INTERNATIONAL İSTANBUL INSURANCE CONFERENCE

"EARTHQUAKE RISK, MODELLING & INSURANCE"

Session 1: Earthquake Risk, Possible Outcomes & Modelling Approach

"Unfolding the quantification of earthquake risk in Turkey"

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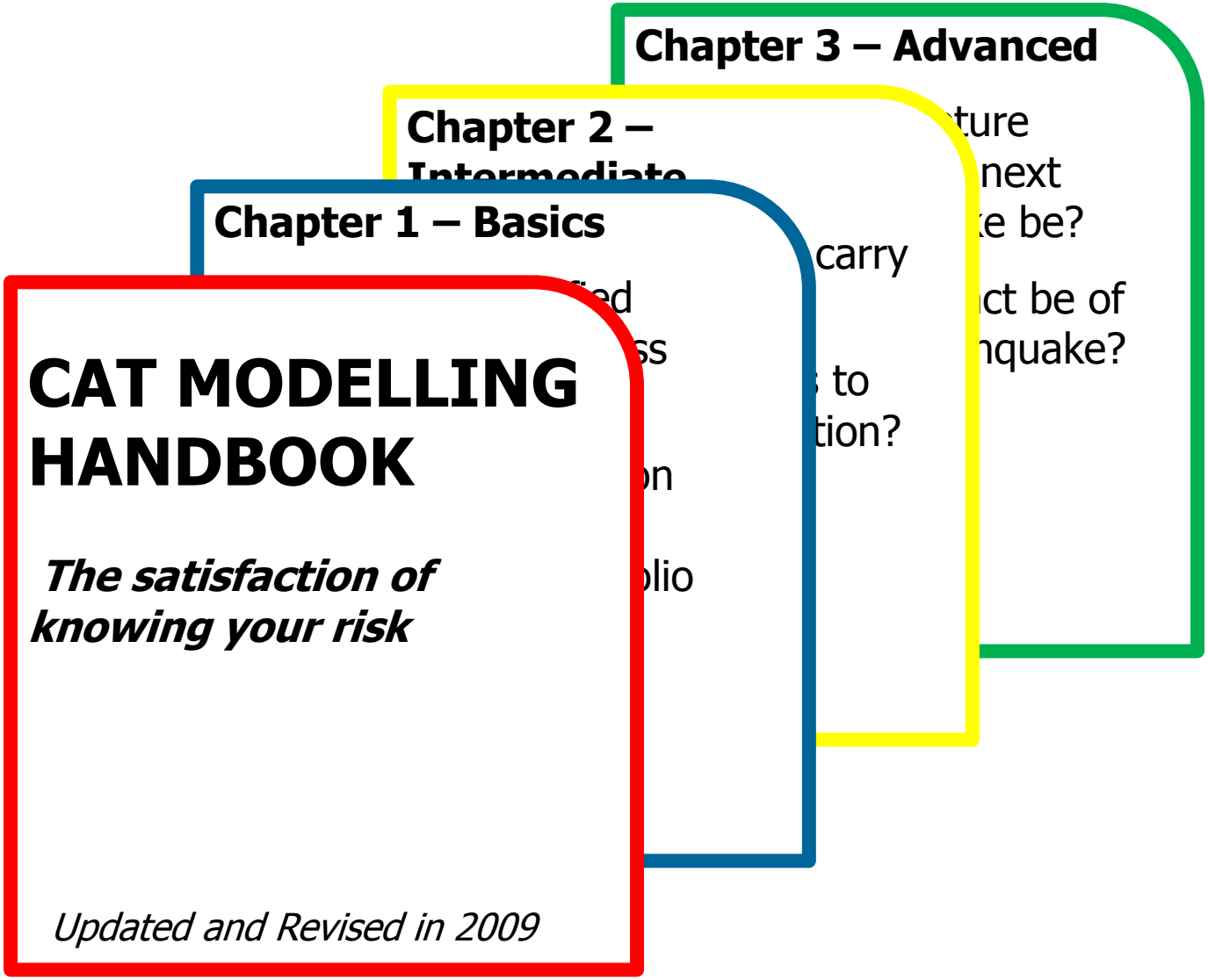
10th September 2009

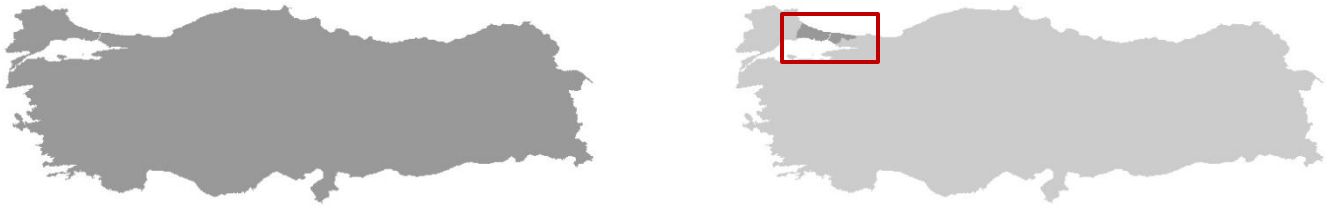
About RMS

- Founded 1989 from a Stanford University masters
- Expanded from earthquake to all nat cat perils
- Clients across all insurance segments
  - Insurer, Reinsurer, Reinsurance Intermediaries, Lloyds
- Leading scientists : 22 nationalities in 130 staff (London)

"Unfolding the quantification of earthquake risk in Turkey"



1 Diversification: High Loss Ratios in Istanbul Region



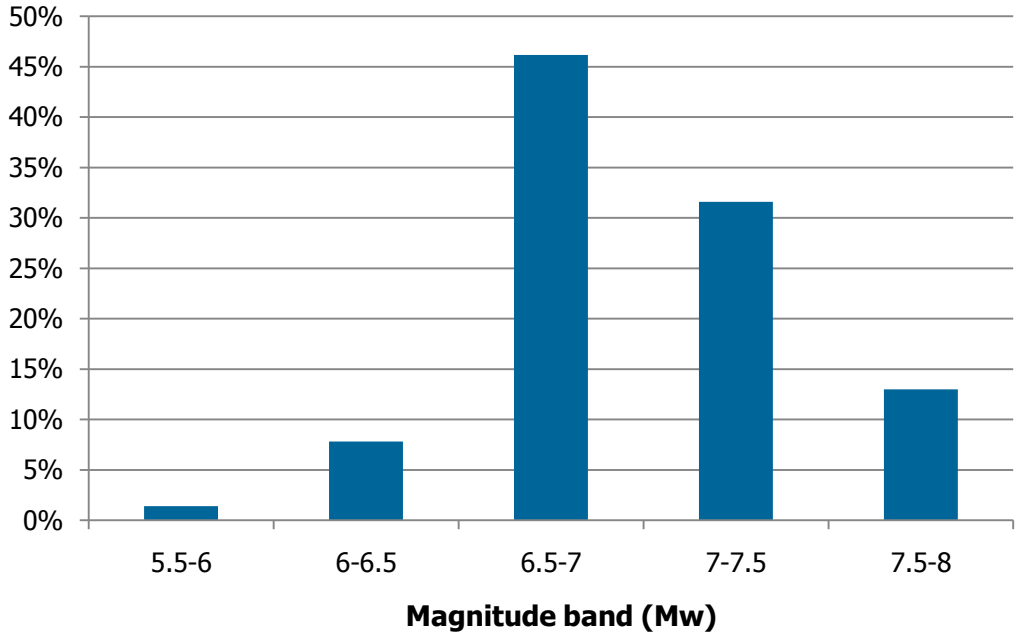
	Whole Country			Istanbul		
Return Period	RES	COM	IND	RES	COM	IND
1,000	6.18%	4.50%	2.91%	12.43%	8.26%	6.76%
500	5.33%	3.88%	2.47%	10.77%	7.14%	5.77%
250	4.38%	3.18%	1.99%	8.91%	5.89%	4.69%
200	4.05%	2.94%	1.83%	8.26%	5.45%	4.33%
100	2.96%	2.14%	1.34%	6.07%	3.99%	3.12%
50	1.75%	1.25%	0.90%	3.52%	2.28%	1.74%
25	0.74%	0.48%	0.46%	1.09%	0.64%	0.51%
10	0.24%	0.15%	0.15%	0.09%	0.05%	0.04%
AAL	0.16%	0.10%	0.08%	0.21%	0.13%	0.10%

1 Mid-size events contribute most to loss

- Frequency-severity combination of events between 6.5 and 7 M_W contribute the largest
- Events below M5.5 cause low levels of ground shaking
- Intensities less than 6_{EMS} cause negligible damage to well maintained properties

RMS Turkey EQ Model

% Contribution to AAL by magnitude band



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2 Do industrial facilities carry different risk? **Past events have shown variations in vulnerability**

- Modelling is validated by experience of industrial facilities losses
- Contents and BI vary by activity of the industrial facility

RMS Survey of 1999 Izmit Earthquake damage

Facility Component Based Approach

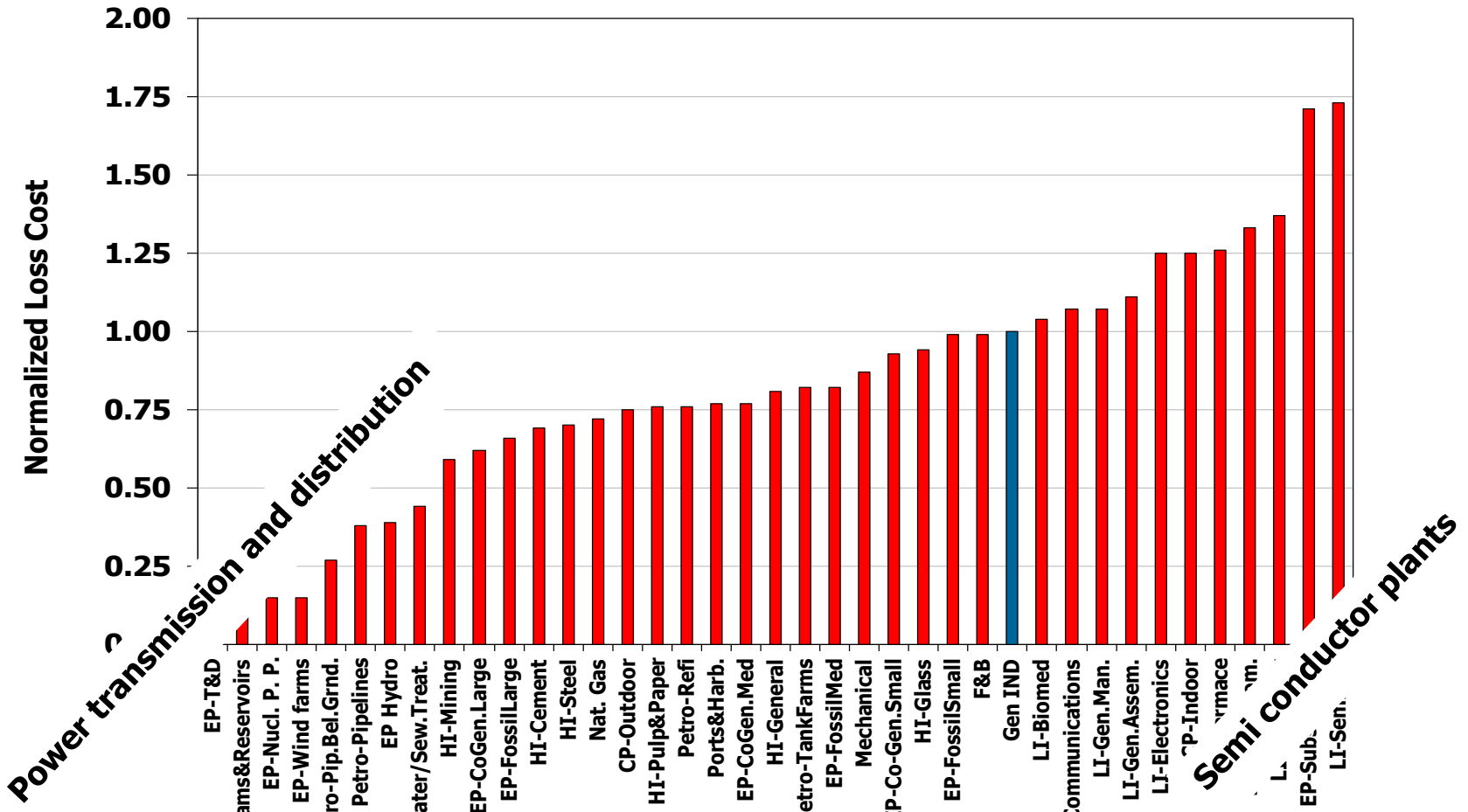
- A composite structure & contents curve is created, by weighting each component curve by its relative value
- Impact on loss from coverage breakdown between building and contents

EXAMPLE.

Chemical Processing

	Struc.	M&E	Stock	
Chemical Processing Equipment	10%	45%	2%	
Tanks	2%	10%	3%	
Pipelines (pipeway and supporting frames)	2%	3%	1%	
Mechanical equipment/ pumps	2%	7%	0%	
Substations, power generators	1%	3%	0%	
Buildings (control room, laboratory, admin.)	7%	2%	0%	
Total:	**24%**	**70%**	**6%**	

Large variability in industrial earthquake risk



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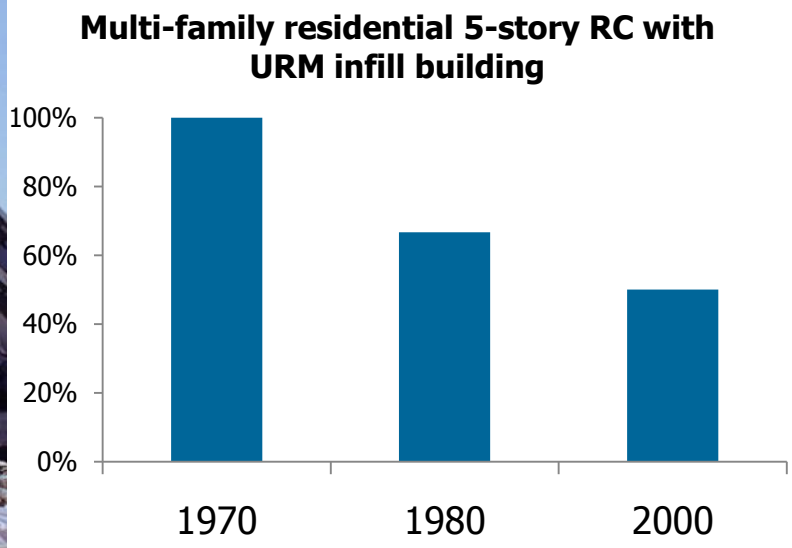
2 *How can I use models to reward good construction?*
Building data differentiates the risks

- Physical models can explore the risk reduction of seismic provisions
- Captures both mitigation and construction to new building codes
- Expect future models to increase the divide between buildings of different ages and typologies

Vulnerability of "Beshkat" Buildings

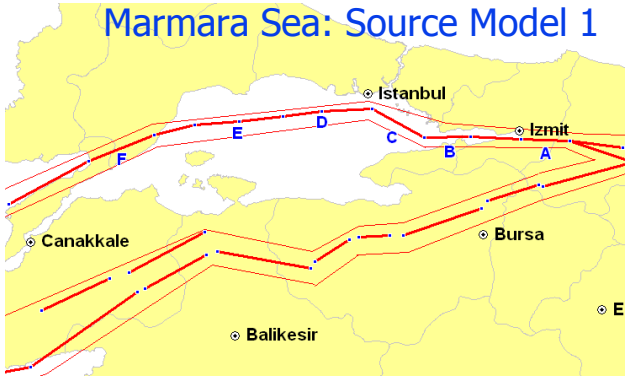
- Example: 5-story building, residential multi-family occupancy, RC with URM infill construction
- Year of construction: 1970, 1980, 2000 – can be a proxy for the effect of mitigation retrofitting

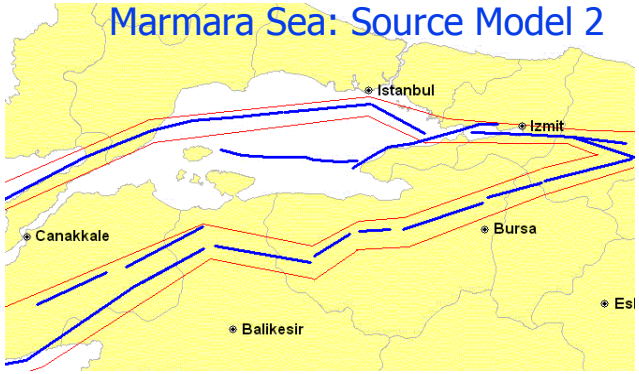


3 *What will the rupture mechanism of the next Marmara Sea quake be?*

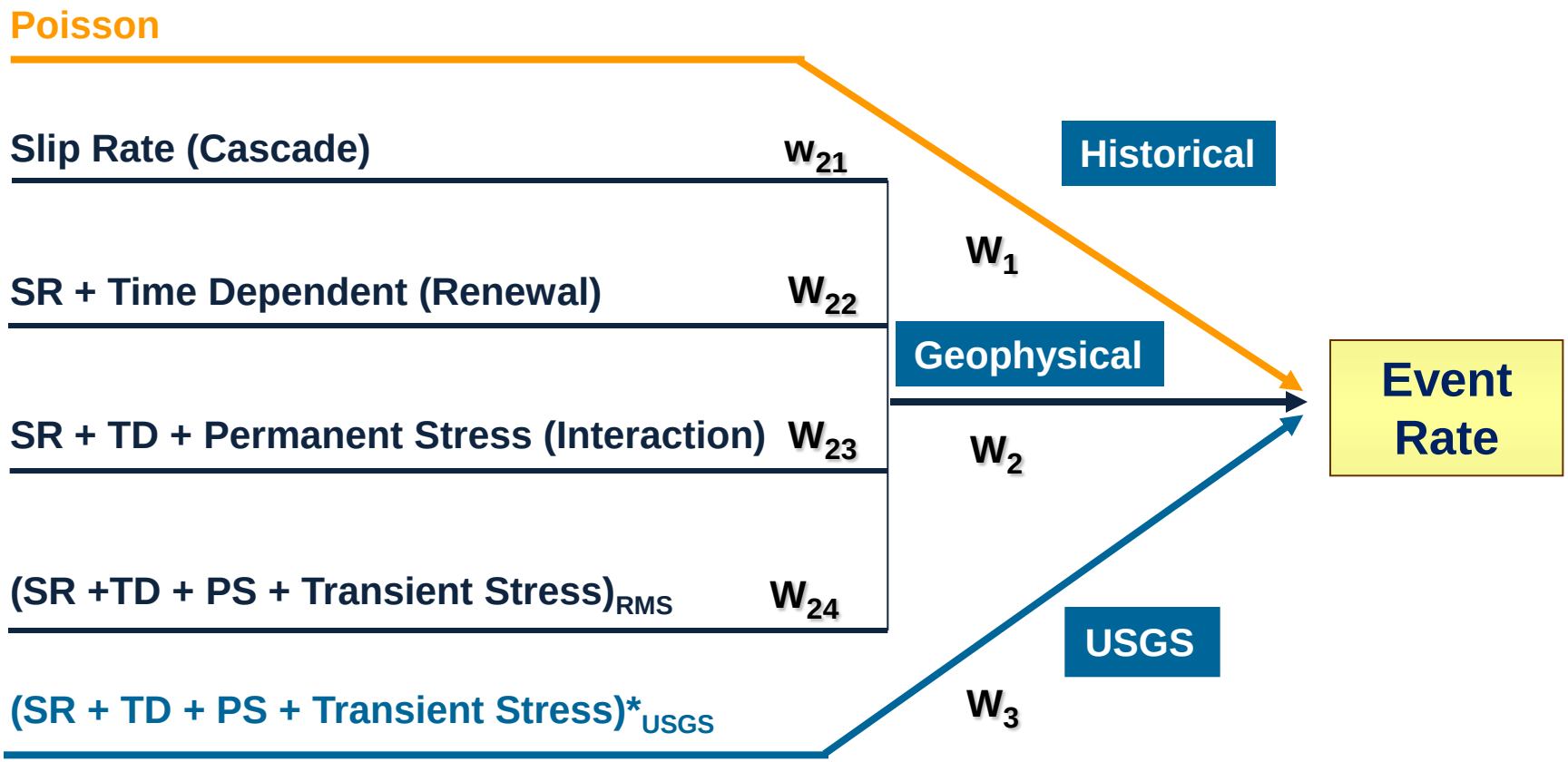
Uncertainty addressed within a logic tree approach

- Two alternate source models for
  - Cascade" ruptures (multiple segments)
  - "Non-Cascade" ruptures (single segments)
- Three recurrence models
  - Poisson Model (Time-independent)
  - Time-dependent Model
  - Stress-Transfer ("Migration") Model





Calculating the Probability of an Event

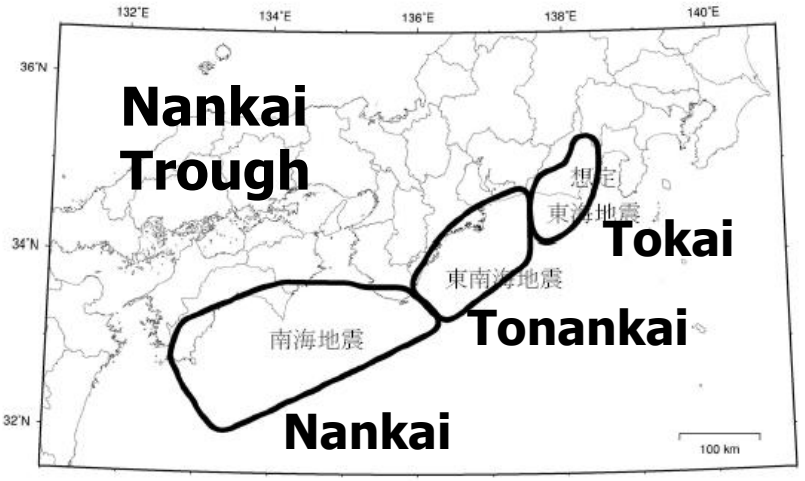


The weights (W_{xx}) are determined from observations of the historical record, expert opinion, and sensitivity analyses

Other examples of weighting of different theories (1):

Japan, Nankai Trough

- Option A: Tokai segment can rupture independently
- Option B: Tokai segment ruptures as part of a cascade with the rest of the source



Date	Nankai	Tonankai	Tokai
Sept 20, 1498			
Feb 3, 1605			
Oct 28, 1707			
Dec 23, 1854			
Dec 24, 1854			
Dec 7, 1944			
Dec 21, 1946			

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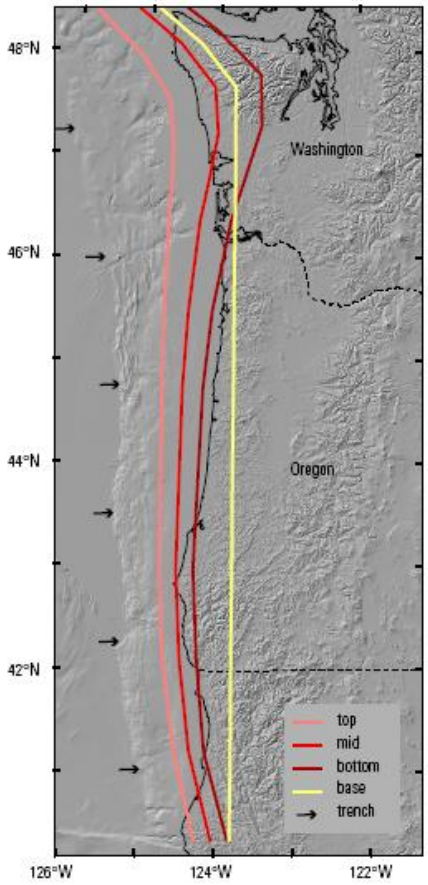
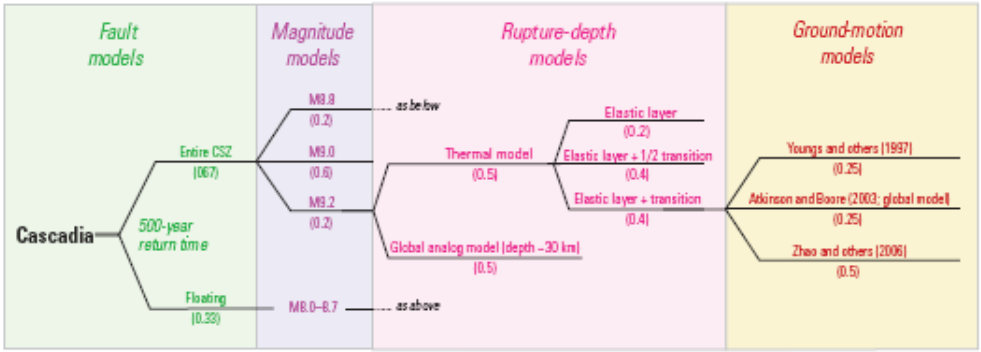
Other examples of weighting of different theories (2):

North Pacific Cascadia Subduction Zone (CSZ) in the US EQ 2009 release





- Entire source ruptures every 500 years
- 2/3 weight - A full rupture M8.8-M9.2
- 1/3 weight - Multiple smaller ruptures M8.0-M8.7

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3

What will the impact be of a large urban earthquake?

Physical modelling is overlaid with the macro-economic effects

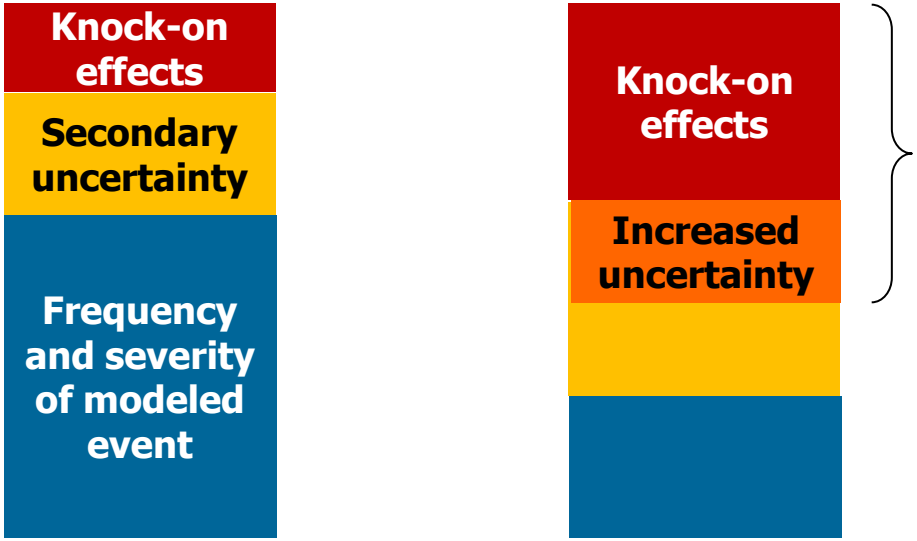
- In extreme events the linear relationship between damage and cost/loss falls down
- Repair costs increase as economic demand surge reduces the ability to carry our reconstruction and repair
- Business continuity is greatly impaired

What is a "Super" Catastrophe?

- Secondary consequences are a major proportion of the loss; and often can be larger than the original event
- Policies with time-element wordings such as business interruption (BI) are exposed to escalating losses

Share of Risk by Source

Most risk from "normal" Cats captured in model



- **Cascading perils**
- **Non-linear knock-on effects**
- **Significant escalation of BI losses**

Conclusions

- Using and interpreting models is not as complex as it looks- building them is more complex
- There is a wide range of vulnerabilities in both industrial and residential risks, and more data will improve the model results
- For larger events it is important to understand what assumptions the modellers make and add own intuition