Fact Sheet:
The 2020 European Seismic Risk Model

Key facts

- During the twentieth century, earthquakes accounted for more than 200,000 deaths and more than 250 billion Euros of direct losses in Europe.
- The highest seismic risk is expected in urban areas that are located in regions with a comparably high level of seismic hazard, and soft soil conditions.
- Cities like Istanbul and Izmir in Turkey, Catania and Naples in Italy, Bucharest in Romania, and Athens in Greece are all prone to high seismic risk. But also cities like Zagreb (Croatia), Tirana (Albania), Sofia (Bulgaria), Lisbon (Portugal), Brussels (Belgium) or Basel (Switzerland) have an above-average level of seismic risk compared to less exposed cities, such as Berlin (Germany), London (UK) or Paris (France).
- Older mid-rise reinforced concrete buildings constructed before the 1980's and low-rise unreinforced masonry houses subjected to high seismic hazard levels are the main drivers of seismic risk in Europe.
- If these building classes in the residential building stock were brought to the level of seismic design required by the latest European standards (Eurocode 8) in just Turkey and Italy alone, the average annual number of fatalities in Europe could be reduced by over 50%, and the average annual economic losses by at least 30%.
- This European model will be used for updates to the Global Earthquake Model's Global Seismic Risk Model.

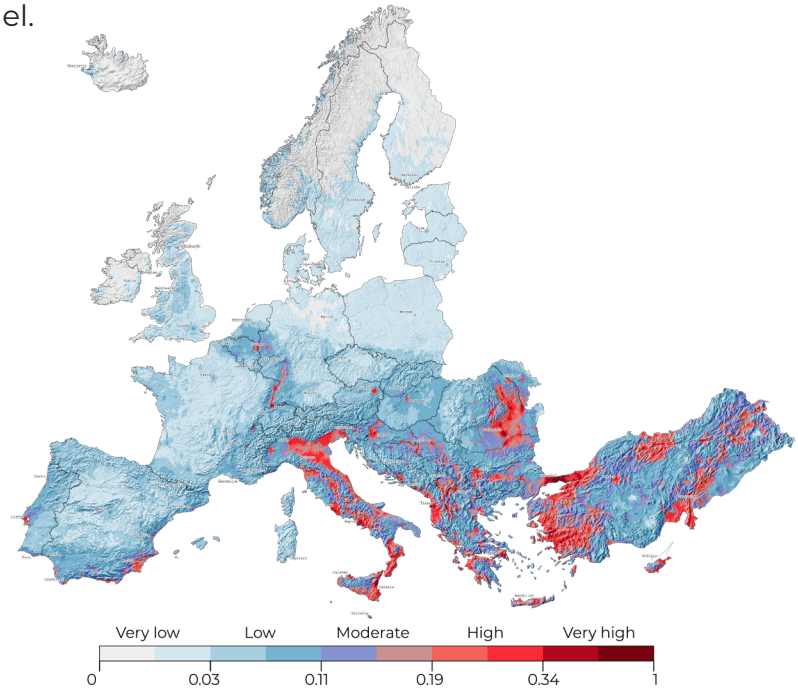


Fig. 1 The European seismic risk map illustrates the relative distribution of losses across Europe through a composite index. This index is produced by combining normalised metrics of average annual economic loss and average annual loss of life, calculated from the 2020 European Seismic Risk Model, and dividing by the GDP per capita [1].

A new, open earthquake risk model for Europe

Main components

The seismic hazard is represented in the model through stochastic catalogues and ground motion fields that have been computed using the latest European Seismic Hazard Model (ESHM20) [2]. The European exposure model has been developed using mainly public census data and contains an estimated 143 Million buildings, which contain an average of 460 Million occupants (over a typical 24-hour period), and a total replacement cost (structural, non-structural and contents) of 50 Trillion Euros, of which 66% is from the residential building stock. A total of 512 vulnerability models have been developed to cover the different classes of buildings within the European building stock, using an analytical approach to represent the response of buildings to earthquake ground shaking. A number of tests and consistency checks, including the estimation of losses from recent damaging earthquakes (Fig. 2), have been carried out during the development of these components.

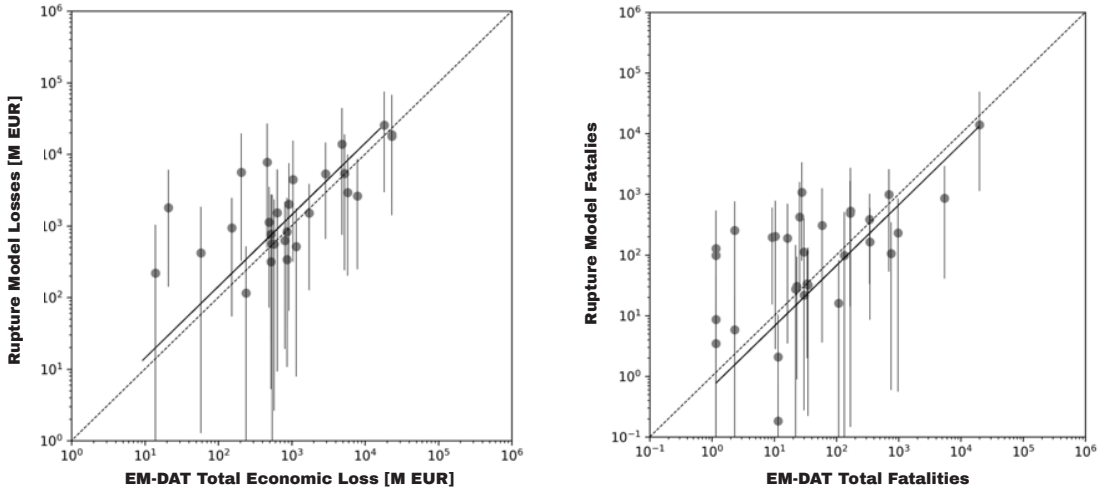


Fig. 2 Comparison of observed (horizontal axis) and modelled (vertical axis) losses in terms of (left) economic losses and (right) fatalities for a number of damaging European earthquakes. EM-DAT: https://public.emdat.be/

Main results

There are two main risk metrics that can be computed with this first version of the European seismic risk model:

- Economic loss due to direct costs to repair/replace the buildings in Europe (residential, commercial and industrial)
- Loss of life of occupants due to damage/collapse of those buildings

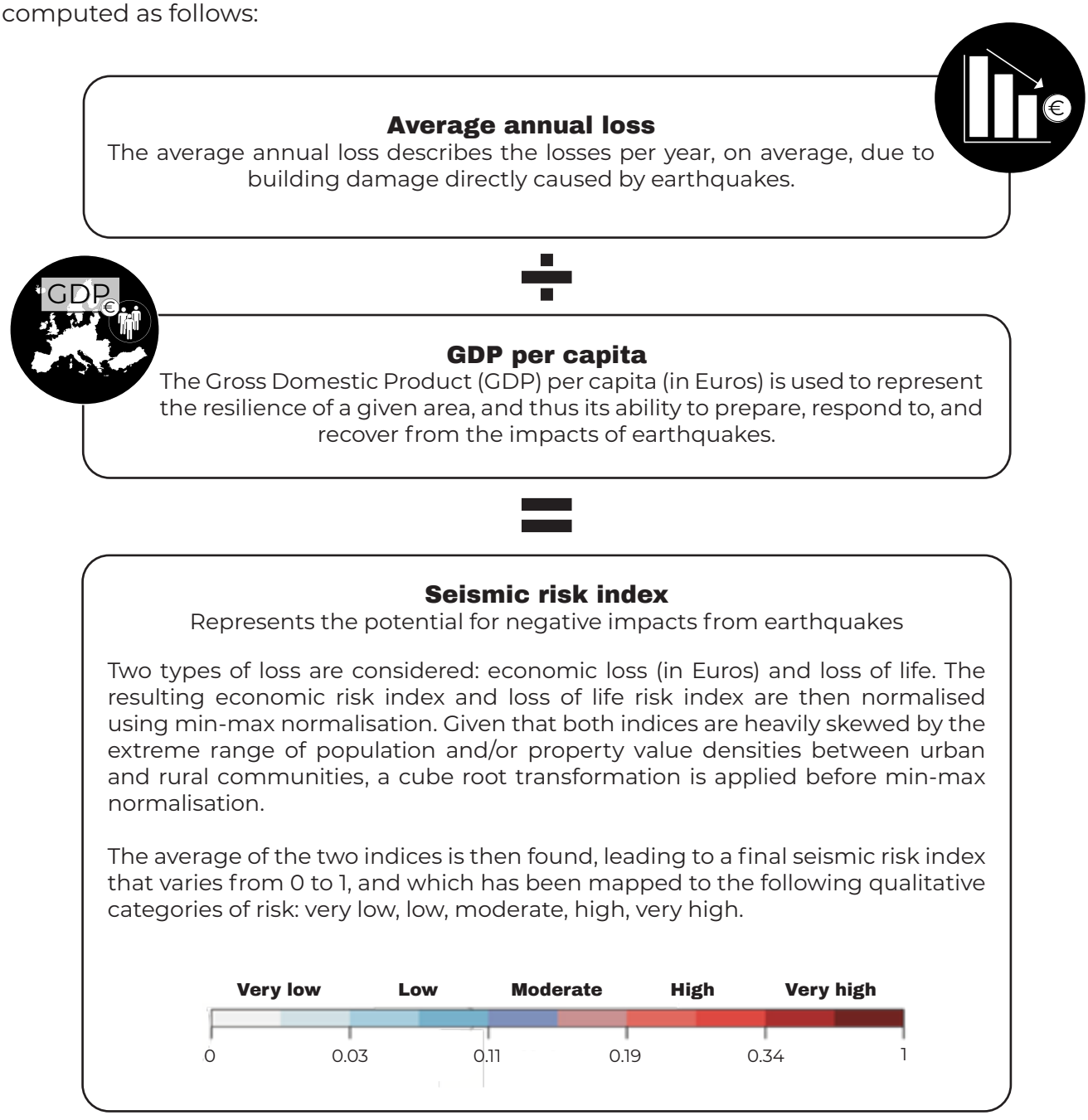
The probability of these losses is accounted for in the risk model, leading to estimations of the average annual losses (i.e. the long-term mean loss per year due to earthquake ground shaking) and losses with specific return periods (i.e. the long-term mean loss value due to earthquake ground shaking that is expected to be equalled or exceeded at least once every X years, where X varies from 50 to 1000).

According to the 2020 European Seismic Risk Model, the average annual economic loss in Europe is around 7 Billion EUR, with almost 70% of this loss occurring in Italy, Turkey and Greece. The average annual loss of life is estimated to be around 900 fatalities, with over 75% of those fatalities in Italy and Turkey alone. Mid-rise reinforced concrete frames

with infill panels designed to outdated seismic design codes, together with low-rise unreinforced masonry buildings, are the two building classes that contribute most to both economic losses and loss of life in Europe. The outputs of the model have been tested using a number of empirical loss databases and the initial outcomes are encouraging and provide a sufficient level of confidence in this first version of the model. Nevertheless, continued improvements to the model are expected following this open release, as more feedback and additional testing is provided by the scientific community.

Seismic risk index

The seismic risk map represents a comparative index that has been calculated using the average annual losses from the 2020 European Seismic Risk Model, which have been disaggregated onto a regular grid across Europe with a resolution of 0.15 degrees, using the built-up density from the Global Human Settlement Layer [3]. The seismic risk index is computed as follows:



More information

Are you interested in additional explanatory material? On www.efehr.org, you will find videos, brochures, access to technical reports, maps and much more information about earthquakes hazard and risk across Europe.

Data access

Additional information, specific data, and parameters are available on www.risk.efehr.org. The input files of the model have been released on the EFEHR GitLab repository for reproducibility of the results and to allow users to further explore the 2020 European Seismic Risk Model: https://gitlab.seismo.ethz.ch/efehr/esrm20.

The scientific data and products of the 2020 European Seismic Risk Model are openly released under the Creative Commons Attribution 4.0 license (CC BY 4.0). These products can therefore be used for private, scientific, commercial and non-commercial purposes, provided adequate citation is used.

Documentation

A technical report on the model is available for download at this site: www.risk.efehr.org/documentation.

Maps

A selection of precomputed results from the risk model are directly accessible through maps and web services at the following link: https://maps.eu-risk.eucentre.it/tags/risk/.

Citation

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A core team of researchers from different institutions across Europe worked collaboratively in the framework of various projects to develop the 2020 European Seismic Risk Model (ESRM20). Many more have contributed to the development of ESRM20 by different means including data compilation and curation, knowledge exchange or by providing feedback at meetings and webinars. This has all been undertaken in close collaboration with the GEM Foundation and the European Plate Observing System (EPOS).

⟶ A list with all names and institutions that have contributed can be found at www.risk.efehr.org/contributors.

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