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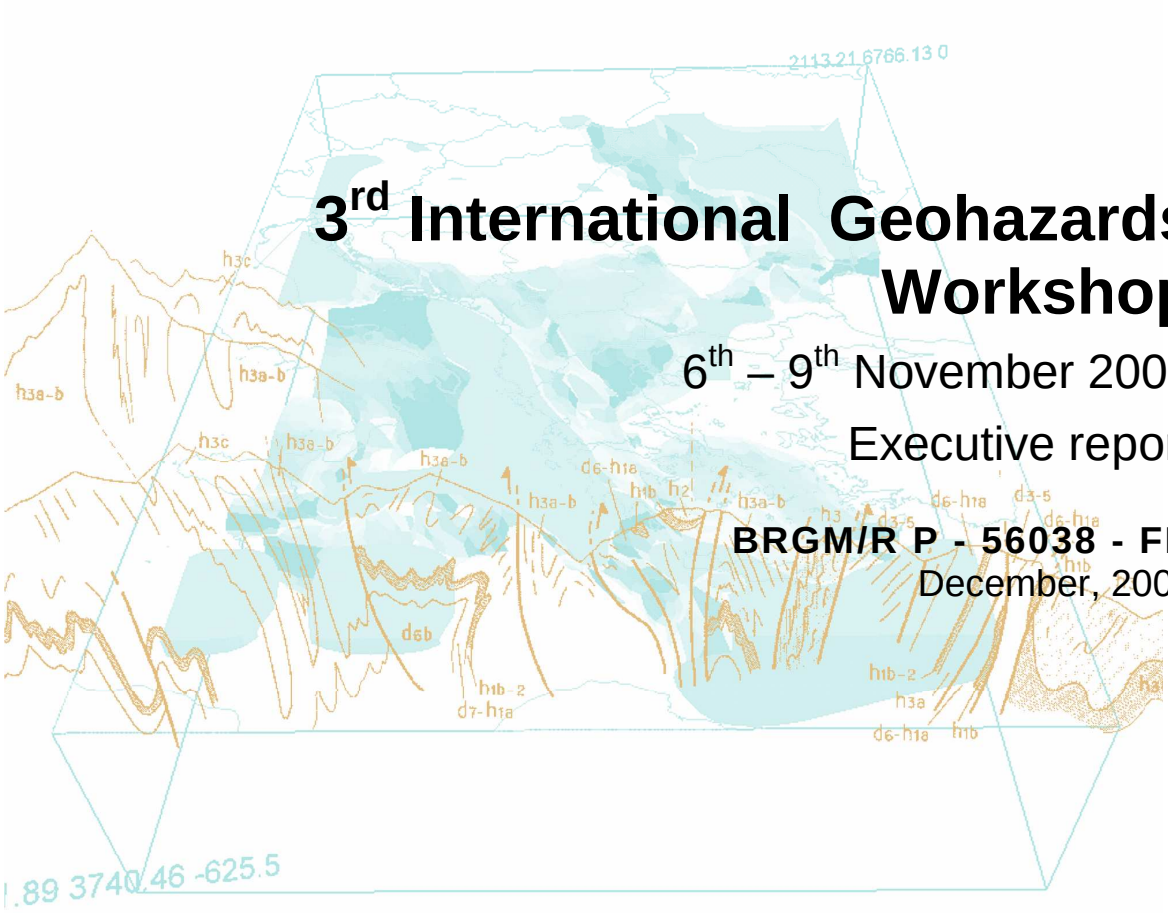

3rd International Geohazards Workshop

6th – 9th November 2007

Executive report

BRGM/R P - 56038 - FR
December, 2007

A Co-funded Bureau by ESA and BRGM

Geoscience for a sustainable Earth

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Executive report

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Synopsis

Understanding our environment is a prerequisite for reducing the vulnerability of our societies and the risk of natural disasters. Earth observations are crucial for improved knowledge of hazards, risks and potential disasters as a basis for efficient decision making, better mitigation, and preparedness for disasters.

The 3rd International Geohazards Workshop was held at ESA premises in ESRIN Frascati (Rome, Italy), from 6th to 9th November 2007. It was co-organised by the European Space Agency (ESA), the Group on Earth Observations (GEO) and IGOS Geohazards, and it was supported by an Organising Committee gathering a wide community of geohazards experts.

This workshop aimed at strengthening the emerging international strategy for disaster mitigation and prevention for the benefit of those exposed to geohazards, namely earthquakes, volcanoes, landslides, and tsunamis.

This workshop was part of the 2007 International Geohazards Week that also included:

- The Global Geodetic Observing System (GGOS) Workshop: “The GGOS Contribution to GEOSS and an Observing System for Geohazards and Disaster Prevention”, 5th November 2007

- User Workshops of ESA geohazards projects (GlobVolcano and Terrafirma), organised on 5th November 2007

The 2007 International Geohazards Week was a GEO event that contributed to the International Year of Planet Earth. 250 participants from more than 40 countries attended to this event.

Contents

1. Executive summary

The principal objective of the 3rd International Geohazards Workshop was to strengthen the emerging international coordinated strategy around Earth Observations for disaster mitigation and prevention for the benefit of those exposed to geohazards, namely earthquakes, volcanoes, landslides, and tsunamis.

Gathering a wide range of experts, data providers, scientists and decision makers in the various fields of geohazards, the workshop also aimed at stimulating:

- The funding of dedicated coordinating actions to improve:
    - The existing observing systems: in-situ, airborne and space based components;
    - The existing monitoring capabilities: funding of research and operational services projects;
    - Access to data;
    - Mutual exchange of knowledge, in particular with developing countries;
- A wide participation to GeoHazNet, the GEO GeoHazards Community of Practice;
- The setting up of an International Coordination Mechanism to streamline cooperation and synergy between international projects, initiatives and programs;
- The establishment of Exchange Fora between users, data providers, scientists and decision makers.

During the 3rd International Geohazards Workshop, a certain number of recommendations were made by the participants following a request by the Organising Committee. These recommendations were based on the various experiences of the participants and contribute to helping the IGOS Geohazards and the GEO Geohazards Communities of Practice[1] to collect requirements and to set priority actions for the

[1] The Geohazards Communities of Practice is defined here as a group of people and institutions that share common interests and interact with each other; this includes providers of source data and information (in situ, remotely sensed or other) as well as the end users of that data with respect to all phases of the geohazards mitigation up to the response/recovery cycle.

coming years. These recommendations are listed per session in the next chapter. In addition to this, some of the key recommendations are summarised below, in order to provide the reader with a synthetic overview of the objectives of the Geohazards Community of Practice.

1.1. SCIENCE AND OBSERVATIONS

An improved access to observations is a key criterion of success for the Geohazards initiative, and more generally, for GEO. Workshop participants recommended:

- **to facilitate access to the space and in-situ data** of a certain number of "Regional Geohazards Virtual Observatories". Regional Geohazards Virtual Observatories consists of a multinational consortium providing a regional center of expertise and data analysis focused upon the particular region's geohazards. They should provide an overview and guidance in the development and operation of the regional research infrastructure, including instrument networks and data systems. The staff of the "Regional Geohazards Virtual Observatories" should provide an interface between research and observational results generated by the research community and the national authorities responsible for developing appropriate mitigation and response.

- **that funding and space agencies issue joint calls** in order to stimulate research and operational monitoring efforts to specific sites. This would be particularly appropriate for the topic of "Regional Geohazards Virtual Observatories" and "Open and Interoperable Data Systems and Archives", which are close and interlinked with each other. Such a call would benefit significantly from Committee on Earth Observation Satellites (CEOS) support.

- **to improve the deployment of digital instrumentation worldwide**. In particular for seismology and earthquake engineering, it is necessary to improve both strong-motion networks in high-risk areas (particularly in less-developed countries in Africa, Asia and South America) and Ocean Bottom Seismometers near high-risk coastal areas.

- **to provide users with high resolution optical, SAR and DEM data** as well as frequent repeat, L-band InSAR, in addition to C-band InSAR.

- **to urgently promote, in Europe, a GMES Core service** that would include the provision of geophysical data for all phases of the disaster crisis management.

- **to perform worldwide a complete assessment of the threats**, including multi-hazard, vulnerability and risk.

1.2. DATA AND INFORMATION FLOWS WITHIN THE END TO END DATA CHAIN

The participants concluded that although the number of currently operational Earth Observation (EO) missions and networks is large, gaps in quality and quantity of information are still present,. In order to fill these gaps and enhance decision support, particularly, different actions might be accomplished by all actors:

- Space agencies and data providers should increase present observational capability, e.g. by means of dedicated EO mission for geohazards. They should encourage data sharing and increase data availability and timeliness (e.g. by means of proper data policies and/or projects).

- Scientific/research bodies should improve algorithms and techniques (e.g. in terms of exportability and reliability to make them immediately applicable on whatever geographic areas and regardless of the specific satellite system). They should improve integration of data and products (e.g. merged multi-mission products).

- End-users/local-national authorities should contribute to the improvement of EO product quality by a direct involvement in validation/assessment sessions.

1.3. ARCHITECTURE

An important next step for the Geohazards Initiative is to perform Geohazards inventories: without an inventory of most if not all geohazard events and studies, understanding of the relationships among geohazards across space and time will remain difficult. Metadata standards exist (e.g. ISO 19115, 19139), Metadata templates and tools exist, catalog standards and implementations exist (ISO, OGC standards, FGDC, NSDI, ORCHESTRA, clearinghouses, etc...). Posting inventories does not imply that data are given away, but enables potential users to know what data have been collected and are or are not available.

Participants of the workshop recommended:

- to use OGC and ISO standards when building and publishing Geohazards databases, in order to ensure their interoperability and their long-term sustainability;

- to learn from the “One Geology”[2] Experience and to consider launching a similar process within IGOS Geohazards;

[2] OneGeology is an international initiative of the geological surveys of the world and a flagship project of the ‘International Year of Planet Earth’. Its aim is to create dynamic geological map data of the world available via the web. See http://www.onegeology.org/

- to participate in the implementation of functioning systems, such as WOVOdat, a project for a global volcanic unrest database;

- to get active in OGC's Risk and Crisis Management Working Group, in order to contribute to building new Information, Technology and Communication tools in support of Geohazards data management.

1.4. CAPACITY BUILDING

Some emerging countries are highly exposed to Geohazards. Developed countries can learn from these countries how these threats are managed there. A mutual exchange of knowledge between developing and developed countries is therefore needed in the field of Geohazards. In particular, participants to the workshop recommended:

- to invest in developing countries' scientific human and technical resources, in particular in the field of Geohazards, in order to develop a capacity to monitor and mitigate their effects;

- to promote active exchange of information between developed and developing countries through the organization of training courses and workshops in developing countries, which are cost effective;

- to strongly insist on the implementation of prevention and mitigation measures, which is usually cheaper and more efficient than remediation or reconstruction actions. When mitigation and prevention are economically not feasible or when it is cheaper just to accept certain disasters (particularly those due to the most extreme events), the issue becomes an ethical one, where the decision is of how much we want to spend to avoid loss of lifes.

- to take into account the technical know-how of engineers and scientists from developing countries;

- to involve communities at risk before, during and after the investigation process, because they provide valuable information about the history of the site.

1.5. INTERNATIONAL COORDINATION, FUNDING, AND LEGISLATION

During the last three years, IGOS Geohazards has been very active in bringing together various Geohazards groups of scientists, engineers, experts and decision makers. In order to move forward, this international cooperation mechanism should be reinforced and more focused under the leadership of GEO. In particular, participants recommended that this coordination mechanism advocates:

- to fund research to mitigate geohazards risk (e.g., for earthquakes, on ground-motion prediction around active faults, local site response to earthquakes and

soil-structure interaction, as well as 3D wave propagation and ground-motion characteristics);

- to address governments to improve Geohazards related legislation (e.g. for earthquakes monitoring of building codes adherence);

- to co-ordinate Geohazards programs worldwide to avoid overlaps and dispersion of resources;

- to sustain a permanent coordination body (“Geohazards Central Bureau”), in charge of the coordination of Geohazards activities under GEO, and based on the work undertaken by the IGOS Geohazards Executive Bureau to identify, for each cooperation action, at which level (national, regional or global) the cooperation that is the most efficient;

- to consider extending the scope of the Charter on Space and Major Disasters to ensure access to acquired data and imagery during all phases of Disaster Risk Management.

2. Background

2.1. WORKSHOP OBJECTIVES

The workshop provided a forum for exchange and encouraged cooperation between Geohazards Earth Observation data users and producers. In addition to this, specific objectives of the 3rd International Geohazards Workshop were to stimulate dedicated coordination actions to:

- **improve the in-situ, airborne and spaceborne components** of the existing observation systems;
- **facilitate the transition of the existing monitoring capabilities** from research to operational services;
- **foster easier and faster access to data**
- **support mutual exchange of knowledge** with countries that are most exposed to geohazards.

Finally, the workshop aimed at contributing to setting up an international coordination mechanism, within GEO, to streamline cooperation and explore synergies between international projects, initiatives and programs.

2.2. WORKSHOP ORGANISERS

2.2.1. The European Space Agency

ESA is the European Space Agency. It is an inter-governmental organisation representing 17 European Member States, plus Canada that participates to the ESA programmes under a cooperation agreement. Its main mission is to provide and promote - for exclusively peaceful purposes - the exploitation of Space Science, Research & Technology and Applications. These objectives are achieved through some dedicated space programmes, a long-term space policy jointly defined with the European Commission, a specific industrial policy and some coordinated activities with the national space programmes of its Member States. With its Earth Observation Programmes, ESA has actively participated to the development of Space application services for the mitigation of Geohazards. With the ERS-1 (1991), ERS-2 (1995) and ENVISAT (2002) series of satellites, ESA has provided over 15 years of C-band SAR observations which has been shown to be an important contribution to the understanding and knowledge of Geohazards phenomena. The ESA satellite missions feature a systematic data acquisition with a background mission designed to secure the acquisition of adequate C-band SAR data over risk-prone areas including seismic

faults, volcanoes and cities (to study urban subsidence). The C-band SAR observation continuity is already provided by the next generation of ESA operational satellites, i.e. the GMES sentinel missions, and the Sentinel-1 SAR Imaging. ESA also participates to international initiatives in Geohazards mitigation through its support to worldwide scientists in Research and Development Projects (EO Principal Investigators), through the funding of flagship demonstration projects (e.g. GlobVolcano) and through the setting up of a GMES Geohazards Service Network (TERRAFIRMA).

2.2.2. The IGOS Geohazards

The objective of the IGOS Geohazard initiative is to respond to the societal, scientific and operational geospatial information needs for the prediction and monitoring of earthquakes, volcanoes, tsunamis (since 2005) and land surface instability using a multi-hazards and risks approach. The IGOS Geohazards theme was initiated in 2001 by the National Oceanic and Atmospheric Administration (NOAA), the United Nations Educational, Scientific and Cultural Organization (UNESCO), CEOS and the International Council for Science (ICSU) in Paris. IGOS Geohazards is participating to the Group on Earth Observations (GEO) as its “Geohazards Community of Practice”.

2.2.3. The Group on Earth Observations

The intergovernmental Group on Earth Observations (GEO) is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next 10 years. GEOSS will work with and build upon existing national, regional, and international systems to provide comprehensive, coordinated Earth observations from thousands of instruments worldwide transforming the data they collect into vital information for society. The GEO was formally established to carry out the GEOSS 10-Year Implementation Plan at the Third Earth Observation Summit in February 2005. GEO is established on a voluntary and legally non-binding basis, with voluntary contributions to support activities.

2.2.4. Workshop Organising Committee

The workshop Organising Committee included members of the following organisations:

- The European Space Agency
- GEO, Group on Earth Observations
- UNESCO
- NASA

- CNES, French Space Agency
- BRGM, French Geological Survey
- BGS, British Geological Survey
- USGS, United States Geological Survey
- FDSN, Federation of Digital Seismological Networks
- GGOS, Global Geodetic Observing System
- International Year of Planet Earth
- APAT, Italian Environmental Agency
- EuroGeoSurveys
- INGV, Italian Institute of Geophysics and Volcanology
- WOVO, World Organisation of Volcano Observatories
- ICL, International Consortium on Landslides – Europe

NASA, GEO, CNES and UNESCO provided support for developing countries participants. ESA supported the local organisation costs and was supported by BRGM for inviting scientists and decision makers as well as for defining the workshop programme.

2.3. THE INTERNATIONAL GEOHAZARDS WEEK AT ESA : OVERVIEW

The 3rd International Geohazards Workshop was organised as part of the International Geohazards Week at ESA.

- The GGOS Workshop (5th and 6th November)
- The Terrafirma 4th User Workshop
- The Globvolcano 1st User Workshop

2.3.1. GGOS Workshop

The Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) is coordinating the geodetic support for Earth sciences. Building upon the work of the IAG Services, GGOS provides the geodetic infrastructure necessary to support the monitoring of the Earth system and global change research. It is integrating the three pillars of geodesy, which is geometry and kinematics, Earth orientation and

rotation, and gravity field and dynamics, in order to maximize the benefit for the scientific community and society in general.

With the global geodetic reference frames and observations of the variations in the Earth's shape, gravity field, and rotation, GGOS provides fundamental contributions to the Global Earth Observation System of Systems (GEOSS). In a detailed strategy process, GGOS is currently developing the plan for a geodetic observing system that will meet future requirements not only of GEOSS but also of science and society in general.

2.3.2. 4th Terrafirma user Workshop

Terrafirma is one of ten services being supported by the European Space Agency's (ESA) Global Monitoring for Environment and Security (GMES) Service Element Programme. Terrafirma provides a ground-motion hazard information service, distributed throughout Europe via national geological surveys and institutions. Terrafirma is based upon the remote sensing technique of Satellite Aperture Radar Interferometry (InSAR) which is able to map ground-motion phenomena from space. Advanced InSAR techniques involves the processing of a large set of radar scenes from an archive dating back to 1991, to identify networks of reflecting ground features, such as buildings, bridges and other structures, against which precise phase measurements can be made over time. The service currently focuses on urban subsidence and landslides. The 4th Terrafirma user workshop was an opportunity to present this technique to potential users from geological surveys, land use planning, environmental agencies and other geologists.

2.3.3. 1st Globvolcano user Workshop

GlobVolcano is an ESA application project that aims at demonstrating the integration of space-based and in-situ observations into integrated services to support Volcano Observatories and other mandate user organisations in their monitoring activities with a particular focus on prevention and early warning. During the GlobVolcano project a worldwide selection of user organisations will cooperate with the project team in order to consolidate and harmonise the information needs and develop a set of key tools addressing these needs. The 1st Globvolcano User Workshop allowed bringing together members of the Globvolcano Consortium and scientists from Volcano Observatories.

3. Summary of oral communications and recommendations

This brief summary of sessions provides an overview of oral communications and recommendations: the readers interested in a specific presentation are invited to visit the ESA website[3], where presentations are available in PDF format.

3.1. TUESDAY 6TH NOVEMBER

3.2. OPENING SESSION

Mark Doherty welcomed the participants on behalf of ESA and presented some applications of space data in the field of geohazards and reminded the audience of the workshop objectives.

Then, **Bernardo de Bernardinis** (replacing Guido Bertolaso) presented the Italian civil protection activities related to Geohazards and its expectations from the Geohazards Initiative, GEO and this workshop. He explained how the Italian civil protection was organised and showed how the early warning systems are working. He was followed by:

Tereza Fryberger from the NASA Earth Science division and co-chair of US-GEO, who presented NASA strategic goals for 2006-16, and the role of the solid earth programme within this strategic view.

Walter Erdelen, UNESCO Assistant Director General for Natural Sciences and co-chair of the IGOS partnership made a statement on UNESCO's role in IGOS-P, GEO and IGOS Geohazards initiatives. He also gave some information about UNESCO's Education programme.

Kaoru Takara, Chairman, Japan Board of Disaster Reduction Hyperbase (DRH) presented Japanese activities in geohazards-related science and technology.

Massimo Cocco replaced Enzo Boschi to present the Italian National Institute for Geophysics and Vulcanology. He stressed the needs of long-term sustainability of monitoring systems, to integrate and coordinate research activities, and finally, the need of a European solid earth initiative linked with GMES and GEOSS.

José Achache, Director of the GEO Secretariat, thanked ESA and BRGM for organising the workshop, and concluded the opening session by a statement on the

[3] http://earth.esa.int/workshops/2007Geohazards/programme.html

GEO initiative: GEO is in charge of implementing a Global Earth Observation System of Systems (GEOSS). It aims at improving and coordinating observation systems, providing easier access and more open data access and fostering use (science, applications, capacity building) to answer society's need for informed decision making. He reminded the audience of GEO data sharing principles: full and open exchange of data. He invited workshop participants to contribute to the GEO portal www.geoportal.org and mentionned GEONETCast as a way to disseminate space-based airborne and in-situ data.

3.2.1. International Famework

Many international initiatives are directly or indirecly adressing the coordination of the geohazards communities.

Edward Derbyshire presented the International Year of Planet Earth (IYPE) that seeks to raise the awareness of the contribution to, and role of the Earth sciences in society in the minds of politicians, decision-makers, the media and the general public. Many other international initiatives focus on the observations needs for specific hazards.

Pedro Basabe presented the International Strategy for disaster reduction and recalled that hazards and extreme events might be increasing, but vulnerability is increasing as well. He recalled that the Hyogo Framework, adopted by 168 governments, set priorities for actions to reduce the underlying risk factors.

David Stevens, United Nations Office for Outer Space Affairs, presented the UN Spider programme, which aims at implementing a gateway to space information for disaster management support, serving as a bridge to connect the disaster management and space communities and is a facilitator of capacity-building and institutional strengthening.

Finally, **Hormoz Modaressi,** French Geological Survey (BRGM), and co-chair of IGOS Geohazards, provided an overview of IGOS Geohazards achievements. He stressed the needs for a multi-risk approach to better respond to the user needs. He also encouraged workshop participants to contribute to GEO, through the participation to communities of practice and to the GEO tasks. He recalled that the success of the IGOS Geohazards over the last three years was only possible thanks to the continuity of the Bureau activity.

3.3. WEDNESDAY 7TH NOVEMBER

3.3.1. Geohazards Observation Programmes of Space Agencies

This session, chaired by **Marc Paganini** (ESA) and **John Labrecque** (NASA), aimed at providing an overview of space agencies solid earth programmes. The following presentations were included:

- The contribution of space based observations to understanding and addressing geohazards: a CNES perspective, **Steven Hosford** (CNES)
- NASA's Architecture for Earth Observations in Support of Decision Making in a Changing World, **John LaBrecque** (NASA)
- The European Space Agency Programmes and Initiatives on Geohazards, **Marc Paganini** (European Space Agency ,ESA)
- JAXA's programmes and initiatives on Geohazards, **Osamu Ochiai**, GEO Secretariat, on behalf of Takashi Moriyama (Japan Aerospace Exploration Agency ,JAXA)
- The Italian Space Agency Programmes and Initiatives on Geohazards, **Simona Zoffoli** (Italian Space Agency)

The participants recommended:

- To focus on European efforts during period 2008-2011 and coordinate the proposal of a GMES Core service for ground movement;
- To use the Geohazards Community of Practice to influence space agencies in defining their satellite High Level Operation plans, including background missions;
- Influence CEOS to agree on a virtual constellation dedicated to the Disaster Management, through the participation to GEO task DI-06-09;
- To concentrate research efforts around some test sites;
- To develop regional disaster monitoring systems of systems such as Sentinel Asia to complement the International Charter by sharing loads.

3.3.2. Examples of Satellite Applications in Geohazards Mitigation

This session, chaired by **Stuart Marsh** (BGS) and **Salvatore Stramondo** (INGV), aimed at providing an overview of major space applications projects. The following presentations were included:

- Satellite detection of power outages following earthquakes and other events, **Christopher Elvidge** (NOAA-NGDC)

- InSAR Monitoring of Landslides in Canada, **Vern Singhroy** (Canada Centre for Remote Sensing)

- Terrafirma, Pan-European Terrain Motion Information Services, **Stuart Marsh** (British Geological Survey (BGS)

- Detection of thermal volcanic eruption precursors using ASTER, **David Pieri** (Jet Propulsion Laboratory)

- Toward Real-Time GPS for Tsunami Warning Systems and Post-Earthquake Damage Assessment and Emergency Response, **Geoffrey Blewitt** (University of Nevada, Reno)

The participants recommended:

- To integrate real-time GPS/GNSS into current Geohazards early warning systems;

- To ensure SAR C, X, and L band continuity, and to ensure the regular monitoring of commonly agreed sites. In particular, for landslides, to focus on large scale triggers such as rainfall, permafrost and glacier melt, rock avalanche or unappropriate land-use practices;

- To build on the expertise of scientific teams currently being funded such as EC and CSA funded landslides teams;

- To strengthen national and international coordination efforts for the planning, research and development of upgrades of already existing Geohazards monitoring systems;

- To develop formal links between Terrafirma and the IGOS Geohazards Theme.

3.3.3. Geohazards Observation Programmes

This session, chaired by **Nicola Casagli** (ICL Europe) and **Hans-Peter Plag** (GGOS), aimed at focusing on thematic Geohazards observations programmes. The following presentations were included:

- The EarthScope Program, **James Whitcomb** (National Science Foundation)

- The Global Geodetic Observing System (GGOS): Backbone for a Solid Earth Observing System for Geohazards Assessment and Disaster Reduction, **Hans-Peter Plag** (University of Nevada, Reno)

- The International Consortium on Landslides (ICL), **Kaoru Takara** (Kyoto University)

- IASPEI activities in Geo-hazards, **Peter Suhadolc** (IASPEI)

- The World Organization of Volcano Observatories (WOVO), **Warner Marzocchi** (Istituto Nazionale di Geofisica e Vulcanologia)

The participants recommended:

- to make digital data freely accessible through the web;

- to improve deployment of digital instrumentation worldwide. For seismology and earthquake engineering, both strong motion networks in high-risk areas, particularly in less-developed countries in Africa, Asia and South America, and Ocean Bottom Seismometers near high-risk coastal areas;

- to improve real-time alert systems, and in particular, to participate to WOVO that aims at creating a global volcanic unrest database. This database will be of prominent importance in managing pre-eruptive phases;

- to fund research to mitigate geohazards risk, e.g., for earthquakes, on ground motion prediction around active faults, local site response to earthquakes and soil-structure interaction, as well as 3D wave propagation and ground-motion characteristics;

- to lobby governments to improve monitoring of building codes adherence and to promote a world campaign on safe building information and risk mitigation measures;

- to co-ordinate Geohazards programs worldwide to avoid overlaps and dispersion of resources.

3.3.4. Round Table - African and Middle East Community of Practice

This session, chaired by **Sospeter Muhongo** (ICSU), focussed on Geohazards sciences in Africa. The following presentations were included:

- The Implementation of the ICSU ROA Science Plan on Natural and Human Induced Hazards and Disasters, **Sospeter Muhongo** (ICSU Regional Office for Africa, South Africa)

- Mapping Land Collapse Geohazard using Remotely Sensed Data and Geographic Information System of the Egyptian Territories, **Mohamed Hegazy** (National Authority for Remote Sensing and Space Science, Egypt)

- Risk and Vulnerability Mapping of Sand Dunes, a prerequisite for land use planning in the Egyptian deserts, **Hala Effat** (National Authority for Remote Sensing and Space Science, Egypt)

- Remote Sensing/geographic Information System Application for Early Warning Systems of Natural Hazard:case Study of Victoria Island, Lagos Nigeria, **Olumuyiwa Solana Sonuga** (University of Lagos, Nigeria)

- Zoning of the natural risks on Mount Cameroon, **Emmanuel Kouokam** (Ministry of Industry, Mines and Technological Dev, Cameroon)

The participants recommended:

- to invest in African countries' scientific human and technical ressources, in particular in the field of Geohazards, in order to develop a capacity to monitor and mitigate their effects;

- to consider other hazards such as coastal erosion and permanent flooding of low lying areas, sand dunes migration, to improve their monitoring (through, for example, space and in-situ data, and an efficient spatial distributions of meteorological stations in dune desert areas);

- to promote technology transfer and trans-boundaries collaboration to minimize the impacts of, e.g., land collapse hazard in less developed countries facing lack of data and experience;

- to monitor African Geohazards high risk areas such as the Mount Cameroon volcano.

3.3.5. Round Table - Latin America Community of Practice

This session, chaired by **Juan Murria** (Universidad de Falcon, Punto Fijo, Venezuela), aimed at focusing on Geohazards sciences in Latin America. The following presentations were included:

- Mass movement processes influenced by climate change in Ecuador, **Elías Ibadango** (DINAGE, Ecuador)

- Early Warning Systems for Disaster Risk Reduction; Don't Forget the Human Element, **Juan Murria** (Universidad de Falcon, Punto Fijo, Venezuela)

The participants recommended:

- to make accessible scientific information collected in different public and private institutions;

- to provide economic resources in developing countries, for the mitigation of geohazards, for land use planning and risk management;

- to improve the cooperation between planning and civil defense institutions, scientists and the communities at risk, in order to take the best decisions for land use planning and risk management;

- to involve communities at risk before, during and after the investigation process, because they provide valuable information about the history of the site;

- to implement prevention and mitigation measures, which is cheaper and more efficient than remediation or reconstruction actions;

- to ensure that the degree of sophistication of early warning systems matches the technical background of the intended users;

- to take into account the technical know- how of engineers and scientists from developing countries;

- to organize training courses and workshops in the developing countries, which are more cost effective;

- to promote active exchange of information between developed and developing countries;

3.4. THURSDAY 8TH NOVEMBER

3.4.1. Working Group 1 - Hazard Databases and Multi-Hazard Assessment

This session, chaired by **Warner Marzzochi** (INGV) and **David Arctur** (OGCii), aimed at formulating recommendations on hazard databases and multi-hazard assessment issues. The following presentations were included:

- PREVIEW: a standard-based platform for the monitoring of geophysical risk, **Daniele Pellegrino** (Telespazio S.p.A.)
- Multi-hazard assessment: Looking 'AHEAD' , **Warner Marzocchi** (Istituto Nazionale di Geofisica e Vulcanologia)
- The European Severe Weather Database (ESWD) - Design, Quality-Control and Applications, **Nikolai Dotzek** (DLR-Institute of Atmospheric Physics)
- Risk assessment for the road network in the French-Italian border region using web services, **John Douglas** (BRGM)
- A global database of large submarine landslides, **Malik Chibah** (University College London) presented by **Matthew Free**
- Remote sensing techniques for monitoring and mapping Geohazards at different spatial and temporal scales, **Nicola Casagli** (University of Florence), presented by **Giacomo Falorni**

Following these presentations, the discussion led to the following recommendations:

- Large efforts are required to create databases and services to make information homogeneous and available to a vast audience;
- There is a need to better organise the geohazards communities to share and use common multi-hazards databases;
- Multi-risk might be more relevant than multi-hazard for society. Multi-hazard is only one part of the risk assessment process, which includes data collection, databases management, multi-hazard assessment and multi-vulnerability assessment;
- During crisis management, databases can be used in real-time to take decisions. Cost/benefit analyses should be performed;
- Interesting cases of a single kind of observation (e.g. deformation) are currently being applied to different hazards. The geohazards communities should think about the way these studies should be integrated with similar ones based on

different types of data. In addition, remote-sensing and in-situ data should be better integrated;

- Very interesting large scale databases on weather extreme events, submarine landslides, and landslides already exist, but the way “incompleteness” is tackled should be better understood. These databases are easily “linkable” to other databases for a multi-hazard assessment;

- Metadata collection is very difficult to achieve. There is a need to enforce metadata collection at time of data capture;

- Harmonization of hazards data models is important but hard to accomplish. It is therefore recommended to start by just sharing hazards data and harmonization will follow;

- Public can participate in data collection using Web 2.0 tools such as web logs, web GIS, etc. This means extra work to ensure quality of data, but can provide much greater data collection capability.

- OGC established a Risk and Crisis Management Working Group to work toward standards and common practices, of which Hormoz Modaressi is co-chair. This is an appropriate place to discuss the need for protocols to help geohazards databases issues;

- An important next step is to perform Geohazards inventories: without an inventory of most if not all geohazard events and studies, understanding of the relationships among geohazards across space and time will remain difficult. Metadata standards exist (ISO 19115, 19139), Metadata templates and tools exist, catalog standards and implementations exist (ISO, OGC standards; FGDC NSDI, ORCHESTRA, clearinghouses, etc.). Posting inventories does not imply that data are given away, but enables potential users to know what data has been collected and is or is not available.

3.4.2. Working Group 2 - Science and Observations

This session, chaired by **Janusz Wasowski** (National Research Council of Italy) and **Stuart Marsh** (BGS), aimed at formulating recommendations on science and observations issues. The following presentations were included:

- ESA Support To Science Element: Towards the achievement of the new scientific challenges for the Living Planet Programme, **Diego Fernandez** (European Space Agency (ESA))

- EO for the Recognition, Mapping and Monitoring of Unstable Slopes, **Janusz Wasowski** (CNR-IRPI)

- Satellite observations of electromagnetic perturbations related to earthquakes, **Frantisek Nemec** (CNRS)

- Using Remote Sensing for seismotectonic observations, **Marcello de Michele** (BRGM)

- Low cost remote sensing applied to disaster risk assessment, **Richard Teeuw** (Portsmouth University)

Following these presentations, the discussion led to the following recommendations:

- The Geohazards Communities can take advantage of existing GPS and ionospheric “seismology” data, as well as, of gravimetric GRACE data.

- ESA should begin a new programme to support science. Geohazards science would benefit much from these projects if joint calls with other agencies could be issued, in order to stimulate the efforts on specific sites.

- A greater focus on small landslides that can be mitigated implies the following requirements: high resolution optical, SAR and DEM data as well as frequent repeat, L-band InSAR, in addition to C-band InSAR.

- Research is needed to take advantage of the promising Demeter data.

- Projects to develop the large potential from an integration of techniques should be funded (Optical image correlation, Conventional, PS InSAR).

- CEOS needs a global and continuous SAR acquisition plan.

- The cost barrier is critical in science and capacity building: free data are needed for high risk areas in developing countries, but also free or cheap GIS software.

3.4.3. Working Group 3 - Regional and International Cooperation

This session, chaired by **Giovanni Rum** (GEO) and **Robert Missotten** (UNESCO), aimed at formulating recommendations on regional and international cooperation issues. The following presentations were included:

- Africa's Science Plan on Natural and Human-Induced Hazards and Disasters, **Sospeter Muhongo** (ICSU Regional Office for Africa)

- Comparative analysis of climate change impacts in the Yarlung Tsangpo (Upper Brahmaputra) and Upper Danube river basins – the BRAHMATWINN Project, **Peter Zeil** (Center for Geoinformation,Salzburg).

- Regional and International Cooperation on Geohazards in South East Asia, **Kong Chiew Low** (Malaysian Meteorological Department)

- Remote Sensing to Support Management of Georisks in Indonesia, **Friedrich Kuehn** (BGR)

- Cooperation Between United Nations, European Union, Italy and the Democratic Republic of Congo on Mitigation of Volcanic and Environmental Risks, **Dario Tedesco** (University of Napoli 2)

- Role of Regional organization for risk reduction and hazard mitigation in Southeast Asia, **Niran Chaimanee** (Coordinating Committee for Geoscience Programmes)

Following these presentations, the discussion led to the following recommendations:

- There is a need to identify at which level cooperation is most efficient. This depends on the objectives and the content:
    - Regional (common developments, infrastructure improvement, operational issues);
    - Inter-regional and International (exchange of experiences, capacity building, science and technology);
    - Build on existing Partnerships, adding themes and programs.
- There is a need of increased coordination among international institutions and national research institutes
- A need exists need to consider extending the scope of the Charter on Space and Major Disasters to ensure access to acquired data, to provide imagery during all phases of the disasters risk management.
- Capacity building is a key element of international cooperation. Mechanisms should be improved to diffuse information worldwide on available opportunities and how to access them.
- A need exists to link Science and Technology to Social Science and Policy.
- There is a need of a complete assessment of the threats: multi-hazard, vulnerability and risk (proposal for specific worldwide initiative coordinated by IGOS).
- Improvements of national infrastructure/regional networks, early warning systems are essential.
- A need exists to share and ensure access to databases (including weather data).

3.4.4. Tsunami Session

This session, chaired by **Emile Okal** (Northwestern University) and **Paula Dunbar** (National Oceanic and Atmospheric Administration, NOAA), focussed on tsunamis. The following presentations were included:

- Far-field tsunami risk in the Indian Ocean from hydrodynamic simulations, **Emile Okal** (Northwestern University)

- U.S. States and Territories National Tsunami Hazard Assessment, Historical Record and Sources for Waves, **Paula Dunbar** (National Oceanic and Atmospheric Administration)

- Geomagnetic dependence of ionospheric disturbances induced by tsunamigenic internal gravity waves, **Giovanni Occhipinti** (IPGP/JPL)

- Tsunami Warning System in Thailand, **Kriengkrai Khovadhana** (Thai Meteorological Department)

- Concept Design of a Near-Space Radar for Tsunami Detection, **Michele Galletti** (DLR German Aerospace Agency)

The participants recommended:

- to improve and expand public access to global tsunami data, through making data openly accessible and, whenever possible, freely accessible via the Web;

- to ensure that data, observational and post-tsunami surveys, are preserved in an archive;

- to adopt common means of assessing and documenting the validity of data as well as a standard, defined terminology for observational data (see also architecture session)

- to conduct a consistent tsunami hazard assessment for all coastal areas at risk from tsunami, which requires historical and paleo-tsunami data. The U.S. Tsunami Hazard Assessment model could be applied in other countries and regions and web applications could facilitate data transfer and exchange;

- Try to coordinate seismological and tsunami networks with space operation centers (such as the European Space Operation Center) to organize data records of tsunami, when an opportunity occurs, with future ESA missions (Sentinel-1-3 for example). This would help test the potential of future tsunami and earthquake geostationary observing systems.

3.4.5. Round Table - Asia Community of Practice

This session, chaired by **Niran Chaimanee** (CCOP), focussed on geohazards sciences in South East Asia. The following presentations were included:

- Multi Sensor Geophysical Parameters for the Early Warning of Earthquakes, **Ramesh Singh** (Indian Institute of Technology Kanpur, India)
- Community Resilience Approach to geological risk reduction and hazard mitigation in Southeast Asia, **Niran Chaimanee** (Coordinating Committee for Geoscience Programmes, Thailand)
- Role of Remote Sensing in Landslide Mitigation in Thailand, **Worawoot Tantiwanit** (Department of Mineal Resources, Thailand)
- Geotechnical Engineering and Global Warming, **Mohd Raihan Taha** (Universiti Kebangsaan Malaysia, Malaysia) presented by **Zamri Chik**

The participants recommended:

- To strengthen cooperation between nNational institutes and international coordination;
- To better integrate capacity building in international networks;
- To better Integrate early warning Systems with local and national communication structures for sustainable use;
- To use already existing early warning systems (e.g. Meteorological networks) for other natural hazards;
- To facilitate real-time access to Geohazards data for warning systems;
- To strengthen mutual exchange of knowledge, in particular, with developing countries.

3.4.6. Programme Proposals

John Labrecque, NASA, presented the Natural Laboratory approach. An effective strategy to increase our understanding of natural phenomena is to focus observations on carefully chosen regions, also called "*geohazards natural laboratories",* where representative behaviors can be investigated and where effective use of the research products can be made appropriate in sufficient context and detail as well as with the appropriate complement of expertise and instrumentation. Geohazards Natural Laboratories are geographic areas designated for the study the terrestrial processes and systems contributing to geohazards through detailed in-situ and remote-sensing measurements. He quoted two examples of Geohazards Natural Laboratories:

EarthScope and Servir, and encouraged the geohazards communities to reproduce this example.

Marc Paganini, ESA, proposed a similar approach, “Supersites”, based on an open and seamless data access to a wide range of key observations (spaceborne, airborne, ground-based), from raw data to processed information over a number of GeoHazards SuperSites. The Geohazards SuperSites would, among other advantages, stimulate the development of new technologies, observation systems, models, tools and would constitute an ideal framework for capacity building actions. A condition of success for this approach is to let other sources of data be provided as well within this framework. The setting up of Geohazards “SuperSites” fits well in the GEO process and is complementary to the regional laboratories proposed by NASA to build regional centers of expertise focused upon a particular region’s geohazards. Finally, he concluded that the challenge of the supersite approach will be to build on existing capacity within the geohazards community and to promote the global application of local best practices, through programmes of education, training and technology transfer.

Falk Amelung, Univserity of Miami, showed the WinSAR approach. One of the major obstacle for the study of geohazards is that for many scientists, SAR data are difficult to access. Whereas in the USA, seismic and GPS data is freely available from the internet this is different for SAR data. SAR imagery can be accessed only through research proposals and is associated with costs. Recognizing the importance of easy access to SAR imagery several U.S. Universities and research institutions formed the WInSAR consortium (Western US InSAR consortium) to share SAR imagery among co-investigators over a password-protected Internet website. He discussed how WInSAR is functioning and presented scientific breakthroughs achieved with WInSAR data. He also discussed first efforts to extend the WInSAR approach to other parts of the world. Natural Laboratories are beeing formed for Central America and Southeast Asia by making SAR imagery available to interested scientists. Non-US WInSAR members are granted access to the imagery in concordance with the policies of the Space Agencies. He encouraged the “Supersite” approach and proposed to support this approach through the provision of software to efficiently distribute SAR data.

The following comments came from the audience:

- **Ramesh Singh** recalled that one should be very cautious before selecting the “supersites” and should carefully consider if the techniques can be applied on the chosen sites. Marc Paganini replied that an open consultation process should be launched to select the “supersites”.

- **Moshen Ghafory-Ashtiany**, IASPEI-SHR, recalled that the reality is that the space-based information and data are neither open nor available in regions (developing countries with high risk) where they are mainly needed, and the same situation prevails for the scientific studies. IGOS Geohazards should ask for open (and possibly free) accessible data for scientific purposes; and open, but not free, for the application to disaster management authorities and users in developing countries.

- **Vern Singhroy** said that the natural laboratories and "supersites" are the same concept. These should be harmonized in order to clarify the message toward other space agencies.

3.4.7. Final round table

The Final Round Table gathered high level participants, who made the following comments on the workshop:

Stuart Marsh, BGS, recalled the work performed in 10 years: IGOS Geohazards established a link with ground-based networks, and now, end-users should be better introduced in the partnership. The 8 IGOS themes have negociated and agreed on how these various groups will contribute to GEO. He stressed the need for Geohazards Communities to be well represented in the GEO Committees in order to push their requirements. He stressed that the 3rd international Geohazards Workshop provided the opportunity to review ambitious Geohazards projects such as Terrafirma, Globvolcano, Earthcope, Sentinel-Asia, etc…

David Arctur, OGCii, recalled that much data from the 1960's are no longer available. Therefore, there is a need to ensure that the data geohazards experts acquire, are not just lost when a funded project ends or because inadequate metadata was collected. If the data models for various Geohazards could be harmonized, then it would be possible to correlate studies and reports on geohazards across locations and time. Information technology such as standard web services can improve accessibility and use of already existing geohazards databases and inventories for researchers in other fields besides geohazards. The OGC Technical Committee and its Risk and Crisis Management Working Group provide a good place to discuss these issues.

Gordon Woo, RMS, reminded the audience that the insurance industry was a key end-user community. He encouraged the sharing of data information across the community and recalled that this industry is also a producer of data and information, and urged closer interactions between scientists and the insurance industry.

Pedro Basabe, ISDR, thanked IGOS Geohazards, GEO and ESA for organising this initiative. He stressed that the community of practice present at this workshop have a large expertise in Geohazards sciences. He encouraged the communities to think about the way knowledge can be translated into practical tools to reduce risk. He recalled that the risk reduction agencies often take advantage of simple applications and already existing mechanisms. He encouraged considering to apply the approach of the Charter to other disaster phases. He stressed that a sustainable approach to capacity building in developing countries is needed and encouraged collaborating with ISDR, to engage with UNESCO, and to participate in the networks and platform for disaster reduction mechanisms.

Jacques Varet, BRGM, reminded the audience that there are a wide variety of geohazards that should be covered by IGOS Geohazards and this kind of Workshop. As example, he quoted geochemical hazards, heavy metals in soils, superficial phenomena like erosion, dissolution, climate change related landslides and coastal

risks. Quite a lot of instruments are available to monitor and to inform the decision makers about the geological threats and geological surveys are the major actors to translate these data into information. He made three comments on the “Supersite” approach. First, many data integration techniques are site-specific. Secondly, he recalled that the end-users need entire sets of data, including in-situ data. Finally, he recommended to reconsider the sites, choosing some less spectacular ones. He recommended the use of the best from both space and in-situ data. Regarding the exchange of data, he recommended the use of tools and programmes such as GMES and INSPIRE. The Geohazards experts have to develop projects, but we also permanent services.

Juan Murria, Universidad de Falcon, Punto Fijo, made a couple of proposals. He.encouraged cooperation with developing countries and took the example of a fruitful cooperation between Venezuela and the French government as an example. He recommended supporting training activities in developing countries and to better include social sciences and societal aspects in risk reduction projects. Finally, he recommended writing letters to governments to have the activities recommended by IGOS Geohazards implemented.

3.5. FRIDAY 9TH NOVEMBER

3.5.1. Architecture (Parallel Session)

This session, chaired by **David Arctur** (OGCii), focussed on architecture for Geohazards data management. The following presentations were included:

- Standards based approaches for cross-domain data integration, **Rob Atkinson** (Social Change Online) D. Arctur (OGC) and K. Millard (HR Wallingford)
- The Importance of Open Standards-Based GIS for Risk and Crisis Management, **Guenther Pichler** (ESRI Inc.)
- Atmospheric Releases Uncertainty Assessment using Remote Sensing, Mesoscale Modeling, and Data Mining, **Guido Cervone** (George Mason University)
- Sharing geoscientific information: Lessons learnt in the geological domain, **François Robida** (BRGM)

The participants recommended:

- To use OGC and ISO standards when building and publishing Geohazards databases, in order to ensure their interoperability and their long term sustainability;
- To get active in OGC's Risk and Crisis Management Working Group, in order to contribute to building new ITC tools in support to Geohazards data management;
- To learn from the "One Geology" Experience in developing GeoSciML, and to consider launching a similar process within IGOS Geohazards.

3.5.2. European Community of Practice

This session, chaired by **Marc Paganini** (ESA), and **Stuart Marsh** (BGS) focussed on geohazards sciences in Europe. The following presentations were included:

- NOVAC – Network for Observation of Volcanic and Atmospheric Change, **Bo Galle** (Chalmers University of Technology)

- Strategies for Integrated Concepts for Monitoring Man-made Geohazards, **Norbert Benecke** (DMT GmbH)

- Multi-hazard Approach to Disaster Risk Reduction in Regional Level by Using Geographical Information Systems and Remote Sensing Techniques. Case Studies from NW Turkey, **Murat Nurlu** (General Directorate of Disaster Affairs)

- The UNU-ITC School for Disaster Geo-Information Management (DGIM), **Norman Kerle** (ITC)

- Lessons Learned from 25 years of post-earthquake fieldwork by EEFIT – the engineering perspective, **Matthew Free** (Arup)

The participants recommended:

- To work on a stronger IGOS (Geohazards) profile through:

    - Improving links to industry professional institutions through regional champions;

    - Communicating through industry publications and conferences:

    - Lobbying for planning legislation to include hazard assessment by appropriate specialists;

    - Distinguishing between coordination (behind the scenes, e.g. through GeoHazNet) and practical and accessible support (e.g. GeoHazData) – the latter should be more visible;

- An international partnership for Geohazards should promote a “Geohazards Fund”, in order to help countries to mitigate risk and recover from disasters linked to geohazards.

3.5.3. Eurogeosurveys Geohazards Working Group

This session, chaired by **Patrice Christman** (EuroGeoSurveys) and **Gonéri Le Cozannet** (BRGM) was a session organised by the EuroGeoSurveys Geohazards Working Group. The following presentations were included:

- Expectations from the Eurogeosurveys Working Group, **Jacques Varet** (BRGM, French Geological Survey)

- The role of the Eurogeosurveys Working Group on Geohazards, **Patrice Christmann** (EuroGeoSurveys)

- The intensity scale ESI 2007, **Luca Guerrieri** (APAT, Italian Geological Survey)

- Geohazards in Lithuania, **Roma Kanopiene** (Lithuanian Geological Survey)
- Two Balkan Environmental Projects, **Margarita Matova** (Geological Institute)
- Multirisk Assessment and Mapping for the North East Bulgarian Black Sea Coast, **Antoanetta Frantzova** (Ministry of State Policy for Disasters and Accidents)
- National Environmental Monitoring of Geological Hazards of the Slovak Republic , **Alena Klukanova** (Geological Survey of Slovak Republic)
- Regional landslide mapping and monitoring in Norway using SBAS InSAR, **John Dehls** (Geological Survey of Norway)
- A GIS Based Volcanic Hazard Map for Tenerife at a 1:25,000 Scale, **Inés Galindo** (Spanish Geological Survey)

The participants recommended:

- to provide EuroGeoSurveys with ideas of projects, so that they can be pushed at the European Commission;
- to create a cartographic infrastructure for geologic hazards and to design and develop an information system for geologic hazards;
- to improve and develop new monitoring systems for geologic hazards;
- to train specialists in crisis management;
- to increase the transfer of knowledge about geologic hazards to citizens.

3.5.4. Some Aspects of Italian Research in Geohazards

This session, chaired by **Marc Paganini** (ESA), and **Salvatore Stramondo** (INGV) focussed on geohazards sciences in Italy. The following presentations were included:

- Earthquake and Volcanic Risks: Scientific research and operational activity. The INGV experience, **Salvatore Stramondo** (Istituto Nazionale di Geofisica e Vulcanologia), presented by **Laura Colini**
- First results from spaceborne SAR analysis in the Valfurva area, Italy, in the framework of the PREVIEW project, **Gaia Righini** (University of Firenze)
- Automatic classification and parameters retrieval of seismic events by neural networks and SAR interferometry, **Fabio Del Frate** (Tor Vergata University)
- A Robust Satellite Technique (RST) for multi-hazard monitoring and investigation, **Nicola Pergola** (National Research Council - IMAA)
- PSInSAR for landslide investigations in civil protection practices, Paolo Farina (University of Firenze), **Alessandro Ferretti** (Treuropa)

- Lava flow simulations using effusion rates from thermal infrared satellite imagery during the 2006 Etna eruption, **Ciro Del Negro** (Istituto Nazionale di Geofisica e Vulcanologia)
- The SIGRIS pilot project: an integrated Earth observation system for the management of seismic risk, **Stefano Salvi** (Istituto Nazionale di Geofisica e Vulcanologia)

The participants concluded that although the number of currently operational Earth Observations missions is high, a gap in quality/quantity of information is still present.. In order to fill this gap, different actions might be accomplished by all actors:

- Scientific/research bodies should improve algorithms and techniques (e.g. in terms of exportability and reliability to make them immediately applicable on whatever geographic areas and regardless of the specific satellite system) They should improve integration of data and products (e.g. merged, multi-mission products);

- Space agencies and data providers should increase present observational capabilities, e.g. by means of a dedicated EO mission to geohazards. They should encourage data sharing and increase data availability and timeliness (e.g. by means of proper data policies and/or projects);

- End-users/local-national authorities should contribute to the improvement of EO product quality by a direct involvement in validation/assessment sessions.

3.5.5. Conclusion of the Workshop

Marc Paganini, ESA, concluded the workshop by thanking the participants and by encouraging them to participate to the Natural Laboratories and “Supersites” approaches.

4. The way forward: 3rd International Geohazards Workshop final declaration

3rd International Geohazards Workshop

Frascati Declaration

8th November 2007

The third International Geohazards Workshop was held at the European Space Agency, Frascati, from 6th to 9th November 2007. About 250 scientists, engineers, risk managers and decision makers, experts in the field of geohazards, participated to this event. The following declaration was adopted:

We, as experts in the field of Geohazards, participating to the 3rd International Geohazards Workshop,

recognizing

- the scientific and operational need of both in-situ and space geospatial data, for the forecasting and monitoring of Geohazards
- the need to address this issue within the framework of the Group on Earth Observations(1) and its Geohazards community of practice
- the need to contribute, within our field of expertise/competency to the Hyogo Framework for Action 2005-2015 and its mechanisms for implementation

recommend

- to promote multi-risk approaches for disaster risk management, starting with user requirements gathering, that put emphasis on the mitigation of Geohazards
- to stimulate an international and intergovernmental effort to monitor and study selected reference sites by establishing open access to relevant datasets according to GEO principles to foster the collaboration between all various partners and end-users

- to facilitate access to geohazards information through development of an architecture of interoperable distributed data and sensors, based on widely recognised interoperability standards and data models
- to stimulate mutual exchange of knowledge between north and south in the field of Geohazards mitigation and to build on capacity
- strengthen relationship between scientific institutions and communities and applied scientists by providing open access to the space and in-situ data
- to strengthen regional coordination efforts building on already existing cooperation mechanisms, initiatives and projects.
- to maintain and build a coordination body to ensure the further development of the Geohazards initiative and Community of Practice

1: The intergovernmental Group on Earth Observations *(GEO) is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next 10 years.* http://www.earthobservations.org

5. References

[1] IGOS Geohazards Theme Report 2004

[2] 2nd IGOS Geohazards Theme Report, 2007

[3] G. Le Cozannet, GEO South East Asia Geohazards Workshop Report, July 2006;http://www.igosgeohazards.org/pdf/GEO_Geohazards_workshop_in_south_east_Asia_final_report.pdf

Appendix 1

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Appendix 2

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