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Seismic Hazard Model 2015 for Switzerland

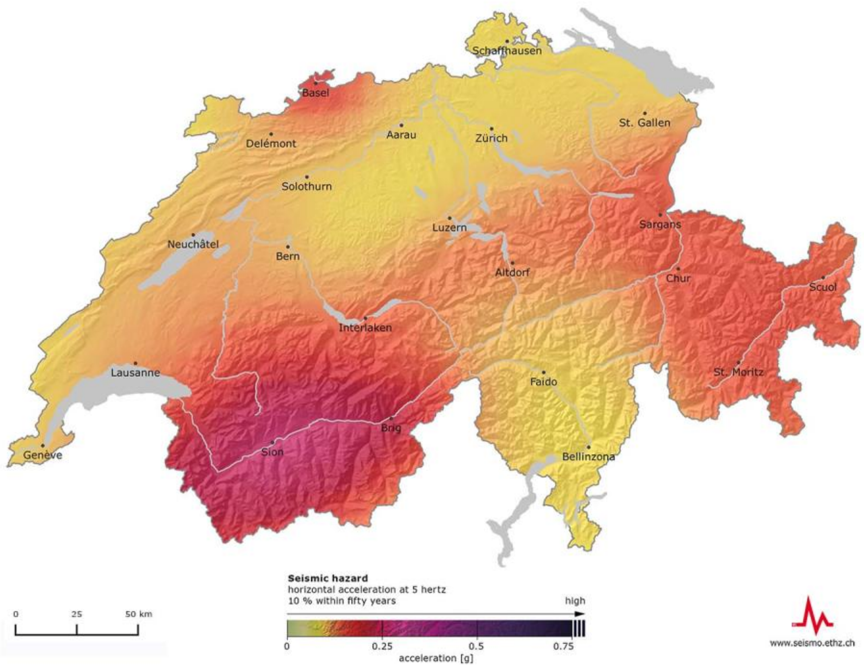
Fact sheet

The updated estimation of the regional seismic hazard distribution confirms that earthquakes are a serious hazard for Switzerland. In the seismic hazard model 2015, Valais remains the region with the highest level of risk, followed by Basel, Graubünden, the St. Gallen Rhine Valley, Central Switzerland, and the rest of Switzerland. However, compared to 2004, Graubünden is now showing a slightly higher level in the risk analysis, with likely ground movements also slightly stronger across Switzerland in several frequency ranges.

In Switzerland, earthquakes are the natural hazard with the greatest potential for causing damage. They cannot currently be prevented or reliably predicted. But, thanks to extensive research, much is now known about how often and how intensely the earth could shake at a given location in the future.

Switzerland’s seismic hazard model is a comprehensive representation of this knowledge. It makes a forecast of potential earthquakes and the resulting ground motions over the next fifty years. The model is based on knowledge of tectonics and geology, information about the history of earthquakes, damage reports, and wave propagation models. Experts and authorities use it as a starting point when making decisions regarding earthquake mitigation and risk management. The Swiss seismic building codes are also based on this model.

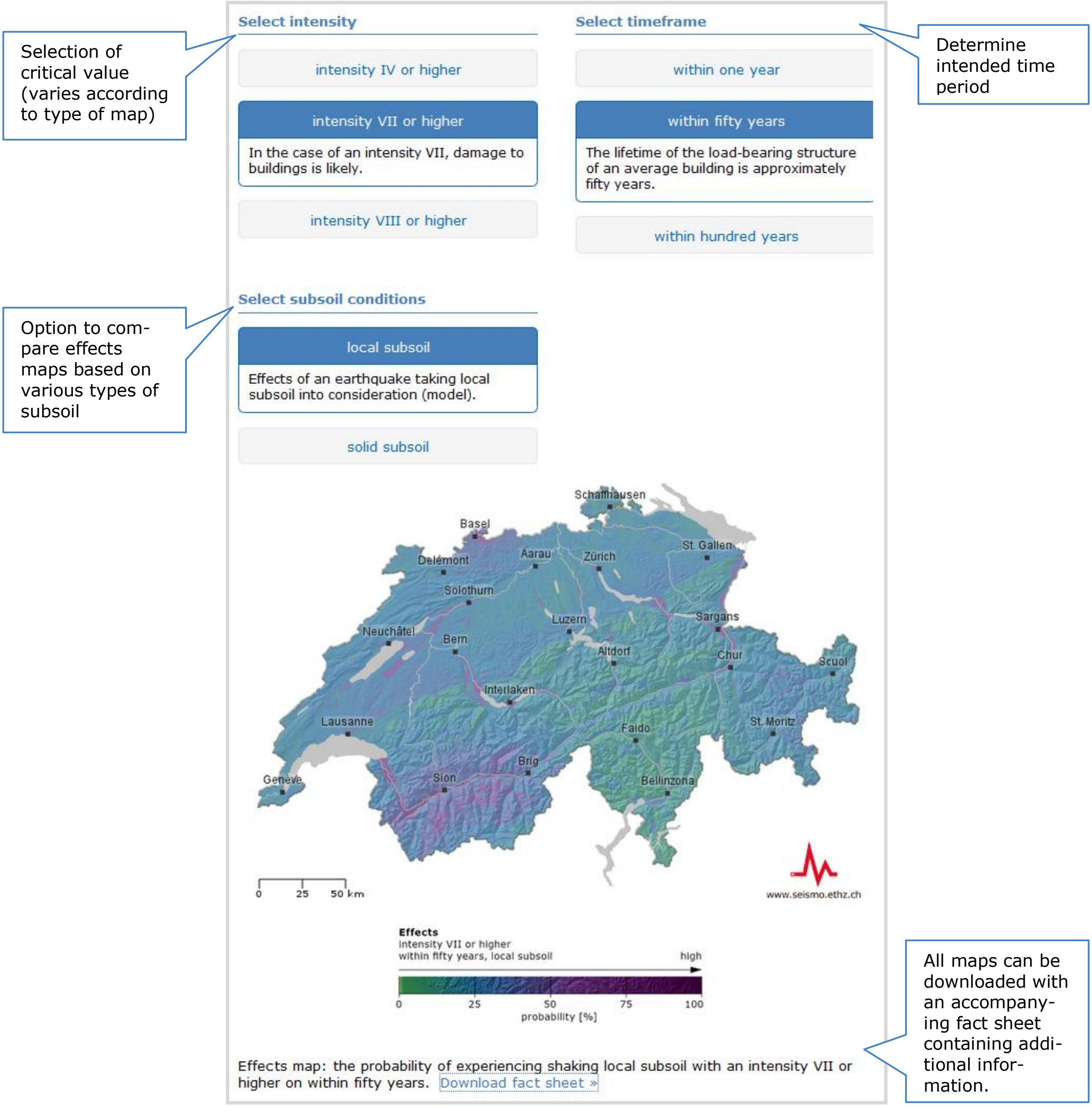
Switzerland’s seismic hazard model 2015 replaces the previous model from 2004. A periodic update reflecting the latest technological and scientific findings forms the basis for adequate protection measures. The seismic hazard model 2015 features new data, revised estimates of historical sources, a homogeneous reference rock, and improved predictive models. The uncertainty regarding estimates of likely ground motions has been significantly reduced relative to the 2004 model, meaning the 2015 model provides a more solid estimate of seismic hazard and a good basis for a nationwide risk model.



Improvements

- New measuring data
  High-quality data was incorporated in the reassessment of the seismic hazard for a period of ten years in the national digital broadband and strong motion measurement network. Switzerland has one of the most modern and densest seismic measurement networks worldwide. It annually records 500 to 800 earthquakes in Switzerland. Knowledge about the distribution of the small and medium earthquakes is an essential aid for estimating future earthquake activity. The recorded ground accelerations also make it possible to develop improved ground movement forecast models.
- Newly evaluated historical data
  Numerous data sources were reevaluated in the scope of the revision of the historical Swiss Earthquake Catalog. They provide important information about all known damaging earthquakes and their effects up to 1975. Since this time, the seismic network in Switzerland has enabled the nationwide instrumental monitoring of earthquake activity. Historical seismology makes a critical contribution to the hazard analysis by assessing the effects of major earthquakes in the past. Such earthquakes only occur rarely in Switzerland, and, in comparison to their return period, the observation period of instrumental seismology turns out to be very short.
- Updated and new macroseismic data
  Macroseismology is a classification of the shaking caused by earthquakes based on the effects observed by persons. It makes it possible to reliably estimate the magnitudes and epicenters of historical earthquakes and link these to modern data.
- Homogeneous reference rock
  Extensive geophysical measurements at different seismometer stations in Switzerland make it possible to determine the influence of the local geology on the recorded seismograms. Effects of the seismic focus, the spread of the seismic waves, and thus the local amplifications can be reliably differentiated this way. This makes it possible to determine the ground movement for a rocky reference surface with a defined speed-depth profile and an average speed of 1,100 m/s. It was not yet possible in 2004 to reliably calculate the influence of the local amplification. This is an essential advancement in comparison to the seismic hazard model 2004 and makes it possible to reduce the uncertainties in the risk estimate.
- Improved forecast models
  In the past 10 years, extensive high-quality seismic data was recorded worldwide in direct proximity to strong earthquakes. The data thus obtained enables an improved understanding of the influences of the local ground, which leads to clearly more reliable forecast models of the ground movement with the aid of modernized analysis methods. The forecast models now also cover a much broader frequency range, which is important for the implementation of the hazard analysis in the construction engineering sector.
- Alternative zoning
  The SED has developed alternative approaches in order to statistically analyze and visualize the distribution of earthquakes according to location, time, and magnitude. This alternative to classic seismotectonic zoning is of particular advantage for regions with spatially distributed seismicity without domineering fault zones, such as can be encountered in the Alps.
- Refined mathematical models
  The open-source software platform OpenQuake, developed in the Global Earthquake Model (GEM) project with participation of the SED, enables a much-improved calculation of the seismic hazard. More complex models make it possible to consider uncertainties to a larger extent and estimate them more precisely. Furthermore, the ground movements are not only modeled for spot sources, but can also be modeled for extensive fissures with varying fissure orientations.

– Easier access for the public
In a newly developed Web application, the SED visualizes how likely certain shaking is in Switzerland. This makes it possible to answer typical questions such as "How often and how strong does the earth shakes in my neighborhood?" statistically for any location in Switzerland. The maps can be classified into three types: the *effects* maps focus on the possible consequences of an earthquake; the *hazard* maps show how often buildings are affected by certain incidents of horizontal acceleration; and the *magnitudes* maps show how often an earthquake of, and above, a certain strength occurs. As well as selecting viewing modes, you can also choose between different time periods.



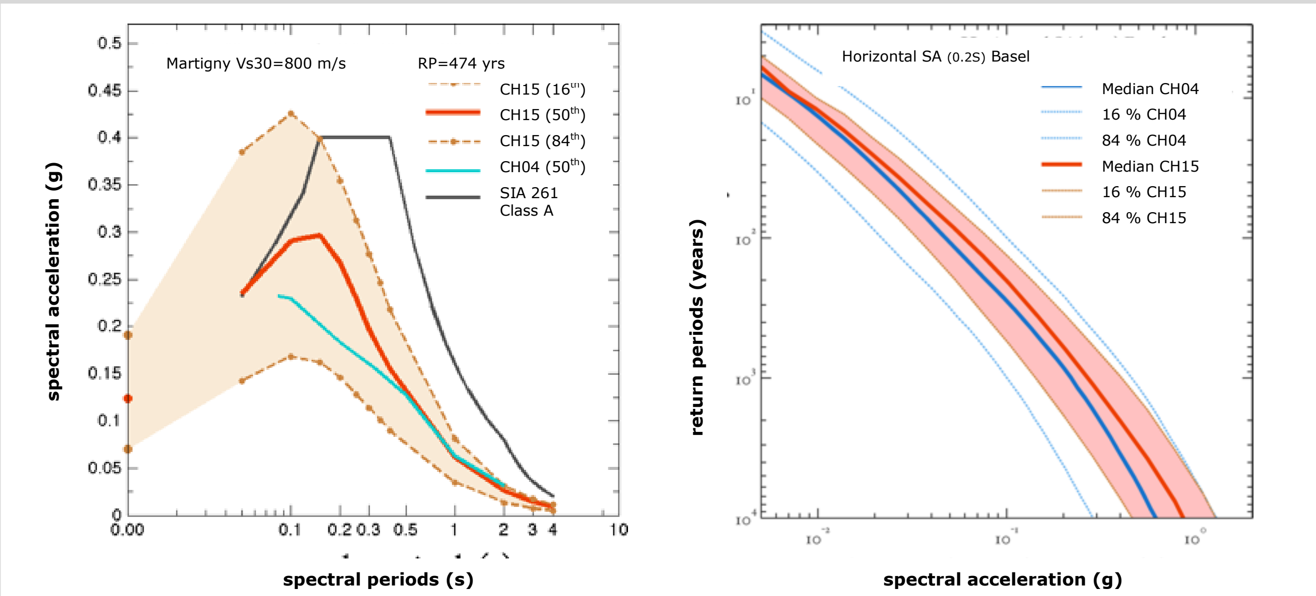
– Improved access for experts
The access to the seismic hazard model will be significantly improved for experts. On a new interactive web portal, construction engineers and geologists can independently view and download answer spectra and hazard curves, as well as de-aggregations. The SED is also creating a new peak ground acceleration (PGA) map, which will be used as a basis for zoning in the SIA 261 building standards. This map coincides very well with the present, only indirectly derived and thus approximative PGA map.

Seismic Hazard Models in Comparison

The seismic hazard model 2015 confirms that Switzerland is an earthquake-prone country. On average, an earthquake with the magnitude of 5 can be expected to occur every 8 to 15 years, even though the last earthquake of this magnitude dates back roughly 25 years (Vaz GR, 1991). With such an earthquake, extensive damage to buildings is likely, depending on the region and the depth. Earthquakes with a magnitude of 6 or greater, which may cause vast and partially severe damage, occur every 50 to 150 years on average. Earthquakes of this magnitude are principally possible at anytime and anywhere in Switzerland. The last earthquake of this magnitude occurred in Upper Valais in 1946 (Sierre VS, 1946).

As expected, the spatial distribution of the seismic hazard has not changed significantly in the past ten years. Valais remains the region with the highest level of hazard in Switzerland, followed by Basel, Graubünden, Central Switzerland, the St. Gallen Rhine Valley, and the rest of Switzerland. The hazard estimate for Graubünden is now similar to the one for the Basel region. This slightly higher classification of the canton of Graubünden can be explained by an adjusted evaluation of previous earthquakes.

Besides the slightly elevated hazard estimation for the canton of Graubünden in comparison to other regions, the seismic hazard model 2015 shows higher values for likely ground movements in many frequency ranges compared to 2004. This is primarily due to the evaluation of extensive newly recorded data in proximity to strong earthquakes in Switzerland and abroad. They often turned out to be higher than previously expected.



The figure on the **left** shows an example comparison, at Martigny, of the 2015 hazard model (CH15) with the 2004 model (CH04) for various frequencies and the SIA-defined standard spectra (SIA261).Compared with CH04, CH15 covers a wider frequency range and for certain frequencies shows somewhat higher hazard. On the **right** we compare the models using so-called hazard curves — the expected return periods of spectral acceleration — for Basel at a frequency of 5 Hz.

The relative differences between 2015 and 2004 are approximately 30 percent for a return period of 475 years and a frequency of 5 Hz for a location in Valais. This corresponds to 0.07 g absolute (gravity acceleration). The rise in percent is higher in regions with lower hazard, such as Central Switzerland or Jura: Although the values here only increased by 0.03 to 0.05 g in absolute, this corresponds to a relative increase of 50 to 70 percent. As of a frequency of 2 Hz or less, however, the values from 2015 are similar to the values from 2004, or up to 10 percent lower in some regions. In general, the uncertainties in the estimation of likely ground movements are 2015 considerably fewer than in 2004. Less substantial uncertainties are a sign that the numerous work efforts that form the basis of the new seismic hazard model are paying off.

Seismic hazard online

Maps

Discover and compare additional maps of effects, hazard, and magnitudes with different parameters and periods by using our web tool:
www.seismo.ethz.ch/en/knowledge/seismic-hazard/maps/

Background information

You can find further information and an extensive scientific report about the seismic hazard model on this site:
www.seismo.ethz.ch/en/knowledge/seismic-hazard/background-information/

For professionals

Professionals can find additional information, specific data, and parameters on this site:
www.seismo.ethz.ch/en/knowledge/seismic-hazard/for-professionals/