EARTHQUAKE RISK
across Europe

What effects should we expect
from future earthquakes in Europe?

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Earthquakes in Europe

Every year, millions of earthquakes hit Europe. Most of these earthquakes are too small to be felt or to cause damaging effects, however, severe events occur periodically. Each time such a strong earthquake affects a region in Europe, it reminds us of the damage it can do to buildings and the environment, as well as the impact on people's well-being.

Earthquakes count as one of the deadliest natural hazards, and their occurrence can neither be prevented nor precisely predicted. However, thanks to earthquake hazard and risk assessments, we gain an improved understanding of where strong shaking is most likely to occur and what impact we should expect from future earthquakes.

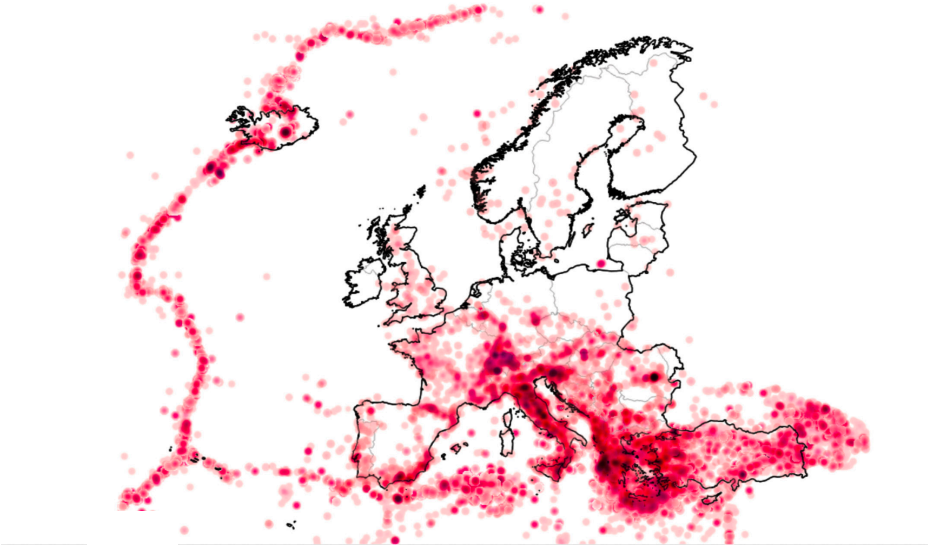


Figure 1: Earthquakes from 1000 AD up to 2014 in Europe.

What is earthquake risk?

Information about earthquake risk, also referred to as seismic risk, provides an estimate of the economic and humanitarian consequences that can be expected from potential earthquakes. Different factors need to be combined to assess earthquake risk across Europe:

Earthquake hazard

Information about how strong shaking is expected where it is most likely to occur.

Soil conditions

Information to infer various soil types across Europe, which have an influence on the expected intensity of ground shaking.

Vulnerability

Estimation of damage to buildings and their contents under given levels of ground shaking, and the ensuing economic losses, as a fraction of replacement costs, and loss of life.

Exposure

Information about the spatial distribution of residential, commercial and industrial building classes in terms of building count, area, occupants and replacement cost.

Earthquake risk assessment helps to efficiently tailor mitigation measures to minimise economic and human losses and make communities all over Europe more resilient against future earthquakes.

What is shown on the earthquake risk map of Europe?

The earthquake risk map of Europe illustrates the relative distribution of expected risk across Europe through a composite index. This index is produced by combining the average annual economic loss and the average annual loss of life calculated from the 2020 European Seismic Risk Model, normalised by the GDP per capita to account for the varying levels of resilience across Europe.

Average annual economic loss

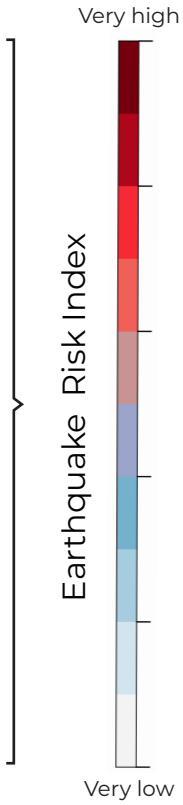
The average annual economic loss describes the expected financial losses per year, on average, due to building damage directly caused by earthquakes.

Example: Over 100 years we may expect a few, rare, large earthquakes (each causing very high economic losses) together with many smaller earthquakes (which may each lead to much lower economic losses), to give rise to economic losses which total € 10 billion. The average annual economic loss would therefore be € 100 million.

Average annual loss of life

The average annual loss of life represents the expected number of fatalities per year, on average, due to damaged and collapsed buildings through earthquakes.

Example: Over 100 years we may expect a few, rare, large earthquakes to cause a total of 200 deaths. The average annual loss of life would therefore be 2.



Countries with the highest earthquake risk in Europe:

1. Turkey
2. Italy
3. Romania
4. Greece
5. Albania

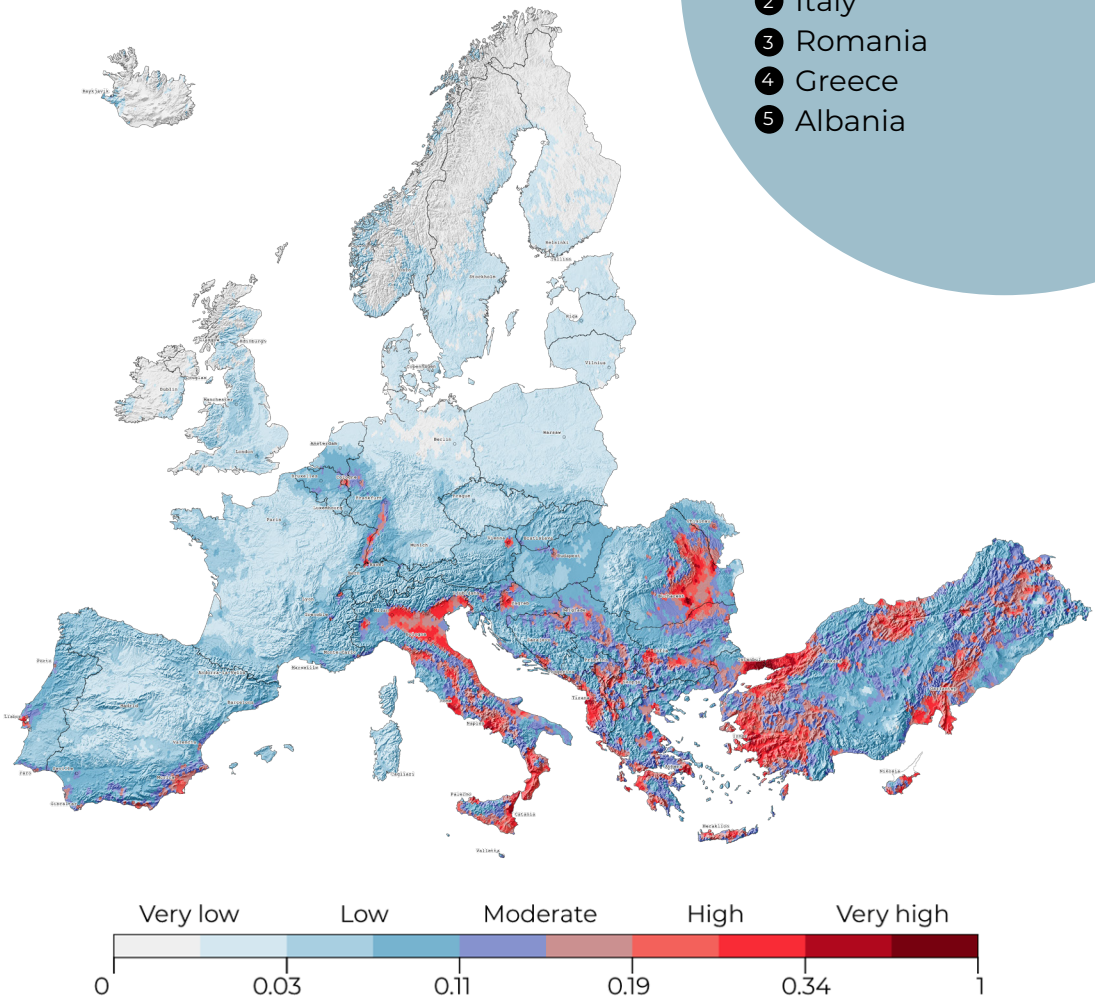


Figure 2: The earthquake risk map of Europe based on the 2020 European Seismic Risk Model. Low risk areas are coloured from white to light blue, moderate risk areas from blue to red and high risk areas appear in dark red.

A closer look at earthquake risk in Europe

Mid-rise reinforced concrete frame buildings constructed before the 1980s and low-rise unreinforced masonry houses subjected to high earthquake hazard levels are main drivers of the seismic risk. Although European countries have recent design codes and standards (Eurocode 8 and national codes) that ensure adequate protection from earthquakes, many older buildings still exist in urban areas and they pose a high risk when earthquakes occur.

> Consequently, the highest risk and thus the most severe consequences of earthquakes are expected in urban areas, located in regions with a comparably high seismic hazard.

Examples of such places are Istanbul and Izmir in Turkey, Catania and Naples in Italy, Bucharest in Romania, and Athens in Greece. These four countries experience almost 80% of the total average annual economic loss due to earthquakes in Europe. But also cities like Zagreb (Croatia), Tirana (Albania), Sofia (Bulgaria), Lisbon (Portugal), Brussels (Belgium) or Basel (Switzerland) have an above-average level of earthquake risk compared to less exposed cities, such as Berlin (Germany), London (UK) or Paris (France).

The most effective measure to reduce earthquake risk in Europe would be to retrofit or replace the most vulnerable buildings. If the residential building classes driving the risk 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%.

What can we learn from an earthquake risk model for Europe?

In science, models unite calculations that determine how something might develop in reality, e.g. financial losses due to a strong earthquake at a given place.

The 2020 European Seismic Risk Model is the very first, harmonised, fully open access earthquake risk model for Europe. Elaborated and documented by research teams across Europe, it offers all interested users a valuable reference upon which to base mitigation decisions.

We can better prepare for future earthquakes.

During the 20th century, earthquakes accounted for more than 200,000 deaths and more than € 250 billion in losses due to damage in Europe[1]. Comprehensive earthquake risk information helps efficiently tailor mitigation measures to make communities more resilient.

We can compare earthquake risk across boundaries.

Many European countries have not yet conducted and published a national earthquake risk assessment. Therefore, this earthquake risk model for Europe allows transnational comparisons, which are crucial to defining European-wide mitigation strategies or insurance policies.

1 The International Disaster Database | www.emdat.be

More information

Learn more about the earthquake hazard and risk across Europe at www.efehr.org. Further information, explanatory material and access to technical reports, maps, data, and much more is available on this website.

Acknowledgments

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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).

⟶ Find a list with all names and institutions that have contributed at www.risk.efehr.org/contributors.

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Whenever making use of scientific products such as input files or when distributing visualisations of the 2020 European Seismic Risk Model (ESRM20), please refer to:

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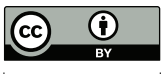

The EFEHR Consortium

The European Facilities for Earthquake Hazard and Risk (EFEHR) is a non-profit network of organisations and community resources aiming to advance assessments of earthquake hazard and risk in the European-Mediterranean area. EFEHR maintains and will further develop the earthquake hazard and risk models for Europe in collaboration with the GEM Foundation and the European Plate Observing System (EPOS).

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