Schweizerischer Erdbebendienst
Service Sismologique Suisse
Servizio Sismico Svizzero
Swiss Seismological Service

ETH zürich

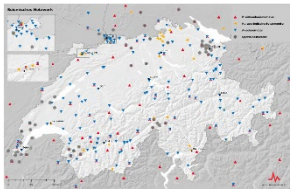
The Swiss Seismological Service (SED) at ETH Zurich



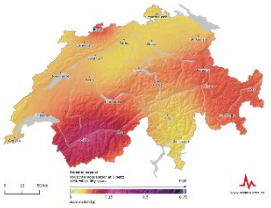
Paolo Bergamo, lead of Engineering Seismology group at SED
paolo.bergamo@sed.ethz.ch

with contributions from SED colleagues A. Imtiaz, P. Roth, A. Shynkarenko, F. Panzera, J. Van Ginkel, P. Janusz

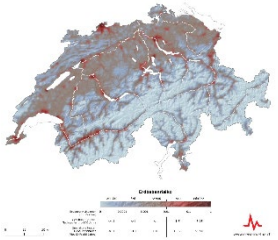
Content



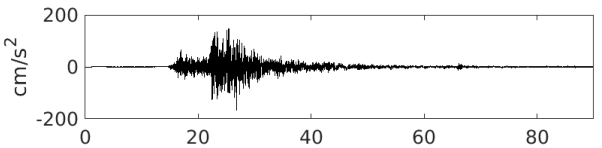
- General introduction of Swiss Seismological Service (SED)



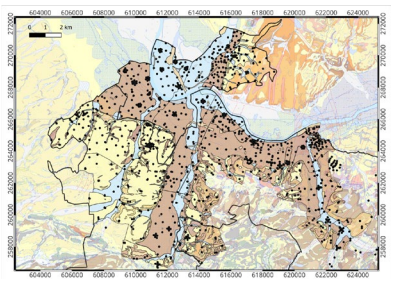
- Seismic hazard



- Seismic risk
- Database of normative compatible waveforms (structural analysis, microzonation)



- Ongoing projects



Swiss Seismological Service at ETH Zurich

Tasks:

- Monitoring of seismic activity in Switzerland and its neighbouring countries
- Assessment of earthquake hazard in Switzerland
- Alarming and informing the authorities, the public, and the media
- Research and teaching
- Swiss involvement in the international monitoring of the Nuclear Test Ban Treaty





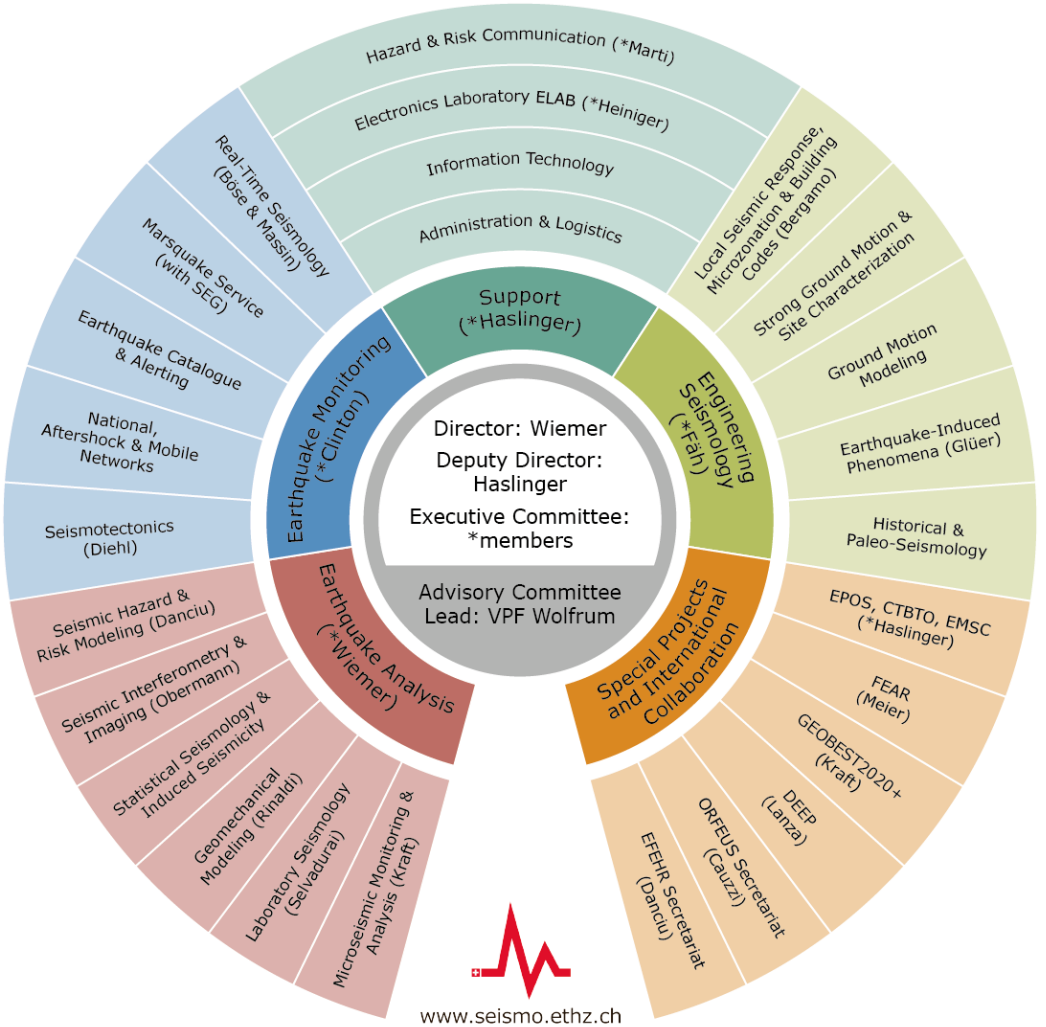
1878: Foundation of the earthquake commission

1911: Inauguration of Switzerland's first permanent earthquake monitoring station in Degenried, Zurich

1914: Foundation of the Swiss Seismological Service as the federal agency for earthquakes

Swiss Seismological Service at ETH Zurich

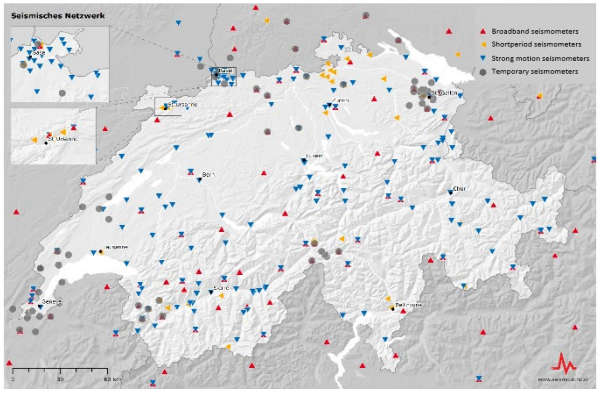
Structure and activities:



Swiss Seismological Service at ETH Zurich

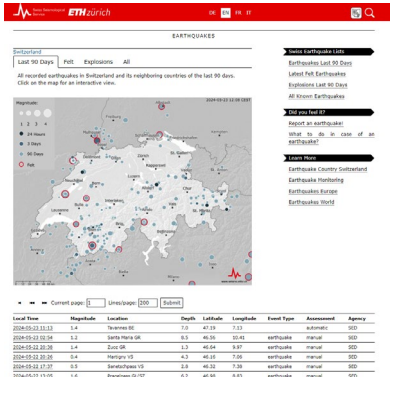
Seismic monitoring:

Seismic network

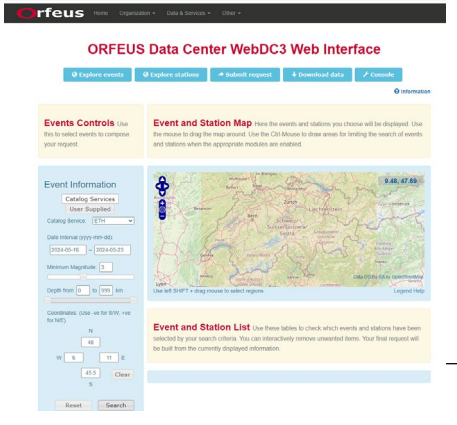


Over 200 seismic stations in Switzerland and neighboring countries.

Earthquake catalogue (https://seismo.ethz.ch/en/earthquakes)



Data access (https://orfeus-eu.org/webdc3/)

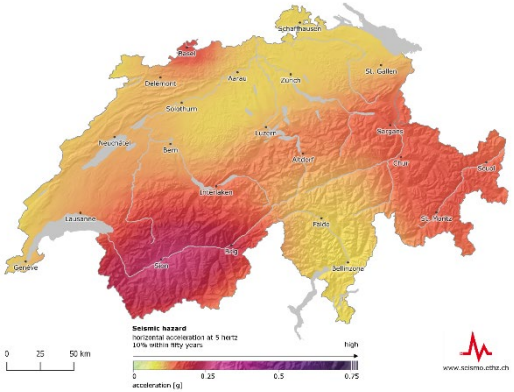


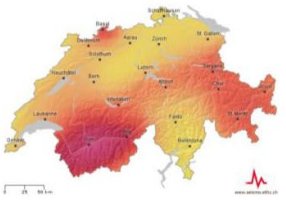
Swiss Seismological Service at ETH Zurich

Hazard assessment:

SED has delivered the **authoritative hazard model for Switzerland**

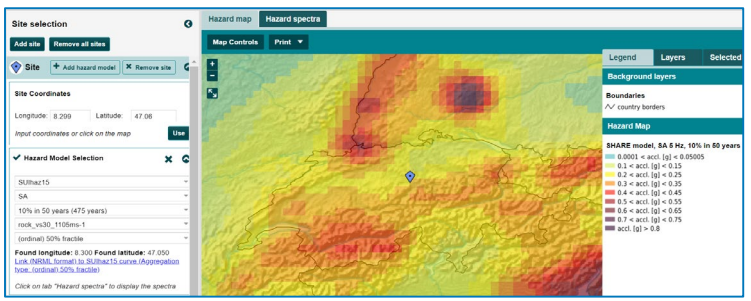
(SUIhaz15, http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/)

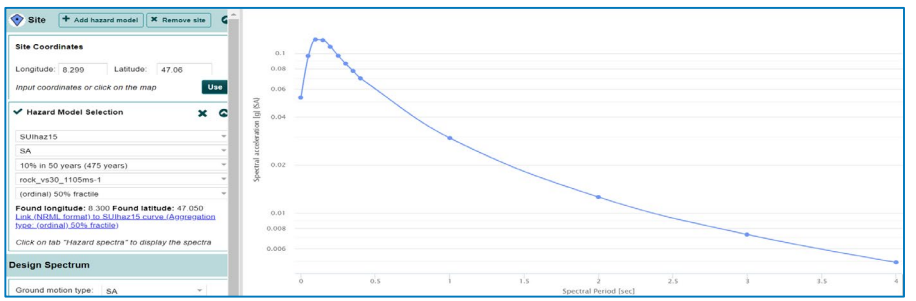


Return period			
75 years, 5 Hz	500 years, 5 Hz	2,500 years, 5 Hz	10,000 years, 5 Hz
			
Probability of exceedance in 50 years:	67%	10%	2%	0.5%

- Data access (hazard curves, uniform hazard spectra UHS):

https://www.efehr.org/earthquake-hazard/data-access/



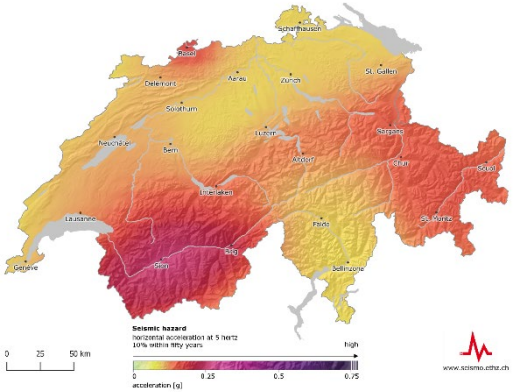


Swiss Seismological Service at ETH Zurich

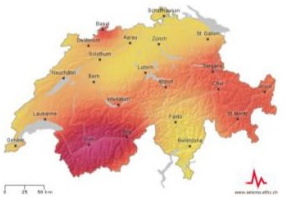
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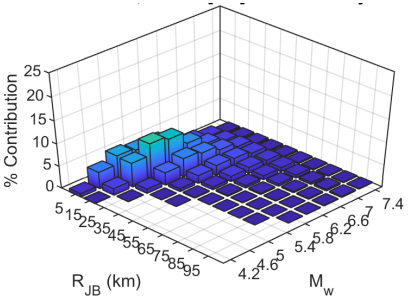
- Data access (hazard curves, uniform hazard spectra UHS):

https://www.efehr.org/earthquake-hazard/data-access/

- Deaggregation of seismic hazard

https://doi.org/10.3929/ethz-b-000579218

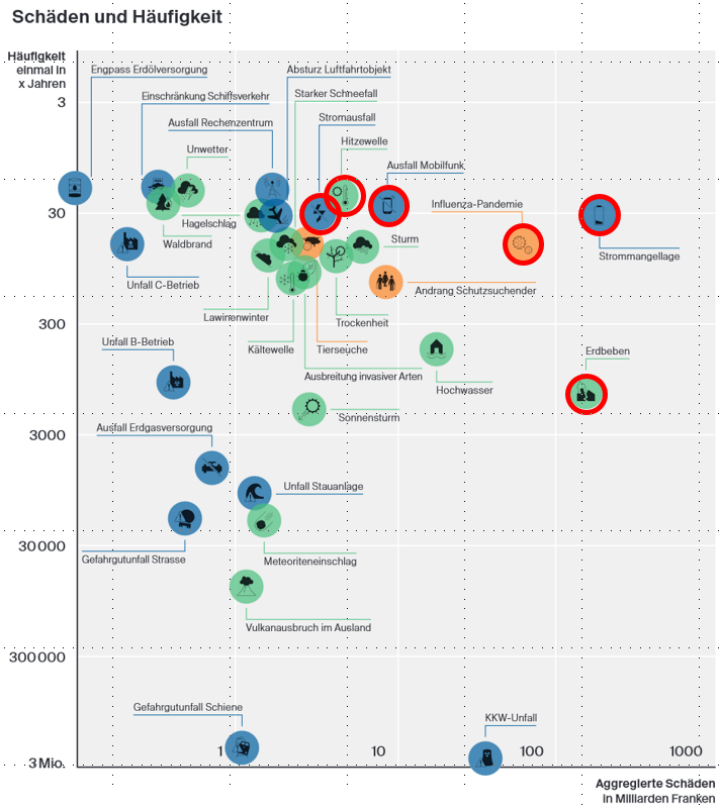
Lon: 5.9°E, Lat: 46.5°N, PGA exceedance, R.P. = 500 yrs



Swiss Seismological Service at ETH Zurich

Risk assessment:

Despite moderate seismicity, **earthquakes are among the five greatest risks** according to the national risk analysis "Disasters and Emergencies in Switzerland" by the Federal Office for Civil Protection.



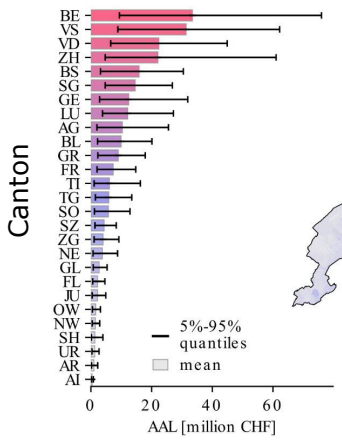
Swiss Seismological Service at ETH Zurich

Risk assessment:

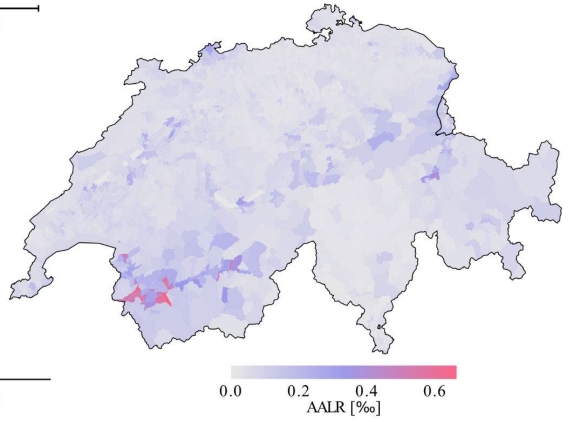
In 2023, SED delivered the **first publicly available earthquake risk model for Switzerland**
(ERM-CH23, http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/)



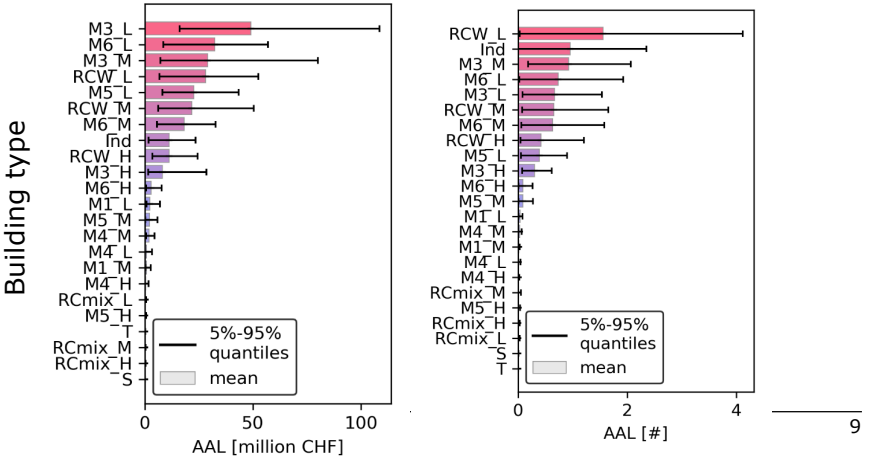
Average annual losses by canton



Average annual loss ratio by municipality



Average annual losses and fatalities by building type



Swiss Seismological Service at ETH Zurich

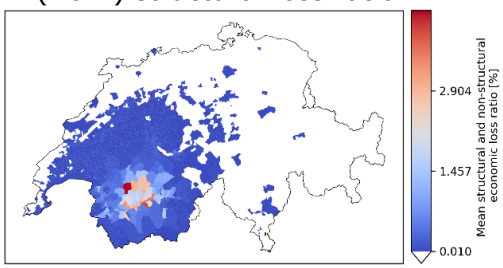
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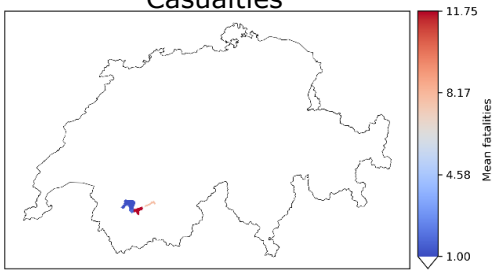
Applications:
- Assessment of damages for particular scenarios, of risk for portfolios

Scenario: M_W = 5.8
in Sierre (1946)

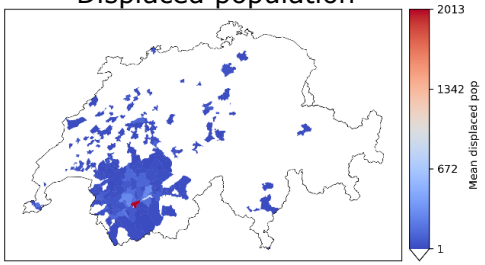
(Non-) structural loss ratio



Casualties



Displaced population



Swiss Seismological Service at ETH Zurich

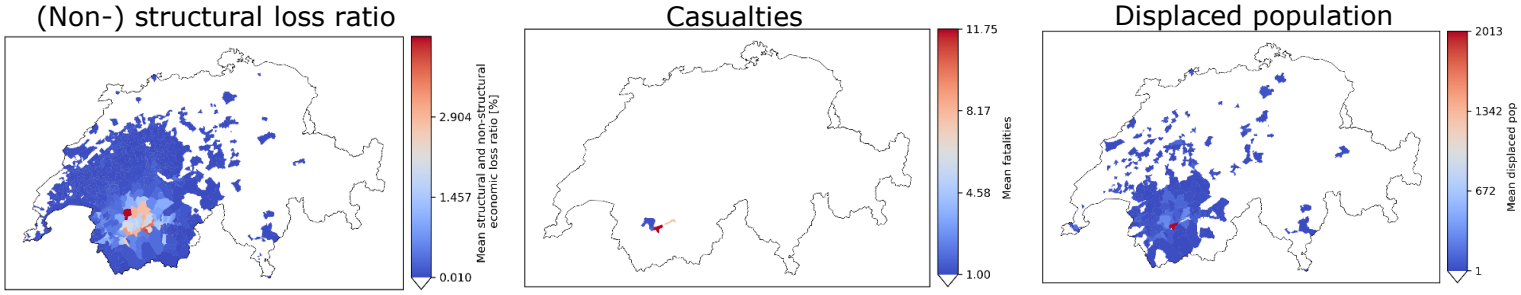
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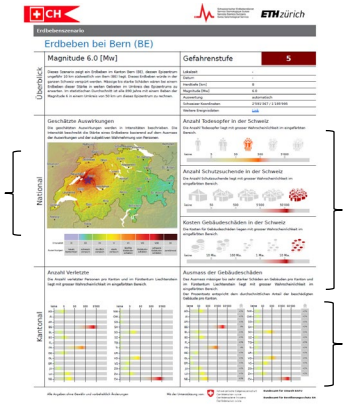
- Assessment of damages for particular scenarios, of risk for portfolios

Scenario: M_W = 5.8
in Sierre (1946)



- Rapid impact assessment of damages immediately after an earthquake

National level:

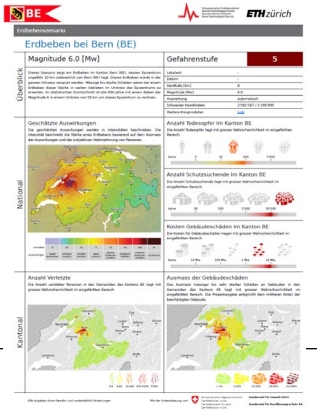


Macroseismic intensity field

Overall casualties, losses, displaced pop.

Casualties, losses by canton

Cantonal level:

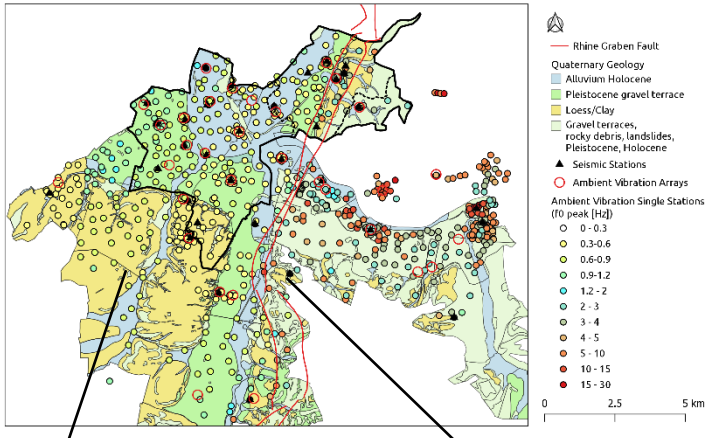


Swiss Seismological Service at ETH Zurich

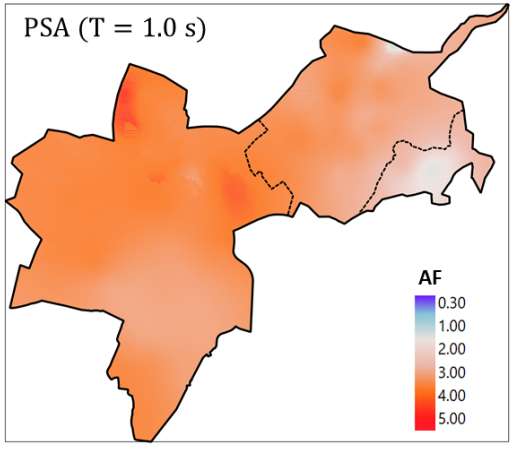
Risk assessment:

In 2018, Canton BS commissioned to SED a dedicated **earthquake risk model for Basel** (ERM-BS24, close to completion)

In situ geophysical measurements



High-resolution soil response model



Higher resolution, lower uncertainty loss estimation

Imtiaz et al. (2021, 2023, 2024)



Ambient noise recordings (~30 mins) -> soil resonance frequency

Temporary seismic stations (~1 year)



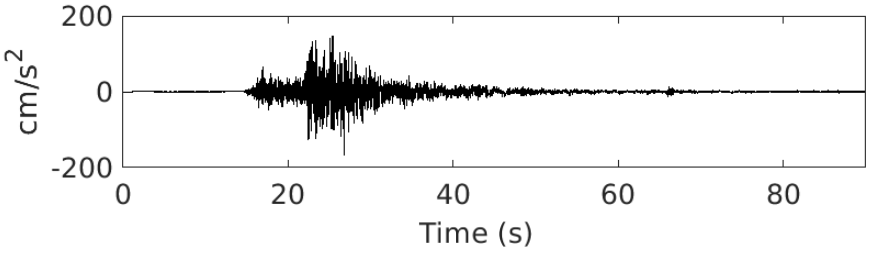
Swiss Seismological Service at ETH Zurich

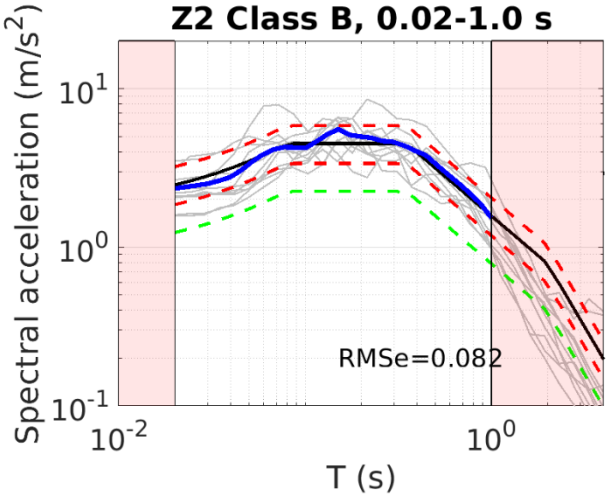
For professionals: database of design-compatible waveforms

In the framework of a BAFU-funded project, in 2023 SED released:

- Selected **design-compatible waveforms for structural analysis studies** (https://doi.org/10.3929/ethz-b-000633621)

75 sets of 11 horizontal-component waveform couples; each set **compatible with the elastic response spectrum** (975 yrs return period) as defined in SIA261 (2020) for each combination of seismic zone (zones 1a, 1b, 2, 3a, 3b) and soil class (soil class A, B, C, D, E). Structures with T_0 = 0.1 – 2.7 s





Swiss Seismological Service at ETH Zurich

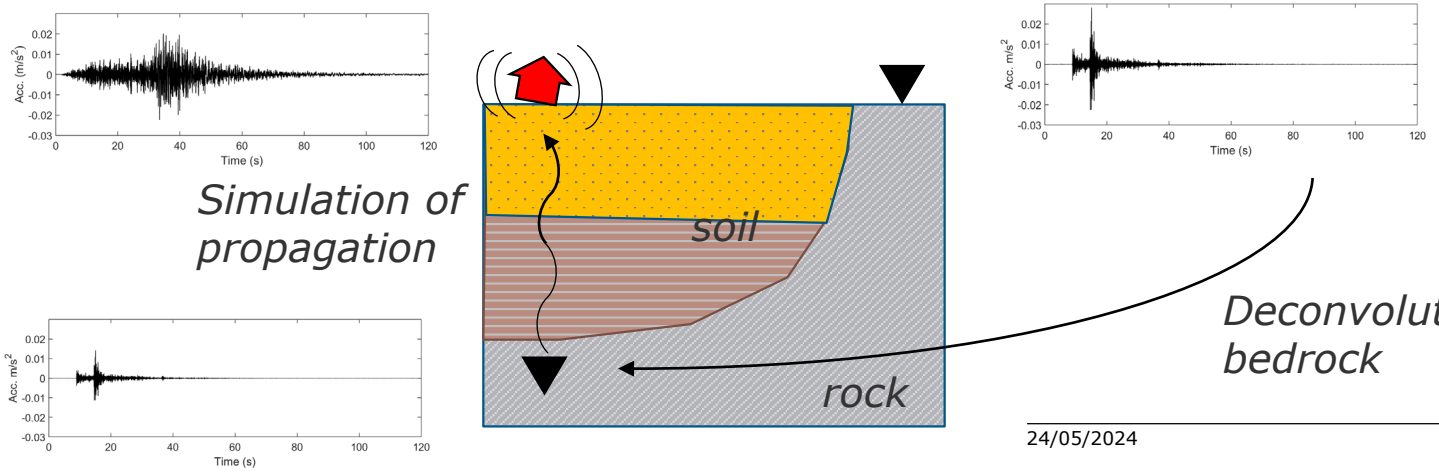
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- Selected **design-compatible waveforms for microzonation studies** (https://doi.org/10.3929/ethz-b-000633618)

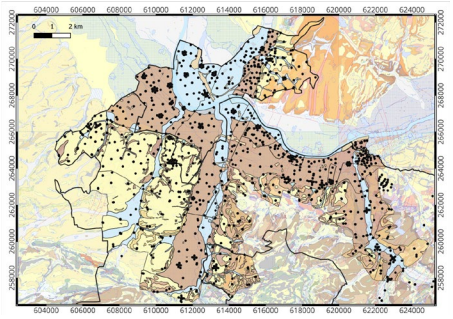
5 sets of 11 horizontal-component waveforms; each set **compatible with the elastic response spectrum** (475 yrs return period) as defined in SIA261 (2020) for each seismic zone (zones 1a, 1b, 2, 3a, 3b) and soil class A (rock)



Swiss Seismological Service at ETH Zurich

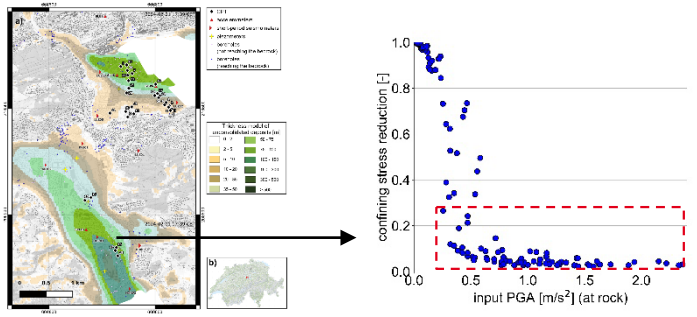
Ongoing projects in Engineering Seismology

- **Microzonation of BS and BL**



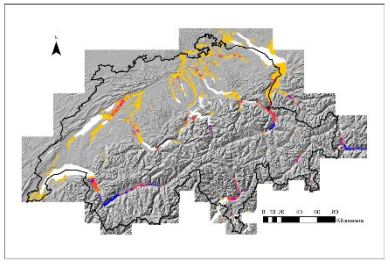


- Simulation **nonlinear soil response and liquefaction in Lucerne** basin from CPT data



High probability of liquefaction

- **Soil response in Swiss alpine valleys** (BAFU-funded)



1D resonance + lateral propagation
1D resonance + lateral propagation, significant aggravation of amplification
Possible 2D resonance + lateral propagation
Very likely 2D resonance + lateral propagation

Vielen Dank für Ihre Aufmerksamkeit

Merci de votre attention

Grazie per l'attenzione

paolo.bergamo@sed.ethz.ch

Visit our website: http://www.seismo.ethz.ch/
http://www.seismo.ethz.ch/en/knowledge/earthquake-hazard-and-risk/for-professionals/

