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National Institute for Earth Physics

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FFCUL
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NOA
National Observatory of Athens

ULEIC
University of Leicester

AMRA
Analysis and Monitoring of Environmental Risk

KOERI
Kandilli Observatory and Earthquake Research Institute

KIT
Karlsruhe Institute of Technology

CAR
Cambridge Architecural Research Limited

METU
Middle East Technical University

BGS
British Geological Survey

NORSAR
Stiftelsen Norsar

KUL
Katholic University Leuven

ULIV
University of Liverpool

JKU
Johannes Kepler University

AIT
Austrian Institute of Technology

www.nera-eu.org

NERA

NETWORK of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Integrating Seismology and Engineering Infrastructures for Earthquake Risk and Mitigation

www.nera-eu.org

NERA Introduction

NERA (2010–2014) integrates key research infrastructures in Europe for monitoring earthquakes and assessing associated hazard and risk. The project aim is to achieve an integration that significantly facilitates cross discipline assessment of hazard and risk assessment and reduce vulnerability of constructions and citizens to earthquakes.

NERA's long-term objective is to integrate seismic and engineering infrastructures and thus establish an effective integrated network of European research infrastructures for earthquake risk assessment and mitigation.

NERA's strategy is to combine expertise in observational and strong ground motion seismology, modelling, geotechnical and earthquake engineering and information technology. Within NERA they develop multidisciplinary advanced infrastructures facilitating integrated data and product access and use of the data to a broad scientific public.

NERA activities take optimal advantage of developments within other relevant EC-projects and European and global initiatives, contributing among others to the ESFRI EPOS infrastructure and the OECD GEM program.

NERA is organised along a number of working packages/activities:

- Cooperative actions (Networking Activities),
- RTD actions (Joint Research Activities),
- Transnational Access and
- Service Activities.

Domenico Girardini
ETH Zurich, Switzerland
NERA-Coordinator

www.nera-eu.org

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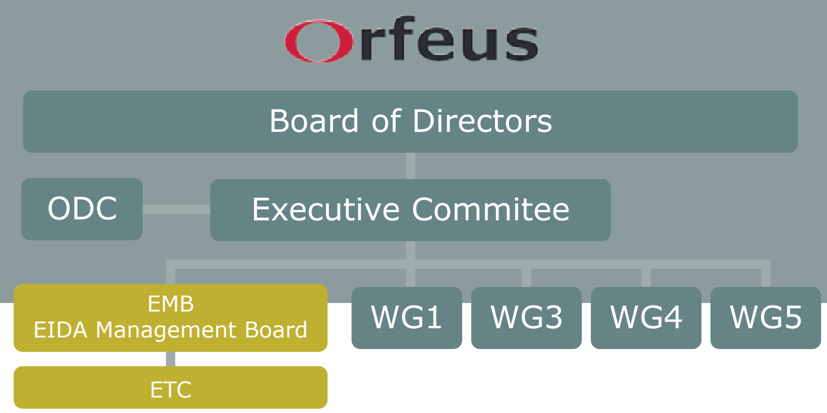
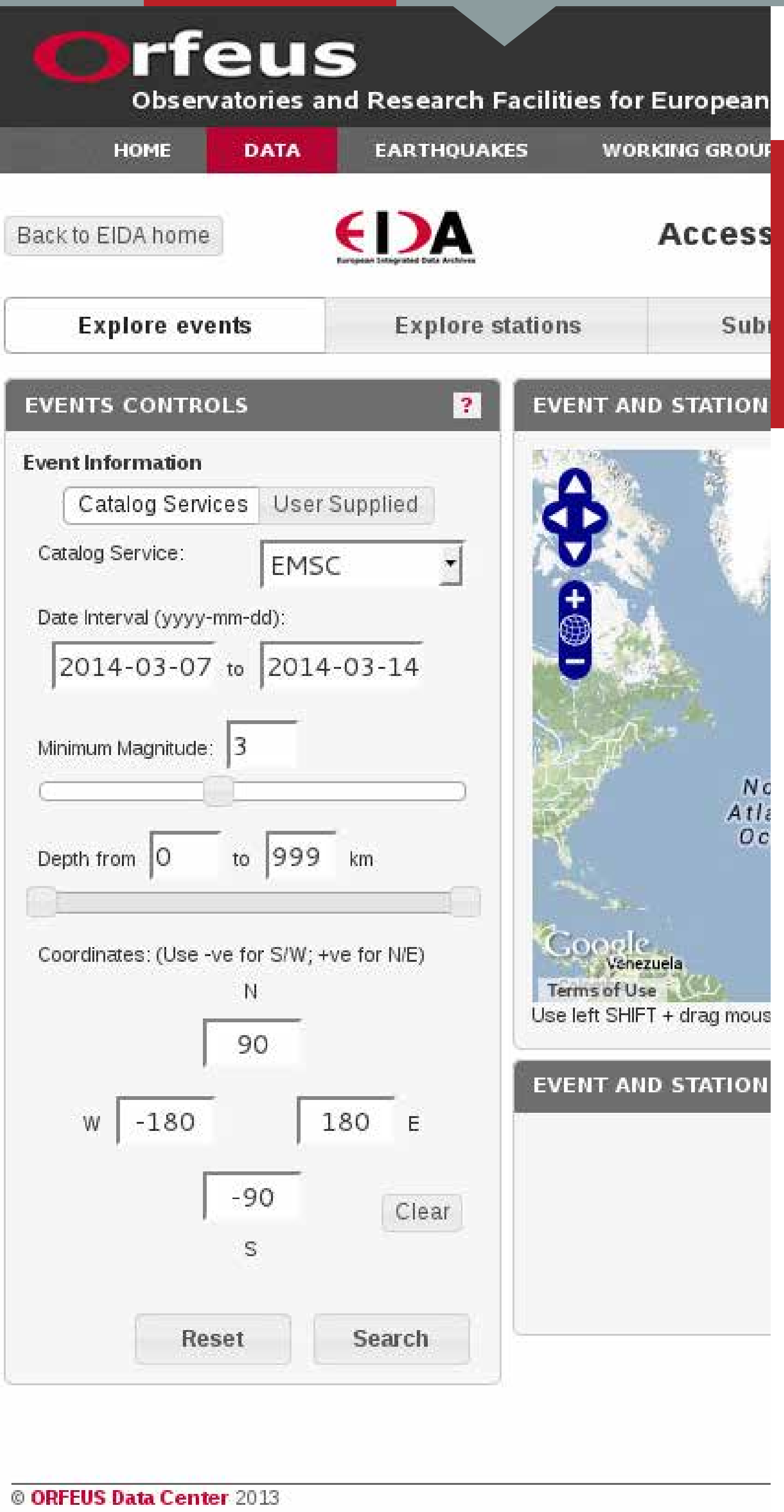
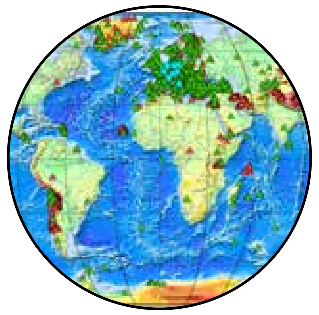
NA 2 Expanding Access to Seismic Waveform Data in the Euro-Med Region





NERA NA2 (www.nera-eu.org/index.htm?page=1205) aims at integrating data archiving and access from permanent and temporary networks recording broad-band seismic data in the larger Euro-Mediterranean region, and expand the collection and storage of and access to data for the whole region. This also implies improving the data quality for research, optimizing technical interoperability, standardizing data collection, format and archive procedures, and quality control standards.

European Integrated waveform Data Archives (EIDA). In 2013 ORFEUS established EIDA (www.orfeus-eu.org/eida/eida.html) to expand the availability of seismic data to the seismological community through a coordinated distributed data archive system. This innovative core waveform data infrastructure provides open, unified access to continuous waveform data from more than 3400 stations from 75 permanent and 42 temporary networks (status March 2014). Current EIDA nodes are: ODC, GFZ, RESIF, INGV, ETH, BGR, IPGP, LMU. Each node provides resources for management and technical support and may additionally provide unique, restricted data and additional services. A common, uniform web interface (WebDC3; developed by GFZ) provides transparent access to EIDA (http://145.23.252.222/eida/webdc3/). Web services are being installed to provide complimentary data access. With this distributed infrastructure ORFEUS expands its archives with open broad-band (BB) data from European networks and research institutes and creates a robust long-term archiving system. Most permanent networks in Europe are currently being archived within EIDA (www.orfeus-eu.org/eida/eida_network_lists.html). With Romania and Turkey joining EIDA in the near future we expect to add approximately 300 BB stations more to the homogeneous data access facility.



Extending integrated access to data from temporary deployments. An overview of the mobile resources in seismology is summarized on the ORFEUS web site: www.orfeus-eu.org/workinggroups/wg3.html. The EIDA infrastructure facilitates also the integration of data from mobile experiments by European organizations within the data archives of permanent networks. This is reflected by the large increase of temporary networks in EIDA for which data is available: from about 20 networks in early 2013 to more than 40 in March 2014, involving more than 800 stations.

Collaboration and training workshops. Regular meetings (technical and management) are organized usually in collaboration with other partners, like ORFEUS/EIDA, EPOS, COOPEUS, IRIS, IPGP, IM, ISE, and others to exchange technical know-how, practical interoperability issues and integration of distributed mobile BB instrumentation (land based, OBS) with permanent networks, and discuss standardizing data collection, format and archive procedures, and quality control standards.

Data quality. Procedures to handle data and provide quality controlled data access are being developed and practices exchanged. These developments build both on top of data acquisition software SeisComP3, but also on new technologies. Simultaneously a next generation of software to handle the increasing complexity of a distributed archive in relation to new services and data quality purposes is being developed and tested.

Coordinating European temporary deployments. A common European deployment strategy for large scale cross border temporary experiments incorporating permanent stations, OBS and mobile land-based equipment. A first plan for the AlpArray is prepared and well embedded in the EIDA infrastructure.

Torild van Eck
ORFEUS, Netherlands

The establishment of EIDA as core waveform data infrastructure in ORFEUS has expanded the access to seismic waveform data in the European Mediterranean region collected from permanent and temporary seismic stations and offers the framework for standardizing data collection and quality control methodologies within mobile deployments.

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NA 3 Networking Accelerometric Networks and SM Data Users

RRSMdb – Waveform extraction for SM and BB data

Scheduling
- ✓ **Real-time** (automatic start based on SeisComP3/EMSC locations)
- ✓ **Playback** (offline start, manual relocations, command line)
- ✓ **Real-time updates** (reprocessing and check on new waveforms, process scheduler)

Waveform query
- ✓ **SeedLink** (real-time) / **ArcLink** (offline)

Extraction rules
- ✓ **Fixed max distance from epicentre or**
- ✓ **Max distance depending on magnitude**
- ✓ **Fixed max length of time window or**
- ✓ **Max length of time window depending on magnitude**

Selection of waveforms to be processed
- ✓ **White/black list**
- ✓ **Saturation (clip) check** (% of full scale in raw counts)
- ✓ **STA/LTA check** (around the estimated onset of P waves)
- ✓ **Co-location check** (BB preferred if not clipped)

Selection of waveforms to be processed

RRSMdb – Processing scheme

Waveform cut-off and 0th order correction
- ✓ **Pre-event cut-off**
- ✓ **Coda cut-off and aftershock removal** (based on normalised Arias intensity, Figini 2006, Paolucci et al, 2008 EESD)
- ✓ **Pre-event baseline removal**

From digital counts to ground-motion units
- ✓ **Bandpass gain correction**
- ✓ **Restitution** (full deconvolution of instr. response, if known)

Filter options
- ✓ **Butterworth is standard**
- ✓ **Filter order**
- ✓ **Bandpass, highpass, lowpass**
- ✓ **Causal, acausal** (zero-phase)
- ✓ **Zero padding** (Boore, 2005 BSSA)
- ✓ **Tapering** (% of pre-event length)

Computation of PGA and integration
Computation of PGA
Optional archival of processed waveforms (miniSEED)

RRSMdb – Computation of engineering parameters

Response spectra
- ✓ **Newmark's method** $\beta = 1/4$ and $\gamma = 1/2$
- ✓ **Custom vibration period range** (log. and lin. spacing, Caltech T)
- ✓ **Configurable set of damping ratios#**
- ✓ **Optional local archival of response spectra** (db and ASCII fomat)

Duration based on Arias intensity USGS Shakemap input
- ✓ **event.xml**
- ✓ **event_dat.xml** (all channels or max of horizontal)
- ✓ **Call script for USGS-style ShakeMap generation**

Rapid Raw Strong-Motion Database
- ✓ **Extension of the original SC3 database for event-specific and waveform-specific strong-motion data**
- ✓ **Optional** (user selects to enable messaging to database)
- ✓ **Rupture information** (if available)
- ✓ **Peak motions and spectra**
- ✓ **Processing chain**

The most successful attempts at gathering strong-motion data in and around Europe were led by Prof. Nicholas Ambraseys through FP4 and FP5 projects and resulted in a pan-European strong-motion databank (www.isesd.hi.is). The recently finished FP6 NERIES project created an infrastructure to collect, process and distribute strong motion data from across Europe (www.seismicportal.eu). In NERA NA3, we have built on these efforts and made use of seismological services. The key products are:

- The Engineering Strong Motion database (ESMdb): single, high-quality accelerometric databank consisting of both modern and historically important strong motion waveforms.
- The Rapid Raw Strong Motion (RRSMdb) database: an automatically produced strong motion database that takes advantage of the state-of-the-art in seismic network processing to provide near-immediate access to any openly available strong motion data following a significant earthquake in Europe.
- An updated station inventory for strong motion stations operational in Europe.

The core tasks of the NA3 group are a| to increase the networking activities among the acceleration networks in and around Europe and b| to improve the dissemination capabilities of the European accelerometric communities. The above objectives imply adopting common data and metadata dissemination strategies and standards for both continuous and triggered accelerometric data by means of making the waveforms and the basic station information available through the European Integrated waveform Data Archive (EIDA, www.orfeus-eu.org/eida/). Within NA3, the database structure of SeisComP3 was extended to include the event-based strong-motion parameters computed by the processing module scwfparam that was also developed within NA3. Due to these services, the Orfeus Data Centre (ODC) can now routinely process (near) real-time accelerometric data for a rapid Internet publication of peak ground-motion values as well as response spectral ordinates of engineering interest. This is the Rapid Raw Strong-Motion (RRSM) database of NA3.

WG 5 Tasks
established under Orfeus

/ Setting rules for data dissemination
/ MoU´s between data providers and ORFEUS
/ Collaborating with EPOS partners for the preparation of projects
/ Contacting similar establishments in other parts of the world
/ Ensure quality of metadata and waveforms:
- checking the quality of processed data of the partner institutions
- suggestion/development of the state-of-the-art techniques for metadata compilation and data processing

/ Ensure IT development improvements:
- Data transfer, optimum data dissemination techniques etc.
- Coordinate with related activities of ORFEUS/EPOS

ESMdb portal:

The ESMdb will distribute strong-motion recordings available in Europe and surroundings since the 1970s. An innovative feature with respect to previous accelerometric databases is that the database can be automatically populated by directly accessing accelerometric records in EIDA. The current ESMdb prototype contains Turkish and Italian strong-motion recordings. The European data contained in the SHARE database will be included before the end of the project.

The final component of the NA3 infrastructure is an updated station book that supports inquiries about the stations and/or specific station information. A significant improvement of this database is that any network operators that maintain metadata information in EIDA will not need to maintain this public database, amendments on EIDA will be immediately visible. Once the proposed infrastructures are built and operating, the objectives of NA3 will be achieved. It is increasingly likely that through the EPOS-Seismology component of EPOS (European Plate Observing System; www.epos-eu.org), these services may be sustained and even extended beyond the NERA project.

Beyond the new services, networking activities among accelerometric and strong-motion data have been actively promoted by international workshops organised by NERA NA3. The first workshop was held in Istanbul in 2012. The major outcome of the workshop is the agreement among data providers to set up a coordination framework for the strong motion community under the umbrella of Orfeus (Working Group 5). The follow up will be held in Ankara in May 2014. The Ankara workshop is to facilitate integration within the EPOS initiative. EPOS is likely to become operational within 2015 and is expected to secure sustained support for the new strong motion services, and guarantee the management of these services at the European level.

Sinan Akkar
Kandilli Observatory and Earthquake Research Institute, Bogazici University, Istanbul

Integrating the accelerometric and strong-motion data in Europe.

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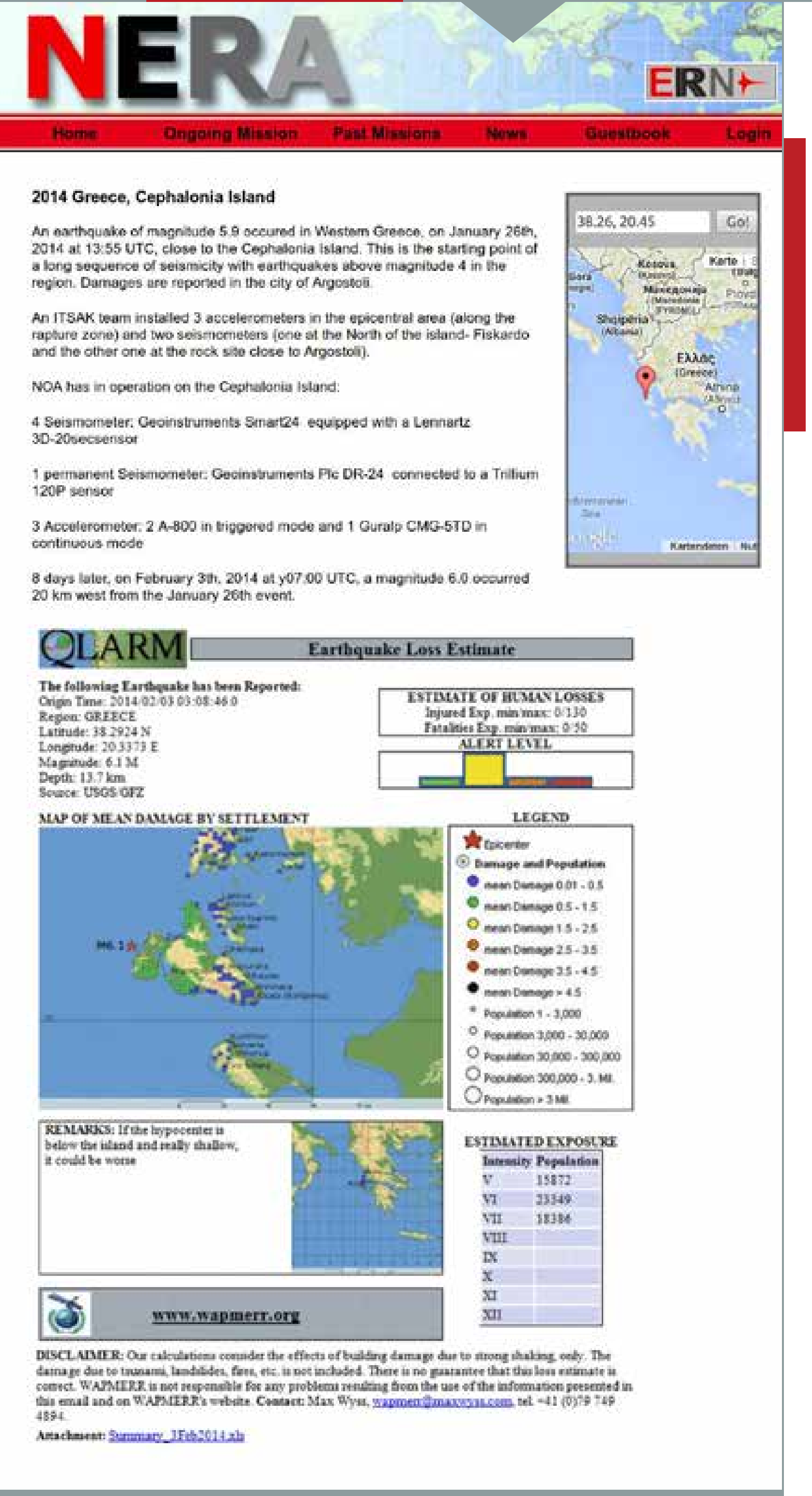
NA 4

Networking European Rapid Response Networks

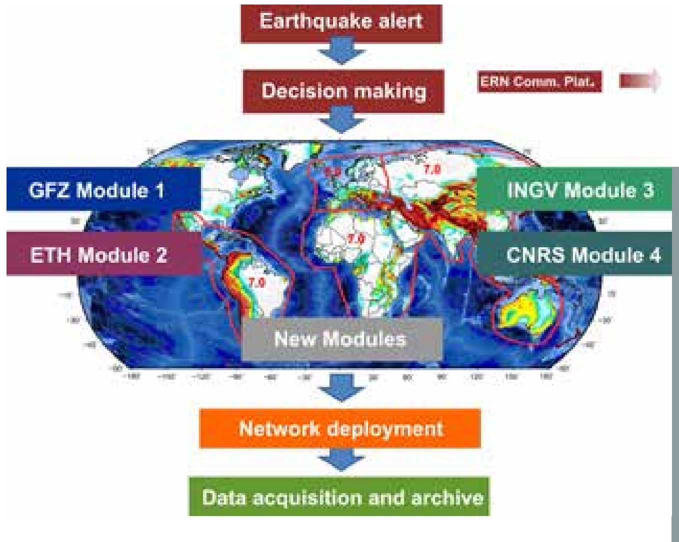


The objective of this work package is to achieve a more efficient response to seismic crises within Europe and globally by creating a modular, mobile and sustainable network pool for rapid deployments. In particular, this network pool is expected to

- facilitate the communication and rapid information exchange between partner institutions;
- coordinate rapid deployment of seismological networks; and
- harmonize data collection, storage and access.

To achieve this goal, at first the concept and the implementation policy of the European Rapid-response Seismic Network (ERN) was developed. Based on this common policy of rapid-response deployments, the main operators of these pools in Europe have started to coordinate their activities. This includes the rapid information exchange between the involved institutions after large earthquakes concerning potential activities and the coordination of seismological network deployments in the cases when rapid-response missions are initiated.

An efficient information exchange and communication between the partners is crucial for ERN-missions. Therefore, an ERN webportal has been developed. A test version of the ERN web-portal has been running since spring 2012: nera-ern.gfz-potsdam.de. Test results are currently evaluated and will be used for improvements in the future, e.g., a google-group for internal communication similar to system used by the French group will be implemented. A web-tool for guiding deployment during an ERN mission has been implemented in the ERN webportal. This tool can help during future emergency missions to achieve a more efficient and optimal station geometry that improves the quality of earthquake locations avoiding common inefficiencies that can usually happen when several teams rush to the epicentral area.



Real-time data transmission is challenging for mobile rapid-response networks. Within this project, appropriate methods are tested. A first test was performed in Emilia Romagna during September 26–30, 2011 by INGV's rapid-response seismic networks. An additional real-time data communication test was performed in Berlin, using an installation of 16 GFZ-WISE (Wireless Seismic Array) and Sosewin (Self-Organising Seismic Early Warning Information System) stations, including VSAT, WLAN, and Mobile Communications (UMTS) to gain more experience in handling the different systems. The application of UMTS and satellite real-time transmission at some selected INGV stations during the two ERN-missions in Northern and Southern Italy in 2012/2013 was successful. The two missions followed the May 20th 2012 Emila earthquake and the October 25th 2012 Pollino event; the field deployments provide a large amount of data. Integration of ERN data in SEED format into the European Integrated Data Archive (EIDA) is a fundamental step to share the data within partners and we strive to achieve this not only for emergency seismic deployments but more generally for temporary deployments. This effort is done together in several working packages of the NERA project and is important to foster international collaboration activities and further integration of research fields in Europe: a recent example is the deployment in Cephalonia.

Sebastian Hainzl
GFZ, Germany

The main operators of rapid response networks in Europe started to coordinate their activities in NA4 with the goal to achieve a more efficient response to seismic crises within Europe and globally by creating a modular, mobile and sustainable network for rapid deployments.

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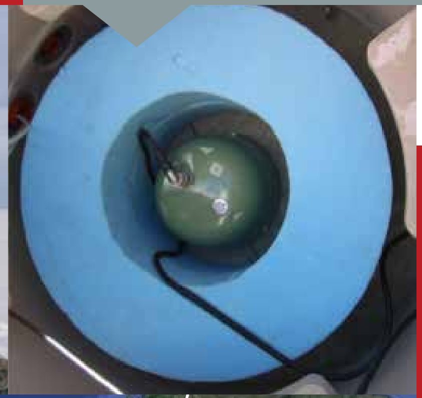
NA 5 Networking Near-Fault Observatories

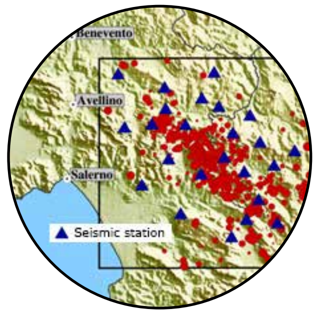


The seismic hazard generated by fault zones slipping in large earthquakes and the need for mitigating risk to population and structures drive the pursuit to understand the physics of faulting and the near-surface response to shaking. To facilitate research into the faulting process and its effects, near-fault observatories (NFO) comprised of dense, multidisciplinary geophysical networks have been constructed in many European fault zones. These NFOs have collected a wealth of data and represent an infrastructure of great importance for research into the faulting process and near-fault site effects.

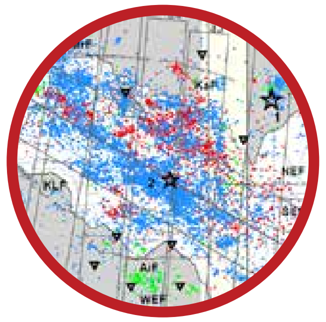
In NERA NA5, six European NFOs are being networked. The fault zones represented by the observatories are in different tectonic regimes: The South Iceland Seismic Zone (SISZ) in Iceland, the Marmara Sea in Turkey and the Corinth Rift in Greece are at plate boundaries, with strike-slip faulting characterizing the SISZ and the Marmara Sea, while normal faulting dominates in the Corinth Rift; the Alto Tiberina and Irpinia faults, dominated by low- and medium-angle normal faulting, respectively are in the Apennine mountain range in Italy; the Valais Region, characterized by both strike-slip and normal faulting is located in the Swiss Alps. The fault structures range from well-developed long faults, such as in the Marmara Sea, to more complex networks of smaller, book-shelf faults such as in the SISZ.

All the fault zones can generate large earthquakes ($M \geq 6$) posing substantial earthquake hazard and two of them, Marmara and SISZ have experienced earthquakes of $M > 7$. Two of the zones, Marmara Sea and Corinth, are under ocean causing additional tsunami hazard and steep slopes and sediment-filled valleys in the Valais give rise to hazards from landslides and liquefaction. Induced seismicity has repeatedly occurred in connection with geothermal drilling and water injection in the SISZ. The active volcanoes flanking the SISZ also bring the added dimension of volcano-tectonic interaction.

Map of the Irpinia Fault Observatory seismic network (triangles) and seismicity (dots):



Map showing seismicity (dots) and seismic stations (triangles) in the Corinth rift:



The research focus at the observatories varies, ranging from small- to large-scale seismicity and includes analysis of: the internal structure of the fault systems, the role different parameters, such as fluids play in fault initiation, site effects, derived processes, such as earthquake generated tsunamis and landslides, and the development of automatic earthquake early warning systems. The infrastructure at the sites is multidisciplinary, including surface and sub-surface observations from seismic, deformation, strain, geo-chemical and electromagnetic equipment, thus representing a wide spectrum of observational data.

Workshops held during the project reviewed the monitoring net-works of the observatories and their analysis tools, their standard practices, real-time and near-real time products, their data quality control methods, data bases and plans of how the observatories will provide sustainable access to the data. Most of the focus was on seismic data, but strong motion and GNSS data was also reviewed.

The work in NA5 has developed further than stated in the initial goals of the project, through establishing grounds for the NFOs to become a working group in the ESFRI project EPOS (European Plate Observing System), thus securing sustained networking of the NFOs and continued developments in research into the faulting process and resulting hazards. Furthermore, the Marmara NFO has obtained a seismic hazard supersite status in the FP7 project Mar-SITE and the SISZ observatory will benefit from developments in the Icelandic volcanological supersite FP7 project FUTUREVOLC.

Participants of the NA5 NFO workshop in Iceland, January 2014:

Kristín S. Vogfjörd
IMO, Iceland

NA5 is networking European NFOs to establish collabo-ration

- on technological developments
- in research of the science of faulting and fault sys-tems and the hazards they generate.

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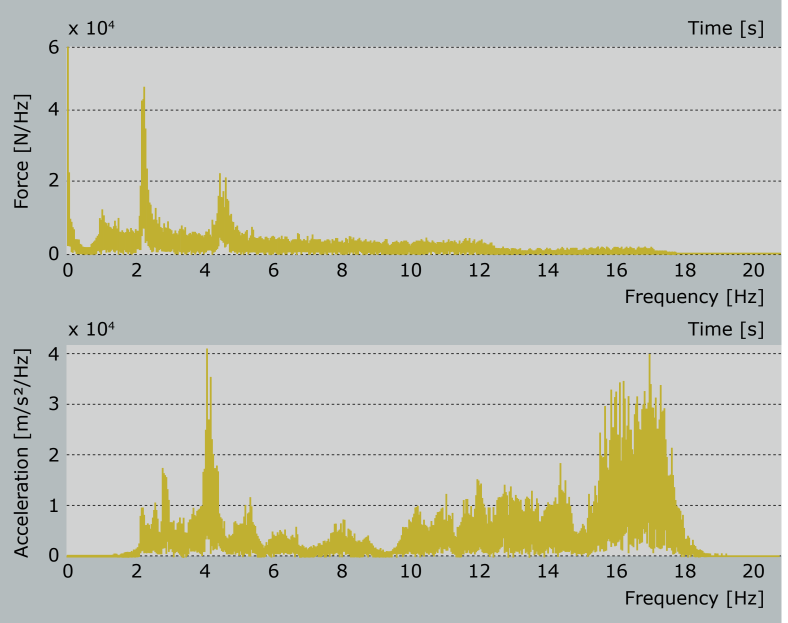
NA 6

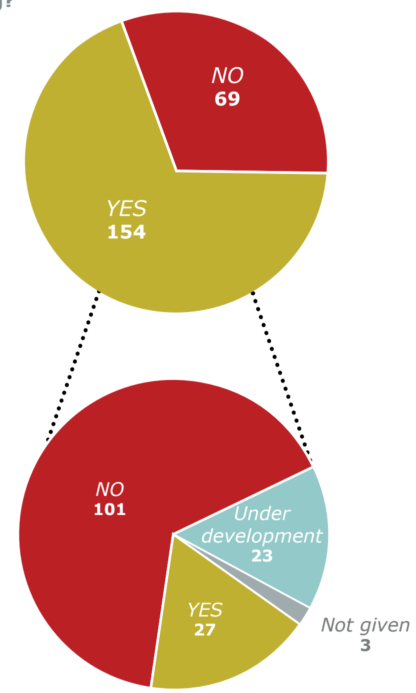
Networking Field Testing Infrastructures



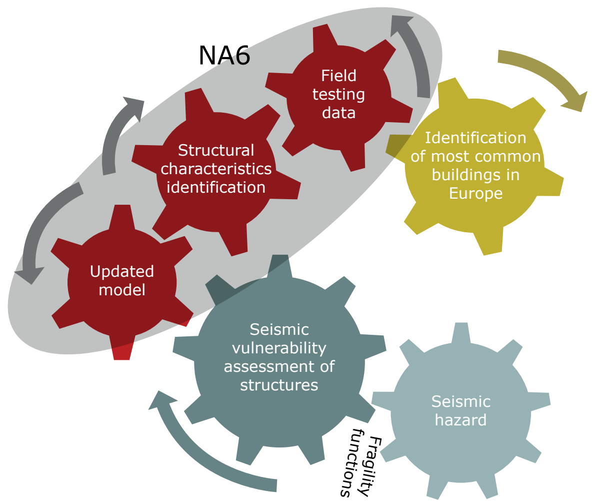
In structural engineering field testing indicates a large class of activities with the aim of improving the knowledge of existing structures and evaluating their actual conditions. This improved knowledge is the basis for an actual real-time assessment of either the remaining life time or the seismic vulnerability of structures. The main objective of NA6 is to harmonize the existing field testing procedures in vibration monitoring and promote their implementation in building practice to improve the seismic vulnerability assessment.

Information about the European and worldwide experience in field testing monitoring of structures was gathered with a questionnaire completed by 223 engineers of 35 different countries, 154 of the interviewees declared to have experience in field testing. The questionnaire results show that the field testing expertise is mainly domain of universities and the principal aim of in-situ tests is the assessment of structures for research or retrofitting. The field testing data are used by the experienced interviewees in 50 % of the cases for pre- and post-earthquake assessment and in 70 % of the cases for more general structural health monitoring and damage detection, mainly to improve the reliability of numerical models of structures. The questionnaire shows that in 75 % of the cases a structure is tested only once and permanent monitoring systems are installed more commonly on bridges than on buildings. More than half of the interviewees design the measurement layout on the basis of the structural analysis results of the designed structure and 90 % of them declared to monitor the structural accelerations. Ambient vibration methods turn out to be more popular than forced vibration methods to test both buildings and bridges. The final result of the questionnaire indicates that in most of the cases no national standards or guidelines are available in the interviewees' countries.

Have you used any measurement technologies with respect to field testing?



Are there national standards or guidelines in your country that impose field testing as a tool for Earthquake Engineering?



In order to meet the need of guidelines for the dynamic testing monitoring NA6 has set out:

1 | Guideline for designing optimal dynamic monitoring strategies,
2 | Guideline for optimal design of forced vibration method.

These guidelines provide a basic overview of all the existing monitoring techniques and describe the testing instrument technologies: they are directed to the engineering community with the aim of increasing the number of technicians working in companies or industries that carry out dynamic tests on structures to improve their seismic vulnerability assessment. Besides the description of the most common technologies used for forced vibration tests, the guideline for design of forced vibration methods outlines the stages of the process to plan forced vibration tests:

- Classification of the structure to test (kind, material, primary elements),
- Identification of the structural characteristics to value,
- Selection of the forced vibration testing method to apply,
- Calculation of the force to apply and duration of the excitation for continuous force methods,
- Design of exciter attachment to the structure if a shaker is used,
- Design of the sensor grid and selection of the technologies for the data acquisition.

The field testing data has to be processed and interpreted to be used in model updating: the guideline for optimal design of forced vibration methods describes the filtering procedures to post-process the field testing data and the algorithms to identify the structural dynamic characteristics. Finally, the guidelines introduce the problem of soil-foundation-structure interaction and propose the optimal design to investigate that interaction. The guidelines are completed by 18 different case studies to help the engineers to understand how to implement the described methods.

Mariantonietta Morga
AIT, Austria

Field testing is the basis for an actual real-time assessment of either the remaining life time or the seismic vulnerability of structures.

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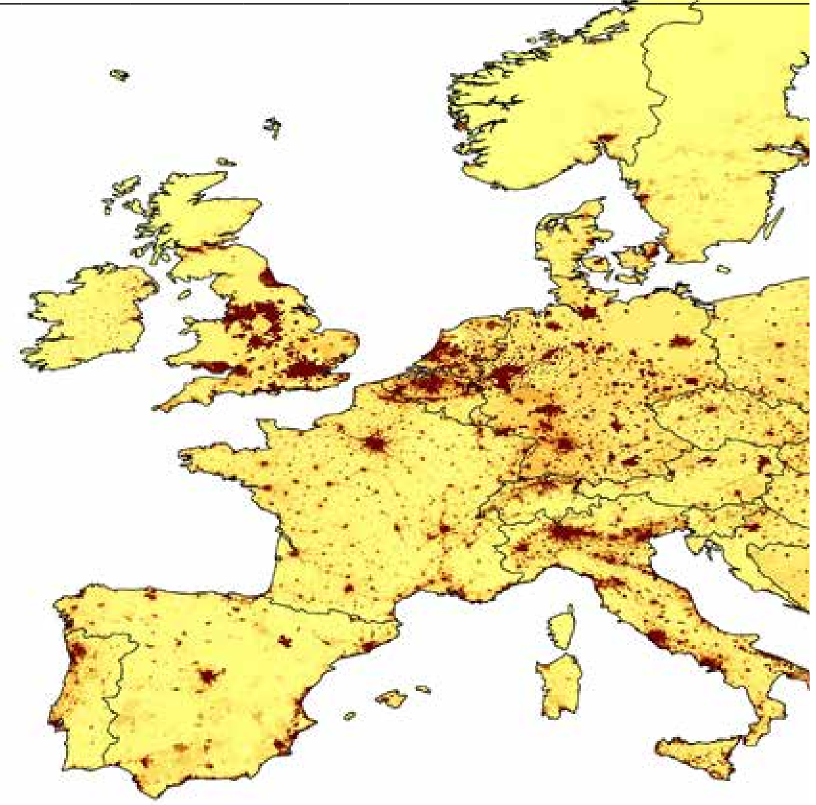
KOERI
Kandilli Observatory and Earthquake Research Institute

AIT
Austrian Institute of Technology

CAR
Cambridge Architecural Research Limited

NA 7 Classification and Inventory of European Building Stock

	Number of Buildings	Number of Dwellings	Average number of dwellings per buidling	Average number of people per building	Average number of people per dwelling
Albania	598 267	1 012 400	1.69	4.68	3.92
Andorra	3641				2.44
Austria	1 774 455	3 757 409	2.13	4.47	2.04
Belarus	1 630 267	3 893 638	2.39	5.77	2.41
Belgium	3 681 826	5 179 638	1.41	4.48	2.11
BiH		1 055 000			3.27
Bulgaria	2 060 745	3 887 076	1.88	3.54	1.88
Croatia		2 257 515			1.90
Cyprus		431 059	2.03		1.94
Czech Rep.	2 115 886	4 756 672	2.25	4.77	2.17

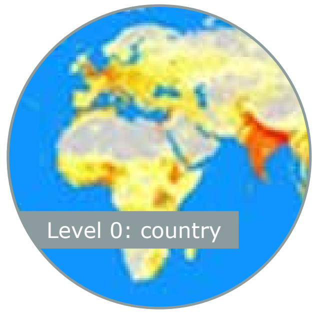


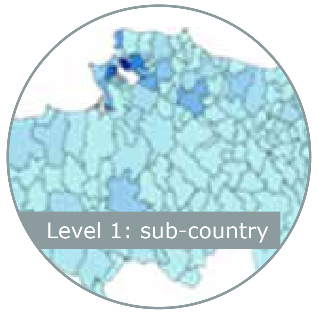
Building Fractions (based on IMPRO Project)	AT	BE	CY	CZ	DE	DK	EE	ES	FI	FR
DX/CR/LFINF/DY/CR/LFINF///RES////EWMA//FC/							0.57		0.45	
DX/CR/LFINF/DY/CR/LFINF/HBET:4,10//RES////EWMA//FC/	0.23	0.31	0.02	0.25	0.28	0.28		0.38		0.21
DX/CR/LWAL/DY/CR/LWAL/HBET:4,10//RES////EWC//FC/	0.02	0.00	0.00	0.32	0.08	0.04	0.03	0.03	0.03	0.01
DX/M99+CB99/LWAL/DY/M99+CB99/LWAL/HBET:1,2//RES////EWMA//FC/	0.00	0.03		0.03	0.03	0.02				
DX/M99+CB99/LWAL/DY/M99+CB99/LWAL/HBET:1,2//RES////EWMA//FM/							0.16		0.26	
DX/M99+CB99/LWAL/DY/M99+CB99/LWAL/HBET:1,4//RES////EWMA//FC/			0.00				0.02	0.00	0.02	0.00
DX/M99+CL99/LWAL/DY/M99+CL99/LWAL/HBET:1,3//RES////EWMA//FM/	0.04	0.00	0.00	0.06	0.00	0.00		0.00		0.23
DX/M99+CL99/LWAL/DY/M99+CL99/LWAL/HBET:1,3//RES////EWMA//FW/			0.11					0.07		0.24

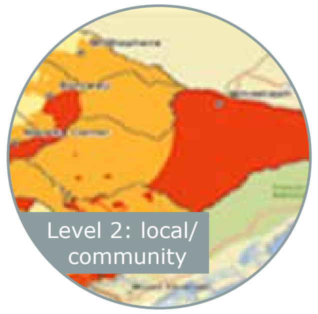
The key objective of this work package is to develop a database that describes the number and area of different European building typologies (e.g. unreinforced masonry bearing wall, non-ductile reinforced concrete moment resisting frame etc.) within each cell of a grid, with a resolution of at least 30 arc seconds (which is approximately 1 km square at the equator) for use in the seismic risk assessment of European buildings. The database structure of the Global Exposure Database, an initiative of the Global Earthquake Model (GEM), is being used to store the European building data. Building inventory data is available at different levels of resolution and characterisation across Europe and thus one of the aims of the database is to produce both homogeneous levels of building exposure data as well as provide a place where detailed, high resolution data can be stored. For this reason, the Global Exposure Database has been designed with a number of different levels, which are split between three different databases.

In May 2011, 'Key Players' in European building inventory data collection were identified and a workshop on this topic was held in Pavia, Italy with these experts in order to understand the existing state-of-the-art of buildings in Europe. Following this workshop, and thanks to the input of the participants, an extensive study of the sources of building data in Europe was carried out.

For every European country (45 in total), the national statistical services have been investigated for any available dataset including building/dwelling censuses, surveys, yearbooks or construction reports, as well as other sources such as building inventory initiatives (e.g. WHE-PAGER), European projects related to energy and environmental assessment of buildings (e.g. TABULA, IMPRO Project), European and international databases (Eurostat, UNECE), detailed local building surveys and post-earthquake reports performed by several experts.







In April 2012, a Building Inventory Validation meeting was held in Pavia, Italy to discuss various methods to test the European building database with test-bed data from a number of areas. A number of tests have been developed which will be used to test the final level 0 and 1 European building database at the end of the project.

What we have now:

- Dwelling/building data for 45 European countries to allow a 30-arc second grid of building count and area to be estimated.
- Level 0 (i.e. national) building/dwelling fractions for 45 European countries (building upon work from the PAGER project, JRC IMPRO-Building Project and census data/expert opinion), to allow the above grid to be disaggregated between different building typologies (described with GEM Building Taxonomy v2.0).
- Level 1 (i.e. sub-national) building/dwelling fractions for 18 European countries (e.g. Albania, Belarus, Bulgaria, Cyprus, Greece, Italy, Portugal, Slovenia, Turkey) using census data and other sources to define building typologies.

Helen Crowley
EUCENTRE, Italy

The main objective of this networking activity is to develop a European building inventory database that can be used in regional seismic risk assessment. The database will provide building stock data at a number of levels of resolution, from country-based down to individual buildings, and will be expected to continue to grow after the project through contributions from users across Europe.

BGS
British Geological Survey

ETHZ
Eidgenössische Technische Hochschule Zürich

INGV
Nazionale di Geofisica e Vulcanologia

CNRS
French National Centre for Scientific Research

AMRA
Analysis and Monitoring of Environmental Risk

NA 8 Networking School Seismology Programs

www.bgs.ac.uk/ssp

www.edusismo.org

www.seismoatschool.ethz.ch

Across Europe scientists and educators are discovering the power of using earthquakes and seismology as an educational tool to inspire and educate students in a wide range of science and geoscience topics. This workpackage promotes sharing of best practice and data between all interested education groups in Europe.

Within the NERA project working group 8 have focussed on sharing best practice, exchanging data and developing software tools for educational seismology.

Teachers from across Europe have been invited to attend five-day workshops to learn all about educational seismology and to share their experience with each other. The first such workshop was held in Naples, Italy run by AMRA in Naples 2012, 24 teachers from six different nations attended the day workshop which received excellent feedback from those attending. Support for teachers attending was provided by NERA and also the EU COMENIUS funding program.

At the EGU conference in 2013 the annual GIFT workshop (Geoscience Education For Teachers) had a natural hazards theme and NERA supported several teachers attending and provided some content for the course.

A second teachers' workshop took place in October 2013 in Nice, France. Support from NERA, the EU COMENIUS fund and industry support enabled us to support teachers from outside the NERA community in Portugal, Romania, and the Faroes; we even had a self-funded teacher from the USA attend. In 2014 a workshop is planned to take place in Switzerland with organisation being done by ETHZ, the EU have replaced the COMENIUS funding scheme for teachers with ERASMUS-PLUS.

Webservices have become the de-facto standard for seismologists to easily exchange waveform data files between data centres. WG8 have developed a version of the IRIS/FDSN webservice tools to allow easy access of data. This tool is currently installed on the Sismos a l'ecole database in France.

Online software tools have also been developed enabling teachers to interactively interpret and compare the data that they have recorded on their schools' seismograph systems. Developments to the widely used SeisGram2K analysis software package enables students and teachers to easily analyse and interpret the data that they have recorded, with interactive traveltime analysis tools and spectrogram analysis added. This tool is currently installed as an embedded java applet on the websites of school seismology programs in France, UK and Switzerland allowing students to interactively interpret event data files through a web-browser. The software is available with menus in French, English, Italian, Portugese, Turkish and Chinese.


A series of 5-day workshops enable teachers to learn from each other


School teachers from across Europe learn about educational seismology (here using people-particle representations of P and S waves)

Paul Denton
BGS, UK

Paul Denton at the British geological Survey leads NA8 within NERA, networking school seismology programs.

EMSC
European-Mediterranean Seismological Centre

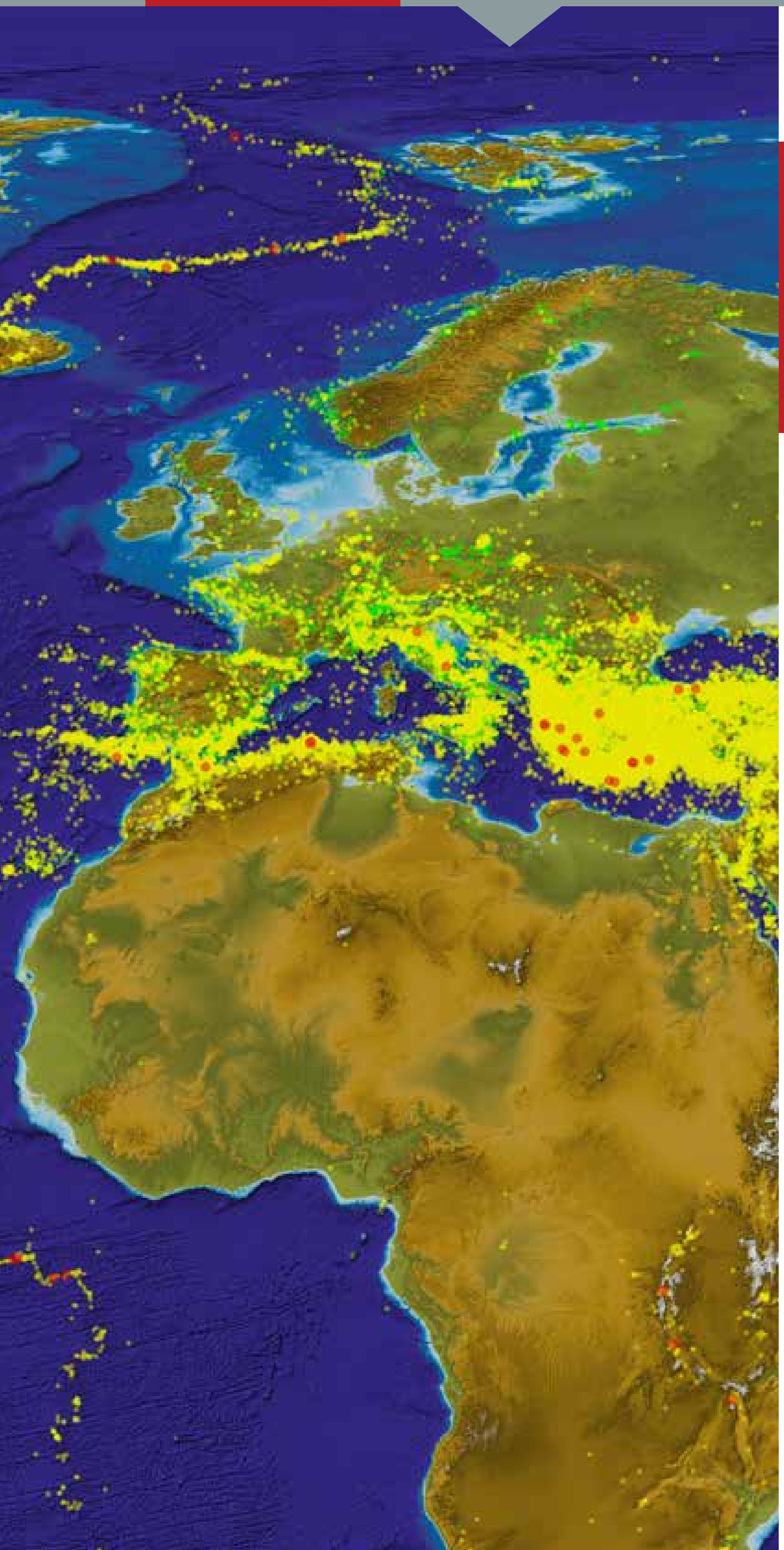
ETHZ
Eidgenössische Technische Hochschule Zürich

KNMI
Royal Netherlands Meteorological Institute

VCE
Vienna Consulting Engineers ZT GmbH

JKU
Johannes Kepler University

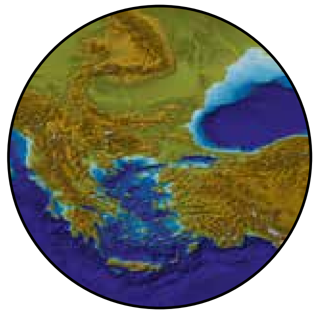
NA 9 European-Mediterranean Earthquake Portal and Services



The aim of the NA9 activity is to improve discoverability, access and usability of seismological, hazard and risk data and products to serve the scientific community in a sustainable way. It is achieved through the development, maintenance and evolution of a single, integrated seismic portal (www.seismicportal.eu) and associated webservices.

The development of the NERA portal and web services covers important strategic goals:

- Inherit and integrate other portal developments and contents delivered in other past and on-going EC projects (NERIES, SYNER-G, SHARE, VERCE)
- Build the appropriate platform to enable the dissemination and integration of NERA products
- Build the proper framework to provide integrated access and enable the long-term provision of services such as the access to integrated seismic waveform (EIDA, ORFEUS), the access to earthquake parameters (EMSC) and the provision of earthquake hazard and risk data and products (EFEHR, ETHZ);
- Provide the platform for a durable integration of diverse efforts in seismology, engineering seismology, earthquake engineering and geotechnical engineering;
- Build the initial seismological and earthquake engineering component for the development of the wider EPOS ESFRI infrastructure;
- Build the dissemination platform for the European component of the OECD-initiated Global Earthquake Model (GEM) program;
- Integrate and coordinate the European activities in the global context.



This activity brings together thematic leaders from the represented seismological (EMSC, ORFEUS), hazard (ETHZ), and engineering (VCE, JKU) communities, to define a common architecture and set of service standards to:

- Integrate varied multi-disciplinary data sets and data providers, including earthquake engineering data, seismic hazard, and multiple seismological data sets;
- Integrate web service implementations within NERA and other geophysical projects (i. e. GEO, FDSN, EPOS, GEM) to provide a set of standardized and interoperable web services;
- Provide a portfolio of web services as a toolkit to serve the current and future needs of the research community by supporting direct data access within scripts and batch processing, and enabling the next generation of data mining, assimilation, and modelling applications;
- Provide a single point to manage multi-disciplinary data, query, and computational result sets;
- Provide the tools to serve a wide spectrum of users;

The long-term sustainability of the developments is ensured through a strong collaboration within the GEM and EPOS initiatives and, on the technical side, low maintenance, interoperable and open-source developments.

Rémy Bossu
EMSC, France

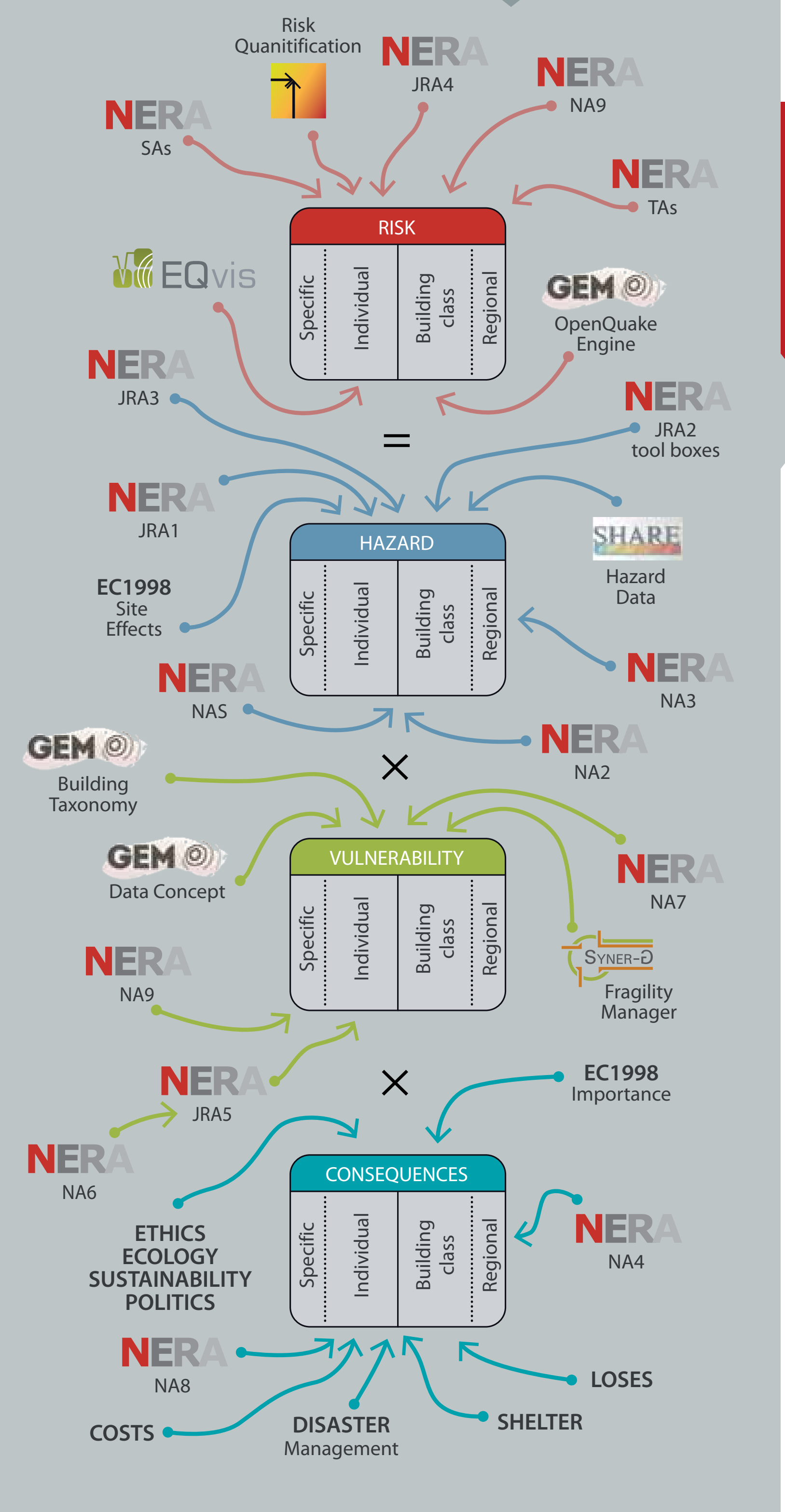
NA9 aims at improving discoverability, access and usability of the data and products for seismologists and earthquake engineers.

KNMI
Royal Netherlands
Meteorological Institute

VCE
Vienna Consulting
Engineers ZT GmbH

EMSC
European-Mediterranean
Seismological Centre

NA 10 Dissemination and Integration

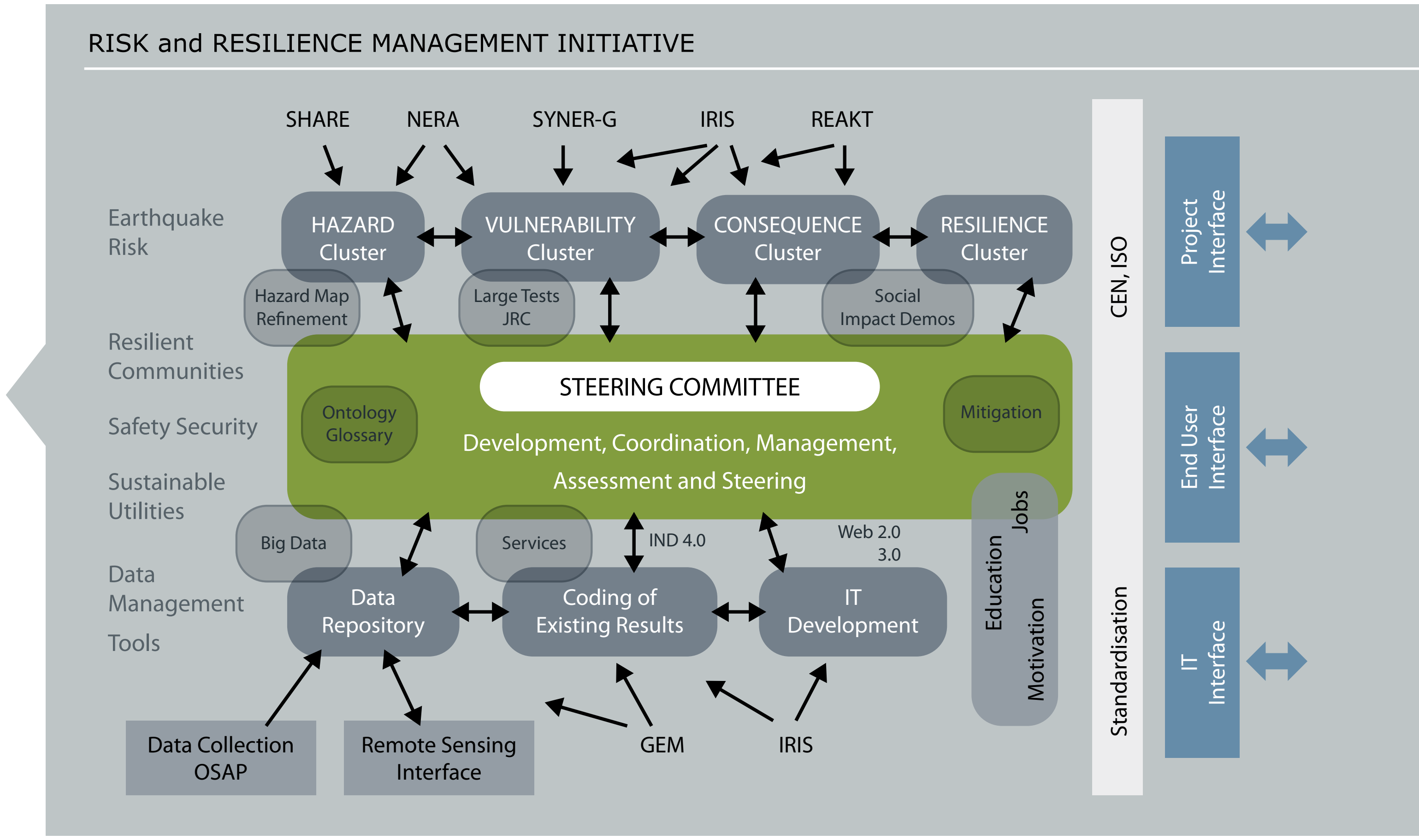


Shaping the Future of Earthquake Risks Mitigation within European Resilient Communities

The NERA consortium consists of a large number of experts relevant for European earthquake risk assessment. This work supports building resilient communities which will be able to resist all kind of disasters in a structured way. The idea how resilience could be added to the current practice of disaster risk assessment is provided in the two figures. The **risk framework** shows the elements of risk and where the respective parameters come from. The second figure provides the proposal for a large **European initiative** that would allow performance models of European communities where a systemic multi-hazard approach becomes feasible and universal evidence driven decision support can be applied.

Concept of a large European Initiative on Resilience Analysis and Community Management

A schematic organization chart on this initiative is given in the figure below. It comprises the determination of risk, which is covered by the hazard-vulnerability and consequence cluster. It will be enlarged by the resilience cluster satisfying the demand. The entire process is managed by a strong IT activity that enables the performance on high computing power level. Respective standardization activities, large demonstrations and tests support the interfaces to society. This concept satisfies all requirements of Horizon 2020 and complies with the post 2015 Hyogo framework of the United Nations.



Helmut Wenzel
VCE, Austria

NERA created a sustainable portal for all users of information related to earthquakes risk. It covers the entire subject from seismology to earthquake engineering and civil protection. We cordially invite the community to submit relevant information for proper display. The results of earthquake related research projects are published as well and their availability is ensured beyond the lifespan of research projects.

CNRS
French National Centre for Scientific Research

ETHZ
Eidgenössische Technische Hochschule Zürich

INGV
Istituto Nazionale di Geofisica e Vulcanologia

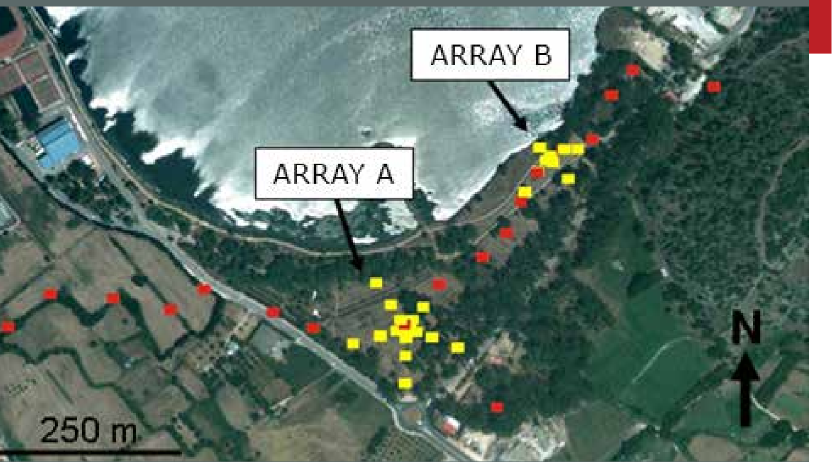
GFZ
GeoForschungs Zentrum

AUTH
Aristotle University of Thessaloniki

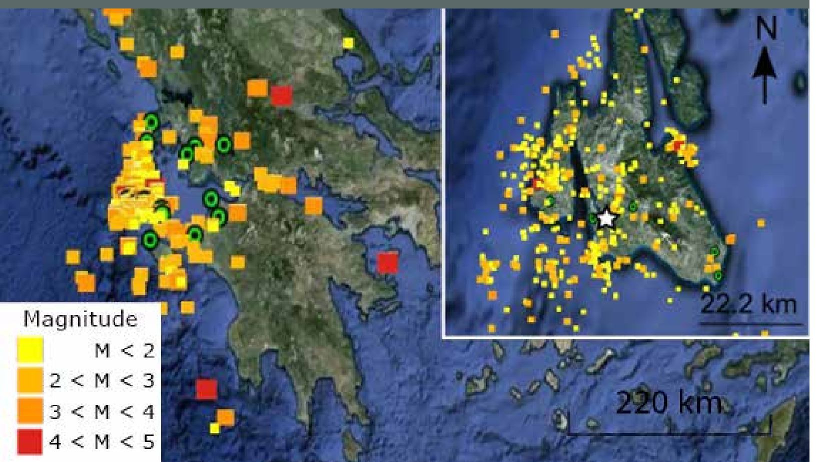
ITSAK
Institute of Engineering Seismology and Earthquake Engineering

JRA 1

Waveform Modelling and Site Coefficients for Basin Response and Topography



Argostoli experiment : Location of seismological stations (red and yellow squares). Yellow squares refer to the two dense arrays



Location map of local and regional relocated earthquakes. The white star indicates the temporary seismological network. The green dots indicate location of stations from the Hellenic Unified Seismographic Network (HUSN) used for relocating the events.

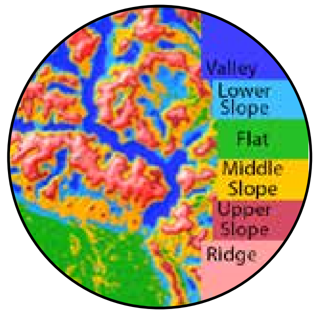
Surface topography effects, directionality and fracturation. The review of available results (recorded data and numerical simulation) suggests that effects of pure geometry are limited to a factor at most two for common topographic features; it also outlines the frequent coincidence of larger than expected amplification with significant directional effects, with a larger motion in the direction transverse to the topography elongation. These results are consistent with large directional effects found on unstable rock slopes, with larger motion at azimuths perpendicular to the open cracks, and with the significant polarization found in fractured fault zones in Italy. The homogeneous reprocessing work performed for several tens of Italian, Swiss, French and Japanese (KiK-net) sites, together with the geophysical experiments performed at two Italian sites, led the JRA1 working group on topography to

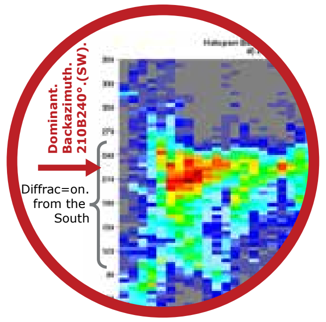
a| interprete large surface topography effects as controlled by combination of topography with pronounced local, shallow heterogeneities (fracturation, anisotropy, weathering, …),

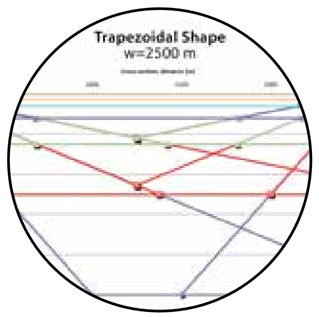
b| express serious doubts about the relevancy of the topographic aggravation factor presently included in the EC8 recommendations,

c| propose a site-specific procedure for cases where site-effects on pronounced topography may be suspected.

Wavefield and ground motion variability in basins. The mobile instrumentation available within the consortium has been installed temporarily for a detailed analysis of the spatial variability over short distances in two carefully selected sites, the Argostoli area (Kefalonia Island, Greece) and the Fucino basin (east of Rome, Italy). The first one is a small alluvial valley (1.5 km wide, 60 m thick, 2 Hz fundamental frequency) in a highly active seismic area. Hundreds of local and regional events have been recorded along two EW and NS lines across the valley and two very dense arrays in the central part of the valley. A similar array of larger size (1 km aperture) was deployed in the Fucino area, a much thicker basin (0.3 Hz fundamental frequency, 15 km wide, 1 km thick) and recorded the Emilia-Romagna sequence of Spring 2012. Both sites gave rise to detailed geophysical surveys, with a special emphasis on the Argostoli site. A systematic analysis coupling 3C-array processing, classical site-to-reference spectral ratio and coherency analysis, indicates a wavefield dominated by strong, stable, locally scattered surface waves, and opens a new way for interpreting 2D/3D overamplification and coherency models.







Aggravation factors in basins: numerical investigations. The objective is primarily to use numerical simulation tools to derive "aggravation factors" quantifying the difference between 2D basin response and the 1D response, the latter being supposed to be the "standard" accounted for in building codes or first level site-specific studies.

A comprehensive parametric study of the linear response of more than 1000 2D valleys was performed for vertically incident plane SH and SV waves. Their geo-mechanical characteristics span a wide range, from 500 m to 20 km for width, 30 m to 1 km for thickness, 125 m/s to 500 m/s for VS30 values, and 2 to 10 for impedance contrast. The results are described in terms of "amplification factors AF" (ratio of output response spectrum to input response spectrum), and ultimately in terms of 2D/1D "aggravation factors", AGF. These AGF are found in the range 1.3–2 in most cases, with a maximum generally near the valley edges, but occasionally in the centre of embanked valleys. These AGF decrease with increasing input ground motion in case of non-linearity. Simple formulae relating these AGF to the geometrical and mechanical characteristics of the valley and the receiver position will be proposed by the end of the project.

Pierre-Yves Bard
ISTerre, Grenoble, France

The objectives of this WP are to build on recent advances and results from instrumental seismology, geophysical exploration and numerical simulation to propose physically sound, economically acceptable and simple enough models for including proper account of effects of surface and subsurface geometry in building codes or microzonation studies.

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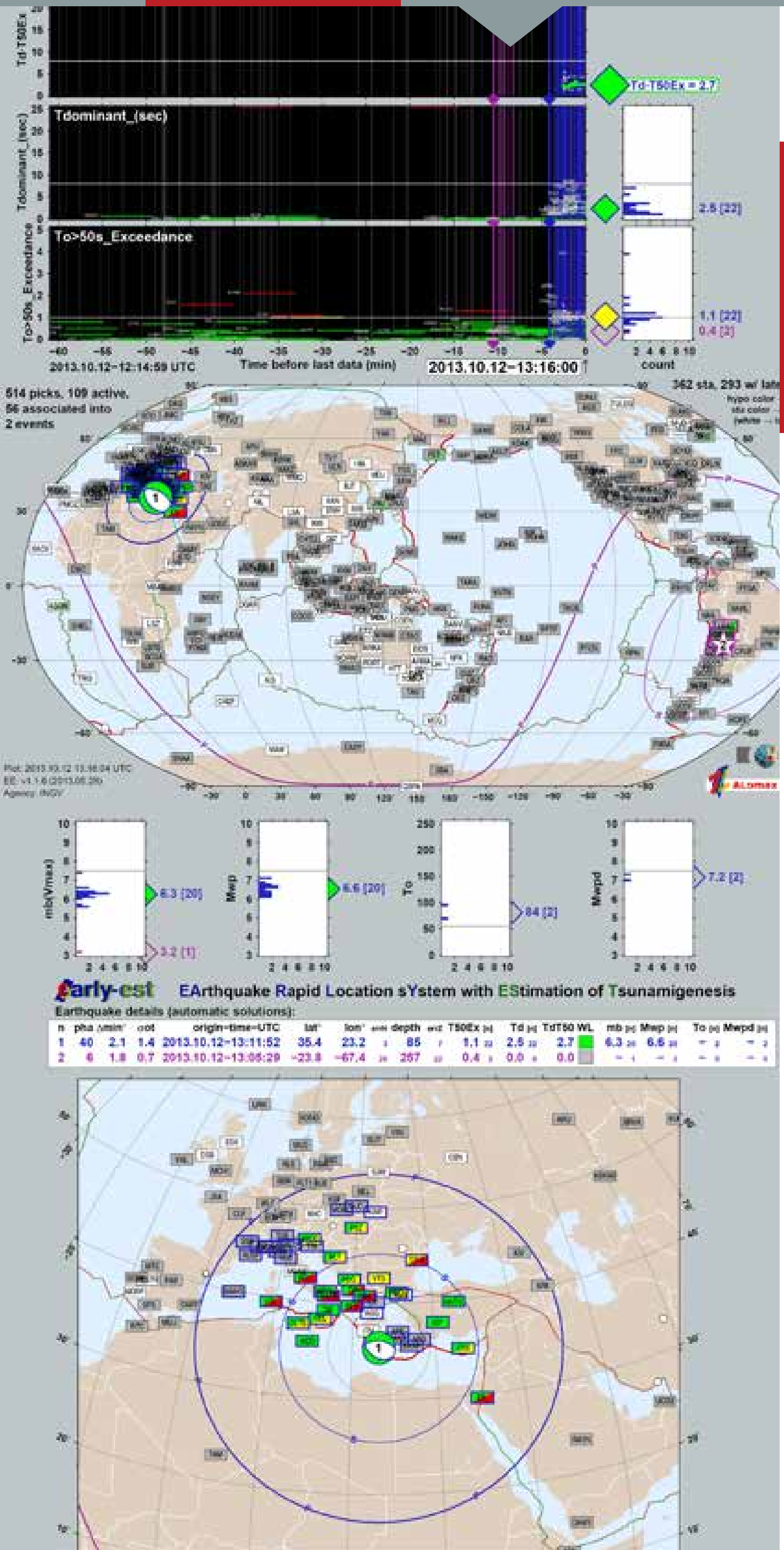
GFZ
GeoForschungsZentrum

NOA
National Observatory of Athens

ULIV
University of Liverpool

JRA 2

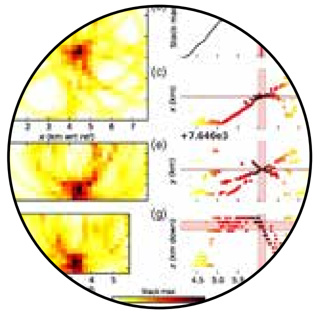
Tools for Real-Time Seismology, Acquisition and Mining



Current advances of communication technology together with the advent of new and rapid ways to communicate at global scale (e.g., social networks such as twitter, facebook, google+ …) have a deep impact not only on the way people interconnect and exchange experiences but also on the way seismological information is disseminated. This represents an important challenge to institutions and agencies in charge of seismic monitoring at a global, regional or national level. There is both a need for shortening the time delay between earthquake occurrence and the release of information, and in improving the accuracy of the analysis and thus the quality of the information being provided. The overall goal is to provide accurate and immediate information to respond to government agencies and the public and, similarly, to provide a clearer picture of the phenomenon (and of its effects) to both seismologists on duty in the seismic centers or others that are responsible to describe what has happened. This whole process requires the seismic monitoring centers to improve their routine analysis by, for example, including innovative procedures previously developed for research purposes. Many of these additional procedures can add substantial information about the ongoing phenomena and therefore improve our comprehension of the earthquake process and its effects.

The software that has been implemented in this work package can be subdivided according to the following main functionalities: input waveforms, detection/location, earthquake size, mechanism and fault finiteness, and ground shaking.

For generic input waveforms, the generic broker software WavesDownloader that adopts the obspy software package (obspy.org) has been developed and it can input data from multiple data centers and it outputs data in several formats besides extracting relevant parameters for waveform phase picking and peak ground motion parameters extraction. Other softwares



(Early-Est and WaveLoc) have been designed to input the data directly using data in the standard MSEED format and perform the analysis. In particular, Early-Est (EArthquake Rapid Location sYstem with EStimation of Tsunamigenesis) aggregates several important analyses for very rapid earthquake sources (non-linear direct global location, various saturating and non saturating magnitudes and focal mechanism) and tsunami potential characterisation (earthquake source duration and dominant period) in one single package and is now being used as primary software of the tsunami alert center at INGV. It is also used as backup software by NOA for its tsunami alert center and is being requested for other tsunami alert centers.

For earthquake size, mechanism and fault finiteness, the development/implementation has been been focused on the software SCARDEC, MWFMNEAR and PyTDMT. The first permits the rapid calculation of moment tensor and source-time function using broadband data at a global scale, the second combines near source strong motion data to determine moment magnitude and mechanism, whereas the third calculates the time domain moment tensor using the python scripting language.

For rapid characterization of the ground shaking, there have been developed scripts for the calculation of finite fault parameters and fault dimensions based on mechanism and magnitude.

For software already being tested for rapid alert and ready for being engineered within seismic surveillance software packages like SeisComP3 and Earthworm, Virtual Seismologist – an earthquake early warning module – and Mbc – a non saturating magnitude for events M8+ have been implemented.

Alberto Michelini
INGV, Italy

Modern seismic surveillance – given the speed information spreads – requires several complementary and redundant data processing methodologies from very fast but inevitably less accurate to less fast but more accurate and reliable to the purpose of providing authoritative answers.

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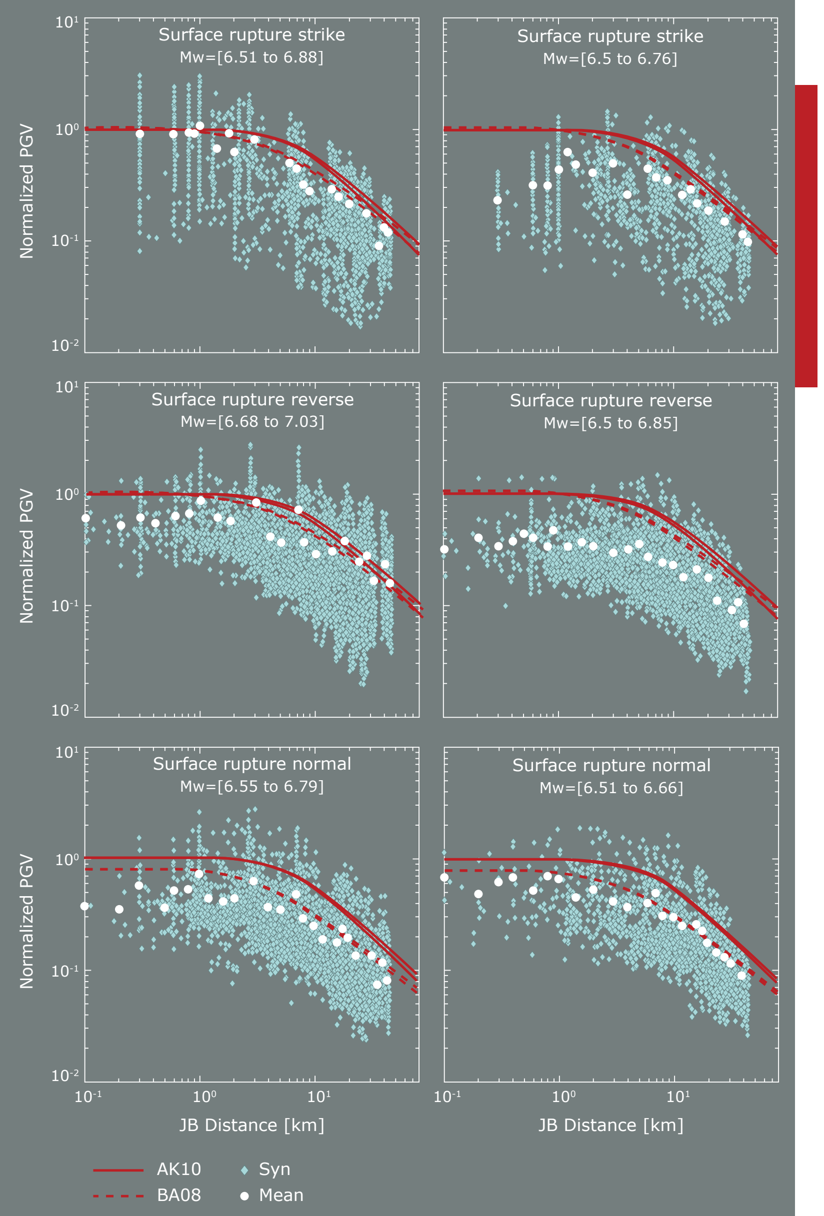
AMRA
Analysis and Monitoring of Environmental Risk

METU
Middle East Technical University

JRA 3

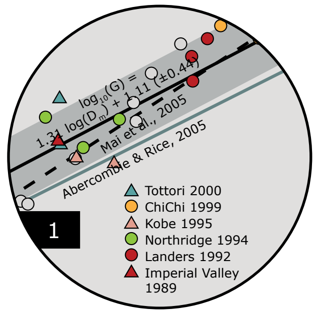
Coherence of Near-Fault Ground Motion Spatial Distribution and Ground Strain

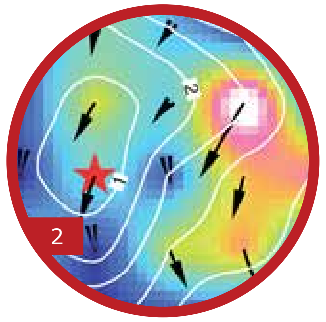


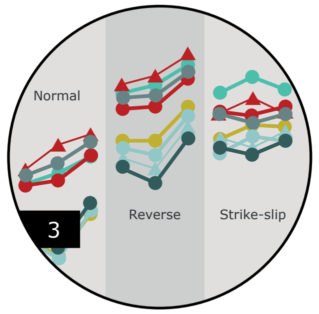
Synthetic PGV compared with the GMPE of AK10 and BA08 of earthquake models with Mw ≥ 6.5. PGVs are normalized with the corresponding maximum value predicted by AK10. The black circles represent the average of the synthetic PGVs around the given distance. Notice the clear reduction (supersaturation) of the average PGV values for buried strike-slip earthquake, surface-rupturing reverse and normal faulting at distances less than 2.0 km [Baumann and Dalguer, 2014, BSSA].

In this WP we bring together competences in physics based on numerical modeling of waveform propagation and frictional sliding to simulate the complexity of earthquake source (kinematically and dynamically) and near-source broadband ground motion (deterministic and stochastic), with the final goal to quantify statistical properties of ground-motion variability and to propose physics-based Ground Motion Prediction Equations (GMPE) for engineering needs. This work involves the derivation of dynamic source parameters from real earthquakes and their scaling relations; the investigation of the upper frequency limit of deterministic ground motion simulations; and the contributions of source complexity to the near-field ground motion spatial variability.

The 2009 L'Aquila, Italy, earthquake is extensively studied for this purpose. A database of 360 synthetic physics-based earthquakes is used to investigate the feasibility of the development of physics-based GMPEs and to study the effects of source parameters on ground motion predictions and the sensitivity of near-source ground motion to source (correlation) statistics.







1 | Fracture energy (G) scaling with average static slip, inferred from the analysis of a set of 31 finite-source rupture models of past earthquakes [Causse et al., 2013, GJI].

2 | Inverted source rupture model of the 2009 L'Aquila earthquake. The panel displays the total slip distribution. The rupture time is shown by white contour lines at 1s intervals; the black arrows represent the slip vector. The red star is the hypocenter [Cirella et al., 2012, GJI].

3 | Ground motion residuals from pseudo-dynamic models (compared to dynamic models) for different levels of source correlations. Simulations show that source parameter correlation produces stronger ground motions, and appropriate correlation in source modeling leads to less randomness in ground motion predictions [Song et al., 2013, GJI].

Louis Dalguer
ETH-Zurich (now at Swissnuclear, Olten, Switzerland)

The JRA3 (WP13) is a Joint Research Activity work package that develops and applies state-of-the-art physics-based numerical techniques for earthquake rupture modeling to quantify statistical properties of ground-motion variability dominated by the source for engineering needs.

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EUCENTRE
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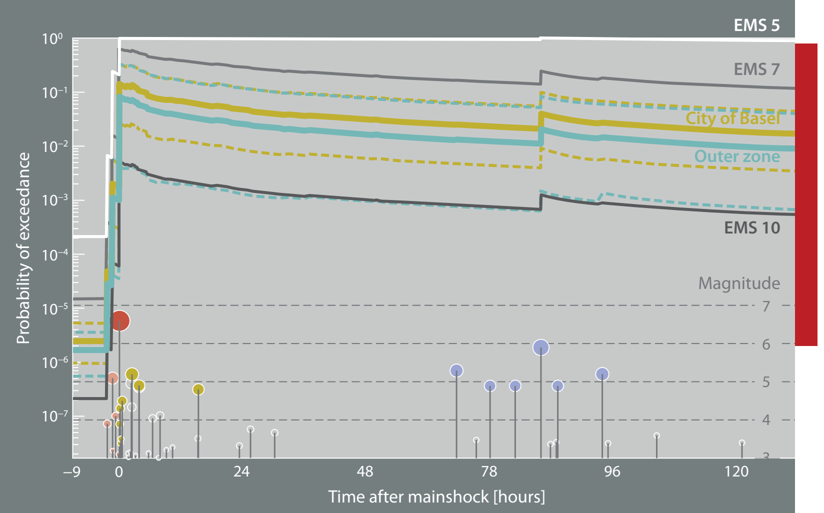
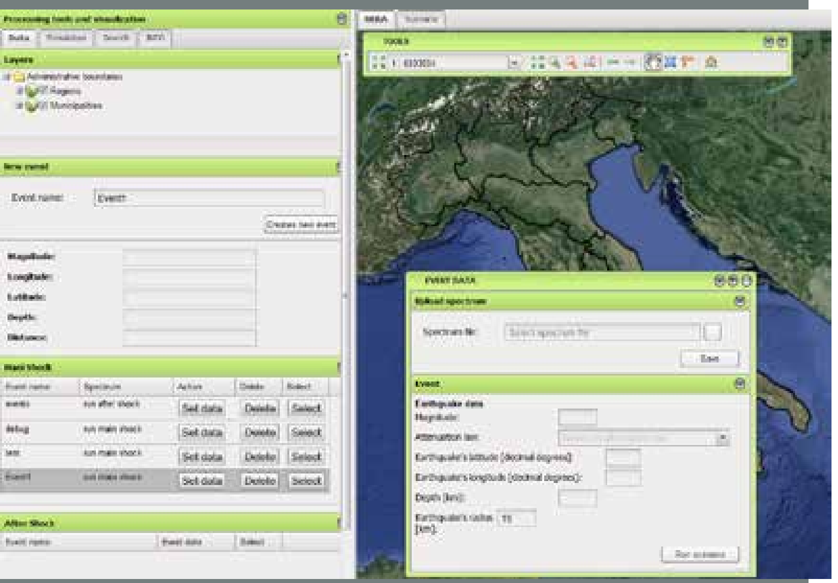
KOERI
Kandilli Observatory and Earthquake Research Institute

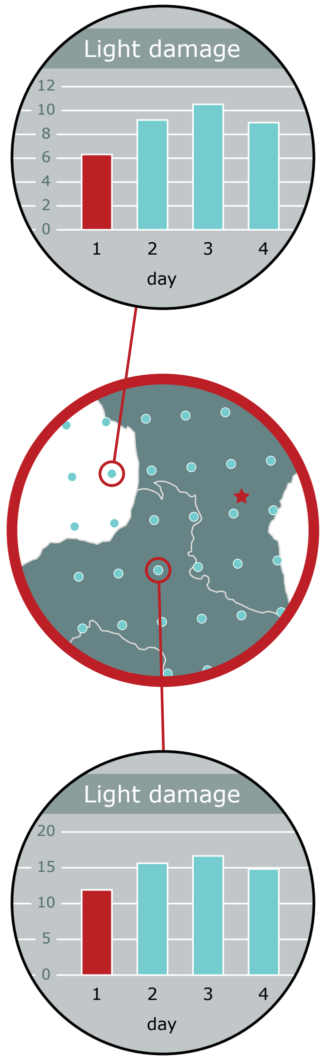
JRA 4 Real-Time Seismic Risk Assessment and Decision Support





Our research group has sought to develop practical approaches to estimate time-varying seismic risk, primarily through two proof-of-concept earthquake sequence scenarios – one inspired by a hypothetical repeat of the 1356 M6.6 earthquake in Basel, Switzerland, and one relevant to a hypothetical repeat of the Mw6.9 earthquake in Calabria, Italy.

For the Basel scenario, we consider an entire sequence of earthquakes that was simulated for the SEISMO-12 disaster exercise in Switzerland – this sequence comprises the events that lead to time-varying hazard, and thus time-varying risk. We use a statistical seismicity model to generate short-term forecasts of seismicity rates and transform these to forecasts of hazard, i.e., the probability of exceeding specific shaking intensities. We apply these hazard forecasts to a building stock model of the potentially-affected settlements surrounding Basel and estimate the resultant seismic risk in terms of human losses. We can generate these forecasts at arbitrary time intervals (regular or irregular) and have developed tools to visualize the results in a number of ways. For example, the figure left/above shows the time-varying hazard (white to grey) and risk (green and blue) in terms of the probability of exceeding one per mill fatalities, in the hours before and the days following the simulated M6.6 earthquake. The hazard is illustrated by distinct intensity levels. Bold lines represent mean probabilities in the city of Basel and the settlements outside the city; dashed lines show the minimum and maximum loss probabilities in the two regions. For this visualization, the loss and hazard forecasts were issued once per hour and each point refers to the following 24 hours. To track the seismicity during this time, stems at the bottom represent earthquakes above M3.



For the scenario in Calabria, we simulated more than 1500 events above magnitude 2 with a stochastic point process model: these events are taken to represent a six-month long sequence, including a strong aftershock. As in Basel, we used a statistical model to estimate the number of events in the following days: for each of the first fifteen days after the Mw6.9, we produce a new forecast for the next month. We transform such rate forecasts to probabilistic displacement response spectra, and we apply these response spectra to a prototypical three-story masonry building.

We describe the building in terms of its capacity curve and update the capacity curve as the sequence proceeds, effectively accounting for progressive damage to the building. The figure beside illustrates this process, showing the time-varying probability of the building undergoing light damage for two locations: this risk is a product of the ongoing sequence and damage that the buildings have already sustained. We are also developing a WebGIS interface to these tools that allow an evaluation of a damage scenario accounting for progressive damage during the ground shaking sequence; a screenshot of the interface is shown left.

Jeremy Zechar
ETHZ, Switzerland

The JRA4 team comprises earthquake engineers and seismologists interested in estimating and forecasting risk to people and buildings as an earthquake sequence happens, accounting for the fact that buildings may be damaged by earlier events.

VCE
Vienna Consulting Engineers ZT GmbH

EUCENTRE
European Centre for Training and Research in Earthquake Engineering

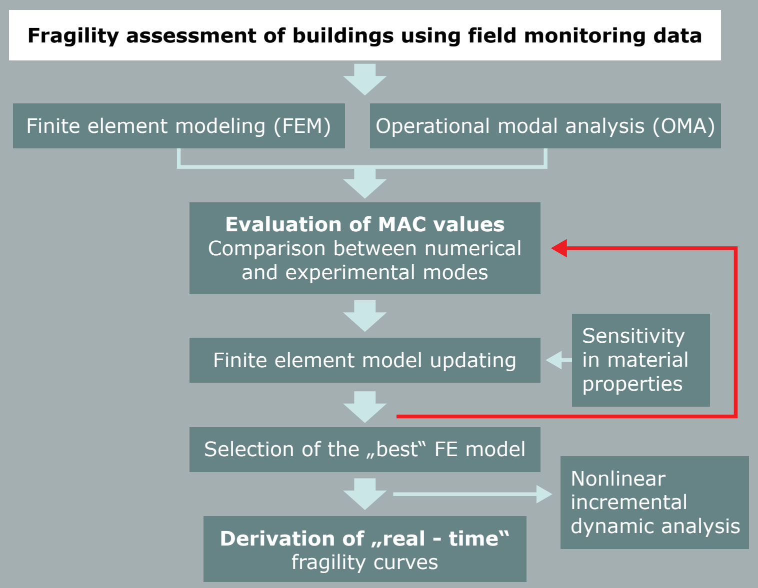
AIT
Austrian Institute of Technology

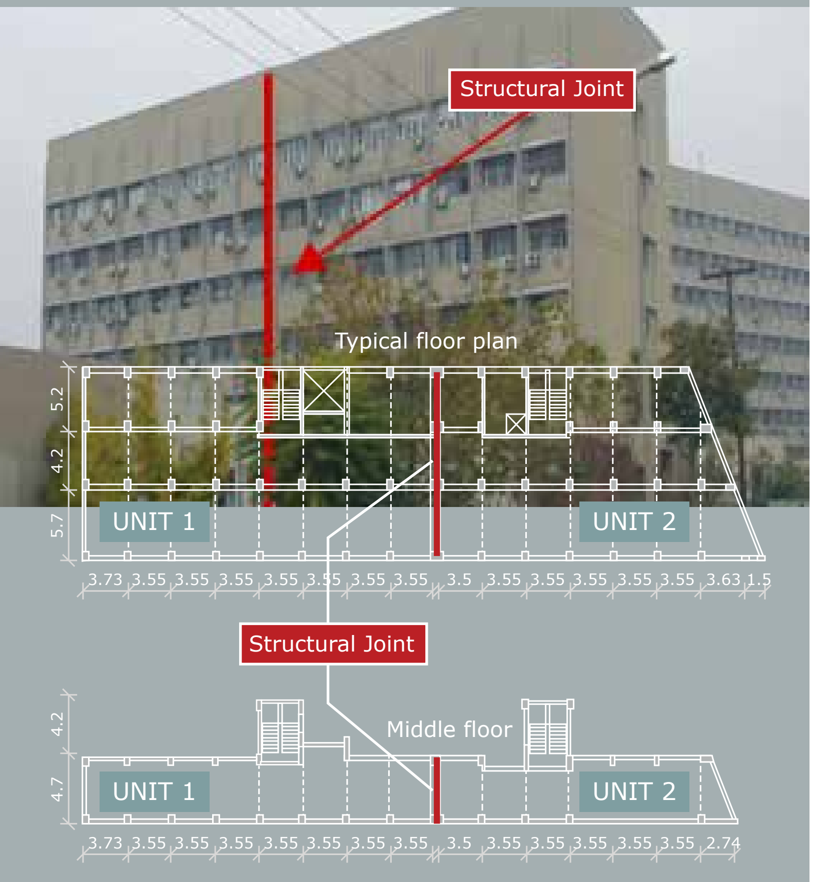
AUTH
Aristotle University of Thessaloniki

KUL
Katholic University Leuven

KIT
Karlsruhe Institute of Technology

JRA 5 Vulnerability Assessment from Field Monitoring

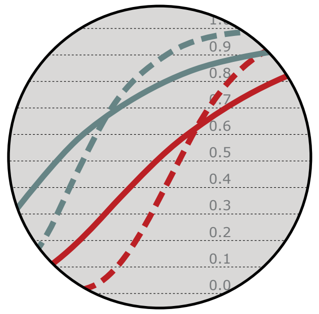


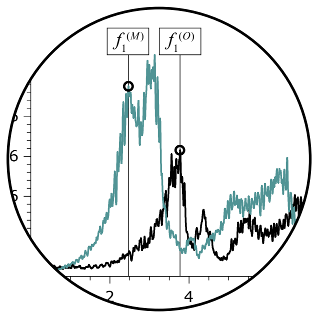


Because of missing information about the structural systems of historic buildings the vulnerability can be hardly assessed by traditional methods such as an inspection. Also the question of material parameters leads to problems. A combined numerical – experimental analysis is the most promising approach to assess these objects. Therefore in situ measurements of brick-masonry buildings in Vienna, Istanbul and Bucharest were executed. Accelerometers placed on every storey on top of each other were recording the impact of ambient and transient excitation. Evaluation of the recorded vibration response renders the dynamic parameters such as natural frequencies and mode shapes. With these data the computer simulation was updated and the differences between the model and reality could be minimized.

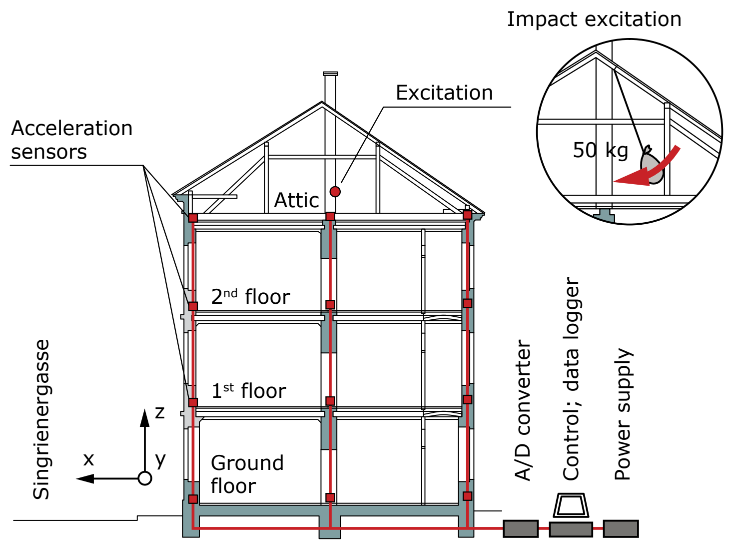
Moreover it is of primary interest to quantify the contribution of non-structural walls to the seismic resistance of a building. The same problems of unknown structure and material parameters of historic buildings appear.

In a unique opportunity, a 150 year old brick masonry building in the city of Vienna was provided for research purposes before it was demolished. Measurements in both states of the building – with and without partition walls – showed that the internal and external load bearing walls are coupled through the timber ceiling and roof construction.





A three dimensional finite element model was generated. With the results from the former measurements the material parameters could be calibrated effectively. After that the stiffness with and without partition walls was estimated. A global lateral stiffness reduction of about 57 % emerged. In a next step fragility curves were computed for this building. It could be shown that measurements can improve the quality of the fragility curves considerably. This subject is still under development.



Helmut Wenzel
VCE, Austria

Kyriazis Pitilakis
AUTH, Greece

Experiences from earthquakes have told us that our vulnerability assessment procedures do not reproduce what we find in the field. Comprehensive methodologies to improve fragilities we apply by using actual monitoring data are desired. How this desire can be satisfied is worked out by the NERA partners in JRA5.

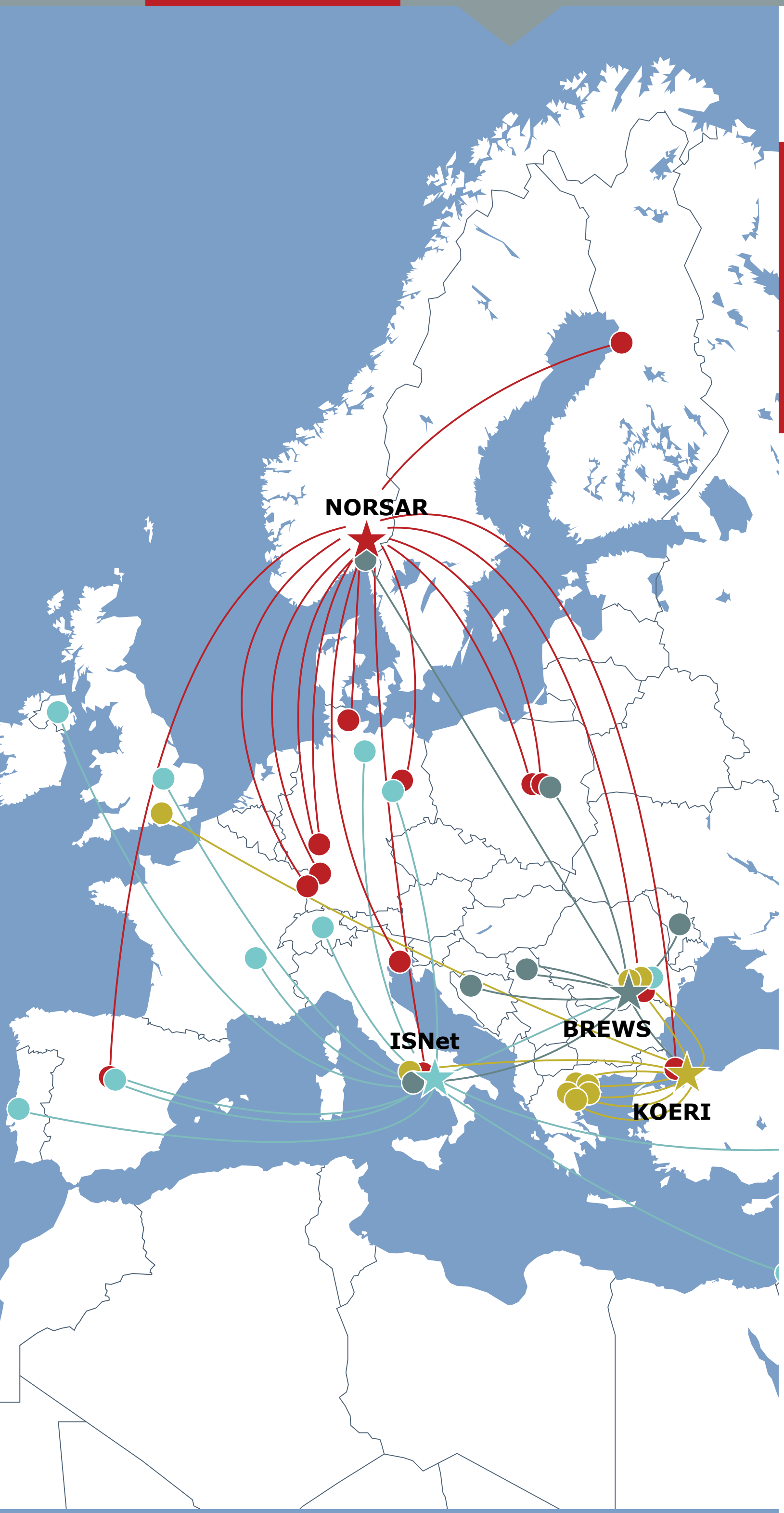
NORSAR
Stiftelsen Norsar

KOERI
Kandilli Observatory and Earthquake Research Institute

NIEP
National Institute for Earth Physics

AMRA
Analysis and Monitoring of Environmental Risk

TA 1–4 Research Facilities Istanbul, Bucharest, Irpinia & NORSAR

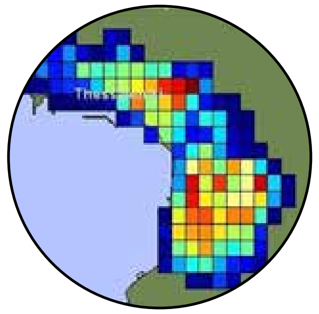


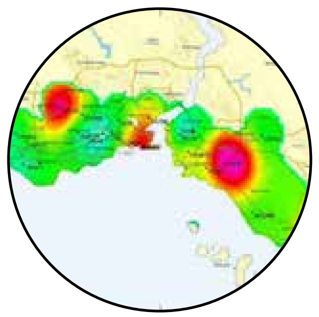
Most users of seismological data do not require physical access to the seismic stations, which are normally installed in remote locations. An exception are those infrastructures constructed for specific monitoring purposes or which are developing innovative technologies, thus offering the unique chance of gaining experience and performing research directly at the infrastructure center, where the specialized knowledge resides. The four NERA Transnational Access Facilities (TAs) offer access to four infrastructures, which allow users from the scientific and technical communities inside and outside the NERA consortium to become familiar with technologies and innovative network operations, which are likely to become future standards; these include large structural monitoring (Bosporus bridge), rapid response systems (Istanbul), early warning networks (Bucharest and Irpinia) and seismic arrays (NORSAR).

The Transnational Access to the four selected infrastructures is managed through a single TA User Selection Panel, composed by the four TA-activity leaders, by the NERA Manager and by two external specialists, in order to guarantee the best interaction/integration between the different proposed user projects and common quality of selection criteria during the whole project period. Major attention is given to new users at the different activities to support research networking and knowledge distribution within Europe; a critical evaluation criterion is the adherence to the NERA spirit and activities.

TA1 | Istanbul:

Istanbul Earthquake Rapid Response System: To provide earthquake rapid response information one hundred strong motion accelerometers were placed in populated areas of Istanbul to constitute a network that will enable rapid shake map calculation and damage assessment after a damaging earthquake.





Bosporus Bridge: The Structural Health Monitoring (SHM) system of the Fatih Sultan Mehmet Suspension Bridge involves continuous measurements of the static and dynamic motions of the bridge by using acceleration, GPS, and rotational sensors with the aim of real-time condition assessment and damage detection.

TA2 | Bucharest Rapid Early Warning System:

Based on a local network in the Vrancea epicentral area and on a dense strong motion network installed in the wider Bucharest area, the BREWS allows a quick estimation of earthquake magnitudes that enables the rapid generation of shake maps and seismic risk management for the city of Bucharest.

TA3 | ISNET – Irpinia Seismic Network:

ISNet is managed and developed by the seismology research group RISSCLab of the University of Naples Federico II. RISSCLab offers access to the ISNet infrastructure – the visiting researchers can have two types of access: online access to seismological data and physical access to the infrastructure.

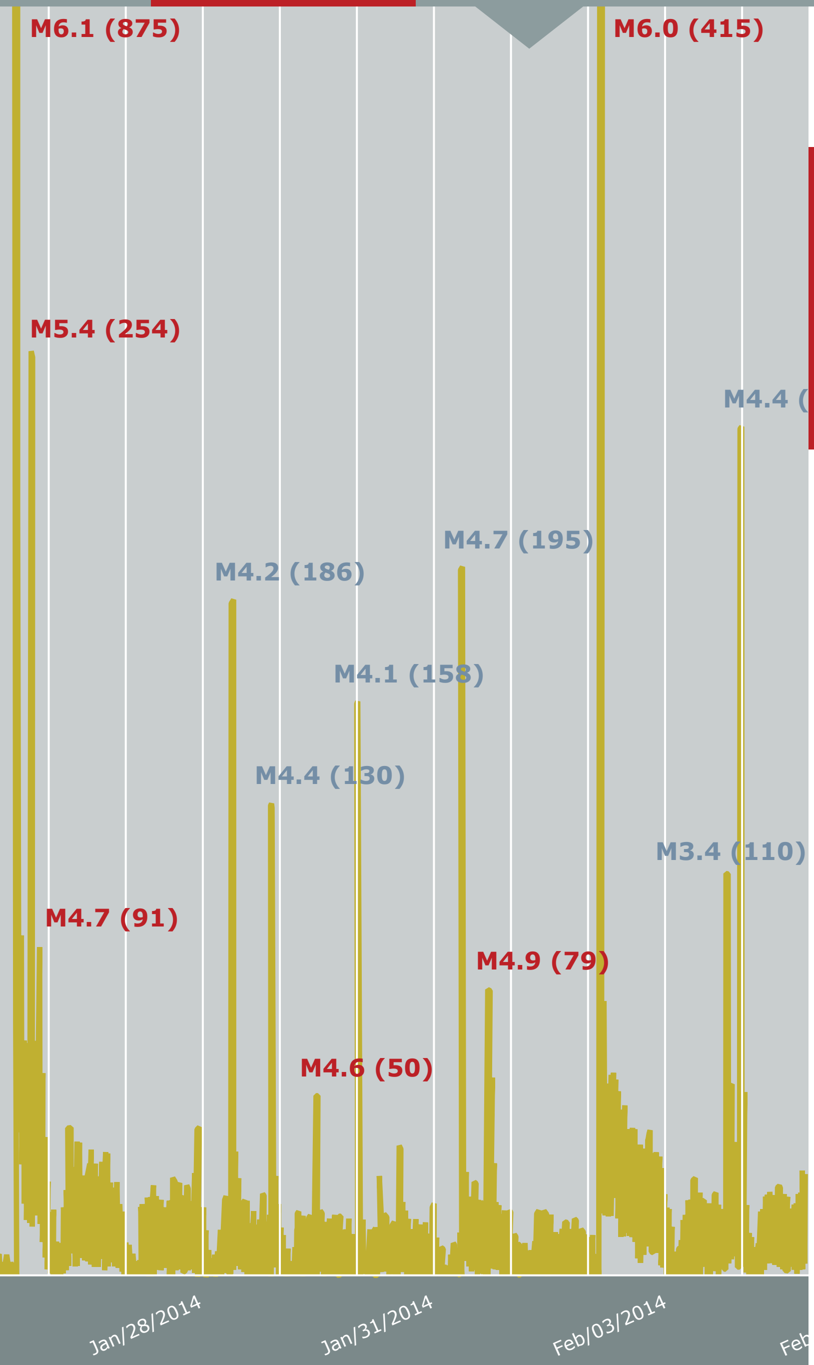
TA4 | NORSAR:

NORSAR and visiting scientists have conducted research within a broad range of research topics that go beyond array seismology per se, including e.g., seismic event detection and location, seismic wave propagation and Earth structure, methods for discrimination between earthquakes and different types of man-made sources, automatic data processing, seismotectonics and characterization of seismic sources.

Johannes Schweitzer
NORSAR, Norway

The TA to research infrastructures is a major component of NERA, giving participating visitors unique opportunities to widen their professional skills. In addition, it familiarizes researchers with working environments at different scientific institutions in Europe, it improves networking between European scientists and creates a base for future Europe-wide cooperation in seismology.

SA 1 Remote Access to Parametric Data and Earthquake Products



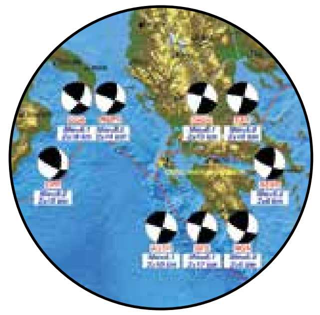
In red: magnitude (peak value) in Cephalonia region
In blue: magnitude (peak value) in other greek regions

Focus on the EMSC website traffic related to the widely felt earthquakes in Greece, 2014-01-25 – 2014-02-20

This service activity operated by EMSC is one of the three European infrastructures (with ORFEUS and EFEHR) offering service provisions in seismology, earthquake hazard and risk. The NERA service activities SA1-3 serve to structure and coordinate the services provided by these three infrastructures to specific user groups.

EMSC provides access to real time earthquake information, parametric data and earthquake products, ensures coordination of seismological observatories practices at Euro-Med and global scales and serves various communities, academics, network operators and the public for both operational and research uses.

EMSC collates parametric data from seismological observatories to provide homogeneous earthquake information at Euro-Med and global scales. Thirty-five thousand earthquakes are located in near real time each year around the Globe. The Euro-Med multi-origins bulletin available since 1998 and often considered to be the definitive record of the seismicity for the region contains nearly 10M arrival times and links seismological observations and products (macroseismic maps, moment tensors, geo-located pictures etc.) from the different seismological observatories.



Twenty-four-seven operational earthquake notifications have been diversified from geographical-alert-threshold and also include rapid -within a couple of minutes- detection of felt earthquakes and alert on impact assessed levels thanks to direct eyewitnesses' involvement. A traditional website (www.emsc-csem.org), a website for mobile devices (m.emsc.eu), ftp, email notifications, browser adds-ons, social networks such as Twitter (@LastQuake), Facebook (www.facebook.com/EMSC.CSEM) offer various ways to broadcast information and ensure a large combined audience of 1.5 million users a month from 200 countries.

Based on extensive data exchange, SA1 activities include strong coordination with seismological observatories and global players such as ISC and NEIC/USGS as well as the definition of standard and policy on issues such as station coding system, nomenclature of seismic event type under the umbrella of the IASPEI.

Rémy Bossu
EMSC, France
SA1 offers access to earthquake information and products for both the academic community and the public.

KNMI
Royal Netherlands
Meteorological Institute

SA 2

ORFEUS Remote Waveform Data Services

This map shows EIDA stations with unrestricted data access (total number: 3176). Stations in green are open (operational; 1403) according to the current metadata, while station in orange are closed (1773). From the total number of stations 1861 stations belong to a permanent network (75), while 1315 stations belong to a temporary network (36). ORFEUS Data Center updates the map daily (last update: **2014/02/27 09:08**)

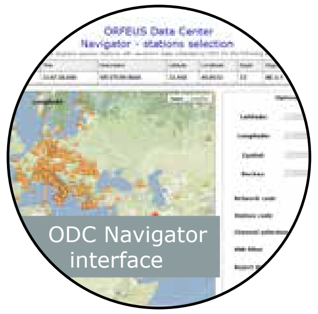
The overall objectives in this workpackage are:

- to provide transparent access to homogeneous, quality controlled waveform data from the Virtual European Broadband Seismograph network (VEBSN) and the networked, distributed European Integrated waveform Data Archive (EIDA) by the scientific community.
- to offer a broad range of efficient tools through different innovative forms of web services and standard internet services to enable access to the waveform data to the seismological community.
- to provide metadata and quality control support and services to researchers (data users) and observatories (data providers) to continuously improve data quality and enable contribution of high quality data to the open ORFEUS archives.

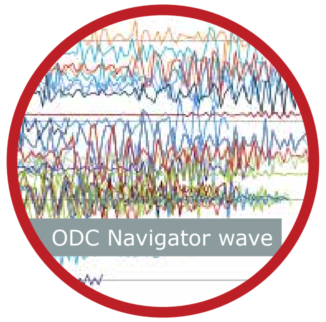
ODC (ORFEUS Data Center) is the central European data archive for long-term backup storage of waveform data and metadata from European broad-band stations (VEBSN). The ODC archive contains data from 1988 until present from about 700 stations belonging to 60 networks.
www.orfeus-eu.org

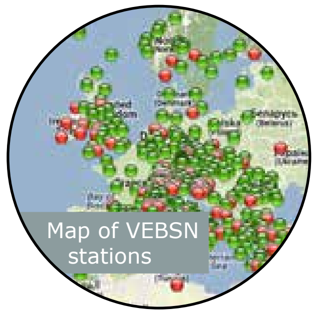
Significant results:
ODC developed and implemented a new, intuitive and interactive interface to search for and to access earthquake data from the VEBSN: ODC **Navigator**. Data selection is based on EMSC earthquake information data (criteria: M > 4.5 Europe; M > 5.5 global), VEBSN station distribution and waveform quality parameters (gaps, signal-to-noise ratio). The interface serves data directly from the ODC earthquake data repository, offers an efficient "quick and dirty" plotting utility to further refine data selection and enables fast downloading of the data.
www.orfeus-eu.org/odc/navigator.html

ODC implemented two standard **FDSN webservices**: fdsnws-station and fdsnws-dataselect to provide transparent access to waveform data and related metadata through standardized webservices. In addition, ODC



ODC Navigator interface


ODC Navigator wave


Map of VEBSN stations

implemented a webservice to provide access to the VEBSN PQLX database to retrieve selected power spectral density values. Also, ODC developed a new database schema (MongoDB) for characterizing the waveform data by data **quality parameters** (e. g. data statistics, gaps, overlaps, data acquisition flags).
www.orfeus-eu.org/fdsnws/station/1
www.orfeus-eu.org/fdsnws/dataselect/1

In 2013 EIDA was established within ORFEUS to further extend the services to the seismological community through a coordinated distributed data archive system. ODC installed SeisComp3 (SC3) and is a fully operational **EIDA node** to provide direct and open access (eida.knmi.nl:18002) to metadata and waveform data from all unrestricted EIDA stations through ObsPy and ArcLink clients like arclink_fetch. Current EIDA nodes: ODC, GFZ, RESIF, INGV, ETH, BGR, IPGP, LMU.

ODC designed and maintains the **EIDA website**, including a dynamically updated, up-to-date station map on Google Maps and the implementation of the WebDC3 interface (GFZ development) to provide access to earthquake catalogues and EIDA data.
www.orfeus-eu.org/eida/eida.html

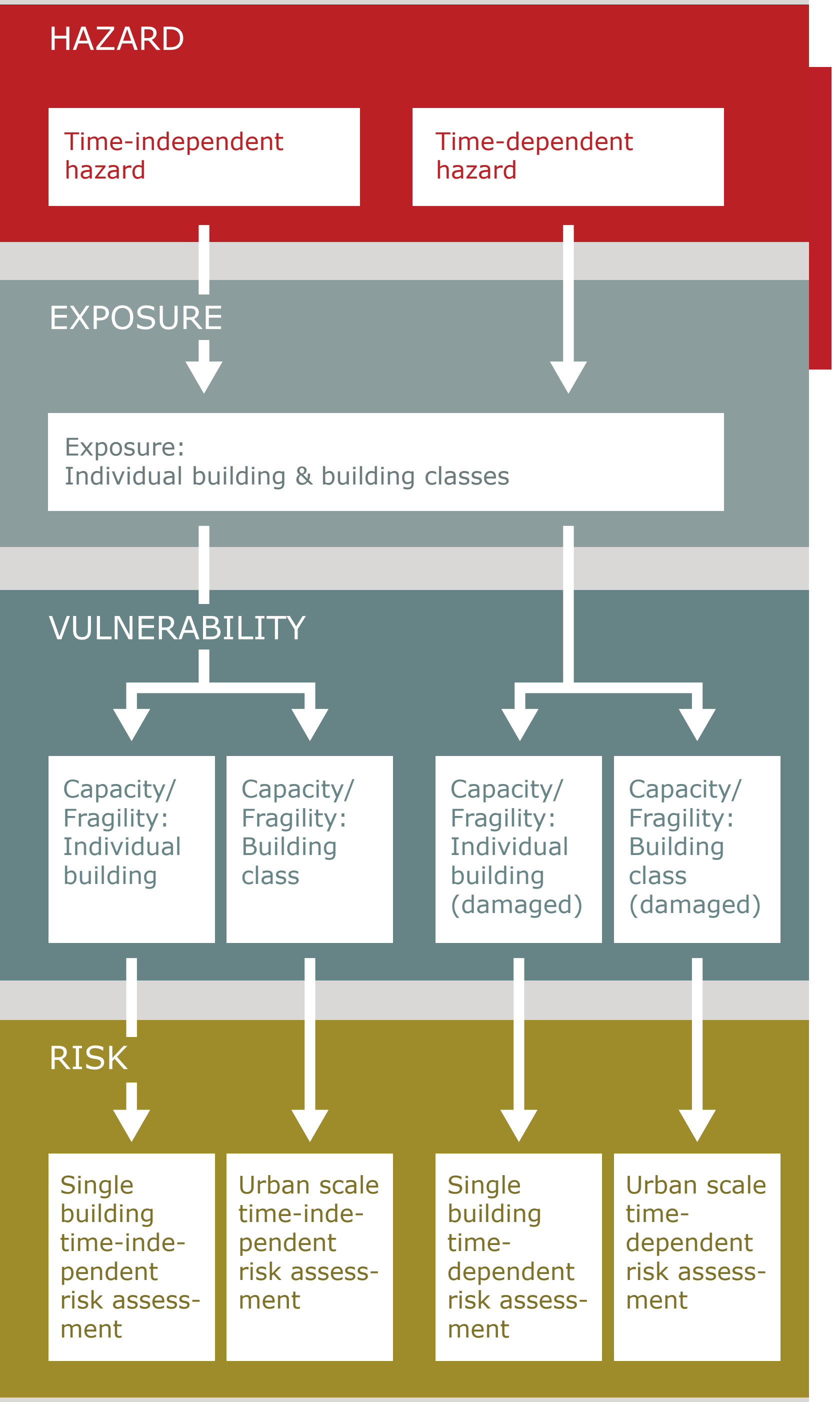
ODC installed and configured a second SC3 system for strong motion data to build up the **RRSM** (Rapid Raw Strong Motion database) in collaboration with ETH and EMSC. Waveform data has been collected and processed since June 2013 using the SC3 module 'scwfparam'. In 2013 two developments were initiated to 1| provide interactive access to the RRSM and enabling network operators to fill the database with site specific information and 2| to develop a user interface to access raw and processed data.

Reinoud Sleeman
KNMI, Netherlands

New services within ORFEUS provide open access to more than 3000 stations from European organizations.

ETHZ
Eidgenössische Technische
Hochschule Zürich

SA 3 Remote Access to Earthquake Hazard & Risk Products



Conceptual workflow of the European Facility for Earthquake Hazard and Risk (EFEHR)

The Mission

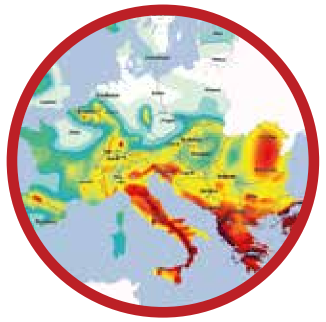
Free and open access to seismic hazard and risk products is a key element to widely promote state-of-the art products. The European Facility for Earthquake Hazard and Risk (EFEHR) is designed as the sustainable community resource to reach this goal. EFEHR, hosted at ETH Zurich, facilitates access to data, models, tools and expertise relevant for the assessment of seismic hazard and risk in Europe. The platform is evolving to a major infrastructure, similar to EMSC and ORFEUS, offering services relevant for the scientific and engineering communities as well as for the general public, stakeholders and decision makers.

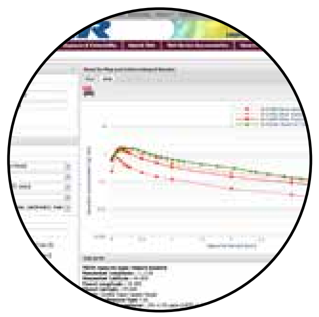
Technology Highlights

EFEHR uses the latest open-source web-technologies to serve its products and its interactive interface. The platform features tutorials and background information on the products. This platform relies on web-service technology that allows to retrieve data from a database of all pre-computed products. With this technology, it is possible to connect with databases hosted at other infrastructures and display the data. For advanced users, the web-service technology offers remote access to all the databases and direct data download using high-level programming languages without navigating the portal.

Access to the 2013 European Seismic Hazard Model (ESHM)

The 2013 ESHM, generated within the EC-FP7 funded project "Seismic Hazard Harmonization in Europe (SHARE)", is the first completed probabilistic seismic hazard assessment (PSHA) made accessible – from input data to extensive documentation, all with short navigation paths. The model results reside in a database that currently stores more than 500 pre-computed hazard maps, as well as more than 120,000 hazard curves and uniform hazard spectra at a spacing of 10km across on-land Europe and Turkey including uncertainties. The vast amount of data of this one project highlights the





necessity of a sustainable resource at the European scale to ensure reproducibility and transparency of PSHAs.

Access Statistics and Feedback

Since the release of the online portal in 2013, the website statistics show an average of a few thousand hits per month – as an example, more than 750 Uniform Hazard Spectra are requested every month. We received constructive feedback from users of the wider scientific community, the engineering community, regulatory national and regional bodies, construction companies, the re-insurance sector and their model suppliers.

The Future

Until the end of the NERA project we will continue to update the EFEHR platform with additional data & tools. These will cover seismic risk related aspects, as soon as they are available from other NERA workpackages or from related projects. In parallel, we aim to set up a scientific governance structure for EFEHR that is well embedded in the European scientific community, and will review the scientific content of EFEHR on a regular basis. This could be realized e.g. by establishing specific working groups on Seismic Hazard and Seismic Risk within the ESC and EAEE frameworks, respectively.

EFEHR is currently identified as the core of the 'Seismic Hazard and Risk' service pillar in the seismological core service structure of EPOS, and will be fully integrated in the EPOS structure as currently developed. EFEHR is the declared European regional center for the Global Earthquake Model (GEM) and will continue to host and/or provide access to relevant GEM data and tools.

Jochen Wössner
Swiss Seismological Service / ETH Zurich, Switzerland

Designing and implementing EFEHR to serve state-of-the-art information on seismic hazard and risk is an exciting challenge. With this activity, our team pioneers in providing an unprecedented online resource on the European scale for users and consumers interested in learning about and mitigating seismic hazard and risk.