Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Report

Outreach and Infrastructure Sustainability Report

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Abstract

This report presents the outreach and the sustainability plan of the portal developments realized during the NERA project. These developments are distributed allowing users to go either to a generic portal (www.seismicportal.eu), EFEHR hazard specific portal (www.efehr.org) or OSAP risk specific one (http://osap.faw.at/).

One of the challenges of NERA was to extend the NERA users community to comprise not only seismologists but also earthquake engineers by providing them with hazard and risk data and products. This was definitely achieved. We realized that one of the developed webservices has even been used by another unexpected community: smartphone application developers increasing the number of monthly individual users to more than 100 000.

All the services have been developed in full coordination with key international actors, using well recognized standards, open source technologies and in coordination with key Solid Earth initiatives such as EPOS and GEM. There are operated by organizations which have been either created to serve the scientific community and/or have been involved in many European projects and initiatives. The portal services are well integrated in the European and global pictures and they are low maintenance services which are used by a large a diverse community ensuring the long term availability.

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Introduction

Infrastructure projects such as NERA are not traditional research projects which stop once the scientific objectives have been achieved. Infrastructure projects aim at structuring a scientific community, proposing improved services to support and facilitate new researches and to offer basis for further integration and coordinated services.

None of these objectives can possibly be achieved without a significant effort for outreach and a good coordination with key players and long-term initiatives at European and global scales. An infrastructure project does not serve its consortium only: it serves the whole scientific community.

This report outlines the outreach strategy developed during the project, presents the actual uses of the portal (www.seismicportal.eu) the key and lasting NERA development, and finally we present how the sustainability plan takes advantages of existing organisations and transformative initiatives such as GEM (Global Earthquake Model) and EPOS (European Plate Observing System).

Outreach strategy

The aim of this section is not to detail every outreach and dissemination activities which have been carried out during the NERA project (this information is available in the different progress reports) but to outline its overall outreach strategy.

NERA project interfaces with 3 overlapping research communities focusing respectively on seismology, seismic hazard and seismic risk. Each of these communities is in direct link with core NERA participants: EMSC and ORFEUS for seismology, EMSC and ETHZ for seismic hazard and VCE for seismic risk. These 4 participants have excellent networking within these communities through membership for EMSC and ORFEUS (they have jointly data exchanges with more than 100 observatories and institutes of the Euro-Med region) and through participation in many European related projects such as IRIS, NERIES, MERIDIAN, LESLOSS, REAKT, SHARE, SYNER-G, VERCE,...

The second level of interactions has been developed through active participation in key scientific meetings. NERA project has participated in joint booth in some of the key scientific meetings such as the European Geophysical UNION (EGU) meetings, the European Seismological Commission (ESC). In August 2014 in Istanbul, NERA organized a dedicated session during the second European Conference on Earthquake Engineering and Seismology (2ECEES) to present its results. The ECEES is a joint event of European Association of Earthquake Engineering (EAEE) and European Seismological Commission (ESC) organized every 8 years. It was a timely and successful event which allowed us to present the NERA outcomes in the only European congress bringing together seismologists and engineers.

Portal and webservices coordination and outreach

The seismic portal (www.seismicportal.eu, Figure 1) is the focal point of seismic services developed during NERA. It links individual portals, the seismic waveform portal (http://145.23.252.222/eida/webdc3/) operated by ORFEUS, the seismic hazard portal (http://www.efehr.org:8080/jetspeed/portal/) operated by ETHZ, the historical data portal operated by INGV (http://www.emidius.eu/AHEAD/index.php), the building assessment portal operated by JAW and JKU (http://osap.faw.at/) and finally the VERCE platform for computational seismology (www.portal.verce.eu) operate by Edinburgh University and ORFEUS.

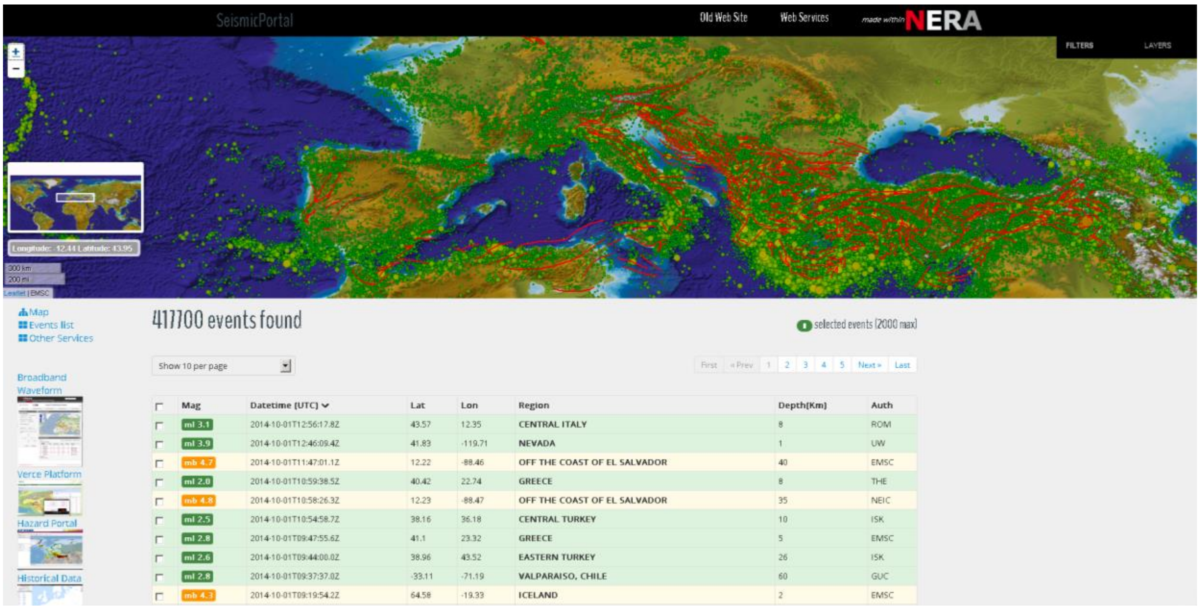

Figure 1: The seismic portal is the focal point of many NERA developments. It links other web portals and offers the possibility to add different layers of information delivered by NERA (e.g., earthquake locations, hazard maps, active faults…) and any layer made available following the OGC standards.

A portal is an excellent tool for data exploration. Thanks to the use of OGC standards, the user can plot many externally-generated-layers such as surface geology, meteorological data etc. Such interactivity is essential for data discovery.

The seismic portal is currently used in average by 3 000 different users a month (Figure 2) from all over the world (Figure 3) which is significant for a scientific service.

Interestingly, the maximum of accesses has been observed during the year 2013 (Figure 2). We surmise that this was caused by the implementation of new features and notably the possibility to map new data layers, but once they have played with new features, users are unlikely to pay regular visits.

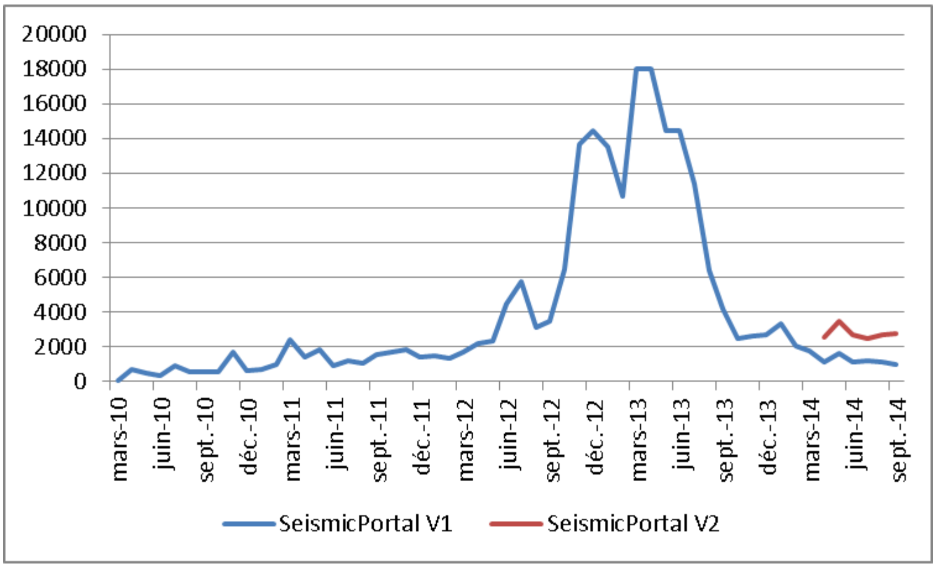

Figure 2: Monthly number of individual IP visiting the seismic portal. The first version of the portal was initially developed during the NERIES project. It underwent major changes during NERA and the user interface was totally revamped in April 2014 in what is now the version 2.

It is important to understand that if a portal is the public face of a project, its accesses only do not always measure the success of the developed services, especially when delivering regularly-updated-datasets.

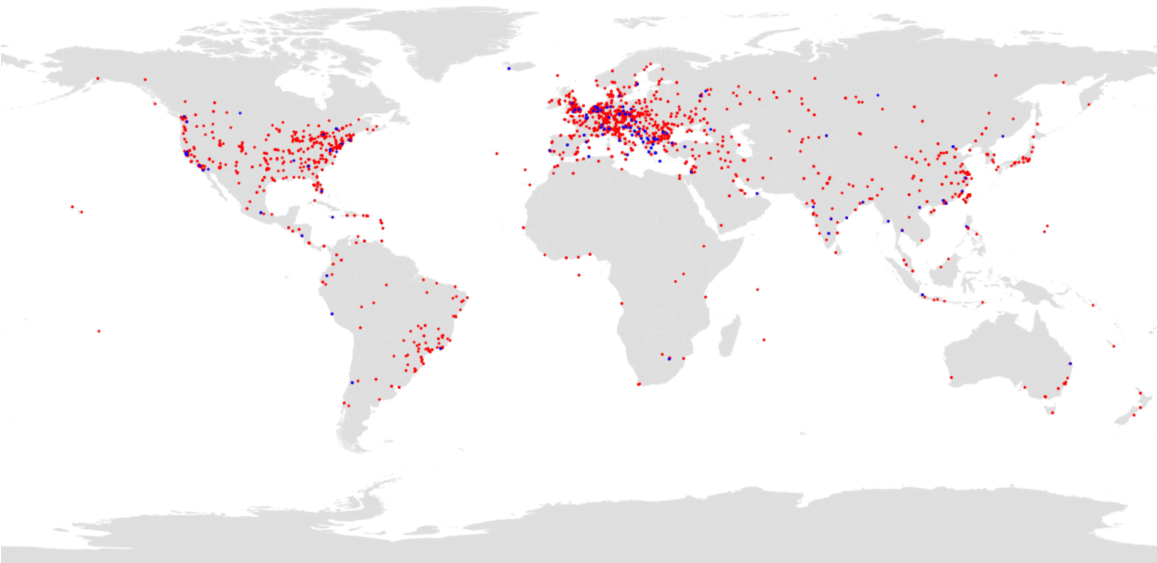

Figure 3: Geographical distribution of the seismic portal users. Blue dots represent accesses through mobile devices.

This is typically the case for earthquake data. With approximately 40 000 earthquakes located a year, the number of updates is far too high for interactive data accesses to be an efficient and appropriate approach (we will see that this is does not apply for more static products such as hazard maps).

The number of invocation of the earthquake webservice is presented Figure 4. The current number of invocations is of 3.5 million a month making it a dramatically successful service. One can see that the new version of the webservice is much more popular than the previous one (Figure 4).

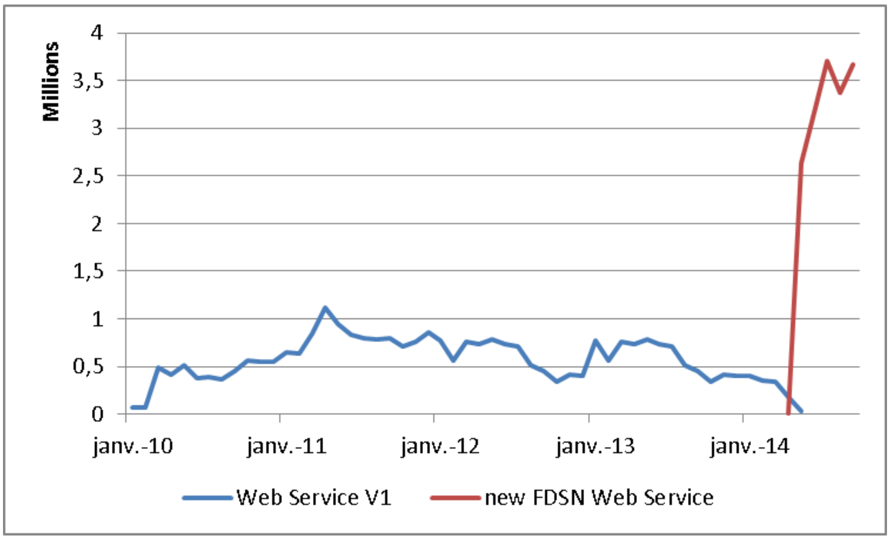

Figure 4: Number of invocations of earthquake webservice per month

There are 2 main reasons. The first one is that this new version is now fully compatible with the FDSN (Federation of Digital Seismic Network) standards. Probably more important, we have invited all the users of EMSC real time information who had diverted some website features (e.g. generation of csv files) to access data in real time to switch to our webservice in order to reduce its maintenance.

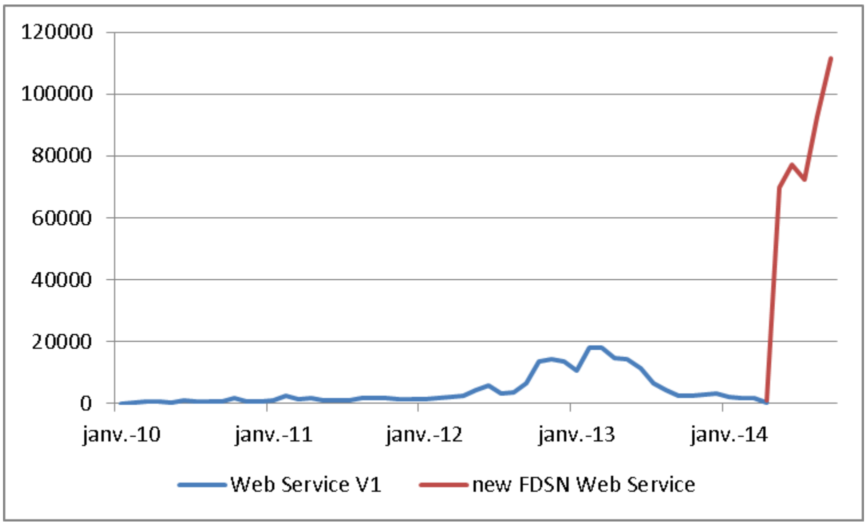

Figure 5: Number of unique users of earthquake webservice per month

One of the striking results of this move has been a surge of individual users of webservices to more than 100 000 a month (Figure 5). It is clear that pushing users to adopt webservices is a good way to evaluate their number and it is also clear that many of these users are not from the seismological community per se and also include the access of smartphone applications which are increasing fast.

Engineering Aspects

With the introduction of the Eurocode, earthquake engineering underwent considerable changes. This makes it necessary to offer information and support to the roughly 2 Million civil engineers in Europe. The valuable harmonisation between the communities of seismologists and earthquake engineers provides opportunities for a considerable extension of outreach and will secure sustainability of the work performed within the NERA project.

Earthquake engineering in Europe

The discipline of earthquake engineering represents the vulnerability side. It is expressed through fragilities that can be applied to buildings, structures, facilities and systems. Earthquake engineering has made major steps forwards toward understanding of the effects of earthquakes. Every new event adds to the knowledge and helps improving, understanding and planning of mitigation measures.

The recent earthquakes in Italy (Emilia-Romagna 2012) have demonstrated that with improved engineering knowledge and better assessment methodologies not only our precious cultural heritage but also important economic assets could be protected. The earthquake in Emilia-Romagna 2012 being of moderate intensity only has destroyed assets of a value of several billion Euros. A good portion of these damages could have been prevented by the application of innovative earthquake engineering approaches.

Figure 6: The Emilia-Romagna earthquake (2012): castello delle Rocche (left) and Sant'Agostino Ceramiche factory (right) collapses. (AFP photos, source: http://www.eqclearinghouse.org)

A recent survey has revealed that in Italy more than 50% of buildings hosting schools do not yet have a certificate of use and occupancy, 34% of those are located in zones with high seismic risk (http://www.ilgiornaledellaprotezionecivile.it/bf/filesupload/Patrimonio_Scolastico_e_Ospedaliero_nelle_aree_a_Rischio__1_93431.pdf). Nevertheless several years have already passed after San Giuliano earthquake in Molise region where 27 young student plus their teacher dead because of the collapse of the school.

Those example demonstrate that Europe still suffers for two main gaps in the field of Earthquake engineering: a) a gap between Europe and the US or Japan in terms of research, investments and technology; b) a main gap between the knowledge of the

European earthquake engineering community and the sensibility to the earthquake risk and consequences among the political institutions and among the citizen.
However, Europe is highly exposed to earthquakes and it has already suffered heavy economic consequences because of them (see Figure 7).

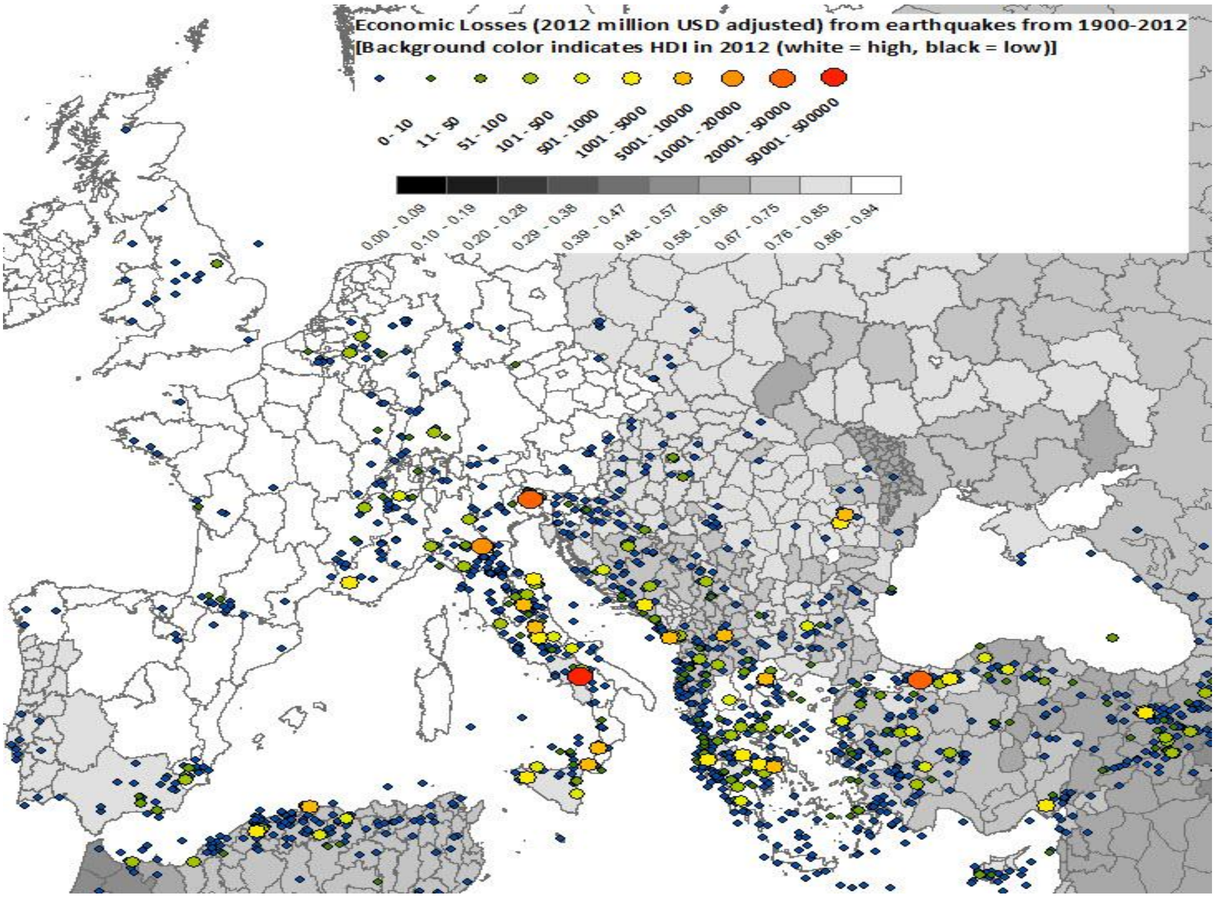

Figure 7: Economic losses of European earthquakes (adjusted to 2012 US$ values) between 1900 and 2012. The Background shading scales with the Human Development Index (HDI) in 2012 with high HDI (white) and low HDI (dark). Notice that European damaging earthquakes occur in various socio-economic contexts.

Earthquake consequences

Resilient societies and systems

Earthquake consequences and their mitigation should be addressed within the framework of resilience (Bruneau et al., 2003) aiming at resilient communities including resilient structures, infrastructure systems and socio-economic environments. A system (technical system, organization, community, etc.) is resilient if it has the adaptive capacity to maintain important functions after any disaster, supports quick response and recovers fast. Thus a resilience model encompasses not only the impact of a disaster but also response and recovery. Moreover it must consider multi-hazard aspects, as a society or system would be considered resilient only if it can cope with many different types of impacts. Models for measuring resilience include four characteristics and four dimensions: The characteristics are: Robustness, redundancy, resourcefulness, rapidity (the 4 Rs). The dimensions are: Technical, organizational, social, and economic. The systems approach will extend our present view of a hazardous event from the moment or time window of impact to the time of response and recovery (Figure 8). It will also encourage inclusion and interaction with a wide stakeholder community (e.g. public and private infrastructure operators, institutions and industry involved in reconstruction, insurance).

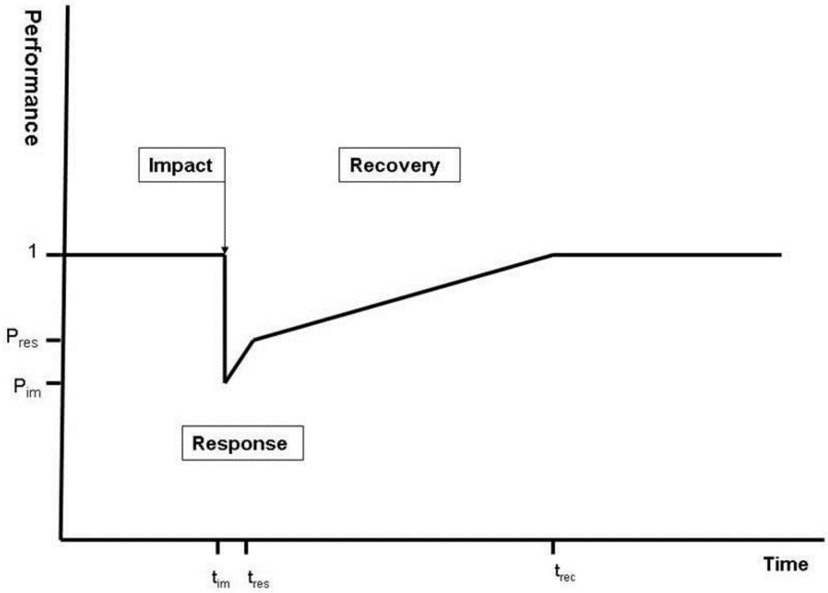

Figure 8: Change in performance over time. The basic metric for resilience is the area between the curves of performance post-impact until recovery is finished and the assumed curve without an earthquake. This area can be reduced by a variety of measures: Reducing direct impact (= increasing Pim), reducing response time (= decreasing tres – tim) and/or increasing performance after response (= increasing Pres), and reducing recovery time (= decreasing trec – tim).

Assessing social and economic impacts from earthquakes depends on the time elapsed from the event, the scale of the analysis and the need of the different stakeholders who have different interests and play distinct roles in the various phases of the disaster. These three dimensions (time, space, stakeholders) are represented in Figure 9, which can be used to operationalize the different types of socio-economic losses. In particular, along the time-dimension three periods of a disaster — emergency, recovery and reconstruction - can be identified. The first period constitutes the immediate aftermath of the event and its short-term consequences where the damaged infrastructure operates in a state of emergency. In this phase emergency managers must deal with the demand generated by damaged infrastructure in terms of temporary shelter needs or hospitalization and treatment of victims. In the mid-term recovery period, while the infrastructure progressively returns to a new state of normal functionality, the disruptions to businesses might be of interest to stakeholders in the insurance sector. And in the long-term reconstruction period, national governments and multi-lateral organizations have to grapple with the costs of permanently rebuilding or upgrading/retrofitting damaged infrastructure, and mitigate the risk from the next event.

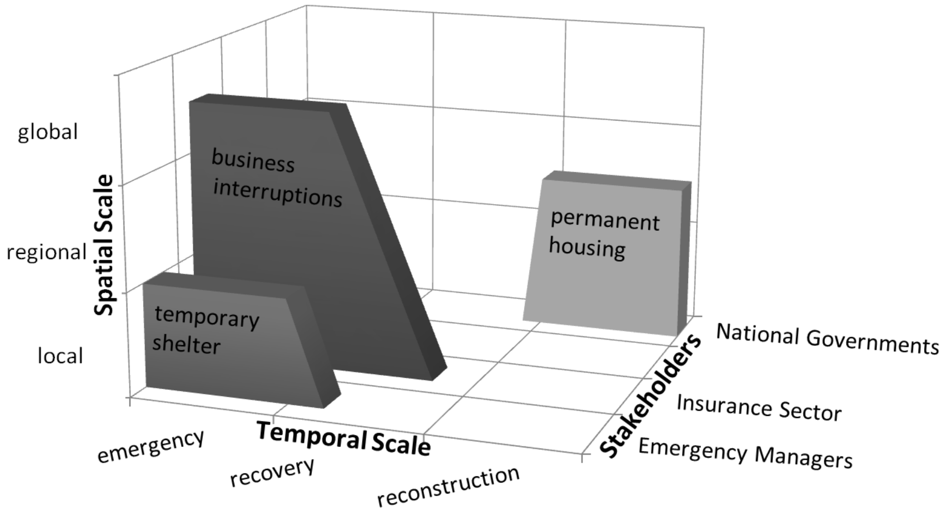

Figure 9: The three dimensions of socio-economic impacts from earthquakes showing the characteristics of temporary shelter, business interruption, and permanent housing.

The resilience concept would potentially allow studying the role of unemployment, loss of social coherence in societies, poverty, excessive migration, etc. on the overall resilience to disasters. For instance poor people may not get loans for a re-start, uneducated persons may have difficulties accessing the opportunities offered in the post disaster phase; youth unemployment may cause loss of trust in institutions and thus inefficiency of response and recovery, small business can be harmed much more severely – in terms of recovery – than larger companies, etc.

Outreach of EFEHR and OSAP

The seismic portal integrates a seismological component, a seismic hazard component named EFEHR (European Facility for Earthquake Hazard & Risk) and a risk component named OSAP (Open Structure Assessment Portal)). In order to give a complete view of the outreach of the developed services we now present the direct accesses to these 2 components.

The EFEHR portal deals with seismic hazard and provides hazard maps, hazard curves and hazard spectra. EFEHR clearly established itself as an essential source of hazard information by attracting a notable interest of several thousands of data requests a month (Figure 10).

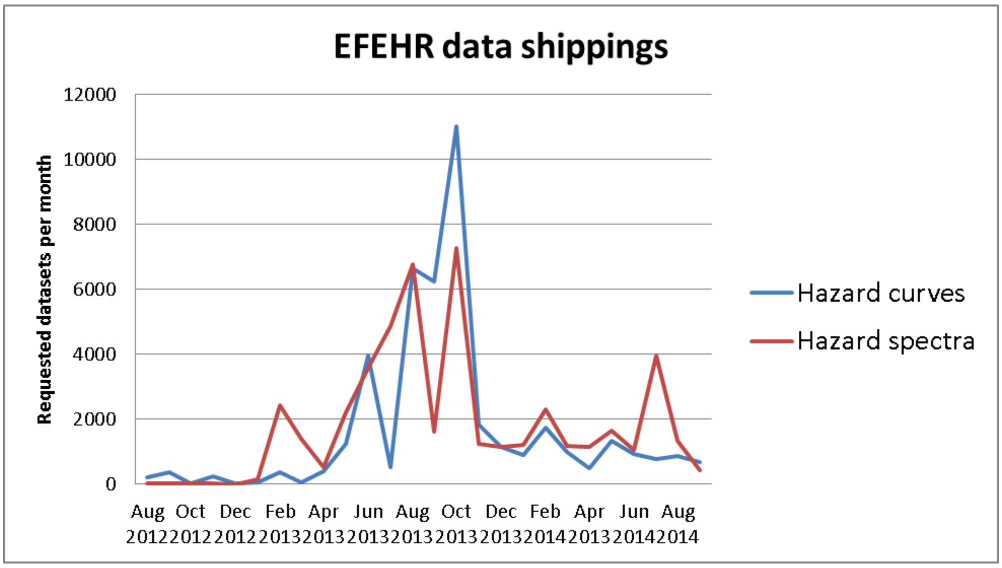

Figure 10: Number of requested datasets on EFEHR portal per month

Interestingly, it seems that the interest in hazard spectra has now overtaken the one in hazard curves which probably reflect a significant share of earthquake engineers in the user community. This is a very important result because one of the challenges of the NERA project was to serve seismologists and earthquake engineers and this seems to indicate that we have succeeded.

Figure 11 shows that interactive data accesses represent about half of the accesses which is a much higher proportion than for seismological data. This confirms that the choice of access type depends on the type of products: interactive access is preferred for stable products like seismic hazard data while programmatic accesses are best suited for regularly updated datasets.

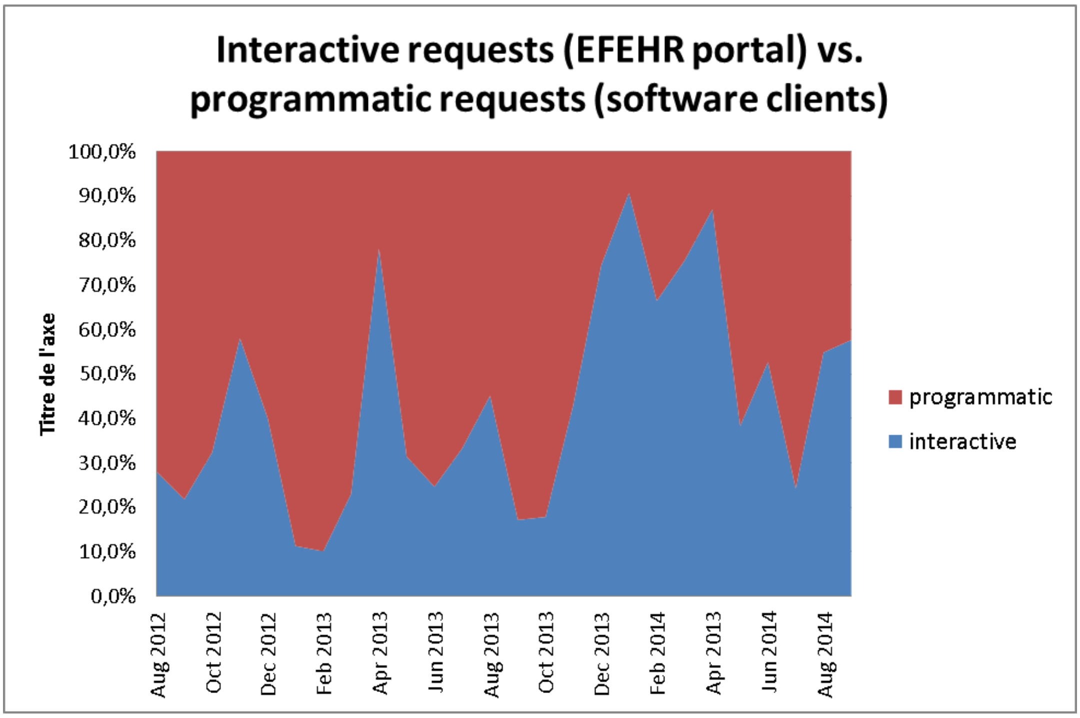

Figure 11: Time evolution of the proportion of programmatic and interactive requests

The OSAP (Figure 12) is very different from the other service components: it does not offer data access but collect information. Potential users only need a single visit to share their information, meaning that the access data are simply not comparable with the other components of the portal. Its main objective is to enable non-professionals (the "crowd") to assess the structural health of buildings (e.g., their own homes), utilizing the paradigm of crowd-sourcing. It tries to resemble easily assessable yet significant structural parameters while maintaining simplicity and comprehensibility among non-experts. The OSAP web-page currently shows an average of about 280 page hits daily whereas 80% originate from Austria, and its database contains approximately 600 buildings.

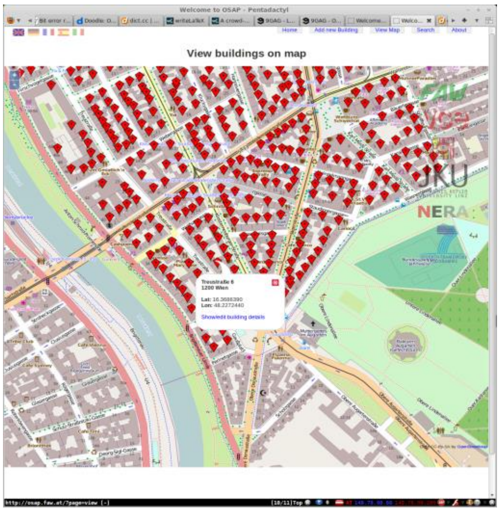

Figure 12: The OSAP user interface

Sustainability plan

The sustainability plan is based on 3 elements: a technological component, an organizational component and a full integration with on-going projects and initiatives.

From a technological point of view, the portal is a modular, distributed and maintenance facility which has been developed using open-source technologies and applying the widely recognized standards such as OGC, QuakeML or FDSN recommendations for webservices.

The portal is operated by organizations which have long track records of serving the scientific community. For example, EMSC and ORFEUS have been created to serve the seismological community and have been maintaining and improving their services for decades; the very first version of the portal was indeed developed during the NERIES project and has been in operation since.

More importantly, the portal is not an isolated development; it is part of a large ecosystem of related organizations, projects and long term initiatives (Figure 13).

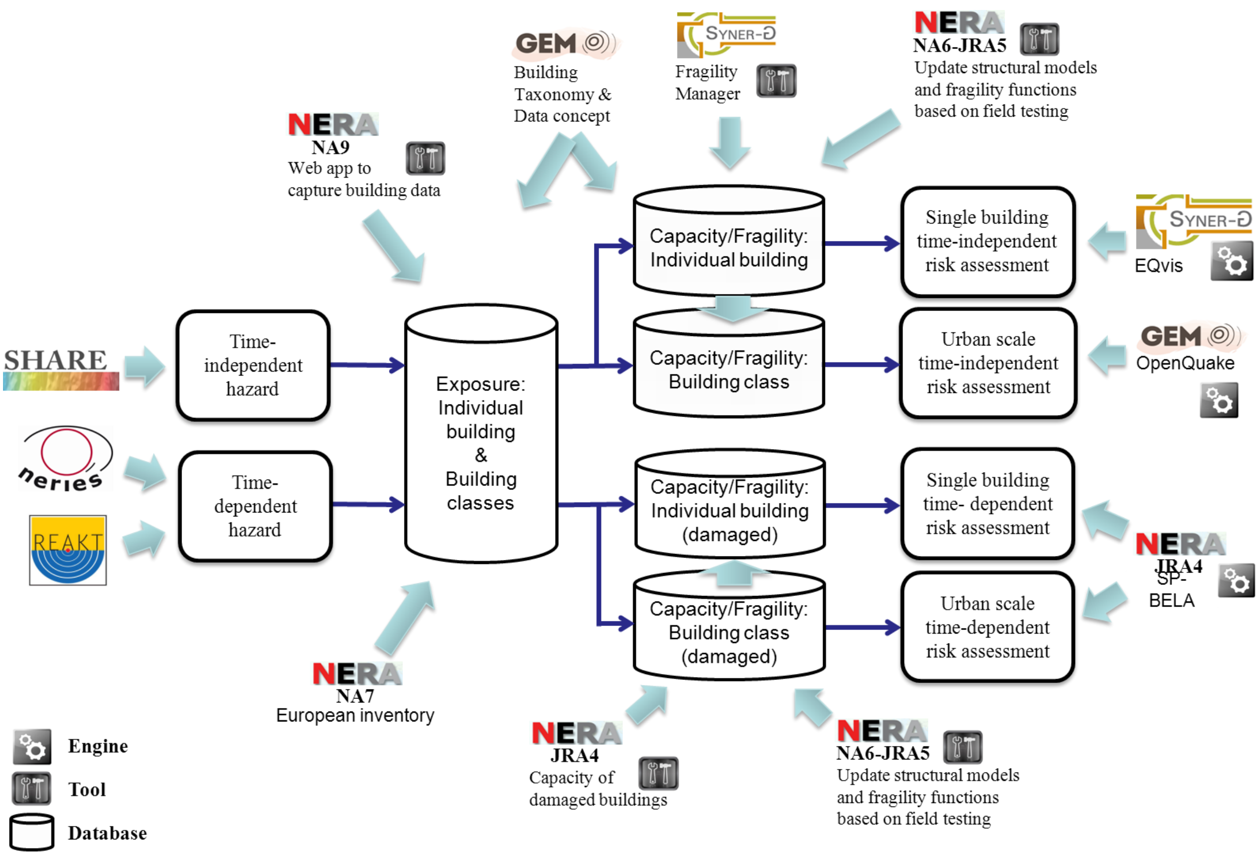

Figure 13: Schematic view of the relation between NERA WP and main initiatives and projects

Provided services are coordinated with our US counterpart, NEIC/USGS and IRIS and benefit to other ongoing EC-projects such as VERCE (Virtual Earthquake Research Community for Europe).

In the longer term, what is key is the shared vision that we have developed with EPOS for the seismological component (European Plate Observing System, the ESFRI initiative for solid Earth) and with GEM (Global Earthquake Model) for the hazard and risk components.

Figure 14 shows the proposed organization of the EPOS seismological services. The first 3 pillars are the follow-up of the NERA service activities (SA1: seismological products, SA2: Waveform data, SA3: hazard and risk). The Hazard and risk pillar is broader than the SA3 and also include the NERA risk component. The 4th pillar, computational seismology is linked to the ongoing FP7 VERCE (Virtual Earthquake Research Community for Europe) project.

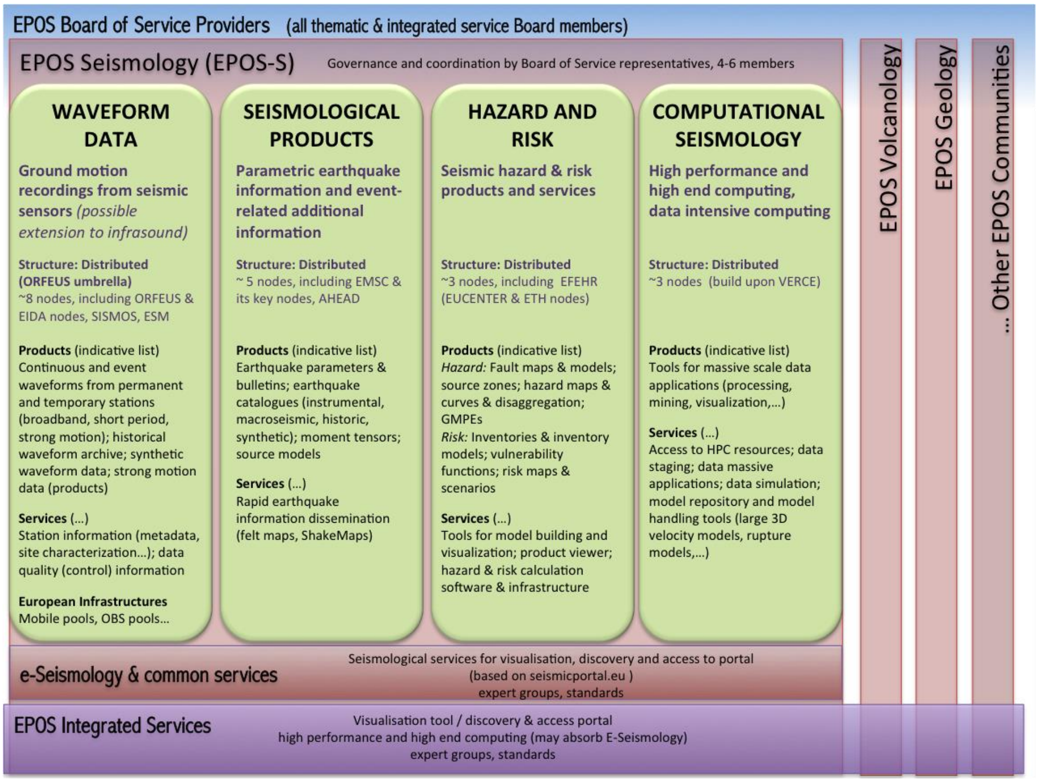

Figure 14: Schematic organization of the seismological thematic core services in the ESFRI initiative EPOS.

As clearly illustrated Figure 14, EPOS seismological services are based on the NERA outcomes with the seismic portal being at the basis of the visualization and access EPOS tools.

Conclusion

There are 2 main conclusions in this report. First the portal developments have found its audience from seismologists to earthquake engineers and are widely used by the scientific community which was one of our key initial objectives. We have even shown that the public, through their use of smartphone applications are benefiting in large number (>100 000) of the information services.

The second conclusion is that these services are there to stay: they are low maintenance services which fully integrated in the ecosystem of Earth sciences projects and initiatives at European and global scales, used by a large and diverse audience and operated by organizations which have been created to serve the academic community.