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The effect of observation errors on the assessment of insurance losses due to seismic activity

with an application in South Africa

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ICA 2014 – Washington DC

2 April 2014

Agenda

- Background
- Earthquake magnitude and intensity
 - Frequency-magnitude Gutenberg-Richer relation and its parameters
 - Uncertainty
 - Measuring Intensity
- Earthquakes and the insurance industry
- Seismic Risk Assessment
 - Background
 - Application: South Africa
 - Sensitivity tests
- Parameter uncertainty and Insured Risks



Earthquakes in South Africa

Tulbagh, Western Cape, 1969
M= 6.3, MMI = VIII



Earthquakes in South Africa

Mining related

Welkom 1976. M=5.2, MMI = VII



Earthquakes in South Africa

Mining related

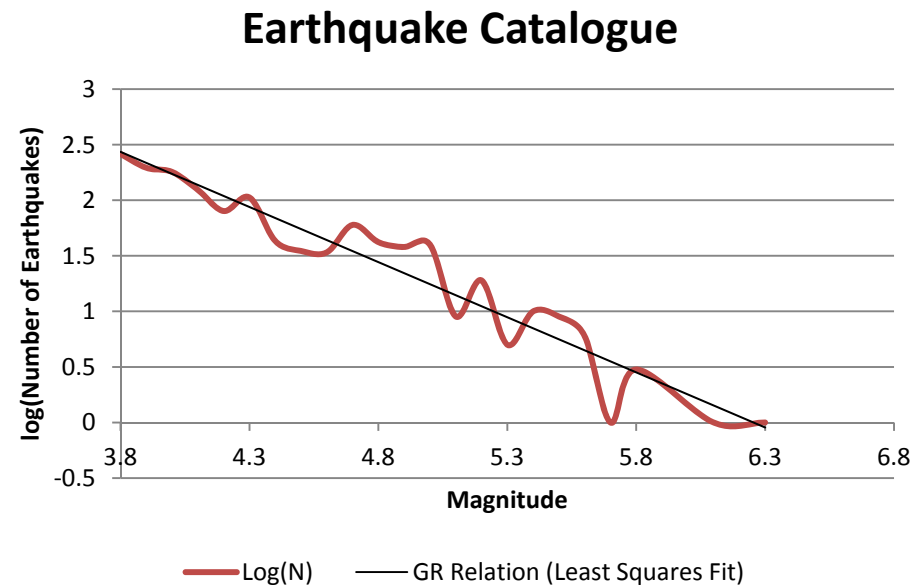
Stilfontein, 2005. M=5.3



Earthquake Magnitude

- Measures the “size” of an earthquake
- Gutenberg Richter Relation:

$$\log N = a - bM$$



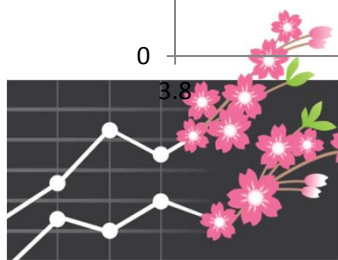
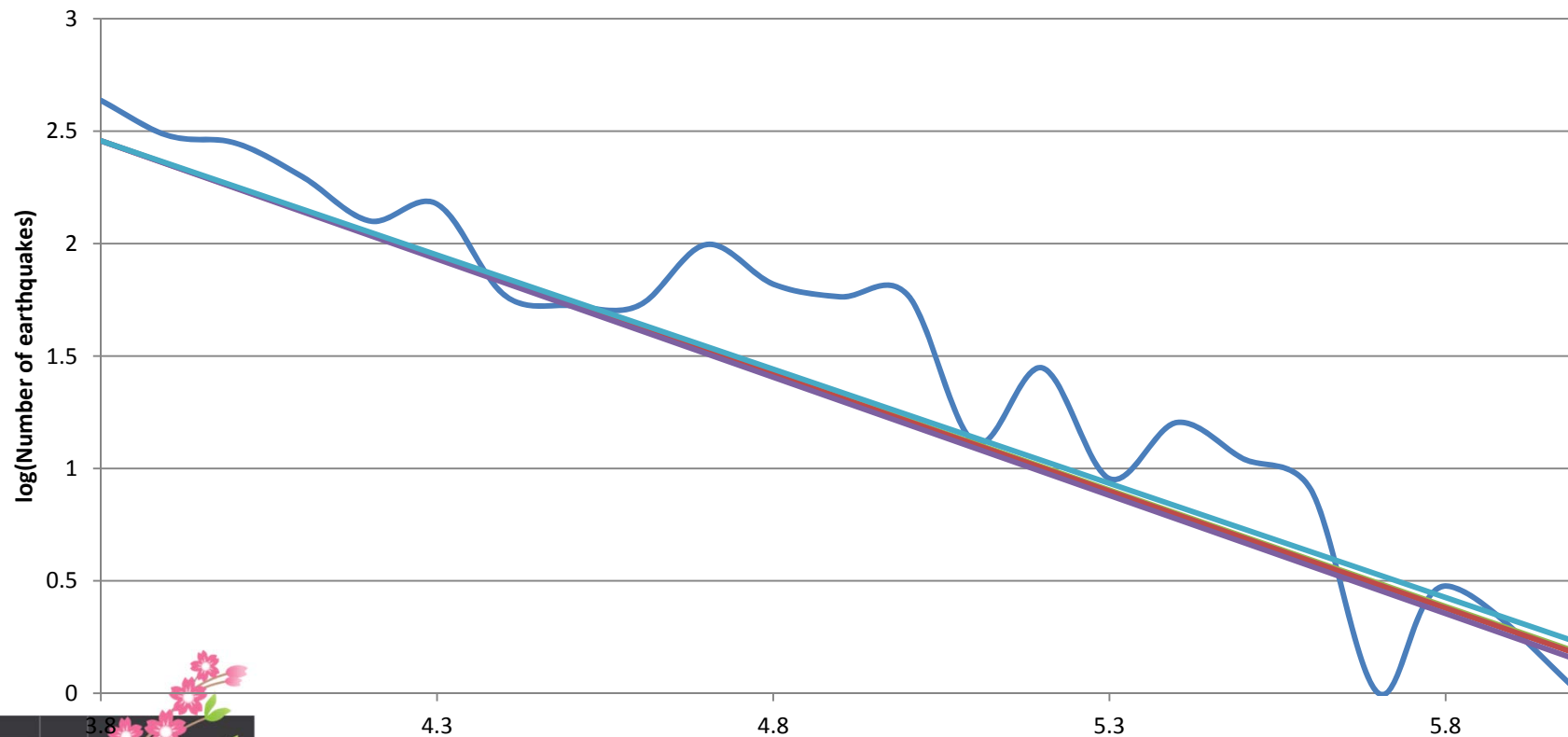
Parameter Estimation

- Least squares method (includes M_{\min})
- Maximum likelihood method
- Include more information: M_{\max}
- Systematic error: $M_{\text{obs}} = M_{\text{real}} + \text{error}$



Earthquake Occurrence Models

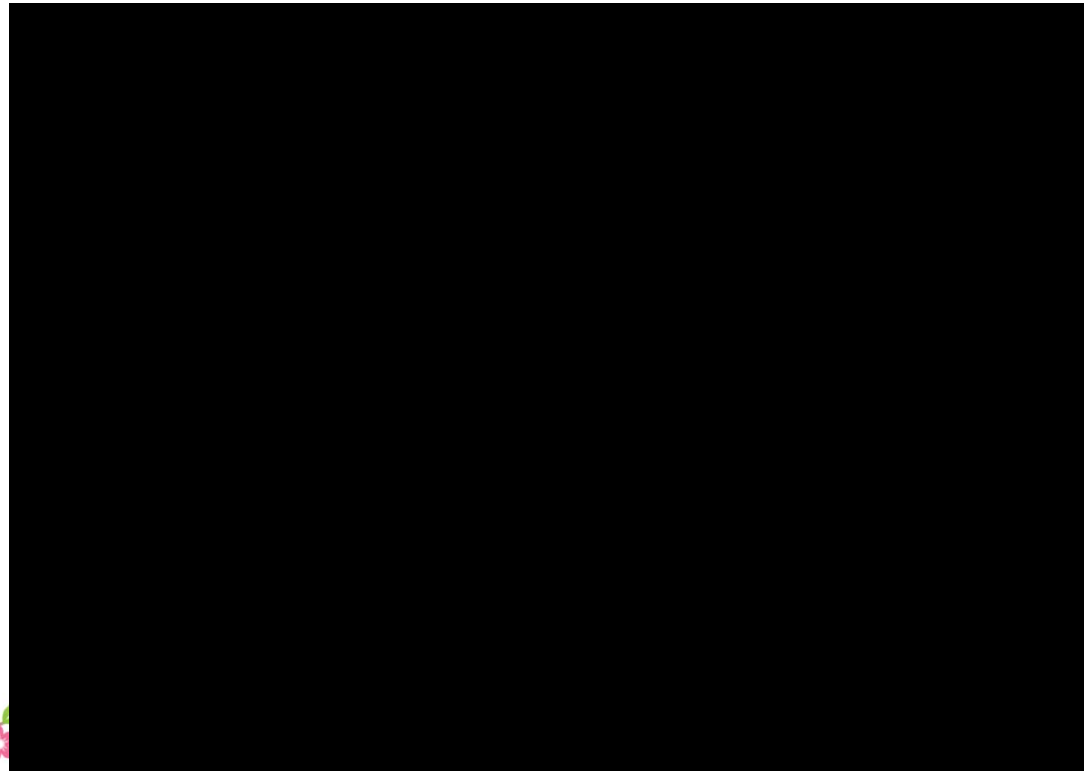
Comparison of estimators



- Actual
- Classic
- Classic, bounded + Normal Errors (with $\sigma=0.2$)
- Classic, bounded + Laplace errors (with $\sigma=0.3$)

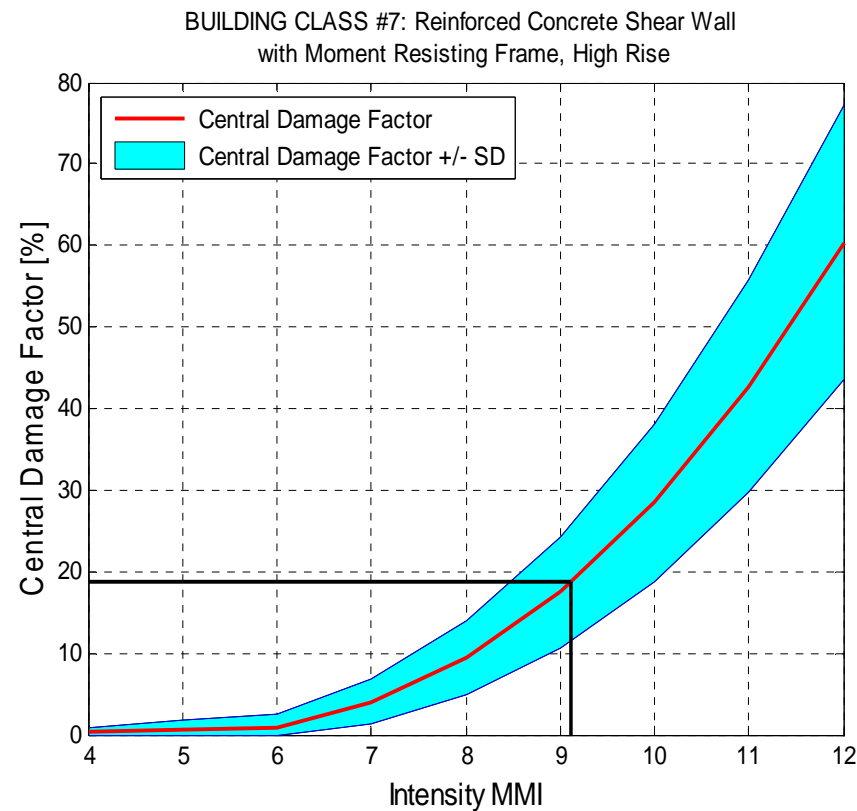
Earthquake Intensity

- Modified Mercalli Intensity Scale



Prediction of Damage by Earthquake

- Damage Probability Matrix (DPM)
- Connects MMI Intensity with damage for a particular building class



Building classes

Most frequent urban building classes in SA



Earthquakes and the Insurance Industry

Problem: High severity and low frequency

Solution: Models



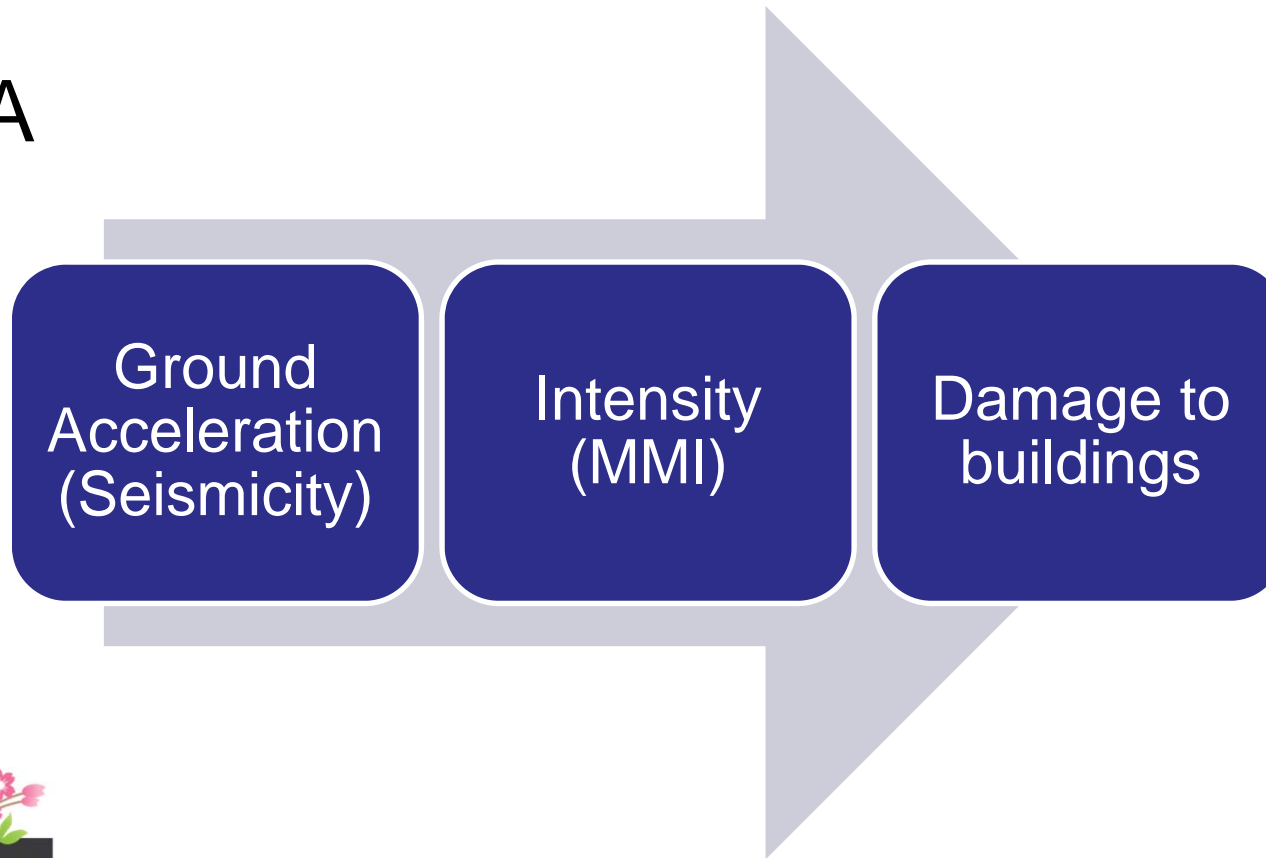
Earthquakes and the Insurance Industry

- Catastrophe modelling:
 - Location
 - Frequency of occurrence
 - Severity
- Probabilistic Seismic Risk Assessment (PSRA)



Earthquakes and the Insurance Industry

PSRA



Parameter Uncertainty and Insured Risks

- The study:



Parameter Uncertainty and Insured Risks

- Data base:

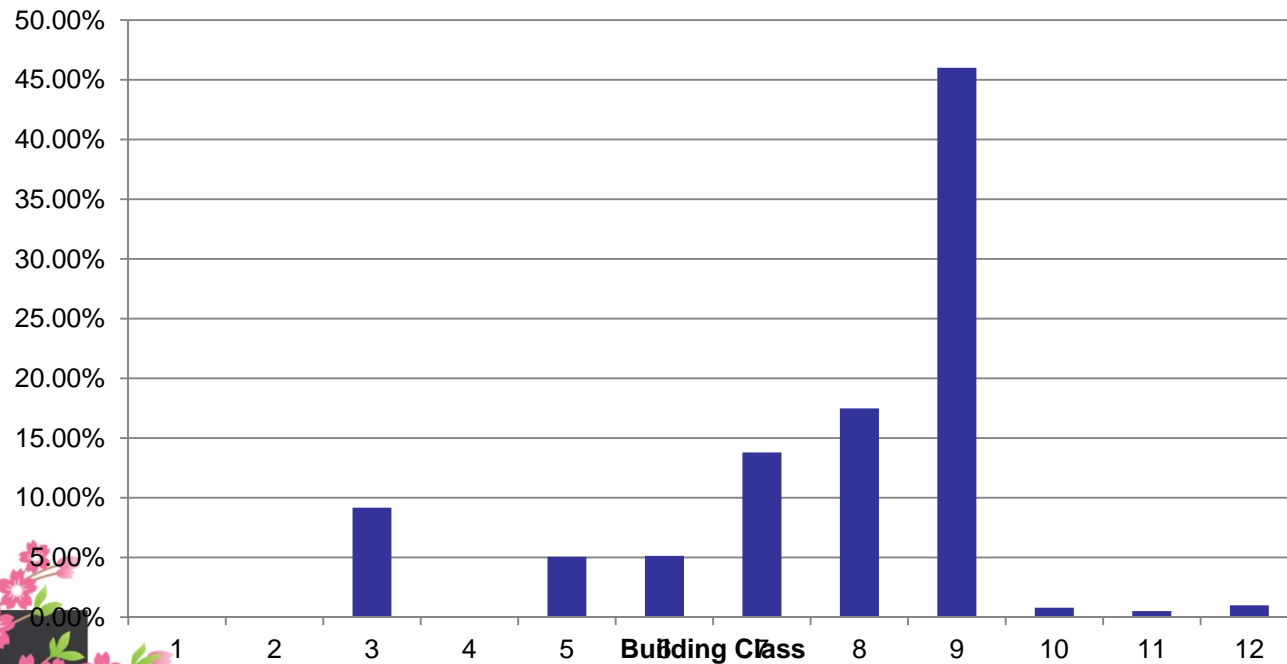
Characteristic	Value
Start date	1901
End date	2013
m_{\min}	3.8
m_{\max}	7.0
\bar{m}	4.2
Number of events larger than 3.8	1307
Estimated average events larger than 3.8 per year	12



Parameter Uncertainty and Insured Risks

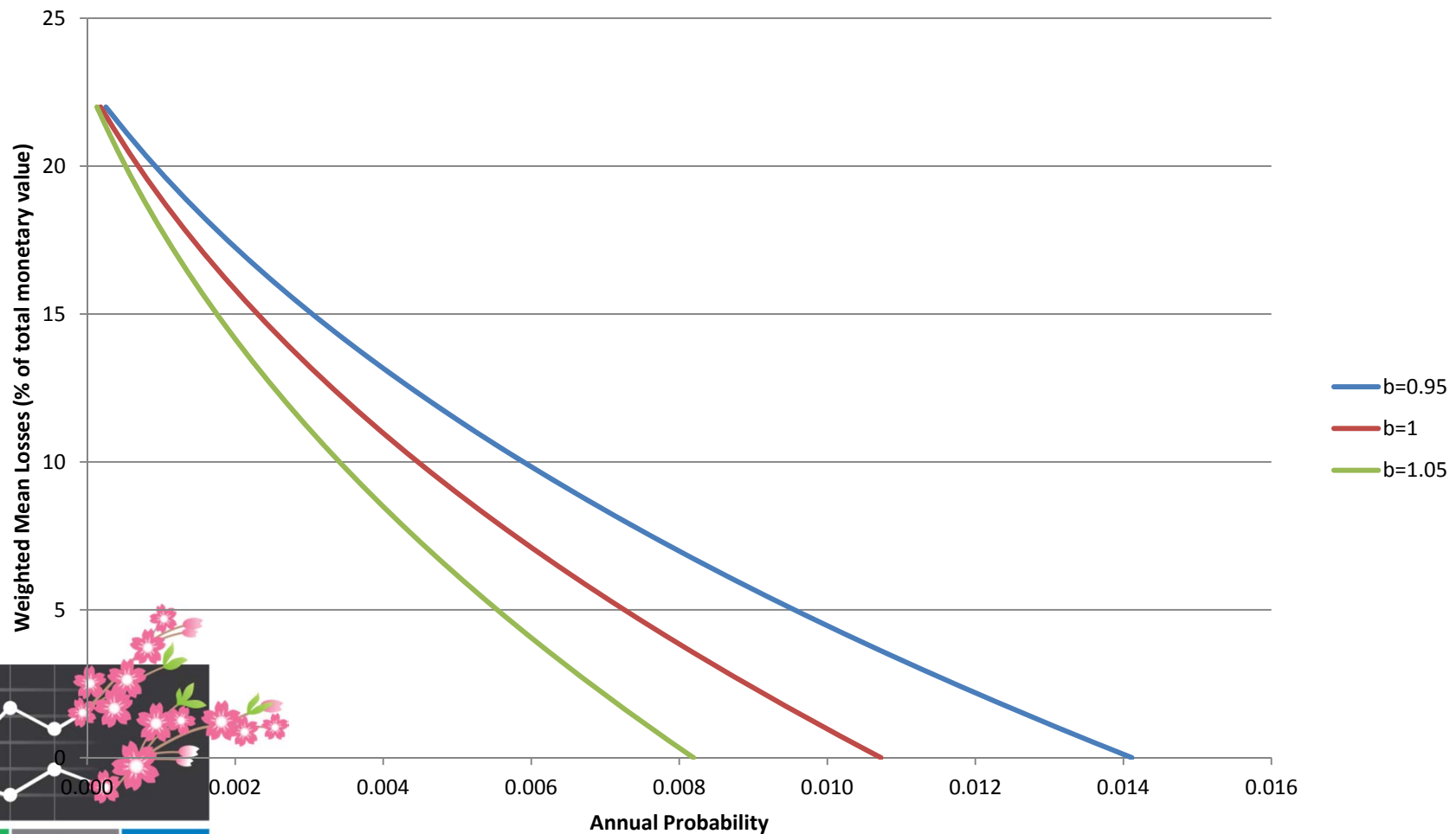
- Building class distribution:

Building class distribution for Cape Town (% of total replacement costs)



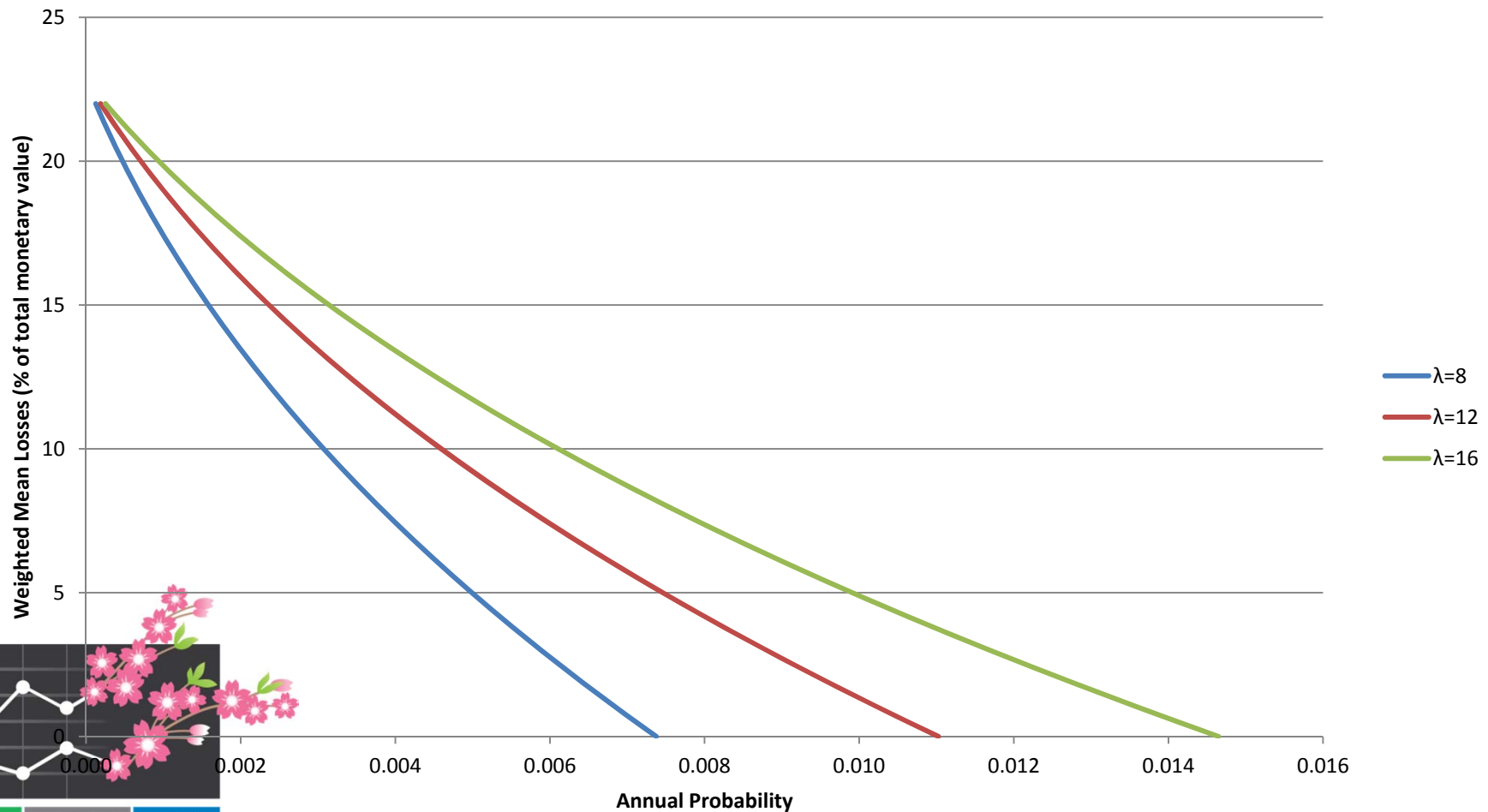
Parameter Uncertainty and Insured Risks: Investigation 1: Varying b values

Probabilities of Mean losses for Cape Town



Parameter Uncertainty and Insured Risks: Investigation 2: Varying activity rate

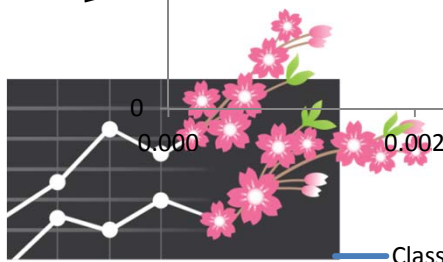
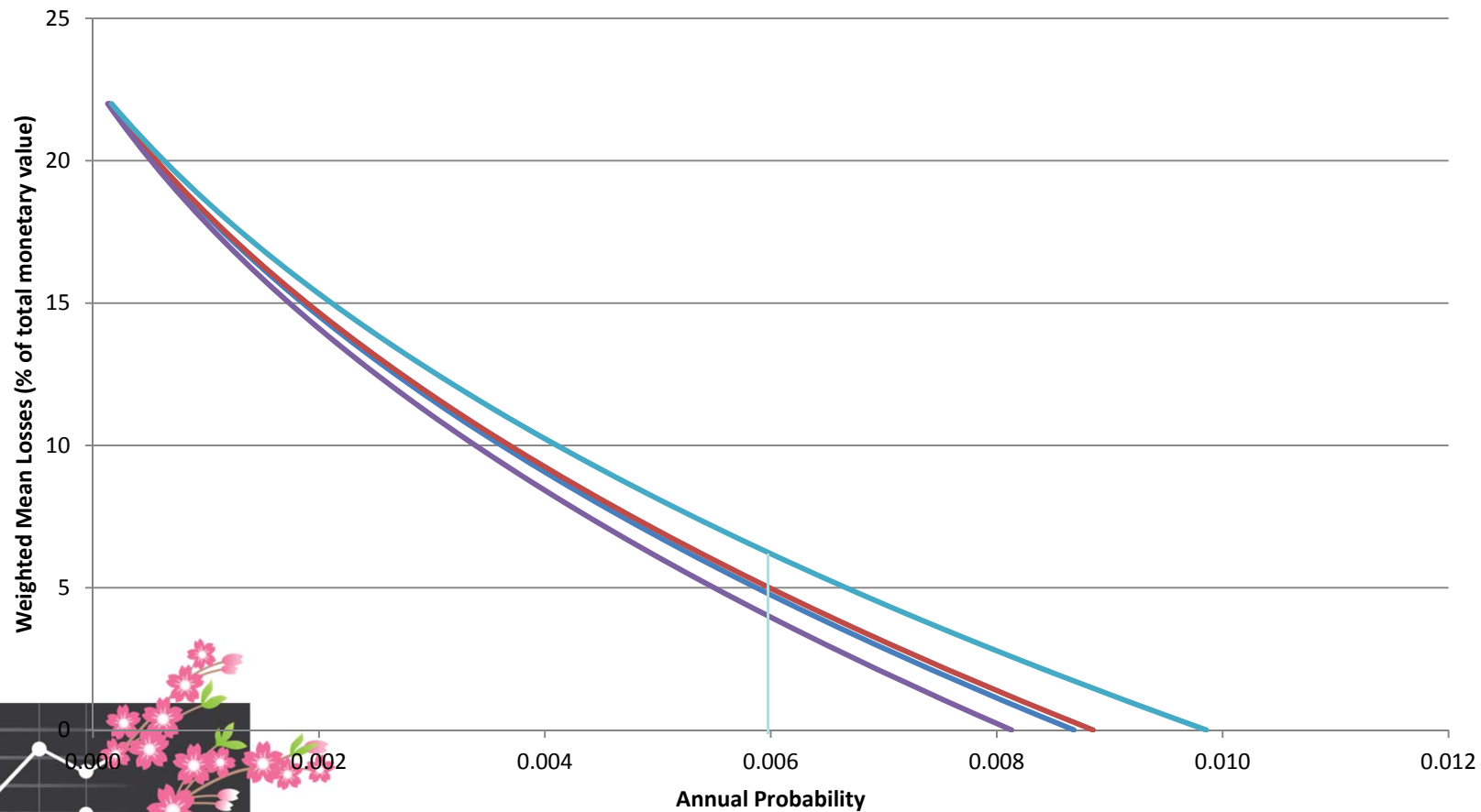
Probabilities of Mean losses for Cape Town



Parameter Uncertainty and Insured Risks:

Investigation 3: Differing methodologies for estimating the b value

Probabilities of Mean losses for Cape Town



Summary

- Seismic risk characteristics
- Earthquakes and insurance
- PSRA
- Losses are sensitive to seismic parameters
 - particularly for areas of low seismicity
- The best method to use is determined by the underlying data





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Questions?

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