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Summary

The Scientific Advisory Board for **R**eal-time earthquake r**I**sk reduction for a re**S**ilient **E**urope (RISE) consists of the following researchers:

- Prof. Bogdan Enescu; Kyoto University, Japan
- Prof. Ned Field; USGS, USA
- Prof. Matt Gerstenberger; GNS, New Zealand
- Prof. Egill Hauksson; California Institute of Technology, USA
- Prof. Naoshi Hirata; University of Tokyo, Japan
- Prof. Tom Jordan; University of Southern California, USA
- Prof. Aldo Zollo; University of Naples Federico II, Italy
- Prof. Ramon Zuniga; UNAM, Mexico

SAB has been informed of the whole project development from the start of the project. Members of the SAB attended the RISE Kick-Off Meeting in September 2019, which was held in Zurich. SAB were invited to the RISE virtual Mid-Term Conference in May 2021. Two SAB meetings were held in December 2020 and May 2021, where WP leaders and the Project Coordinator presented the work in progress followed by a Q&A session.

RISE Management provided access to the project's intranet (Alfresco site) to all SAB members, where there is numerous project information, submitted milestones and deliverables, meeting minutes etc. SAB members are invited to RISE seminar series "ZOOMing into RISE", where RISE participants from every WP give scientific talks every other week and results of research are being discussed within the RISE Community. SAB receives the internal and external newsletters, and are included in the mailing lists for receiving the various project news and information. The latest and most comprehensive information SAB received is the Mid-Term Report of the Consortium (Deliverable 1.14) that was submitted to the EC on 31 August 2021.

This deliverable is the mid-term report of the Scientific Advisory Board (SAB). It is based on the information provided through various channels described above. It is compiled, distributed to the participants and available to the EC. The report comments on the progress made and recommendations to further improve the project.

INTRODUCTION

RISE brings together 19 partners from across Europe and five international participants into a multi-disciplinary effort involving earth-scientists, engineering-scientists, computer-scientists, and social-scientists. In the RISE vision, reducing earthquake risk and enhancing resilience requires progress on numerous technological, societal, and methodological frontiers but all targeted towards a common and sustainable framework on dynamic risk that RISE is providing. Within this framework, RISE consists of 8 work packages:

WP1 - Management: Ensure successful management of the project, from a technical, administrative and financial perspective
WP2 - Innovation: Exploiting innovation, technology advances and opportunities of big data for earthquake loss reduction
WP3 - Advance: Advancing operational earthquake forecasting and earthquake predictability
WP4 - Effects: Advancing loss and resilience assessment for earthquake early warning and operational earthquake loss forecasting
WP5 - Society: Data Gathering and Information Sharing with the Public and Policy-makers
WP6 - Demonstration: Pilot and demonstration sites for RISE technologies and methods
WP7 - Testing: Rigorous testing and validation of dynamic risk components
WP8 - Impact: Exploitation, dissemination and services for securing a demonstrable societal, economic and scientific impact of RISE

While WP1 is dealing with project management, WP2 has been exploring the use of new technologies in developing accelerometers, use of portable excitation sources, enhanced seismic networks, creating high quality earthquake catalogues. WP3 focuses on building a new generation of models for operational earthquake forecasting (OEF) to substantially improve earthquake forecasting performance. These models will then be tested in RISE Testing Centre (WP7) under the CSEP umbrella. In WP4, RISE engineering teams have been developing the second generation real time seismic structural assessment and rapid loss assessment (RLA) tools for Europe. The aim is to operationalize earthquake loss forecasting (OELF) for Europe, including time-variant hazard and time-variant vulnerability that accounts for damage accumulation. WP6 is the demonstration work package where Switzerland is selected as the main testbed to demonstrate the potential of the approach and technologies. RISE social scientists have been working on dynamic risk communication in WP5; how to cope with the challenges due to high level of uncertainties in earthquake risk and how to best communicate the risk for better preparedness such as rehearsing evacuation procedures, ensuring supplies are in hand and all lines of communication are open. WP8 is split into two distinct topics; developing the project's internal and external communication tools and building the IT framework for operating time dependent seismic risk infrastructures.

In this assessment of the SAB, each member of the board provides their view on RISE work, results and achievements in the first half of the project and gives suggestions for the second half.

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1. Evaluation by Prof. Bogdan Enescu (Kyoto University)

1.1 Overview on RISE work, results and achievements during the first reporting period

- Overall, I am impressed with the achievements made during the first reporting period of the project. I particularly appreciate the successful inter-connection between the eight working packages (WP1 - WP8) and the advances that have been made to put theory and seismological observations into practice (e.g., for real-time risk reduction). Besides the efforts dedicated to developing OEF models (WP3), social scientists have been working on risk communication strategies (WP5). I think this is a very important direction of research, since risk communication is critical for successful disaster mitigation and has been less investigated so far.
- The central concept of dynamic risk is linking various working packages of the project and creates the necessary framework for tackling natural hazards beyond those due to earthquakes. I think this is the right vision and the different parts of the project are successfully working to achieve their goals, while cooperating one with each other.
- Among the various efforts of the project, I would like to emphasize those dedicated to a new CSEP2.0 software toolkit for earthquake forecast developers. The application of earthquake forecasting methodologies for large datasets or large areas (e.g., the whole territory of Italy), as well as the development of a new generation of Operational Earthquake Forecast (OEF) models, are also worth mentioning. I hope such efforts could be generalized at the European scale in the future. The preparation of the first OEF for the state of Israel is also a remarkable achievement.

1.2 Suggestions for the second half of the project

- When dealing with seismicity and earthquake forecasting, we inevitably need to consider the quality of the data, the completeness of earthquake catalogs and so on. I think there is still a rather large gap between data quality and completeness, as well as data availability between different European countries. I think this is one of the most difficult challenges when implementing the earthquake hazard assessment plan for a resilient Europe.
- One of the greatest challenges in Seismology is making meaningful earthquake forecasts. The recent advances in data analysis, which include the application of machine learning and deep learning techniques, as well as big-data analysis, are promising, but still far from offering a breakthrough. Operational earthquake forecasting may need such qualitative jumps, so the current project and other large European projects in the field may wish to put more effort in this direction.
- The project undoubtedly has obtained many considerable achievements in a relatively short amount of time; I hope the second half of the project will be able to connect such various achievements in a unique platform.
- A dedicated number of a scientific journal, gathering various main achievements of the project, would be a useful reference for the researchers in the field.

2. Evaluation by Prof. Ned Field (USGS)

The midterm RISE report indicates very good progress with respect to wide and ambitious goals for improving real-time earthquake risk assessments (broadcasts and forecasts) in Europe. This is particularly impressive given challenges posed by COVID19. Although I read the entire report, it is obviously impossible for only one individual to evaluate everything, especially when accomplishments can only be summarized in a report like this. In what follows I provide some broader considerations as "food for thought", many of which go a bit beyond the stated scope of this project, but in my opinion will nevertheless be important to achieve the stated goals long-term. Most of my comments stem from what I see as a bit of a statistical seismology bias in the earthquake forecast model developments.

- The report gives the strong impression that CSEP tests are the key to earthquake forecasting improvements. While testing models is indeed critical (e.g., as the quintessence of science), there are limits to what it can tell us with respect to larger earthquakes that can dominate hazard (due to their rarity). Yes, "*Helmstetter et al. (2007) was the most informative time independent earthquake model in California during the 2006–2010 evaluation period*", but this was only with respect to forecasting small earthquakes, and this model actually states the opposite with respect to what is otherwise considered the most hazardous area in California. In other words, CSEP tests can be very misleading with respect to areas of highest hazard and risk, and there is very little discussion of how this is being addressed (let alone acknowledgment of the issue). I also think it disingenuous and misleading to discuss CSEP tests without quantifying how long it will take to get useful, definitive results.
- A related problem is a lack of consideration of known faults (which is why many believe Helmstetter et al. (2007) fails where it matters most). While the report contains some mention of faults, modeling details are lacking and there is no occurrence of the word "paleoseismology" in the report. I worry that a big part of the problem is being neglected here, especially when other Europeans are focused on this issue (e.g., the Fault2PSHA group).
- The report refers to "physics-based" models (e.g., those that include coulomb effects), but in my opinion these are not the important (or most potentially useful) ones. The latter are multi-cycle physics-based simulators (e.g., RSQSim), which are capable of generating synthetic catalogs over thousands to millions of years within a fault system. The advantage here is that forcing models to perform over multi-cycles identifies model inconsistencies that won't be found from a CSEP-type focus. In fact, I'd argue that we have learned more about what does and does not work from multi-cycle simulations than we have from CSEP.
- I find CSEP results like that in Figure 7.1.3 frustrating in that it's hard to know exactly why certain models are performing better than others, especially when there are endless varieties within any class of model (e.g., a little tweak to an ETAS model might be very consequential). What exactly are we learning? I realize it's a big job to sort all this out, but don't we have to do this to make these analyses useful?
- Even if CSEP were to demonstrate that one model is superior to another at the magnitudes we care about, this does not mean that it is necessarily more useful. All models are wrong, so what really matters is whether a possible improvement (e.g., spatially variable b-values) is net value added (because a simpler, less costly model might be more useful). This question, in my opinion, is both more answerable and more immediately useful than what CSEP is currently pursuing. In other words, we need to add valuation to our verification and validation protocols. This isn't trivial, but it does require the type of forecasting infrastructure RISE envisions, so it seems well aligned overall.
- I was a bit disappointed in a seemingly lack of progress with respect to testing ground motion models, and a lack of discussion with respect to issues of primary concern right now in the US, including the ergodic assumption, spatial correlations in ground motion (e.g., across portfolios), and directivity effects. I also wonder about the use of physics-based ground motion models in RISE.

Again, I provide the above constructive criticism as food for thought, but the focus on these issues should not obscure the great overall progress within the RISE project.

3. Evaluation by Prof. Matt Gerstenberger (GNS)

3.1 Overview on RISE work, results and achievements during the first reporting period

- The RISE team has made an impressive amount of progress during challenging times. It appears the project is tracking well and producing a large number of results and publications across all aspects of the project. I have read the entire report, but of course I am not qualified to comment on all topics and it is challenging to put sufficient detail in such a report so that the panel is able to provide precise commenting; therefore my comments have mostly remained very high level.

- The hazards and risk communications work is a critical package and seems to be advancing well and delivering very useful results for most of the other work packages (and beyond). In many ways this is an important section of work linking together the other work packages and helping to guide them.

- The continuation of CSEP testing is a clear benefit to the project and to the greater forecasting/hazard community. The focus on model combinations and understanding of how best to capture epistemic uncertainty in this is exciting and I look forward to the results.

- I am encouraged by the focus on the OELF and related tools and imagine these tools will become increasingly in demand.

- Overall I feel the RISE team is producing a large amount of work that is beneficial to the EU and the global community.

3.2 Suggestions for the second half of the project

- It is not clear how well linked together all of the projects are. There clearly are benefits in close collaboration between the groups and if this is not happening I would encourage more consideration of that. One example is the chain related to the catalogue improvement work and the impact of magnitude in hazard and risk; the OEF world has traditionally worked in Ml or magnitude-agnostic-space but the hazard and risk work presumably needs to be done using GMMs which rely "consistently" estimated Mw. This discrepancy can introduce challenges or bias (perhaps this particular issue is being handled well). Another is the flow of information from WP5 to the other WP to inform any necessary fundamental changes to modelling procedures. Development of tests, as mentioned below, is another.

- As I mentioned, it's great to see the CSEP testing continue. I struggled some to understand what the exact goals of the testing are and if they are being aligned to the other WPs. Largely the goals seem short-term and OEF aligned and I would encourage there to be consideration given to if the results are informing answers to questions the end-users and modellers are asking; this also requires a clear understanding of what those questions are. If not already I would encourage the testing group to develop the tests collaboratively with the modellers (OEF and OELF) and WP5. The testing seems to be in the style of past CSEP tests (community agreed in 2005?); these past CSEP experiments had significant learnings, are these being taken on board? There is ground motion testing under way and mentioning of hazard testing and I assume you are targeting end-user needs beyond short-term. Will other data sets (e.g., fault-based data, geodetic data) be considered to inform end-user questions related to longer-term earthquake behaviour? Presumably the CSEP testing and optimisations/hybrids/ensembles results will also be dominated by "high seismicity" regions; these testing results will likely not identify models that perform well in low seismicity regions and I would encourage some focus on that. I look forward to the work on taking into account a proper probabilistic scheme for the epistemic uncertainty!

- The primary focus of WP5 seems to be related to how to wrap communication around the hazard/risk information so that it is best understood by (mostly qualitative?) end-users. Another related aspect is working with the end-users to identify their specific needs and how the tools (not just the communication) may be changed to best suit these needs. A challenge in this can be that many end-users will not really understand their needs until an earthquake occurs and they begin to make decisions based on the OEF or OELF or other hazard/risk information. We have found that mixing end-users who have experienced multiple quakes with other inexperienced users to be very beneficial. It is also not clear to me if technical end-users are covered in this work. In our experience they have created the most demand on our time during response and require very different products to the more qualitative users. The better set up these pathways and tools are ahead of an event the better the outcomes will be. This includes such things as specific loss metrics or methods of quantifying epistemic uncertainty in a way that can directly inform decisions. I would encourage focus on this in the next phase if it is not already planned.

- I wonder if WP8 will focus on more specific metrics around impact in the next phase. From what I understand the WP8 metrics have primarily stopped at uptake. I understand assessing impact in a complex social chain can be very challenging to do, but I would encourage consideration of such things as wellness and resilience indicators. Perhaps this is largely covered in Task 4.6. The CBA looks like an impressive and important task and I look forward to these outcomes.

- SAIPB Process: I would suggest some changes to encourage increased engagement/involvement from the SAIPB would benefit the process and allow for more informed comment on the work of the RISE team. Obviously this is not easy to do with a panel spread across the globe but some practical tweaks to the process may allow for more informed and useful input from the panel.

4. Evaluation by Prof. Egill Hauksson (California Institute of Technology)

4.1 Overview on RISE work, results and achievements during the first reporting period

- The RISE project progress so far is impressive, and the RISE group is staying on track and accomplishing its expected research and implementation goals by addressing the key RISE objectives of advancing risk reduction for resilient Europe to limit the adverse impacts of future earthquake hazards. In particular, the RISE group is making substantial progress towards the new RISE paradigm of perceiving and managing earthquake risk as an evolving, integrated, and dynamic risk.

- The project participants have successfully engaged in communication and dissemination activities. The management (WP1) has been highly effective and has provided a steady leadership, sometimes under adverse conditions, to ensure solid progress on the various Work Packages (WPs). The use of Alfresco for communications and Zenodo for open data and publication access is very innovative and illustrates the forward thinking of the RISE leadership.

- The achievements for Operational Earthquake Forecasting (OEF), Earthquake Early Warning (EEW), Rapid Loss Estimation (RLE), and Recovery and recovery efforts that have been made during the first reporting period are very significant. The scope of RISE products delivered so far is very impressive and covers significant parts of the work packages. All the WP are interdisciplinary, and the investigators have managed to seamlessly connect them into a systemic workflow.

- Substantial progress has been made on WP2 that provides input to the other WPs. It applies innovative technologies and big data to advance the progress of OEF, EEW, and RLA. So far, the RICE group has accomplished various aspects of proof of concept for the various available technologies. The overall development and testing of OEF models (WP3) and risk communications (WP5) exceed the state of the art. The innovative development of the CSEP2.0 software toolkit in support of development and deployment of Operational Earthquake forecasting is an excellent example of the risk management infrastructure being developed by RISE.

- The development and exploration of new low-cost instrumentation for building monitoring as well as developing a portable shaking excitation source for analyzing engineered structures, is important (WP2). Deployment of DAS arrays has provided novel insights into earthquake detection under adverse conditions. In addition, development of dynamic exposure models based on OpenStreetMap/ OpenBuildingMap are making a significant contribution to dynamic risk assessment. Further, development of the concept of dynamic risk is important for addressing risks associated with the whole spectrum of natural hazards.

- The application of EEW to specific buildings in Istanbul provides new ways of testing and developing complex EEW systems, which will have high impact in regions where they may be deployed in the future. The attempts at evaluating various geophysical and geochemical earthquake percussors may not provide statistically significant data. But such data are needed to make progress towards meaningful earthquake prediction (WP3).

- WP4 is focused on loss estimates for EEW and OELF. Time invariant building exposure models for 44 European countries are being developed and tested. These models will provide decision makers with the necessary information to effectively manage post-earthquake response and recovery. These types of vulnerability models are also helpful for estimating the financial and societal impact of future events. These models may become time variant during major earthquake sequences. OELF improvements will generate estimates of short-term seismic risk at regional and national scale. The current stage of implementation of WP6 includes pilot implementations as well as testing activities for OEF, EEW, RLA, and SHM, demonstrating the high likelihood for successful outcome of the RISE project.

4.2 Suggestions for the second half of the project

- During the remaining 18 months of the project, we recommend continued implementation of all the WPs that are in progress. We also recommend enhanced emphasis on harmonization of the different WPs as well as assimilation of the WPs into workflows that will benefit future applications in real disasters as well as long term planning for societies on local, national, and European scale.
- The current WPs are turning out to be well thought out and provide guide rails for the continued research and development. Ongoing effort to document and present RISE tools and facilities to future use such as by government officials and practicing engineers is encouraged.
- The RISE group should continue to address issues such as making data analysis methods more resilient to variable data quality across the European region.
- The RISE group should address the question if high-resolution earthquake catalogs (HRC) will add significant new information to OEF. In part the parameter selection used to generate the HRCs may remove any new potential precursory data patterns. The question remains, what are the optimum parameters for generating HRCs without massaging out any previously not discovered statistical patterns? In other words, the seismologists that generate HRCs are likely to calibrate their magnitudes using their preconceived opinion of an appropriate b-value for the whole catalog, and thus they may inadvertently remove any potential b-value anomalies.
- The RISE group should consider how the EU privacy rules will affect their WPs when collecting large volumes of data from cell phones, smart home appliances, or other devices that may explicitly or implicitly track personal user data.
- The timeline in Figure 6.4.13 represents the current state of the art that we see needed to complete the necessary steps in the recovery and reconstruction process following a natural disaster. That it takes weeks to months to years to complete the structural assessments contributes to increasing the costs and impacts of major disasters. Unifying the tasks and shortening this timeline through the integration of WPs could be how the RISE work contributes to shortening this time needed for recovery. In other words, if all the results of the RISE work were being applied, what would this timeline look like?

5. Evaluation by Prof. Naoshi Hirata (University of Tokyo)

5.1 Overview on RISE work, results and achievements during the first reporting period

I am very much impressed that the RISE project is well organized and has achieved many important findings, such as real time monitoring and operational forecasting seismic activities.

It is generally very difficult to integrate many different disciplines. The project includes earth-scientists, engineering-scientists, computer-scientists, and social-scientists. Particularly collaboration among natural scientists and social scientists is sometimes very hard. The RISE project has so far developed good collaborations.

A rapid estimation of seismic disaster damage by seismic sensing technology and risk assessment is very important. In Japan also it is important to nearly real-time assessment of damage by a large earthquake but still it is challenging.

5.2 Suggestions for the second half of the project

A rapid estimation of seismic disaster damage by seismic sensing technology and risk assessment technology is very important. Implementation of such a method to real society needs many experiences in earthquake prone countries/regions where the society is well-prepared for earthquake hazard, such as Japan, California, New Zealand etc.

Even in Japan, it is very difficult to implement such technology because many people do not want to know real damage situation caused by a large earthquake. The estimates are sometimes much larger than what people can personally manage, and they simply forget it or blame a person. Although it is very challenging, it is necessary to convince people to prepare for disasters before they encounter them. I hope the RISE project provides a realistic way to implement a scientific sound technology to enhance social resilience to natural disasters.

6. Evaluation by Prof. Tom Jordan (University of Southern California)

WP1: The RISE Management Team has done an effective job in organizing the scientific activities, coordinating the various working groups, and communicating the research results across the RISE community. They have developed an evolving Project Management Plan that features an Implementation Plan and a Data Management Plan, as well as internet-based facilities for supporting project communication. The latter include a Zenodo Platform, which facilitates the sharing of data and publications, and the Alfresco platform, which provides a shared workspace and a central hub for posting internal progress reports and meeting proceedings. Email communications and virtual meetings within and among the various working groups have been successfully coordinated under WP1. As a result, the overall productivity of the RISE Project has been relatively high given the difficulties posed by the COVID-19 pandemic. Forward planning for the second phase of the project appears to be well advanced. The prospects are good that RISE will achieve most of its major objectives.

WP2: RISE is wisely investing in new modes of seismic data collection, monitoring, and data modeling. Several DAS experiments have investigated the deployment of this new type of sensor technology in urban and wild environments, and progress has been made in identifying seismic sources, modes of wave propagation, and data characteristics. The low-cost QuakeSaver HiDRA sensor, based on MEMS technology, has been developed and deployed, and a patent application for the device has been submitted to the European Patent Office. One project under WP2 involves the use of innovative portable excitation sources for field testing of existing and densely instrumented structures, which recognizes that the vibrational diagnosis of building health is an endeavor with a promising future. Appropriate attention is being given to the key observational problem of building better seismicity catalogs and new types of waveform datasets. The challenge will be to fuse the observational constraints into products useful in earthquake forecasting and seismic risk assessment.

WP3 and WP7: A primary focus of RISE is the development of better earthquake forecasting techniques; in pursuing this goal, the efforts under WP3 and WP7 are organizationally intertwined and thus reviewed together. WP3 aims towards the twin goals of (1) assessing the intrinsic predictability of earthquake activity through exploratory forecasting and (2) implementing the new understanding into probabilistic forecasting models with complete descriptions of the epistemic uncertainties. WP3 research on the first goal involves exploratory research on an interesting mix of novel forecasting methods. Work on the second is leading to improved methods for operational earthquake forecasting (OEF), including ETAS and EEPAS models, as well as models based on rate-state friction and the Coulomb failure function. Few details of the OEF implementations are provided in the RISE Mid-Term Report, but progress towards goal (2) appears to be good. Considerations of how expert opinion can be better used in set prior probabilities and assessing epistemic uncertainties have been postponed due to pandemic restrictions on in-person meetings.

WP7 seeks to measure the performance of the OEF models being developed by WP3 through rigorous retrospective and prospective testing in well-controlled forecasting environments. The Interim Project Report indicates that the planning by these working groups to integrate these capabilities into a viable forecasting enterprise is well along, and that the eventual success, as measured by tangible improvements in long-term and/or short-term forecasting methods, seems likely.

A central objective of WP7 is the incorporation of pyCSEP, a new software toolkit, developed by SCEC in collaboration with RISE, into the new testing framework of CSEP2.0. Several papers on the design and development of pyCSEP and CSEP2.0 have been published or are in preparation. A major objective is the application of the CSEP2.0 testing methodology to the prospective evaluation of the 10-year CSEP earthquake forecast experiment in Italy, and papers on the results of this experiment are now in preparation. Pseudo-prospective testing of OEF candidate models have been conducted by SCEC and RISE using the 2019 Ridgecrest sequence. One important area of investigation, optimizing earthquake forecasting capabilities through ensemble modelling (Task 7.3), has not yet reported results.

From the SCEC perspective, the collaboration with the RISE community through WP3 and WP7 has been very productive, and this partnership is leading the way towards the improved forecasting models and validation methodologies.

WP4: This work package involves the development of loss-assessment tools, loss-forecasting procedures (built on OEF), near-real-time recovery forecasting, technologies for structural health monitoring and damage detection, and a cost-benefit analysis framework. A key element of WP4 is the development of the European ShakeMap system, which is now online. A second is the implementation of time-independent and time-dependent vulnerability models as part of a system for operational earthquake loss forecasting (OELF). Progress on these topics, as documented in the Mid-Term Report, appears to be very good, although no deliverables have yet been submitted. WP4 is also considering various ways to improve earthquake early warning (EEW) systems. Scenario-based calculations show that, under ideal circumstances, the effectiveness of EEW in mitigating seismic risk can be very high; however, the plausibility of this optimistic conclusion can be questioned and less ideal scenarios should be considered.

WP5, WP6 and WP8: Not reviewed.

7. Evaluation by Prof. Aldo Zollo (University of Naples)

7.1 Overview on RISE work, results and achievements during the first reporting period

- RISE delivered a huge amount of work and products which are already available at the intermediate term. The report well illustrates the project development with a truly interdisciplinary approach which is based on a dynamic community of seismologists and engineers, forming a nice mix of young and experienced researchers.

- Beyond the expected developments and progresses in key topics of the project (e.g. OEF and RLA) there is an impressive and multi-scale experimentation of consolidated and new technologies for the real-time earthquake observation and building monitoring (WP2 and WP6). As for the seismological observing system, I find very promising and innovative the implementation and testing of compact, miniaturized accelerometric sensors to be assembled in large-N arrays and the use in urban sites, in extremely high-noise conditions, of the optical fiber DAS for earthquake detection and shallow structure imaging.

- As for the EEW component of the project, among other less mature studies, I mention the new development, implementation and testing of building-specific early warning systems (task 4.5, two high-rise buildings in Istanbul) based on an integrated regional-wide and onsite approach, the latter based on real-time ground-motion measurement at a local installed accelerometric array and possibly using sensors developed in WP2. Given the location of this pilot-site nearby a relatively high seismicity region of Europe, this could represent a reliable proof-of-concept of a end-to-end early warning system

7.2 Suggestions for the second half of the project

- A great effort has been already done to set up procedures/links aimed at improving the interaction among WP activities and products. In particular, the key-role of WP6 in testing at pilot-sites the method and technology project development is crucial and it must be reinforced. Along this direction, how the enhanced seismicity catalogues now available at regional and national scale thanks to the application of template matching and ML techniques (WP 2), could be used and possibly implemented in the general OEF and OELF frames is a matter of investigation in RISE.

- EEW – In RICE the experimentation of crowdsourced, smartphone-based EEW is ongoing. It seems needing more convincing validation, especially on the alert reliability and its effective use. A link and reference to the similar and earlier started experience of MyShake at Berkeley University is strongly suggested. The interesting test of the EEW onsite method at two high-rise buildings in Istanbul is promising and has the potential of innovative outcomes. The pilot site, among all the ones of the project, is indeed located in a high seismicity region of Europe, so that massive testing on real earthquake data is feasible. The EEWS merges and combines the earthquake information derived from the regional and local installed networks, possibly using technologies developed in RISE. Data and analysis of the performance of the real-time system even in case of no-damaging small to moderate size events should be very informative about its predictive power and sensitivity to false alerts. A further boost in RICE is expected for the experimentation and operation of well consolidated EEW nation-wide systems, as the VS in Switzerland. In particular, in Italy, where initiatives along this direction are ongoing at INGV and University of Naples in collaboration with the Italian Railway company for controlling the high-speed train traffic during earthquake emergencies.

8. Evaluation by Prof. Ramon Zuniga (UNAM)

8.1 Overview on RISE work, results and achievements during the first reporting period

- The main strength of the RISE initiative is that it involves a multidisciplinary team of people, resources, and institutions, including earth-scientists, engineers, computer scientists, and social scientists all with the main goal of providing innovative tools to assess and overcome seismic risk in Europe. RISE engages 19 partners from eight different European countries and five international partners. The coordination and communication among all the partners are in itself an enormous task and it has been carefully carried out by people related to WP8.
- The results of RISE will generate a strong impact not only in Europe but around the world. As an example, WP2 which consists of the developing, testing, and installation of a new and high-performance low-cost accelerometer (QuakeSaver), and the development and testing of a portable excitation source for testing structures provide innovations that will reverberate in many places, but particularly in countries with lower financial capabilities for seismic monitoring. Additionally, the dynamic exposure model developed using OpenStreetMap/OpenBuildingMap data will provide a key tool for dynamic risk assessment, and it will be feasible to extend it to other countries.
- Related to another task, people working under WP3 developed the mathematical background which substantially improves the performance of current earthquake forecasting models and already published these methodologies, making them available to the scientific community. Under WP4, scientists and engineers of RISE released a database of building exposure models for 44 European countries together with the open source tools for disaggregating the national exposure models with high resolution. Furthermore, the first database of European capacity curves for over 480 building classes has been released which will surely provide a solid ground for loss estimation and preparedness. On the social impact side of the spectrum, how to best communicate the risk for better preparedness and for possible preventive measures such as building evacuation, has been tackled by people involved in WP5. In particular EQN, the smartphone app which turns smartphones into motion detectors or alert sending devices has been demonstrated successfully to act as the very first smartphone-based EEW system. These are just some of the main achievements of RISE so far in my opinion. Overall, the advances of RISE are sound and solid and it is to be expected that work will continue on the positive track already set.

8.2 Suggestions for the second half of the project

- I find highly encouraging the many developments and achievements of RISE so far. I expect that all the people involved in the project will surely continue with their successful track.
- I would suggest trying and disseminating the results to a wider audience not only through the regular channels of scientific journals and meetings but perhaps through special sessions and talks delivered even as part of a series.

- It is clear that seismic risk varies from region to region and it would be very valuable to provide a comparison of the current and future advances and gains of RISE in each region of the project.
- By knowing the expectations and improvements of seismic risk determination and preparedness at a regional level, as provided by the results of RISE, other countries could be in the possibility of taking advantage and making use of such a wide scoping effort.