



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

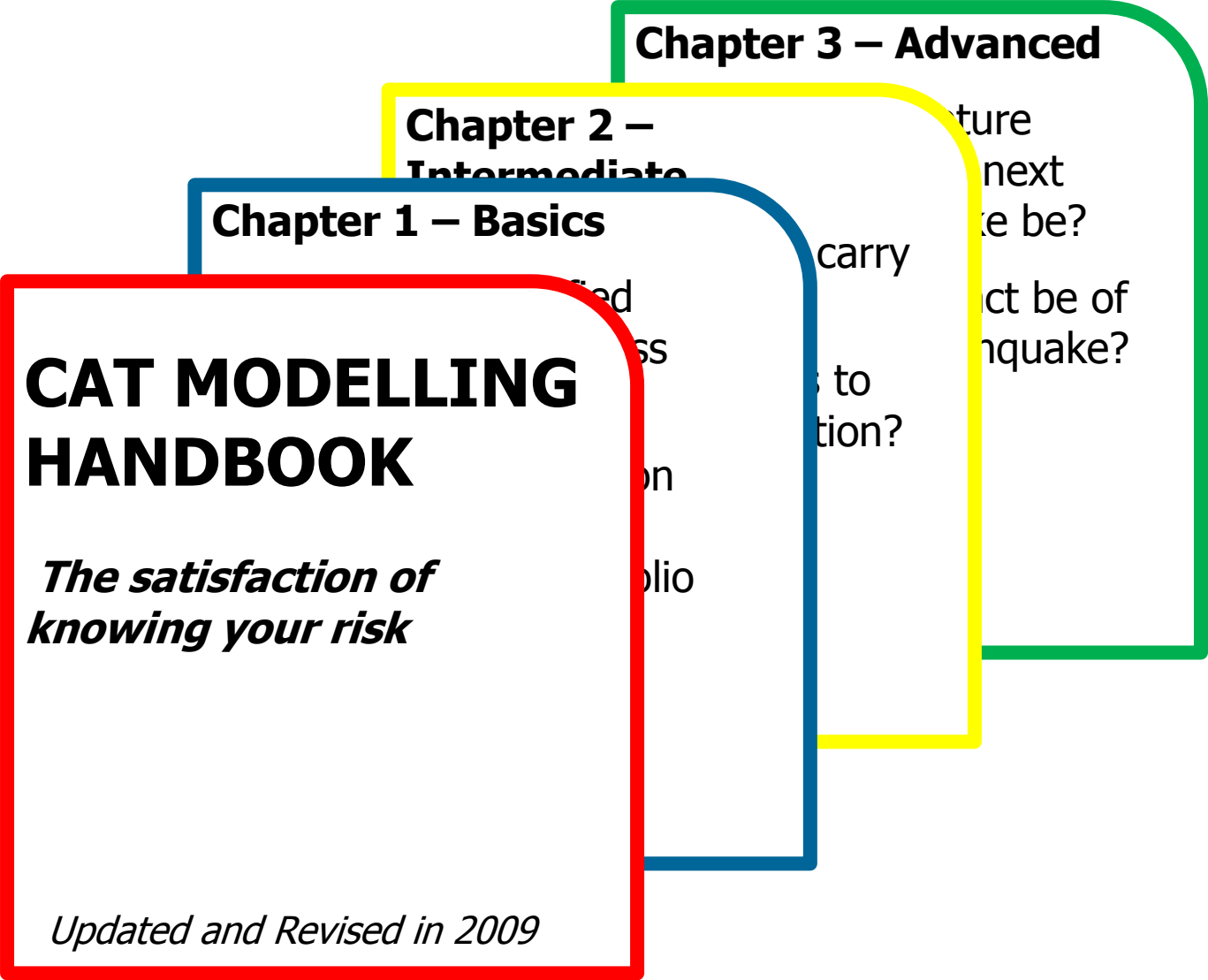
Bringing Science to the Art of Underwriting™



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



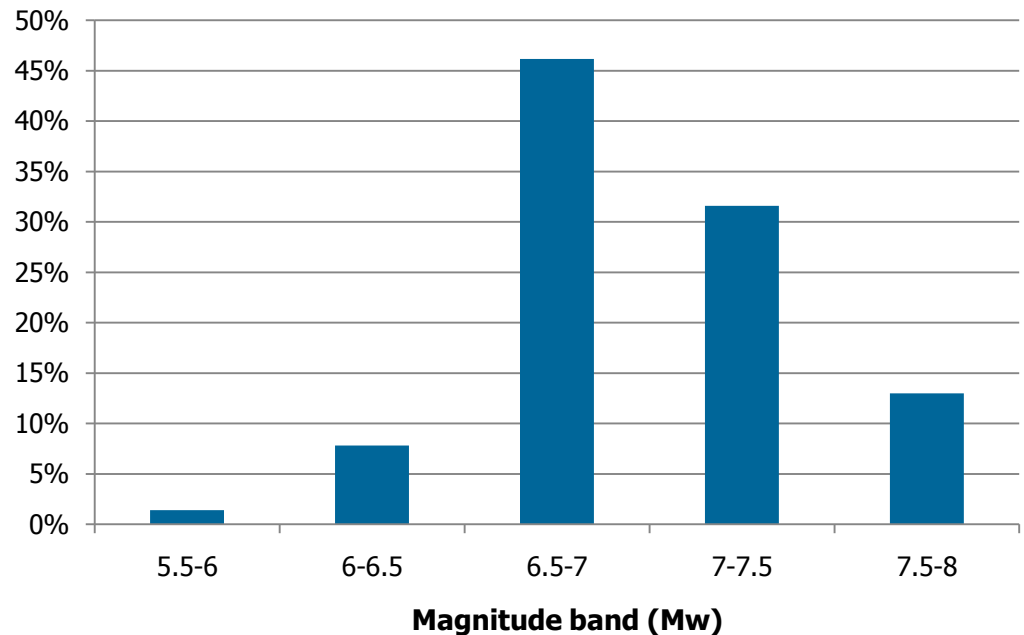
	Whole Country			Istanbul		
Return Period	RES	COM	IND	RES	COM	IND
1,000	6.18%	4.50%	2.91%	12.43%	8.26%	6.76%
500	5.33%	3.88%	2.47%	10.77%	7.14%	5.77%
250	4.38%	3.18%	1.99%	8.91%	5.89%	4.69%
200	4.05%	2.94%	1.83%	8.26%	5.45%	4.33%
100	2.96%	2.14%	1.34%	6.07%	3.99%	3.12%
50	1.75%	1.25%	0.90%	3.52%	2.28%	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



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

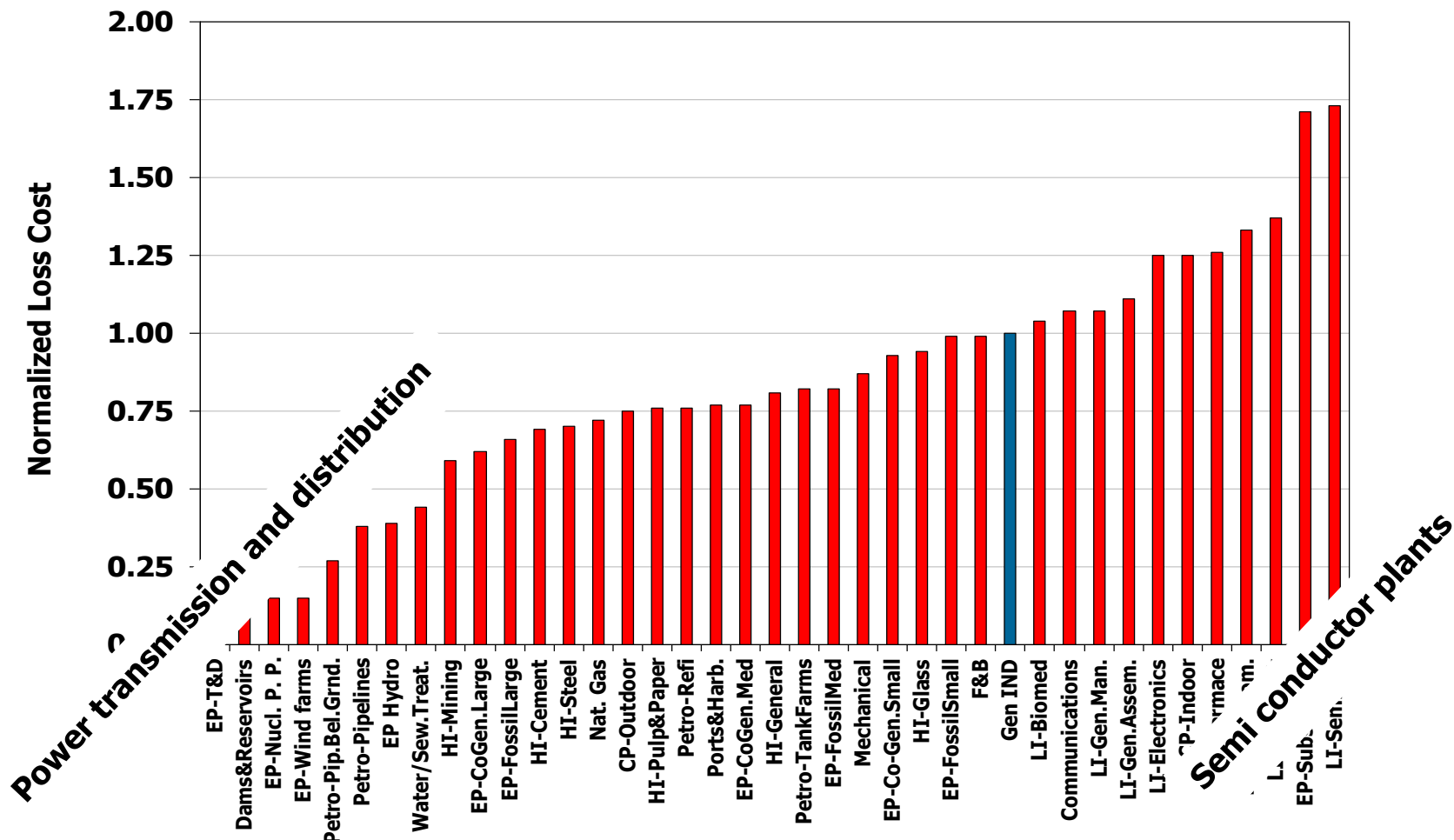
- A composite structure & contents curve is created, by weighting each component curve by its relative value
- Impact on loss from coverage breakdown between building and contents

EXAMPLE.

Chemical Processing

		Struc.	M&E	Stock	
Chemical Processing	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



2

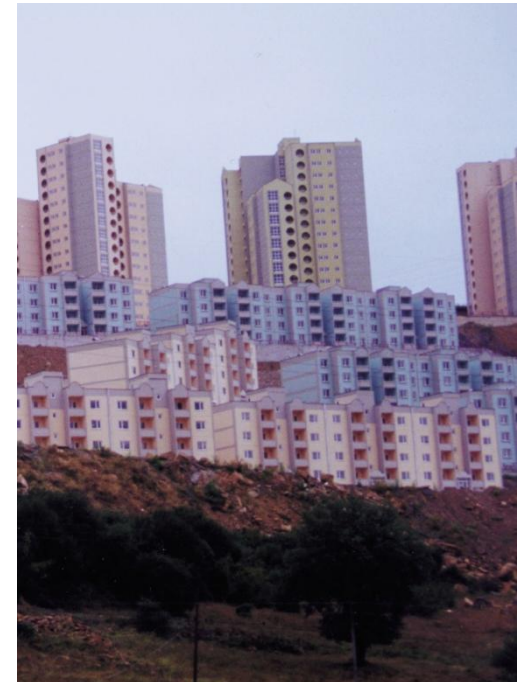
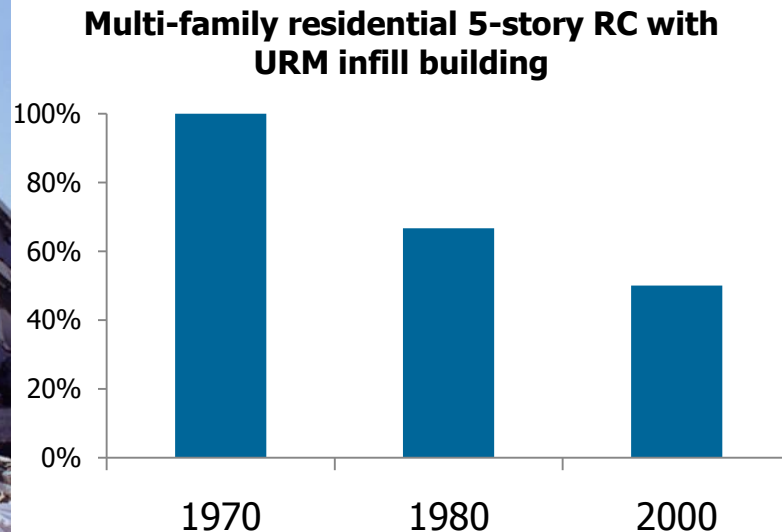
How can I use models to reward good construction?

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

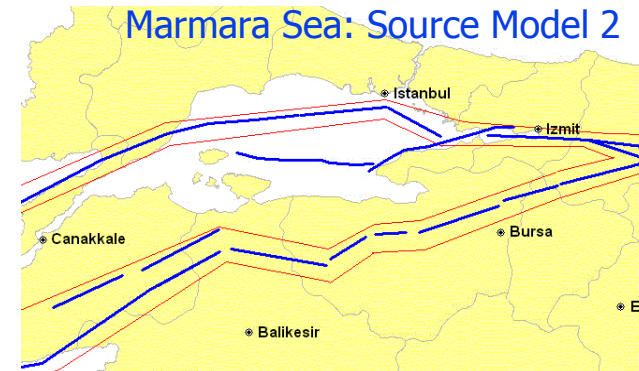
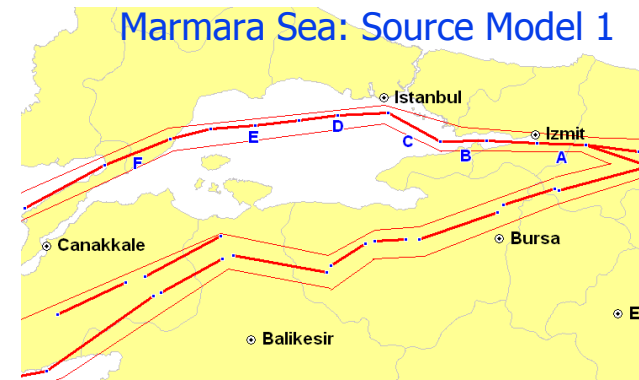


3

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

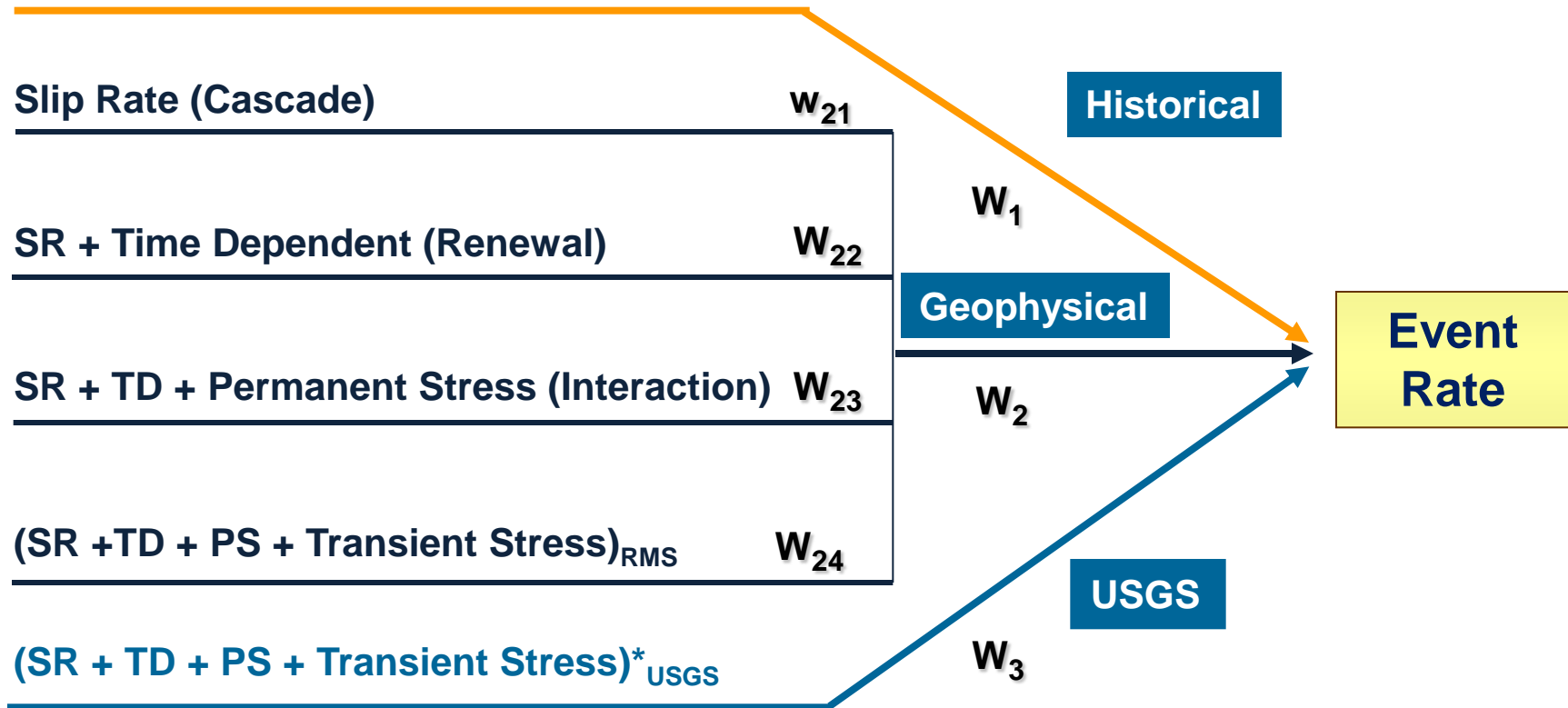
Uncertainty addressed within a logic tree approach

- 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

Poisson

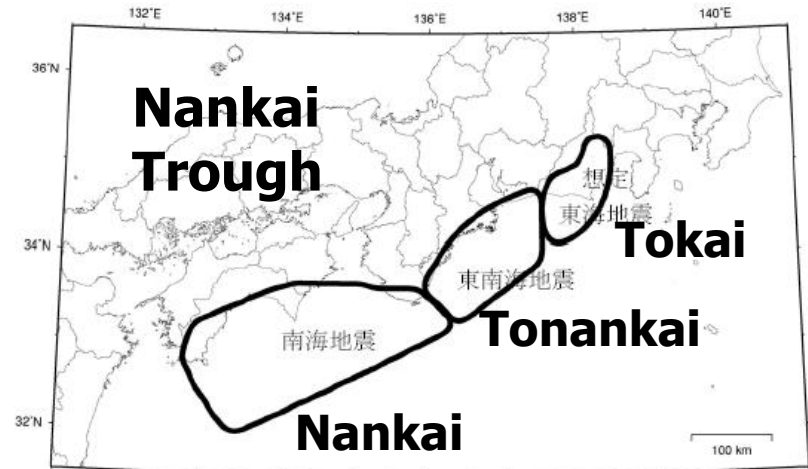


The weights (W_{xx}) are determined from observations of the historical record, expert opinion, and sensitivity analyses

Other examples of weighting of different theories (1):

Japan, Nankai Trough

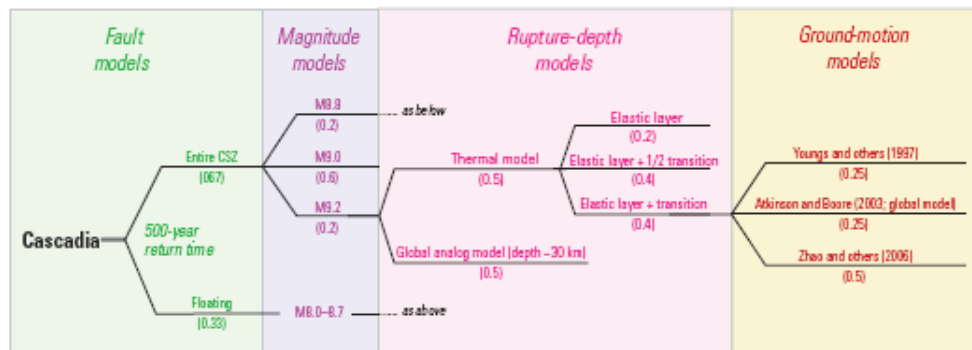
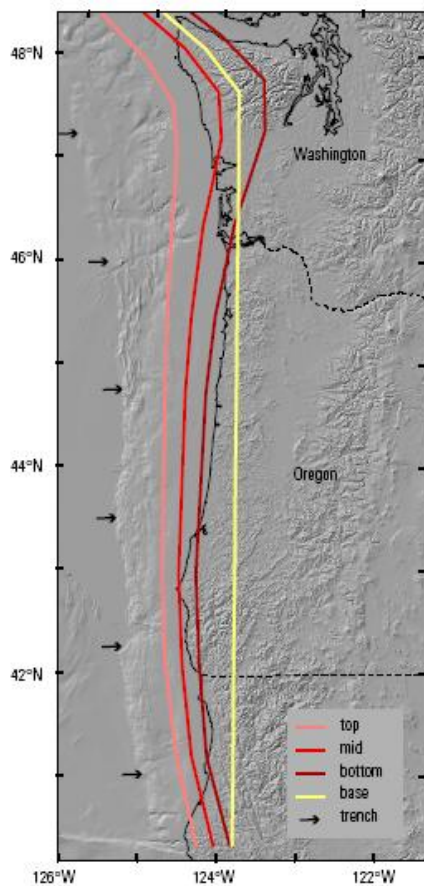
- Option A: Tokai segment can rupture independently
- Option B: Tokai segment ruptures as part of a cascade with the rest of the source



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	██████████		

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

3

What will the impact be of a large urban earthquake?

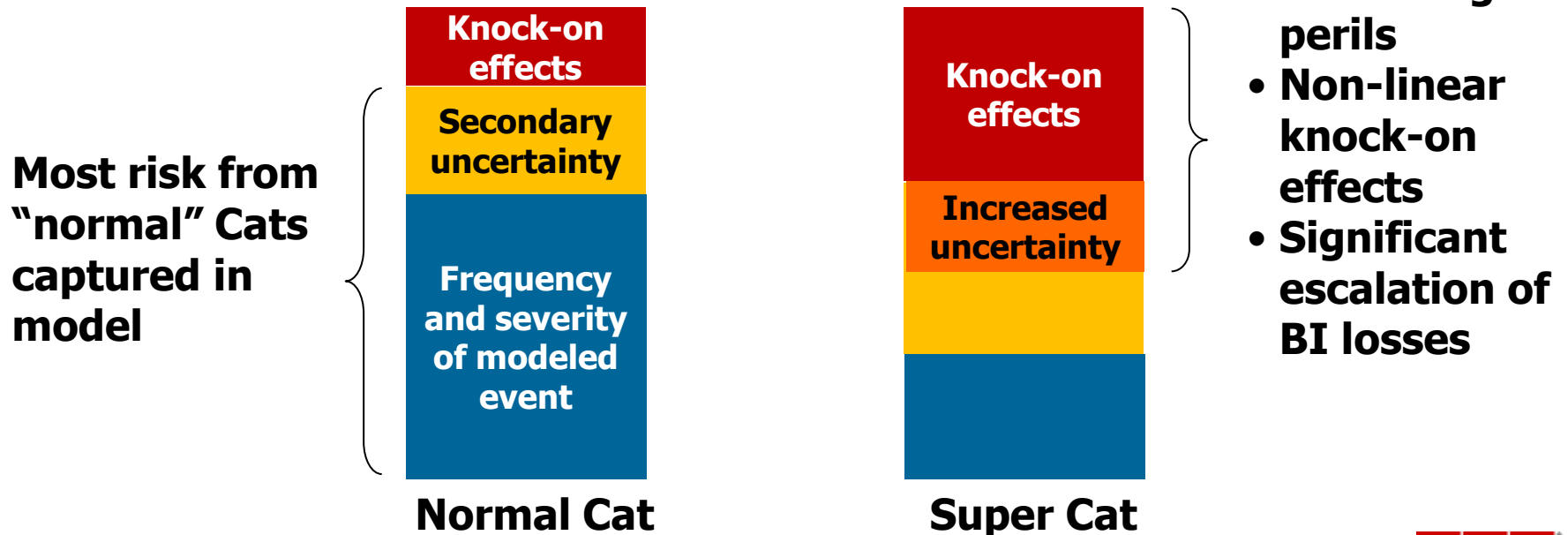
Physical modelling is overlaid with the macro-economic effects

- 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 out 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



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