

From the models to actions

How to communicate seismic hazard and risk assessments?

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ETH zürich



EUCENTRE
FOR YOUR SAFETY.

27.11.2024

Only when we know what could happen, we can act.

- Knowing seismic hazard and risk is at the beginning of any mitigation action.
 - Where do we have to expect damaging earthquakes?
 - How often do such earthquakes occur?
 - How well will the built environment withstand?
- Reducing the potential consequences of earthquakes in Europe is not only a technicality in the hands of trained professionals.
- Bringing the models to the people is a necessity AND a challenge!

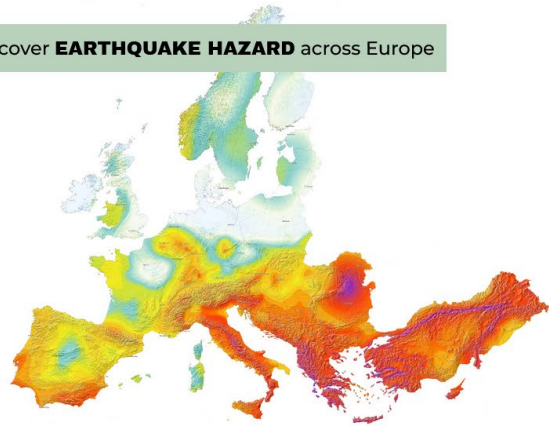


How to launch a seismic hazard and risk models?

EARTHQUAKE HAZARD across Europe

Earthquake hazard describes the potential ground shaking due to future earthquakes in Europe.

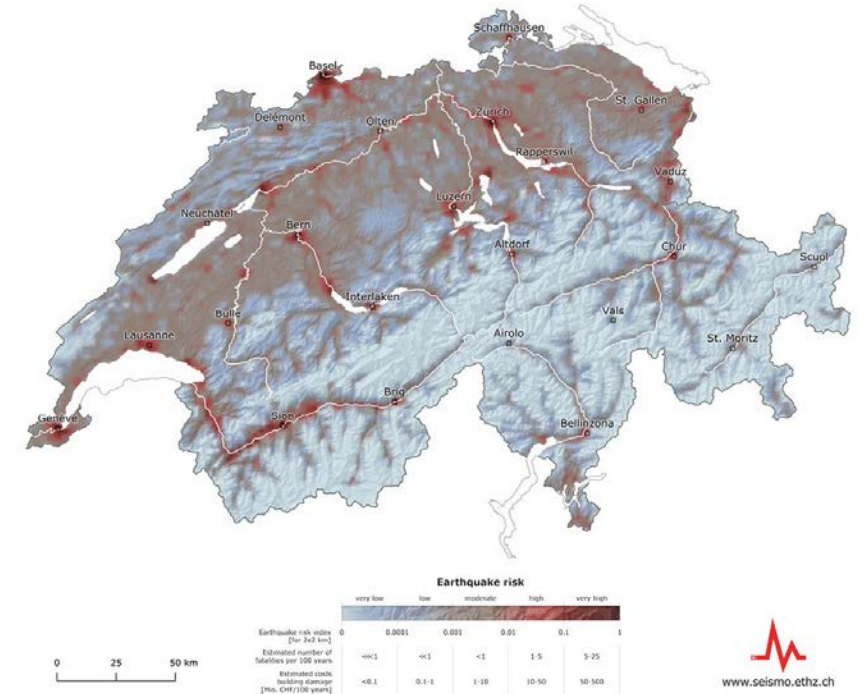
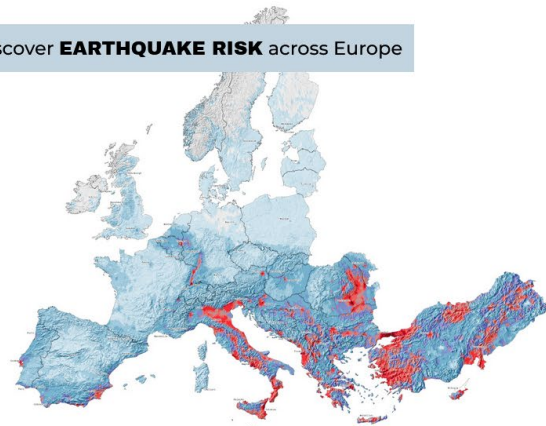
Discover **EARTHQUAKE HAZARD** across Europe



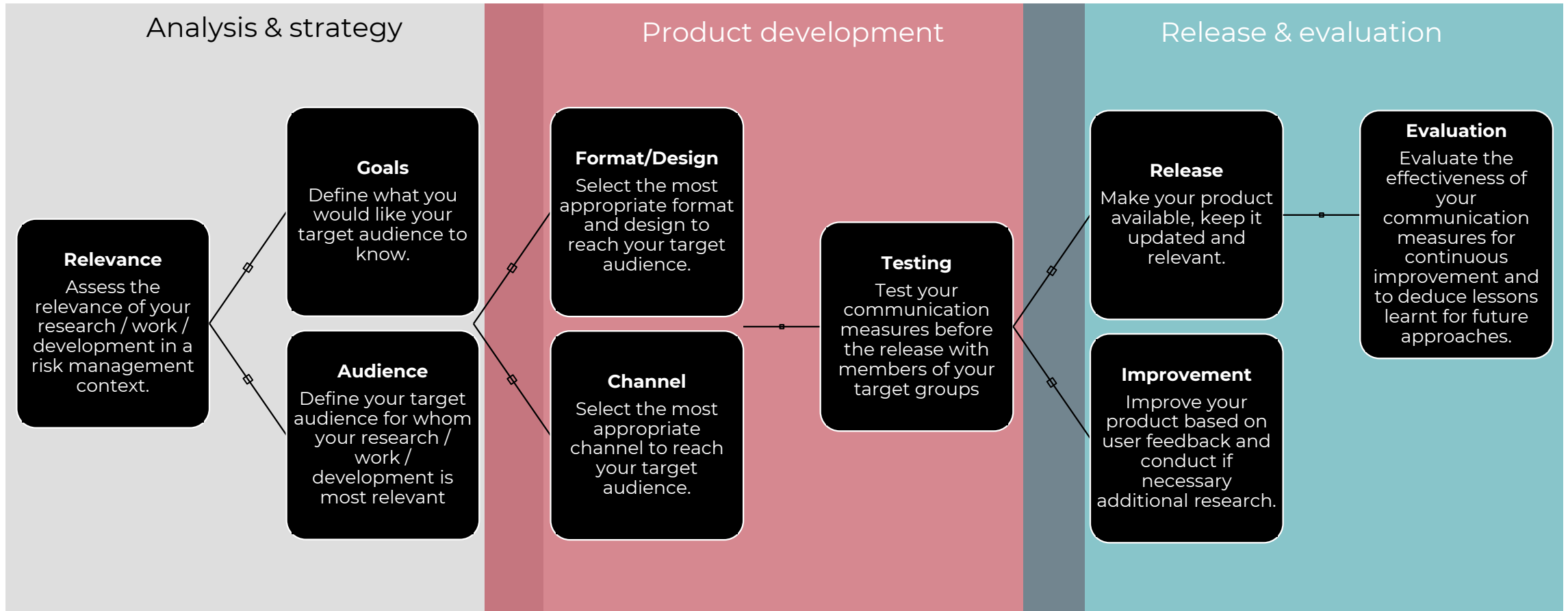
EARTHQUAKE RISK across Europe

Earthquake risk estimates the impact that can be expected from future earthquakes in Europe.

Discover **EARTHQUAKE RISK** across Europe



Process



Process

- Iterative design process
- Interdisciplinary product development
- Transdisciplinary testing
 - Student survey
 - Workshop with national stakeholders
 - Two representative online surveys in Switzerland

Publications

Marti, M., Dallo, I., Roth, P., Papadopoulos, A. N., & Zaugg, S. (2023). Illustrating the impact of earthquakes: Evidence-based and user-centered recommendations on how to design earthquake scenarios and rapid impact assessments. *International Journal of Disaster Risk Reduction*, 90, 103674. <https://doi.org/10.1016/J.IJDRR.2023.103674>

Dallo, I., Marti, M., Valenzuela, N., Crowley, H., Dabbeek, J., Danciu, L., Zaugg, S., Cotton, F., Giardini, D., Pinho, R., Schneider, J. F., Beauval, C., Correia, A. A., Ktenidou, O.-J., Mäntyniemi, P., Pagani, M., Silva, V., Weatherill, G., & Wiemer, S. (2024). The communication strategy for the release of the first European Seismic Risk Model and the updated European Seismic Hazard Model. *Natural Hazards and Earth System Sciences*, 24(1), 291–307. <https://doi.org/10.5194/nhess-24-291-2024>

Dallo, I., Schnegg, L. N., Marti, M., Fulda, D., Papadopoulos, A. N., Roth, P., Danciu, L., Valenzuela, N., Wenk, S. R., Bergamo, P., Haslinger, F., Fäh, D., Kästli, P., & Wiemer, S. (2024). Designing understandable, action-oriented, and well-perceived earthquake risk maps – The Swiss case study. *Frontiers in Communication*, 8, 1306104. <https://doi.org/10.3389/FCOMM.2023.1306104>

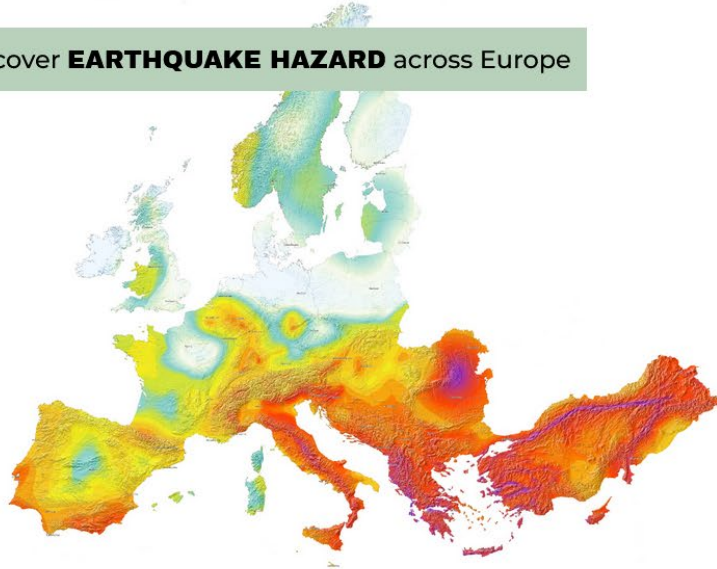


Launching the European earthquake hazard and risk models

EARTHQUAKE HAZARD across Europe

Earthquake hazard describes the potential ground shaking due to future earthquakes in Europe.

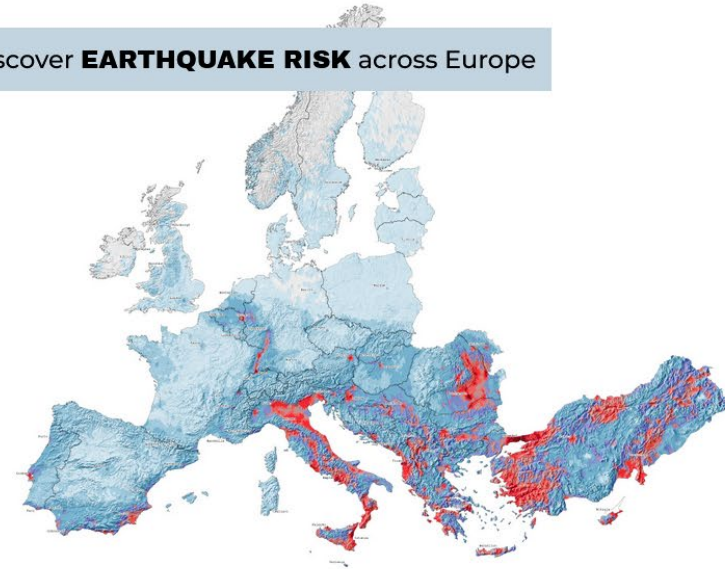
Discover **EARTHQUAKE HAZARD** across Europe



EARTHQUAKE RISK across Europe

Earthquake risk estimates the impact that can be expected from future earthquakes in Europe.

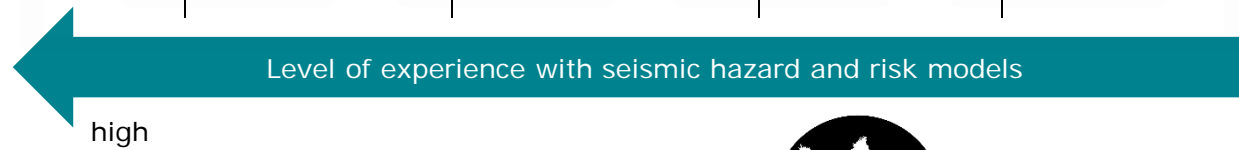
Discover **EARTHQUAKE RISK** across Europe



Target audiences

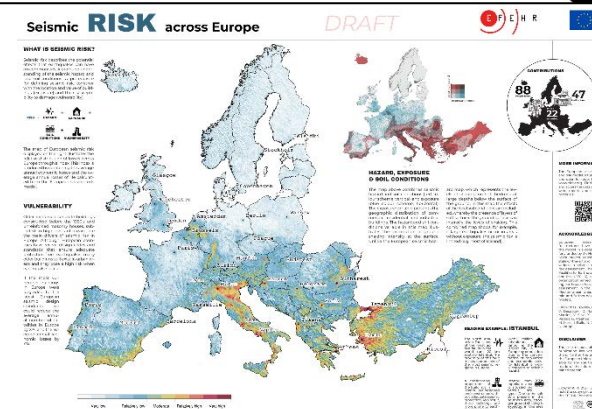
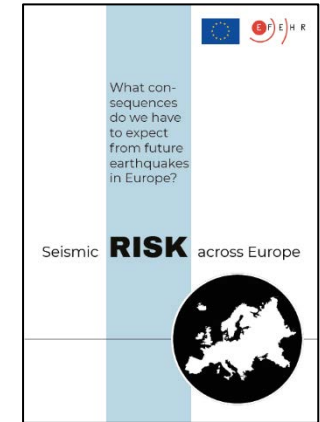
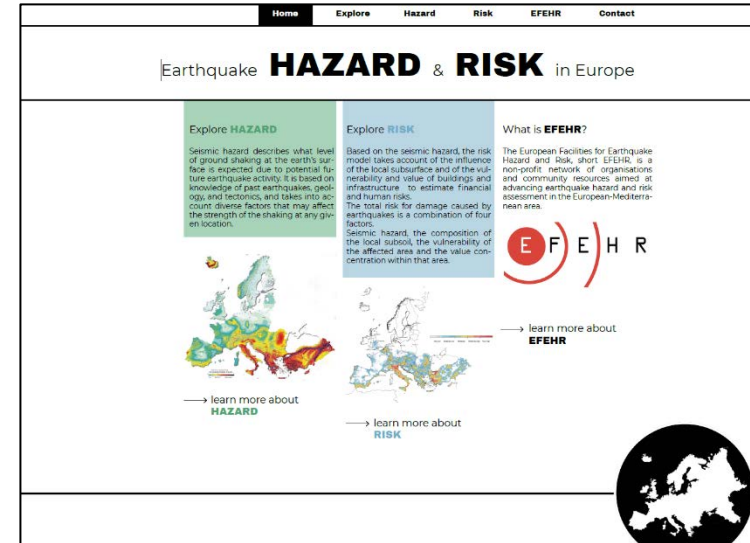
- We identified more than 20 target audiences
- To reduce complexity, we introduced four personas each representing a subset of our target audiences
- “How much would Persona A like that we add another layer of information?”

Target audience	Modelers & Researchers	Professional users	Scientific community	Interested Public and Media
Name	Leon	Joséphine	Dimitris	Kristina
Job	– CAT Modeler	– Disaster risk manager	– Geologist	– Journalist
Organisation	– SwissRe	– French Civil Protection	– U. of Patras	– Jutarnji list
Country	– Switzerland	– France	– Greece	– Croatia
Summary	<i>Leon will integrate the openly available input data of the European seismic hazard and risk models for their own analysis and commercial platform.</i>	<i>Joséphine wants to translate up-to-date information into concrete recommendations for action to reduce personal injury and property damage.</i>	<i>Dimitris needs openly available geological data to integrate them into his own research.</i>	<i>Kristina aims at transforming information related to Croatia into relevant and interesting stories for her readers.</i>



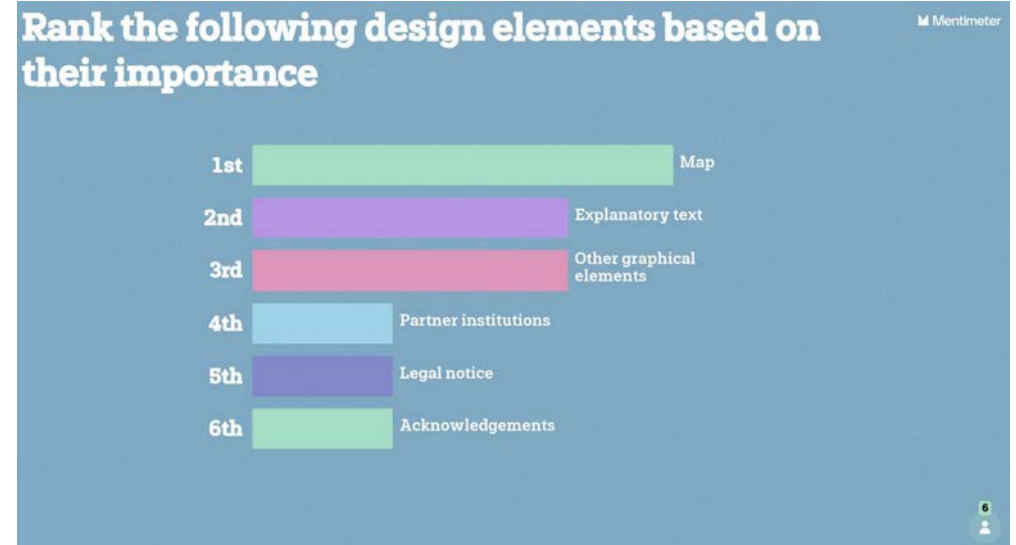
Products

- Redesign of the main entry point to explore the models www.efehr.org
- Posters
- Flyers
- Factsheets
- Technical report
- Press release
- Social media materials
- Explainer video
- Questions & answers
- Interactive map viewer



Product development – the example of the European seismic risk poster

- Target audiences: experts and semi-experts
- Important content elements
 - Title
 - Seismic loss index map (human & economic loss) (main map)
 - Explaining seismic risk
 - Combined hazard (site amplified hazard), exposure map and significant earthquakes map
 - Most vulnerable buildings
 - Reading example
 - QR code to access additional information
 - Authors
 - Copyright
 - Acknowledgement



Product development – the example of the European seismic risk poster

First draft

Testing version

Seismic RISK across Europe

SEISMIC RISK OVERVIEW

Seismic risk describes the potential effects of ground motions on the built environment. Therefore a profound understanding of the seismic hazard & the building exposure to the seismic activity. Combined with data on vulnerabilities and the location and value of buildings and their susceptibility, seismic risk allows to estimate the consequences that can be expected to occur at specific locations.

ABOUT THE EUROPEAN SEISMIC LOSS INDEX

The European Seismic Loss Index map shows the general distribution of seismic loss across Europe. Losses are measured in terms of the use of buildings and population, not relative to other parts of Europe or to the consequences from earthquakes hazards, and is composed of two parts: the Average Annual Economic Loss and the Average Annual Loss of Life (L₁).

DAMAGING EARTHQUAKES

The map shows an overview of damaging earthquakes with a minimum magnitude of 5 in Europe in the last 100 years. The colour scale represents the magnitude. The size of the circles represents the frequency of how many such earthquakes have already occurred.

EXPOSURE & HAZARD

The exposure model simultaneously portrays the two different variables, seismic hazard (red colour scheme, vertical) and the 'exposure model' (horizontal scheme, horizontal). The more intense the colour, the higher are the values of the two variables and their combination.

READING EXAMPLE: ISTANBUL

Hazard
The hazard map shows the level of seismic hazard in Istanbul. The hazard is high, as indicated by the red color.

Exposure
The exposure map shows the level of exposure in Istanbul. The exposure is high, as indicated by the red color.

Vulnerability
The vulnerability map shows the level of vulnerability in Istanbul. The vulnerability is high, as indicated by the red color.

CONTRIBUTIONS

88 people from...
47 installations in...

MOST VULNERABLE BUILDINGS

Older reinforced concrete buildings constructed before the 1980s and unreinforced masonry houses subjected to high levels of hazard are main drivers of seismic risk and therefore can cause significant economic and human losses. Although many countries have already updated building standards, many older buildings still exist in urban areas and potentially pose a high risk when earthquakes occur. If all of the most vulnerable buildings in Europe were brought up to the level of seismic design required by the latest European standards, we could reduce the average annual number of fatalities in Europe by 20%, and the average annual economic losses by 15%.

ACKNOWLEDGEMENT

The European Seismic Loss Index map is based on the work of the European Seismic Loss Index Consortium (ESLIC) and the European Seismic Loss Index Consortium (ESLIC).

MORE INFORMATION

For more information, please visit the website: www.efehr.org

EU DISCLAIMER

The European Seismic Loss Index map is based on the work of the European Seismic Loss Index Consortium (ESLIC) and the European Seismic Loss Index Consortium (ESLIC).

Seismic RISK across Europe

WHAT IS SEISMIC RISK?

Seismic risk describes the potential effects that earthquakes can have on communities. A profound understanding of the seismic hazard and local soil conditions is a prerequisite for defining seismic risk, together with the location and value of buildings (exposure) and their susceptibility to damage (vulnerability).

RISK = HAZARD + EXPOSURE + SOIL CONDITIONS + VULNERABILITY

The map of European seismic risk displayed on the right illustrates the relative distribution of losses across Europe through a index. This index is produced by combining the average annual economic losses and the average annual losses of life calculated from the European seismic risk model.

VULNERABILITY

Older reinforced concrete buildings constructed before the 1980s and unreinforced masonry houses, subjected to high levels of hazard, are the main drivers of seismic risk in Europe. Although European countries have recent design codes and standards that ensure adequate protection from earthquakes, many older buildings still exist in urban areas and they pose a high risk when earthquakes occur.

If the most vulnerable buildings in Europe were upgraded to the latest European seismic design standards, we could reduce the average annual number of fatalities in Europe by 20%, and the average annual economic losses by 15%.

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47 installations in...

READING EXAMPLE: ISTANBUL

The North Anatolian Fault, one of the most active faults in the world, runs 20 km south of Istanbul. The proximity of the fault makes Istanbul one of the most seismic regions in Europe.

Istanbul has a high population density and is highly exposed to seismic hazard.

With 15 million inhabitants, Istanbul is the most densely populated city in Europe by population. Due to the concentration of population and economic activity, Istanbul is highly exposed to seismic hazard.

A considerable proportion of the buildings in Istanbul are designed without adequate seismic protection. As a result, these buildings are more prone to earthquake damage.

Istanbul's most populated area is situated on vertical soil conditions. Due to the soil conditions, the ground shaking is expected to be stronger in this area of the city.

DISCLAIMER

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DRAFT

Final version of the European seismic risk poster

The **EARTHQUAKE RISK** map of Europe

WHAT IS EARTHQUAKE RISK?

Earthquake risk describes the potential effects that earthquakes can have on communities. A profound understanding of the earthquake hazard and local soil conditions, which tells us about the expected levels of future ground shaking, is a prerequisite for defining earthquake risk together with the location and value of buildings (exposure) and their susceptibility to damage (vulnerability).



HOW TO READ THE EARTHQUAKE RISK MAP OF EUROPE

The earthquake risk map of Europe illustrates the relative distribution of risk due to earthquakes across Europe through an index. This index combines quantities of average annual economic loss and 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.

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.

The "very high" risk index areas could have an average annual economic loss of up to 65 M EUR and could reach over 30 fatalities a year, whereas the losses in a "moderate" risk index area could instead be up to 25 M EUR, with up to 2 fatalities per year.

READING EXAMPLE: ISTANBUL

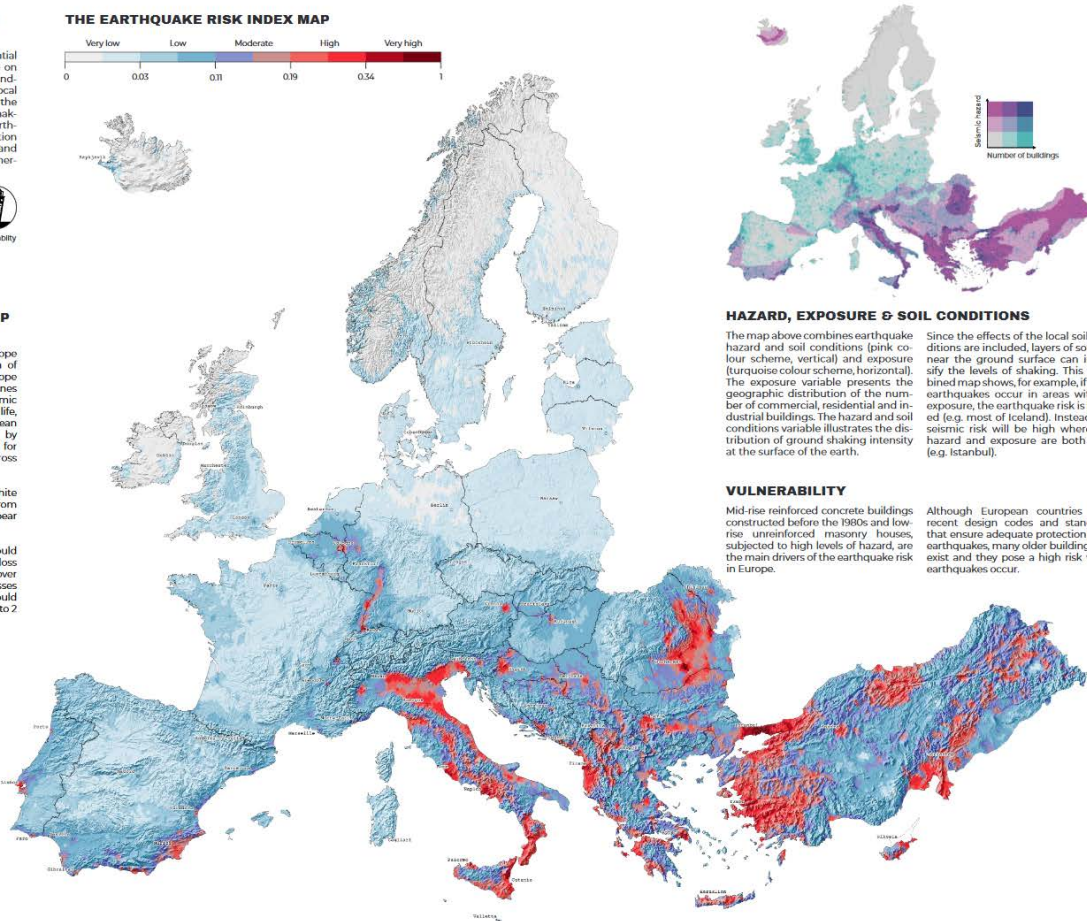
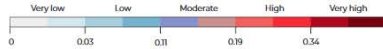
The North Anatolian Fault, one of the most active faults in the world, runs 200 km south of Istanbul. The proximity of the fault makes Istanbul one of the most seismic regions in Europe.

Istanbul metropolitan area is situated on various soil types. Due to the soft soils present in the southern area, stronger ground shaking is expected in this area of the city.

With 15.1 million inhabitants, Istanbul is the largest city in Europe by population. Due to the concentration of population and economic activity near active faults, Istanbul is highly exposed to seismic hazard.

A considerable proportion of the buildings in Istanbul are designed and constructed without adequate seismic protection. As a result, these buildings are more prone to earthquake damage.

THE EARTHQUAKE RISK INDEX MAP



HAZARD, EXPOSURE & SOIL CONDITIONS

The map above combines earthquake hazard and soil conditions (pink colour scheme, vertical) and exposure (turquoise colour scheme, horizontal). The exposure variable presents the geographic distribution of the number of commercial, residential and industrial buildings. The hazard and soil conditions variable illustrates the distribution of ground shaking intensity at the surface of the earth.

Since the effects of the local soil conditions are included, layers of soft soil near the ground surface can intensify the levels of shaking. This combined map shows, for example, if large earthquakes occur in areas without exposure, the earthquake risk is limited (e.g. most of Iceland). Instead, the seismic risk will be high where the hazard and exposure are both high (e.g. Istanbul).

VULNERABILITY

Mid-rise reinforced concrete buildings constructed before the 1980s and low-rise unreinforced masonry houses, subjected to high levels of hazard, are the main drivers of the earthquake risk in Europe.

Although European countries have recent design codes and standards that ensure adequate protection from earthquakes, many older buildings still exist and they pose a high risk when earthquakes occur.



MORE INFORMATION

Discover more about earthquake hazard and risk across Europe at www.efehr.org.



ACKNOWLEDGEMENTS

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 ESM20 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 Photo Observing System (EPOS). Here you can find the list with all names and institutions.



The development of the 2020 European Seismic Risk Model (ESRM20) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements 720960, 618564 and 80715 of the projects SERA, EPOS-IP and RISE.



CITATION

Crowley, H.J., Dabbeek, J., Despotaki, V., Rodriguez, D.P., Martins, L., Silva, V., Romão, X., Pereira, F., Washwell, G., Danclou, L. (2023) European Seismic Risk Model (ESRM20). EFER Technical Report 002, V1.0.0, 84 pp. <https://doi.org/10.2414/EFUC-EFER-TR002-ESRM20>

- 1. EUCENTRE Foundation, Pavia, Italy
- 2. GEM Foundation, Pavia, Italy
- 3. University of Porto, Porto, Portugal
- 4. GZ Foundation, Germany
- 5. ETH Zurich, Switzerland
- 6. former affiliation

LICENSE



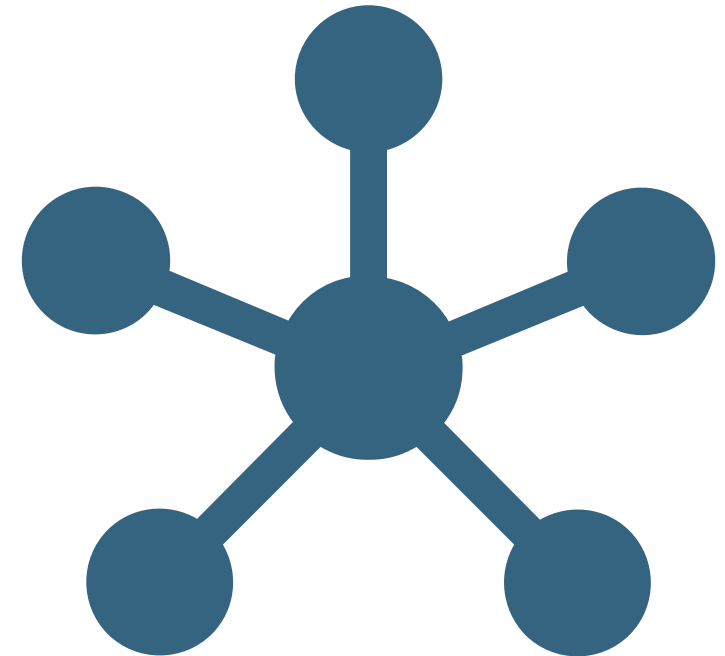
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Distribution channels

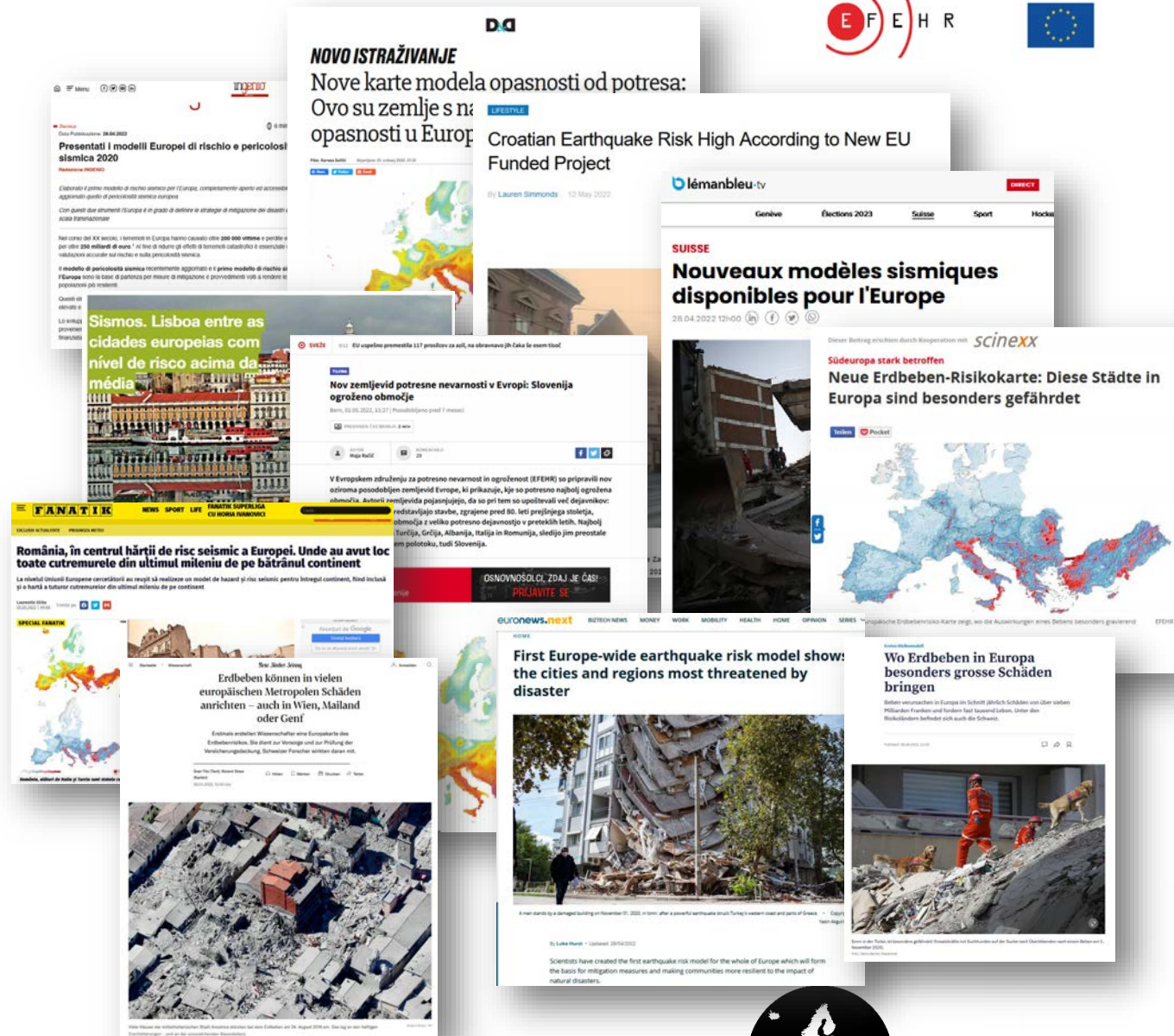
- Using established communication channels of the EFEHR consortium
- www.efehr.org website as the primary information hub to access the models.
- Close collaboration with EFEHR partner organizations and other institutions interested in sharing the knowledge about seismic hazard and risk in Europe



Media coverage

- 14 articles on websites, newsletters
- 37 articles in newspapers, online magazines
 - National press from various countries
 - Switzerland, Germany, UK, Greece, Portugal, Slovenia, Italy, Ireland, Romania, France, Croatia
- International media and websites: EuroNews, Newswise, Swissinfo, Science X
- 40 post on social media channels
- 1 report in the radio

→ Often, text was adapted from the official EFEHR press release



Conclusions

- **Start early**

The models do not need to be final to allow for product development and testing.

- **Listen to each other**

Transdisciplinary collaboration requires interest and respect for other perspectives as well as room for discussions.

- **Take it step by step**

Not only the models need time to develop, but also the communication materials. Usually, the first draft is not the final draft, do not start the process with this expectation.

- **Evaluate**

Even carefully designed communication materials may fail and be misunderstood. Therefore, test the communication materials in advance and evaluate if they really portray the message you intended.

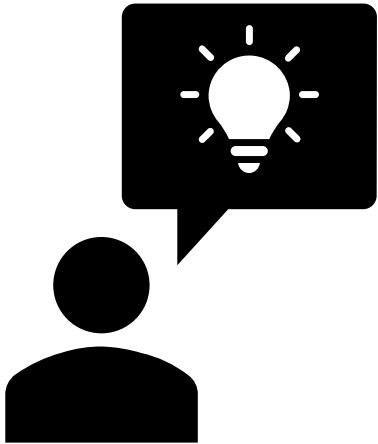
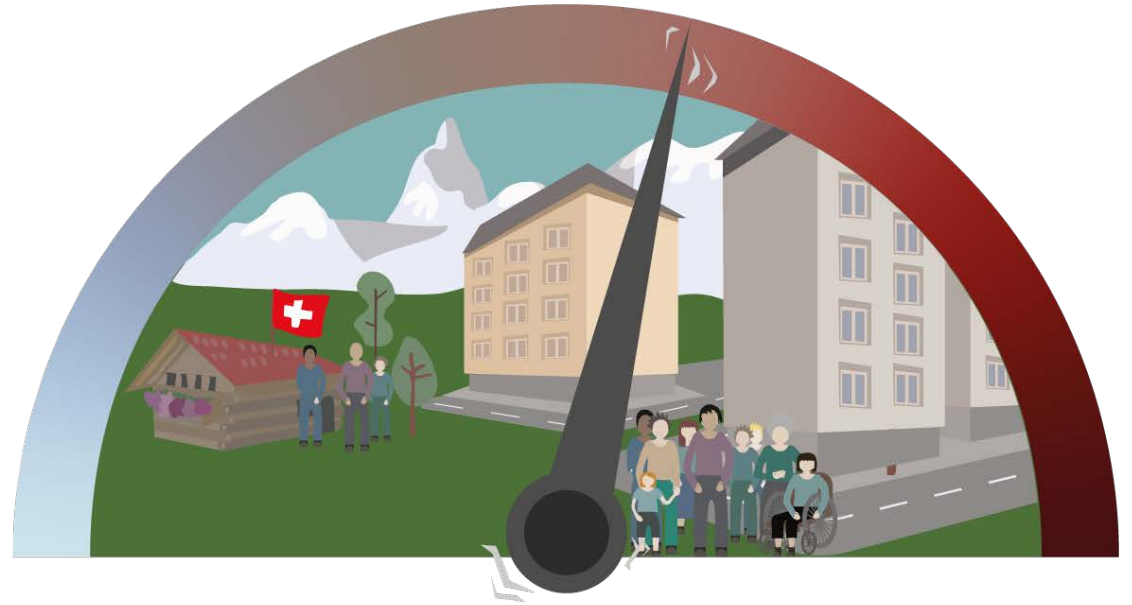
- **Stay tuned**

The job is not completed after the release. Be prepared to make changes, respond to requests, and continue sharing your knowledge.



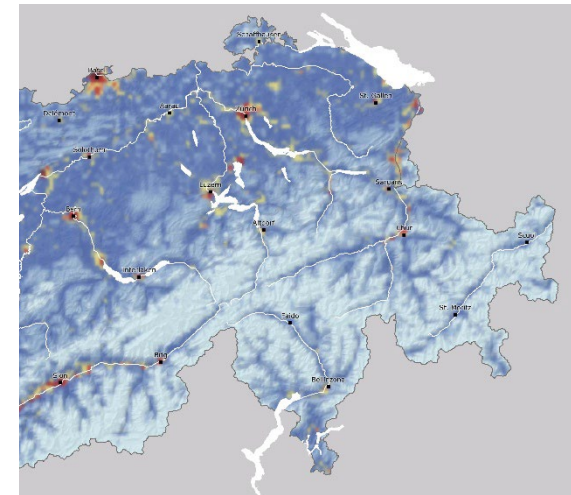
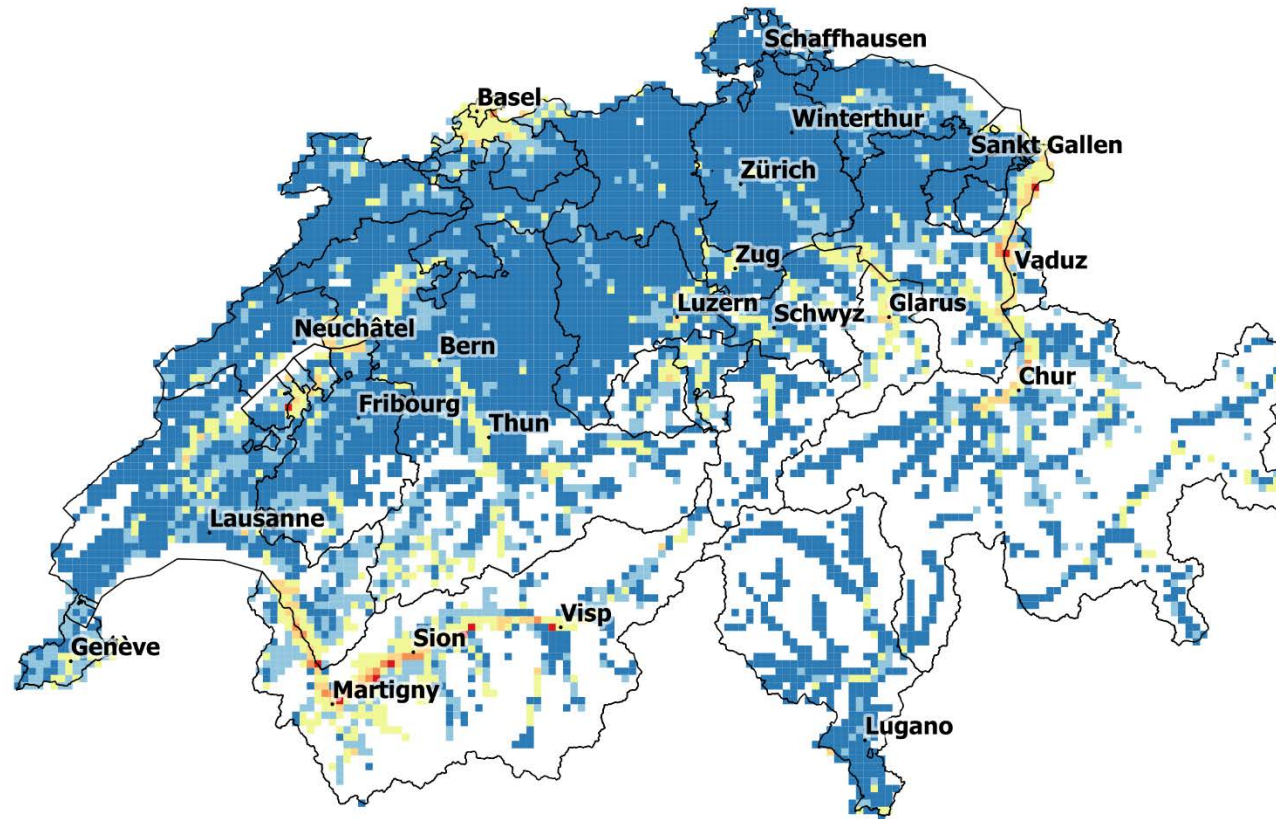
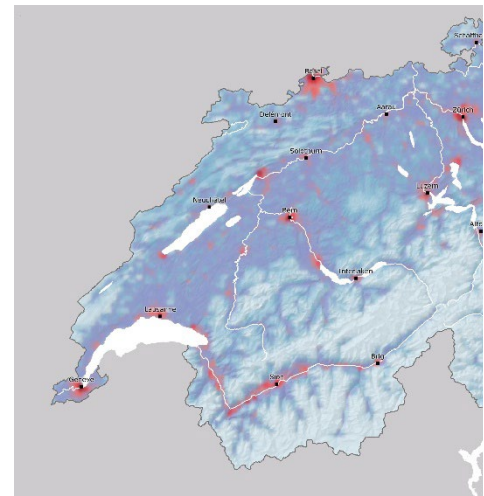
Launching the Swiss earthquake model

- Aim
Provide information that allow the public, the authorities and the economy to make informed decisions and support event management.



Which map shall it be?

- Earthquake risk map as the main communication product to inform the Swiss public.
- How do you design a map like this, including a legend, so that it adequately reflects the earthquake risk and supports its assessment?

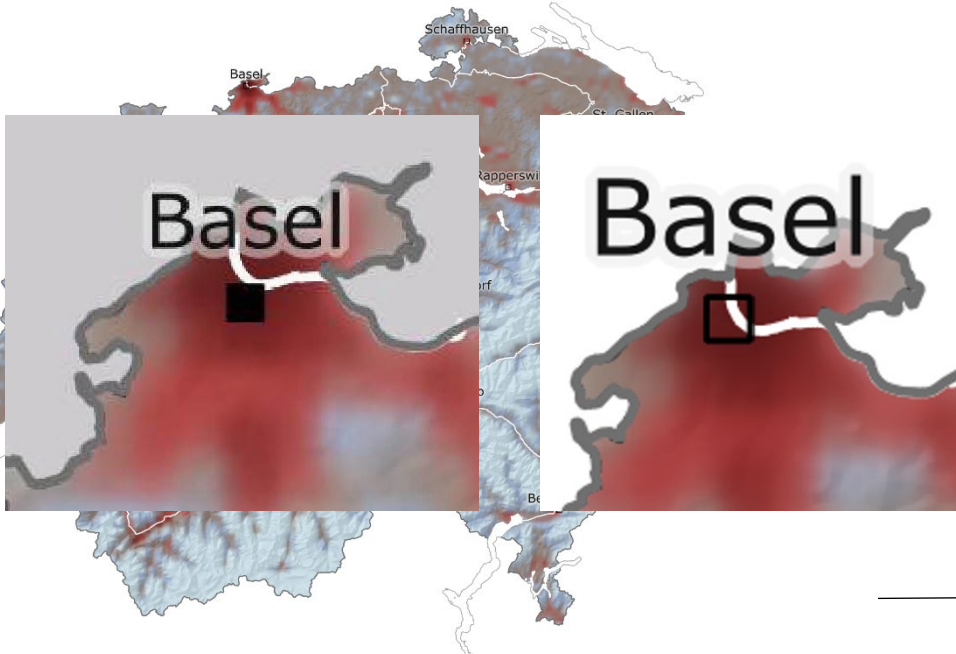


Which map shall it be?

- Most popular version
- Highest intention to take actions.
- Better understanding that all of the Swiss plateau has an elevated earthquake risk.
- Better understanding that most places in Switzerland are potentially at risk.

The Swiss plateau (the region between Lake Geneva and Lake Constance) and the Valais are at greater risk of earthquakes than the rest of Switzerland.

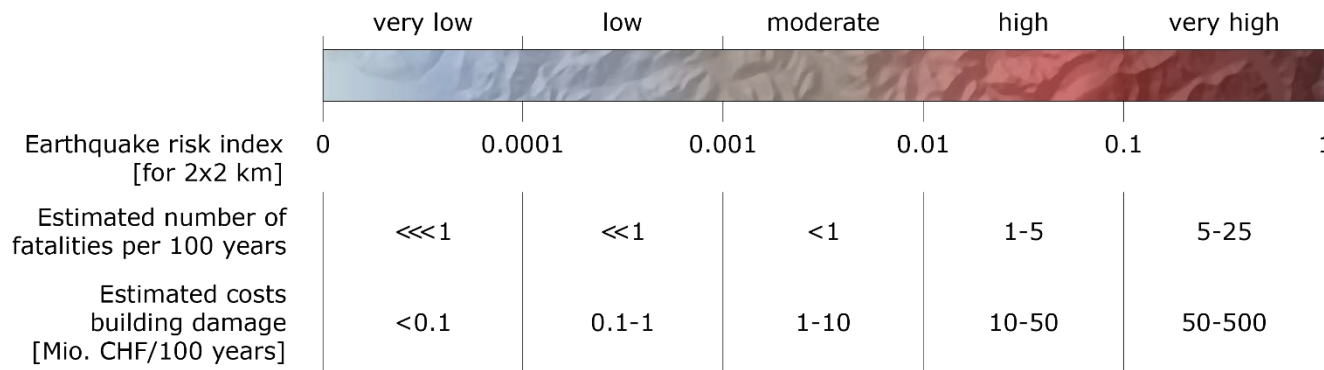
The risk of earthquakes is greatest in urban areas (cities).



Which legend shall it be?

- Testing of six different versions
- Most complex version was among the favoured legends and led to the most adequate interpretation.

Earthquake risk



Erdbebenrisiko

sehr tief —————> sehr hoch



Erdbebenrisiko

sehr tief tief moderat hoch sehr hoch



Erdbebenrisiko

sehr tief tief moderat hoch sehr hoch



Geschätzte Anzahl Todesopfer [Ø / 100 Jahre]	<1	<1	<1	1	10
Geschätzte Kosten Gebäudeschäden [Mio. / Ø / 100 Jahre]	0.05	0.4	3.7	28.85	206.5

Erdbebenrisiko

sehr tief tief moderat hoch sehr hoch



Geschätzte Anzahl Todesopfer pro 100 Jahre	<1	<1	<1	<-3	3-22
Geschätzte Kosten Gebäudeschäden [Mio. CHF/100 Jahre]	0-0.1	0.1-0.9	0.9-8.3	8.3-66.0	66.0-479.0

Erdbebenrisiko

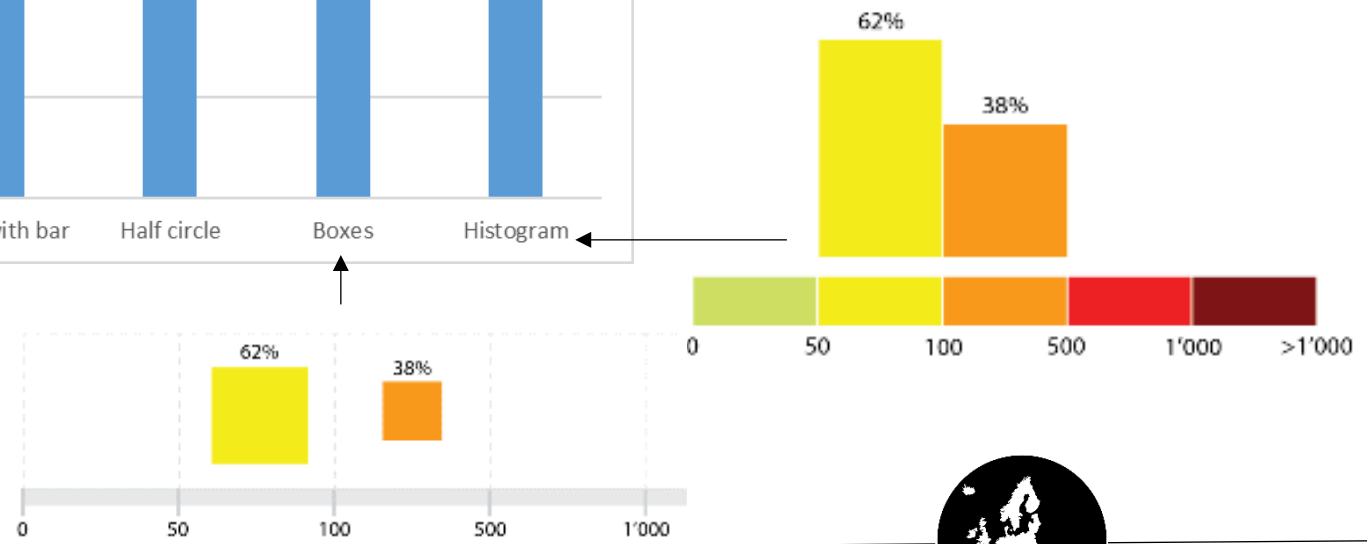
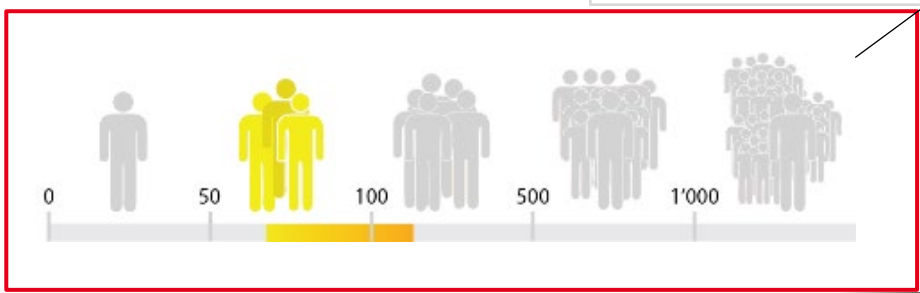
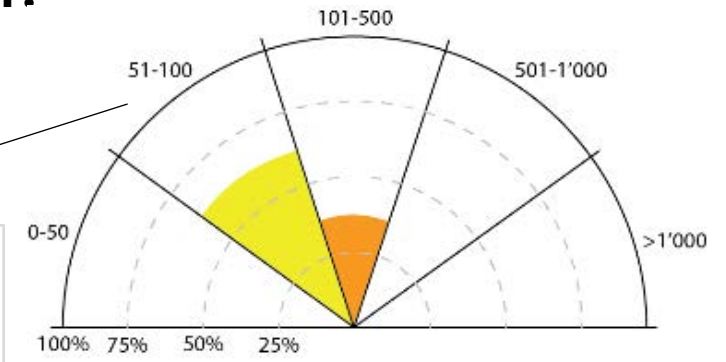
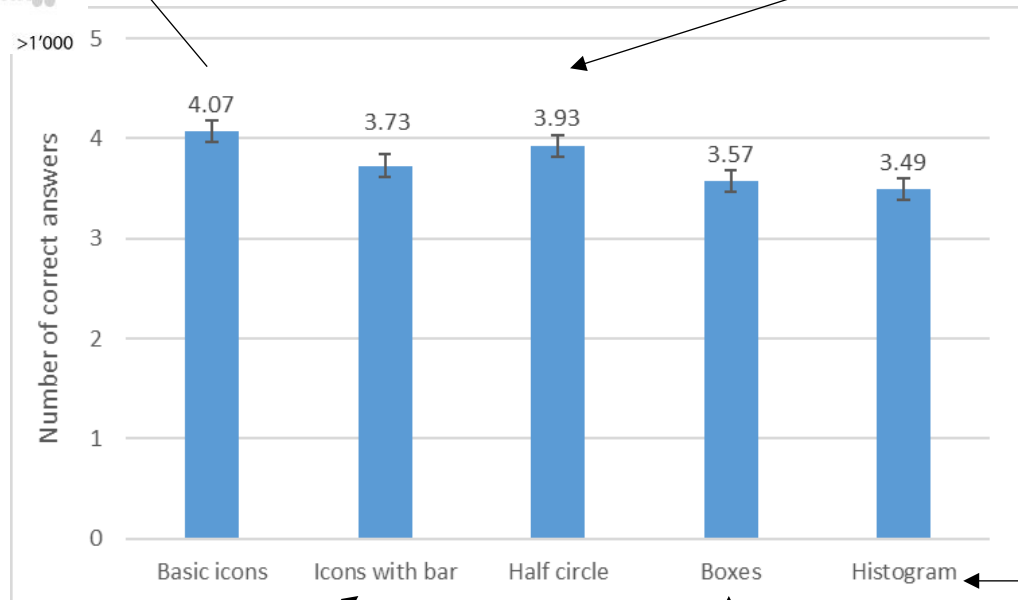
sehr tief tief moderat hoch sehr hoch



Index	0	0.0001	0.001	0.01	0.1	1
Geschätzte Anzahl Todesopfer [Ø / 100 Jahre]	<1	<1	<1	1	10	
Geschätzte Kosten Gebäudeschäden [Mio. / Ø / 100 Jahre]	0.05	0.4	3.7	28.85	206.5	



Which design shall it be to depict rapid impact information?

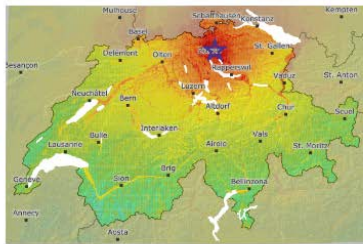



Which design shall it be to depict rapid impact information?



Earthquake scenario

Earthquake in the vicinity of Zürich (ZH)

Overview	Magnitude 6.0 [Mw] In this scenario, an earthquake has occurred in the canton of Zurich (ZH), with the epicentre located approximately 10 km northeast of Zurich (ZH). This earthquake would be felt across Switzerland. An earthquake of this magnitude would be expected to cause moderate to heavy damage within a wide radius of the epicentre. On statistical average, an earthquake with a magnitude of 6 is to be expected within a 50 km radius of this epicentre every 1210 years.	Danger level <div style="background-color: #800000; color: white; padding: 5px; text-align: center; font-weight: bold;">5</div>
	Local time: - Date: - Hypocentral depth (km): 8 Magnitude (Mw): 6.0 Assessment: automatic Swiss coordinates: 2'688'037 / 1'256'734 Additional data: Link	
National	Estimated effects The estimated impacts are described in intensities. The intensity describes the strength of an earthquake based on the extent of the impact and the subjective perception of a person.	Number of fatalities in Switzerland The number of fatalities is very likely to fall within the coloured range.
		Number of people seeking protection in Switzerland The number of people seeking protection is very likely to fall within the coloured range.
National	Cost of damage to buildings in Switzerland The cost of damage to buildings is very likely to fall within the coloured range.	Extent of building damage The extent of moderate to very heavy damage to buildings per canton and in the Principality of Liechtenstein is very likely to fall within the coloured range. The percentage corresponds to the average proportion of damaged buildings per canton.
		

5 Earthquake Impact Assessment

Earthquake with a magnitude of 6.6 near Basel

Location: Basel
 Coordinates: lat=47.47, lon=7.58
 Depth: 10 km

Issued: 14.12.2020, 15:45, Version 1

Summary
 Local ground motion at most, considerable shaking effects, but above necessary national building standards of before and after seismic retrofits. In some areas of maximum aftershock risk, there is a risk of damage to old buildings and structures, especially in the case of high seismicity and long-term ground motion.

Probability of fatalities
 Probability of fatalities (in Mio. CHF)

Estimated economic losses (in Mio. CHF)

Estimated number of injured

Estimated building damage

Erste schnelle Schadensabschätzung – Ausgabedatum: 03.02.2022, 11:48 Uhr

Erdbeben bei Konolfingen (BE)

Magnitude 6.1 [Mw] | Gefahrenstufe 5

Überblick
 Ein schweres Erdbeben ereignet sich am 03.02.2022 im Kanton Bern bei Konolfingen. Die Magnitude beträgt 6.1 Mw. Die maximale Bodenbeschleunigung (MSB) wird auf 0.25 g geschätzt. Die maximale vertikale Auslenkung (MVA) wird auf 1.5 cm geschätzt. Die maximale horizontale Auslenkung (MHA) wird auf 1.5 cm geschätzt. Die maximale relative Verschiebung (MRV) wird auf 1.5 cm geschätzt. Die maximale relative Verschiebung (MRV) wird auf 1.5 cm geschätzt.

Geschichte Auswirkungen
 Die geschichtliche Auswirkungen werden in überlappenden Bereichen beschrieben. Es ist zu erwarten, dass die Auswirkungen in den betroffenen Gebieten mittel- bis langfristige Auswirkungen haben werden.

Anzahl Todesopfer in der Schweiz
 Die Anzahl Todesopfer liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Anzahl Schutzsuchender in der Schweiz
 Die Anzahl Schutzsuchender liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Kosten für Gebäudeschäden in der Schweiz
 Die Kosten für Gebäudeschäden liegen mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Anzahl Verletzte
 Die Anzahl Verletzte liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Gebäudeschäden
 Die Schäden an Gebäuden werden in überlappenden Bereichen beschrieben. Es ist zu erwarten, dass die Auswirkungen in den betroffenen Gebieten mittel- bis langfristige Auswirkungen haben werden.

Erdbeben bei Marly (FR)

Magnitude 5.5 [Mw] | Gefahrenstufe 3

Überblick
 Dieses Szenario zeigt ein Erdbeben bei Marly (FR), dessen Epizentrum ungefähr 8 km südlich von Marly liegt. Die maximale Bodenbeschleunigung (MSB) wird auf 0.15 g geschätzt. Die maximale vertikale Auslenkung (MVA) wird auf 1.0 cm geschätzt. Die maximale horizontale Auslenkung (MHA) wird auf 1.0 cm geschätzt. Die maximale relative Verschiebung (MRV) wird auf 1.0 cm geschätzt.

Geschichte Auswirkungen
 Die geschichtliche Auswirkungen werden in überlappenden Bereichen beschrieben. Es ist zu erwarten, dass die Auswirkungen in den betroffenen Gebieten mittel- bis langfristige Auswirkungen haben werden.

Anzahl Todesopfer in der Schweiz
 Die Anzahl Todesopfer liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Anzahl Schutzsuchender in der Schweiz
 Die Anzahl Schutzsuchender liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

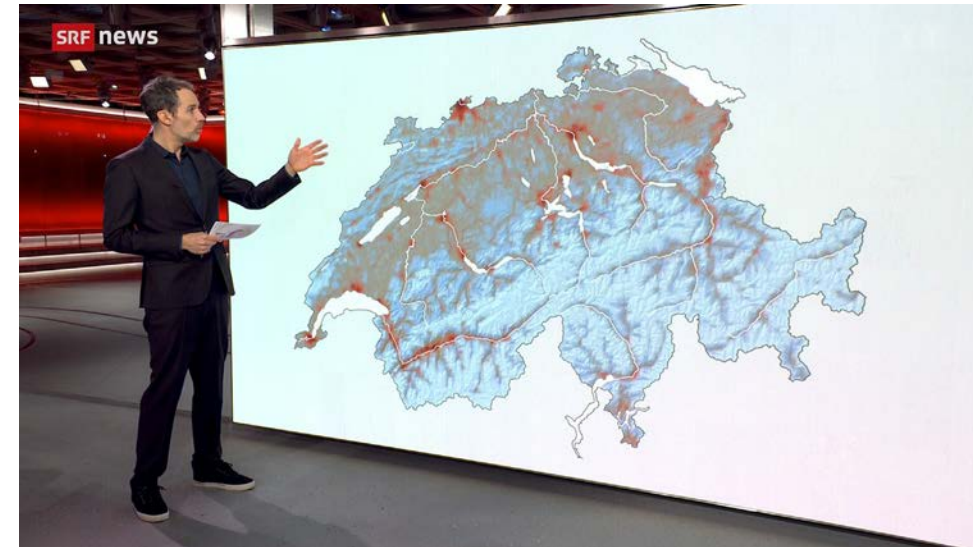
Kosten für Gebäudeschäden in der Schweiz
 Die Kosten für Gebäudeschäden liegen mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Anzahl Verletzte
 Die Anzahl Verletzte liegt mit grosser Wahrscheinlichkeit im angegebenen Bereich.

Gebäudeschäden
 Die Schäden an Gebäuden werden in überlappenden Bereichen beschrieben. Es ist zu erwarten, dass die Auswirkungen in den betroffenen Gebieten mittel- bis langfristige Auswirkungen haben werden.

What did we learn?

- Informed decisions require comprehensible and accessible information.
- We as experts do not always intuitively choose the best version. Your perspective is important, but your stakeholders and users know better!
- Products are needed and will also be essential for future discussions.
- Make a plan.
 - Sometimes, your goals seem obvious, but it is worth while thinking about them in more detail.
 - Your models have the most impact if their results become accessible to a wide group people.
- Do not be afraid of an iterative process. Allocating «useless» products is more costly than investing in the design process.



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EXCLUSIV ACTUALITATE PROGNOZA METEO

România, în centrul hărții de risc seismic a Europei. Unde au avut loc toate cutremurele din ultimul mileniu de pe bătrânul continent

La nivelul Uniunii Europene cercetătorii au reușit să realizeze un model de hazard și risc seismic pentru întregul continent, fiind inclusă și o hartă a tuturor cutremurelor din ultimul mileniu de pe continent

Laurențiu Sirbu 03.05.2022 | 09:06 Trimite pe:

SPECIAL FANATIK

România, alături de Italia și Turcia sunt statele cu cel mai ridicat risc seismic. Sursa foto: colaj Fanatik.

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