Deliverable 1.1

D1.1 Project Management Plan (PMP) Updated

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Summary

This document is the first deliverable of RISE (D1.1) and it contains the first Project Management Plan (PMP). It has been prepared by WP1 and reviewed by the Management Board. There will be an update to the PMP annually.

PMP describes the tools needed for the execution of the project RISE (Part1: Project Management) as well as establishes a roadmap for execution of the project (Part 2: Implementation Plan). The PMP will be the backbone of the project implementation, and aims to achieve the best quality of work while managing the time and resources efficiently. The project management pays special attention to the coordination of the work within whole RISE community being carried out in a collaborative way. Therefore, the Work Package (WP) 1 constructs a feedback mechanism between Work Packages that concurrently disseminates information and results. The PMP will support and enhance the cross WP/task collaboration as it identifies the various interconnections between tasks and subtasks within and across work packages.

This deliverable is structured in two parts. Part 1 (Project Management) and Part2 (Implementation Plan).

Part 1 (Project Management) highlights the main project management features and deals specifically with the management approach. It describes the role of the governance structure in managing RISE, the Management tools and procedures, Financial management and Risk management, all designed according to the provisions of the RISE Grant Agreement (GA) in force.

Part 2 (Implementation Plan) is composed of an Implementation Plan for each Work Package. It is more of an action plan, where it describes the tasks in greater detail than in the GA, and serves as a roadmap for shorter and longer term. The Implementation Plan divides the tasks into subtasks that will serve as next steps or to do list. It includes the people responsible for each task and estimated time needed to complete that task.

1. Project Management

1.1 Project Description

RISE (Real-time Earthquake Risk Reduction for a Resilient Europe) is a Horizon 2020 Project under the GA 821115. RISE started on September 1st 2019, and the project will run for 3 years, ending on 30th August 2022.

RISE promotes a model of earthquake risk taking advantage of the advances in science and technology. RISE will deal with time dependent earthquake risk, and will introduce the concept of dynamic risk. RISE proposes a series of coordinated activities in the domains of Operational Earthquake Forecasting, Earthquake Early Warning, Rapid Loss Assessment and Recovery and Rebuilding Efforts. The approach of RISE is multi-disciplinary, involving earth-scientists, engineering- scientists, computer scientists, and social scientists. It is multi-scale in space and time, and addresses these scales in a highly systemic and consistent way. To maximise the impact of RISE, an interdisciplinary team of researchers and practitioners from 24 institutions (including 5 contributing partners from outside of Europe) in 13 countries are working together to achieve the goals of RISE (Figure 1).

Figure 1: Map of the participating institution in the RISE consortium.

The first section of the PMP, Project Management, deals with the management principles, structure and organization of the project governance, the nominated RISE governing bodies, the management tools that will be used throughout the project, the mechanisms that are set for budget control, reporting, decision making processes as well as principles for improving interactions and effective communication within RISE.

1.2 Project Partners

The relationship between the RISE parties is established through the RISE GA No 821115, and through the supplementary Consortium Agreement which establishes internal arrangements between Beneficiaries regarding their operation and coordination to ensure that the action is implemented properly. Both the Grant Agreement and the Consortium Agreement are signed by all parties and therefore fully in force. The Consortium Agreement is part of the next WP1 Deliverable D1.6 (Data Management Plan) due M4.

RISE involves 19 parties from institutions across Europe (Table 1), 3 linked third parties (Table 2) and 5 International Partners (Table 3) listed in the GA Annex 1-part B.

No	Name	Short name	Country
1	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	ETH	Switzerland
2	HELMHOLTZ ZENTRUM POTSDAM DEUTSCH-ESGEOFORSCHUNGSZENTRU	GFZ	Germany
3	ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA	INGV	Italy
4	VEDURSTOFA ISLANDS	IMO	Iceland
5	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA	UNIBO	Italy
6	UNIVERSITY OF BRISTOL	UNIVBRIS	United Kingdom
7	THE UNIVERSITY OF EDINBURGH	UEDIN	United Kingdom
8	UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II	UNINA	Italy
9	BAR ILAN UNIVERSITY	BIU	Israel
10	CENTRO EUROPEO DI FORMAZIONE E RICERCA IN INGEGNERIA SISMICA	EUCENTRE	Italy
11	EURO-MEDITERRANEAN SEISMOLOGICAL CENTRE	EMSC	France
12	UNIVERSITE GRENOBLE ALPES	UGA	France
13	THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	UCAM	United Kingdom
14	BOGAZICI UNIVERSITESI	BOUN	Turkey
15	KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT-KNMI	KNMI	Netherlands
16	STMICROELECTRONICS SRL	ST-I	Italy
17	UNIVERSITA' DEGLI STUDI DI BERGAMO	UniBg	Italy
18	UNITED KINGDOM RESEARCH AND INNOVATION	UKRI	United Kingdom
19	QUAKESAVER GMBH	QUAKE	Germany

Table 1. List of RISE Beneficiaries

Name	Short Name	Country	Institution which it is linked to
ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE	OGS	Italy	INGV
INSTITUT FRANCAIS DES SCIENCES ET TECHNOLOGIES DES TRANSPORTS, DE L'AMENAGEMENT ET DES RESEAUX	IFSTTAR	France	UGA

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	CNRS	France	UGA

Table 2. List of linked Third Parties

Name	Short Name	Country
UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO	UNAM	Mexico
NATIONAL UNIVERSITY CORPORATION, KYOTO UNIVERSITY	KYU	Japan
INSTITUTE OF GEOLOGICAL AND NUCLEAR SCIENCES LIMITED	GNS	New Zealand
NATIONAL UNIVERSITY CORPORATION THE UNIVERSITY OF TOKYO	UTOKYO	Japan
UNIVERSITY OF SOUTHERN CALIFORNIA	USC	USA

Table 3. List of RISE International Partners

1.3 Governance Structure

The management plan and decision-making structure of RISE is designed following well-tested mechanisms, proven to be effective in projects of comparable size and scope (REAKT, NERIES, NERA, SERA, EPOS-IP). RISE governance is assured by the General Assembly, the Project Coordinator, and the Management Board. On the other hand, RISE implementation is supported by the Scientific Advisory and International Partner Board (SAIPB) and the Stakeholder Panel (SP). The management of the project relies on the Project Office (PO). Figure 2 shows for a graphical representation of the management structure, as it was defined in the GA. The functions and responsibilities of RISE Boards are summarized below.

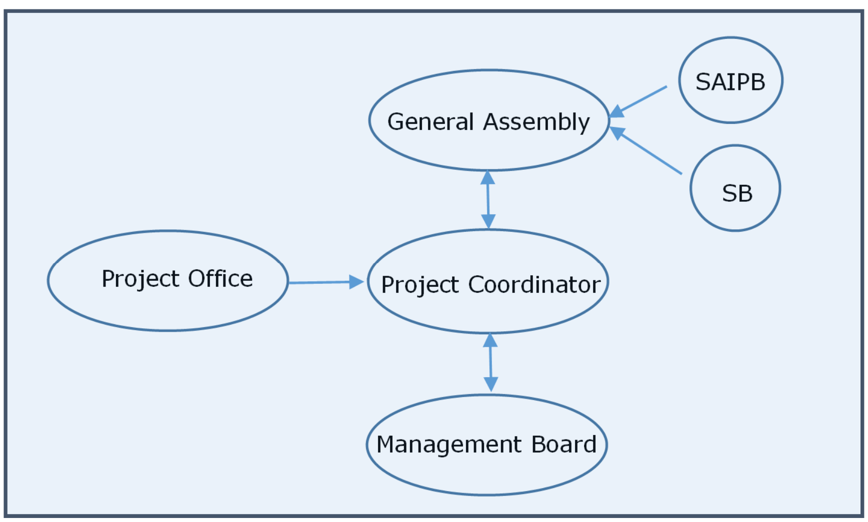

Figure 2. The graphical representation of the management structure

The **Project Coordinator,** Professor Stefan Wiemer (ETH), is responsible for the global coordination and organization of the activities. He is assisted by the Project Office, including the RISE Manager (Banu Mena Cabrera), the Communication Officer (Michele Marti) and administrative/financial officers (Romano Meier), responsible for the operational and financial administration of RISE as well as for the provision of required documentation to the European Commission. ETH European Grants Access office supports the project office in specific queries related to the execution of the project (H2020 queries, supply of supporting documents, preparation of the Consortium Agreement).

The **Management Board** (MB) is in charge of the operational management (decision process, risk assessment, information flows) of the RISE implementation and of ensuring the cohesion of the whole RISE community.

The **General Assembly** is composed of one representative of each beneficiary consortium member and will be the body ultimately responsible for the GA.

The **Project Office** (PO) is responsible for the operational and financial administration of RISE as well as for the provision of the required documentation to the European Commission. PO will assist the Coordinator in all his tasks, will organize and manage the meetings of the project and its boards.

The **Scientific Advisory and International Partner Board** (SAIPB) will oversee the project development progress, outreach and dissemination activities, the integration with EPOS and the overall impact of RISE.

The **Stakeholder Panel** (SP) will advise RISE on the needs and requirement of end-user communities and ensure an ongoing dialogue between RISE participants and stakeholders. Discussion with members of the stakeholder panel have started, but they will require a little more time. The final composition of the SP will be determined by month 6.

The following RISE Boards are nominated at the RISE kick-off Meeting (MS1 due M1).

MEMBERS OF THE GENERAL ASSEMBLY	
Name of Beneficiary	**Name of Representative Person**
1. ETH (RISE Coordinator)	Stefan Wiemer
2. ETH (RISE Manager & WP1 Leader)	Banu Mena Cabrera
3. ETH (WP8 Leader)	Michele Marti
4. GFZ (WP7 Leader)	Danijel Schorlommer
5. INGV	Lauro Chiaraluce
6. IMO	Kristin S. Vogfjord
7. UNIBO	Paolo Gasperini
8. UBRIS	Max Werner
9. UEDIN (WP2 Leader)	Ian Main
10. UNINA (WP3 Leader)	Warner Marzocchi
11. UNINA (WP4 Leader)	Iunio Iervolino
12. BIU	Shlomo Havlin
13. EUCENTRE (WP6 Leader)	Helen Crowley
14. EMSC (WP5 Leader)	Rémy Bossu
15. UGA	Laurent Stehly
16.UCAM	Alexandra Freeman
17. BOUN	Erdal Safak
18. KNMI	Reinoud Sleeman

19. UNIBG	Francesco Finazzi in us
20. UKRI	Margarita Segou
21.QSGmbh	Marius Isken

Table 4. Members of the General Assembly

MANAGEMENT BOARD	
Name of Beneficiary	**Name of Representative Person**
1. ETH (RISE Coordinator)	Stefan Wiemer
2. ETH (RISE Manager & WP1 Leader)	Banu Mena Cabrera
3. UEDIN (WP2 Leader)	Ian Main
4. UNINA (WP3 Leader)	Warner Marzocchi
5. UNINA (WP4 Leader)	Iunio Iervolino
6. EMSC (WP5 Leader)	Rémy Bossu
7. EUCENTRE (WP6 Leader)	Helen Crowley
8. GFZ (WP7 Leader)	Danijel Schorlommer
9. ETH (WP8 Leader)	Michele Marti

Table 5. Members of the Management Board

SCIENTIFIC ADVISORY AND INTERNATIONAL PARTNER BOARD (SAIPB)		
Name of Beneficiary	**Name of Representative Person**	**Position**
USGS	Ned Field	Research Geophysicist at USGS
Kyoto University	Enescu Bogdan	Professor of Seismology at the Division of Earth and Planetary Sciences, Kyoto University
Caltech	Egill Hauksson	Professor of Geophysics at Seismological Laboratory, Caltech
GNS	Matt Gerstenberger	Seismologist and Head of Earthquake Forecast Team at GNS
USC	Tom Jordan	Professor of Earth Sciences and former director of SCEC
University of Naples	Aldo Zollo	Professor of Seismology and Digital Signal Processing
UNAM	Ramon Zuniga	Professor of Geophysics with focus on Seismology
ERI, University of Tokyo	Naoshi Hirata	Professor of Geophysics focus on Observational Seismology

Table 6. Members of the SAIPB

1.4 Project Management Overview

The management of RISE is carried out by WP1. It aims at contributing to the smooth running of the project and ensuring that all the contractual, financial, and administrative project commitments are met. The RISE management includes the RISE Coordinator, RISE Project Office and the RISE Management Board. The tasks RISE Management will focus on are summarized below.

- Executing the project according to the provisions of the Grant Agreement and the Consortium Agreement
- Establishing and maintaining the interaction among the RISE parties
- Guaranteeing the functioning and communication of the governance boards: General Assembly, Management Board, Scientific Advisory and International Partner Board, Stakeholder Panel

- Establishing mechanisms to collect, review and submit deliverables and reports and to achieve a high quality in all RISE products.
- Liaising with the parties on contractual aspects (deliverables, reporting, reviews, finances)
- Liaising with the European Commission on contractual aspects (deliverables, reporting, reviews, finances)
- Monitoring the financial execution of the project (budget control, financial planning, financial eligibility)
- Ensuring the internal and external dissemination of the project in collaboration with WP8
- Monitoring the project risks and finding ways to mitigate them
- Coordinating with the EPOS team on aspects relevant to both projects
- Planning of actions that shall improve the quality of the project

WP1 – Management has the following deliverables and milestones over the course of the RISE project.

WP1 Deliverables:

- D1.1, D1.2, D1.3, D1.4: Project management plan updated [M3, M12, M24, M36]
- D1.5, D1.6, D1.7, D1.8, D1.9, D1.10: Minutes of Meeting of the RISE management board conducted [M6, M12, M18, M24, M30, M36]
- D1.11: Mid-term report of the Scientific Advisory Board [M20]
- D1.12: Final report of the Scientific Advisory Board [M36]
- D1.13: Strategic integration of RISE activities with EPOS-IP [M18]
- D1.14: Mid-term report, including impact assessment and updated risk register [M18]
- D1.15: Final reporting to the EU commission [M36]
- D1.16: Data Management Plan [M4]

WP1 Milestones:

- MS1: RISE Boards nominated (SP, SAB, MB, GA) [M1]
- MS2: Project internal communication established [M3]
- MS3: Kick-off meeting [M3]
- MS4: Midterm-conference [M18]
- MS5: Successful mid-term evaluation from Scientific Advisory Board [M20]
- MS6: Final conference [M36]
- MS7: Successful final evaluation from Scientific Advisory Board [M36]
- MS55: Implementation of periodic monitoring of Key Performance Indicators [M6]
- MS58: First new EPOS service operational [M24]

The milestones MS1, MS2 and MS3 have been completed, and addressed throughout this report.

1.5 Project Management Tools and Services

WP1 be using various tools and services for the collection of data and documents from RISE Parties, for the internal and external communication and for the general management of the project. These include but not limited to the project intranet, external website, email lists, internal and external newsletters as well as regular meetings at different management levels. WP1 will ensure the timely running of the project through confirming that the Milestones are met, and the deliverables and reports are submitted in time.

As part of the project's internal communication, we have set up the following tools and services in the first three months of the project (MS2 due M3):

1. RISE Intranet

Setting up a project Intranet is an important part of internal communication. RISE project intranet is recently launched (November 2019) to all RISE participants. The site will be hosted by ETH, using a platform called Alfresco. The site is accessible on https://alfresco.ethz.ch/share/page/site/rise/. A snapshot of the Intranet is shown in Figure 3. Access to the intranet is granted by the RISE Project Office at ETH, and all authorised members have the role of Collaborator. This role gives all participants of RISE the right to read, upload and download documents, add/remove/edit lists of events/tasks and contribute to discussions.

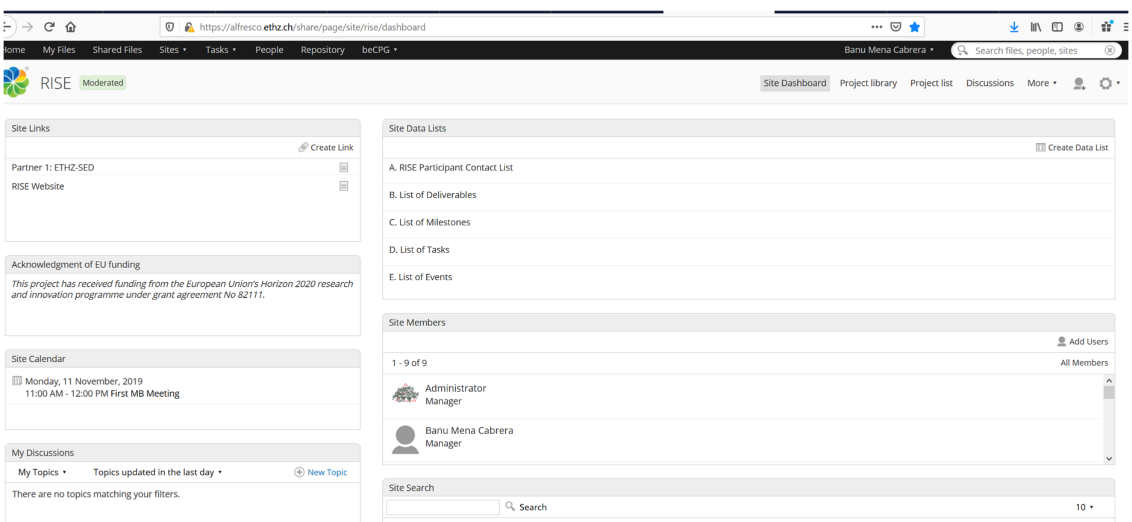

Figure 3. A snapshot of RISE intranet released on Alfresco Platform

The main purpose of the intranet is to provide a common space to share project documents, therefore it is the main document repository for RISE. All important project documents such as the Grant Agreement, the Consortium Agreement, Deliverables and Interim Reports, Meeting Presentations, Guidelines, Logos, Templates and more can be found on the Intranet. The project deliverables as well as interim reports to be submitted to the EC will be collected within this space. We aim to use the Intranet not only as a project repository, but also a space to support the timely implementation of the project by keeping all project information together under one site. Therefore, this platform will also be used to keep track of events, tasks, deadlines related to the RISE project. The important events will be recorded under "Calendar", and participants can follow the progress and deadline of the deliverables and milestones under the "Data Lists".

A guideline is distributed to all RISE community, to ease the use of the site. The Intranet is maintained by WP1.

2. RISE Website:

RISE website is launched in September 2019 by WP8. External website is used for sharing relevant project information, dissemination materials and linking to the internal website. The RISE website promotes visibility and transparency towards stakeholders. It contains a number of sections including news and events, project results, reports, publications, deliverables. The full content of the website is ready and accessible on www.rise-eu.org. The website is regularly updated by WP8. Below is a screenshot of RISE Website.

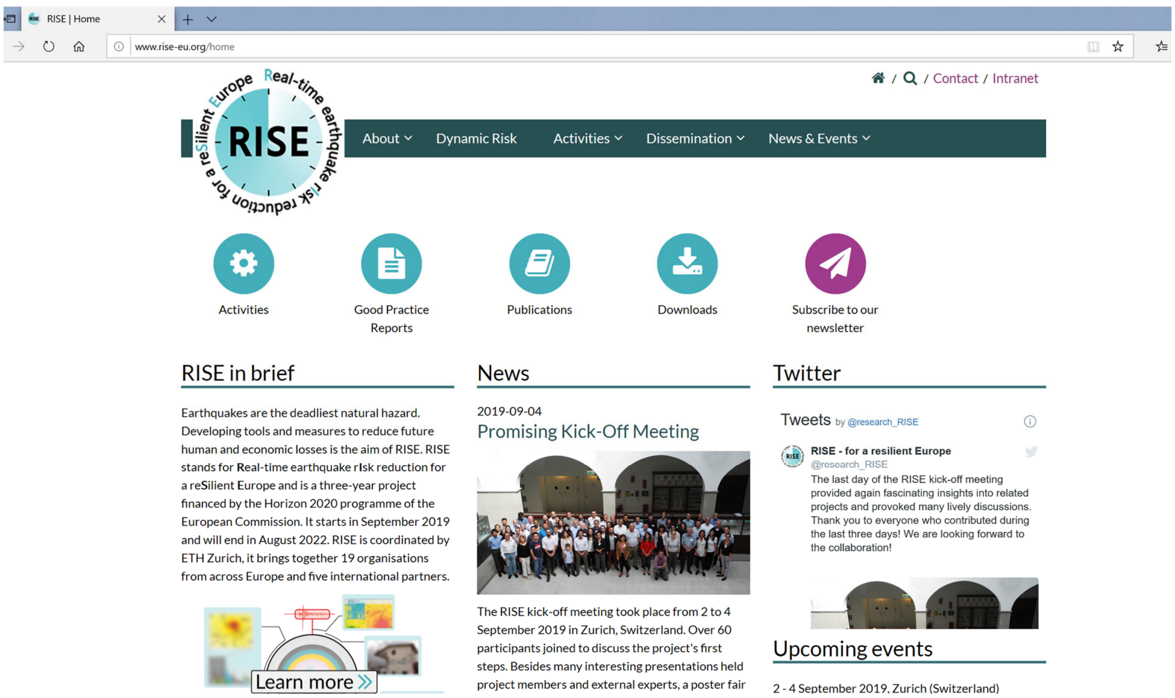

Figure 4. Screenshot of RISE Website

3. RISE Internal Newsletters

Internal newsletters targets project members and intend to strengthen RISE internal communication. A typical internal newsletter contains information related but not limited to:

- Organizational matters
- WP updates
- Past and Upcoming Meetings
- Miscellaneous project information
- Calendar

The first internal newsletter will be released in M3. Figure 5 shows a snapshot of the first RISE Internal Newsletter. An internal newsletter will be published every 4 months during the RISE project.

Figure 5. A snapshot from the first RISE Internal Newsletter.

4. RISE External Newsletters

RISE external newsletters target all interested stakeholders and aims at communicating project updates and progress. It will cover information on WPs, meetings, calendar and any miscellaneous topic that RISE community wants to share with the public. Each issue will cover a different topic of RISE research and will release information suitable for non-expert readers. An external newsletter will be published once a year during RISE project. RISE Newsletters are published by WP8.

5. E-mail distribution lists

Dedicated e-mail distribution lists are created for the whole consortium, each WP, Management Board, General Assembly, Legal Signatory Representatives, Financial Contacts and other specific sub-groups. Email lists are used to communicate relevant project information with the right group of people. All project deadlines are reminded in advance using email lists. Various information is shared using email lists (e.g. dates of project meetings).

6. RISE Project Meetings

WP1 organizes regular meetings at different levels as described in Task 1.6. We organize Project Meetings, Management Board Meetings and General Assembly Meetings. WP and cross-WP meetings are organized by the WP leaders, however WP1 will provide support where needed. Meeting dates are decided by the Project Office based on the feedback collected from all members of the respective meeting using the doodle services. Special effort is made to choose the most convenient location and time period for all RISE community.

First Project Meeting was the ***RISE kick-off meeting***, which took place in Zurich between 2-4 September 2019 (MS3 due M3). Figure 6 is a group photo taken during the Kick-off meeting. The details of this meeting such as the Agenda, the Meeting Minutes, the Meeting Presentations can be all found on the RISE Intranet (Documents/General Meetings/Kick-off).

Figure 6. Group Photo taken at the RISE Kick-off Meeting in Zurich

General Assembly had come together during the Kick-off and took a number of decisions. Minutes of this first General Assembly meeting are uploaded on the RISE Intranet. One of the decisions was to have the RISE general meetings annually. Currently we are planning the next RISE Annual Meeting, which will take place in Sep/Oct 2020.

Management Board meetings are established to control the progress of the work and updates of the project plan. MB meetings will happen every two months. First MB meeting was held in November 2019. The minutes of MB meetings will be submitted to the EC as deliverable reports (D1.5, D1.6, D1.7, D1.8, D1.9, D1.10). First MB Meeting Minutes can be found in RISE Intranet.

Stakeholder Board Meetings and meetings at sites with treatments in operation will be organised by WP1.

7. Management of Deliverables, Milestones and EC Reports

The procedure for the collection and approval of deliverables has been agreed already with the Management Board and presented to the RISE parties during the Kick-off Meeting. Since the deliverable dates are the actual deadlines for uploading the deliverables onto the EC portal, the WP leaders will be invited to upload their deliverables onto the intranet no later than two weeks before the deadline. As soon as received, the RISE Project Office will conduct a quick check of compliance, and forward the deliverable to a designated person in the Management Board, who will be asked to respond within one week on the suitability of the report to be submitted. Small amendments will be conducted if necessary before the final upload, unless the deliverable had to be delayed (in exceptional cases) if substantial deficiencies were found. Upon green light by the MB reviewer, the RISE Project Office will proceed with uploading the document onto the EC portal.

Concerning the management of EC reports (two reporting periods after month 18 and month 36), the approach will be similar to the one just described. In this case, the RISE Project Office will have two months after the reporting period has ended to upload all the relevant documents onto the EC portal. WP leaders (technical report) and financial contacts for each party (financial report) will upload their materials onto the intranet no later than one month after the end of the reporting period. After a rapid check by the RISE Project Office, technical reports will be sent to the MB reviewers listed above, who will be expected to respond in the following two weeks. The RISE Office will then have two weeks to assemble the technical reports and submit them to the EC, and four weeks to assemble the financial reports (as these are not sent to the MB for review).

A key instrument to monitor the timely progress and impact of RISE and the effectiveness of the planned workflow will be the project Milestones. Milestones will be regularly monitored by the Project Office. Although unlike the deliverables, milestones are not in the form of a report in most cases, they have various ways of verification. WP1 will ensure that the Milestones are met, and verified properly.

1.6 Financial Management

The financial management of the project will be conducted by the Coordinator and the Project Manager with the support of the RISE Project Office, as described in Task 1.1 of the GA. Moreover, the ETH Financial Department will be involved in specific tasks (such as release of pre-financing, interim and final payments to the parties requested by the RISE Project Office, reimbursement of expenses, certificate of financial statements for ETH, monthly reports of project expenditure, etc.). The ETH European Access Grants office will also be available for specific queries regarding the financial management of the project. A financial meeting with the parties involved at ETH has already taken place in November 2019.

The RISE Project Office will distribute to the parties a set of financial documents including:

i) templates for financial reporting in agreement with the H2020 form C for financial reporting,

ii) financial guidelines for cost eligibility and reporting of project costs,

iii) template for requesting budget modifications to the RISE Project Office.

1.7 Risk Monitoring

Monitoring of the project risks is under the responsibility of the Coordinator, the Project Manager and the Management Board, who will maintain the Risk Register and develop appropriate measures to mitigate identified risks. The first release of the Risk Register will be a WP1 deliverable (D1.2 due M12), concentrating on risks likely to occur and with substantial impact on time, cost or quality for the project.

A crucial step in risk management is the early and accurate identification of critical risks. The RISE risk management framework has been established at the start of the project, to ensure that the project maintains its schedule and targets. This process aims at identifying, analysing and prioritizing risks inherent in the project and then determining the appropriate actions to eliminate or mitigate their effects. The Management Board will:

- identify possible risks and measure their impact on the success of the project
- monitor the key performance indicators determined by WP8 in “Plan for exploitation and dissemination of results” (PEDR; D8.1 due M3) and issue alerts if performance is below expectations
- decide specific mitigation measures and assign internal responsibilities for their implementation
- maintain a Risk Register that lists all the identified risks, a current assessment of the threats they represent to the success of RISE, the entities responsible for taking appropriate action, the potential action, and its current status.

The likely critical risks are grouped into three categories: strategic, financial and technical risks. Table 7 lists the possible risks, and proposes possible risk mitigation measures.

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	Technical risk -- Project duration of 3 years too short Potential Impact -- Failure to deliver in time and quality	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	Mature communities and partners; the time available before grant initiation sufficient to secure all required resources; MB monitors timely delivery implementation status. Use CE principles.
2	Technical risk -- Dependencies too strong between WPs Potential Impact -- Delayed delivery in one WP hindering progress in other WPs	WP2, WP3, WP4, WP5, WP6, WP7, WP8	Frequent communication and exchange between WP; alternative models/sensors available, MB monitors timely delivery implementation status.
3	Financial risk -- Underestimation of required resources for scientific developments (medium) Potential Impact -- Scientific contributions fail to be integrated, tested or distributed	WP2, WP3, WP4, WP5	RISE design based on the experience of past successful projects of comparable class; monitor spending closely, increase in-kind contributions if needed.
4	Financial Risk -- Available resources spread too thinly, with too many WPs and beneficiaries (medium) Potential Impact -- Failure in maintaining the planned workflow and timeline	WP2, WP3, WP4, WP5, WP6, WP7	RISE design based on the experience of past successful projects of comparable class; monitor efficient and appropriate management, redistribute tasks between partners

5	Strategic risk -- Failure to integrate RISE services in EPOS (small) Potential Impact -- Long-term sustainability may not be achieved	WP8	RISE design done in close coordination with EPOS-IP, many individuals also have responsible roles in EPOS.
6	Strategic risk -- Disconnect between earthquake engineers & seismologist (small) Potential Impact -- Limited integration and reduced impact on risk reduction.	WP2, WP3, WP4, WP5	Each WP designed to be interdisciplinary. Use meetings for exchange and community building, rely on stakeholder panel to adopt end-user perspective.
7	Strategic risk -- Disconnect between natural scientists, social scientists and economists (small) Potential Impact -- Limited integration and reduced socio-economic impact	WP5, WP8	WPs designed to be interdisciplinary. Use meetings for exchange and community building, rely on stakeholder panel to adopt end-user perspective.
8	Strategic risk -- Failure to timely identify and mitigate risks (small) Potential Impact -- Potential risks are discovered too late to enable efficient recovery	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8	Benefit from experienced WP leaders; MB to regularly update the Risk Register; monitor mitigation measures.
9	Strategic risk -- Underestimate ethical or privacy related risks (small) Potential Impact -- Improper use of data and products, lack of acceptance.		Rigorous application of the Ethical standards and guidelines of Horizon2020; monitor by MB and SAB
10	Strategic risk -- Over- dependence on key individuals (medium) Potential Impact -- Lack of community building, poor involvement of partners	WP1, WP8	Adopt a management plan tailored to the complexity of the project and use MB, ExeCom to monitor overdependence.
11	Strategic risk -- Reduced visibility and impact (medium) Potential Impact -- Failure in maximizing the impact	WP8	Use and regularly monitor key performance indicators, alert MB if goals are not met.

Table 7. List of possible critical risks and corresponding risk mitigation measures

The first Risk Register will be discussed and formed in the second MB meeting scheduled on January 13, 2020. During the project execution, these risks as well as other identified risks during the execution will be updated in the Risk Register. The Risk Register will be regularly evaluated in each MB. The MB will have the possibility to add new risks to the register, and will propose mitigating actions for the identified ones.

2. Implementation Plan

Scope

The work-plan of RISE is composed of 8 Work Packages (WP), each coordinated by an experienced scientist (Figure 7). The WPs overall represent a work breakdown that is broadly structured in three blocks and progresses from Innovation (i.e., R&D, WPs 2–5) through Demonstration and Testing (WPs 6&7) to Dissemination and Operational Services (WP8). Tasks will be performed to a large extent in parallel, rather than in a sequential development, following the principles of Concurrent Engineering coordinated by WP1

Broadly, the scope of the Implementation Plan is to describe the tasks in greater detail than in the Grant Agreement, create a roadmap for short and longer term, divide the tasks into subtasks that will serve as next steps or to do list, and will help keep track on the people involved and Person Months (PMs) spent at each task. Every task has a task leader and commonly a number of individuals from different beneficiaries supporting the task. Task leaders are responsible for their own task and report primarily the work to the WP leader. This approach will be applied to each Work Package. This documents also aims at ensuring a good communication between tasks and WPs as there are many interfaces between WPs. Most importantly, the Implementation Plan will ensure that all tasks and activities are well planned and well-coordinated. The Implementation Plan organizes the scientific work to be carried out in Work Packages 2, 3, 4, 5, 6, 7, 8 and links the interconnected tasks, deliverables, milestones. As WP1 mainly deals with the project management and management principles are covered in Section 1 of this PMP, it is not included in the Implementation plan. The Implementation Plan will be updated annually (D1.2, D1.3, D1.4 due M12, M24 and M36 respectively), to reflect the progress made, therefore there will be room to adjust the changes we face throughout the project.

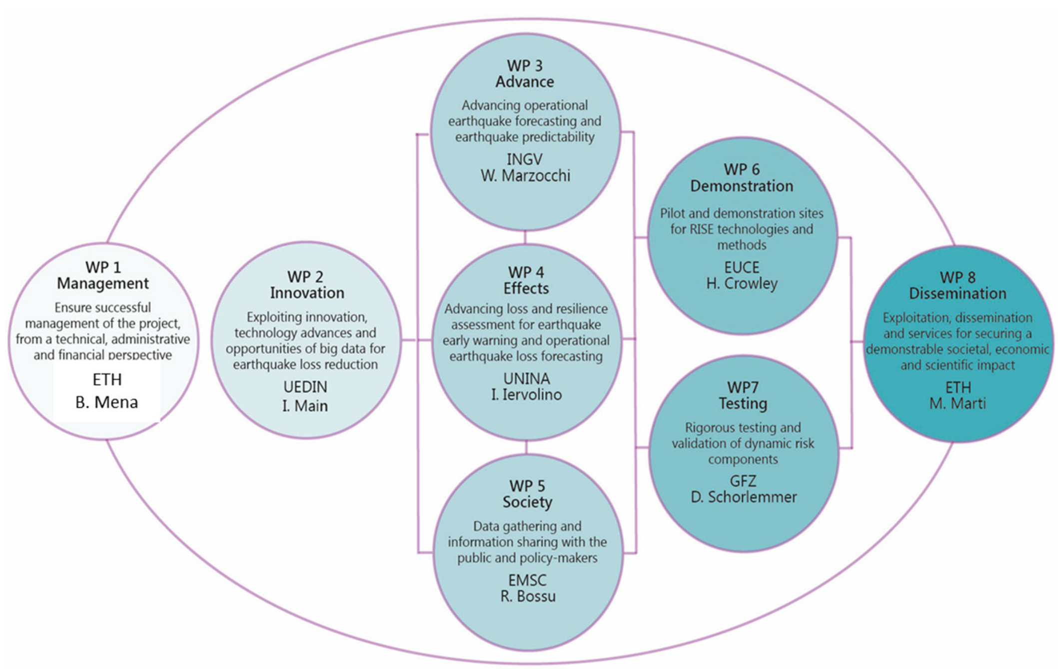

Figure 7. Schematic representation of the RISE Work Packages.

2.1 Work Package 2 – INNOVATION

"Exploiting innovation, technology advances and opportunities of big data for earthquake loss reduction"

Lead: UEDIN

Authors: Ian Main; Andreas Fichtner, Marius Isken, Erdal Safak, Lauro Chiaraluca, Laurent Stehly, Carlo Cauzzi, Danijel Schorlemmer

General Description of WP2

The overarching aim of this work package is to assess and exploit the opportunities for innovation, technology advances and big data to improve OEF, EEW and RLA. RISE has identified the most relevant of these opportunities, and proposes a set of integrated tasks to maximise the potential and impact of these new technologies and methods for earthquake risk reduction. We will address this by completing the seven separate tasks—with milestones and deliverables—as described below. The focus is on assessing, developing and testing the capability of the technologies listed to address the overarching goals of RISE. Many of these are under development, emerging, require prototyping or a feasibility study, or are more mature, but have not yet been applied in a realistic test case for OEF, EEW and RLA. There is much synergy between the technologies described in the different tasks. For example, we will develop the capability for active sources to determine building and site response to ground shaking together with the development or testing of novel sensor types. We will use improvements in computational techniques to develop new earthquake catalogues from conventional and denser seismic networks, based on analysing full waveform data, and, in turn, examine how these new catalogues may be used to improve OEF, EEW and RLA. We propose a mix of medium-to high risk with medium-to-high gain tasks. WP2 delivers input to all subsequent WPs, and is specifically linked to WP6 ('Pilot and Demonstration'), where we will thoroughly optimise and test these innovations, and to WP8 that focusses on exploitation and dissemination. We will also liaise with WP2 on how to implement these innovations in Operational Earthquake forecasting, and WP7 on how these might later be tested. To identify and operate breakthrough technologies, WP2 specifically relies on the input and guidance of our industrial partners in the consortium and the stakeholder panel, as well as on interaction with our international partners from outside of Europe.

Partner number and short name	PMs
ETH	24.00
GFZ	30.00
INGV	43.00
OGS	4.00
IMO	6.00
UNIBO	16.00
UEDIN	20.00
UNINA	5.00

EUCENTRE	4.00
UGA	14.00
IFSTTAR	3.00
CNRS	3.00
BOUN	18.00
KNMI	3.00
ST-I [To be replaced]	6.00
UKRI	2.00
QUAKE	20.00
Total	221.00

Table 8. Beneficiaries and Person Months per Beneficiary for WP2

Deliverable Number	Deliverable Title	Lead beneficiary	Type	Dissemination level	Due Date (in months)
D2.1	Large-scale DAS logistic feasibility study on new applications	ETH Zürich	Report	Public	18
D2.2	Deployment of prototype array	ETH Zürich	Demonstrator	Public	12
D2.3	Report on all DAS field deployments	ETH Zürich	Report	Public	36
D2.4	Field ready internal next generation sensors	QUAKE	Other	Public	15
D2.5	Functional next generation sensors and hyper-dense networks and sensor	QUAKE	Other	Public	36
D2.6	Specifications on portable excitation sources and structure selection	BOUN	Report	Public	6
D2.7	Results of excitation sources and recommendations	BOUN	Report	Public	30
D2.8	Progress of new generation catalogues for public dissemination	INGV	Report	Public	18
D2.9	Accuracy and precision of earthquake forecasts using the new generation catalogues for open dissemination	INGV	Report	Public	36
D2.10	Report on the temporal change the upper crust properties using ambient noise techniques	UGA	Report	Public	24
D2.11	Technical solutions on open, dynamic, high volume, cloud-based services	ORFEUS (GFZ, INGV, KNMI, ETHZ)	Report	Public	18
D2.12	Technical development of prototype big data solutions	ORFEUS (GFZ, INGV, KNMI, ETHZ)	Demonstrator	Public	36
D2.13	An open, dynamic, high- resolution dynamic exposure model for Europe	GFZ	Websites, patents filling, etc.	Public	36
D2.14	Assessment of the technology readiness and operational capability	KNMI	Report	Public	36

Table 9. List of Deliverables of WP2

Milestone number	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS8	Deployment of experimental arrays, effects of coupling, instrument characteristics and detectability of regional earthquakes	GFZ	12	Data streamed, quality controlled
MS9	Urban DAS array fully operational in a city	ETH	18	Data recorded, validated by WP leader
MS10	Hardware and software for indoor and outdoor sensor, first test deployment	QUAKE	15	Prototype running and validated by WP leader
MS11	Software for the back-end data centre system, further experiments	QUAKE	24	System operational, validated by WP leader
MS12	Completion of experiments, tuning, and testing	QUAKE	36	All data archived, check by WP leader
MS13	Acquisition of portable impact generator and eccentric mass shaker; improvements to the capacity of the vibroseis truck	BOUN	12	Prototype operational and tested, check by WP leader
MS14	Completing field tests on selected instrumented structures, using three excitation sources, collecting vibration records	BOUN	24	Test on buildings conducted and documented
MS15	Comparison of vibration data with those from earthquakes and ambient forces	BOUN	36	Analysis completed and documented
MS16	Database with the earthquake catalogue for internal dissemination	INGV	24	Database validated and online, check by WP leader
MS17	Screening for ambient noise anomalies in test regions	UGA	8	Analysis completed and validated by WP leader
MS18	Finalisation of the whitepaper and selection of the preferred technical solutions	ORFEUS (GFZ, INGV, KNMI, ETHZ)	18	Paper ready and checked by ExeCom
MS19	Prototype implementation of the preferred technical solutions at selected EIDA primary nodes and demonstration of possible uses within the EEW, OEF and RIA domains	ORFEUS (GFZ, INGV, ETHZ)	36	Prototype running and checked by WP leader
MS20	Automated proxy-based building classification for all buildings in Europe	UNINA	30	Software running and checked by WP leader
MS21	Integration of mini-sensor data from buildings into the GDE system	GFZ	36	System running, check by WP leader
MS37	Sensors set up and collecting data in buildings in Tokyo, Lourdes, Turkey and Valais	QUAKE, GFZ	12	Stations online, data streaming, check by WP lead

Table 10. List of Milestones of WP2

Management and Communication

This work Package requires a very well integrated collaboration both within each task and across the seven different tasks. Each of the Task leaders listed below will be responsible for their own task, including organising the collaborations between contributing partners for that task, and communicating overall progress to the WP leader. The overall WP leader will be part of the management board for the project, which will meet annually, and be responsible for organising interactions with the other Work Packages. The WP leader will be responsible for leading the writing of the 18-month report, and communicating progress to the RISE management board. Any issues of risk of not meeting the task deliverable dates listed below must be communicated in a timely way to the WP leader, including those that rely on earlier delivery from other tasks, or that might hold up a subsequent work packages progress.

A monthly Skype meeting of task leaders is planned, focussed on progress reports, timelines and deliverables, as well as to discuss more technical issues that can be solved with a group discussion. Any issues identified will be minuted, with a specific action plan to be followed up within and between tasks after the meeting.

We will also contribute to inter-Package workshops as planned by the management board. As an example, we have already planned a joint workshop with Tasks 3.3 and 2.7, so that those working on novel methods of OEF in WP2 can understand the issues involved in testing, and have input to design of new testing protocols to accommodate the new methods. This is necessary because the absence of such protocols is currently a barrier to testing the new methods to be developed. At this stage we have not identifies any critical issues other than the need to design new testing protocols mentioned above, and the need to keep on top of communication between Task leaders at the different levels outlined above. We do not underestimate this challenge - many tasks are of themselves complex, as is the overall project, and we will address this as described above.

WP Overview

The overarching aim of this work package is to assess and exploit the opportunities for innovation, technology advances, and big data to improve OEF, EEW and RLA. We will develop a set of integrated tasks to maximise the potential and impact of these new technologies and methods for earthquake risk reduction. We will address this by completing the seven separate tasks—with Task leaders, milestones, deliverables and timelines as described in the table below. The focus is on assessing, developing and testing the capability of the technologies listed in the proposal to address the over-arching goals of RISE. Many of these are under development, emerging, require prototyping or a feasibility study, or are more mature, but have not yet been applied in a realistic test case for OEF, EEW and RLA. There is much synergy between the technologies described in the different tasks. For example, we will develop the capability for active sources to determine building and site response to ground shaking together with the development or testing of novel sensor types. We will use improvements in computational techniques to develop new earthquake catalogues from conventional and denser seismic networks, based on analysing full waveform data, and, in turn, examine how these new catalogues may be used to improve OEF, EEW and RLA. WP2 delivers input to all subsequent WPs, and is specifically linked to WP6 ('Pilot and Demonstration'), where we will thoroughly optimise and test these innovations, and to WP8 that focusses on exploitation and dissemination. To identify and operate breakthrough technologies, WP2 specifically relies on the input and guidance of our industrial partners in the consortium, and the stakeholder panel, as well as on interaction with our international partners from outside of Europe.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Milestones
Task 2.1	Andreas Fichtner - ETH	1/9/19	31/8/22	D2.1.1, 2.1.2, 2.1, 2.8, 2.9
Task 2.2	Marius Isken - QUAKE	1/9/19	31/8/22	D2.2, 2.8, 2.9

Task 2.3	Erdal Safak - BOUN	1/9/19	31/8/22	D2.3.1, 2.3, 2.8, 2.9
Task 2.4	Lauro Chiaraluce - INGV	1/9/19	31/8/22	D2.4.1, 2.4.2, 2.1, 2.8, 2.9
Task 2.5	Laurent Stehly - UGA	1/9/19	31/8/22	D2.5, 2.8, 2.9
Task 2.6	Carlo Cauzzi - ETH	1/9/19	31/8/22	D2.6.1, 2.6.2, 2.8, 2.9
Task 2.7	Danijel Schorlemmer - GFZ	1/9/19	31/8/22	D2.7, 2.8, 2.9

Table 11. List of Tasks of WP2

2.1.1 Task 2.1 "Utility and value of high-density DAS"

Task Overview

Distributed Acoustic Sensing (DAS) is an emerging technology for the measurement of (seismically induced) strain in conventional fibre optic cables. The outstanding potential of DAS lies in its ability to co-use existing telecommunication cables, especially in densely-populated urban areas where conventional seismic station deployments are challenging.

The goal of this work package is to assess the utility of DAS for (1) high-resolution seismic tomography and site characterisation, (2) near-real-time earthquake source inversion and earthquake early warning, and (3) structural health monitoring, especially of tall buildings equipped with dense cable networks. Ultimately, this work package is intended to serve as preparation for large-scale DAS experiments in urban areas that are exposed to significant seismic hazard.
During the first 12 months we will perform pilot studies with the DAS system. In a controlled underground environment, we will specifically study the effective instrument response of the cable-DAS system as a function of coupling. For this, we plan to perform active experiments but also to record ambient noise and earthquakes.

During the subsequent 12 months we will install the system in a Swiss city, most likely Bern. The research focus will be on the identification and analysis of the recorded signals and on their usefulness for very local (few metres scale) seismic tomography. Depending on the estimated instrument response, we will try to estimate site effects. All results will be summarised in a final report. The table below shows the breakdown of Task 2.1 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
DAS Pilot Experiment	Fully operate an experimental DAS array composed of several kilometres of cables installed under widely variable conditions (trenched and well-coupled, loosely coupled in a conduit for telecommunication cables, strongly to loosely coupled in a building).	Krystyna Smolinski, ETH Zurich, 6 PM
DAS Instrument Response Studies	Using the experimental array, finalise studies on the effects of coupling, instrument characteristics, and detectability of regional earthquakes.	Krystyna Smolinski, ETH Zurich, 6 PM
Urban DAS Experiment	Urban DAS array operational in a city that remains to be chosen.	Krystyna Smolinski, ETH Zurich, 6 PM

DAS for Urban-Scale Seismic Hazard, Final Report	Final assessment of the logistic feasibility of a large-scale DAS array covering a major urban area. Final assessment of the utility of DAS measurements to achieve the above-mentioned goals: (1) high-resolution seismic tomography and site characterisation, (2) near-real-time earthquake source inversion and earthquake early warning, and (3) structural health monitoring.	Krystyna Smolinski, ETH Zurich, 6 PM

Table 12. Breakdown of Task 2.1

2.1.2 Task 2.2 "Next generation sensors and hyper-dense networks"

Task Overview

The objective of this task is to develop low-cost seismic sensors for indoor and outdoor use. The QUAKE team and the ETH team will develop independent equipment.

QUAKE: The first 6 months will be spent investigating and evaluating the usefulness of different seismic sensory systems (MEMS and coil). Subsequently, a versatile, modular sensor platform will be developed and tested. The system will be suited for indoor and outdoor deployment.
Within the task, we will collaborate and exchange experience by means of Skype calls and use of online team collaboration platform, to ensure the best outcome. If necessary, physical visits to partners will be undertaken.
The sensory systems will be field-tested at locations in Turkey, Japan and Switzerland to monitor the shaking of buildings and ground shaking at outdoor locations. Here we plan tight cooperation with T2.3 and the use of a controlled excitation source to benchmark and validate the implemented automatic data processing routines.
In the long term, data acquired by the sensors will deliver crucial information for SHM such as inter-story drift, spectral intensities and top story displacement data. A large number of smart low-cost sensors will be deployed in urban areas to contribute to Global Dynamic Exposure (GDE) models and rapid loss assessment models. Further we strive to cooperate with T2.4 to implement seismic signal processing techniques on the sensor platform.

ETH: The first 6 months are dedicated to selecting components for the complete monitoring station, and building the prototype. It will be verified if close coordination with QUAKE hardware is possible. The field deployment in the Valais will focus on the region around Sion, and will be coordinated with instrumentation of the structures in Task 6.1. All tools developed in Task 2.4 will be tested using the data collected in the field deployment.
The WP leader will be informed about the progress at M6 and M12. We will revise and update the work plan at M12 and M24

The table below shows the breakdown of Task 2.2 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 1	Evaluation of state-of-the-art MEMS accelerometer, to identify suited systems for low-cost sensors (LCS).	Marius Paul Isken, QUAKE, Engineer: 2 PM Marius Kriegerowski, QUAKE, Engineer: 2 PM
Subtask 2	Design of an LCS embedded hardware system for indoor and outdoor use.	Marius Paul Isken, QUAKE, Engineer: 1 PM Marius Kriegerowski, QUAKE, Engineer: 1 PM External Contractor, Electrical Engineer: 6 PM
Subtask 3	Implementation of the LCS on-device software for analysis and data transmission.	Marius Paul Isken, QUAKE, Engineer: 2 PM Marius Kriegerowski, QUAKE, Engineer: 2 PM
Subtask 4	Implementation of the LCS backend software and infrastructure for data accumulation.	Marius Paul Isken, QUAKE, Engineer: 2 PM Marius Kriegerowski, QUAKE, Engineer: 2 PM
Subtask 5	Testing of LCS at designated testing sites, and with controlled excitation sources.	Marius Paul Isken, QUAKE, Engineer: 1 PM Marius Kriegerowski, QUAKE, Engineer: 1 PM Erdal Safak, BOUN
Subtask 6	Development of low-latency, low-cost autonomous seismic stations	Lukas Heiniger ETH, Seismologist: PM 6
Subtask 7	Field testing stations in Valles, Switzerland	John Clinton, ETH, Seismologist: PM 6
Subtask 8	Preparation of task report	Marius Paul Isken, QUAKE, Engineer: 1 PM

Table 13. Breakdown of Task 2.2

2.1.3 Task 2.3 “Innovative portable excitation sources for field testing of existing and densely instrumented structures”

Task Overview

The objective in this task is to develop portable excitations sources that can generate vibrations in structures with amplitudes larger than those of ambient vibrations. Towards this objective, an impulse generator will be designed and manufactured. The existing mobile seismic shaker (a vibroseis truck) will be upgraded to perform soil-structure interaction tests. The equipment will be used to excite multi-story buildings, and the results will be compared to those from ambient vibrations and earthquakes. At the end of the Task, a report will be prepared to summarize the specifications on portable excitation sources, the structures selected for the tests, test results, and the recommendations on utilization of test equipment.

The table below shows the breakdown of Task 2.3 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 1	Specifications and design of portable excitation sources	Erdal Safak, BOUN: 3PM Ahmet Korkmaz, BOUN: 1PM
Subtask 2	Manufacturing of test equipment	Outside contractor: 3.0PM
Subtask 3	Selection and testing of structures using the test equipment.	Erdal Safak, BOUN: 3PM Eser Cakti, BOUN: 1PM Ahmet Korkmaz, BOUN: 1PM A Ph.D. student: 1PM

Subtask4	Analysis of test data, and comparison of results with those from ambient vibrations and earthquakes.	Erdal Safak, BOUN: 2PM A Ph.D. student: 2PM
Subtask5	Preparation of task report	Erdal Safak, BOUN: 1PM

Table 14. Breakdown of Task 2.3

2.1.4 Task 2.4 "Advancing observational capabilities"

Task Overview

Post-processing existing data to improve the baseline for OEF and predictability research:

INGV effort - We will generate higher-resolution and more consistent earthquake catalogues for the Italian peninsula (CSEP testing region, for the period 1981–today, INGV).
We will relocate all events using the Double Differences (DD) location algorithm, starting from the existing catalogues of absolute hypocentres (named CLASS1.0; Chiaraluce p.c.) obtained by non-linear inversion locations algorithm (NLL) and using a 3-dimensional velocity model for both P- and S-waves (Di Stefano p.c.).

We will use absolute travel times for relocating the seismic events occurred in the 1981-2005-time window while we will add relative arrival times measurements for the 2005-2018 one. The refinement will be performed by cross correlating the seismic events recorded at the same stations. While making these measurements we will also measure the S-waves maximum amplitude on the two horizontal components in order to determine (a consistent set of) data for computing local magnitudes (M_L).

Hypocentral data will be integrated with available focal mechanisms drawn from online moment-tensor catalogues and from the literature. This procedure will eliminate the majority of issues and biases commonly associated with inconsistencies related to hypocentre locations, resolution and magnitude due to changes in the number of available stations, network geometry, magnitude-calculation procedures, earthquake-location techniques, seismic-sensor types and so on. The homogenized catalogue will serve as an input for OEF model development and testing.

ETH effort: An automatic open-source software embedded within SeisComP3 will be tested and released, which will be used to relocate the entire Swiss catalogue as well as the Hengill area in Iceland.

Template matching:

INGV and INGV LTP (OGS) effort: Using a subset of the improved catalogue, we will perform network-wide cross-correlation analyses using a matched filter algorithm to the continuous waveform archives.

Our test region is the central Italian area and specifically we will focus on the seismicity occurred soon after the L'Aquila 2009 (1st of January 2010) and right before the 2016 seismic sequences (23rd of August 2016). The improved catalogue, expected to contain at least one order of magnitude of events more, will be used to both investigate the Central Italy 2016 seismic sequence preparatory phase and the impact of the availability of the improved catalogue on OEF analysis (in collaboration with WP3).

ETH / Caltech effort: Matched filter correlation approach developed at Caltech will be tested and compared to traditional template matching techniques already used on the catalogue. Application to targeted and well-studied swarms within Switzerland and the Hengill area in Iceland.

Machine learning:

ETH / Caltech effort: Machine learning approaches have been developed at Caltech applied to generate their entire catalogue, including stages in phase detection and identification; event association; event type allocation; and first motion identification. We will adopt and adapt where needed these approaches to the Swiss and Hengill, Iceland datasets, in particular looking at distinguishing between tectonic, geothermal and volcanic seismic sources.

UEDIN and BGS will test if the resulting higher-resolution earthquake catalogues produced with steps 1–3 can improve the information gain of OEF models developed in (T3.2, T3.3), specifically the physics-based forecasts and the INLA models for OEF. Our aim remains the same as that in the proposal, i.e. we will test if the resulting higher-resolution earthquake catalogues produced with steps 1–3 can improve the information gain of OEF models (T3.2, T3.3) and operationalise the advances for use in a real-time network, as input for dynamic risk services (T8.5).

Activities months 12 – 36:
When High-resolution catalogues are available, we will test the new OEF models from Task 3.3 on the new data set, leading to deliverable 2.4.2 at 36 months.

Hardening EEW capabilities in Switzerland and Iceland:

ETH effort: We will harden the open-source EEW suite we develop and distribute within SeisComP3. We will extend the existing user display tool EEWD to be more user-friendly. We build new features in our EEW suite that can consume OEF information and contribute to site-specific EEW alerts using building information or SHM observations.

The table below shows the breakdown of Task 2.4 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 1	(a) High-resolution earthquake catalogues generation for three RISE test regions: (a) the Italian peninsula (CSEP testing region, for the period 1981–today, INGV), Switzerland (1975–today, ETH) and Iceland (2000–today, IMO). (b) Homogenization of the hypocentre locations and magnitude. (c) Hypocentral data will be integrated with available focal mechanisms.	Lauro Chiaraluce, INGV, Coordination (3PM) Maddalena Michele, INGV, Earthquakes relocation (20PM) Raffaele Di Stefano, INGV, Velocity models (7PM) Diana Latorre, INGV, Catalogue extension (6PM) Barbara Castello, INGV, Magnitude calculation (5PM) Tobias Diehl, ETH, Earthquake relocation (5pm)
Subtask 2	Using catalogues from Task 2.4.1, network-wide cross-correlation analyses to the continuous waveform archives (template matching) will be performed to enhance the number of events. **Area 1** - Central Italy before the 2016 seismic sequence onset and after the 2009 L'Aquila, to investigate the 2016 preparatory phase and the impact of the availability of the improved catalogue on OEF analysis. **Area 2** – Mine specific swarm and aftershock sequences in the Swiss national catalogue.	Lauro Chiaraluce, INGV, Coordination (2PM) Alessandro Vuan, OGS, Template matching analysis (2PM) Monica Sugan, OGS, Template matching analysis and Earthquakes relocation (2PM) Francesco Grigoli, ETH, template matching (5pm) Men-Andrin Meier, Caltech, template matching (5pm)
Subtask 3	Adopt and refine machine learning tools from Southern California for phase detection and identification, association, first motion identification, event type assignment. Apply to Swiss and Icelandic datasets	Francesco Grigoli, ETH, template matching (5pm) Men-Andrin Meier, Caltech, template matching (5pm)
Subtask 4	Test the capability of high-resolution catalogues to improve operational earthquake forecasts (a) using INLA and (b) physics-based forecasts	Ian Main, UEDIN, Seismologist (3.6M) Margarita Segou, BGS, Seismologist (0.5PM) Mark Naylor, UEDIN, Seismologist (0.9PM) Francesco Serafini, UEDIN, PhD Student (6PM) Junhao Cheng, UEDIN, PhD Student (6PM)
Subtask 5	Hardening EEW capabilities in Switzerland and Iceland -develop EEW tools that 1) includes OEF as input; 2) allow seamless integration of cheap sensors and 3) explore how to incorporate information from SHM or building specific information into alerts. Also focus on hardening base software within SC3 and develop EEWD for end-users.	John Clinton, ETH, management (2pm) Post-Doc, ETH, research and development (12pm) Iceland?

Table 15. Breakdown of Task 2.4

2.1.5 Task 2.5 "Explore the use of ambient noise correlations to systematically monitor the temporal evolution of active faults"

Task Overview

The aim of this task is to 1) look for precursory signal before large magnitude Earthquake that occurred in central Italia (L'Aquila, Amatrice, Norcia…) and 2) to explore systematically different areas in Europe. To that end we will use both noise cross-correlations and auto-correlations to monitor the temporal evolution of the medium.

During the Master of Estelle Delouche, we used seismic noise autocorrelations in Central Italia to monitor the temporal evolution of the upper crust. We observed fluctuation in the measurements that could correspond to precursory signals. In the upcoming three years we would like to 1) refine these measurements and assess their robustness 2) work on their interpretation and 3) to automate their interpretation using Machine Learning algorithm.

Task Work Plan - short term (1-12 months):

During the Master of Estelle Delouche, we used seismic noise autocorrelations in Central Italia to monitor the temporal evolution of the upper crust. We observed fluctuation in the measurements that could correspond to precursory signals. In the upcoming three years we would like to 1) refine these measurements and assess their robustness 2) work on their interpretation and 3) to automate their interpretation using Machine Learning algorithm.

During the first 12 months of the PhD of Estelle Delouche (at ISTerre), our main goal will be to look for the best method to detect precursory signals before large magnitude Earthquake that occurred in Central Italia using seismic noise auto-correlations at a single station. To that end, we will refine the method used during the Master of Estelle Delouche to detect precursory signals by testing the influence of several parameters such as the way the noise records are pre-processed, the choice of the frequency band, the way the measurements are performed on the auto-correlations, …

Task Work Plan - long term (12-36 months):

During the second year of the PhD of Estelle Delouche, we will focus on the physical interpretation of the temporal change that are visible on seismic noise auto-correlations. This will be done in close collaboration with Anne Obermann (ETHZ).

In particular, we would like to have a robust way to evaluate if our measurements are sensitive to a change in the source of noise, change of the attenuation/velocity of the crust. We will in particular 1) compare our result with more traditional dv/v measurements, 2) evaluate the sensitivity of our measurements with respect to the attenuation of the medium and 3) to transient signal that may be buried in the noise records. Moreover, we would like to analyse the result.

Finally, we will attempt, using either supervised or unsupervised machine learning algorithm to classify automatically measurements done during pre-seismic, post-seismic phase and at rest. This will be helpful to check the feasibility to look for precursory signals to earthquake in near real-time.

Moreover, a postdoc will be recruited specifically to explore different dataset in Europe. Potential target includes Greece, Turkey, Piton de la Fournaise Volcano.

The table below shows the breakdown of Task 2.5 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Refining the measurements performed on seismic noise autocorrelation to look for precursory signals to large earthquake at a single station	Estelle Delouche, Isterrre, PhD: 6PM Laurent Stehly, ISTerre, Res.: 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM
subtask 2	Mapping the change in the upper crust in Central Italia using seismic noise autocorrelations	Estelle Delouche, Isterrre, PhD : 6PM Laurent Stehly, ISTerre, Res. : 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM
subtask 3	Interpreting our observation : comparison with dv/v measurements	Estelle Delouche, Isterrre, PhD : 6PM Anne Obermann : 1.5 Laurent Stehly, ISTerre, Res. : 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM
subtask4	Interpreting our observation : evaluate the sensitivity of our measurements with respect to attenuation and to transient sources	Estelle Delouche, Isterrre, PhD : 6PM Anne Obermann : 1.5 PM Laurent Stehly, ISTerre, Res. : 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM
subtask5	Using ML algorithm to discriminate automatically between measurements done during pre-seismic, posts-seismic phase and at rest.	Estelle Delouche, Isterrre, PhD : 12 PM Laurent Stehly, ISTerre, Res. : 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM
subtask6	Looking for precursory signals in different area in Europe.	Postdoc, Isterrre : 12 PM Laurent Stehly, ISTerre, Res. : 0.6 PM Christophe Voisin, ISTerre, Res : 0.6 PM Anne Obermann, ETHZ, Res : 0.6M

Table 16. Breakdown of Task 2.5

2.1.6 Task 2.6 “Strategies for scalability, high-volume data access and archival beyond existing waveform services, exploiting cloud-based services”

Task Overview

Within the first 12 months we will start the preparation of the M18 report (D 2.11): we will focus on the following issues to be addressed:

- Metadata (KNMI, GFZ, all)
- Data formats (KNMI, all)
- Data processing engines (INGV, all)
- Cloud Services (all)

We will profit from and extend the previous works carried out within SERA and ESC-hub. We plan Skype calls for coordination every two months and we will inform the WP leader about the progress at M6 and M12. We are preparing a shared google doc (evolving into the deliverable due at M18) and drive (for documents, references etc.).

Between month 12 and month 36 we will finalise D2.11 and prepare D2.12. We will revise / update or work plan at M12 and M24. We would appreciate to have access to the data of a DAS experiment from ETHZ or GFZ to test the functionality of the prototype implementation associated with D.12. We aim at a close cooperation with Task 8.2, coordinated by STM.

The table below shows the breakdown of Task 2.6 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Preparation of deliverable D2.11	Alberto Michelini & co-workers at INGV (2 PMs) Javier Quinteros & co-workers at GFZ (3 PMs) Carlo Cauzzi, John Clinton & co-workers at ETHZ (2 PMs) Reinoud Sleeman & co-workers at ODC/KNMI (3 PMs) STM experts
subtask 2	Preparation of deliverable D2.12	Alberto Michelini & co-workers at INGV (2 PMs) Javier Quinteros & co-workers at GFZ (3 PMs) Carlo Cauzzi, John Clinton & co-workers at ETHZ (2 PMs)

Table 17. Breakdown of Task 2.6

2.1.7 Task 2.7 “Develop an open, dynamic and high-resolution exposure model for EEW, OEF and RLA based on crowdsourced big data”

Task Overview

In Task 2.7 we will develop a high-resolution (building-level), dynamic, and open exposure model for Europe. This model will mainly be based on data from OpenStreetMap which we will interpret using engineer-developed mapping schemes to derive probabilistic estimates of vulnerability classes, numbers of people in buildings, and the replacement values of buildings. We will use the exposure model of SERA and local expertise combined to enrich the OpenStreetMap dataset or fill the gaps in building data where they exist in the open datasets.

The work on Task 2.7 is split into technical work and scientific/engineering work. The technical work includes the setup of the server infrastructure for this massive processing of data. Likewise, the basic system as already developed to process OpenStreetMap data in near real-time needs to be installed and made operational. Within the H2020 project LEXIS, we will develop a rule database system for fully algorithmic applications of mapping scheme rules including a full probabilistic description of all values of interest. In RISE, we will include this database system into the RISE workflow. Due to the partial lack of building data in some areas, we will implement a completeness assessment tool for visual inspection of areas of interest. This work will be done in collaboration with the Heigit centre at the University of Heidelberg and shall result in a smartphone application for crowd-sourcing such tasks to the wider OpenStreetMap community. Finally, we will implement data extraction tools of the full exposure model for simple access to the exposure data.

The scientific work is first focusing on three case studies to implement the procedure for filling up the gaps in building coverage in OpenStreetMap. The first case study focuses on San Francisco (US) where sufficient building data is available to develop a full model. The second case study on the city of Cologne (Germany) will provide experience in complementing building information for a dataset that contains all building footprints but no further details. The last case study on Attica (Greece) will help us to implement the approach to fill gaps in building data with aggregated models while simultaneously using building data where it is available, resulting in a mixed-resolution exposure model. The major step in Task 2.7 is the selection and application of engineer-developed mapping schemes and their translation into fully probabilistic assessment of all exposure indicators for every building in Europe. This selection and implementation process will be done country- or region-wise to account for all local/regional/national peculiarities.

The table below shows the breakdown of Task 2.7 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Set up of the server infrastructure for processing OpenStreetMap building data and further open data sources.	Thomas Beutin (6PM), Karsten Prehn (4PM), Cecilia Nievas (1PM), Danijel Schorlemmer (0.5PM) (GFZ)
subtask 2	Creating full exposure models for test cases in San Francisco (US), Cologne (Germany), and Attica (Greece).	Cecilia Nievas (1PM), Karsten Prehn (2PM), Danijel Schorlemmer (0.5PM) (GFZ)
subtask 3	Development of the processing unit for vulnerability classification	Marius Kriegerowski (11PM), Karsten Prehn (1PM), Thomas Beutin (0.5PM), Cecilia Nievas (1PM), Danijel Schorlemmer (2PM) (GFZ)
subtask4	Development of the completeness assessment service including a smartphone application for crowdsourcing these tasks.	Karsten Prehn (2PM), Marius Kriegerowski (1PM), Danijel Schorlemmer (0.5PM), Thomas Beutin (0.5PM) (GFZ)
subtask5	Implementing engineer-provided mapping schemes for fully probabilistic estimates of all exposure indicators for each building.	Cecilia Nievas (9PM), Danijel Schorlemmer (2.5PM), Karsten Prehn (3PM) (GFZ) Helen Crowley (2PM) (EUCE)

Table 18. Breakdown of Task 2.7

2.2 Work Package 3: ADVANCE

"Advancing operational earthquake forecasting and earthquake predictability"

Lead: UNINA

Authors: Warner Marzocchi, Christophe Voisin, Paolo Gasperini, Antonio Rinaldi, Domenico Giardini

General Description of the WP 3

Advancing Operational Earthquake Forecasting as a key element of dynamic risk assessment is achieved through a range of coordinated activities. Using community accepted retrospective and fully prospective testing as tools for performance evaluation (-->WP7), WP3 will have a measurable impact on advancing the state-of-the-art and state of practical OEF implementation in Europe and worldwide. Focus areas are:

- Improving process understanding: By conducting targeted experiments, we will contribute to advancing high-quality earthquake predictability research. This includes a multi-parameter search for precursory signals and operationalising ambient noise time-series analysis.
- Transfer knowledge from other disciplines to OEF, such as rock-deformation labs, underground labs, induced seismic sequences, and adopt novel statistical methods from ecology that combines geological, tectonic and seismic data for developing innovative spatio-temporal triggering models, with full quantification of uncertainty in a Bayesian framework (T7.1).
- Develop next generation of physics-based earthquake forecasting models and techniques (T7.2); this includes models mostly based on continuum mechanics and on statistical physics (e.g., network theory) which may benefit from the availability of high-quality seismic data (T2.4).
- Develop next generation of stochastic and hybrid earthquake forecasting models (T7.2); improve description of space- time variability in the frequency-magnitude distribution and earthquake clustering properties, exploiting advances in observational capabilities.
- Develop workflows to formally integrate expert-based OEF assessments into dynamic risk assessment.

Partner number and short name	PM
ETH	24.00
GFZ	22.00
INGV	8.00
IMO	8.00
UNIBO	18.00
UNIVBRIS	22.00

UEDIN	30.00
UNINA	26.00
BIU	44.00
UGA	15.00
CNRS	3.00
BOUN	2.00
UKRI	2.00
Total	224.00

Table 19. Beneficiaries and Person Months per Beneficiary for WP3

Deliverable Number	**Deliverable Title**	**Lead beneficiary**	**Type**	**Dissemination level**	**Due Date (in months)**
D3.1	New perspectives in OEF models through the analysis of candidate precursors	UGA	Report	Public	24
D3.2	Exploring the limits of earthquake predictability	UNIBO	Report	Public	30
D3.3	A new generation of OEF models	UNINA	Report	Public	24
D3.4	Scalability of new OEF techniques from the field to the laboratory to Bedretto URL	ETH	Report	Public	20
D3.5	Guideless for experts' judgments in OEF	ETH	Report	Public	18

Table 20. List of Deliverables of WP3

Milestone number	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS16	Database with the earthquake catalogue for internal dissemination	INGV	24	Database validated and online, check by WP leader
MS17	Screening for ambient noise anomalies in test regions	UGA	8	Analysis completed and validated by WP leader
MS23	Scheme of OEF model to include anomalies	UNINA	12	Workflow defined and check by ExeCom
MS24	Defining testing experiments	GFZ	12	Test defined and checked by ExeCom
MS25	Prototype of OEF model "experts'-based"	ETH	24	Prototype operational and check by WP L
MS26	OEF codes for testing in WP6 & 7	UNINA	24	Codes transferred to WP6/7, check by WP L
MS38	Second round of CSEP test of Italy running	GFZ	28	Test running, check ExeCom
MS46	Data object and format definition for exchange between modules	GFZ	9	Concept ready check WP lead

Table 21. List of Milestones of WP3

Overall management and communication

Task interaction will be mostly organized and discussed among task leaders through email and/or teleconference. These teleconference will be made every 3 months. The first one is planned on Nov. 15. The interaction among the partners will be made mostly through teleconference and during large RISE meetings. The WP leader plans also some direct contact with specific partners to be updated about the work.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Mile-stones*
Task 3.1	Christophe Voisin - UGA	1/9/19	1/9/21	D3.1
Task 3.2	Paolo Gasperini - UNIBO	1/9/19	1/3/22	D3.2, MS23
Task 3.3	Warner Marzocchi - UNINA	1/9/19	1/9/21	D3.3, MS24, MS26, MS38, MS46
Task 3.4	Antonio Rinaldi - ETH	1/9/19	1/5/21	D3.4
Task 3.5	Domenico Giardini - ETH	1/9/19	1/9/21	D3.5, MS25

Table 22. List of Tasks of WP3

2.2.1 Task 3.1 “Exploring seismic and non-seismic precursory signals”

Task Overview

Activities in the next 12 months

Subtask 1: The first twelve months of WP3.1 will be devoted to a complete literature survey on the topics of earthquake precursors. A special emphasis will be paid on the use of Radon measurements as a possible precursor in various contexts. The L’Aquila earthquake will serve as a case study.

In parallel, WP2 will provide systematic measurements of the evolution of the crust through continuous seismic noise. We will investigate the existence of precursors to past earthquakes that occurred in Europe (primary target: Italy).

Activities months 12 – 36

Subtask 2: The second year will concentrate on the use of the Italian database of Radon measurements.

Subtask 3: The third year will focus on the assessment of the new measurements issued from continuous seismic noise measurements as possible precursors to earthquakes.

The table below shows the breakdown of Task 3.1 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Literature survey	Christophe Voisin (UGA)
subtask 2	Radon database analysis	Antonio Piersanti (INGV)
subtask 3	Seismic noise and precursors	Christophe Voisin (UGA), Estelle Delouche (UGA), Laurent Stehly (UGA)

Table 23. Breakdown of Task 3.1

2.2.2 Task 3.2 "Enhancing earthquake predictability"

Task Overview

This task will dissect the limits of earthquake predictability. Hypotheses investigated here are not yet ready to be implements as a forecasting model, but have the potential to push the limits of earthquake predictability.

In subtask1 precursory spatiotemporal seismicity patterns before (and maybe after) strong earthquakes will be searched, using the homogenized and higher resolution catalogue already available for Italy and Southern California and subsequently the new ones developed in Task 2.4 for other EU regions. In the recent literature, the b-value of the Gutenberg- Richter (GR) frequency-magnitude distribution was hypothesized to be a proxy of differential stress (DS, the difference between minimum and maximum stress eigenvalues) within the Earth's crust. In particular low b-values seems to be associated with high levels of DS and vice versa high b-values with low DS. Thus, observations of low b-values might indicate the phase of preparation of an impending strong earthquakes while high b-values a quiet period. This hypothesis can be investigated by analysing the time evolution of b-value computed using seismic catalogues with homogeneously determined magnitude. At present only the catalogues of Italy since 1995 and of Southern California since 1981 appears to comply such requirement. Other parameters that will be studied are the a-value (productivity) of the GR and the parameters of various models of seismic sequence time-decay (e.g. p and c of the Omori law) based on likelihood analysis.

The codes will be developed by the participants themselves mainly in Matlab but also other languages (e.g. Fortran and Python) will be used for back compatibility. In the first year the analysis will be limited to Italy and Southern California and will successively be extended to other areas as soon the new catalogues for such areas will be made available by Task 2.4.

In subtask2, the reliability of the magnitude-independence assumption, i.e., the earthquake magnitudes of future earthquakes are independent and identically distributed (usually, according to a truncated Gutenberg-Richter law) will be tested. Recent empirical analyses by the INGV group have shown possible departures from this assumption, but the probability gain associated with such departures has yet to be quantified. Moreover, we will build a space-time dependent frequency- magnitude distribution, rooted in basic physical principles and complying with empirical observations.

In subtask3, systematic empirical studies to search for additional explanatory variables in the triggering properties of earthquakes will be conducted. Obvious candidates include (i) surface heat flow, (ii) geodetic strain-rate, (iii) thickness of the seismogenic zone, (iv) lithology (inferred rigidity, rheology if available), (v) plate tectonic setting, (vi) inferred regional stress field, (vii) triggering susceptibility, (viii) time since last major earthquake (on well-characterised faults), and some variables that can be measured during a seismic sequence such as (i) source focal mechanism, (ii) aseismic after slip moment, (iii) stress drop, and (iv) Shake Map footprint. Specifically,

we will search for dependencies between these variables and various clustering properties including (i) size/timing/location of largest triggered event, (ii) triggering productivity, (iii) foreshock statistics, (iv) swarm-like behaviour. The research will benefit from advances in observational capabilities (T2.4) and exploit computational statistics to uncover hidden relationships.
The table below shows the breakdown of Task 3.2 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Search for precursory spatiotemporal seismicity patterns before and after strong earthquakes	Paolo Gasperini, UNIBO, subtask leader and researcher (PM to be spent 3 per year) Laura Gulia, UNIBO, post doc (PM to be spent 11 per year) Emanuele Biondini, PhD student (PM to be spent 11) Barbara Lolli, INGV (BO), Researcher (PM to be spent 2 per year)
subtask 2	Analysis the reliability of the magnitude-independence assumption	Warner Marzocchi (UNINA) (8 PM) Angela Stallone (INGV) (2 PM) 1 post doc (UNINA) (4 PM)
subtask 3	Search for additional explanatory variables in the triggering properties of earthquakes	Sebastian Hainzl (GFZ) (12 PM) Maximilian Werner (UNIBRIS) (10 PM)

Table 24. Breakdown of Task 3.2

2.2.3 Task 3.3 “A new generation of OEF models”

Task Overview

OEF is still in a nascent stage. The most reliable OEF models are based on a mathematical description of one feature, earthquake clustering. The aim of this WP is to explore novel approaches to improve OEF capabilities, i.e., to move forward from a simple description of the earthquake clustering process. This task benefits from the results of the other tasks, because foe example, any increase in the earthquake predictability will potentially lead to better OEF capabilities. The OEF models developed in this WP will be built independently, because we want to take advantage of the description of the earthquake generation process from different independent perspectives. It will be a goal of WP7 to combine all these forecasts in one ensemble.

The link with WP7 cannot be overemphasized. Any model produced in WP3 has to be tested according to the CSEP procedures. This is the only guarantee to test scientific hypotheses and to improve earthquake forecasting.

The subtasks listed in the table describe the main activities in this WP.

- *Importance of high-quality data in improving OEF*: here we explore what is the benefit from a PEF perspective to have seismic quality of much better resolution. In fact, new methods to analyse seismic signals allowed significant improvement in the earthquake location and detection.

- *OEF model based on the time memory in the catalogue*: a new approach to analyse the time memory of the seismic catalogue shows that the time memory is longer than what expected by a classical ETAS model. Here the challenge is how to implement this knowledge in a OEF model to test how much it may increase OEF performance.

- *OEF model based on network theory*: Network theory is an advanced physical method to study space-time correlation between events. While this procedure was successfully applied in many fields, here we want to explore how this procedure may be successfully applied to earthquake forecasting.

- *A novel Bayesian OEF model*: here we explore how a novel Bayesian approach developed for ecological systems may be applied to OEF purposes.

- *Next-generation ETAS:* ETAS models are the most reliable OEF models. However, they have a simple structure that, for instance, do not take into account the spatial variability of the parameters. Here we aim at building a more sophisticated ETAS model, which is more flexible to take into account possible spatial variabilities of the clustering process.

- *Simple ETAS*: ETAS models are very difficult to parametrize in particular for areas with a small number of earthquakes. Here we aim at building a simpler ETAS, which preserves the capability to describe satisfactorily earthquake clustering, but that can be applied anywhere, even at European scale. The price to pay for such a flexibility is a weaker forecasting skill, but maintaining the accuracy.

In the first year of activity we aim at
- building the theoretical structure for each OEF model reported in the table.
- Interacting with WP7 to define the format of the OEF models to be tested with real data.

The second year of activity will be entirely devoted to prepare the algorithm that can be then tested in WP7.

The table below shows the breakdown of Task 3.3 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
subtask 1	Importance of high-quality data in improving OEF	G. Falcone (INGV; 4 PM), M. Segou (BGS), 1 post-doc BGS, Warner Marzocchi (UNINA), 1 post doc (UNINA; 1PM)
subtask 2	OEF model based on the time memory in the catalogue	Shlomo Havlin (BIU; 11PM), Yosef Askhenazy (BIU; 11PM), Warner Marzocchi (UNINA; 1PM), Giuseppe Falcone (INGV; 1PM)
subtask 3	OEF model based on network theory	Shlomo Havlin (BIU; 11 PM), Yosef Askhenazy (BIU; 11 PM), Warner Marzocchi (UNINA; 1 PM), Giuseppe Falcone (INGV; 1 PM)
subtask 4	Develop a new OEF model class rooted in INLABRU, a novel Bayesian statistical approach	Mark Naylor, UEDIN, Seismologist (1.8PM) Finn Lindgren, UEDIN, Statistician (1.4PM) Kirsty Bayliss Post-Doctoral Researcher (10PM) Francesco Serafini, PhD Student (24PM)

		Ian Main, UEDIN, Seismologist (1.8PM)
subtask 5	Next-generation ETAS	S. Nandan (ETH), S. Wiemer (ETH)
subtask 6	Simple ETAS	Warner Marzocchi (UNINA; 7PM), 1-postdoc (UNINA; 5PM), Giuseppe Falcone (INGV; 1 PM)

Table 25. Breakdown of Task 3.3

2.2.4 Task 3.4 "Knowledge transfer from and to other scales"

Task Overview

OEF is typically operating at regional to national scales. However, cross-fertilization between OEF and thriving induced seismicity research, from different spatial scales, will enrich OEF forecasting models by adding physical constraints. Of special interest are the scales of centimetres (rock deformation labs), the scale of decameters (undergrounds labs such as the Bedretto lab in Switzerland) and GeoEnergy reservoir scale. Induced seismicity in this context offers important opportunities to understand earthquake physics under somewhat more controlled and repeatable conditions. In GeoEnergy contexts, but also in earthquake swarms, it is known that fluid-propagation and deformation-induced poro-elastic effects play an important role in triggering seismicity. Likewise, static-stress triggering plays a significant role in induced earthquake sequences, contributing, for example, up to 40% of overall seismicity in the Basel reservoir. Task 3.4 accounts for two subtasks to exploit the knowledge and opportunities offered by other scales by:

1 extending modelling approaches developed and calibrated by ETH for induced seismicity analysis to natural sequences
2 testing next generation OEF forecast models developed in T3.3/3.4 at the rock-laboratory scale, exploiting a new triaxial press at ETH (LabQuake-X) as well as the decameter Bedretto underground experiment.

Activities in the next 12 months:
In the first year, activities will focus on subtask 1, adapting models developed for induced seismicity at the scale of large natural earthquakes. We will develop and test a stochastic modelling approach based on poroelastic green functions and a hybrid 'seed' model (GreenPoroSeed). Starting from a similar model developed for induced seismicity (e.g. Gishig & Wiemer, 2013; Rinaldi & Nespoli, 2017), the new approach will take advantage of Green Function's method to calculate the poroelastic stress changes in a stratified medium due to dislocation. Once the stress changes are computed, these will be passed to a stochastic seismicity simulator to assess possible reactivation. The 'seeds' are hypothetical hypocenter distributed in space that can get reactivated if the conditions of stress are satisfied. By employing a poroelastic model, the new approach will account for pore pressure generated by stress variation (e.g. large earthquakes).

The stochastic seed model in the current version accounts for earthquake-earthquake interaction, but can also be improved by adding a temporal component to the stress evolution (e.g. rate-and-state models – Cattania et al., 2018). Further improvement will feature a dependency of the *b*-value on the state of stress (Petruccelli et al., 2019).

The new approach will help testing if a combination of physical and stochastic models can provide useful insights for better prediction. We will test such coupled hydro-mechanical model to natural sequences. The first application will be the 2012 Emilia Romagna sequence, for which Coulomb stress calculation in a poroelastic medium has well explained the distribution of aftershocks (Nespoli et al., 2018). The poroelastic seed model will be also test against the sequence in Apennines (e.g. Amatrice-Norcia), where very often the effects of over pressurized fluid has been fundamental (Miller et al., 2004). If successful, the model will be further developed for testing against other models in task T3.3 and in task T7.2. This subtask will be carried out by A. Petruccelli in collaboration with A. Rinaldi.

Activities months 12 – 36:
The models developed in task T3.3 and T3.4 (subtask 1) will be tested in the framework of induced seismicity and at small scale (laboratory or underground facilities) to shed light on the forecasting of seismicity. This will constitute a fundamental step for the scalability and adaptability of the tested models. This subtask will be carried out mostly by P. Selvadurai, in collaboration with A. Petruccelli and A. Rinaldi.

The table below shows the breakdown of Task 3.4 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Adaptability of models from induced seismicity to natural seismicity	A.P. Rinaldi, ETHZ, Senior Researcher, (2 PM) A. Petruccelli, ETHZ, Postdoc, (6 PM)
subtask 2	Scalability of OEF models to lab and rock-lab	P. Selvadurai, ETHZ, Postdoc (6 PM)

Table 26. Breakdown of Task 3.4

2.2.5 Task 3.5 “Incorporating expert judgment in earthquake forecasting for risk assessment purposes”

Task Overview

Not all knowledge on future earthquake occurrence can be fitted into numerical models, and especially not in near real-time. Especially during times of a seismic crises, expert assessment that incorporates a wider range of observations and a-priori knowledge may be a highly valuable and needed input. Expert knowledge can also be used to interpret and communicate the output of probabilistic earthquake forecast models to the media, the public and decisions makers. In New Zealand, RISE participant GNS science has successfully used three scenarios, each with an expert assigned likelihood, to communicate during an ongoing sequence. The Italian Grande Risk Commission, the USGS, as well as the Swiss Seismological Service, uses written statements that describe possible scenarios. However, there is a lack of established best-practise on how to integrate, in a transparent and reproducible way, expert judgement into OEF. Task 3.5 will:

- define procedures and guidelines to build representative hazard scenarios for the evolution of seismic activity, accounting for the geological context of the region, seismicity migration patterns, geodetic information, historical events etc. The definition of the scenarios will be rooted in experts' judgment, whereas the probability of these scenarios will be coupled with OEF outcomes.
- explore structured elicitation sessions as well as Bayesian Networks to forecast the evolution of the seismicity over a time window of one or more months. These sessions will consider well-known limitations of the experts' judgment, such as confirmation biases, expert overconfidence, and anchor bias.

This work heavily leverages on the experience of our international partners from Japan (ERI, KYU), the USA (USC, USGS), New Zealand (GNS) and Mexico (UNAM). Forecasts based on experts' judgment will be carefully compared (through the procedures developed in WP7) with the forecasts of physics and/or stochastic models to quantify whether and how experts' judgment may increase forecasting capabilities. Our aim is to develop a global consensus and good practise on how to integrate experts' judgment into OEF.

Activities in the next 12 months: To initiate the work, we will conduct a survey of established procedures for risk communication and expert elicitation, drawing first of all on the expertise of the partners in RISE but also from selected partners beyond. This will establish in a summary report the state of the art in the domain. We will also look beyond seismology into existing procedures in other domains (other natural hazards). This work will take about 12 months.

Activities months 12 – 36:
In a second steps, we will then conduct a high-level workshop on the subject with selected invited international experts. This workshop could be attached to the next RISE annual meeting. Based on the outcome of the workshop, we will compile a 'good practise' report that will lead to a publication and deliverable 3.5

	Short Description of Subtasks	**Persons and intuitions involved**
subtask 1	Survey of existing procedures	Lead: ETH (3 PM, person not yet known) , small input from all partners
subtask 2	Workshop of international experts	Open to all experts from RISE plus selected international experts and representatives from Civil protection (at months 12-14, coupled to RISE annual meeting.
Subtask 3	Good practise recommendation (paper and report) (D3.5)	Lead ETH (Giardini)

Table 26. Breakdown of Task 3.5

References:

- Cattania et al., 2018. *The forecasting skill of Coulomb-based seismicity forecasting models during the 2010-2012 Canterbury, New Zealand, earthquake sequence*, Seism. Res. Lett., 89 (4): 1238-1250

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2.3 Work Package 4: EFFECTS

"Advancing loss and resilience assessment for earthquake early warning and operational earthquake loss forecasting"

Lead: UNINA
Authors: Iunio Iervolino, Helen Crowley, Eugenio Chioccarelli, Bozidar Stojadinovic, Eleni Chatzi, Erdal Safak, Banu Mena Cabrera

General Description of the WP4

This WP addresses risk and resilience analysis for EEW, as well as for short- and long-term risk management during and after seismic sequences. In particular, this WP will combine, in a rigorous probabilistic framework, the models developed in its tasks and/or in other WPs, for seismic risk and resilience management, considering a multi-hazard context. The key objectives of this WP are:

- develop a 2nd generation real-time seismic structural assessment and RLA tools for Europe;
- improve and operationalize earthquake loss forecasting for Europe (e.g., Italy, Turkey and Switzerland) and structure-specific early warning, eventually including time-variant hazard and fragility, accounting for accumulating damage; develop time-varying vulnerability methods applied to buildings during long-term and short-term sequence of earthquakes;
- develop near real-time recovery forecasting, rebuilding management and resilience assessment for infrastructures. Machine learning will be used to construct robust diagnostics able to trigger alarms and remedial actions;
- advance technologies for data-driven SHM and damage detection in structural systems in the context of EEW and OELF during seismic sequences;
- develop a user-ready risk-cost-benefit analysis framework for quantifying socio-economic costs, implementation of which will allow for rational decision making at local, regional and national level.

Partner number and short name	PM
ETH	36.00
GFZ	6.00
INGV	2.00
UNINA	50.00
BIU	8.00
EUCENTRE	38.00
EMSC	18.00
UGA	15.00
BOUN	18.00
KNMI	3.00

Total	194.00

Table 27. Beneficiaries and Person Months per Beneficiary for WP4

Deliverable Number	Deliverable Title	Lead beneficiary	Type	Dissemination level	Due Date (in months)
D4.1	Second generation of models for RLA service demonstration for Europe	EUCENTRE	Demonstrator	Public	30
D4.2	Second generation of models for RLA service report for Europe	EUCENTRE	Report	Public	30
D4.3	Operational earthquake loss forecasting for Europe	UNINA	Report	Public	33
D4.4	Development of RRE forecasting services in Open Quake	ETH	Demonstrator	Public	24
D4.5	The use of structural health monitoring for rapid loss assessment	ETH	Websites, patents filling, etc.	Public	30
D4.6	Advances in performance-based earthquake early warning in Europe	BIU	Report	Public	33
D4.7	Good-practise report on risk-cost-benefit in terms of socio-economic impact	ETH	Report	Public	32

Table 28. List of Deliverables of WP4

Milestone-number	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS20	Automated proxy-based building classification for all buildings in Europe	UNINA	30	Software running and checked by WP leader
MS27	RLA service for Europe transferred to WP6	EUCENTRE	24	Service operational in WP6
MS28	OELF service for Europe transferred to WP6	UNINA	24	Service operational in WP6,
MS29	Risk-cost benefit framework applied to test site Switzerland	ETH	24	Report check by ExeCom
MS32	Real time data exchange between EMSC and Bergamo	EMSC	4	Data exchange operational, check ExeCom
MS33	Implementation of the AIDR platform for landslides and fire detection	EMSC	6	Platform running, check WP lead
MS44	Operational versions for OEF, RLA and crowdsourcing based EEW capabilities at European level installed	EUCENTRE	24	Services online, Check ExeCom and SAB
MS57	First version of standardised exchange protocol released	ETH	18	Protocol released, check ExeCom

Table 29. List of Milestones of WP4

Overall management and communication

Different occasions for the interaction between tasks of WP4 are foreseen. In particular, at least two in person meetings and six teleconferences per year are planned. The first meeting is the plenary RISE kick-off meeting of course, which is held once a year. It is a meeting point which, among the other things, allows persons involved in the different WPs to observe the overall activities and advancements of the WP4. Second, for all those who are engaged with WP4, at least one additional in person meeting is scheduled. In this occasion, each task will present developed models, results and all that concerns the fixed goals. In order to guarantee a good cooperation between tasks, task leaders are required to attend a teleconference (e.g., Skype meetings) once a month or at least once every two months. In this occasion, the presence of key people involved in WP3 (operational earthquake forecasting) and WP6 (pilot and demonstration sites for RISE technologies) is also particularly important. In fact, the communication between WP4 and WP3 and WP4 and WP6 is fundamental. This is because, among the other things, WP3 is demanded to provide the input data for the probabilistically time-variant losses assessment at different scales (both time and spatial), which is one of the main activities of WP4, while in WP6 a number of applications are considered to demonstrate how the results of WP4 can be used for seismic risk mitigation services.

Task summary				
	Lead Institution and Task Leader	Start Date (month)	End Date (month)	Linked Deliverables (D)and Milestones (M)
Task 4.1	Helen Crowley – EUCENTRE	1	30	D4.1, M4.1
Task 4.2	Eugenio Chioccarelli – UNINA	1	33	D4.2, M4.2
Task 4.3	Bozidar Stojadinovic – ETH	1	24	D4.3, M4.3
Task 4.4	Eleni Chatzi – ETH	1	30	D4.4
Task 4.5	Erdal Safak – BOUN	1	33	D4.5
Task 4.6	Mena Cabrera Banu – ETH	1	33	D4.6

Table 30. List of Tasks of WP4

2.3.1 Task 4.1 "Exposure and Vulnerability for OELF and RLA and 2nd generation RLA service for Europe"

Task Overview

Task 4.1 will cover both static and dynamic exposure and vulnerability models, as well as the setting up of RLA and OELF services for Europe.

Subtask 4.1.1. Exposure models describe the spatial distribution across Europe of the residential, commercial and industrial building count, population, and replacement cost, characterized in terms of building classes. Task 4.1 will consider both static and dynamic exposure models, the former building upon the European models being developed in SERA, the latter being those developed in Task 2.7. Subtask 4.1.1 will focus on the testing of the existing static models by EUCE within a European Rapid Loss assessment service (developed both in this task and in Task 6.5) as well as within Operational Earthquake Loss forecasting (Task 4.2, Task 6.2). This activity will mainly be carried out by EUCE.

Subtask 4.1.2. The static European vulnerability models being developed in SERA will be further expanded to cover probability of injuries, homeless, debris etc. and a service will be designed and developed (after month 12) to make them available for both European RLA and OELF. This activity will mainly be carried out by EUCE.

Subtask 4.1.3. There are a number of different ways in which exposure and vulnerability models can be 'dynamic'. The exposure model might be automatically updated at regular intervals (such as with data from OpenStreetMap) or it might be updated with data following an earthquake (e.g. reported damage), or data from sensors (e.g. on period elongation). Likewise, vulnerability models can be dynamic as they can account for the time-evolution of the residual structural capacity during a seismic sequence. We feel that there is a need to standardise the definition of dynamic exposure and vulnerability models, and the various ways they can be used within 'dynamic risk assessment'. We thus propose to draft a white paper on 'Dynamic exposure and vulnerability modelling'. EUCE will propose an outline to then be extended/reviewed/revised by the following partners: UNINA, ETH, GFZ, QUAKE, SACERTIS. A first version of this white paper will be produced by month 12.

Subtask 4.1.4 The high-resolution building exposure model being developed in Task 2.7 will be incorporated to the RLA and OELF services being prepared herein, as a natural extension of subtask 4.1.1. The focus will be set on ensuring compatibility between the attributes of the dynamic exposure model and the RLA and OELF services. For example, the dynamic exposure model will yield probability distributions of exposure parameters such as structural typology, numbers of storeys, number of people in each building, etc., and the tools and software that conform the RLA and OELF services need to be able to operate using a model with such features. Meetings between EUCE and GFZ will be undertaken during the first 12 months. While a complete European exposure model developed using this data might not be finalised by the end of the project, a functioning prototype will be produced to demonstrate the workflow and capabilities of such a model.

Subtask 4.1.5 The three pillars of EPOS (ORFEUS, EMSC and EFEHR – represented in RISE though ETH, KNMI, INGV and EUCE) plan to work together to develop a European ShakeMap Service. Whilst there is a political dimension to publicly providing such a service, the focus within the RISE project will be to produce a platform for research and testing, maintaining and building upon the prototype that is currently available here: http://shakemap-eu.ethz.ch/. The main technical activities that are needed to achieve such a goal include upgrading to ShakeMap 4.0 (ETH), the integration of felt reports from EMSC (which is being carried out in collaboration with USGS, using a similar approach to Did You Feel It?), the triggering of the service following events reported by EMSC (to be undertaken in collaboration with ETH), the use of European ground motion models and the regional site amplification model (ETH). Other potential issues of research include the testing of how felt reports can be used to rapidly determine finite ruptures using the FinDer software (EMSC in collaboration with ETH) and how the 'doughnut effect' (i.e. lack of crowdsourced information as providing a proxy for damaging shaking level) can be used to map areas of intensity > 7.

Subtask 4.1.6 This task will link subtask 4.1.5 (European ShakeMap service) with subtasks 4.1.1 and 4.1.2 (European exposure and vulnerability services), and the OpenQuake-engine to develop a Rapid Loss Assessment service that will be tested in Task 6.5. These activities will be mainly undertaken by EUCE.

Subtask 4.1.7 This task will link WP3 (Operational Earthquake Forecasting) with subtasks 4.1.1 and 4.1.2 (European exposure and vulnerability services), and the OpenQuake-engine to develop an Operational Earthquake Loss Forecasting (OELF) service that will be tested in Task 6.5. This activity will be mainly undertaken by EUCE and UNINA.

The table below shows the breakdown of Task 4.1 into subtasks.

Subtask	Short description of subtask	Persons and institutes involved
4.1.1	Preparation of service to provide European exposure models (at uniform resolution, following testing of various resolutions) for RLA and OELF	Helen Crowley, EUCENTRE, (1PM) Jamal Dabbeek, EUCENTRE (4PM)
4.1.2	Further development of vulnerability models and service to make them available to RLA and OELF	Helen Crowley, EUCENTRE, (1PM) Francesco Cavalieri, EUCENTRE (6PM)
4.1.3	White paper on dynamic exposure and vulnerability models	Helen Crowley, EUCENTRE, (0.5PM) Jamal Dabbeek, EUCENTRE (0.5PM) Francesco Cavalieri, EUCENTRE (0.5PM) Danijel Schorlemmer, GFZ (0.5PM) Cecilia Nievas, GFZ (0.5PM) Georgios Baltzopoulos, UNINA (0.5PM) Eugenio Chioccarelli, UNINA (0.5PM) Iunio Iervolino, UNINA (0.5PM) Bozidar Stojadinovic ETH (0.5PM)
4.1.4	Integration of the dynamic exposure model of Task 2.7 into the services developed in 4.1.1.	Helen Crowley, EUCENTRE, (2PM) Jamal Dabbeek, EUCENTRE (4PM) Danijel Schorlemmer, GFZ (1PM) Cecilia Nievas, GFZ (4PM)
4.1.5	Expand the technical features of a European ShakeMap service: upgrade to ShakeMap 4.0, felt reports from EMSC, triggering by EMSC services, European ground motion and site amplification	Carlo Cauzzi, ORFEUS-ETH Alberto Michelini, ORFEUS Rémy Bossu, EMSC Sylvain Julien-Laferrière, EMSC Phillip Kästli, ETH Reinoud Sleeman, KNMI Helen Crowley, EUCENTRE, (0.5PM)
4.1.6	Link up the European ShakeMap service with the services for exposure and vulnerability as well as the OpenQuake-engine	Helen Crowley, EUCENTRE, (1PM) Francesco Cavalieri, EUCENTRE (2PM)
4.1.7	Link the Operational Earthquake Forecasting services from WP3 with the services for exposure and vulnerability as well as the OpenQuake-engine	Helen Crowley, EUCENTRE, (1PM) Francesco Cavalieri, EUCENTRE (2PM) Iunio Iervolino, UNINA (3PM) Eugenio Chioccarelli, UNINA (3PM) Pasquale Cito, UNINA (3.5PM)

Table 31. Breakdown of Task 4.1

2.3.2 Task 4.2 "Improve and operationalize earthquake loss forecasting (OELF)"

Task Overview

Task 4.2 extends WP3 by using OEF as input to compute probabilistically time-dependent losses at different time and spatial scales and different probability levels. The Task is divided in four subtasks described in the following.

For subtask 4.2.1, contributions from those partners that have experiences about vulnerability and exposure models of Italy, Turkey and Switzerland are expected. Subtask 4.2.2 will profit of the interaction with Task 4.1 while, as pertaining to subtask 4.2.4, the activities are strongly subordinated to the interaction with Task 4.1 and 4.4.

Subtask 4.2.1. One of the aims of the Task 4.2 is to operationalize OELF in Italy, Turkey and Switzerland, turning them into robust and sustainable services for rational decision making (--> WP8). Thus, a preliminary screening of available data of vulnerability and exposure for each county is required. Then the homogeneity, the scale and the format of data has to be discussed in order to allow the operational implementation of OELF.

Subtask 4.2.2. The analytical formulation of OELF was developed in 2015 accounting for the models of vulnerability and exposure that were available for Italy. Thanks to the completed and ongoing research projects in the field of large scale risk assessment and rapid loss assessment in both the European and Italian context, it is possible that the quality and the type of data related to large scale exposure and vulnerability have been improved in the last years. Thus, it has to be verified if new data can be directly implemented in the analytical formulations and in the numerical algorithms already developed for OELF. Otherwise, procedures should be modified to account for the most recent models of vulnerability and exposure. To give an example, the vulnerability models implemented in the current version of OELF are the so-called damage probability matrices (DPMs) that are based on the national census end empirically calibrated for Italy analysing the observed damages after strong earthquakes. This approach allows to implicitly account for all the variabilities of the Italian building portfolio but, on the other hand, does not allow to control the effect of each source of uncertainties on the final result. Moreover, it is usually impossible to distinguish the damages due to the mainshock from those produced by the following aftershocks. Finally, DPMs cannot be used if the damage accumulation has to be considered (subtask 4.2.3). An alternative approach is the computation of building class fragility functions in which the effect of each source of uncertainties can be easily quantified. Input values to use DPMs and fragility functions are different thus modifying the type of vulnerability model in OELF requires some modifications to the general framework.

Subtask 4.2.3. The current OELF is a time-dependent loss assessment because hazard is a time-dependent model. However, it has two main limitations: (1) the structural vulnerability models are not able to account for damage accumulation and (2) the exposure is assumed to be constant. To overcome these limitations, we will study, as part of OELF, a method to represent the damage evolution. This work will be done drawing inspiration from the developed single-structure reliability models accounting for damage accumulation due to subsequent seismic shocks. Thus, evolutionary vulnerability models will be developed for building classes. Similarly, the possibility of introducing time-dependent exposure will be investigated. The whole subtask 4.2.3 will be developed during the three years of the project.

Subtask 4.2.4. This subtask will study the possibility and the alternatives to integrate real-time structural health monitoring output with the OELF system. More specifically, it will be studied if it is possible to convert the information from structural monitoring in input parameters for updating the vulnerability models. This is, in fact, not straightforward and is one of the current research frontiers. Strategies to integrate OELF and RLA information will also be discussed.
Activities months 12 – 36

While subtask 4.2.1 should be mostly completed in the first year of the project, all of the other subtasks will be developed during the whole three years of the project.

The table below shows the breakdown of Task 4.2 into subtasks.

Subtask	Short description of subtask	Persons and institutes involved
4.2.1	Collecting and analysing available data of vulnerability and exposure for Italy, Turkey and Switzerland	Helen Crowley, EUCENTRE (XPM) Adriana Pacifico, UNINA (3PM) Eugenio Chioccarelli, UNINA (1PM) Participant from ETH (X PM)
4.2.2	Improving OELF framework in accordance with the available data	Eugenio Chioccarelli, UNINA (1PM) Iunio Iervolino, UNINA (1PM) Pasquale Cito, UNINA (3PM)
4.2.3	Developing state-dependent vulnerability model	Eugenio Chioccarelli, UNINA (5PM) Iunio Iervolino, UNINA (6PM) Georgios Baltzopoulos, UNINA (4PM)
4.2.4	Integrating RLA and SHM to OELF	Participant from UGA (x PM) Participant from Eucentre (x PM) Georgios Baltzopoulos, UNINA (1PM)

Table 32. Breakdown of Task 4.2

2.3.3 Task 4.3 "Develop near real-time recovery forecasting for infrastructures"

Task Overview

The total losses caused by an earthquake and its aftershock sequence include not only the direct losses to the built environment and the civil infrastructure systems, but also the indirect losses caused by the disruptions in the higher-level functions of the impacted community over time, losses in services provided by the infrastructure systems over time, and, importantly, the cost of the Recovery and Rebuilding Effort during the post-earthquake recovery period. The goal of Task 4.3 is to develop, validate and verify a model to compute the costs of RRE in near real-time and thus enable RRE forecasting. As opposed to real-time earthquake early warning, near-real-time RRE implies that the preliminary estimates are available within a few hours after the event, and that they are updated as new information is obtained and new events occur (e.g. aftershocks) during the recovery process. The RRE model is built using the OpenQuake engine and is intended to be a part of the European operational forecasting and early warning capacity.

The first objective, addressed in the first year, is to extend the OpenQuake engine to include component recovery functions for components of infrastructure systems and the built inventory that parallel the existing OpenQuake engine vulnerability function capabilities. This includes the development of meta-data and database functions that enable recalling different recovery functions (that represent the probability of full-function restoration after a given recovery time) for different recovery durations, as well as adding the information about recovery cost and time estimates. The focus will be on the Swiss built inventory and infrastructure systems, as well as on the functional recovery to the full, pre-earthquake, level. Recovery functions from SYNER-G, HAZUS and FEMA p-58 and similar sources will be collected first, followed by further investigation and modeling to fill in the gaps. Provisional recovery function data will be added to the OpenQuake engine to enable the RRE forecasting model. Close collaboration with T4.1 and OpenQuake developers is required to achieve this objective.

The second objective is to develop an RRE forecasting model. This model is based on:
1) a stochastic-process-framework and will include modelling of the main event and the aftershocks and their impact on recovery (in synergy with T4.2);
2) a compositional demand/supply framework for resilience quantification (Re-CoDeS); and
3) the STREST stress test framework for critical non-nuclear civil infrastructures.
The model will account for the effect not only of aftershocks, but also of sequences of main events as well as the effect of degradation over the lifetime of service of infrastructure systems of a community and provide an estimate of the direct losses and the costs of the recovery. This will make it possible for decision makers to incorporate recovery cost estimates into stress-tests conducted for European critical infrastructures.

The third objectives of T4.3 is to verify and validate the developed RRE forecasting model using the available data for the built environment and infrastructure system recovery in recent earthquakes (e.g. 2010 Kraljevo, 2012 Emilia-Romagna). Upon completion, the RRE forecasting tool is expected to contribute towards an early warning capacity for more resilient European society.

Exploratory research will be conducted to extend the RRE model towards predicting the cost and time of partial functional recovery and use that model to follow the evolution of the recovery process. An increase in the robustness of the RRE forecasting model using machine learning techniques to incorporate real-time SHM data and finding (from Task 4.4) and citizen feedback data (from WP5) in damage and recovery estimation will also be explored.

The work in this task complements the RLA efforts in Task 4.1, is based on the OELF method developed in T4.2 and utilizes the collected SHM data provided from Task 4.4 to increase its robustness using machine-learning tools. Task 4.6 may benefit from the RRE forecasts developed in this task. Collaboration with task 6.2, 6.4 and 6.5 in WP6 is possible.

The table below shows the breakdown of Task 4.3 into subtasks.

Subtask	Short description of subtask	Persons and institutes involved
4.3.1 (3m)	Formulate recovery functions for most widespread Swiss building typologies. Such functions estimate the effort required to regain full functionality.	B. Stojadinovic, IBK-ETH, Professor, (<1PM)[1] Y. Reuland, IBK-ETH, Post-Doc, (1.5PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM)[2] Iunio Iervolino, UNINA (<1PM) Collaboration with Task 4.1
4.3.2 (3m)	Formulate recovery functions for most widespread Swiss infrastructure system components. Such functions estimate the effort required to regain full functionality	B. Stojadinovic, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (1.5PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM) Iunio Iervolino, UNINA (<1PM) Collaboration with Task 4.1
4.3.3 (6m)	Integrate provisional recovery functions into the OpenQuake computational framework. In collaboration with task 4.1, identify an appropriate formulation (format, data structures, APIs) of recovery functions.	B. Stojadinovic, IBK-ETH, Professor, (1PM) Y. Reuland, IBK-ETH, Post-Doc, (3PM) L. Bodenmann, IBK-ETH, PhD student, (3PM) Iunio Iervolino, UNINA (<1PM) Close collaboration with Task 4.1 is required.
4.3.4 (6m)	Implement and verify the Re-CoDeS framework (possibly in OpenQuake) to quantify Recovery and Resilience Efforts (RRE) for infrastructure systems and communities using a compositional demand/supply resilience quantification framework in near-real-time.	B. Stojadinovic, IBK-ETH, Professor, (1PM) Y. Reuland, IBK-ETH, Post-Doc, (3PM) L. Bodenmann, IBK-ETH, PhD student, (3PM) Iunio Iervolino, UNINA (<1PM) Close collaboration with Task 4.1 is required.
4.3.5 (3m)	Validate the developed RRE forecasting model using the available data for the built environment and infrastructure system recovery in recent earthquakes.	B. Stojadinovic, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (1.5PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM) Iunio Iervolino, UNINA (<1PM) Collaboration with Task 4.6. Explore collaboration with WP6
4.3.6 (3m)	Extend the RRE forecasting towards predicting partial functional recovery (such as the probability to recover a given level of functionality after a given period of time) for infrastructure components and systems.	B. Stojadinovic, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (1.5PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM) Iunio Iervolino, UNINA (<1PM) Collaboration with Task 4.1, 4.2, 4.4
4.3.7 (3m)	Update the evolution of RRE predictions due to disruptions in the recovery process (e.g. aftershocks). Explore uncertainty reduction that can be achieved based on SHM data and citizen feedback	B. Stojadinovic, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (3PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM) Iunio Iervolino, UNINA (<1PM) Collaboration with Tasks 4.2; 4.4.

[1] Prof. Stojadinovic's contribution in this project is covered by external funds.

[2] Mr. Bodenmann's contribution in this project is covered by external funds.

	using machine learning techniques. Apply the STREST stress test methodology using RRE estimates.	
4.3.8 (3m)	Writing Deliverable 4.4 "Development of RRE forecasting services in OpenQuake". Describe the recovery forecasting services in OpenQuake: recovery function meta-data and operators and prototype recovery functions. Describe the developed RRE forecasting model and its validation using available post-earthquake recovery data.	B. Stojadinovic, IBK-ETH, Professor, (1PM) Y. Reuland, IBK-ETH, Post-Doc, (3PM) L. Bodenmann, IBK-ETH, PhD student, (1.5PM) Iunio Iervolino, UNINA (<1PM)

Table 33. Breakdown of Task 4.3

2.3.4 Task 4.4 "Advance technologies for data-driven SHM and damage detection"

Task Overview

The goal of this task is to assess the feasibility of an automated 'smart'-tagging of earthquake-hit buildings as safe or unsafe for users. Replacing lengthy and potentially subjective visual-inspection campaigns with data-driven tagging offers the potential for rapid, yet approximate, assessment of the building state in the immediate aftermath of an earthquake. Further, monitoring of building responses to ambient and seismic excitations can reduce uncertainties relating to condition assessment, such as those tied to material properties, structural behavior and environmental and ageing conditions. Updating of this information though data can assist engineers in updating seismic fragility maps.

Within the next 12 months, simulations and possibly measurement campaigns are conducted to achieve the key objective of identifying damage-sensitive features for successful damage detection (subtask 4.4.1). Indicators of non-linearity, modal properties (such as damping and mode shapes), time series and spectral transformation analysis tools and machine-learning techniques form, among others, the set of possible data-driven strategies to detect onset of damage.
Physics-based models that operate at various levels of detail and computational cost are required for model-based SHM. In absence of measured structural responses to seismic actions, high-fidelity three-dimensional nonlinear models are required to simulate measurement data. On the other hand, repetitive forward simulations are required to perform near-real time model updating within a SHM framework in order to reduce uncertainties and predict the influence of accumulated damage on structural behaviour (subtask 4.4.3). For such a repetitive task, models of reduced computational complexity are required. This will take place in collaboration with task 4.2, which deals with modelling damage accumulation. The type and amount of measurement data that is required to efficiently inform such models will be assessed with sensor configurations estimated according to structural typologies.

Subsequently, feasibility of a SHM platform that operates at both ambient and seismic levels of operation will be explored in order to provide dynamic (at regular time intervals) updated information on the structural state (fragility functions) allowing for structural assessment and possibly smart tagging of higher confidence. Beyond exploration of SHM solutions that are tailored to specific structural types and operate at structure-specific levels, integration with dense networks of low-cost sensors developed as part of WP2 (T2.2) will be further investigated. Finally, the possibility for validation as part of the pilot projects established in WP6 (T6.1) will be sought.

The table below shows the breakdown of Task 4.4 into subtasks.

Subtask	**Short description of subtask**	**Persons and institutes involved**
4.4.1 (4m)	Assess the type and amount of measurement data that is required to detect the presence of damage in a typical European building	E. Chatzi, IBK-ETH, Professor, (<1PM [3]) Y. Reuland, IBK-ETH, Post-Doc, (2PM) Iunio Iervolino, UNINA (<1PM) *Contribution form ETH Project DynaRisk and* P. Martakis, IBK-ETH, PhD student (2PM [4])
4.4.2 (4m)	Study ideal sensor configurations to localize critical failure mechanisms. Assess if and how such configurations change with building types and pre-existing damage.	E. Chatzi, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (2PM) Iunio Iervolino, UNINA (<1PM) *Contribution form ETH Project DynaRisk and* P. Martakis, IBK-ETH, PhD student (2PM)
4.4.3 (6m)	Find strategies to reduce computational complexity of nonlinear SHM and repetitive forward simulations in order to enable near real-time model updating.	E. Chatzi, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (2PM) Iunio Iervolino, UNINA (<1PM) *Close collaboration with Task 4.2* *Contribution form ETH Project DynaRisk and* P. Martakis, IBK-ETH, PhD student (4PM)
4.4.4 (6m)	Test feasibility of near real-time smart tagging of earthquake-hit buildings in simulation.	E. Chatzi, IBK-ETH, Professor, (1.5PM) Y. Reuland, IBK-ETH, Post-Doc, (4.5PM) Iunio Iervolino, UNINA (<1PM) *Close collaboration with Task 4.2*
4.4.5 (6m)	Test and validate post-event assessment and smart-tagging capabilities.	E. Chatzi, IBK-ETH, Professor, (2PM) Y. Reuland, IBK-ETH, Post-Doc, (4.5PM) Iunio Iervolino, UNINA (<1PM) *Collaboration with Tasks 2.2, 6.1*
4.4.6 (3m)	Compilation of Final Report on Deliverable 4.5: "The use of structural health monitoring for rapid loss assessment"	E. Chatzi, IBK-ETH, Professor, (<1PM) Y. Reuland, IBK-ETH, Post-Doc, (3PM) Iunio Iervolino, UNINA (<1PM)

Table 34. Breakdown of Task 4.4

2.3.5 Task 4.5 Improve and operationalize earthquake performance-based EEW

Task Overview

The objective of Task 4.5 is to develop location- and structure-specific Earthquake Early Warning (EEW) algorithms for real buildings. First, by using the 20-year-long earthquake data from the EEW

[3] Prof. Chatzi's contribution is covered by external funds

[4] Mr. Martakis' contribution is covered by external funds

stations near the fault and an instrumented building in Istanbul, the attenuation of ground motions from the EEW stations to the building will be investigated. The critical threshold response parameters for the performance of the building and the corresponding ground motion values that need to be recorded at the EEW stations will be identified. The identified EEW values will be used to issue an early warning for the building, giving approximately 5 to 7 seconds early warning time. A computer program will be developed to issue the warning.

The table below shows the breakdown of Task 4.5 into subtasks.

Subtask	**Short description of subtask**	**Persons and institutes involved**
4.5.1 (M01-03)	Compilation of earthquake records from the EEW stations and the instrumented building.	Erdal Safak (BOUN): 1PM Eser Cakti (BOUN): 1PM A Ph.D. Student (BOUN): 1PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested)
4.5.2 (M04-09)	Development of the attenuation of various ground motion parameters from the EEW stations to the building base.	Erdal Safak (BOUN): 1PM Karin Sesetyan (BOUN): 1PM A Ph.D. Student (BOUN): 1PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested)
4.5.3 (M09-12)	Identification of the correlation of critical response parameters with the base motion of the building.	Erdal Safak (BOUN): 1PM A Ph.D. Student (BOUN): 1PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested)
4.5.4 (M13-18)	Identification of threshold response values for the building (from the design calculations) and the corresponding critical base motions.	Erdal Safak (BOUN): 1PM Ufuk Hancilar (BOUN): 1PM A Ph.D. Student (BOUN): 1PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested)
4.5.5 (M19-24)	Identification of ground motion values at EEW stations that will cause critical base motions for the building.	Erdal Safak (BOUN): 1PM Ufuk Hancilar (BOUN): 1PM A Ph.D. Student (BOUN): 1PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested)
4.5.6 (M25-36)	Development of a real-time software to perform the subtasks outlined above and field tests.	Erdal Safak (BOUN): 1PM Two Ph.D. Students (BOUN): 2PM Iunio Iervolino, UNINA (<1PM) Participants from other institutions (if they are interested).

Table 35. Breakdown of Task 4.5

2.3.6 Task 4.6 A user-ready risk-cost-benefit analysis framework for quantifying socio-economic impact

Task Overview

In this task we will evaluate some of the seismic risk reduction measures and tools developed in RISE in terms of their cost and benefit. In an ideal world with unlimited resources, it may be the first and most important risk reduction method to increase the resilience of buildings through changing building codes for more robust structural design principles, construct all buildings to a high standard following the modern building codes or strengthening all existing buildings as needed. However, in the real world we face many challenges and have limited time and resources. Moreover, investment decisions require quantification of risks, costs and benefits. Societies must decide how much they are willing to invest in disaster-risk reduction, and how to invest limited resources in the most effective way. A cost-benefit analysis will provide information on how to wisely use the resources in order to make maximum benefit. In this way, any action can be justified at each step of the decision-making process.

Work Plan:
This task requires input from other WPs in order to proceed with cost-benefit analysis, therefore the main work within this task will only start after the first "Task 4.6 Workshop" that will be organized in Month 10. In that workshop, we will address the main questions that are aimed to be answered under this task. The answers to these questions will be among the RISE impact and legacy. The output of this task will feed into Task 8.3.
Sample questions to seek a reply for:

- What is the cost-benefit of OEF? e.g. OEF for Switzerland? Can we compare it with traditional seismic risk reduction methods such as modifying building codes for building more resilient structures, directing more resources to building strengthening?
- Given the limitations in warning times, how much contribution can EEW make to earthquake resilience? How can we quantify benefit of EEW? What parameters cause different cost and benefit (moving sensors, which sensors to use)? Define the test parameters with researchers who work on EEW (J. Clinton, M. Boese).
- What is cost-benefit of changing building codes?
- Should we focus on building strengthening more than other methods?
- Cost-benefit of new technologies such as low cost dense IoT sensors?
- What is the cost-benefit of different seismic network designs? Shall we use higher quality less dense networks, lower quality but highly dense seismic networks or a mixture of both? Test site Switzerland.
- Are there low cost individual actions that can be taken such as society's vigilance, preparedness of the household etc?
- Cost-benefit of communication. Evaluate different ways of communication within a cost-benefit framework: Quantify the cost-benefit of using a smart phone based hazard app connected to the national dynamic risk server providing information on EEW and OEF. Is

significant saving of human life feasible through official nudging of low cost measures that individuals can choose themselves to adopt? Collaboration with 8.2.

- If we were given a certain amount of budget by state of a certain country (e.g. Italy, Switzerland), which risk prevention methods should be prioritized? Where to spend the money first?

Main output of this task:
Good practice report on risk-cost-benefit in terms of socio-economic impact (D 4.7, due Month 32)

The table below shows the breakdown of Task 4.6 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutes involved
Subtask 4.6.1 (Workshop on M10) <1PM	Define the questions: Select different risk measures to compare in terms of cost-benefit	S. Wiemer (ETH), Economist to be hired, M. Boese(ETH),L. Danciu(ETH), P. Kastli (ETH), H. Crowley (EUCENTRE), P. Gueguen (UGA), S. Nandan (ETH), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.2 [1PM]	Define cost functions for the selected risk measures such as: Casualties, injuries, Business interruption, RRE, evacuations	Economist to be hired (ETH), B. Mena (ETH), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.3 [1PM]	Cost of Performance based damage assessment vs. damage assessment using SHM	Collaboration with Task 4.2, Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.4 [2PM]	Quantify the economic benefit of EEW, considering different scenarios (moving sensors makes how much of a difference, etc)	J. Clinton(ETH), M. Boese(ETH), U. Hancilar, Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.5 [2PM]	Quantify the economic benefit of OEF	In collaboration with WP3: Shyam Nandan (ETH), W. Marzocchi (UNINA), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.6 [1PM]	Cost – benefit analysis of different network building scenarios: optimized network with minimized costs?	Collaboration with T2.1: M. Isken(Quake), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.7 [1PM]	Compare costs for Building strengthening vs. OEF	Economist to be hired (ETH), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.8 [1PM]	Sensitivity analysis for cost of various risk reduction measures	Economist to be hired (ETH), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.9 <1PM	Cost-benefit of communication	Collaboration with Task 6.4 M. Marti (ETH), Iunio Iervolino, UNINA (<1PM)
Subtask 4.6.10 [2PM]	IT framework	P. Kastli (ETH), L. Danciu (ETH), Iunio Iervolino, UNINA (<1PM)

Table 36. Breakdown of Task 4.6

2.4 Work Package 5: SOCIETY
"Data Gathering and Information Sharing with the Public and Policy-makers"

Lead: EMSC
Authors: Remy Bossu, Alexandra Freeman, Michele Marti

General Description of the WP5

Advances in dynamic risk assessment will only have a measurable impact on the resilience of societies and the economy if we are able to establish effective two-way communication with stakeholders. Doing so remains a major challenge, but, thanks to the dramatic changes in wireless communication technologies, progress in social sciences, and the universal presence of social media, there are also unique opportunities to engage and inform people. Critical points of communication occur well before an event (planning), as an event is suspected to be imminent, and during a crisis. This work stream aims to tackle all three topics to ensure the best possible usage of all available information for the benefit of society. Citizen-science projects or crowdsourcing offers opportunities to collect highly valuable and very dense datasets on multiple hazards that can, for example, be used to enrich EEW and RIA Applications. At the same time, the omnipresence of location-aware mobile devices can be explored to deliver tailor-made and culture-specific alerts and information to people. Success will require interdisciplinary work with links between scientists, social scientists and practitioners outside academia. The specific objectives of this WP are therefore:

- Discuss the needs and understand the existing decision-making environments and usual routes of communication for each of the different audiences for risk messages (long-term decision-makers, government and organizational leaders, emergency services, public) in different countries.
- Review best practices in risk communication, focusing on dynamic information communication in a range of fields, including medical, economic/financial, natural hazards, engineering, and environmental.
- Undertake an iterated user-centered design process to develop a method of communication, with user-testing across different countries involved to integrate the design process. This will culminate in a formal controlled evaluation of the communications.
- Improve procedures for using internet-based intensity questionnaires for two-way communication and deriving useful scientific information on earthquakes (e.g., fast characterization of seismogenic faults).
- Exploit the LastQuake* (280k users), Earthquake Network† (400k users) and MeteoSuisse Apps (2 Million Users) for their synergies for crowdsourced EEWS and RIA.
- Detect triggered fires and landslides through social media monitoring and consider warnings also in a multi-hazard context.

Partner number and short name	PM
ETH Zürich	18.00
INGV	1.00
UNIBO	6.00
UNINA	1.00
EMSC	32.00
UCAM	24.00
UniBg	20.00
Total	102.00

Table 37. Beneficiaries and Person Months per Beneficiary for WP5

	Deliverable Title	Lead beneficiary	Type	Dissemi-nation level	Due Date (in months)
D5.1	Review of best practice in communication of dynamic risk in all fields	UCAM	Report	Public	9
D5.2	Evaluation of current communications pathways to public and to policy-makers in Italy, Switzerland, and France	UCAM	Report	Public	18
D5.3	Designing & implementing the seismic portion of dynamic risk communication for long- term risks, variable short-term risks, early warnings	UCAM	Report	Public	18
D5.4	Field evaluation of the risk communication strategy	UCAM	Demonstrator	Public	8
D5.5	Good practice recommendations report	UCAM	Report	Public	36
D5.6	The potential of crowdsourced EEWS	EMSC	Report	Public	20
D5.7	Detection of landslides and fires from Twitter monitoring	EMSC	Report	Public	26
D5.8	Near real time estimate of parameters of significant European earthquakes based on web	EMSC	Demonstrator	Public	30
D5.9	Crowdsourced EEW services	EMSC	Demonstrator	Public	36
D5.10	Improving earthquake information in a multi- hazard context	ETH	Report	Public	24

Table 38. List of Deliverables for WP5

Milestone number	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS30	First draft of communication measures	UCAM	12	Draft review by ExeCom
MS31	Launch Field evaluation	UCAM	18	Field experiments running, check WP L
MS32	Real time data exchange between EMSC and Bergamo	EMSC	4	Data exchange operational, check ExeCom
MS33	Implementation of the AIDR platform for landslides and fire detection	EMSC	6	Platform running, check WP lead

MS34	Development of a new version of Boxer code particularly suited for web questionnaires	UNIBO	18	Software running validated by WP lead
MS35	Prototype service for seeded crowdsourced locations	EMSC	24	Prototype running, check by ExeCom
MS36	Concept for multi-hazard warning app completed	ETH	12	Concept ready, check by Ex-eCom

Table 39. List of Milestones for WP5

Overall management and communication

The internal communication within WP5 is mainly implemented through emails, phone conferences alongside an experiment to use Slack tool. These exchanges are and will remain particularly active during the first year of the project to ensure that the practical experience in public dynamic risk communication gained by EMSC and UNIBG is shared with UCAM and ETHZ. This is also true for task 5.2 which requires close collaboration between UNIBG and EMSC.

Alongside these informal exchanges, WP5 meetings are organised when required. The first of such meeting will take place between end 2019-early 2020 and will also include the communication team of the sister project Turnkey to ensure cross-fertilisation on the topic of dynamic risk communication.

Technical visits between EMSC and UNIBG are likely to happen, the first one in 2020 to implement real time data exchanges and work towards operationalisation. A technical visit of INGV at EMSC is likely to take place in 2020 to –tentatively- implement modified Boxer software initially developed for historical seismicity on real time felt reports collected at EMSC.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Milestones
Task 5.1	Alexandra Freeman – UCAM	1	36	D5.1, 5.2, 5.3,5.4, 5.5 MS30 MS31
Task 5.2	Remy Bossu - EMSC	1	36	D5.6, 5.7, 5.8 MS32 MS33 MS34 MS35
Task 5.3	Michèle Marti – ETHZ	1	36	D5.10 MS36

Table 40. List of Tasks of WP5

2.4.1 Task 5.1 Dynamic Risk Communication

Task Overview

Activities in the next 12 months:

We will address the following topics in the next 12 months:

1) What is known about risk communication in fields which might in some way be relevant: low probability events, dynamic risk, geographical risk variation? (Academic literature and practice review).

The team is starting by reviewing practice across a number of fields - ranging from meteorology to terrorism threats; global finance to health system management – where dynamic risk (particularly with a geographical spread) is communicated. This involves both contacting professionals around the world and an academic literature review. Our aim is to produce a report on the current 'state of the art' across fields to see what can be learned from what is already done and researched in other fields. We will also research seismic communication in non-RISE countries such as Japan, Mexico and the US.

2) Who are the key audiences and how do they currently obtain information (policymakers, infrastructure managers, civil protection, emergency services and publics) – in France, Switzerland, Italy?

Our next task is finding out the key audiences for the information that RISE and other seismic hazard/risk projects can produce. What information are they most interested in (e.g. hazard or risk?)? How do they currently obtain it? What decisions do they make with it? What is good and bad about the current process?

This will involve close co-operation with RISE colleagues based in the key countries (France, Italy & Switzerland), and conversations with a range of potential audiences in those countries (requiring language expertise in French/German/Italian).

3) What kinds/formats/pathways of information are important for each of these audiences?

Once we have identified the key audiences and current practice, this will inform us about the major media and formats that are important for seismic communication for them. For example, would information to the public best be shared in an app (specialist or within a generalist app?), on a website, via social media, via traditional broadcasters? What about for emergency responders, or infrastructure managers, or local/national government?
We will then produce a report on our findings of 2) and 3) together.

4) What information might be available (including in the different time periods – long-range, medium-range, EEW and RLA)?

Whilst carrying out tasks 1-3, we will be learning from our RISE partners exactly what information it is possible to produce. This will be a two-way discussion as we also pass on requests and information needs gleaned from our interviews with potential audiences. For example, what level of detail is actually useful in a risk map? And in what format/over what timescale would they like it? What levels of false alarm or uncertainty are tolerable for the different audiences?

This will require constant communication with all RISE partners throughout months 1-24.

5) Develop potential new pathways of information (e.g. via broadcast media, web services etc) in each country

Towards the end of the first 12 months, we expect to be building a picture of what pathways to information the different audiences most want used, and therefore to start putting together the partnerships that will be required to deliver them (e.g. with website hosts, app hosts or local broadcasters).

6) Develop potential new formats of information

At around the same time, we will start developing new information communication formats for these media, learning from the needs of the audiences, the review of literature and practice, and the feedback on their existing information pathways – as well as what our RISE partners can produce. This will be the start of a long user-centred design process in which we will constantly be designing and re-evaluating the materials with the audiences. It will need input from RISE partners who are producing the information that we are attempting to communicate.

Activities months 12 – 36:

After 10-12 months of user-centred design of different communication formats, we would carry out a final quantitative evaluation of them to ensure that they are communicating the information in a clear and well-understood way. Then we would hope to be able to start implementing these with our channel partners (i.e. broadcasters, website hosts etc), as well as putting in place a plan for field evaluation. The evaluation would take place over the remaining months of the RISE project and end in a final report.

The table below shows the breakdown of Task 5.1 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
subtask 1	What is known about dynamic risk communication? Reviewing literature & practice	Sarah Dryhurst, UCAM, lead academic 6PM Research Assistant, UCAM, 3PM
subtask 2	Identifying key audiences and communication pathways in Italy, Switzerland, France	Sarah Dryhurst, UCAM, lead 3PM Research Assistant, UCAM, 3PM **, ETH
subtask 3	Developing new formats for information (iterative user-centred design)	Sarah Dryhurst, UCAM, lead 12PM Research Assistant, UCAM, 12PM **, ETH
subtask 4	Evaluating potential new formats (quantitative)	Sarah Dryhurst, UCAM, lead 2PM Research Assistant, UCAM, 2PM **, ETH
subtask 5	Implement & disseminate new formats, and design field evaluation	Sarah Dryhurst, UCAM, lead 1PM Research Assistant, UCAM, 1PM **, ETH
subtask 6	Field evaluation & write-up	TBC

Table 41. Breakdown of Task 5.1

2.4.2 Task 5.2 Crowdsourced EEWS and RIA

Task Overview

Task 5.2 is "Crowdsourced EEWS and RIA". The final aim is to explore the possibility of crowdsourced early warning systems and fully exploits crowdsourced data for rapid impact assessment. It is based on the exploitation of data collected by 2 smartphone apps, namely LastQuake (operated by EMSC) and Earthquake Network (operated by UNIBG), as well as innovative real time analysis of felt reports collected by EMSC to derive earthquake parameters.
Task 5.2 includes 4 subtasks. The first one aims at joint analysis of data collected from the 2 apps for rapid information and possible early warning. The second one combines the analysis of crowdsourced and seismic data to speed-up determination of earthquake parameters. The third one explores the possibility to detect triggered landslides and fires on Twitter after large earthquakes. Finally, the fourth task will explore the possibility to determine earthquake parameters (using a modified Boxer algorithm) from felt reports

Task Work Plan - short term (1-12 months):
There are 2 main aims for task 5.2.1 during the first 12 months. One is to establish real time data exchanges between EMSC and UNIBG, which is the first step for joint-operational data analysis. We are also currently analysing the performances of Earthquake Network in terms of early warning service (a joint work with Turnkey project). We have strong indications that early warning has already been provided to Earthquake Network users (mainly in South America) in some cases but need time to fully understand the data as well as possible interactions with existing early warning systems in Mexico. Beyond this technical analysis, 2 700 answers were received from earthquake network users who were located in the area of the M8 Peru earthquake of May 26 2019. Some of them confirm the reception of an Earthquake Network notification before the shaking. We want to understand how such an early warning is perceived, understood, whether it triggers actions etc.

The Task 5.2.2 aims at making "Crowdseeded Seismic Locations" (CSLoc) a fully operational service. In the first 12 months we aim at refining quality criteria as well as developing procedures to avoid duplicating earthquake locations.

In task 5.2.3 we currently focus on the detection of landslides. Collaboration has been established with Qatar Computer Research Institute to use their AIDR (Artificial intelligence for Disaster reduction). We aim at the end of the first year to have a very first prototype of real time monitoring of Twitter collecting landslides related tweets. We are also looking for copyright free databases of landslides pictures to train the AI system. Finally, last June Twitter has decided to unable the functionality of geo-located tweets which may impact our developments.

The task 5.2.4. will explore the possibility to exploit felt reports using a modified Boxer algorithm (INGV and UniBo) to determine earthquake location and magnitude, and if possible in the first few minutes, before a seismic location is available.

Task Work Plan - long term (12-36 months):

The planning of task 5.2.1 will depend on the results of the analysis of the current EEW capacities of Earthquake Network app. If it is demonstrated (as it seems to the case), one will need to evaluate false alert rate and develop a strategy to limit it. Results from task 5.3 will be implemented in both apps to improve public communication. Finally, as audience of both apps is increasing fast, major changes in the way data are analysed in real time are likely to be required. A full CSLoc service (task 5.2.2) is expected to go online by the end of year 2. Performances monitoring will be required to optimize results. Landslide Twitter detection will be tested during year 2. Depending on the results an extension will be developed for fires. However, it must be stressed that such a system can only tested during large destructive earthquakes which may or may not occur during the course of the project.

Based on initial results, the possibility to rapidly determine finite rupture for felt reports is likely to be demonstrated during year 2 of the project. If so, we will work towards the implementation of this system in EMSC operations and interfacing it with our rapid impact assessment tool.

The table below shows the breakdown of Task 5.2 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask 1	Joint analysis of data collected from the 2 apps for rapid information and possible early warning	Robert Steed, EMSC, data scientist, 12 pm Matthieu Landes, EMSC, seismologist, 1 pm Laure Fallou, EMSC, sociologist, 1 pm Julien Roch, EMSC, seismologist, 1 pm Sylvain Julien Laferriere, EMSC, data scientist, 1 pm
subtask 2	Combined analysis of crowdsourced and seismic data to speed-up determination of earthquake parameters	Robert Steed, EMSC, data scientist, 6 pm Matthieu Landes, EMSC, seismologist, <1 pm Julien Roch, EMSC, seismologist, <1 pm
subtask 3	Detection of triggered landslides on Twitter after large earthquakes	Julien Roch, EMSC, seismologist, 7 pm
Subtask 4	Source parameters determination from felt felt reports using a modified Boxer algorithm (INGV).	Matthieu Landes, EMSC, seismologist, 2 pm Gianfranco Vannucci, UNIBO, seismologist 6 pm Paolo Gasperini, UNIBO, 1 pm

Table 42. Breakdown of Task 5.2

2.4.3 Task 5.3 Improving earthquake information in a multi-hazard context

Task Overview

How to best communicate earthquake information in a multi-hazard context to non-experts?
Including non-experts in a multi-perspective bottom-up approach can complement and enhance traditional top-down approaches. Therefore, a user-centred systemic approach will be applied, with a major emphasis on user requirements driving technological development. Furthermore, a combination of quantitative and qualitative methods will allow to better understand the wider social and

structural context. The research procedure schematically shown in Figure 8 is divided into three studies (blue highlighted on the plan), which build on each other. The findings of our own studies and of best practices from other projects will be used to fulfil the milestone 36 and deliverable 5.10 of RISE (red boxes on the plan).

Task Work Plan – short term (1-12 months):

Study 1: Presentation of multiple hazards

With a survey in the German-speaking part of Switzerland we will assess end-users' preferences for hazard maps, hazard categories and content of warning messages which are currently used on multi-hazard warning apps. In addition, we will assess which communication channels the population prefers in order to receive warnings and which hazards should be combined on a central app. For that, we will apply a survey-based statistical technique called "Conjoint analysis", which allows as to determine how people value different attributes.

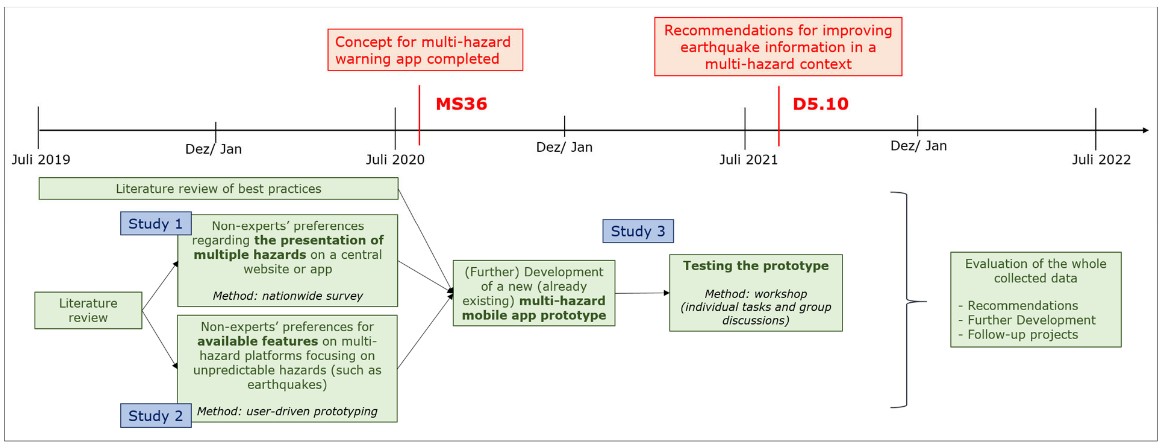

Figure 8. Schematic representation of WP5 research procedure.

Study 2: Preferred features

Based on the results of the first study, "user-driven prototyping" workshops are planned. They will serve to understand which features of multi-hazard warning apps non-experts prefer. The primary focus is on warnings of unpredictable hazards (such as earthquakes) which require immediate actions. In addition, we will conduct interviews with the authorities that provide the information for the different hazards. This allows to understand the needs for information, content of warning messages and available functions (e.g. report a hazard) which differ among the different hazards.

Task Work Plan - long term (12-36 months):

Study 3: (Further) Development of (existing) multi-hazard warning app

The findings of the previous two studies and of the other working groups of the work package (e.g. UCAM) will serve as a basis to design and (further) develop a multi-hazard warning app prototype. The prototype (e.g. new function, extended information content) will be tested during workshops (individual tasks and group discussions). Thereby users will be able to test the prototype and share their experiences and perceptions of the prototype.

Interaction and Collaboration

We hope to collaborate with existing multi-hazard platforms to extend earthquake information on the current Apps and to test the extended app with non-experts.

The table below shows the breakdown of Task 5.3 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
subtask	In the last decades, the use of mobile apps, websites and social media as communication channels has grown. With it also the potential to combine information about different natural, technological and anthropogenic hazards. A multi-hazard approach has various potentials. Just to name a few, the design of consistent hazard maps and warning messages, the communication of common emergency preparedness measures, a collaboration between responsible federal agencies and a better understanding of warnings by non-experts to allow them to take appropriate actions. So far, information processing in multi-hazard context has not been rigorously tested and research studies are still needed. This task aims to assess non-experts' preferences and perception of multi-hazard warning apps and to extend the information available on the current Apps used in Switzerland. In the final report, successful strategies and general recommendations will be summarized.	Irina Dallo, ETH, PhD, (16 PM) Michèle Marti, ETH, task leader, (2 PM)

Table 43. Breakdown of Task 5.3

2.5 Work Package 6: DEMONSTRATION
"Pilot projects for demonstrating the use of innovative technology in buildings within OELF, RLA, performance- based EEW & SHM"

Lead: EUCENTRE

Authors: Helen Crowley, Cecilia Nievas, Iunio Iervolino, Kristin Vogfjord

General Description of the WP6

This WP has the main objective of piloting the research and developments made in the previous WPs at specific sites across Europe, in order to demonstrate the improvements made upon current capabilities. This will also benchmark the effectiveness of the proposed services for seismic risk reduction. Through focusing activities on specific sites, RISE will foster interactions not only among researchers but also with a number of stakeholders, represented for example in our stakeholder panel, thus ensuring the applications are tested and validated under relevant operational conditions. Our diverse pilot and demonstration activities cover a wide range of potential applications of OEF, EEW, RIA and SHM; they also cover very different scales, from building scale application to national and even Europe-wide scale. Specifically, we will:

- Demonstrate how the use of big data collected through innovative technologies at the building-level can be used for critical risk mitigation services including OELF, performance-based EEW and SHM.
- Provide clear applications to demonstrate the chain from earthquake predictability to OELF and RLA at regional and national levels.
- Clearly integrate a large number of activities from WPs 2 to 8 by developing a user-centric dynamic risk framework for Switzerland.
- Steps towards the development of services for RLA, EEW and OEF at a European level.

Partner number and short name	PM
ETH	12.00
GFZ	20.00
IMO	9.00
UNINA	20.00
EUCENTRE	28.00
EMSC	4.00
UGA	9.00
UCAM	6.00
BOUN	9.00
QUAKE	3.00
Total	133.00

Table 44. Beneficiaries and Person Months per Beneficiary for WP6

Delivera-ble Num-ber	Deliverable Title	Lead beneficiary	Type	Dissemination level	Due Date (in months)
D6.1	Report on the use of building data collected through innovative technology in OELF, RLA, EEW and SHM	GFZ	Report	Public	36
D6.2	Report on testing OEF and extending earth-quake forecasts to loss forecasts in Italy	UNINA	Report	Public	36
D6.3	Report on the Iceland demonstration site for earthquake predictability and RLA	IMO	Report	Public	36
D6.4	Report on the user- centric dy-namic risk frame-work for Switzerland application	ETH Zürich	Report	Public	36
D6.5	Report on the develop-ment of RLA, EEW and OEF at European scale	EUCENTRE	Report	Public	36
D6.6	Framework for the assessment of eco-nomic losses in a dy-namic risk context	ETH Zürich	Report	Public	6

Table 45. List of Deliverables for WP6

Mile-stone number	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS37	Sensors set up and collecting data in buildings in Tokyo, Lourdes, Tur-key and Valais	QUAKE, GFZ	12	Stations online, data stream-ing, check by WP lead
MS39	Upgraded EEW capability in Iceland operational	IMO	12	System operational, check ExeCom
MS40	Improved observational capa-bilities operational	IMO	24	System operational, check ExeCom
MS42	National Swiss stakeholder board es-tablished	ETH	8	Nomination letters, check Ex-eCom
MS43	Dynamic risk services for Switzerland operational	ETH	30	Service online, Check ExeCom & SAB
MS44	Operational versions for OEF, RLA and crowdsourcing based EEW capa-bilities at European level installed	EUCENTRE	24	Services online, Check ExeCom and SAB

Table 46. List of Milestones for WP6

Overall management and communication

Many of the tasks of this work package are each fairly standalone, and thus minimal interaction between tasks is required. There is, however, a need for a strong interaction between each task and the other work packages of RISE. In order to improve communication between partners, and to gain insight into the other activities across RISE, a Slack workspace (https://rise-wp6.slack.com/home) has been set up for WP6 and all partners will be invited to join and encouraged to contribute with updates on the activities across the project.

The task leaders for each task have the role of ensuring the technical and scientific developments in the other WPs of the project will be adequately transferred to these demonstration activities. There is thus less need in this WP for dedicated work package meetings and conference calls, but the WP leader will follow up with each task leader individually once every 3 months to ensure that the activities are on track. Given that all task leaders will attend the annual meetings; short WP side meetings will be organised at these events.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Milestones
Task 6.1	Cecilia Nievas - GFZ	1	36	D6.1 MS37
Task 6.2	Iunio Iervolino - UNINA	1	36	D6.2
Task 6.3	Kristin Vogfjord - IMO	1	36	D6.3 M39 and M40
Task 6.4	Stefan Wiemer - ETH	1	36	D6.4 and D6.6 MS42 and MS43
Task 6.5	Helen Crowley - EUCENTRE	1	36	D6.5 MS44

Table 47. List of Tasks of WP6

2.5.1 Task 6.1 "Pilot projects for demonstrating the use of innovative technology in buildings to support OELF, RLA, performance-based EEW and SHM"

Task Overview

Sub-Task 6.1.1. The sensors whose data will be used in Task 6.1 are of different kinds and are deployed/administered by different organisations. These are:

- Low-cost medium-quality sensors based on MEMS accelerometers of Task 2.2, developed and deployed by QuakeSaver. There are currently 45 prototype stations operating in Tokyo Metropolitan Area and Hokkaido (online since October 2018). An additional 100 (in- and outdoor) sensors will be installed within Task 2.2.
- XblueSeis 3C rotation sensors (temporary experiment) and EST 3C sensors (permanent) deployed in the City Hall of Grenoble (Alpes, France) by UGA. This is a public 12-storey reinforced concrete structural wall building built in 1965, for which continuous recordings at 200 HZ are available since 2000.

- Around 10 MEMS accelerometer sensors capable of monitoring ambient vibration, to be deployed semi-permanently by ETH in a new mid-rise steel frame building in Sion (VS, Switzerland), alongside additional rotational sensors, which will be deployed temporarily.
- Accelerometric sensors (permanent) deployed in the Sapphire Tower in Istanbul (Turkey) by BOUN. Data from these sensors are used in Task 4.5 to develop the conceptual framework and software to be applied in Sub-Task 6.1.5. The Sapphire Tower is a 62-storey reinforced concrete building, for which continuous recordings at 200 Hz since 2010 are available.

Within Sub-Task 6.1.1, details regarding the installation of these sensors, their functionalities, and the software that allow for the data that they record to be retrieved and used will be gathered. A memo on the status of these sensors will be produced as milestone MS37. All parties involved will supply the needed information to the Task Leader by month 11, so as to allow time for its preparation.

Sub-Task 6.1.2. The Dynamic Exposure Model of Task 2.7 will be developed based on open data such as OpenStreetMap, open cadastral data services and existing exposure models, such as that of the European Seismic Risk Model (ESRM20) currently being developed under the Horizon 2020 project SERA. The installation of a large number of low-cost, medium-quality sensors such as those of Task 2.2 has the potential to generate a valuable input for the exposure model in two main ways.

A first pilot study will consist of attempting to improve the classification of buildings into structural typologies by using knowledge on the dynamic properties of the buildings (i.e., modes and periods of vibration) derived from sensor data combined with empirical relations between the fundamental period of vibration, height and lateral load-resisting systems existing in the literature, e.g. using continuous beam-like structural models.

Secondly, it will be shown how the model can incorporate SHM data on deterioration and damage. As an actual implementation of such data requires that the sensors of Task 2.2 record seismic motions that cause damage and this cannot be guaranteed to occur within the timeframe of the project, this subtask will build upon idealised data with the purpose of demonstrating how such data can be processed and incorporated to the model, considering natural wandering of the model with external loading (e.g. environmental conditions) as false alarms. It is noted that data on deterioration and damage are often considered to be a component of vulnerability and not exposure. However, the nature of these data is geospatial and needs to be stored accordingly. QUAKE will provide processed sensor data of Task 2.2 and Sub-Task 6.1.1 for this purpose; these same data will be delivered to Task 2.6 to aid in the development of strategies for scalability and high-volume data access.

GFZ will provide the Dynamic Exposure Model of Task 2.7 and carry out the pilot study to enrich it with the results from the low-cost sensor data processing.

UGA will provide guidance on the use of sensor data for SHM and for inferring structural characteristics of buildings. As this Sub-Task builds upon Sub-Task 6.1.1, Task 2.2 and Task 2.7, work will only start after Month 12.

Sub-Task 6.1.3. Full-scale testing of the capabilities of the innovative technologies in the RISE project within EEW, OELF and RLA would require a substantial amount of data from past strong earthquakes to have been recorded by the sensors of Sub-Task 6.1.1. As this data does not exist at this point in time, Sub-Task 6.1.3 focuses on conducting a proof of concept of how such data could be used. A test area with building-by-building exposure information will be subject to a computational simulation of a damaging earthquake sequence. This area may be real or idealised; this will be decided based on the results obtained in Task 2.7 for the Dynamic Exposure Model but should contain fully characterized buildings as well as buildings for which only a probabilistic classification can be made due to lack of building data. It will be assumed that these buildings are undamaged and instrumented with the MEMS accelerometers of Task 2.2 and that, as a consequence, their fundamental period of vibration has been derived from ambient vibration measurements. A first earthquake shock will be applied and resulting damage states will be calculated for all buildings by means of fragility functions, possibly based on non-linear time-history analyses (NLTHA) of single-degree-of-freedom (SDOF) systems calibrated to represent the buildings in the exposure model. The input ground motions and related intensity measures will be calibrated to represent site-specific conditions, assumed to be derived from MEMS accelerometers located at the ground floor of these buildings. The output of this stage will consist not only in allocating each building to a damage state but also quantifying the period elongation that results from the structures undergoing inelastic deformation. The latter will represent the data that could be extracted from ambient vibration measurements using the MEMS accelerometers after the first shock. These results will be presented making a clear distinction of those that would represent the classic output of a RLA (estimates of losses) and those that are intended to simulate the sensors (change in dynamic properties of the buildings). With this information on the current damage state of the structures, an OELF will then be run assuming a particular pattern of seismicity at the site (using sequences of events characteristic of those encountered in OEF) and state-dependent fragility functions that account for the damage state of the buildings after the first shock (possibly making use of the models developed for Task 6.2). Figure 9 shows a schematic diagram of the components of this Sub-Task.

GFZ will provide the Dynamic Exposure Model and define the earthquake sequence scenario, potentially informed by the OEF models developed by WP3. UNINA will provide guidance on the development and use of state-dependent fragility functions. UGA will provide guidance on the simulation of ambient vibration measurements. GFZ and EUCE will carry out the RLA and OELF simulation, with support and discussion with all partners. As this Sub-Task builds upon Sub-Task 6.1.1 and Task 2.7, work will only start after Month 12.

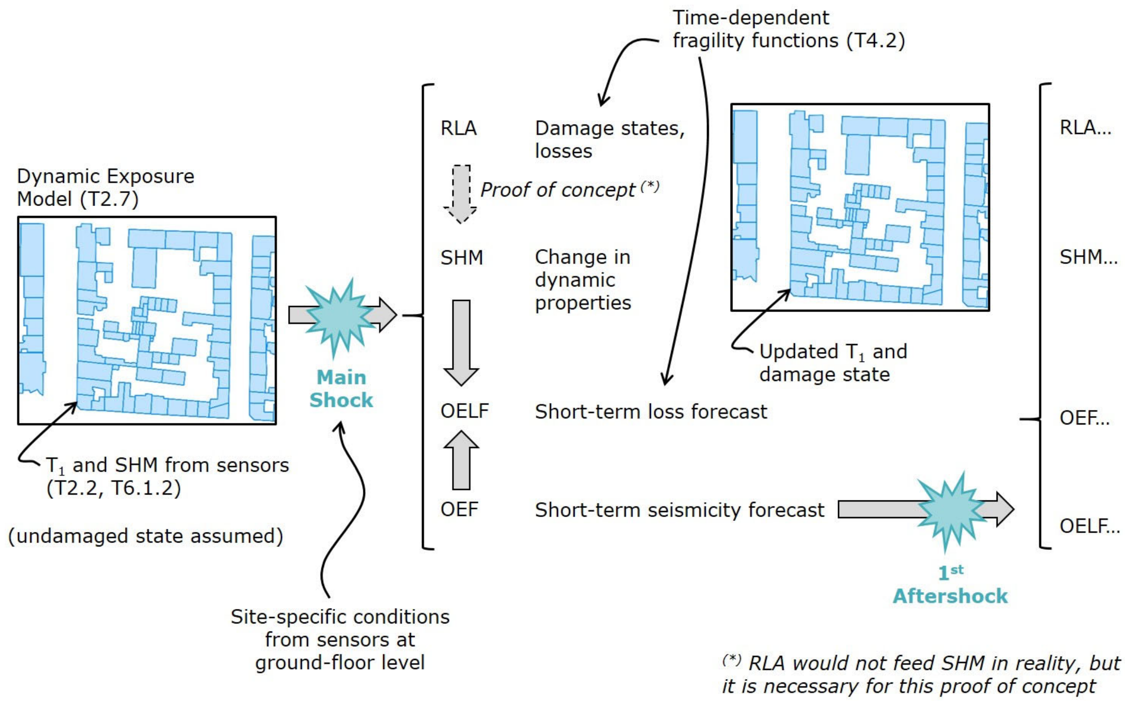

Figure 9. Schematic description of Sub-Task 6.1.3.

In the unlikely case of a damaging earthquake in the Tokyo area occurring within the timeframe of this project, the same analysis can be performed on recorded data in sensor-equipped buildings. Given that the number of buildings with such sensors is constantly increasing, there is a chance that a real-world scenario may happen during the project period.

Sub-Task 6.1.4 will follow a procedure very similar to that of Sub-Task 6.1.3 but will focus on the City Hall of Grenoble (Grenoble, France). The earthquake sequence scenario will be the same as for Sub-Task 6.1.3, defined by GFZ. UNINA will provide guidance on the use of state-dependent fragility functions for time-variant risk assessment in the short-term. UGA will carry out the RLA and OELF simulation, and explore the feasibility of implementing the methods developed in Task 4.4. GFZ and EUCE will provide guidance and support when required. As this Sub-Task builds upon Sub-Task 6.1.1 and Task 4.4, work will only start after Month 12.

Sub-Task 6.1.5. A 3D finite-element computer model of the Sapphire Tower in Istanbul will be created and calibrated against the existing recordings of ambient noise and earthquakes for the already instrumented building. The framework and software developed in Task 4.5 will then be tested using earthquake recordings that will be gradually scaled up to produce increasing demands. The conditions under which early warnings are issued by the system will be analysed and used to illustrate the capabilities of performance-based EEW systems. Results will be used to develop early warning criteria for aftershocks. All activities will be carried out by BOUN, with support from all partners when required. As this Sub-Task builds upon Sub-Task 6.1.1 and Task 4.5, work will only start after Month 12.

The table below shows the breakdown of Task 6.1 into subtasks.

	Short Description of Subtasks	Persons and institutions involved
subtask 6.1.1	Installation or use of various types of sensors in buildings to monitor shaking and structural health over time and after earthquakes. Establishment of the software processing chain for analysing these data.	Marius Isken, QUAKE (1PM) Philippe Gueguen, UGA (2PM) Eleni Chatzi, IBK-ETH (0.5PM[5]) Yves Reuland, IBK-ETH (1PM) John Clinton, ETH (3PM) Erdal Safak, BOUN (0.5PM) Ufuk Hancilar, BOUN (0.5PM) Cecilia Nievas, GFZ, (0.25PM)
subtask 6.1.2	Incorporation of data from low-cost sensors (Task 2.2) into the Dynamic Exposure Model of Task 2.7.	Danijel Schorlemmer, GFZ (2PM) Cecilia Nievas, GFZ, (4PM) Marius Isken, QUAKE (2PM) Philippe Gueguen, UGA (2PM)
subtask 6.1.3	OELF and RLA for seismic sequences in a test area using the Dynamic Exposure Model of Task 2.7, SHM data from low-cost sensors (Task 2.2), OEF models (WP3) and state-dependent fragility functions (Task 4.2).	Cecilia Nievas, GFZ (5PM) Danijel Schorlemmer, GFZ (1PM) Karsten Prehn, GFZ (2PM) Helen Crowley, EUCE (1PM) Jamal Dabbeek, EUCE (1PM) Philippe Gueguen, UGA (2PM) Georgios Baltzopoulos, UNINA (2PM) Eugenio Chioccarelli, UNINA (3PM)
subtask 6.1.4	Analogous to Sub-Task 6.1.3 but for instrumented buildings (City Hall of Grenoble, France)	Cecilia Nievas, GFZ (2PM) Danijel Schorlemmer, GFZ (1PM) Helen Crowley, EUCE (1PM) Jamal Dabbeek, EUCE (1PM) Philippe Gueguen, UGA (3PM) Georgios Baltzopoulos, UNINA (1PM) Eleni Chatzi, IBK-ETH (0.5PM) Yves Reuland, IBK-ETH (1PM)
subtask 6.1.5	Test of the structure-specific EEW framework developed in Task 4.5, using the Sapphire Tower (Istanbul) as a case-study.	Erdal Safak, BOUN (4PM) Ufuk Hancilar, BOUN (4PM) Eleni Chatzi, IBK-ETH (0.5PM) Yves Reuland, IBK-ETH (1PM)

Table 48. Breakdown of Task 6.1

2.5.2 Task 6.2 "Demonstrating OELF at regional and national levels: Europe and Italy"

Task Overview

The overall aim of this task is to demonstrate the OELF capabilities being developed in WP4. In this task we thus plan to undertake the following sub-tasks:

Subtask 6.2.1. Develop operational earthquake forecasts for the regions being studied. Italy will be one of the countries considered, whereas the other countries will be chosen as the activities of WP3 progress. Ideally, a European OEF will be developed in WP3 and will allow any country to be considered in this task (given that time invariant exposure and vulnerability models will be available for the whole of Europe from Task 4.2).

Subtask 6.2.2. This activity will be carried out at the scale of municipalities and regions for the Italian territory. For each municipality, the number and the typology of buildings and the number of inhabitants per building typology will be used. The mathematical framework of the OELF analyses described in Iervolino et al. (2015) will be used together with OEF from subtask 1, and time-

[5] Prof. Chatzi's contribution is covered by external funds

variant models of structural vulnerability and exposure (to be developed in Task 4.2). Losses will be computed in terms of expected values of damaged, evacuated or collapsed buildings and expected values of injured inhabitants and fatalities. Time variant vulnerability models may benefit from both RLA and SHM information (to also be explored further in Task 6.1). In order to consider the latter, the format of typical outputs from Task 4.4 should be defined before the third year of the project.

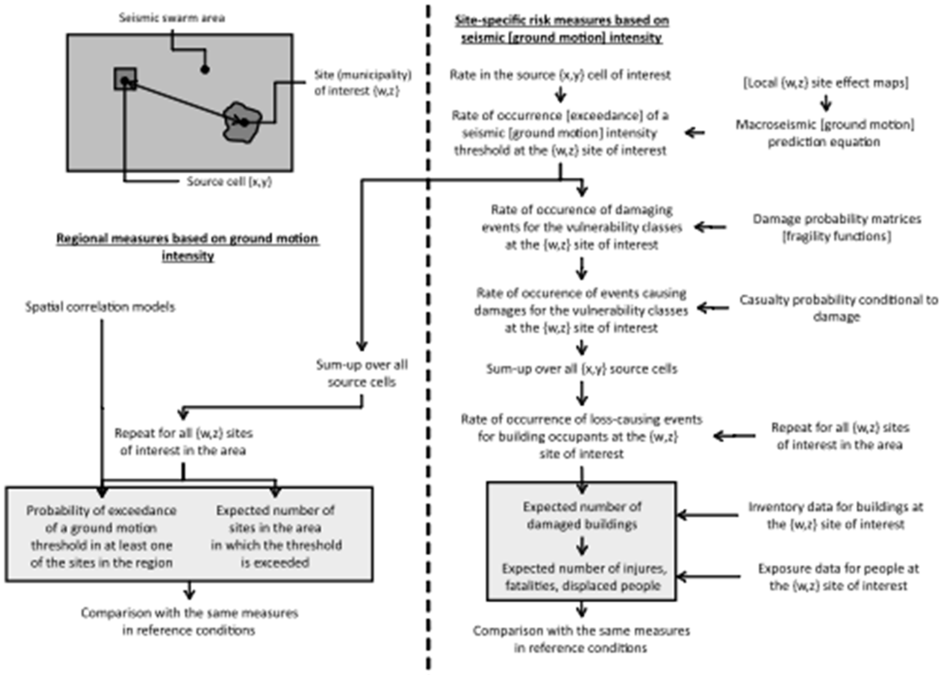

Figure 10. Summary of the short term risk assessment used for OELF (Iervolino et al., 2015)

Subtask 6.2.3. This sub task will test the use of OELF for some countries in Europe, using time invariant (static) vulnerability and exposure models from Task 4.1 and the OEF from subtask 1.

Subtask 6.2.4. We will explore how OEF and OELF results could be distributed to consumer applications connected to the Internet of Things (cars, elevators, etc.)

The table below shows the breakdown of Task 6.2 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 6.2.1	Develop OEF for Italy and other European countries for which OELF will be tested (as output of the research in WP3).	Warner Marzocchi, UNINA (1PM)
Subtask 6.2.2	Extend earthquake forecasts to OELF, as a demonstration of the research carried out in WP2, and more specifically Task 4.2. The use of time variant (dynamic) exposure and vulnerability models for Italy will be explored. Probabilistically time-dependent losses at different time and spatial scales and different probability levels will be calculated and OELF data made available to selected end-users for their decision making.	Iunio Iervolino, UNINA (2PM) Eugenio Chioccarelli, UNINA (<1PM) Pasquale Cito, UNINA (6.5PM)
	Demonstrate how to extend earthquake forecasts to OELF for some countries in Europe, using time	Helen Crowley, EUCE (2 PM) Francesco Cavalieri, EUCE (4 PM)

Subtask 6.2.3	invariant (static) vulnerability and exposure models from Task 4.1.	Researcher (TBD), EUCE (2.5 PM)
Subtask 6.2.4	Explore how OEF and OELF results could be distributed to consumer applications connected to the Internet of Things (cars, elevators, etc.)	Name Surname, Institution, (X PM)

Table 49. Breakdown of Task 6.2

References

Iervolino I., Chioccarelli E., Giorgio M., Marzocchi W., Zuccaro G., Dolce M. and Manfredi G. (2015) "Opernational (short-term) earthquake loss forecasting in Italy", BSSA, 105(4), pp. 2286-2298.

2.5.3 Task 6.3 "Application of the chain from earthquake predictability to EEW and RLA in Iceland"

Task description

The main objective of this task is to demonstrate many of the developments made in WP2 and WP3, with a specific focus on Iceland.

Sub-task 6.3.1 will demonstrate improved observation capabilities of new sensor networks, including the possibility of using a suitably located fiber-optic telephone cable (Task 2.1) in the South Iceland Seismic Zone (SISZ).

Sub-task 6.3.2 will test operational earthquake forecast models (WP3) using Icelandic sequences. Since 2016 'Mapseis' automatically runs an ETAS forecast for M=3.5 and M=6.5 events in the SISZ and Reykjanes Peninsula (RP) once a day, at 1AM. Recent seismicity data will be used to test these forecasts. An improved earthquake catalogue is also being developed that may help improve the temporal resolution of changes in seismicity.

Sub-task 6.3.3 will use Iceland as a detailed test case for the Rapid Loss Assessment (RLA) services developed in WP4, before finalising these services and demonstrating their capabilities in Task 6.5. This activity will thus be mainly undertaken between months 12 and 24 so that feedback can be provided to sub-task 6.5.2 which will be mainly carried out between months 24 to 36.

Sub-task 6.3.4 In this task, risk-cost-benefits of different options for a real-time risk reduction capacity for Iceland will be simulated. This task will be mainly undertaken by ETH.

The table below shows the breakdown of Task 6.3 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
Subtask 6.3.1	Demonstrate improved observational capabilities by integrating new sensor networks and processing tools from WP2	Post-doc, IMO, (2 PM) ETH,
Subtask 6.3.2	Test existing and new OEF models (WP3) on Icelandic sequences	Post-doc, IMO (2 PM)
Subtask 6.3.3	Install RLA capability for Iceland	Helen Crowley, EUCE (2 PM) Francesco Cavalieri, EUCE (2PM)

		Researcher (TBD), EUCE (2.5 PM) Sylvain Julien-Laferriere EMSC (1PM) Post-doc, IMO (2 PM)
Subtask 6.3.4	Simulate Risk-Cost-Benefits of different options for a real-time risk reduction capacity for Iceland	ETH, Post-doc, IMO (2 PM)

Table 50. Breakdown of Task 6.3

2.5.4 Task 6.4 "Application of a User-Centric Dynamic Risk Framework for Switzerland"

Task Overview

Switzerland is a country of moderate seismicity but high seismic risk, owing to the high population and infrastructure density, and the historical building stock. Switzerland also operates one of the densest and most modern seismic networks in Europe: The Swiss Seismological Service currently processes real-time data from about 250 broadband and strong motion stations, with an average station spacing of less than 10km. The network operates a prototype SeisComp3 based EEW system, including a User display created in the REAKT project; shake maps are computed and web-based Did You Feel It? (DYFI) surveys conducted. A traditional national risk model that includes a national site amplification layer, and a national inventory of all buildings, will be available by 2021. Within RISE, we will integrate all real-time risk-related components already available with numerous new developments to create a single dynamic risk platform. This will demonstrate the potential of the Approach and technologies and lead to a measurable improvement in the resilience of Switzerland. Specifically, we will:

Sub-task 6.4.1 Demonstrate improved observational capabilities through the integration of new sensors (Task 2.2) and new processing tools (Task 2.4) as well as continuous real-time search for precursory signals in geodetic and ambient noise correlations (Tasks 2.5 and 3.1).

Sub-task 6.4.2 Develop a national Dynamic Risk Information Service (DRIS) that will serve to a wide range of stakeholders in real-time harmonized and standardized information on dynamic risk (namely EEW, OEF, OELF, RLA). Information will be available via standardised web services to all applications connected to the IoT, we will demonstrate this capability with selected industry applications.

Sub-task 6.4.3 Demonstrate the targeted two-way communication strategy for Switzerland (T5.1) and improved tools for multi-hazard warning and information using web and app-based techniques (T5.3).

Sub-task 6.4.4 Illustrate an example risk-cost-benefit analysis (developed in Task 4.6) that evaluates available developing pathways from a socio-economical perspective, resulting in a white-paper on real-time earthquake risk reduction options for Switzerland.

We will use the Nov. 2019 Sion earthquake sequence as a template for the current state of practise for OEF and network processing in Switzerland, allowing us to define a roadmap forward but also to measure progress achieved.

The table below shows the breakdown of Task 6.4 into subtasks.

	Short Description of Subtasks	**Persons and institutions involved**
Subtask 6.4.1	Demonstrate improved observational capabilities in Switzerland using the developments of WP2	Luca Scarabello, ETH, (2 PM) Tobias Diehl, ETH, (1 PM) John Clinton, ETH, (0.5 PM) NN QUAK
Subtask 6.4.2	Develop a national Dynamic Risk Information Service (DRIS)	Philipp Kaestli, ETH (3 PM) Daniel Ambrister, ETH (4 PM) Laura Sarson, ETH, (4PM) Helen Crowley, EUCE (0.5 PM)
Subtask 6.4.3	Demonstrate two-way communication strategy for Switzerland (link to WP5)	Irina Dallo, ETH, PhD, (3 PM) Michèle Marti, ETH (1 PM) Sarah Dryhurst, UCAM (<1PM)
Subtask 6.4.4	White-paper on real-time earthquake risk reduction options for Switzerland (Link to task 4.6)	Maren Boese, ETH, (2 PM) Banu Mena Cabrera (1 PM) Stefan Wiemer (<1PM) John Clinton (<1PM) Carlo Cauzzi (<1PM)

Table 51. Breakdown of Task 6.4

2.5.5 Task 6.5 "Demonstrating RLA, EEW and OEF capabilities at a European level"

Task Overview

This task links with the databases and services for RLA and OELF developed in Task 4.1. Given that this WP depends on the results of WP4, all partners in this task will be actively involved in WP4 to ensure the input products are ready for demonstration of the operational capabilities of the RLA and OELF services from month 24-36. The majority of the input from WP4 will need to be undertaken during the first 18 months such that the final 18 months (months 18-36) will be focused on undertaking subtasks 6.5.1 to 6.5.4 described in the table above. On the other hand, Subtask 6.5.5 can and should begin earlier, to provide feedback to the outputs of the services.

Subtask 6.5.1. As described in WP4, the three pillars of EPOS (ORFEUS, EMSC and EFEHR – represented in RISE though ETH, KNMI, INGV and EUCE) plan to work together to develop a European ShakeMap Service. Following the technical improvements to the service that will be undertaken in Task 4.1 (prototype available here: http://shakemap-eu.ethz.ch/), testing and demonstration of the service will be undertaken in this sub-task.

Sub-Task 6.5.2 Based on the outcomes of Task 4.1 (where the European ShakeMap service will be linked with time invariant European exposure and vulnerability services and the OpenQuake-engine) a Rapid Loss Assessment service will be made available and it will be tested and demonstrated in this task for a number of countries in Europe, also accounting for the lessons learned in the application of the service to Iceland in Task 6.3. This task will be mainly undertaken by EUCE with support from EMSC.

Sub-Task 6.5.3. The Operational Earthquake Forecasting service developed in WP3/Task 4.1 will be tested and demonstrated in this task for a number of countries in Europe. This task will be mainly undertaken by UNINA.

Sub-Task 6.5.4. Following the testing of the components of the Operational Earthquake Loss Forecasting service for a number of countries in Task 6.2, it will be shown in this sub-task that the service can be made operational for Europe. This task will be mainly undertaken by EUCE with support from UNINA.

Sub-Task 6.5.5. In this sub-task we will explore how to effectively communicate the outputs of RLA and OELF results for different stakeholders, from Civil Protection Agencies to (potentially) the general public. This task will link up with the activities of WP5 (Task 5.1). Existing outputs of OELF (e.g. Figure 11) and RLA (e.g. Figure 12) will be evaluated by different stakeholder groups. This task will be undertaken by UCAM and ETH with support from EMSC and EUCE.

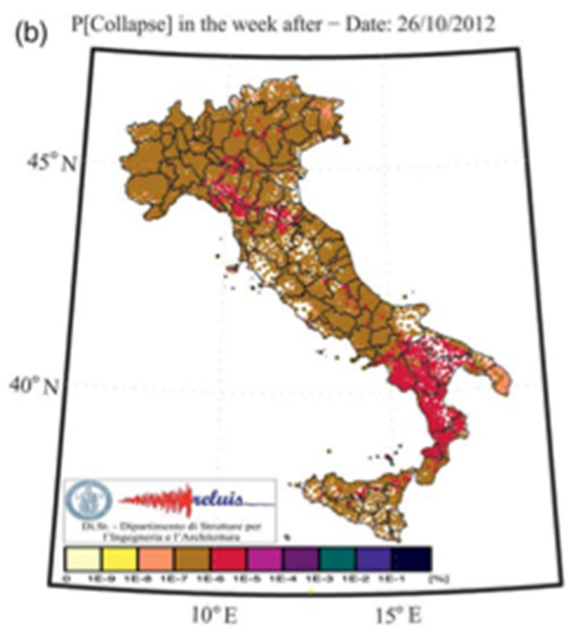

Figure 11. Example output of OELF: weekly probability of collapsed buildings

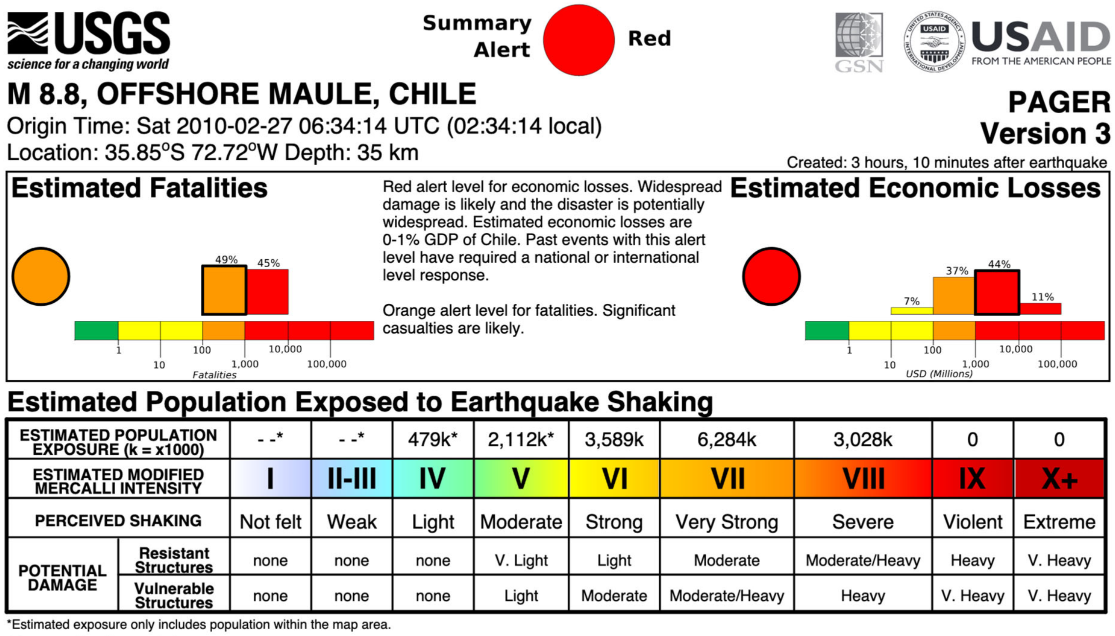

Figure 12. Example output of RLA: PAGER Earthquake Impact Scale

The table below shows the breakdown of Task 6.5 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 6.5.1	Testing and verification of the capabilities of the European ShakeMap service	Carlo Cauzzi, ORFEUS-ETH Alberto Michelini, ORFEUS Rémy Bossu, EMSC Sylvain Julien-Laferrière, EMSC Phillip Kästli, ETH Reinoud Sleeman, KNMI Helen Crowley, EUCENTRE, (< 1PM)
Subtask 6.5.2	Testing and verification of the European Rapid Loss Assessment service	Helen Crowley, EUCENTRE (1 PM) Francesco Cavalieri, EUCENTRE (2 PM) Sylvain Julien-Laferriere EMSC (2PM)
Subtask 6.5.3	Testing and verification of European Operational Earthquake Forecasting service	Warner Marzocchi, UNINA (2PM)
Subtask 6.5.4	Testing and verification of the European Operational Earthquake Forecasting Loss service	Helen Crowley, EUCENTRE (1 PM) Francesco Cavalieri, EUCENTRE (2 PM) Pasquale Cito, UNINA (0.5PM)
Subtask 6.5.5	Explore the communication of RLA and OELF results for different stakeholders, from Civil Protection Agencies to (potentially) the general public	Alexander Freeman, UCAM (<1PM) Sarah Dryhurst, UCAM (4PM) Michele Marti, ETH (1PM) Laure Fallou, EMSC (1PM) Helen Crowley, EUCE (<1PM)

Table 52. Breakdown of Task 6.5

2.6 Work Package 7 – TESTING

"Rigorous testing and validation of dynamic risk components"

Lead: GFZ
Authors: Danijel Schorlemmer, Asim Khawaja, Max Werner

General Description of Work Package 7

Rigorous testing and validation of all dynamic risk model components is critical to enable hypothesis-driven research and to allow societies to appraise and confidently adopt models for decision-making and loss reduction. Earthquake risk-related decisions, especially during seismic crises, are generally very costly, often controversial and sometimes a question of life and death. The science, methods and tools underpinning these decisions must, in our view, be rigorously tested. To avoid cognitive biases, evaluations must be conducted independently from model owners and follow community-accepted standards. Model evaluations and comparisons provide independent benchmarking, enabling users to assess the relative utility of new forecast models.

Aside from model selection, performance evaluation also forms the backbone of building robust and dynamically weighted ensemble models. RISE WP7 addresses the testing, model evaluation, model validation and ensemble modelling by adopting and transforming the CSEP. CSEP is a global platform for independent, reproducible and transparent testing of earthquake prediction algorithms and forecast models. Learning from best practices in other science disciplines, and coordinating with the global CSEP community, we will transform and expand the CSEP platform to suit the testing needs of OEF. We will design a more flexible and sustainable framework (nicknamed here CSEP2.0) with significantly improved testing capabilities to enable the transfer of scientific knowledge and models (→WP2-5) to trusted operational tools for loss reduction (→WP8).

Partner number and short name	PM
ETH Zürich	4.00
GFZ	40.00
UBRIS	4.00
UEDIN	17.00
UNINA	19.00
BIU	4.00
UKRI	1.00
QUAKE	3.00
Total	92.00

Table 53. Beneficiaries and Person Months per Beneficiary for WP7

Deliverable Number	Deliverable Title	Lead beneficiary	Type	Dissemination level	Due Date (in months)
D7.1	Distribute new CSEP2.0 software code	GFZ	Other	Public	24

D7.2	Report on first results of key hypothesis testing	GFZ	Report	Public	24
D7.3	How to define the best OEF model to be used for societal purposes: ensemble modelling	UNINA	Report	Public	24
D7.4	Testing centre software codes for high-density testing of non-linear ground-motion models and high-resolution exposure/risk models	GFZ	Other	Public	24
D7.5	Report on the test metrics of non-linear ground-motion models and high-resolution exposure/risk models	BOUN	Report	Public	24
D7.6	Report presenting first results of the prospective study	GFZ	Report	Public	36
D7.7	Distribute ground-motion testing software codes	GFZ	Other	Public	36
D7.8	Report on first results of ground-motion testing	GFZ	Report	Public	36

Table 54. List of Deliverables for WP7

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS22	OEF output format for testing	INGV	6	Format define, and validated by WP leader 3, 7
MS45	Concept for modularization	GFZ	6	Concept ready check WP lead
MS46	Data object and format definition for exchange between modules	GFZ	9	Concept ready check WP lead
MS47	EU Testing centre at GFZ fully operational	GFZ	24	Service online, Check ExeCom & SP
MS48	Software development for tailored experiments completed	UNIVBRIS	12	Software tested, check WP lead
MS49	Implementation of key hypothesis tests and new metrics	UNIVBRIS	24	Hypotheses implemented. Check WP L
MS50	Complete test runs for all key hypotheses	UNIVBRIS	33	Test results published, check ExeCom
MS51	Review of ensemble modelling procedures in other fields	INGV	12	Review complete. checked by WP leaders
MS52	Definition of a set of ensembles modelling procedures to be applied in the CSEP framework	INGV	24	Ensemble approach ready, check by WP Lead
MS53	Development of instrumental intensity computation for IoT sensors	QUAKE	6	Codes ready, check by ExeCom
MS54	Development of test metrics for micro-zonation and groundmotion model testing using high-density sensor networks	GFZ	24	Testing metric ready, check ExeCom
MS57	First version of standardised exchange protocol released	ETH	18	Protocol released, check ExeCom

Table 55. List of Milestones for WP7

Overall management and communication

This work package is strongly dependent on work packages 2 and 3. Therefore, we will set up bi-weekly management calls with the WP leaders and calls with participants. It will be crucial to integrate the model development in WP2 & WP3 with the testing in WP7. The key approach for this integration is to have every modeller becoming part of the testing team. Each modeller will have to design and implement the test(s) for their model in collaboration with the WP7 team, which will help with the integration into the testing centre. This goal can only be achieved through intensive communication and regular workshops. We plan to have a first workshop of the modeller/tester group in early January.

Because of the strong dependence of this work package on the activities in other packages, this management plan needs to be updated regularly to reflect the arising needs for the testing group as well as the adaptions other WPs have to make to accommodate the testing needs.

We identify several risks for the deliverables of WP7. While the development of CSEP2.0 components is an independent task, meaningful tests using the new software stack are truly dependent on the availability of testable models from WP3. Similarly, the availability of the European dynamic exposure model is a prerequisite for the exposure testing in Task 7.4. The testing of high-resolution ground-motion models will fully depend on the distribution of sensors and the occurrence of earthquakes in the test region(s).

Overall task description

One of the main goals of RISE is to improve the quantification of dynamic risk and support those who make decisions to mitigate that risk and minimise loss. This involves forecasting future hazards and risks, and testing the effectiveness of the forecasts using different hypotheses and methods (→WP3), novel technologies (→ T2.1, 2.2) and higher resolution data sets (→ T2.4). Testing allows us not only to measure and improve the forecast accuracy and precision, but also to test the hypotheses themselves, and hence improve our understanding of the Earth. Such ‘blind tests’ have long been the gold standard for proof in science and medicine. No medication would be allowed on the market that has not been certified in meticulous, formal testing, e.g. employing double-blind studies. The standards in earthquake science, on the other hand, have been highly variable in the past decades and sometimes found lacking. We believe that no OEF, EEW or RLA method should be applied that has not been certified by a community-endorsed validation programme. Accordingly, we will use and advance state-of-the-art testing protocols for evaluating the consistency and quality of our forecasting models, including their accuracy and precision, and the utility of the platforms we will develop to inform decision making. Retrospective tests are a necessary, but not sufficient, condition for developing effective prospective forecasts. We will therefore also conduct fully prospective tests, which often require continuous operation over 5–10 years to deliver meaningful results about moderate to large earthquakes.

The CSEP Collaboratory has greatly improved the quality and rigour of scientific research on earthquake forecasting and predictability. CSEP also helped the community overcome a standstill due to fragmentation and controversy. We can now fully exploit and build on CSEP’s achievements, overcoming current limitations by transforming CSEP while paving the way towards a sustainable long-term effort within EPOS.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Milestones*
Task 7.1	Asim Khawaja - GFZ	1/9/19	31/8/22	D7.1
Task 7.2	Max Werner - UNIVBRIS	1/9/19	31/8/22	D7.2, 7.6
Task 7.3	Warner Marzocchi - UNINA	1/9/19	31/8/22	D7.3
Task 7.4	Danijel Schorlemmer - GFZ	1/9/19	31/8/22	D7.4, 7.5, 7.7, 7.8

Table 56. List of Tasks of WP5

2.6.1 Task 7.1 "Developing and implementing the CSEP2.0 framework and test-centre"

Task Overview

In Task 7.1 we will develop the new version of the CSEP software stack, called CSEP2.0. The software stack will be transformed from a monolithic system into a modular set of primitives and functions that can be combined with simple scripting, following the recently defined community roadmap. The modular approach will allow to script new experiments with greater flexibility in the setup of new styles of tailored experiments to tackle scientific questions that we were not able to address with the old system. This will allow to reuse all core parts of the old system but grant new flexibility in the setup of new styles of tailored experiments to tackle scientific questions that we were not able to address with the old system. A further advantage of the modular system will be possibility of modellers to use CSEP2.0 for their own research and model development.
Likewise, the new RISE testing centre will be setup using the CSEP2.0 software stack. We will first clone the Japan testing centre and then re-implement it using the new system for comparison. In a second step, the European testing centre experiments will be merged into the RISE testing centre.

The new EU testing centre will be installed as an EPOS service. The EU testing centre will operate in close coordination with the US/SCEC and New Zealand testing centres.
In a next step, we will add new data products, e.g. synthetic catalogues and new input data streams as experiments designed by the WP3 will demand. These new experiments will also demand new testing metrics that need to be implemented.

All mentioned developments will be carried out in close coordination with the US/SCEC and NZ testing centres, with the goal of a common, shared code base that can continue to be used globally yet flexibly. We will extend the RISE testing centre and CSEP2.0 in ways that will enable independent and rigorous testing of induced seismicity forecast models.

<u>Activities in the next 12 months</u>
Subtasks 1 & 2: We plan to complete the milestone MS45 "Concept for modularization", the basis for further software developments.

Subtask 3: First part of the implementation of the new software stack shall be finished within the first year.
Subtasks 4 & 5: First new data products and test metrics will be implemented if experiments in WP3 have been designed.

<u>Activities in months 12-24</u>
Subtask 3: Completion of the CSEP2.0 software stack.
Subtasks 4 & 5: Implementation of new data products and new test metrics as necessary for the experiments defined in WP3.
Subtask 6: Implementation of the RISE testing center to be populated with experiments.

The table below shows the breakdown of Task 7.1 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
Subtask 1	Design of the CSEP2.0 software structure	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC); Max Werner (UNIVBRIS); Warner Marzocchi (UNINA)
Subtask 2	Design of the new testing centre software system	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC); Max Werner (UNIVBRIS); Warner Marzocchi (UNINA)
Subtask 3	Implementation of the CSEP2.0 software stack	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC);
Subtask 4	Implementation of new data products	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC); Max Werner (UNIVBRIS); Warner Marzocchi (UNINA)
Subtask 5	Implementation of new testing metrics	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC); Max Werner (UNIVBRIS); Warner Marzocchi (UNINA)
Subtask 6	Implementation of the RISE testing centre	Asim Khawaja, Thomas Beutin, Pablo Iturrieta, Danijel Schorlemmer (GFZ); William Savran (USC);

Table 57. Breakdown of Task 7.1

2.6.2 Task 7.2 "Test new physics-based, stochastic and hybrid OEF models"

Task Overview

Task 7.2 forms a critical component of the RISE project, because it contains the formal retrospective and prospective evaluation of the new generation of short-term forecasting models developed in WP3. The task requires strong coordination between WP3 and WP7. Subtask 1 involves an evaluation of new physics-based Coulomb rate/state friction earthquake forecast models developed in WP3 against past earthquakes in the CSEP Italy testing region, as well as a comparison of the models' predictive skill against other models already implemented within CSEP Italy during

CSEP1. This will be a major step forward in the development and assessment of the Coulomb stress hypothesis for earthquake triggering at a national level, and require the CSEP2 formats and procedures to be in place. Subtask 2 will test the new stochastic and hybrid forecast models from WP3 in the same manner against past earthquakes in the CSEP Italy testing region, and compare their performance against other existing CSEP Italy models. Subtask 3 comprises the potential recalibration of these models for prospective and automated forecasting within the new CSEP2 testing centre for the Italian testing region. Finally, subtask 4 will develop testable expressions of key hypotheses of earthquake occurrence models. These will be chosen after discussion and co-ordination amongst the participants from a number of candidates, including spatially- and/or temporally varying b-values, models of foreshock probabilities, presumed differences between on/off-fault earthquakes and the long-term stability of earthquake rates.

Activities in the next 12 months

Develop an inventory for data types to be accommodated by CSEP (month 12)

Identify how to put forecasts from INLABRU from Task 3.3 software into CSEP (month 12)

Activities months 12–36

Assess impact of mesh design on model evaluation for complex, high spatial-resolution forecasts, e.g. those based on fault maps (month 18)

Evaluate the potential for INLABRU to improve generation, evaluation and forecasting power of OEF (month 36, feeding into D7.2).

The table below shows the breakdown of Task 7.2 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
Subtask 1	Retrospective evaluation of new physics-based models (from WP3) against past earthquake sequences in Europe and comparison against existing CSEP Italy models	Junhao Cheng (UEdin) Margarita Segou (BGS) Max Werner (UBris)
Subtask 2	Retrospective evaluation of new stochastic and hybrid models (from WP3) and comparison against existing CSEP Italy models	Max Werner (UBris) Lizhong Zhang (UBris)
Subtask 3	Prospective model calibration and installation of physics based, stochastic and hybrid models to prospective CSEP Italy testing region	Junhao Cheng (UEDIN) Max Werner (UBris) Danijel Schorlemmer (GFZ) Bill Savran (SCEC) Warner Marzocchi (UNINA)
Subtask 4	Tailored experiments to test key hypotheses of time-independent and time-dependent models (spatially varying b-values; stability of long-term rates; foreshock probabilities)	Coordination by: Danijel Schorlemmer (GFZ) Stefan Wiemer (ETH) Warner Marzocchi (UNINA) Ian Main (UEDIN) Max Werner (UBRIS)

Table 58. Breakdown of Task 7.2

2.6.3 Task 7.3 “Optimizing earthquake forecasting capabilities through ensemble modelling”

Task Overview

Activities in the next 12 months

Subtask 1: In the first year we plan to complete the milestone MS51 " Review of ensemble modelling procedures in other fields", which is an essential step to take advantages from the work made in different fields, and to understand what we can do better,

Subtask 2: In the first year, we plan to define the general innovative probabilistic framework that can be applied for OEF purposes.

Subtask 3: In the first year we plan to develop the general scheme of the hybrid model, which merges the skill of physics-based and stochastic models.

Activities in months 12-24

Subtask 1: In the second year, we plan to prepare a scientific paper on the content of milestones MS51 that has been prepared in the first year.

Subtask 2: In the second year, we finalize the deliverable D7.3 "How to define the best OEF model to be used for societal purposes: ensemble modelling", which may be applied for OEF purposes

Subtask 3: In the second year, we plan to prepare a code of a hybrid model which may be submitted for testing.

The table below shows the breakdown of Task 7.3 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
Subtask 1	Review of the existing ensemble model strategies	Warner Marzocchi 1 Postdoc UNINA
Subtask 2	Developing innovative ensemble modelling strategies	Warner Marzocchi 1 Postdoc UNINA
Subtask 3	Hybrid physical/stochastic models	Max Werner 1 postdoc Ian Main

Table 59. Breakdown of Task 7.3

2.6.4 Task 7.4 “Formal testing of ground motion forecasts, micro-zonation, exposure and loss models”

Task Overview

This task expands the CSEP software stack for the testing centre system to accommodate other components of the seismic hazard and risk chain beyond the seismicity forecasts. The logical first step in this expansion strategy is to get ground-motion models into the testing framework. We will revisit the tests performed so far and implement the most effective ones, considering the notion of hazard testing too. In a first step these procedures will be implemented in a separate testing workflow for research on ground-motion models in collaboration with the URBASIS project. Upon successful evaluation of the software implementation, it will be transferred into the testing centre software stack. This approach will be the same for all components of the new tests developed in this task.

As soon as a larger set of sensors has been brought out for high-resolution ground-motion measurements, we will combine the testing routines with this data to test the local amplification model for the very area with the sensors.

<u>Activities in the next 12 months</u>

Subtasks 1: Compilation of sets of observational data for ground-motion model testing.

Subtask 2 & 3: First testing workflow will be implemented using evaluated test metrics for ground-motion model testing.

<u>Activities in months 12-24</u>

Subtask 5: Moving the testing codes for ground-motion models into the testing center.

Subtasks 6: Implementation of testing metrics for hazard testing.

The table below shows the breakdown of Task 7.4 into subtasks.

Subtask	**Short Description of Subtasks**	**Persons and institutions involved**
Subtask 1	Compilation of ground-motion data for retrospective and pseudo-prospective tests.	Karina Loviknes (GFZ)
Subtask 2	Implementation and evaluation of testing metrics for ground-motion models.	Karina Loviknes, Pablo Iturrieta, Danijel Schorlemmer (GFZ), Warner Marzocchi (UNINA)
Subtask 3	Implementation of the testing workflow for ground-motion models.	Karina Loviknes, Pablo Iturrieta (GFZ)
Subtask 4	Combination of high-resolution local amplification measurements with ground-motion model tests.	Karina Loviknes, Fabrice Cotton, Danijel Schorlemmer (GFZ)
Subtask 5	Testing of ground-motion models in the testing center	Karina Loviknes, Asim Khawaja, Pablo Iturrieta, Fabrice Cotton, Danijel Schorlemmer (GFZ), William Savran (USC)
Subtask 6	Implementation and evaluation of hazard testing metrics.	Pablo Iturrieta, Karina Loviknes, Fabrice Cotton, Danijel Schorlemmer (GFZ)
Subtask 7	Implementation of loss testing metrics.	Cecilia Nievas, Karsten Prehn, Pablo Iturrieta, Danijel Schorlemmer (GFZ)

Table 60. Breakdown of Task 7.4

2.7 Work Package 8 – IMPACT

"Exploitation, dissemination and services for securing a demonstrable societal, economic and scientific impact of RISE"

Lead: ETH
Authors: Michele Marti

General Description of the WP8

WP 8 focuses on securing the broad societal, economic, and scientific impact of RISE; an impact which is both demonstrable and long-term. This process will start on day one of the project, continue throughout, and expose all activities in RISE to an ongoing dialogue targeting stakeholder and end-user needs. Supported by the RISE stakeholder panel, WP8 adopts an interdisciplinary and multi-hazard user perspective and translates all RISE outputs and deliverables into tangible products and services, useful for and used by a wide range of stakeholders. WP8 contains a comprehensive set of communication, dissemination, exploitation, and decision-support actives, prioritised in relation to what is needed to maximise impact:

- RISE will implement and periodically review a comprehensive Plan for the Exploitation and Dissemination of Results (PEDR).
- Standardisation is a key enabler of interoperability and community uptake. RISE will define protocols and standards (e.g., meta-data, web-services) for automated broadcasting and accessing dynamic risk information.
- RISE will enrich existing operational services and create new services at the local, national, and European level. Long- term operation of services will be ensured through national agencies and EPOS.
- RISE offers a wide range of dissemination and external communication activities, including workshops, best practise series or reports and a web page.
- Technology and knowledge transfer are important contributions to exploitation and dissemination. This includes interaction with industrial partners, capacity building, training, and establishing good practise.

Partner number and short name	PM
ETH	24.00
GFZ	1.00
INGV	2.00
IMO	2.00
UNIBO	2.00
UNIVBRIS	2.00
UEDIN	1.00
UNINA	8.00

BIU	2.00
EUCENTRE	6.00
EMSC	4.00
UGA	2.00
UCAM	6.00
BOUN	2.00
ST-I (to be replaced)	6.00
UniBg	2.00
QUAKE	2.00
Total	80.00

Table 61. Beneficiaries and Person Months per Beneficiary for WP8

Delivera-ble Num-ber	Deliverable Title	Lead ben-eficiary	Type	Dissemina-tion level	Due Date (in months)
D8.1	Update PEDR (month 3)	ETH	Report	Public	3
D8.2	Update PEDR (month 12)	ETH	Report	Public	12
D8.3	Update PEDR (month 24)	ETH	Report	Public	24
D8.4	Description of standards for dynamic risk services	ETH	Report	Public	18
D8.5	Report on the sustainable operation of dy-namic risk services within EPOS	ETH	Report	Public	36
D8.6	Harmonised platform for OEF forecasts and ensemble models	ETH	Demonstrator	Public	30
D8.7	EU forecast testing centre operational	ETH	Demonstrator	Public	36
D8.8	EU RLA service operational	ETH	Demonstrator	Public	36
D8.9	OEF services in Italy, Switzerland and Eu-rope wide operational	ETH	Demonstrator	Public	36
D8.10	External Newsletter released (month 6)	ETH	Websites, pa-tents filling, etc.	Public	6
D8.11	External Newsletter released (month 18)	ETH	Websites, pa-tents filling, etc.	Public	18
D8.12	External Newsletter released (month 36)	ETH	Websites, pa-tents filling, etc.	Public	36

Table 62. List of Deliverables for WP8

Milestone number	Milestone title	Lead bene-ficiary	Due Date (in months)	Means of verification
MS16	Database with the earthquake catalogue for internal dissemination	UNINA		Database validated and online, check by WP leader
MS18	Finalisation of the whitepaper and selection of the preferred technical solutions	KNMI	18	Paper ready and checked by ExeCom
MS22	OEF output format for testing	UNINA	6	Format define, and vali-dated by WP leader 3, 7
MS43	Dynamic risk services for Switzerland operational	ETH	30	Service online, Check ExeCom & SAB

MS55	Implementation of periodic monitoring of Key Performance Indicators	ETH	6	Monitoring operational, check ExeCom
MS56	Community agreement on requirements and technical baseline for dynamic risk service standardisation	ETH	9	Concept for a standardisation document, check ExeCom
Con	First version of standardised exchange protocol released	ETH	18	Protocol released, check ExeCom
MS58	First new EPOS service operational	ETH	36	Service online, Check ExeCom & SP
MS59	RISE web page fully operational	ETH	4	website online, check ExeCom
MS60	15th publication related to RISE submitted	ETH	20	papers on website, check ExeCom
MS61	3rd best practise report online	ETH	24	Report online, check ExeCom
MS62	First Training workshop conducted	ETH	18	Workshop conducted, check ExeCom
MS63	Final conference conducted	ETH	36	Meeting minutes and beneficiary participation recorded

Table 63. List of Milestones for WP8

Overall management and communication

WP 8 will manage and communicate according to the needs of the different tasks.

For tasks 8.1 and 8.4, most of the work will be conducted at ETH with input from the whole consortium. Therefore, inputs from project partners has to be requested regularly. This will mostly have via email and via announcements at annual meetings.

For tasks 8.2 and 8.3 a working group needs to be established, which has a regular exchange via email and skype and meets at least every half a year to discuss current progress and future activities.

Task summary				
	Lead Institution and Task Leader	Start Date	End Date	Linked Deliverables and Milestones
Task 8.1	Michèle Marti – ETH	2019/09	2022/08	D8.1, 8.2, 8.3
Task 8.2	Philipp Kästli – ETH	2019/09	2022/08	D8.4, 8.6, 8.7, 8.8 MS 22, 18, 57, 16, 58
Task 8.3	Michèle Marti – ETH	2019/09	2022/08	D.8.5, 8.9 MS62, 43
Task 8.4	Michèle Marti – ETH	2019/09	2022/08	D8.10, 8.11, 8.12 MS59, 60, 61, 62, 63

Table 64. List of Tasks of WP8

2.7.1 Task 8.1 "Plan for the Exploitation and Dissemination of Results (PEDR)"

Task Overview

Activities in the next 12 months:

During the first 12 project months, the first version of the Plan for the Exploitation and Dissemination of Results (PEDR) will be compiled by the communications team at ETHZ. It will define different measurements how to evaluate the projects impact with verifiable data. The quantitative data measured will cover the following dimensions: website users, Twitter followers, newsletter subscribers, number of publications in renowned journals, participants of stakeholder exchange (workshops, discussion rounds during conferences, access programmes, and presentations).

The communications team will also define minimal numbers that need to be reached in order for the impact to be considered sufficient. The result of this first PEDR will then additionally become the first deliverable to be handed in towards the end of M4, D8.1.

A second, updated PEDR will need to be compiled in M13. In the meantime, the PEDR will be re-evaluated and adapted in order to determine whether the measurements taken into account are still relevant and can holistically describe the project's impact or if some of them need to be adapted or exchanged with other measurements.

In order to be able to compile each PEDR, the communications team will reach out to the work package leaders one month before the PEDR's deadline and ask for the relevant data. Along with the request, they will provide the work package leaders with a template that needs to be filled in for each reporting period. In the template, the team asks for the details on the qualitative impact of the project, consisting in a short report of 250 to 500 words describing their impact with regards to science, society, technology, and economy.

Crucial for all of the abovementioned work is the collaboration of the work package leaders and the communications team. This task cannot be executed if the communications team does not receive the requested input by the set deadline.

Activities months 12 – 36

The PEDR will be updated continuously as was described above in order to define the most adequate definition of a project's impact on society. Updated PEDRs need to be compiled for project months M13 and M25. Beginning in M15, actions will be determined in order to improve the statistics and heighten the impact.

Simultaneously, the work package leaders will repeatedly be asked to fill in the abovementioned template to report on their work. Again, this task is depending on the input of the task leaders.

The table below shows the breakdown of Task 8.1 into subtasks.

Subtask	Short Description of Subtasks	Persons and institutions involved
Subtask 8.1.1 Quantitative measurements	The measurements in order to control the quantitative impact of the project's results need to be set. So far, the following measurements are taken into account: • Number of website users • Twitter followers • Newsletter subscribers • Number of publications in renowned journals • Participants of stakeholder exchange (workshops, discussion rounds during conferences, presentations, access programs)	Communications team, ETHZ, keeping track of the different measurements, updating the measurements if needed. All project members, providing input (numbers of visitors, information about published articles, etc.)
Subtask 8.1.2 Qualitative measurements	In order to measure the project's qualitative impact, each work package will need to create a report for each reporting period. The report consists of 250 to 500 words and should summarise the impact that was achieved during the last reporting period with regards to science, society, technology, and economy. A template will be provided to the WP leaders.	Communications team, ETHZ, creating template, compiling final report summarising each WPs findings All WP leaders, filling in the reports every reporting period

Table 65. Breakdown of Task 8.1

2.7.2 Task 8.2 "Standardization of data and data access services"

Task Overview Activities in the next 12 months

Task 8.2 focuses in the next twelve months on setting the baseline to establish operational dynamic risk services for Europe. To this aim, technical standards need to be defined, documented, and established in close collaboration with the community.

Activities months 12 – 36

After the first year, a white paper will describe the preferred technical solution. A workshop with the partners involved will be conducted to discuss the first outline of the white paper and therewith set the baseline for the upcoming deliverables at the end of the project.

Task Breakdown

Subtask	Short description of the subtasks	Persons and institutions involved
Subtask 8.2.1 OEF output format testing	OEF testing capabilities already exist (CSEP 1); operation capabilities are under development (RT-RAMSIS). However, input and output parameters and formats need to be homogenized, extended, implemented in the respective platforms, and documented for model contributors. Development of CCEP2 platform following Schorlemmer (2018). Responsibility and location of forecast testing center to be negotiated. It could become an EFEHR task.	Philipp Kästli, ETH will coordinate this milestone with Danijel Schorlemmer, GFZ. Software development organized by GFZ; Operations: to be decided.
Subtask 8.2.2 Description of standards for dynamic risk services	This is an important deliverable, which should incorporate all previous milestones and already define a vision for MS18 dedicated to the whitepaper describing preferred technical solutions.	New person hired at ETH in collaboration with task leader and a network of involved partners. Task 5.1 shall contribute their vision an public display of dynamic risk services.
Subtask 8.2.3 Harmonised platform for OEF forecasts and ensemble models	This task brings together the achievements made in other RISE work packages namely WP3 and WP6. It builds on the different preceding milestones. Suggested to extend the currently developed RT-RAMSIS platform for time-dependent induced seismicity to time-dependent natural seismicity	SED IT dev team to implement in collaboration with task leader and a network of involved partners
Subtask 8.2.4 Rapid loss assessment software; including operational setup for Europe	Integration of Shakemap (extended for probabilistic path effects) with OpenQuake Risk stage. To be decided: Alerting Service?	Event data source by EMSC, ground motion data source by ORFEUS Exposure and vulnerability data by SERA, updated by WP4 Software integration by ORFEUS/SED IT dev/op teams (contributions by EUCE)
Subtask 8.2.5 Establishing operational capability of services	Ensuring operational service for the EU forecasting centre, RLA, and OEF. This sets the basis for being able to establish dynamic risk services within EPOS and in Italy, Switzerland, and France.	New person hired at ETH in collaboration with task leader and a network of involved partners

2.7.3 Task 8.3 “RISE operational services and applications”

Task Overview

Activities in the next 12 months

In this period, task 8.3 will establish the relationship with important stakeholders for operational dynamic risk services. Dedicated contact persons will be sought in every relevant institution. In addition, information about the current state and plans for dynamic risk services at the different institutions will be collected and analysed. In addition, efforts in dynamic risk communication and presentation will be investigated.

Questions to be tackled:

- Streamlining of OEF testing and operations
- Operational responsibility of OEF testing, and rapid loss, alongside with the distribution of rapid loss information

Activities month 12 – 36

Based on the current state and future plans for presenting dynamic risk, insights from established approaches, and the knowledge gained in WP5 with respect to communicating dynamic risk a road map will developed to make such services available for EPOS, Italy, Switzerland, and France. At least one roundtable with the contact persons in the relevant institutions will be organized to facilitate knowledge exchange.

Task Breakdown

Subtask 8.3.1 OEF infrastructure and services set up for Switzerland and	Operative set-up of 8.2.3, amended with public displays for the results, and (to be decided) threshold based alerting	INGV and SED op teams to run Michèle Marti, Irina Dallo from ETH in collaboration with Alexandra Freeman and Sarah Dryhurst from UCAM and a network of partners in Italy and France based on subtask 8.2.2.
Subtask 8.3.2 Operational dynamic risk services in Italy, Switzerland, and France	In each of these countries, a dynamic risk service has to be made available until the end of the project. Again, technically this effort will base on the work conducted in task 8.2, namely in subtask 8.2.5 and is enriched by the findings collected in WP5 to ensure effective communication.	Exposure and vulnerability data by SERA, updated by WP4 Software by SED IT and EUCE dev teams Adequate public representation of TD risk by Michèle Marti, Irina Dallo from ETH in collaboration with Alexandra Freeman and Sarah Dryhurst from Cambridge and a network of partners in Italy and France.

2.7.4 Task 8.4 "RISE external communication, good practice series, and training"

Task Overview

Activities in the next 12 months

A website was established and went live shortly before the kick-off meeting in September 2019 (www.rise-eu.org). The website is based on the content management system OpenCMS. It acts as the main information portal for interested stakeholders, featuring news about latest developments, results (preliminary as well as final), best practice reports, and upcoming as well as past events. During the next 12 months, presentations of the pilot sites of RISE will be added to the website. Until M4, the communications team will create a concept of what should be included in the site presentations. The task leaders will then be asked to fill in the site templates until the end of M5. Until the end of M6, all sites will be added to the website.

RISE will also distribute a "RISE Newsletter" promoting RISE activities, event, results, and contributions of the project members. The first newsletter will be released towards the end of M4. In order to compile it, all task and work package leaders will be asked for their input in the first week of M4. During M1, a template will be created for the external newsletter using the platform MailChimp by Janine Aeberhard (ETH). The task and work package leaders will be asked to send their input to the communications team via e-mail who will then edit it if necessary and eventually distribute the newsletter. The same process will be applied for all of the following newsletters until the end of the project. During the next 12 months, an external newsletter will be released in M3 and in M12.

Before the kick-off meeting in September 2019, a Twitter account was created (@research_RISE) in order to keep the interested public updated about the project. All WP and task leaders are asked to send inputs they would like to have distributed via Twitter to the communications team as soon as possible. They will then edit it as needed and publish it on the Twitter account. They will also tweet about results, events, news, and promote the project's best practice reports.

Publications in high quality peer reviewed international journals or conference proceedings remain a major output of RISE that will have a lasting impact on the physical sciences, engineering and social science communities. RISE brings together many of the most productive and most-cited scientists in their respective domains and we anticipate that no less than 100 publications will result from the RISE activities. During the next 12 months, we expect 20 publications to be contributed to different journals.

We will compile a series of at least five good practice reports based on RISE deliverables into a homogenized online library of open access reports available for browsing and download from the RISE and EFEHR websites. In order to start coordinating the best practice reports, the RISE members were given the opportunity to add their contributions to a poster. Additionally, Janine Aeberhard (ETHZ) will distribute an online table in M3 that the participants need to fill in until the end of M4 with details about what they would like to contribute, until when and who the internal reviewer will be. The reports will follow the approach implemented by ETH for geothermal energy and written with an end-user perspective in mind. Each report will receive a DOI in order to be traceable; they will be updated throughout the project and form an important legacy of RISE.

Activities months 12 – 36

The website, newsletter, and Twitter account will continue to be organized the way described above. Additionally, the website will include interactive graphics, short videos such as interviews with key stakeholders, and presentations of the pilot sites of RISE that will be organized in between M12 to M36.

Publications in high quality peer reviewed international journals or conference proceedings remain a major output of RISE that will have a lasting impact on the physical sciences, engineering and social science communities. RISE brings together many of the most productive and most-cited scientists in their respective domains and we anticipate that no less than 100 publications will result from the RISE activities. We will also sponsor at least three dedicated sessions at international conferences. Details of this will be defined at a later stage.

Additionally, RISE plans to sponsor at least three dedicated sessions at international conferences. The details will be decided at the second annual meeting of the project.

The submitted RISE best practice reports will continuously be added to a homogenized online library of open access reports available for browsing and download on the RISE and EFEHR websites. Each report will receive a DOI in order to be traceable; they will be updated throughout the project and form an important legacy of RISE. We will seek to update and continue them beyond the project as part of EPOS.

RISE will also offer three training workshops to selected groups of stakeholders:

- A 3-day workshop focused on training of young scientists in interdisciplinary and dynamic risk assessment, presenting introductions to the methodologies, and tools. This workshop will be hosted in the form of a summer or winter school.
- A two-day workshop focused on good practice for end-users from governmental and regulatory agencies, including civil defence offices and national services from around Europe. The focus will be to introduce capabilities and limitations of real-time earthquake risk assessment as a tool for more resilient societies.
- A one-day workshop focused on exploitation of business opportunities and applications with users from industry. This includes hardware/sensor manufacturers, software and App developers, and also insurance companies.

Following the successful example of REAKT, the key lessons learned in RISE and recommendations for future research, development and implementation will be published as a special volume in a relevant journal (e.g., Bulletin of Earthquake Engineering). This will represent in a comprehensive format the legacy of RISE for the scientific and engineering communities.

The RISE final conference will be designed as a public 2.5-day workshop in the tradition of the acclaimed Lenzburg PSHA or Schatzalp induced seismicity workshops previously organised by the coordinator of RISE. We will bring together about 170 of the leaders from around the world in the domain of real-time risk assessment for an exchange of the state-of-the-art and future direct

The table below shows the breakdown of Task 8.4 into subtasks.

Subtask 8.4.1 Website	
Responsibility	ETH Zurich
Task	Setup and updates of website www.rise-eu.org. The website is the main external communication tool of RISE.
Function	Access to project information, current developments and achievements, contact and other useful information
Success factor	Website traffic, number of page views, document downloads, feedback and emails received
Tool	OpenCMS
Persons and institution involved	Communications team, ETHZ, maintaining website (1PM) All project members, providing input (<1PM)

Subtask 8.4.2 External newsletter	
Responsibility	ETH Zurich
Task	Regularly distribution (month 3, 12, 24, 36) of an external newsletter: create template, plan content, edit newsletter
Function	Provide deeper insights to the project (compared to news on the website), spread knowledge, inform about achievements of RISE
Success factor	Growing of mailing list, opening and click rate, feedback
Tool	Mailchimp
Persons and institution involved	Communications team, ETHZ, creating and distributing newsletters to subscribers (2PMs) All project members, providing input (<1PM)

Subtask 8.4.3 Social Media	
Responsibility	ETH Zurich
Task	Post project news and relevant information about related projects (e.g. conferences). Minimum: liking and retweeting updates once a week. Follow accounts from partners and related projects
Function	Visibility; inform when RISE participants give talks in conferences, publish a paper, or had a successful collaboration
Success factor	Followers, frequency of posts
Tool	Twitter
Persons and institution involved	Communications team, ETHZ, creating and maintaining Twitter account (<1PM) All project members, providing input (<1PM)

Subtask 8.4.4 Best Practice Reports	
Responsibility	ETH Zurich
Task	Editing and designing good practice guidelines, coordinating best practice reports At least five good practice reports will be compiled based on RISE deliverables and be made available to browse and download on the RISE and EFEHR websites. The best practice reports will be updated and continued even after the project as part of EPOS.
Function	Visibility, provide access to preliminary results
Success factor	Number of publications

Tool	Word template
Persons and institution involved	Communications team, ETHZ, creating and providing template, coordination of review process, add it to website (<1PM) At least ten project members, all institutions, acting as authors and / or reviewers (3PMs)

Subtask 8.4.5 Training workshops	
Responsibility	ETH Zurich
Task	Offering three training workshops to selected groups of stakeholders: • Young scientists in interdisciplinary and dynamic risk assessment: 3-day workshop presenting introductions to the methodologies and tools. Hosted in the form of a summer or winter school • End-users: two-day workshop focused on good practice for end-users from governmental and regulatory agencies, including civil defence offices and national services from around Europe. The focus will be to introduce capabilities and limitations of real-time earthquake risk assessment as a tool for more resilient societies • Industry: A one-day workshop focused on exploitation of business opportunities and applications with users from industry. This includes hardware/sensor manufacturers, software and app developers, and insurance companies.
Function	Visibility
Success factor	Number of workshops, number of participants
Persons and institution involved	Communications team, ETHZ, advertising the events on the different communication channels (<1PM)

Subtask 8.4.6 Presentations at conferences	
Responsibility	ETH Zurich, all
Task	Connect with scientists from other fields; dissemination of scientific results
Function	Visibility
Success factor	Increased collaboration, growing newsletter mailing list
Persons and institution involved	Communications team, ETHZ, advertising the publications on the different communication channels (<1PM) Members of the RISE project, providing input about their publications (<1PM)

Subtask 8.4.7 Special Issue	
Responsibility	ETH Zurich
Task	Towards the end of the project, a special issue will be created in a journal (to be determined) to demonstrate and summarize all of the project's results and progress. The special issue could either be a full RISE-only issue or an issue dedicated to a RISE-related topic where we provide inputs from each work package.
Function	Provide information to all relevant stakeholder, visibility
Success factor	Number of contributions, depending on journal: number of reads
Tool	Mailchimp
Persons and institution involved	Communications team, ETHZ, advertising and coordinating the inputs for the special issue (1PM) Members of the RISE project, providing input about their publications to the communications team (<1PM), create input for the special issue (PMs of their work package) Management Board, coordinating with the chosen journal, organizing input from members (2PMs)

Subtask 8.4.8 Final conference	
Responsibility	ETH Zurich
Task	Organise the final conference, designed as a public 2.5-day workshop in the tradition of other acclaimed workshops previously organised by the coordinator of RISE. We will bring together about 170 of the leaders from around the world in the domain of real-time risk assessment for an exchange of the state-of-the-art and future directions.
Function	Visibility, provide access to results
Success factor	Number of participants, number of presentations
Persons and institution involved	Communications team, ETHZ, advertising and coordinating the inputs for the final conference (1PM) Management Board, organising and coordinating the workshop (2PMs) Members of the RISE project, providing inputs for the conference (PMs of work package)

Table 66. Breakdown of Task 8.4