Schweizerischer Erdbebendienst
Service Sismologique Suisse
Servizio Sismico Svizzero
Swiss Seismological Service

ETH zürich

Earthquake risk in Switzerland

What are the likely effects of earthquakes in Switzerland?

Earthquakes and their impacts

Earthquakes are among the greatest risks facing Switzerland, along with pandemics and power shortages. Their occurrence can neither be prevented nor predicted. Seismic measuring stations record approximately 1,000 to 1,500 tremors each year in Switzerland and its neighbouring regions, of which around 20 are felt by the public. A quake with the potential to cause damage can be expected roughly every eight to 15 years. Catastrophic earthquakes in Switzerland and neighbouring regions are likely to occur less frequently, on average every 50 to 150 years.

What could happen in Switzerland?
Until now, there has been a great deal of uncertainty about what impacts earthquakes could have in Switzerland. From 2023, the earthquake risk model for Switzerland will allow the expected effects of earthquakes on people and buildings to be soundly quantified for the first time.

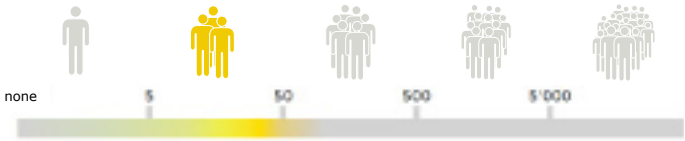
The last damaging earthquake with fatalities in Switzerland occurred in Sierre (VS) in 1946, with a magnitude of 5.8. Four people lost their lives and over 3,500 buildings were damaged as a result of the quake. The damage amounted to over CHF 26 million.

If a severe earthquake were to happen, the impact in Switzerland could be similar to that of the magnitude-6.2 quake in Amatrice (Italy) in 2016.

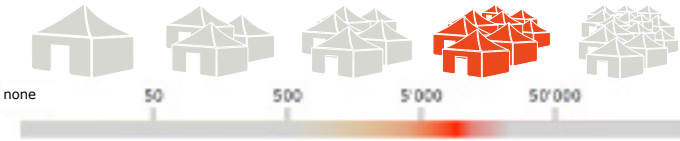
Sierre scenario

If the earthquake in Sierre were to happen again today, the expected effects could be far greater because many more people and assets would be affected than in 1946.

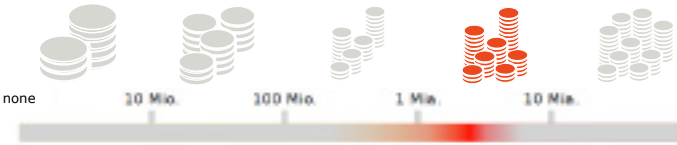
Expected number of fatalities



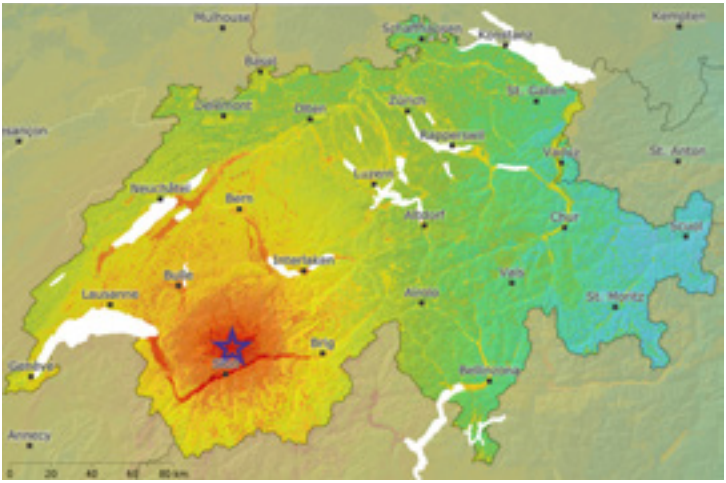
Expected number of people seeking protection



Expected costs of direct damage to buildings



The map shows the expected effects in Switzerland in the event of a magnitude-5.8 earthquake in Sierre.

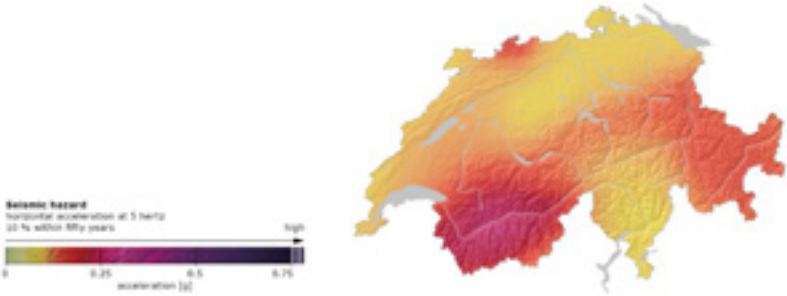


What is earthquake risk?

Earthquake risk describes the possible effects of earthquakes on buildings and the associated financial and human losses. It is made up of four factors:

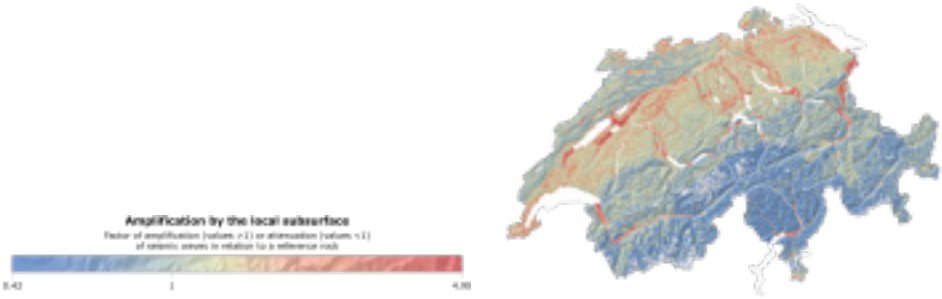
Earthquake hazard

Earthquake hazard indicates how often earthquakes might occur in a given location and how strong the tremors are likely to be. In Switzerland, the canton of Valais is the region with the highest hazard, followed by Basel, Grisons, the St. Gallen Rhine Valley, Central Switzerland and then the rest of the country.



Local subsoil

The local subsoil influences how strong the tremors of an earthquake will be at a particular location: the softer the subsoil, the more the seismic waves are amplified and the greater the likelihood of damage. In places with soft sediments, such as in valleys and on lake shores, as well as in parts of the Swiss Plateau, earthquake-triggered shaking can be up to ten times stronger than somewhere located on solid rock.

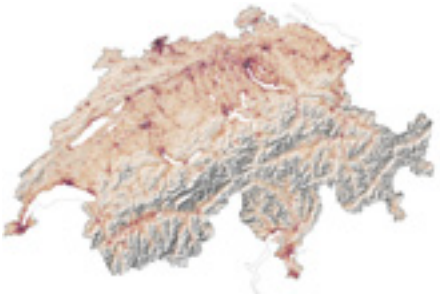


Building vulnerability

Vulnerability describes the susceptibility to damage of buildings at given earthquake magnitudes. For the earthquake risk model, the vulnerability for different, representative building types was derived based on their characteristics and divided into so-called vulnerability classes. On this basis, the building stock was statistically assigned to these classes based on simple characteristics such as the number of storeys or the construction period. This, combined with information on the people and assets affected, makes it possible to determine the consequences for residents and the financial losses. The latter are expressed as a proportion of the building reinstatement costs. The majority of Swiss buildings were not built in accordance with the currently applicable building standards for earthquake-resistant construction.

Affected people and assets

This factor encompasses the spatial distribution of Switzerland's more than two million residential, commercial and industrial buildings. It also includes the number of people occupying these buildings and the reinstatement costs. Densely populated areas have a greater earthquake risk than rural areas with fewer people and buildings potentially affected. Other possible secondary impacts on infrastructure, losses due to landslides, fires or business interruptions, and variations in building occupancy over time are not yet factored into the earthquake risk model.



How high is the earthquake risk in Switzerland?

Over a period of 100 years, earthquakes can be expected to cause economic damage of CHF 11 to 44 billion to buildings and their contents alone. In total, up to 1,600 people would lose their lives and an estimated 40,000 to 175,000 would become homeless on a short-term or long-term basis. On top of this, there is damage to infrastructure and losses due to other effects of earthquakes such as landslides, fires or business interruptions. However, these are not yet included in the model. The risk is not evenly distributed over time, but is dominated by rare, catastrophic earthquakes that usually happen without warning.

Cities with the highest earthquake risk

1. Basel
2. Geneva
3. Zurich
4. Lucerne
5. Bern

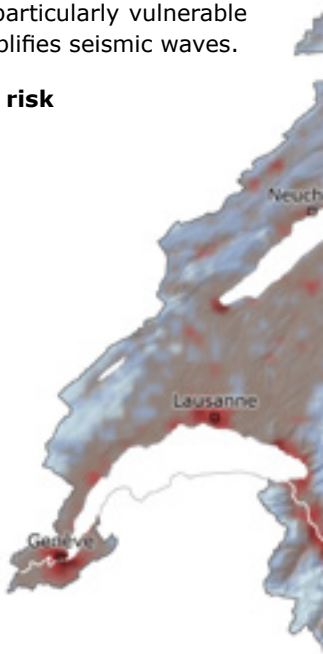
Although the earthquake hazard in these regions differs, all five cities have, by virtue of their size, a large number of people and assets that would be affected by an earthquake. In addition, these cities have many buildings, some particularly vulnerable and often located on soft subsoil that amplifies seismic waves.

Cantons with the highest earthquake risk

1. Bern
2. Valais
3. Basel-Stadt
4. Zurich
5. Vaud

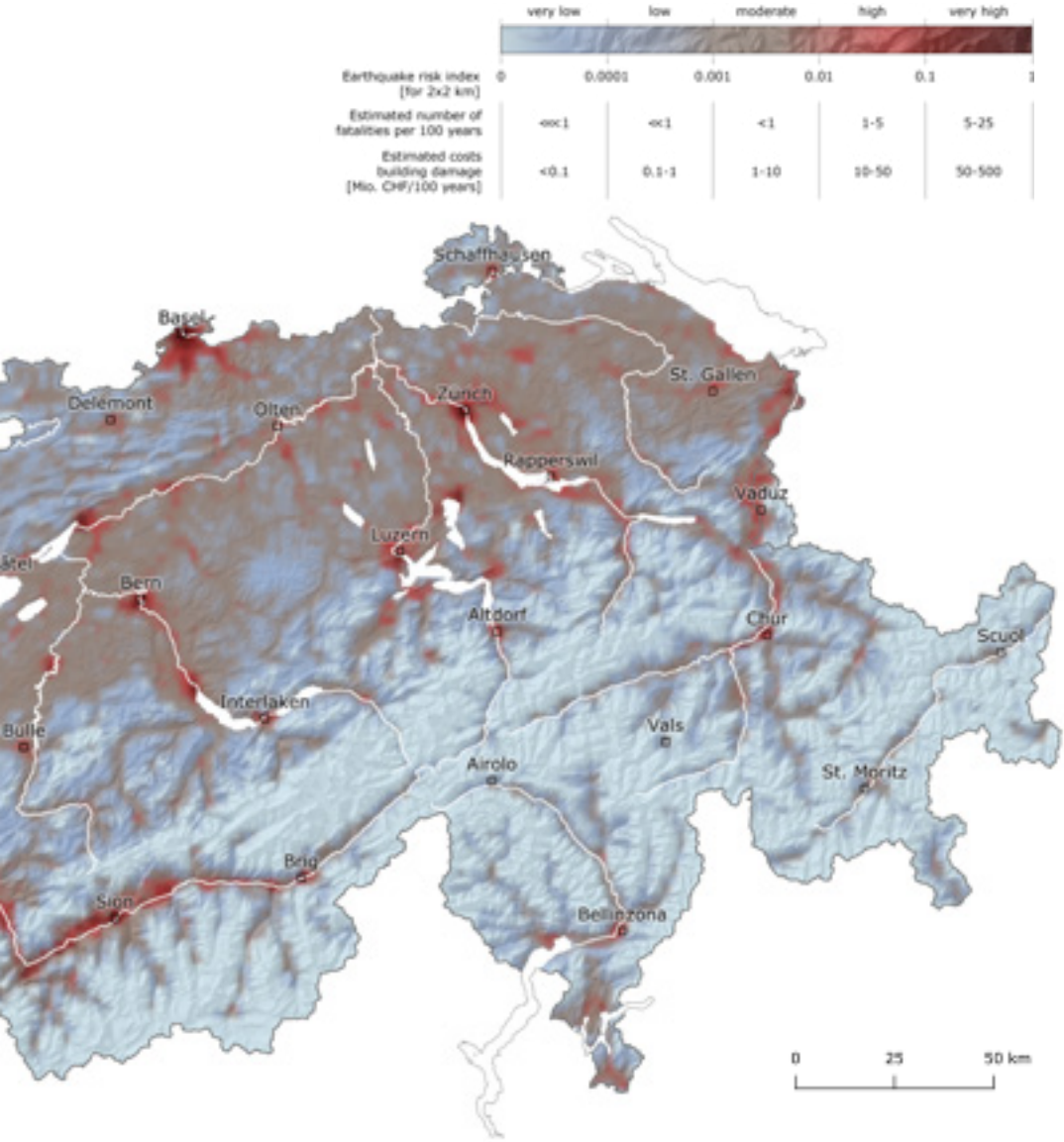
Damage to buildings

At approximately CHF 25 billion, the cantons of Bern, Valais, Zurich, Vaud and Basel-Stadt account for over half of the expected financial losses from damage to buildings and their contents over a 100-year period. Like all other modelled values, this figure is subject to some uncertainty.



What does the earthquake risk map show?

The earthquake risk map is based on an index that combines the expected number of fatalities with the estimated financial losses due to building damage. The values indicated always refer to an area of 2 x 2 kilometres. The earthquake risk is highest in the areas coloured dark red. The light-blue areas have a lower risk because there are relatively few people and assets in these locations. Even so, the damage to individual buildings in these regions could be devastating. An earthquake risk exists, therefore, throughout Switzerland.



Mitigating earthquake risk

Severe earthquakes could trigger a supraregional emergency in Switzerland, taking several months or even years to deal with and demanding extraordinary measures and financial resources. It is therefore all the more important to prepare measures and emergency plans today, so that when the next earthquake strikes it is clear who is required to do what and using what means and resources. This will enable the country to cope better with a major earthquake.

Earthquake-resistant construction
Earthquake-resistant building design offers the best protection against the effects of an earthquake, along with securing objects that could fall or topple. The aim of earthquake-resistant construction is to prevent a building from collapsing and thereby avoid fatalities and injuries. It also helps to keep key buildings functional in the event of an earthquake and limit subsequent damage. New buildings must meet the requirements of the applicable construction standards for earthquake safety. Existing buildings should be inspected and, if necessary, upgraded in the case of major conversions or refurbishments. Compliance with earthquake-resistant construction is the responsibility of owners and the professional planners/designers they appoint.

Earthquake insurance
Taking out earthquake insurance is the traditional way to protect against financial damage caused by an earthquake. This is wise because, even where earthquake-resistant construction methods are applied, an earthquake can still do massive damage to buildings. Currently, only the Canton of Zurich insures earthquake damage to buildings under the compulsory fire and natural hazards insurance (as at March 2023). Private insurers also offer complementary solutions.

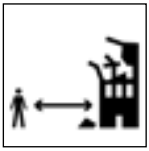
Behaviour

Behaving correctly before, during and after a severe earthquake can save lives and prevent possible injuries. In the event of strong tremors, people should seek cover from falling objects and then be prepared for aftershocks that may cause further damage.

Key recommendations about what to do during an earthquake:

- If you are inside a building, seek cover (e.g. under a sturdy table).

- If you are already outside, do not enter a building.



- Stay away from buildings, bridges, pylons, large trees and other objects that could collapse or fall.

- If you are near a body of water, move away from the shore.

- If you are in a vehicle, stop driving and stay inside the vehicle while the quake lasts.
- Do not stop on bridges, in tunnels or in underpasses.
- Keep away from roadside buildings (they could collapse).

These and other recommendations on what to do during a strong earthquake can be found at www.seismo.ethz.ch.

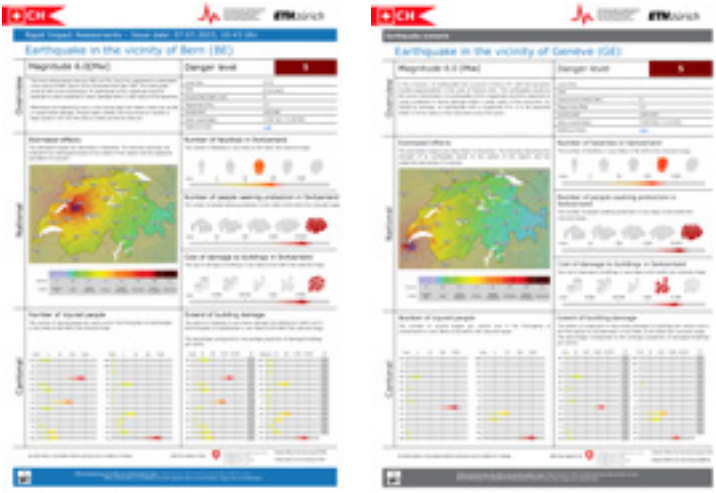
Scenarios and Rapid Impact Assessments

As well as compiling risk assessments for specific periods and locations, the Swiss Seismological Service (SED) at ETH Zurich can now use the earthquake risk model to develop scenarios. Among other things, this makes it possible to illustrate the effects that damaging historical earthquakes in Switzerland would have if they occurred today.

For example, if the magnitude-6.6 Basel earthquake of 1356 were to be repeated, the expected death toll in Switzerland would be around 3,000, with damage totalling approximately CHF 45 billion.

As well as historical scenarios, the SED provides a scenario for a damaging magnitude-6 earthquake for every cantonal capital and one other locality in each canton. Such an earthquake happens on average every 50 to 150 years somewhere in Switzerland or its neighbouring regions. These scenarios, 59 in total, are intended to help make the authorities and public more aware about the impacts of damaging earthquakes in Switzerland.

Based on the earthquake risk model, the SED will publish a Rapid Impact Assessment (RIA) after each earthquake with a magnitude of 3 or greater. The RIA will inform the public and emergency services about the expected impacts in the event of damaging earthquakes, or quakes that can be felt over a wide area. Isolated damage is possible near the epicentre with quakes of around magnitude 4 or above.



Draft RIA for a fictitious earthquake in Bern (BE) (left) and the national overview of a scenario for Geneva (GE) (right)

About the earthquake risk model for Switzerland

As of 2023, Switzerland has the first national and publicly accessible earthquake risk model. It is part of the federal government's programme of measures for earthquake mitigation, coordinated by the Federal Office for the Environment (FOEN), the aim of which is to ensure comprehensive earthquake risk management at federal level. The findings of the model will help to improve earthquake mitigation and event response.

The SED developed the earthquake risk model for Switzerland at the request of the federal government, in collaboration with the FOEN, the Federal Office for Civil Protection (FOCP), EPFL and other partners from industry.

Model development
The processing of the underlying data was key to the development of the earthquake risk model for Switzerland. Over 3 million individual earthquakes that could potentially occur in Switzerland and neighbouring regions were simulated. Switzerland's more than 2 million residential, commercial and industrial buildings were divided into vulnerability categories according to certain criteria in order to be able to model the possible damage caused by earthquakes. In addition, improved data on the amplifying effects of the subsoil conditions provide a significantly better picture of local impacts.

Model uncertainties
Despite the improved data, uncertainties in the modelling mean that there are likely to be differences compared with the actual impacts of an earthquake. The earthquake risk model will be further refined and calibrated in the coming years to reduce these uncertainties and so improve the model results.

Financing
The earthquake risk model for Switzerland costs CHF 4.5 million to develop. The costs were shared equally between the FOEN, FOCP and ETH Zurich.

Earthquake risk online

Earthquake risk tool

Determine your personal earthquake risk (approximate value) using our interactive tool:
www.seismo.ethz.ch/knowledge/earthquake-hazard-and-risk/earthquake-risk-switzerland/earthquake-risk-tool/

Maps

You can find maps of earthquake risk, earthquake hazard, amplification factors and more on our website:
www.seismo.ethz.ch/knowledge/earthquake-hazard-and-risk/maps/

Scenarios

A total of 59 scenarios illustrate the possible effects of earthquakes in Switzerland:
www.seismo.ethz.ch/knowledge/earthquake-country-switzerland/earthquake-scenarios/

Technical report

A detailed scientific report on the earthquake risk model can be found here:
www.doi.org/10.12686/a20

For professionals

Professionals will find further information as well as specific data and parameters on this page:
www.seismo.ethz.ch/knowledge/earthquake-hazard-and-risk/for-professionals/

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