Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Report

D4.1 European Rapid Response Seismic Network (ERN) implementation policy and deployment

Activity:	*Networking European Rapid Response Networks*
Activity number:	*NA4, Task 4.1*
Deliverable:	*ERN implementation policy and deployment*
Deliverable number:	*D4.1*
Responsible activity leader:	*GFZ*
Responsible participant:	*GFZ*
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Seventh Framework Programme

EC project number: 262330

1. Summary

The main operators of rapid response networks in Europe started to coordinate their activities with the goal to achieve a more efficient response to seismic crises within Europe and globally. The partners developed a common concept of the implementation policy and rapid-response deployments which will serve as a basis for a Memorandum of Understanding between the involved partner institutions in future. This concept will help to create a sustainable network which facilitates the communication between partners and the rapid deployment of modular, mobile seismological networks and data exchange and availability.

2. Introduction

Rapid response networks are an important element of the response to seismic crises. They temporarily improve the detection capacity of local and regional networks during periods of special interest, such as foreshock/aftershock sequences, swarms or induced seismicity. In areas where no local networks are available, temporary networks are often the only means for collecting seismic information. High quality datasets recorded by rapid response networks are important for decision makers to assess the current situation, as well as for scientific studies related to hazard, seismo-tectonics and earthquake physics (Parolai et al. 2004; Sobiesiak, 2000; Walter et al. 2008).

Rapid response missions require a high degree of flexibility and preparedness. A typical mission as a response to a magnitude 7+ event, with a rupture length exceeding 50km, may involve 30-50 stations belonging to 4-5 individual networks (institutions) and spread over several hundred square kilometers, all to be accomplished within hours to days in the middle of a disaster area. The commonly enormous logistics of such missions, the specific demand on the instrumentation in terms of robustness and power consumption, the financial and human resources needed to maintain a rapid response team, the challenges of ensuring data quality and integration into existing data, make rapid response missions a very challenging task.

Within Europe, temporary deployments are primarily a national task, organized by some of the major networks, geologic services or research institutes. The Mw 6.3 L'Aquila earthquake of April 2009 is a success story of collaborative rapid response networks; French, Italian and German groups coordinated the deployment of their stations (including building monitoring) to form a joint network (Margheriti et al. 2011; Mucciarelli et al. 2011). However, the experience gained in this mission also emphasized the necessity to optimize collaboration, facilitate rapid data exchange and structure data processing procedures among the rapid response network community. What is urgently needed to improve the ability of rapid response networks to support emergency management and hazard mitigation is networking of the existing capabilities throughout Europe. Integration and networking is needed at different levels: instrumentation, data exchange, data processing and decision-making, logistics and strategy.

In the framework of NERA-NA4 *Networking European Rapid Response Networks*, we established for the first time a concept for coordination, data acquisition, storage and exchange which is shown in a schematic plot in Fig. 1 and discussed in detail in the following sections. However, it is important to mention that the ERN-concept is dynamic in the sense that it is explicitly open to additional modules and to participation of other groups and institutions.

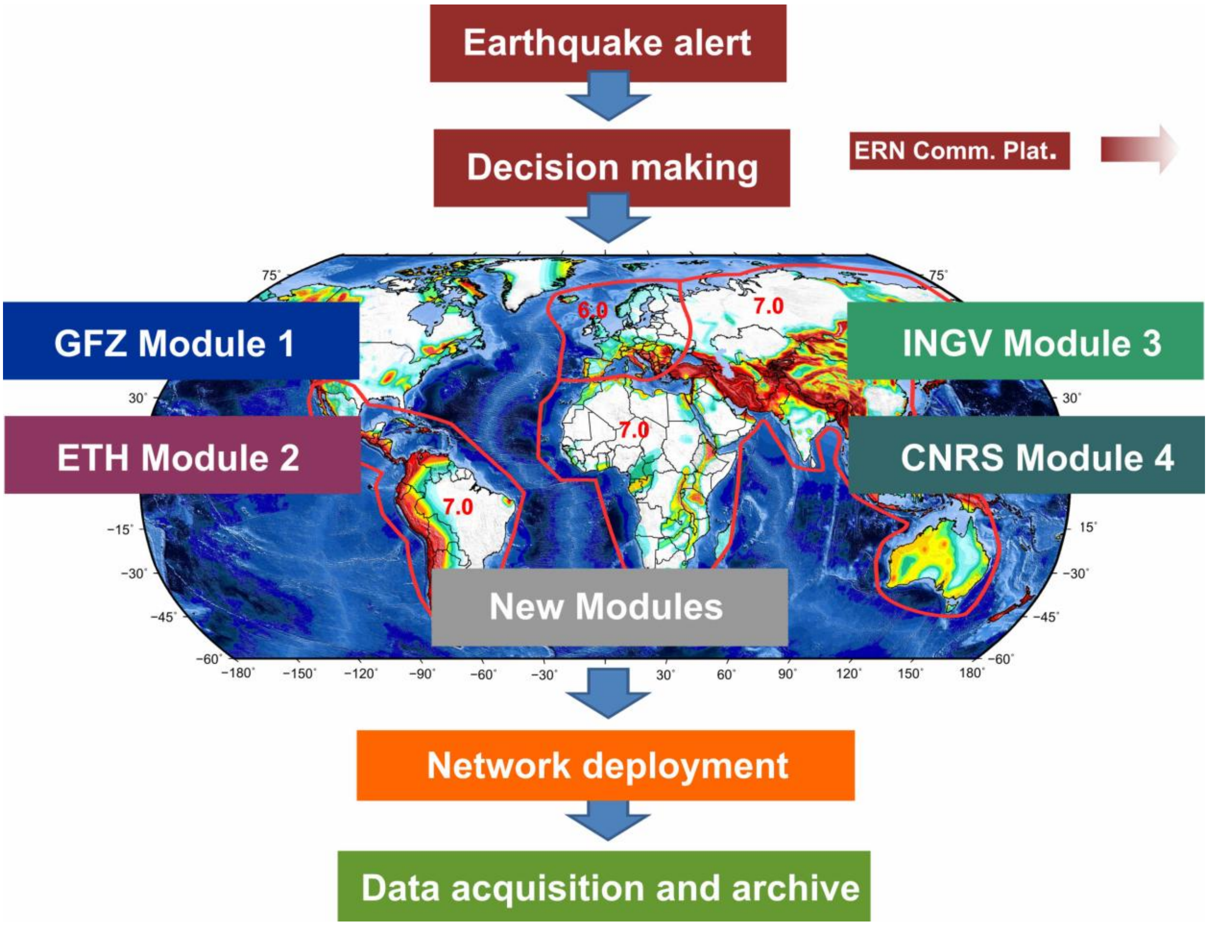

Figure 1: Schematic illustration of the ERN concept.

3. General implementation structure and policy

3.1 Current partner

Currently, the ERN consists of four European institutes, GFZ, ETH Zurich (ETHZ), INGV and ISTerre-GeoAzur. The participating institutions, representing some of the major players in the domain of earthquake rapid response teams in Europe, form the core of this network, which is expected to incorporate other rapid response teams in future.

3.2 Existing modules

The seismologic rapid response modules of the four institutions are subject to changes due to reorganization and replacements of old stations etc. Details of the current status are shown in the appendix (Sec. A2, Tables 1-4).

In summary, the INGV- and the GFZ-module have both a number of instruments fully dedicated to rapid-response missions within ERN. These instruments are routinely maintained and kept always ready for rapid deployments. In addition, both institutions have easy access to instrumental pools, e.g. the Geophysical Instrument Pool Potsdam (GIPP), allowing the use of additional instruments depending on their availability.

The ETHZ module consists of instruments which are used for other temporary experiments as well. However, the instruments will be always available within 48 hours for rapid response actions.

The CNRS-module has no instruments fully dedicated to the ERN at the moment. A part of the national pool of mobile instruments ("SISMOB") can be used for rapid response missions, but will be used by several teams for their programmed campaigns. Thus their availability depends on the schedule of those campaigns.

3.3 Extension of modules and partners

The ERN is open for new modules and partners. The network will strongly benefit from the incorporation of additional instruments, modules and institutions. However, extensions and new collaborations have to be in agreement with the ERN implementation policy and deployment (described in this deliverable). In particular, the defined standards of interoperability and data exchange should be considered.

3.4 Standards of interoperability

Data standards are defined in close cooperation with NERA-NA2 (Expanding access to seismic waveforms in the Euro-Med region).

To facilitate data exchange, the partners have agreed to use in future missions the miniSEED data format in order to facilitate data exchange (seedlink and arclink) and data storage into the European Integrated waveform Data Archive (EIDA). Sampling rates are fixed to 100 sps or higher for velocimeters (seismological observations) while 200 sps for accelerometers (earthquake engineering). Metadata and streams name will be provided according to the SEED standard.

3.5 Data policy

In future, data recorded during a rapid-response mission of the ERN are integrated as soon as possible into the EIDA system. By default, the data will be openly distributed to the entire community. If stated to all partners prior to the deployment, for specific studies, the data from a particular agency can have restricted distribution for up to 2 years. However, also in this case, the data must be made immediately accessible to all active participants in the rapid deployment.

Delaying opening the data collected by a particular partner is only possible if this is clearly communicated to all other participating agencies at the design stage of the intervention, in order to provide all participants with an opportunity to design an optimal network configuration for the scientific community (see also section 4.3).

3.6 Coordination of regular activities

Regular (annual) workshops of rapid-response network operators are an important component of the ERN coordination. These meetings have several functions. Firstly, they will be used to coordinate scientific publications. Secondly, they allow the reporting of previous field experiences and discussion of technical issues. Finally, these workshops are used to update the ERN concept and policy agreements, if necessary, and to develop guidelines for future directions of instrumentation (e.g. highly portable instruments and real time communication) and initiation of new collaborations (e.g. addition of new modules and agreements).

A list of meetings within the first year of the project is given in the appendix (Sec. A1).

Another important component of the ERN coordination is the central ERN portal which will be built within the NERA portal (see milestone MS10 *ERN communication platform;* delivery date: November 2012) in close cooperation with NERA-NA9 (European Mediterranean Earthquake Portal and Services). It will act as central communication platform not only during a rapid-response mission (for this case, see Section 4.2). The platform will be also used for regularly updated contact information of network operators, partner institutions, and available instruments of the ERN modules. Furthermore it will enable access to background information, training manuals, software etc related to rapid response.

3.7 Agreements with third party institutions and countries

Existing agreements with institutions in the affected country can help significantly to facilitate rapid-response missions in the case of catastrophes. In particular, the German Task Force (i.e. the GFZ-module of the ERN) has a number of pre-existing bilateral agreements (see appendix A3) which help for

- prompt transmission of invitations,
- prompt arrangement of entry visa,
- organization of duty-free equipment transportation,
- contacts of local authorities,
- fast transport of teams and equipment to the disaster area (support in logistics like providing 4x4 cars, helicopter etc.).

Because of the importance of agreements (Memorandum of Understanding or, equivalently, Letter of Understanding), existing agreements are intended to be renewed and new bilateral agreements will be initiated (based on existing contacts, see Appendix A3-B). New agreements will be adapted to the specific concept of the ERN.

A template of a Memorandum of Understanding (MoU) is under preparation which will be used for future agreements with partner countries and institutions. In this template, it will be specified that the partner joining the consortium will have as benefit full access to data collected during the ERN mission as well as will be part of scientific activities based on the collected data. Their task will be to provide a contact person as reference in case of ERN mission and logistic support (see above). Moreover, they will provide a fundamental contribution facilitating the logistics.

Besides agreements with partners in foreign countries, each ERN-module will initiate and renew contacts to institutions in its own country (e.g. army, civil protection, or technical emergency services) helping with logistic support.

4. Rapid-response situation

The partners agree on the following Standard Operational Procedure (SOP).

4.1 Earthquake alert

Automatic alerts after large earthquakes will be sent via e-mail, SMS, pagers, etc to the group members of each team. This alert system will be implemented via the ERN-communication platform (see Section 4.2). The web-portal will also provide central access to first damage and loss estimates provided from available sources, e.g. via PAGER or World Agency of Planetary Monitoring and Earthquake Risk Reduction (WAPMERR).

The standard values for target events of the ERN will be earthquakes with magnitude M>6 in Europe. However, exceptions are possible, e.g. in the case of induced seismicity or swarm activity.

Outside Europe, the standard threshold magnitude for ERN actions will be M=7.

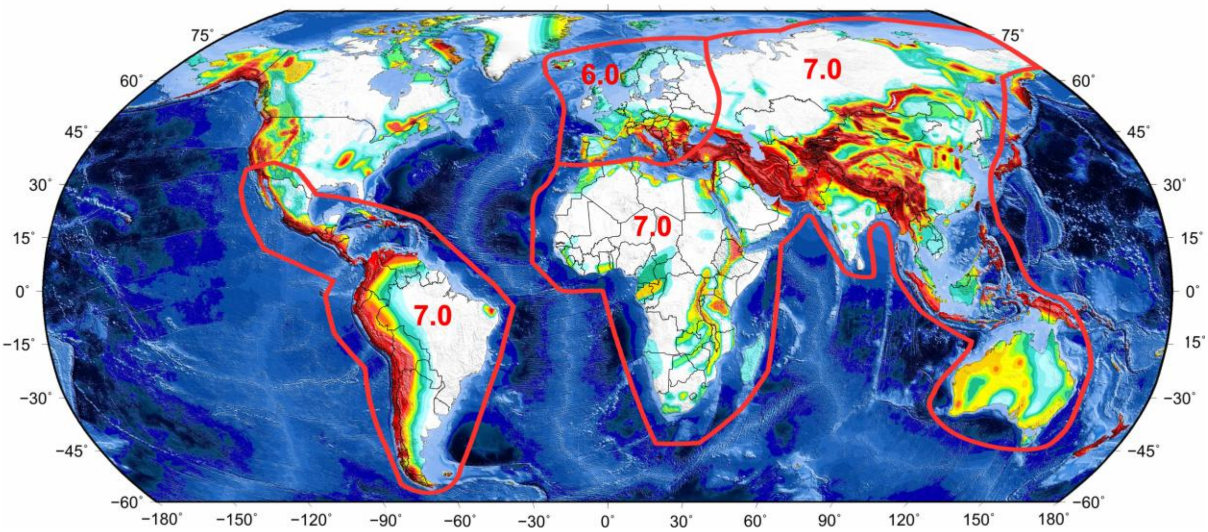

Figure 2: Threshold magnitude levels for ERN deployments on top of the color-coded seismic hazard level.

4.2 Communication

First communication between the partner groups will be done via telephone or via the chat service implemented into the ERN communication platform (Fig. 3, Milestone MS10) . The contact telephone numbers are given in appendix A2 (Tables 1-4) and will be additionally available at the ERN-web-portal (in a password restricted area).

The web-portal will be used for seamless information flow between participants, including the access to pre-existing information about infrastructure and building inventory as well as local topography and geological conditions, also from satellite imagery; and the access to relevant agreements and contact information of local authorities and scientists. Appropriate logistic information and the intended time schedule for the network installation is communicated as soon as possible and made available to the ERN community via the ERN communication platform.

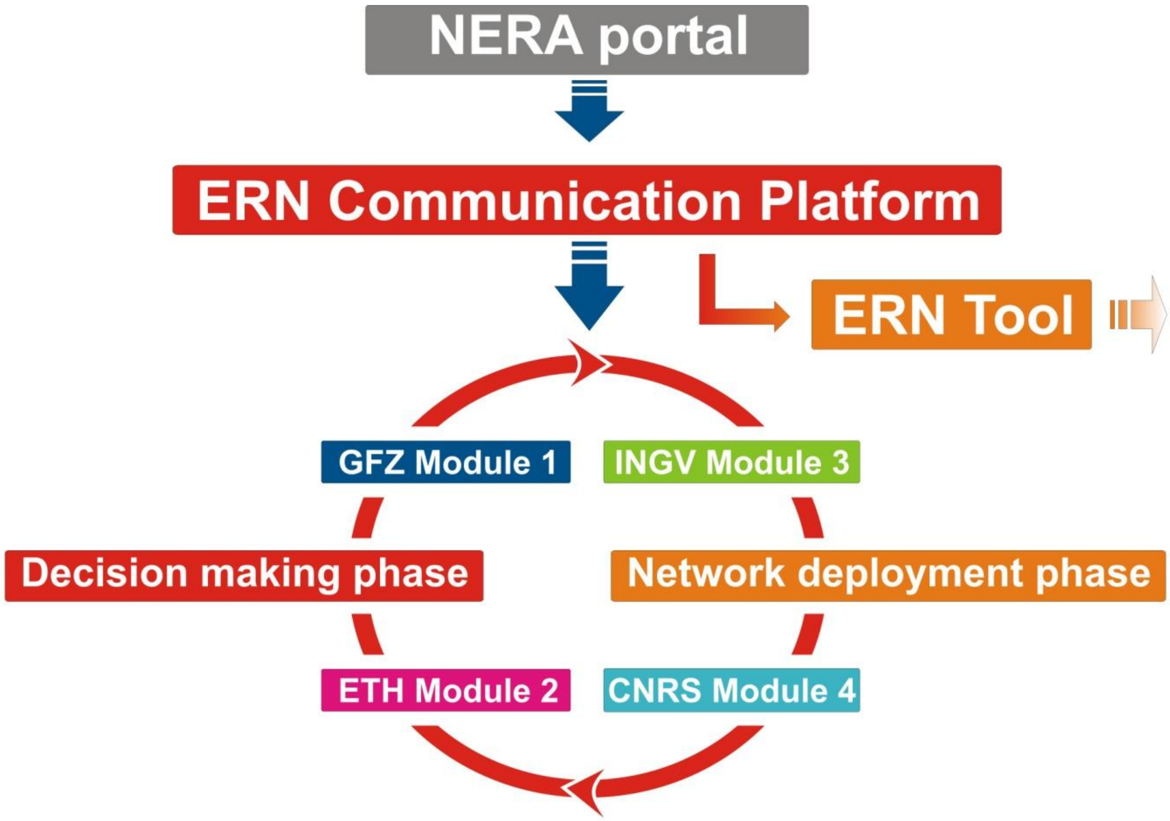

Figure 3: Schematic representation of the ERN communication.

4.3 Decision making

The decision whether or not a module will be sent, is taken by the responsible institute independently. The final decision will be included as soon as possible into the ERN communication platform in order to be shared with other partners also involved in the decision making phase. However, the willingness of the partners to participate in a specific rapid-response mission will certainly play a role in the decision process of each institute.
Part of the decision making process is that each module interested in participating, declare at a very early stage whether they will request a restricted use of their data such as in the case of use for a PhD thesis or not, before the intervention begins. That information can be a

determinant condition regarding the implication or not of the other partners and affect the planning of the network on the field.

4.4 Network deployment

Once final decisions are made network operators should use the web-tool (Fig. 4) for further planning. The web-tool is provided within the ERN communication platform, which is designed for guidance of deployments of joint rapid response networks. This web-tool will be provided as Deliverable *D4.2 Guiding tool for deployment of joint rapid response networks* at the end of the second year. This ERN web-tool will combine different information and the outcome will be a map with the optimal network geometry resulting from the overlay/combination of the following layers (depending on their availability):

- digital Elevation Model,
- existing permanent seismic stations,
- geology,
- population density,
- streets and railways,
- critical infrastructures,
- industries,
- historical seismicity,
- optimal network geometry obtained from Experimental Design (ED) applet,
- others…

The first three layers should be available worldwide while the additional number of layers will be country dependent.

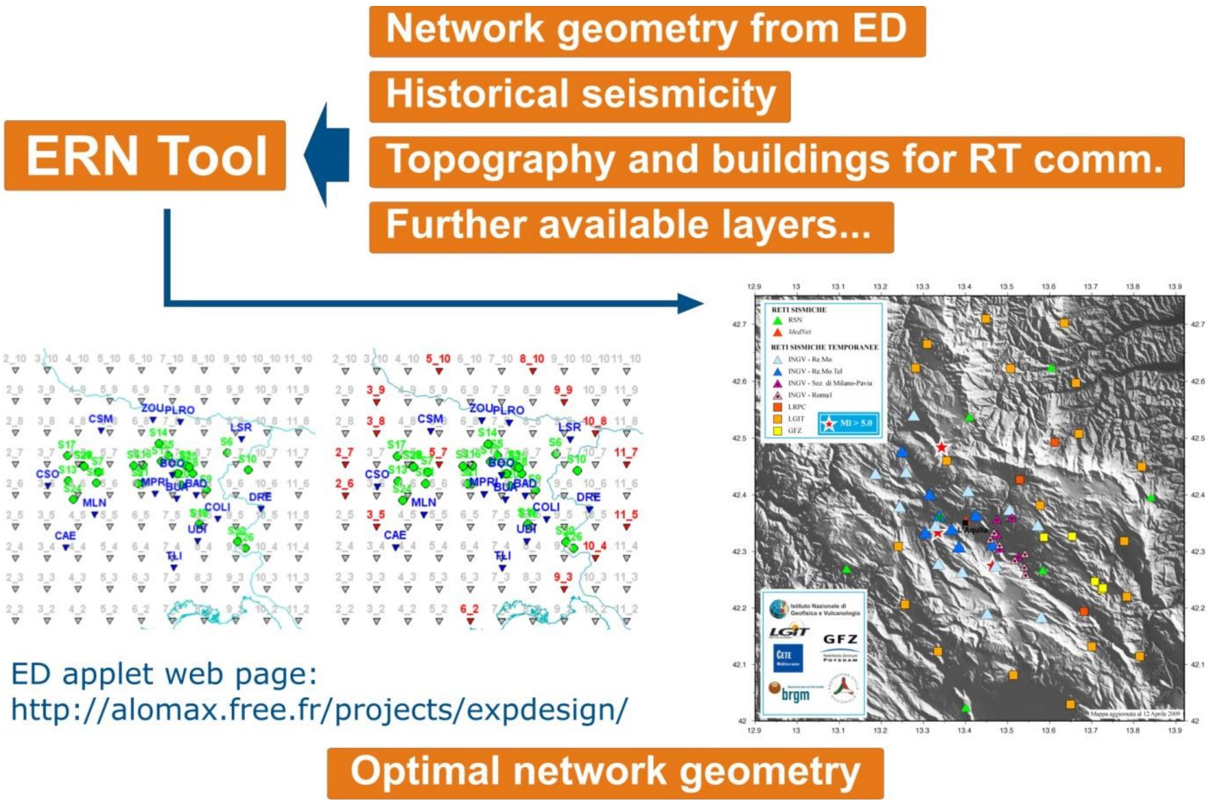

Figure 4: Schematic representation of the ERN tool (under preparation D4.2)

The ERN-web-portal will not only provide access to the web-tool. It will also be used for updating information and rapid information exchange between the different partners. Specifically, rapid information submitted by first teams in the field (including contact information of network operators, instrument metadata and installation location and specifications, local conditions) will be of great importance to guide the other teams.

A guideline for field crews is in preparation to facilitate the rapid deployment and ensure high data quality.

4.5 Data acquisition, distribution and processing

In future, real-time data transmission will increasingly be a viable option. While this is not the case at the moment, solutions for real time data transmission are in the testing phase (D4.3).

As soon as waveform data become available at a local network, they will be made available to all partners within short time to allow immediate processing and analysis. All partners participating during a rapid-response mission should be part of scientific activities based on collected data.

The duration of the mission will depend on the seismicity level, the data quality, the availability of the instruments, etc. In any case, termination of the deployment will be jointly discussed within all involved partners though for any particular station the final decision will remain with the network contributing the hardware.

5. Conclusion

The ERN implementation and deployment policy will produce a more efficient rapid aftershock deployment response to seismic crises. The modular design will facilitate the sustainability of the ERN and the addition of new partners/modules. In particular, the decision making phase will take advantage of the ERN communication platform while the deployment of the network will be supported by a dedicated tool. Last but not least, standards in acquisition and storage will allow a quick exchange and handling of the data.

As specified at the beginning of this document, the ERN implementation and deployment policy are dynamic concepts. In particular, future experiences of first ERN deployments will indicate further needs and improvements. Therefore, the concept will be certainly updated underway although this deliverable will be a sort of a benchmark.

Reference list

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Picozzi, M.; Ditommaso, R.; Parolai, S.; Mucciarelli, M.; Milkereit, C.; Sobiesiak, M.; Di Giacomo, D.; Gallipoli, M. R.; Pilz, M.; Vona, M.; Zschau, J. (2010): Real time monitoring of structures in task force missions: the example of the Mw=6.3 Central Italy Earthquake, April 6, 2009. Natural Hazards, 52, 2, 253-256.

Sobiesiak, M.M. (2000), Fault Plane Structure of the Antofagasta, Chile Earthquake1995, Geoph. Res. Lett., 27, 577-600.

Walter, T.R., Wang, R., Luehr, B.-G., Wassermann, J., Behr, Y., Parolai, S., Anggraini, A., Günther, E., Sobiesiak, M., Grosser, H., Wetzel, H.-U., Milkereit, C., Sri Brotopuspito, K., Prih Harjadi, Zschau, J. (2008), The 26 May 2006 magnitude 6.4 Yogyakarta earthquake south of Mt. Merapi volcano: Did lahar deposits amplify ground shaking and thus lead to the disaster?, G-cubed: Geochemistry Geophysics Geosystems, 9, Q05006, doi:10.1029/2007GC001810.

Appendix

A1. List of activity meetings

(a) WP4-subgroup.meeting, NERA kick-off meeting, Vienna, 17. November 2010
Topics: Organization and distribution of the tasks between the partners.
Participants: B. Delouis (GEOAZUR), A. Govoni (INGV), S. Hainzl (GFZ), A. Strollo (GFZ),

(b) Meeting in Rome (INGV), 20.-21. December 2010
Topics: Specification of INGV-module, in particular, availability of instruments and people as well as the used data format and its way of archive and exchange.
Participants: A. Govoni (INGV), L. Margheriti (INGV), A. Strollo (GFZ)

(c) Meeting in Zurich (ETH) in 31.1.-1.2.2011:
Topics: Specification of ETH-module in particular, availability of instruments and people as well as the used data format and its way of archive and exchange.
Participants: J. Clinton (ETH), S. Husen (ETH), A. Strollo (GFZ)

(d) Conference call (GFZ-GEOAZUR)
Topics: Clarification of CRNS-modul, in particulpar the availability of instruments and their contribution into the ERN.
Participants: B. Delouis (GEOAZUR), A. Strollo (GFZ)

(e) Meeting in Rome (INGV), May 23, 2011
Topics: ERN concept development
Participants: A. Govoni (INGV), L. Margheriti (INGV), M. Pignone (INGV), A. Strollo (GFZ)

(f) Meeting in Grottaminarda (INGV), May 25, 2011
Topics: Development of the ERN web-tool
Participants: M. Pignone (INGV), G. Cecere (INGV), A. Strollo (GFZ)

A2. Module description

INGV-MODULE	
fully dedicated instruments	instruments depending on availability
4 Reftek 130 6 channels DAS 4 Trillium compact 120s (seismometer) 4 Episensors (accelerometers)	up to 20 Reftek 130 DAS various sensors
involved people	
Name	contact
Aladino Govoni Lucia Margheriti Scientist on duty for rapid deployments in Italy Milena Moretti Maurizio Pignone Valentino Lauciani	++390651860710 aladino.govoni@ingv.it ++390651860519 lucia.margheriti@ingv.it ++39335/7587553 ++390651860336 milena.moretti@ingv.it ++390825/446057814 maurizio.pignone@ingv.it ++390651860666 valentino.lauciani@ingv.it

Tab.1: Current status of the INGV-module.

GFZ-MODULE	
fully dedicated instruments	instruments depending on availability
15 EDL PR6-24 DAS 15 Mark L4C-3D 1Hz 7 K2 Accelerometers	20 Sosewin low coast wi-fi DAS with accelerometers for structural health monitoring (Picozzi et al. 2010) various instruments from the Geophysical Instrument Pool Potsdam (GIPP)
involved people	
Name	contact
Jochen Zschau (responsible) Tobias Boxberger Erwin Günther Sebastian Hainzl Claus Milkereit Stefano Parolai Thomas Walter Heiko Woith Marko Pilz Birger-Gottfried Lühr	++49-3312881200, zschau@gfz-potsdam.de ++49-33128828674, tobias.boxberger@gfz-potsdam.de ++49-3312881291, guenth@gfz-potsdam.de ++49-3312881897, hainzl@gfz-potsdam.de ++49-3312881297, online@gfz-potsdam.de ++49-3312881290, parolai@gfz-potsdam.de ++49-3312881253, twalter@gfz-potsdam.de ++49-3312881234, radon@gfz-potsdam.de ++49-33128828664, pilz@gfz-potsdam.de ++49-3312881206, birger-gottfried.luehr@gfz-potsdam.de
comments: Instruments are partially old (>10 years) and have to be replaced soon.	

Tab.2: Current status of the GFZ-module.

ETHZ-MODULE	
fully dedicated instruments	instruments depending on availability
-	5-10 Taurus DAS 5-10 Trillium Compact Seismometers 5 Kinemetrics EpiSensors accelerometers
involved people	
Name	contact
Stephan Husen (responsible) John Clinton Florian Haslinger	++41446334409, shusen@sed.ethz.ch ++41 446334436, jclinton@sed.ethz.ch ++41446334670, florian.haslinger@sed.ethz.ch
comments: ETH will include the rapid response instruments in the ERN with a response time of 48 hours. The instruments are being used for temporary experiments in Switzerland as well but always available within 48 hours for rapid response actions.	

Tab.3: Current status of the ETHZ-module.

CNRS-MODULE	
fully dedicated instruments	instruments depending on availability
-	up to 35 Taurus DAS up to 35 CMG40T seismometers up to 20 CMG5T accelerometers
involved people	
Name	contact
Bertrand Delouis (contact) SISMOB: Anne Paul (responsible) Cécile Cornou Olivier Coutant Glenn Cougoulat Sandrine Roussel	++33-492942626 delouis@geoazur.unice.fr ++33-476635258 anne.paul@obs.ujf-grenoble.fr ++33-476635251 cecile.cornou@obs.ujf-grenoble.fr ++33-476635253 olivier.coutant@obs.ujf-grenoble.fr ++33-476635247 glenn.cougoulat@obs.ujf-grenoble.fr ++33-476635227 sandrine.roussel@obs.ujf-grenoble.fr
comments: The French committee in charge of coordinating the actions of French teams is leaded by Bertrand Delouis (GéoAzur-Nice). He should be contacted at first. ISTerre-Grenoble is responsible for the French pool of mobile instruments SISMOB and the French seismic data archive and distribution center (future EIDA node).	

Tab.4: Current status of the CNRS-module.

A3. ERN Networking (List of relevant agreements and contacts)

Currently, the partners have the following relevant contacts and agreements:

(A) **Letter of Understandings**
The existing agreements (generally with GFZ) have to be partially renewed and will be replaced by new agreements adapted to ERN concept (see section 3.7) in near future.

- **Armenia:**

National Survey of Seismic Protection

- **Kazakhstan:**

- LLC Institute of seismology, Almaty;
- NNC National Nuclear Centre, Almaty

- **Kyrghyztan:**

- Central Asian Institute for Applied Geosciences (CAIAG) Bishkek;
- Seismological Institute of the National Academy of Sciences;
- International University for Innovation and Technology, Bishkek;
- Kyrgyz state university of Construction, Transportation and Architecture, Bishkek.

- **Nicaragua:**

Insitituto Nicaraguense de Estudios Territoriales, Managua (INETER)

- **Rumenia:**

National Institute of Earth Physics, Bukarest

- **Tajikistan:**

Institute of Seismology, Dushanbe

- **Turkey:**

Ministry of Public Works and Settlement, General Directorate of Disasters Affairs, Earthquake Research Department, Ankara

- **Turkmenistan:**

- Institute of Seismology, Ashgabat**;**
- Scientific Research Institute of Seismic Resistant Construction, Ashgabat

- **Uzbekistan:**

Seismological Institute of the Academy of Sciences of Uzbekistan

- **Venezuela:**

Fundacion Venezolana de Investigaciones Sismologicas (FUNVISIS), Caracas

(B) **Some useful contacts to local scientists**

- **Albania:**

Prof.Dr. Neki Kuka, Head of Department of Geoinformation Technologies, kuka@geo.edu.al; Llambro Duni, Istutute of Geoscience dept seismology, duni@sizmo.edu.al (Tirana, MN partner); Edmond Dushi, Istutute of Geoscience dept, seismology dushi@sizmo.edu.al

- **Algeria:**

Mr. Yelles- Chaouche AbdelKarim, Director of CRAAG, Seismic Monitoring and alert Center, Interior Ministry kyelles@yahoo.fr

- **Austria:**

Wolfgang Lenhardt, Zentralanstalt für Meteorologie und Geodynamik Abteilung Geophysik, wolfgang.lenhardt@zamg.ac.at

- **Bosnia:**

Sveto Vrhovac, Seismology Service of Bosnia and Herzegovina, sveto@blic.net

- **Bulgaria:**

Prof. Dr. Dimcho Solakov, Geophysical Institute Bulgarian Academy of Sciences Bulgaria, MN partner, dimos@geophys.bas.bg

- **Chile:**

Prof. Sergio Barrientos, Universidad de Chile, sbarrien@dgf.uchile.cl

- **Croatia:**

Kresimir Kuk, Croatian Seismological Survey, University of Zagreb, kresok@irb.hr

- **Czech Republic:**

Jan Zedník, GI-ASCR, Prague, jzd@ig.cas.cz

- **Greece:**

Nicos Melis, NOA, Grecia Director National network, nmelis@gein.noa.gr

- **Macedonia:**

Dr Lazo Pekevski, Seismological Observatory Faculty of Natural Sciences and Mathematics University "Sts Cyril and Methodius", lpekevski@seismobsko.pmf.ukim.edu.mk

- **Malta:**

Pauline Galea, University of Malta, pauline.galea@um.edu.mt

- **Marocco:**

A.Iben Brahim, Centre National pour la Recherche Scientifique et Technique(CNRST), ibenbrahim@cnr.ac.ma (MN partner); Jabour Nacer, Laboratoire de Géophysique jabour@cnrst.ma; Said Belcadi, Directeur par intérim du CNRST de recherches universitaires 2003,
belcadi@cnr.ac.ma

- **Montenegro:**

Prof. Branislav Glavatovic, Seismological Observatory of Montenegro Director glavatovic@seismo.co.me, Ljiljana Vucic, vucic@seismo.co.me

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Mladen Zivcic, Geophysical Survey of Slovenia, Mladen.Zivcic@gov.si

- **Syria:**

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