussion.

In conclusion, the workshop was very effective to identify relevant and crucial issues. The following two topics deserve a particular remark.

There was a long and thorough debate on the key drivers for the Supersites projects: science or service to policy makers? It is clear that improving scientific understanding of causative processes will certainly lead to increasing the capacity to provide better services to decision-makers. However, it has been clarified that the key motivation for the Supersites projects is to enhance progress in science.

The second issue concerns an effective action to guarantee the adoption of effective and harmonized approaches to tackle the key challenges and to address the critical issues. To this task it has been proposed to define and adopt a roadmap including a timeline and workflow to keep the three projects coordinated. The roadmap should consist of a design and a delivery phase (perhaps including a validation phase) to address the following issues:

- Access Policy
- Common data models and e-RIs implementations
- Data management plan
- Web services interoperability
- Integrated use of data (satellite & in-situ)
- Progress in science
- Sustainability issue
The latter issue has also been discussed during the Workshop. The key challenge is to guarantee the long-term sustainability (both in terms of financial and human resources) of the infrastructures and services created through the projects. This issue is relevant for GEO and for the European Commission.

**SESSION 3:**
EU Supersites: Interest for Regions and Economic Sectors  
*Rapporteur: Michael Symonds*

All project presenters gave an account of the regional and economic interest to the Supersites concept. MARsite, for example, includes seafloor and land-based monitoring in the Sea of Marmara, making use of links with existing networks and building on previous projects and experience. The benefits to the scientific community were highlighted by the speakers.

All speakers, highlighted ways for the application of the three EC Supersites projects’ research results at an EU and global level and pointed out to the resulting benefits. These include a number of recommended actions that lead to concrete benefits:

- **build a catalogue of models before the actual event.** The feedback received from actual events can improve those models with obvious benefits to the scientific community.

- **Make simple messages for stakeholders.** At times, decision making can be complicated as a result of too much detail given and too many players involved. Media are a key end-user but they need to understand the background so they can interpret what they are seeing or being communicated. An indicative example of the role of Media in spreading the Supersites concept around the world is the recent [BBC documentary on FUTUREVOLC](https://www.bbc.com/news/science-56335289).

- **TerraSAR-X data:** lots of very impressive pictures are produced. The challenge now is to make this data accessible to the specialists with obvious economic benefits to relevant SMEs.

The presenters of the projects DORIS, EVOSS, LAMPRE, PREFER mentioned that the acquisition of data is expensive, especially that of the hi-resolution data. An effort is made to make this data widely available to the various customers. The role of SMEs is of importance here. The questions raised in this respect were: What should be the price, and based on what? One view that was welcomed by the discussants was that even if the customers may have limited or no purchasing capacity, they will, nevertheless acquire the willingness to pay for services and data that has been shown to work. Quality of data, therefore, as well as its availability is both important prerequisites towards realising economic benefits as a means of activating a large portion of the market segment. Policy guidance from the EC will also be welcome. The role of GEO is of equal importance in particular by building on existing databases and making it open and more accessible, retrieving more data, ensuring the continuity, filling the gaps, and processing it into meaningful information for customer use.
Various organisations such as the GEO, can through GEOSS’ broker strategy, provide useful information for decision-making by making more sources available. EUMETNET is also undertaking atmospheric monitoring. The data are fed in weather forecast models which are then used to advise governments on disaster preparation plans. EUMETNET’s presenter noted that acquiring confidence in data quality necessitates the establishment of data quality standards. This is especially critical when there is a need for integration with other existing networks.

SMEs can add value/benefit by being asked to undertake specific tasks such as the production of deformation time-series making thus available the presentation of earthquakes and volcanoes over time or/and the setting up of cloud infrastructure in order to accommodate more users.

**SESSION 4:**
Articulating Long-Term Monitoring and Delivery of Services

*Rapporteur Joan Marti*

The focus of discussion in Session 4 was the articulation of long term monitoring strategies and delivery services to users inside and outside Supersites, but it also included presentations on other EC-supported initiatives and projects, which can be complementary to Supersites. This configuration of presentations enabled the discussion on several other topics in addition to long term monitoring, including: objectives and end-users of all these initiatives, their added value, interaction and integration among all them, as well as other aspects related to their potential deliverables such as communication among the different stakeholders involved in hazard assessment and management, the present state of knowledge on hazard forecasting, quantification of uncertainty in hazard forecasting, involvement of civil protection agencies and authorities in scientific initiatives, dissemination and exploitation of results or early working systems, among many other topics.

Users in the Workshop audience indicated the need to have a staged approach concerning the progressive transfer from R&D to operations. For Civil protection Agencies this is not a straightforward exercise and has to be based on probabilities, error bars, etc. For volcanic observatories and seismological institutes (e.g. the Kandili observatory in Turkey, EVOSS Volcanic Observatory) data integration is a fundamental aspect in project development. The GEO Secretariat indicated that operational infrastructures need to be defined and developed to support the projects for both R&D and pre-operational aspects (in view of transfer to operational projects such as Copernicus services).

User segments from different societal benefit areas (SBAs) are concerned with the issues that the Supersites projects are addressing. They primarily include Disaster Risk Management (DRM) alongside with other areas such as for instance Energy, Minerals, Transport, etc. Developing user communities and managing their expectations is a key aspect of the projects. Users must not be passive but active. Especially concerning risk reduction, exposure and vulnerability of hazard
risks, to develop the use of new technologies (space, new IT methods, etc) requires to engage users and work with them.

Different user groups have interest in the Supersites projects and they concern the development of user communities that have different needs and requirements. The types of users are several: science users as the first category of Supersites users, decision makers from organisations with a (typically national) mandate, users in a variety of other thematic domains (aviation safety, insurance, organisations engaged with natural sites conservation e.g. coastal sites potentially affected by tsunamis or hydro-geological risks, etc). The three Supersites projects comprise user organisations with an operational mandate concerning risk management (seismological institutes, volcanic observatories, civil protection authorities) and in-sector providers (from the user segment, e.g. geoscience centres transforming data into information such as european geological surveys).

Further to users identified by the projects, there are other users not using new technologies and those are not aware or able or cannot afford such technologies.

Given the role of Supersites in broadening the scientific understanding of the causative geological processes and narrowing down the uncertainty in Hazard and Risk Assessment, it is natural to consider scientists as the main actors of this initiative. However, from the Session’s discussions is clear that a broader set of stakeholders is looking at Supersites as a source of data for delivering accurate actionable information. Supersites would not communicate data and information or operational services directly to Civil Protection Agencies but to those institutions that are in charge of monitoring of unrest areas. Real-time rapid Geohazards data observed on the Supersites could be critical in making prediction and risk scenarios during major events (earthquake incidences and volcano eruptions). In addition, distributed sensing using mobile smartphones and observations collected by “citizen scientists” should be considered in the establishment of the overall Supersites infrastructure.

Participants in Session 4 considered that it is a priority to enhance cooperation among all initiatives supported by EC, i.e. Supersites as regions prone to natural hazards, research projects and scientific networks. The common thread to these initiatives is the focus on the assessment and management of natural disasters. This should imply promoting interaction and integration among all them, but this would also require to identify in each case their potential deliverables and end-users. This is something that was not clear in all cases.

A second point of major discussion was the communication of scientific information to authorities, media, population, and also among scientists with different backgrounds and expertise. It is obvious that a different language is required depending on whom you communicate with. It is particularly relevant that scientific information reaches decision makers in the right language and at the right time to make the correct decision. This reached another significant topic; that is the need to quantify uncertainty in Hazard and Risk Assessment. It was widely recognised during the discussion that there is a high level of uncertainty involved in risk quantification and this needs to be understood by and communicated to all stakeholders involved in the Risk assessment and management process. Relevant questions that need to be answered by end-users and raised during the discussions include:

- Are we really capable to forecasting natural catastrophic events?
- What is the degree of precision in each case?

- The introduction of cost-benefit analysis as an effective way to help decision makers was also identified as an important topic in Session 4, in addition to the role of scientists in crisis management. Should they act only as advisors or should they undertake other actions such as risk (impact) analysis in addition to hazard assessment?

Other points of discussion referred to data selection and included the identification of end-users for all the data that Supersites and other related initiatives can provide, the application of regulations and the setting up of a control system for the dissemination and exploitation of such results, and how to maintain these huge databases, in particular once the initiative created to develop them is not active anymore. A potential solution for this, suggested from previous experience of some of the presenters, was that the creation of such data-bases can be undertaken by relevant authorities early enough in the process and right from the very beginning. Finally, concerning long-term monitoring, the question was raised regarding the basic technical capacity required to sufficiently fulfil accurate monitoring in order to forecast catastrophic events. In this sense, it was proposed that monitoring work on Supersites through the 3 EC Supersites projects can be used as guidance in answering such a question.

The discussion during this Session also emphasised the importance of developing use-cases in order to describe to different stakeholders (scientists belonging to difference communities, non-scientific stakeholders, etc.) the potential applications, the impact of an improved monitoring and understanding of the physical processes causing earthquakes, unrest episodes, volcanic eruptions, etc. The added values of the projects as a key contribution for improving science for society have also been mentioned. Although the primary goal of this projects is not to deliver services to policy-makers and civil defence agencies, it has been discussed as the integrated use of data, the new data products and a better understanding of continuous monitoring relying on the causative process, would certainly foster a better service to society in the long-term.

On the basis of the discussion carried out in Session 4, several recommendations can be made:

- facilitate sharing of knowledge and experiences, making knowledge and data open and available to everybody. From all Supersites and other Natural Hazard-related EC projects, it is required to validate dissemination activities to ensure that dissemination is optimum in all cases

- promote training on Natural Hazard Assessment and Management to all sectors of society (e.g. scientists, authorities, media, population)

- facilitate involvement of authorities and civil protection agencies from the early beginning into Hazard Assessment and setting up of databases and resources. It is crucial to let all relevant actors know how scientific work in this matter is conducted and how results are obtained.

- define specific communication strategies and languages for each stakeholder. This includes developing effective models to transfer information and to help decision makers in making timely and correct decisions.

- improve cooperation and interaction among the different initiatives supported by the EC.

- facilitate accessibility to large databases by moving the calculations to the data rather the other way around as it has been the case in the past.
- use the experience gained from the EC funded Supersites projects to define guidelines on Hazards Monitoring and early working systems.

- quantify uncertainty. Both Supersites and EC projects such as VUELCO, should work together to achieve this essential goal.

### CLOSING SESSION:

Wrapping up the Workshop: Conclusions and recommendations for the effective clustering of Supersites,

Efthimios Zagorianakos

The Supersites concept is another major contribution from the Group on Earth Observations. It can be seen as an incubator of innovation, in other words, as geographical areas where novel Earth Observation (EO) technologies are tested in order to find meaningful and useful answers to complex research questions posed by the Geohazards scientific community. The element of ‘open access’ and the challenges that it poses, brings together the scientific community with the end-user of the data.

The European Commission (EC) endorses these two actions, that is, monitoring of geographical areas prone to Natural Hazards and open access to the resulting data. These actions were discussed during the Workshop as well as ways to foster collaboration amongst the Supersites projects and projects with similar research mandates. Four areas of potential collaboration distributed in the four parallel Sessions of the Workshop were distinguished.

Session 1 dealt with the exploration of the available and appropriate key technologies for the monitoring of Supersites. The key word here was ‘collaboration’ and the focus was on the areas of monitoring and IT technologies. The need for collaboration in order to define and develop operational infrastructures to support the Supersites projects for both R&D and pre-operational aspects, was stressed. The creation of a European Geohazards Office was recommended as a way to foster cooperation between the EC Supersites projects and other projects with similar research mandate. The role of the Office would be to report on the existing monitoring procedures and IT resources, and coordinate a common response to information and product delivery and alert to decision-makers and civil defence agencies. Legal issues and the relevance of the proposed Office in relation to the projects’ scope of work shall be considered.

Collaboration should also be extended to integrate:

- other disciplines within environmental sciences interested in Supersites activities

- in situ as well as remote sensing monitoring data

- different kinds of Geohazards events (e.g. landslides, subsidence, tsunamis and, in the near future, glaciers, wildfires, floods)

- different software and IT capabilities

- end users’ with scientists’ understanding of novel technologies
Session 2 dealt with data management challenges. The promotion of an integrated use of data which can foster the developing of new data products was pointed out as a priority. It is important that a start be made with the construction of a data e-infrastructure which will enable the sharing of the data observed on the Supersites among the global Geohazards community. Another idea that was voiced was the development of web services for all three EC Supersites projects through a federated IT approach. Several existing web-services were presented which provided an important reference model for IT implementation. The key challenge, however, in terms of data management, was seen to be the long-term sustainability of data infrastructures and services created through the projects. Both the GEO and the EC are committed to support and enhance through time the relevant financial and human resources.

Session 3 dealt with the economic and regional benefits accrued from research on Supersites. Significant economic benefits were mentioned as regards employment and market uptake for SMEs active in EO technologies. SMEs can be involved in several undertakings such as in identifying and connecting with end-users, setting up of a cloud infrastructure, in the provision and delivery of Supersites data and, in the future, in the provision of services. There are economic benefits to be realised in terms of boosting growth in the EO industry through the active involvement of SMEs. Government agencies also receive benefits since Supersites research will enable more informed decisions leading to less financial loses to the taxpayer in future events. Media can also have a role in spreading widely the advancements in Supersites research rendering thus a more clear and easily understood benefit to European citizens.

Session 4 dealt with the communication aspect of the Workshop projects and in particular with the delivery of service to end-users. The main point raised was the development of user communities and the management of their expectations towards early warning. Active participation should be encouraged and carefully promoted. By ‘end-users’, it was mostly meant decision makers such as government departments, local authorities and Risk Management agencies. It was also poited out that future advancements in monitoring and IT technologies will require the engagement of citizens and working with them in areas of risk reduction, exposure and vulnerability of hazard risks. The idea of ‘citizens as sensors’ that was put forward by Gilles Ollier, received aknowledgement from the audience. It might no be far the day when citizens will be able to send data from sensors in their mobile phones, for example, on the real-time mapping of the dispersion of volcanic plume. Could the concept of a ‘community of communities’ flourish amongst the Supersites community?

CLOSING SESSION:
Concluding Remarks from the Organisers
Gilles Ollier

This Workshop has provided the ground for a celebration of the Geohazards Risk Management community. About 100 participants attended the workshop during these two days, including representatives of many other, non-Supersites FP7-funded projects with similar themes as well as individuals from relevant organisations, research project members, Directorates of DG RTD and other Directorates General (ENTR and ECHO). The Secretary General of the European Research
Council (who is also the President of the European Geophysical Union) also attended for the first half day.

The objective of the workshop was to focus the attention of the broad European community involved in the domain of Geohazards Risk Management on the new concept of ‘Supersites’ and to call for their support taking advantage of the three new Supersites projects recently launched under FP7. As this novel concept builds on long-term monitoring of the sites prone to Geohazards, the Workshop was also intended to develop possible solutions to sustain the monitoring effort beyond the end of the FP7 projects and to engage public and private, national and regional resourcing for the long-term.

The Workshop was also an opportunity to explore and develop synergies with the European Plate Observatory System (EPOS) - that is the priority infrastructure in the domain of Geohazards - identified and launched through the ESFRI (European Strategy Forum on Research Infrastructures). The Supersites concept is recognised by EPOS as an important research element of the EPOS infrastructure.

Below, the main outcomes of the Workshop are summarised:

- Confirmation of the validity of the ‘Supersites’ concept
- The high potential of remote-sensing data which remains to be integrated with in-situ data was recognised, as well as the associated need to actively test novel Earth observation technologies in selected regions with the support of the EO industry.
- In terms of data-flow management and processing, the collaboration between projects will focus on access issues, on interoperability, and on the integration of redundant data infrastructures. Advantage will be taken of new developments in IT data-science such as cloud facilities.
- The major benefits stemming from research and innovation through the Supersites concept are the underpinning of service development for end-users and decision makers using the data (for example, national civil protection authorities).
- There are important potential economic benefits in the development of the Earth Observation industry through the active participation of SMEs in Supersites research.
- In relation to engaging end-users, the idea of ‘citizens as sensors’ was put forward as a research and innovation area to be further developed.
- The workshop saw the Supersite concept as a new avenue leading to the development of a scientific and innovation exploitation platform to better understand the processes leading to Geohazards.