Portfolio Seismic Risk Assessment Using Regional Earthquake Scenarios

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3000-ft Overview

- Regional Earthquake Source-Types
- Ground Motion
- Design Ground Motion
- Seismic Risk Assessment
- Portfolio Seismic Risk Assessment

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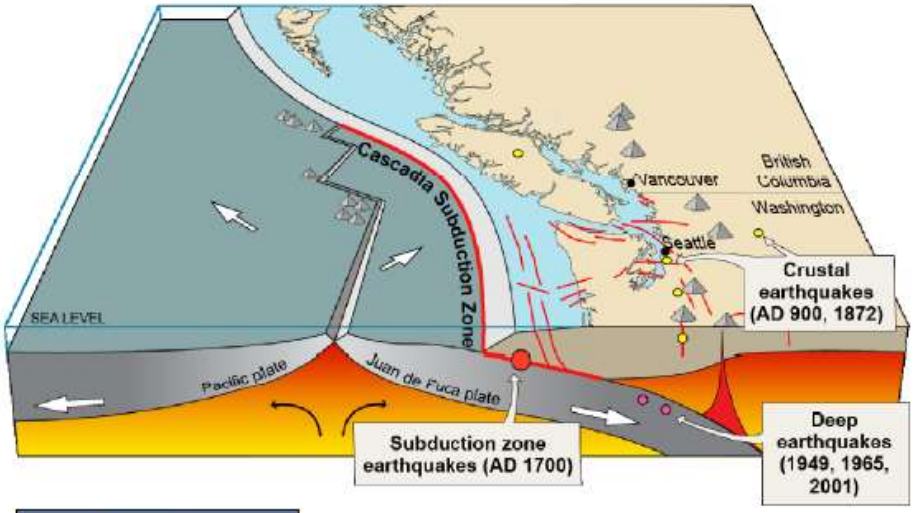
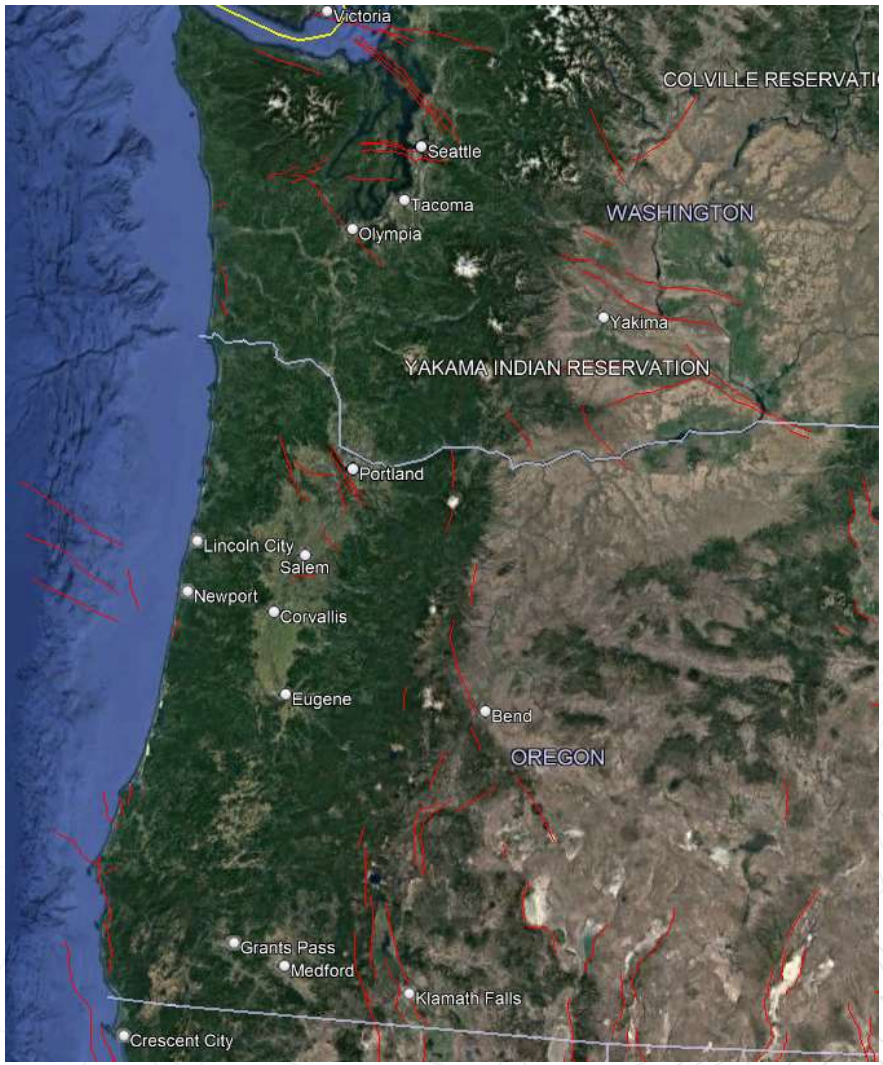
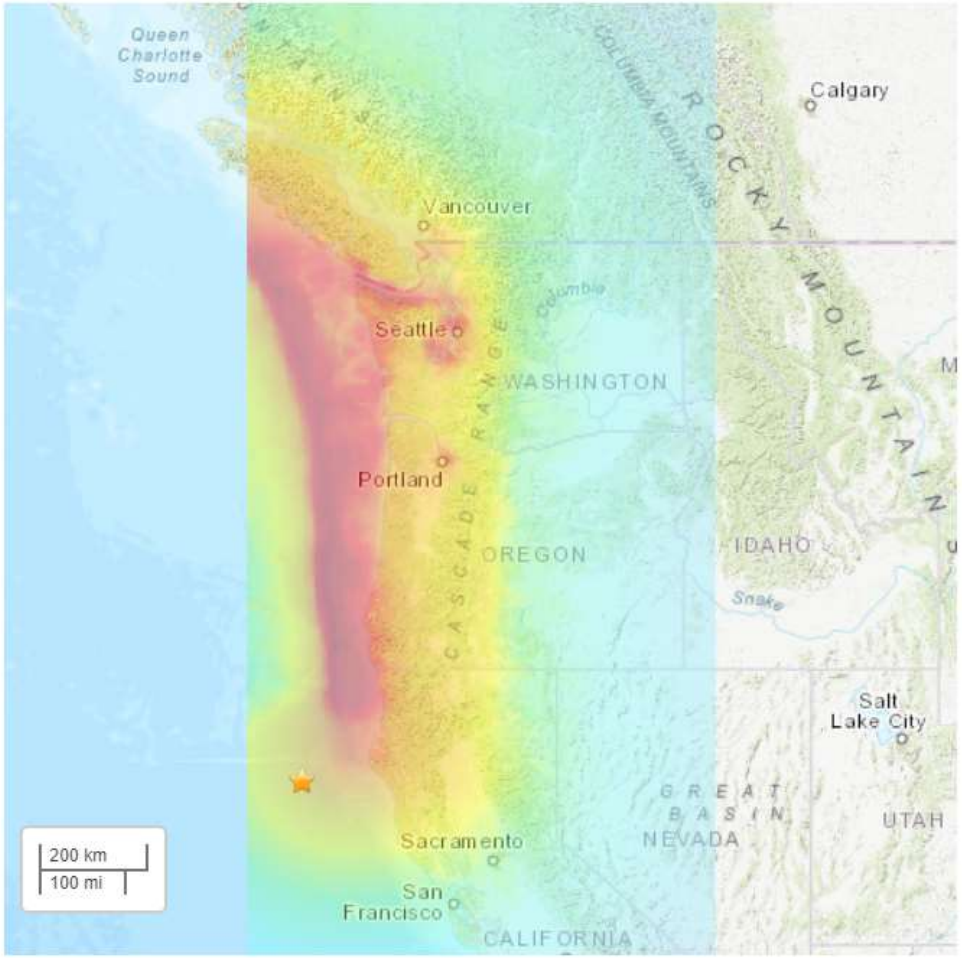
Important Regional Earthquake Source-Types





Cascadia Subduction Zone

- Interface earthquakes
  - Design event is a M9.1
  - 300-to-1,000-year return period
  - Long-period energy
- Intraslab earthquakes
  - Design event is ~ M7.1
  - Short-period energy

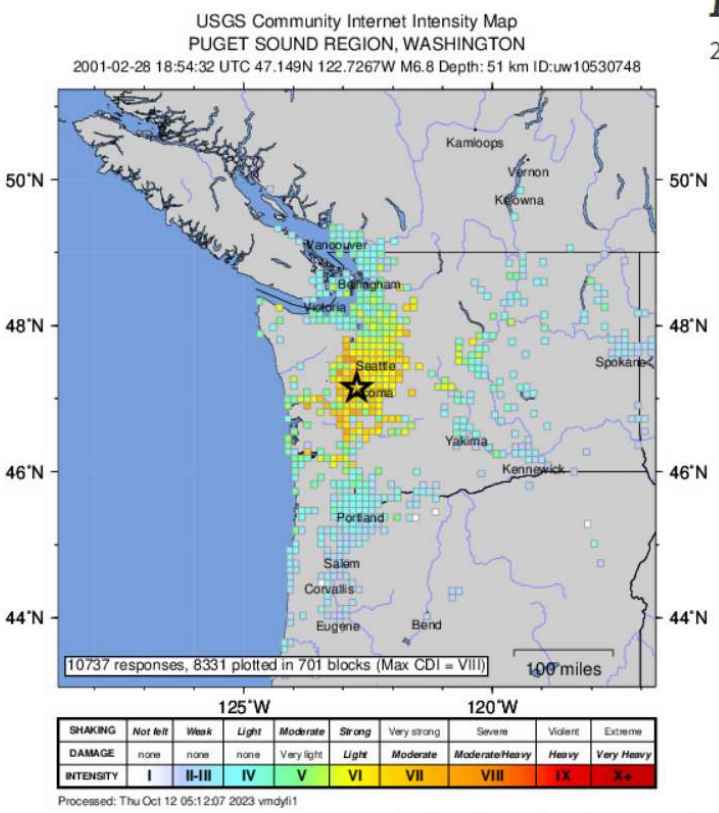


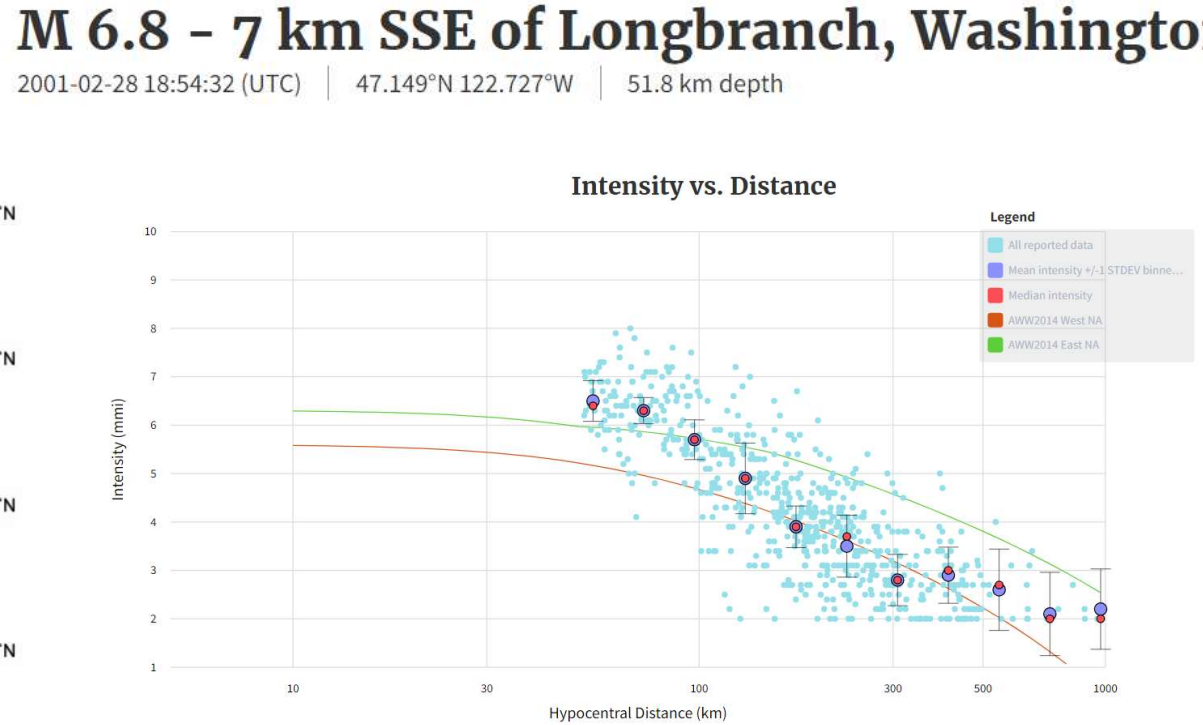
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 1: Processed 2020-11-17T19:34:46Z

△ Seismic Instrument ○ Reported Intensity ★ Epicenter

USGS Did you feel it?





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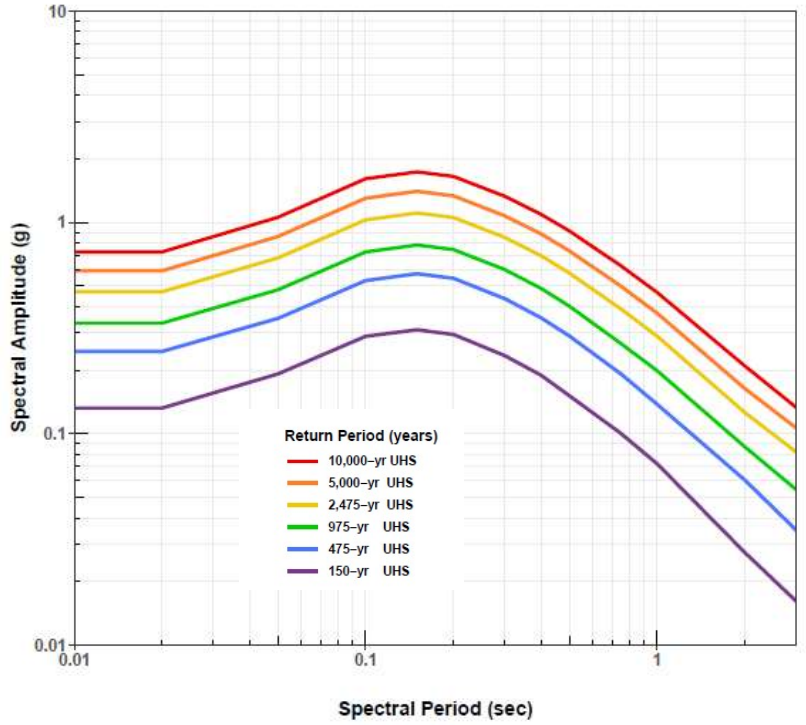
Design Ground Motion

What are we designing too?

- Not maximum; too costly
- ASCE 7-16 – current building code
  - 2% in 50 yrs ~ 2,475 yr ground motion
- High-hazard dams
  - 2,475-year to 10,000 yr ground motion
- Port facilities
  - 2,475 yr ground motion
- Risk tolerance
- Consequences

Uniform Hazard Response Spectra



Seismic Risk Assessment

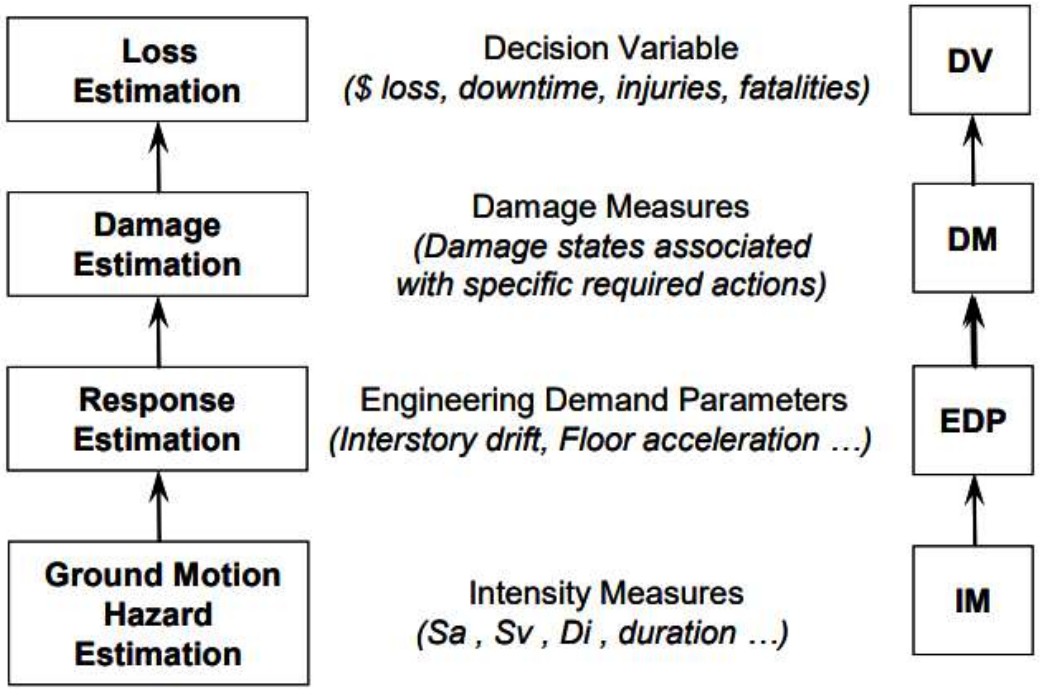


Fig. 2.1. Components of PEER performance assessment methodology (Modified from Miranda, 2005)

- One building
- Distributed Infrastructure
  - Exposure Data
- Owners
  - Emergency planners
  - USACE
  - USBR
  - Utilities

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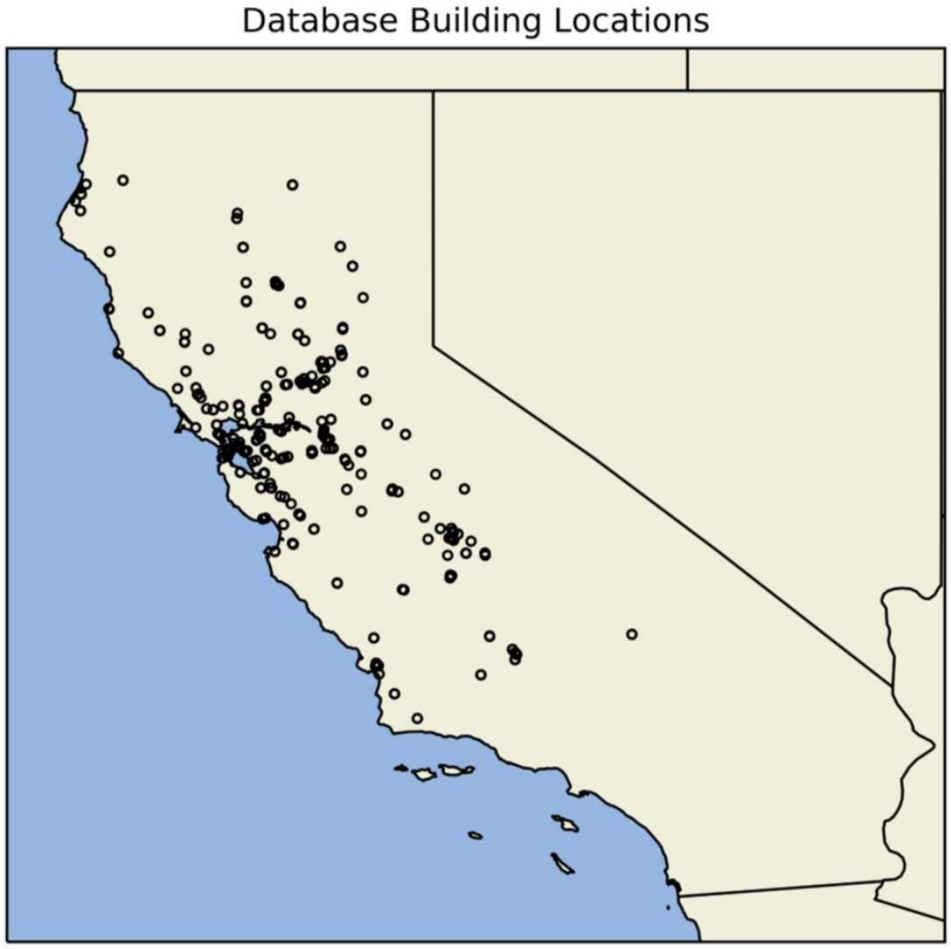
Offshore Wind Distributed Infrastructure

- Off-shore
  - Turbines
- Near-shore
  - Substation
- Onshore
  - Ports
  - Power-station
  - Transmission Lines
- Risk Assessment
  - Loss of power
  - Inform onshore locations of new assets

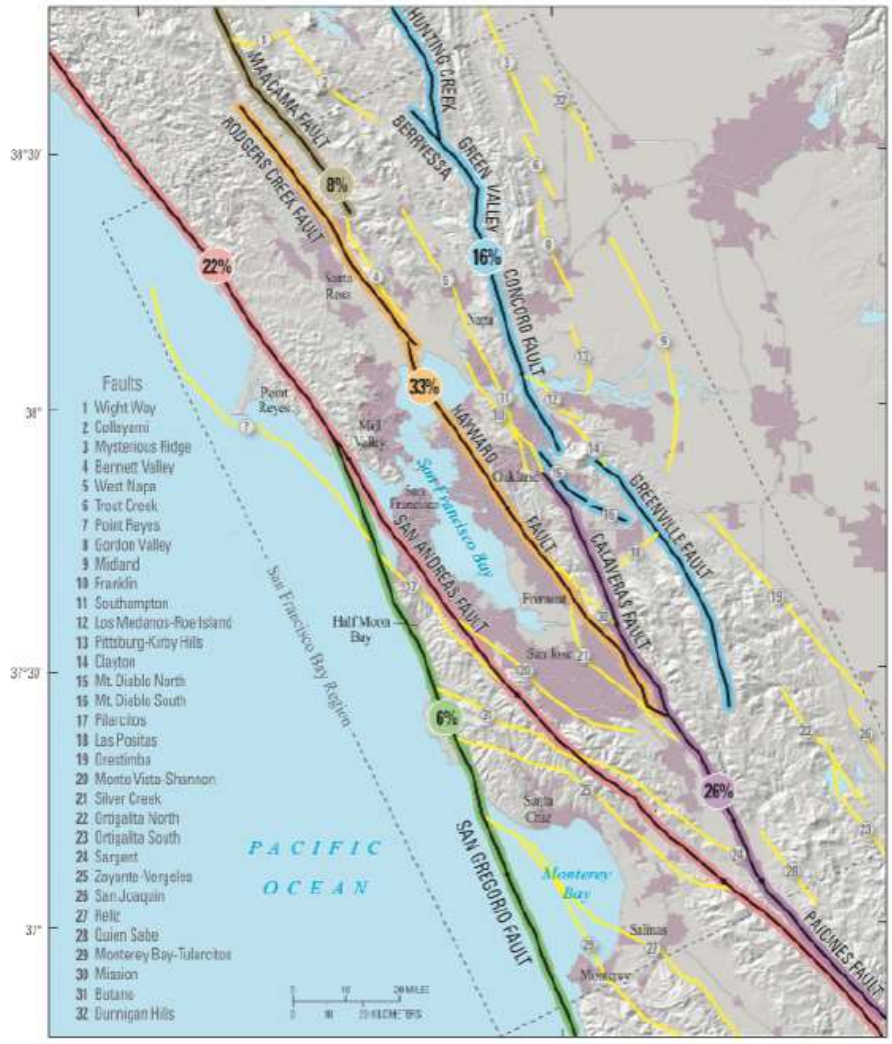
Building Portfolio Example



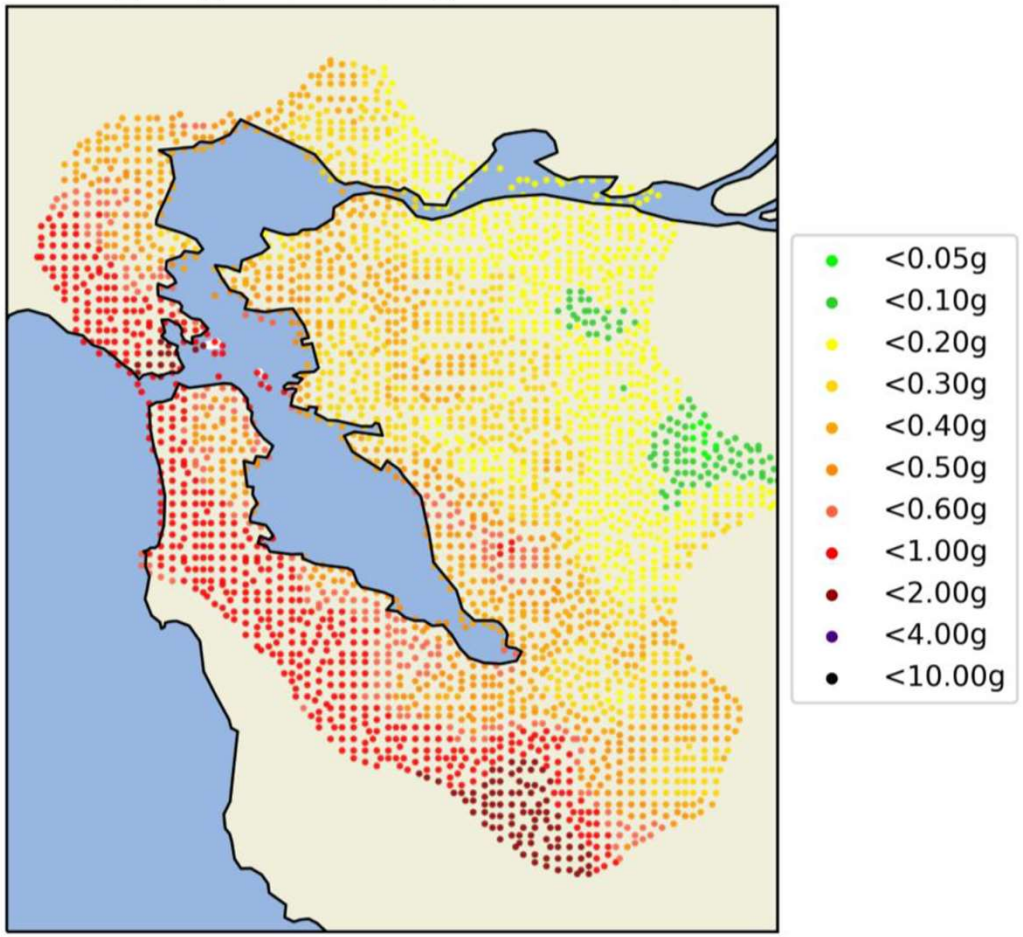
Selected Scenarios

- 14 parent scenarios selected from UCERF3 deaggregation

Parent Fault	Magnitude
Calaveras (North)	6.68
Calaveras (Central)	6.85
Calaveras (South)	6.94
Concord	6.53
Green Valley	6.69
Greenville (South)	6.18
Greenville (North)	6.98
Hayward (South Ext.)	6.85
Hayward (South)	6.90
Hayward (North)	7.61
San Andreas (N. Coast)	7.02
San Andreas (Peninsula)	7.81
San Andreas (Santa Cruz Mtn.)	7.73
Clayton	7.14

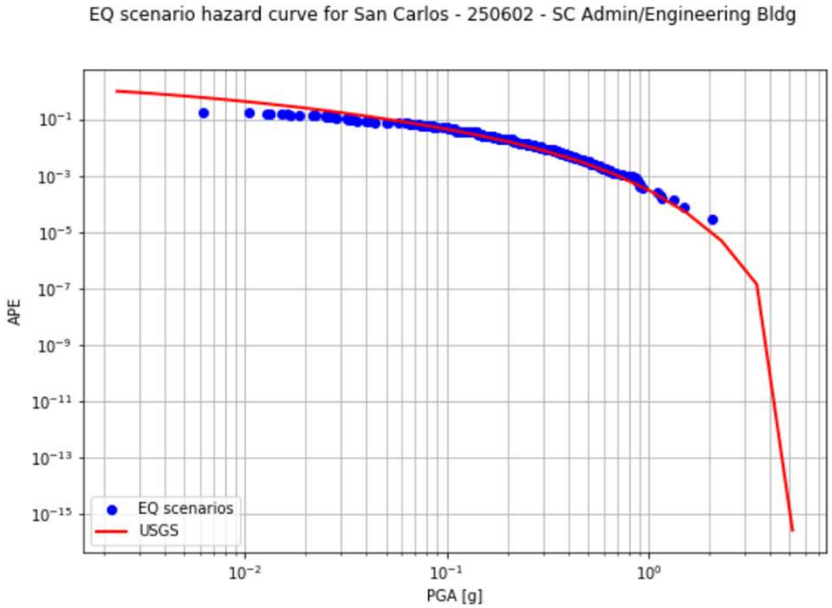


Ground Motion Maps



Target Hazard Curves

280 Maps



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Portfolio Seismic Risk Assessment

Infrastructure Exposure Data	Location Built Year Assessment value Footprint
Seismic Hazard Model	Seismic source characterization Ground motion characterization Spatial correlation Local site conditions
Seismic Fragility Model	Ground motion records Record selection Dynamic analysis Damage-loss functions
Portfolio Seismic Risk Assessment	Seismic loss curves Seismic risk metrics Critical earthquake scenarios Seismic risk management

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Some thoughts….

- Seismic hazard is an important design consideration.
- Portfolio seismic risk assessment may be worthwhile.
- Able to evaluate safety and financial risk.
- Inform potential loss of power in a seismic event.
- Prioritize asset of existing structures.
- Inform location selection of new structures.

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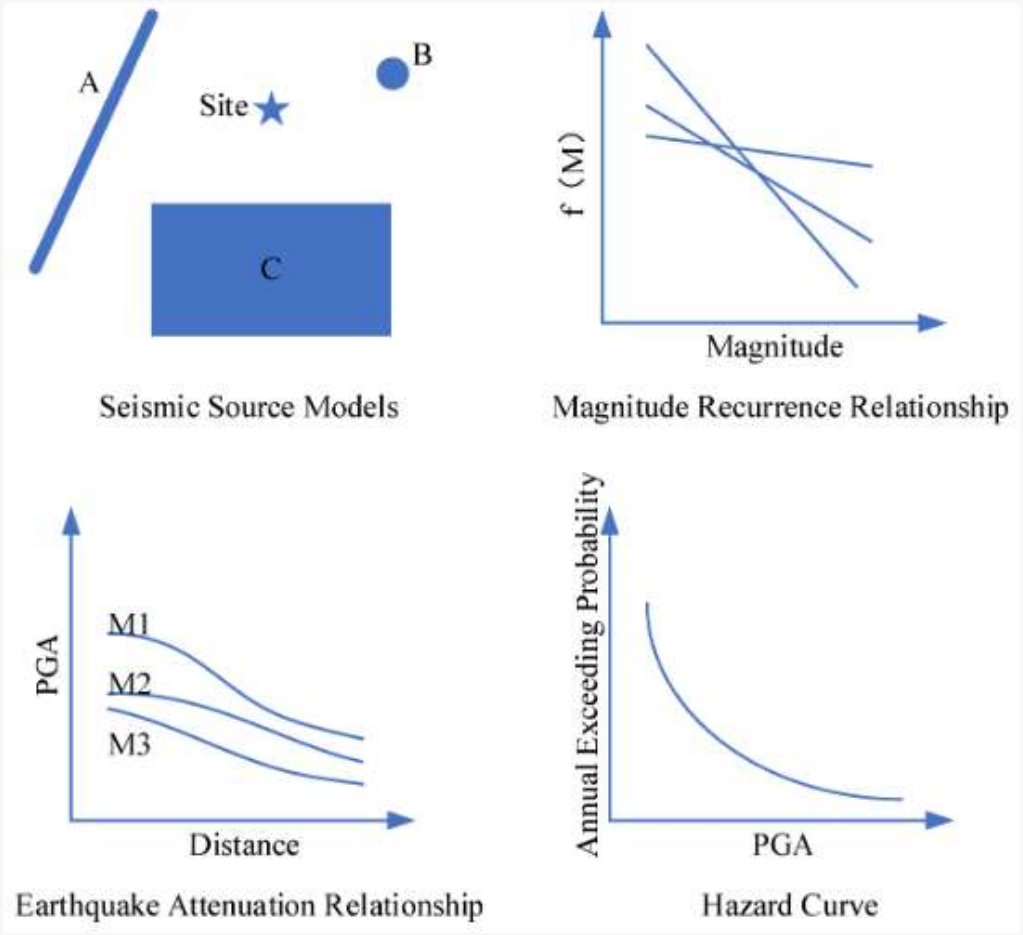
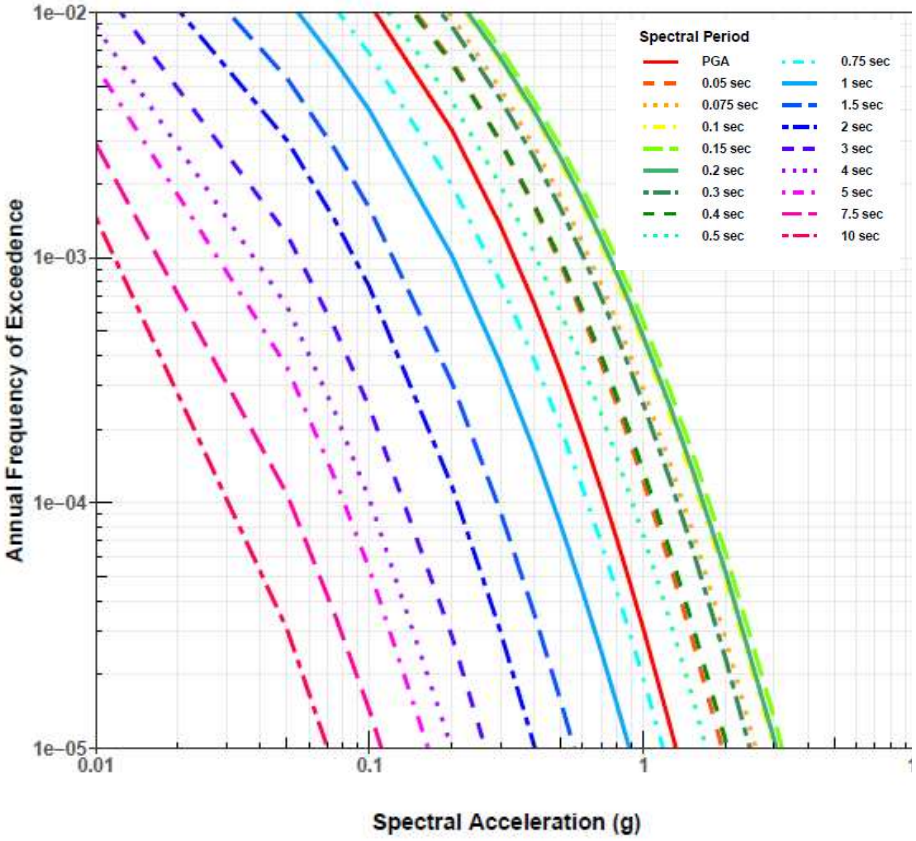
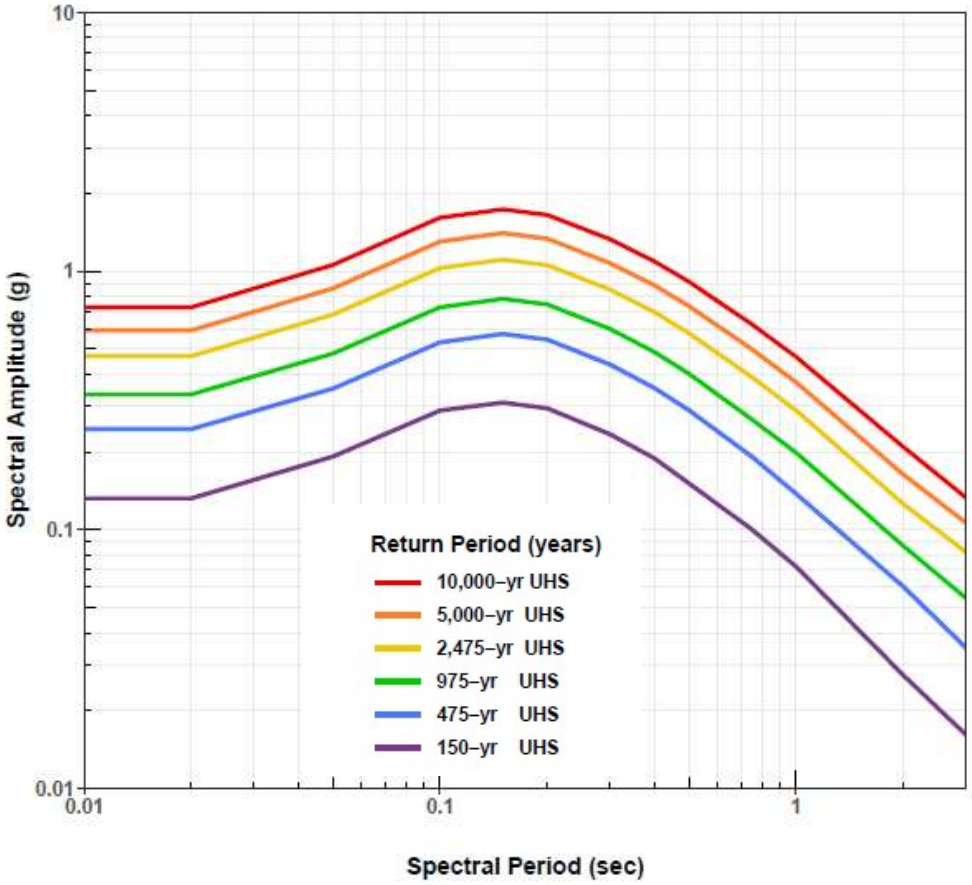
Seismic Hazard

- Probabilistic Seismic Hazard Analysis (PSHA)
- Deterministic Seismic Hazard Analysis (DSHA)

Figure 1. Steps underlying PSHA.



Hazard Curves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