The Science of Catastrophe Modeling:
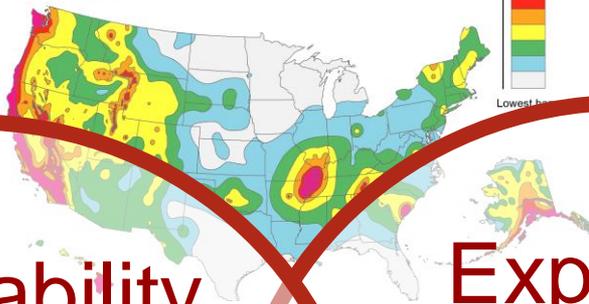## A Journey from Hazard to Risk

Maiclaire Bolton

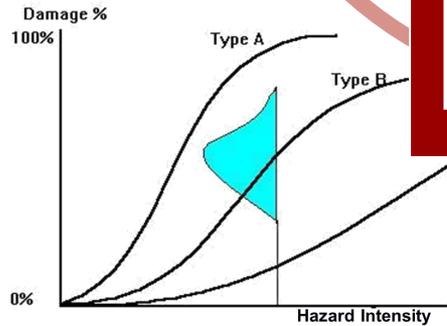Senior Product Manager,
Global Earthquake Products

CoreLogic®
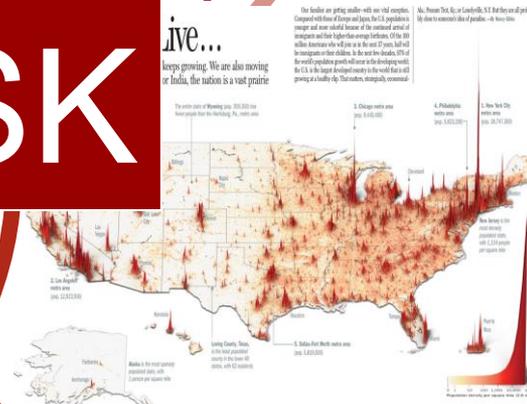
The Journey from Hazard to Risk

Hazard

Vulnerability

Exposure

RISK

Probabilistic Modeling: The Spectrum of Risk

High-Frequency events
Impact: Cash-flow

Low-Frequency events
Impact: Solvency

M6.0 Napa
(2014)

M6.7 Northridge
(1994)

M6.3 Christchurch
(2011)

Probabilistic Modeling: The Spectrum of Risk

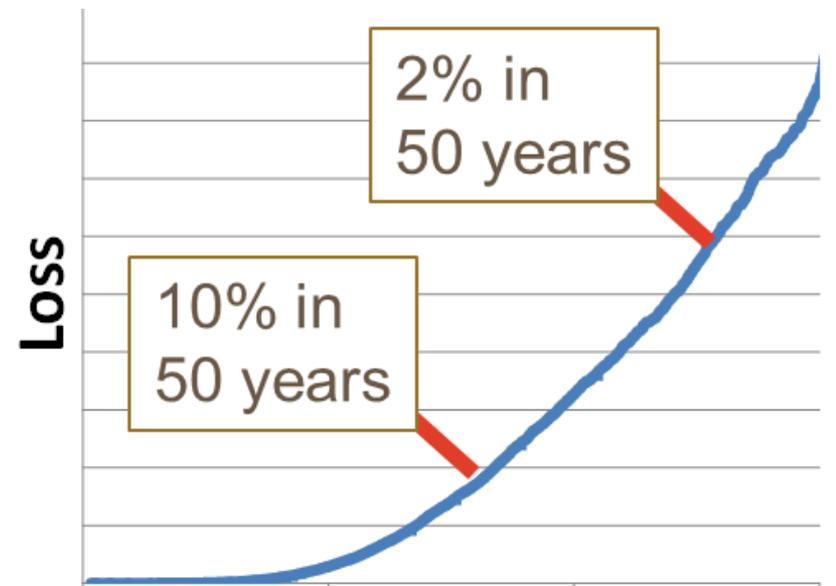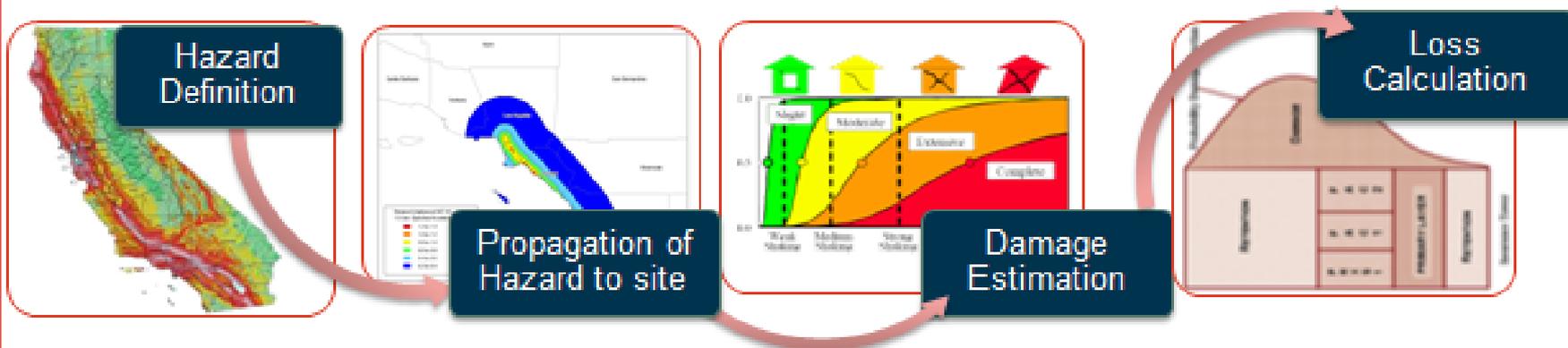| High-Frequency events **Impact: Cash-flow**		Low-Frequency events **Impact: Solvency**

A Probabilistic analysis:

- Involves the evaluation of <u>all potential</u> loss-causing event occurrences, and their outcomes.

A Probabilistic analysis output:

- Allows Cat Model users to convert abstract hazard risk to probabilities associated with economic consequences – the same manner in which they address their other business risks

2% in 50 years

10% in 50 years

Loss

Probabilistic Earthquake Modeling Methodology Framework

Hazard Definition

Propagation of Hazard to site

Damage Estimation

Loss Calculation

Event Catalog:

- Location
  - Where?
- Magnitude
  - How Big?
- Frequency
  - How Likely?

Event Footprints:

- Ground Motion Distribution
- How Intense?
- Attenuation Relationships
- Soil Maps
- Site Adjustments

Vulnerability:

- Structure Type
- Occupancy
- Bldg. Damage
- Contents
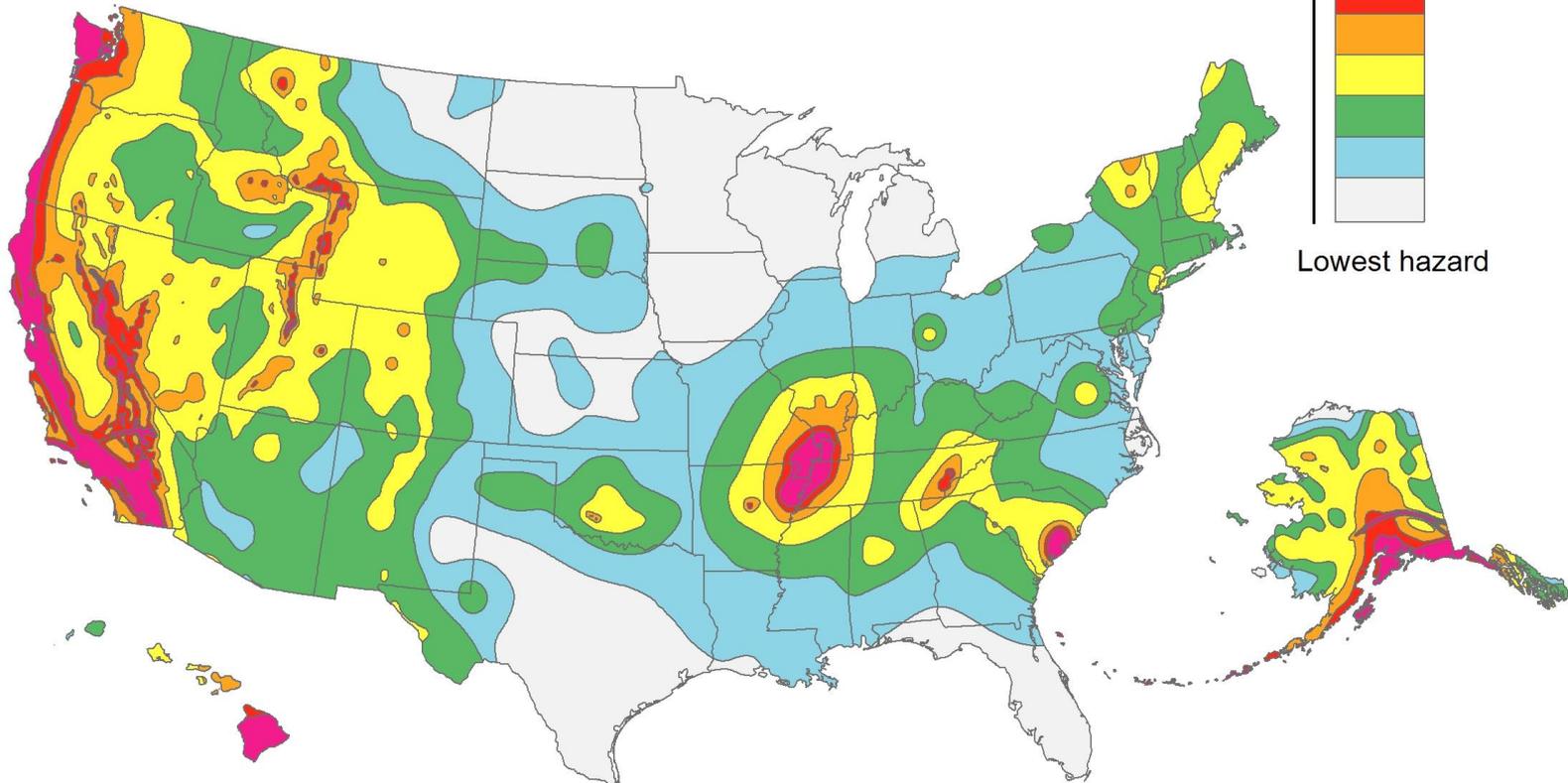- Time Element
- Spatial Correlation

Losses:

- Treaty Type
- Policy Structure
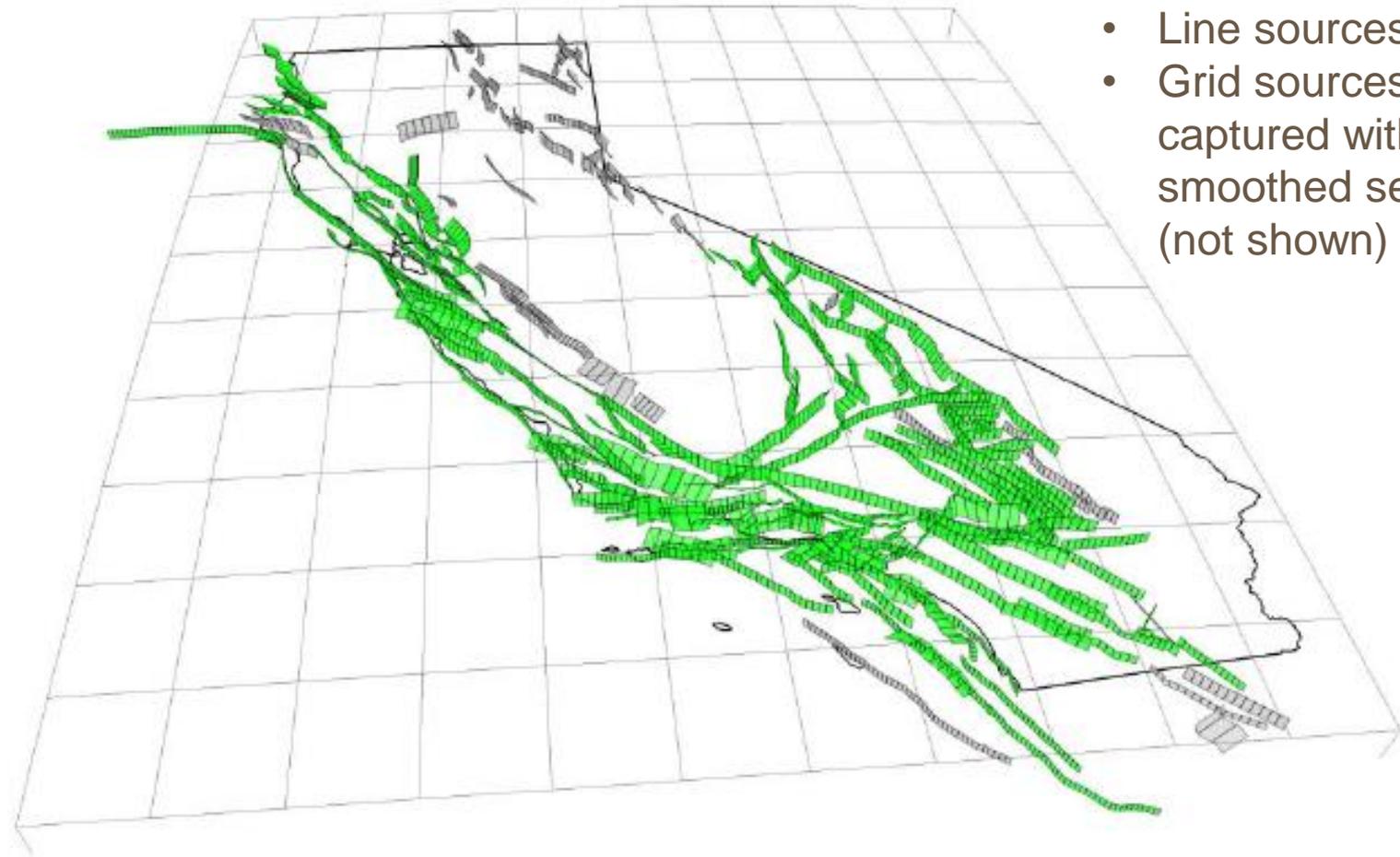- Historical Losses
- Configuration
- Other Details

Hazard Modeling

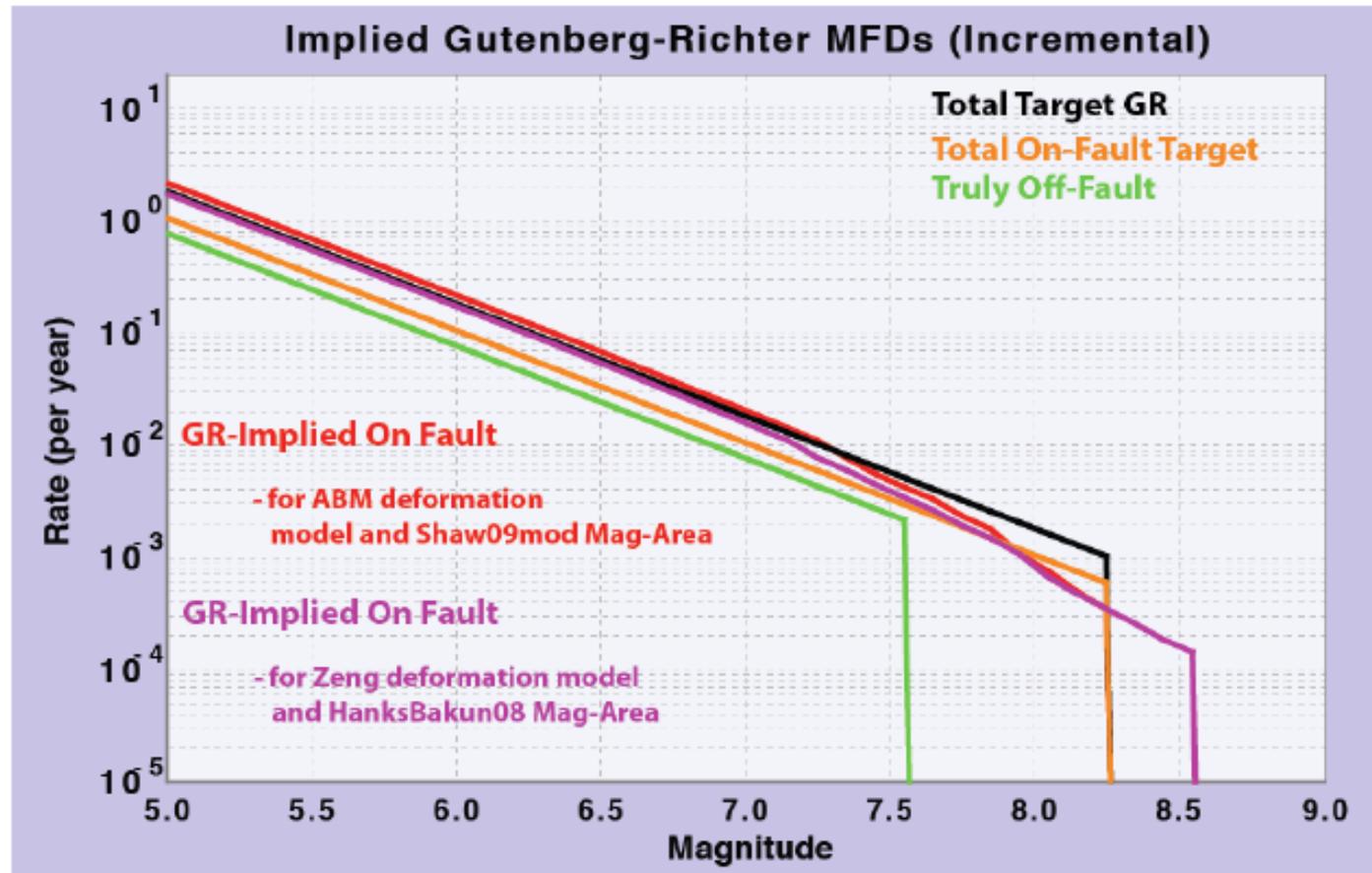# Cat Models are based on the same data that Forms the National Seismic Hazard Model

Defining a Stochastic Event Set:
Fault Source Geometry

Types of seismic sources:
- Line sources
- Grid sources: captured with smoothed seismicity (not shown)

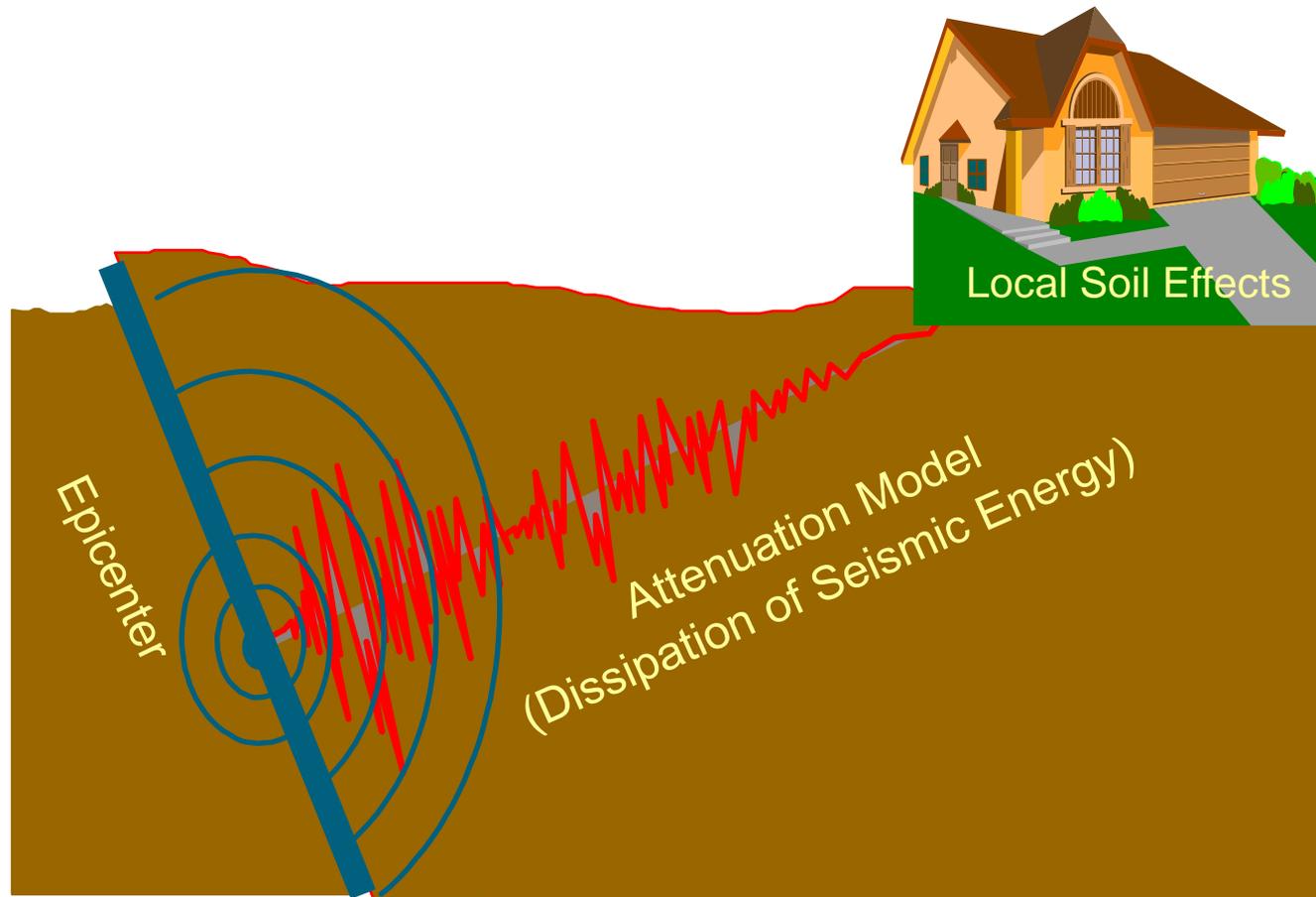# Defining a Stochastic Event Set: Assessing Magnitude and Frequency
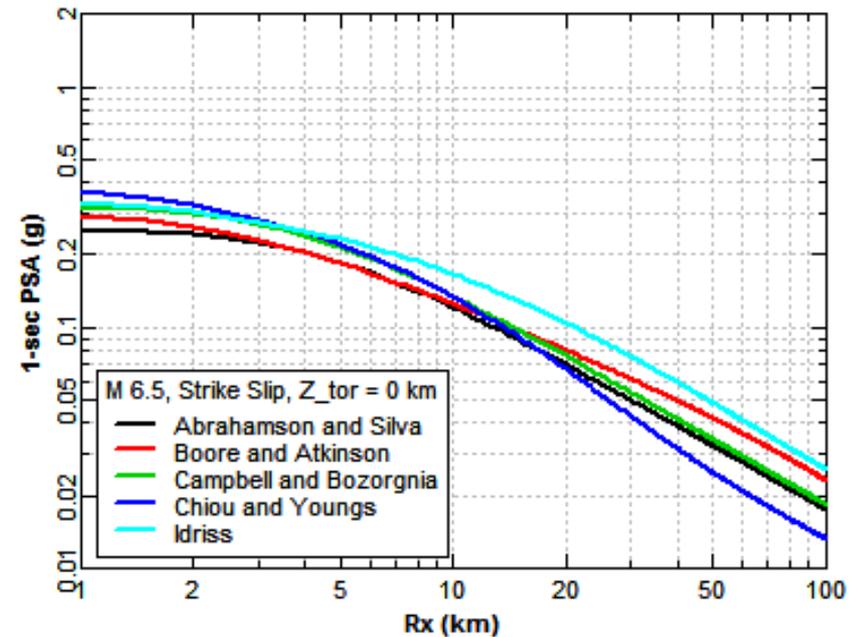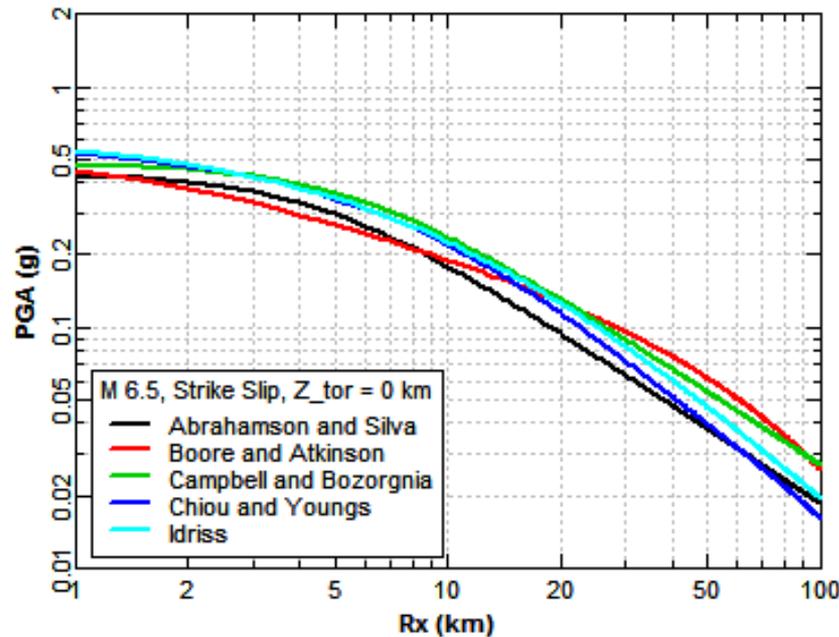

UCERF3

Ground Motion Modeling

Ground Motion Attenuation

Local Soil Effects

Epicenter

Attenuation Model
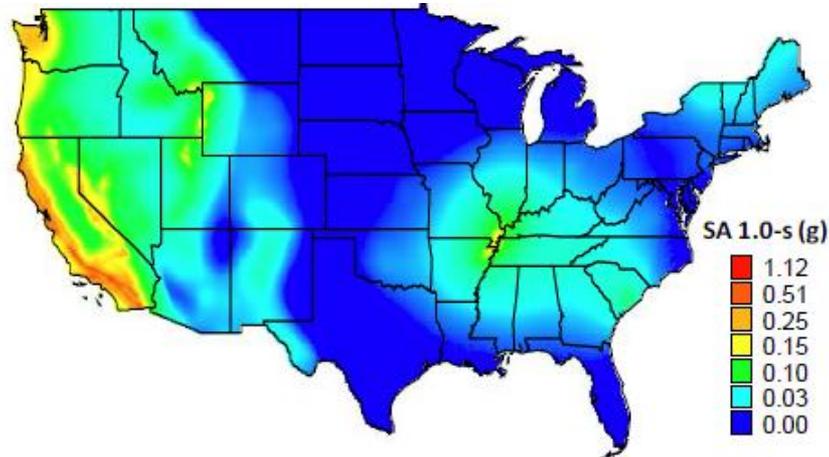(Dissipation of Seismic Energy)

Ground Motion Model

- Ground motion prediction equations (GMPEs) are used for unique tectonic environment.
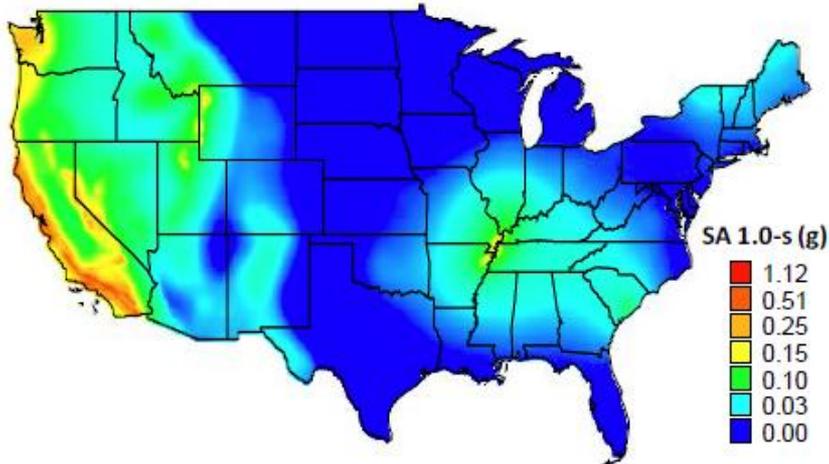- Multiple equations often used and weighted

Validation of Seismic Hazard

USGS Seismic Hazard Map (475-year, Time-Independent, on Soil B-C)

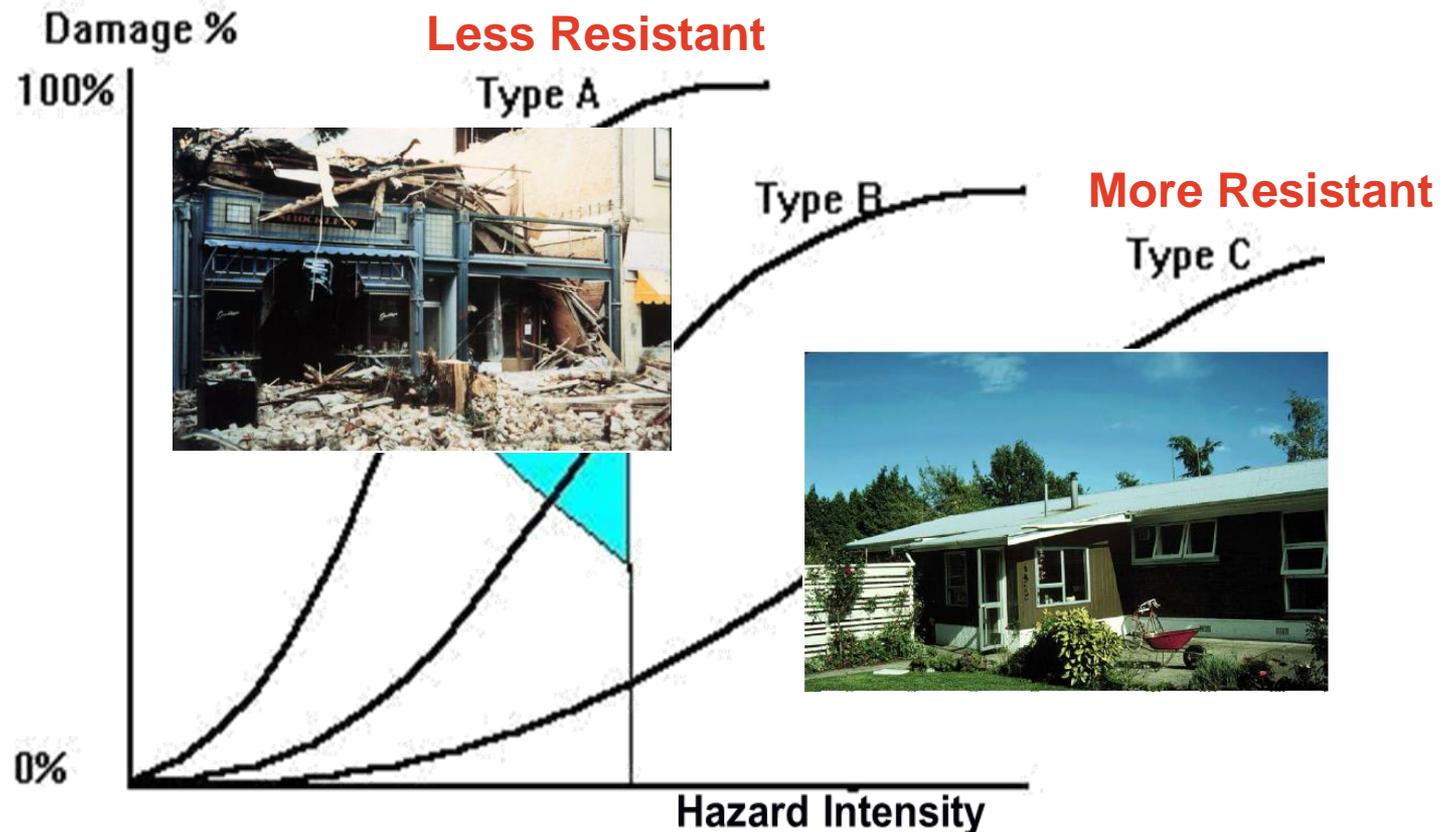Modeled Seismic Hazard Map (475-year, Time-Independent, on Soil B-C)

Vulnerability Modeling

Vulnerability: Translating Hazard to Loss

- Vulnerability relates damage to hazard intensity

Key Factors of Assessing Vulnerability

- General structure of a building
  - Construction type
  - Building height
  - Building age
- Quality of construction
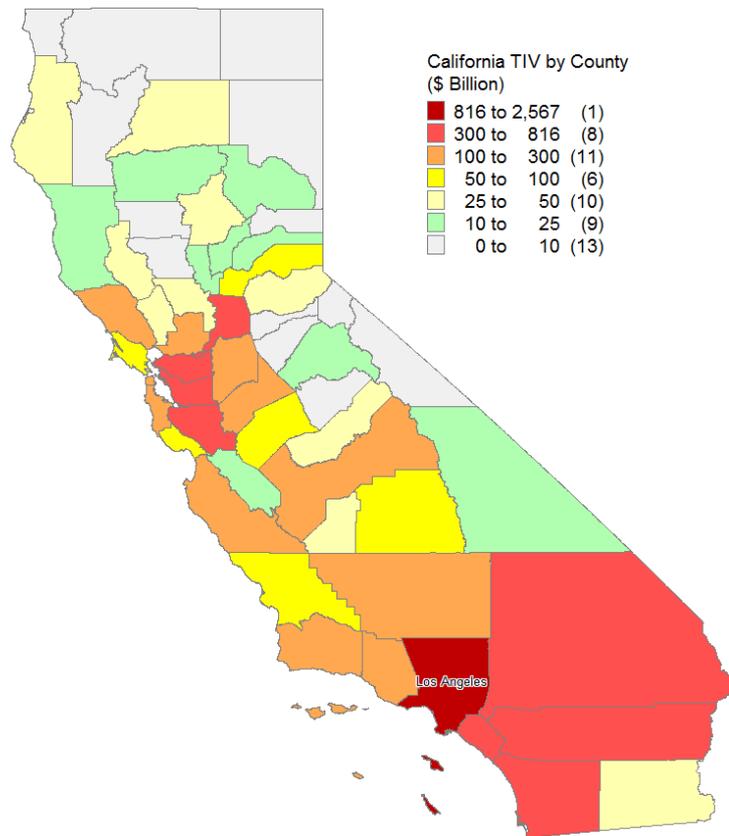- Occupancy

Concepcion, Chile, 2010

Financial Loss Modeling

Using a Catastrophe Model

Insights into Exposure Distribution

California TIV by County
($ Billion)

816 to 2,567	(1)
300 to 816	(8)
100 to 300	(11)
50 to 100	(6)
25 to 50	(10)
10 to 25	(9)
0 to 10	(13)

Los Angeles

**Example:** Portfolio of insurable assets in California.

- Exposure distribution by county

Questions a Risk Manager may consider:

- What is the distribution of assets?

- Where are the assets concentrated?

- What is the vulnerability of these assets?
  - What is their value?
  - What is their age?
  - What is their construction type and quality?
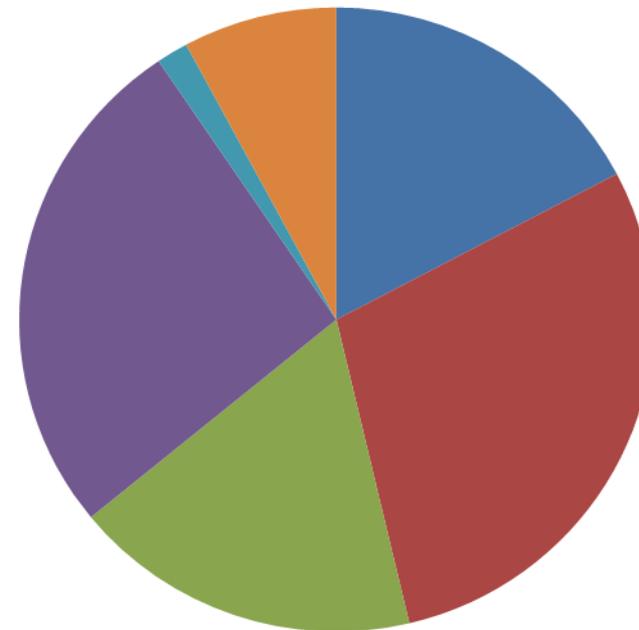
Managing Earthquake Risk

Fault Sources Driving the 250-Year Loss
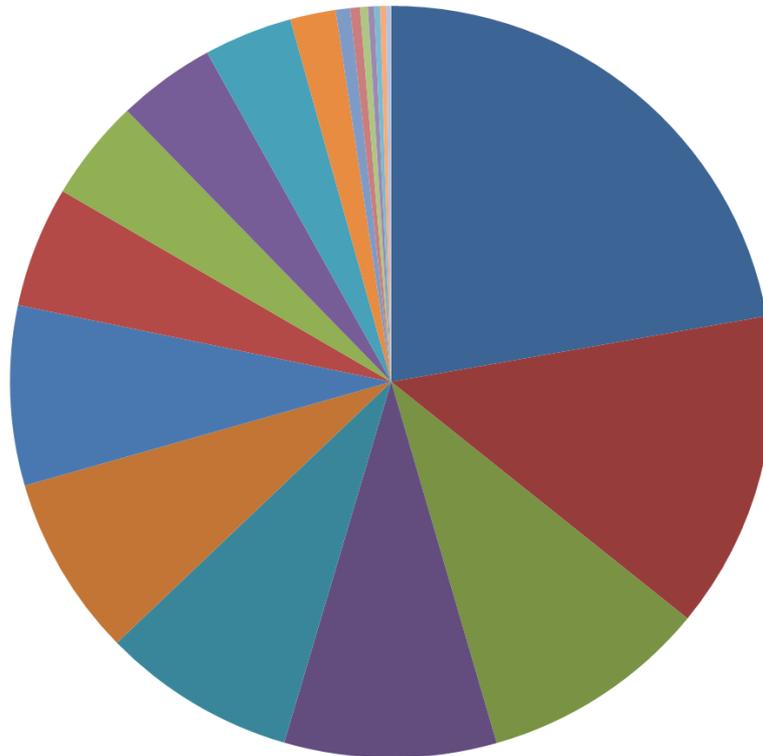
- N. San Andreas
- Puente Hills

Magnitudes Driving the 250-Year Loss

- M6.0-6.5
- M6.5-7.0
- M7.0-7.5
- M7.5-8.0
- M8.0-8.5
- M8.5-9.0

Questions?

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