

Deliverable 1.13

D1.13 Strategic Integration of RISE Activities with EPOS

Deliverable information	
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Summary

RISE work packages cover innovation (R&D), demonstration, testing, dissemination and operational services. Within these domains RISE researchers have been developing and enhancing methodologies and models, implementing and testing the models, developing various tools and products all of which are available on the RISE portal (<https://zenodo.org/communities/riese-h2020>).

Coordination and integration of RISE services with the European Plate Observatory (EPOS, www.epos-eu.org) are critically important tasks for RISE to ensure sustainability and to have a lasting impact. This was already outlined as key success criteria in the proposal and workplan. So far, we focus on three areas for providing services linked to EPOS services; operational earthquake loss forecasting (OELF), rapid impact and loss assessment (RIA/RLA) and testing of earthquake forecasting models. RISE has from the start been closely connected to EPOS through involvement of key stakeholders as well as by designing milestones and deliverables to facilitate and support EPOS integration. In addition to the specific service developments, RISE has also developed strong ties to the EPOS-SP project, in particular for assessment of ethical issues affecting the provisioning of real-time services in the context of earthquake hazard and risk. The RISE services for EPOS are building on the ongoing efforts for harmonised European Hazard and risk assessment, a new hazard and risk model for Europe will be released in late 2021 and RISE uses the consistent model components for its services. Likewise, the future governance of the services is embedded in EFEHR, the European Facilities for Earthquake Hazard and Risk (<http://www.efehr.org>). RISE service operation and future development are also integrated in the community response to the call HORIZON-INFRA-2021-SERV-01-07 call “Research Infrastructure services advancing frontier knowledge” and HORIZON-INFRA-2021-TECH-01-01 (Interdisciplinary digital twins for modelling and simulating complex phenomena at the service of research infrastructure communities).

1. Introduction

This deliverable summarizes the status of EPOS integration of RISE activities after the first 24 months. Particular attention is given to relevant related projects & initiatives (e.g. the discussion on ethical issues in real-time services within EPOS and the EPOS-SP project, activities on metadata and service data modelling attached to the EPOS ICS development and testing, coordination and harmonization in design and implementation of service interfaces).

The RISE project was on purpose structured to facilitate the integration of services into the EPOS framework as they are developed. Relevant milestones and deliverables are defined at appropriate times during the project, covering testing and validation of RISE developments also as EPOS services, as well as respective service organisation issues.

2. General RISE-EPOS integration

Activities within RISE have from the start of the project been closely intertwined with EPOS, facilitated by participation of key EPOS stakeholders from various EPOS Thematic Core Services (TCS) and the Integrated Core Service (ICS) in RISE as well as by conscious implementation of EPOS links in the management structure of RISE. Close ties are also established with the current EPOS Sustainability Phase (EPOS-SP) project, in particular with WP 6 of EPOS-SP that addresses Societal Relevance, and – with particular relevance to RISE – looks at ethical issues in the context of (near) real-time services for hazard and risk. The future governance of the services is embedded in EFEHR, the European Facilities for Earthquake Hazard and Risk (<http://www.efehr.org>).

2.1 Ethical issues for real-time services

Within the framework of ‘ethical’ we broadly look at any issues or conflicts that may arise in the context of society’s interaction with services and their products, like presentation to and uptake of a service or information by stakeholders (e.g. authorities or media) and the general public, communication of scientific observation, facts and opinions, explanation of scientific background, methods and uncertainties.

In the framework of the EU Horizon2020 EPOS SP project, a task within WP6 “Value for Society” is conducting three case studies focusing on products and services in the hazard and risk domain that are produced and published rapidly following an ‘event’, or more general shortly after the observation / collection of data. In the initial discussions it became already clear that the previously used term ‘near-real-time’ for such rapidly available products or services is leading to misunderstanding, we now denote these products and services as ‘up-to-date’.

These EPOS SP case studies shall cover the following areas:

1. dynamic earthquake risk assessment, in collaboration with EPOS TCS Seismology and TCS NFO, also the collaboration with RISE is explicitly foreseen;
2. adaptive systems for controlling deformation and induced seismicity, in collaboration with EPOS TSC Anthropogenic Hazards and the EC COFUND project COSEIMIQ;
3. public communication of anthropogenic hazards (on the specific example of induced seismicity from a copper ore mine in Poland, in collaboration with TCS Anthropogenic Hazards).

The first study is being conducted in close collaboration with RISE focusing on the recent damaging earthquakes in Croatia. It mainly involves Michèle Marti, RISE WP8 (lead) and WP5 and Rémy Bossu, RISE WP5 (lead) and EPOS TCS Seismology. Focus is on the up-to-date products and services EMSC has provided and how these were perceived by different users.

All three case studies will be documented following a standardized procedure. In a joint workshop, the findings of the three cases studies with respect to the potentials and challenges when providing up-to-date products and services will be discussed and a set of recommendations elaborated. This final set of recommendations will be documented in EPOS SP MS76 “Real-time service case studies” (Sep 2021).

2.2 (Meta)Data models, data policies and FAIRness issues

At the time of this report the scientific development of services is still ongoing, and only first proof-of-concept studies or design models have been realized so far. All developments in the different activities of RISE, however, are based on established community standards (where applicable) with respect to data and product formats and data models. These range from specialized formats and protocols like quakeML (IUGG/IASPEI seismic event description standard), fdsnws-services (FDSN web service standards for exchange of seismic data, event information and metadata), via open standard calculation engines like OpenQuake (the Global Earthquake Model GEM supported standard for seismic hazard and risk calculation), to generic standards like OGC WMS and WFS for exposing information on websites.

Making use of these open standards, and – where necessary – actively engaging with the relevant governing bodies of these standards in further developing them, already secures ‘first-order’ FAIRness of the final products and services. It also facilitates later integration into the EPOS portfolio of interoperable services, as data and metadata models are already known and their expression in the EPOS DCAT-AP metadata model is either existing or will be rather straightforward.

Furthermore, the service developments in RISE are closely linked to the existing EPOS TCS communities, mainly EPOS Seismology and there the three pillars ORFEUS, EMSC and EFEHR. All EPOS

communities have adopted and are following the EPOS Data Policy, supporting Open and FAIR data, products and services.

3. EPOS integration strategies for RISE service developments

The overall objective of RISE is to advance real-time earthquake risk reduction capabilities in support of an increase of the resilience of the European society towards the impact of earthquakes. Among the various activities within the project that span all related phenomena and relevant time-scales, RISE is set to bring a number of services into operation within the EPOS Delivery Framework (EDF). The EDF comprises the EPOS Integrated Core Service (ICS), a central cross-domain IT infrastructure that provides standardized and interoperable discovery and access to data and products services from the different solid Earth science domains gathered in EPOS, together with the domain-specific Thematic Core Services (TCS) that operate and govern the specific services within their scientific and data provider communities. RISE service developments mainly connect to the EPOS TCS Seismology and its three pillars ORFEUS, EMSC and EFEHR, the TCS Near-Fault Observatories (NFO), and the TCS Volcano Observations. The main services that are targeted for EPOS integration within RISE are Operational Earthquake and Earthquake Loss Forecasting (OEF/OELF), Rapid (Earthquake) Impact / Loss Assessment (RIA/RLA), and Earthquake forecast model testing.

The development, integration and validation plan / pipeline for service integration within EPOS is well established and relatively straightforward, it also strongly relies on the governance mechanisms of EPOS overall and the TCS internally.

In brief, the 'workflow' of service development and integration can be described as follows:

- i. scientific development of a new service and realization as prototype / pilot;
- ii. assessment of the service (content, relevance, usability) on the domain community / TCS level, and implementation of an operational service within the TCS service portfolio;
- iii. validation of the service for EPOS (ICS) integration (checking technical, governance and financial issues), acceptance and inclusion as EPOS service by integration on ICS.

The RISE project structure directly supports this workflow, and allows monitoring progress through relevant milestones and deliverables. RISE participants are firmly embedded in the domain communities and have exhaustive experience as service operators, also for already fully integrated EPOS services.

The central infrastructure of the EPOS ICS (ICS-C) is currently in its pilot operational phase (POP), where the already integrated TCS services and the ICS-C platform itself undergo final testing and hardening in an operational setup, while the development of the distributed part of the ICS (ICS-d), which is expected to provide advanced computational services (HPC, big data applications, complex visualisation, workflow implementation platforms) is just getting underway. EPOS POP will last until end of 2022 and is made up of consecutive work cycles (pitches). These pitches address specific developments and amendments of the TCS-ICS interfaces as identified by the ICS and TCS expert communities together, additionally supported by user testing feedback. The participation of the various RISE actors in these POP activities through their roles within the EPOS TCS ensures that emerging requirements for the EPOS integration of RISE services can be addressed timely and in an integrated manner.

Relevant Milestones

- *MS 44 Operational version for OEF, RLA and crowdsourcing based EEW capabilities at European level - Feb 2022*
- *MS 58 First new EPOS service operational - Feb 2022*

Relevant Deliverables

- *D2.11 Technical solutions on open, dynamic, high volume cloud-based services – Aug 2021*
This Deliverable describes current state-of-the-art technical solutions to rapidly serve, access and process massive seismic datasets, including the current strategies provided by the European Integrated Data Archive (EIDA; <http://www.orfeus-eu.org/data/eida/>), the recommendations compiled by the EPOS-ORFEUS Competence Center (CC) within project EOSC-Hub (<https://www.eosc-hub.eu/>), emerging challenges to handle new exotic datasets like those generated by distributed acoustic sensing (DAS) systems, and initial experiences gained into Cloud services and distributed computing environments for data processing and interactive exploration at ORFEUS associated data centres.
- *D8.5 Report on sustainable operation of dynamic risk services within EPOS - Aug 2022*
- *D6.5 Report on the development of RLA, EEW and OEF services at European scale - Feb 2023*

3.1 Operational Earthquake (Loss) Forecasting

RISE is developing an operational earthquake and earthquake loss forecasting (OEF / OELF) service and will implement them on national scale in Italy (Operator INGV) and Switzerland (Operator ETH), as well as on European scale within EPOS. RISE provides measures of short-term seismic risk at regional and national scale. On the basis of results of the Italian system for operational earthquake forecasting (OEF-Italy) (Marzocchi et al., 2014) the operational earthquake loss forecasting (OELF) system, named MANTIS, was developed (Iervolino et al., 2015). In the first version of MANTIS the possible damage accumulation during seismic swarm was neglected, whereas in this task the upgraded version of the OELF system, MANTIS V.2, is under development to account for this issue.

The EPOS service will be governed within EFEHR, the EPOS Seismology pillar responsible for earthquake hazard and risk, and the EFEHR consortium will take responsibility for the operationalisation of the service (identifying the appropriate service provider institution, service assessment) and its validation and integration with EPOS.

These OEF/OELF services will also benefit from a standardized communication and presentation approach that will be developed within RISE.

Relevant Milestones

- *MS 22 OEF output format for testing - Feb 2020*
The forecast formats have been discussed and implemented in the codes.
- *MS 25 Prototype of OEF model 'experts-based' - Feb 2022*

Relevant Deliverables

- *D8.6 Harmonized platform for OEF forecasts and ensemble models – Aug 2022*
- *D8.9 OEF services in Italy, Switzerland and Europe wide operational – Feb 2023*

3.2 Rapid Impact and Loss Assessment

Rapid Impact Assessment, and derived from that Rapid Loss Assessment, after a severe event, can support civil protection agencies and emergency services to rapidly gain an overview of the expected building damages, number of fatalities, injured and displaced persons as well as economic losses. Such information allows coordinating and allocating the resources for the emergency response in an efficient manner.

While these services have a clear value for emergency response, making them available and accessible as EPOS services (i.e. open for everybody) poses significant challenges, as mentioned in 2.1 above under 'ethical issues'. However, such RIA/RLA outputs and products can also be produced in

advance as ‘scenarios’ that can be utilized to build up and support the awareness for damaging earthquakes among different stakeholders, and for those scenarios these issues are less severe.

Development and testing of RIA/RLA products and services within RISE will be documented in future deliverables due 2022, but the work in progress can be found in the Mid-Term report (D1.14). Further EPOS integration will be following the established workflow, again under the governance and coordination of EFEHR.

RIA / RLA estimations require as input a good estimate of the ground shaking. This is provided via so-called ShakeMaps, and within RISE further work on the European ShakeMap system prototype (available at <http://shakemap.eu ingy.it/>) has been accomplished (D1.14). Operational and governance issues of the European ShakeMap service are currently being discussed within EPOS TCS Seismology, where also the further EPOS integration will be organized.

Relevant Milestones

- *MS 27 RLA service for Europe transferred to WP6 – Feb 2022*

Relevant Deliverables

- *D4.1 Second generation of models for RLA service demonstration for Europe – Aug 2022*
- *D4.2: Second generation of models for RLA service report for Europe – Aug 2022*

3.3 Earthquake Forecast model testing

RISE WP7 evaluates newly developed physics-based, stochastic and hybrid earthquake forecast models that might be suitable for operational earthquake forecasting (OEF) in order to drive model improvement and characterise confidence in the model forecasts. The details in model testing will be reported in a separate deliverable due 2022 but some of the ongoing developments can be found in D1.14. Activities here are closely integrated also with the global community, in the context of the CSEP2.0 development (<https://cseptest.org>) and use pyCSEP (<https://docs.cseptest.org/#>).

Relevant Milestones

- *MS 47 European testing centre at GFZ fully operational – Feb 2022*

Relevant Deliverables

- *D8.7 EU forecast testing centre operational – Feb 2023*