The Case for Using Mean Seismic Hazard

presentation on the opinion paper of McGuire, Cornell and Toro, 2005

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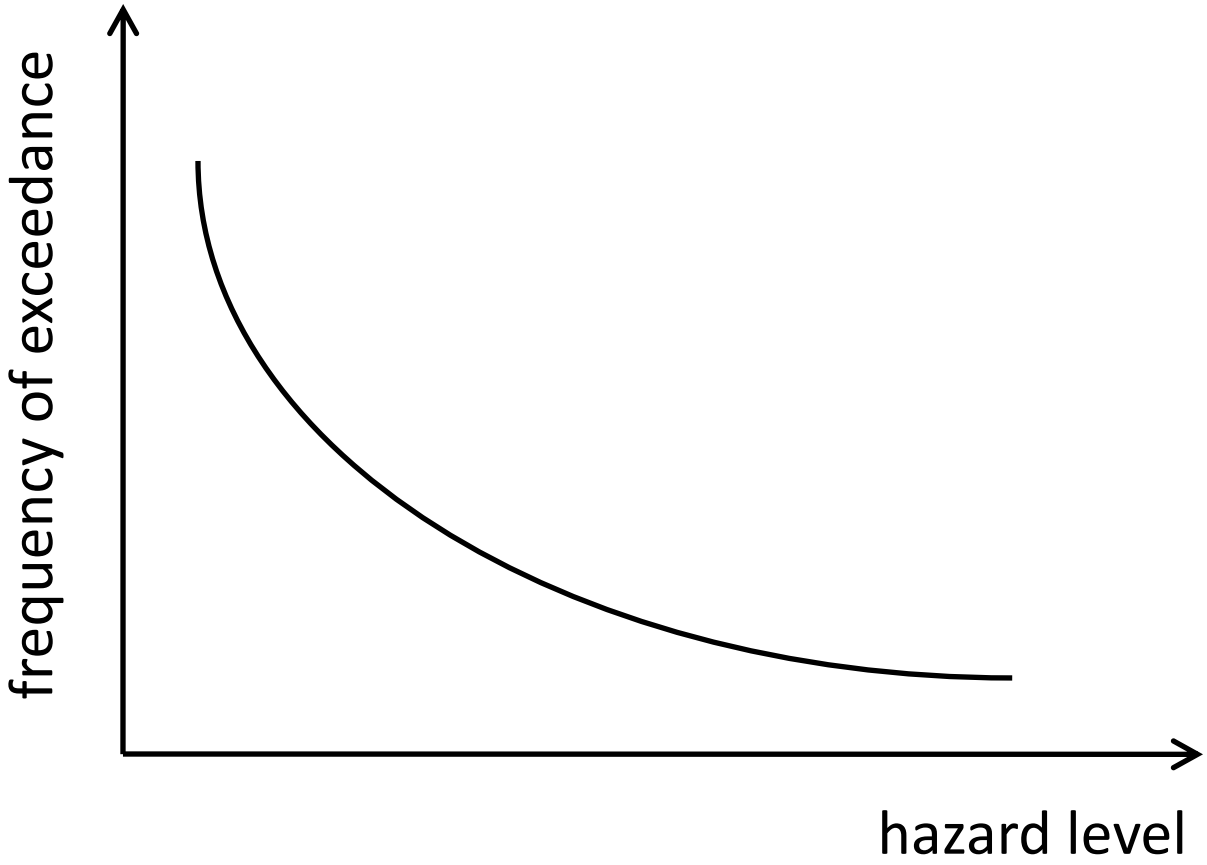
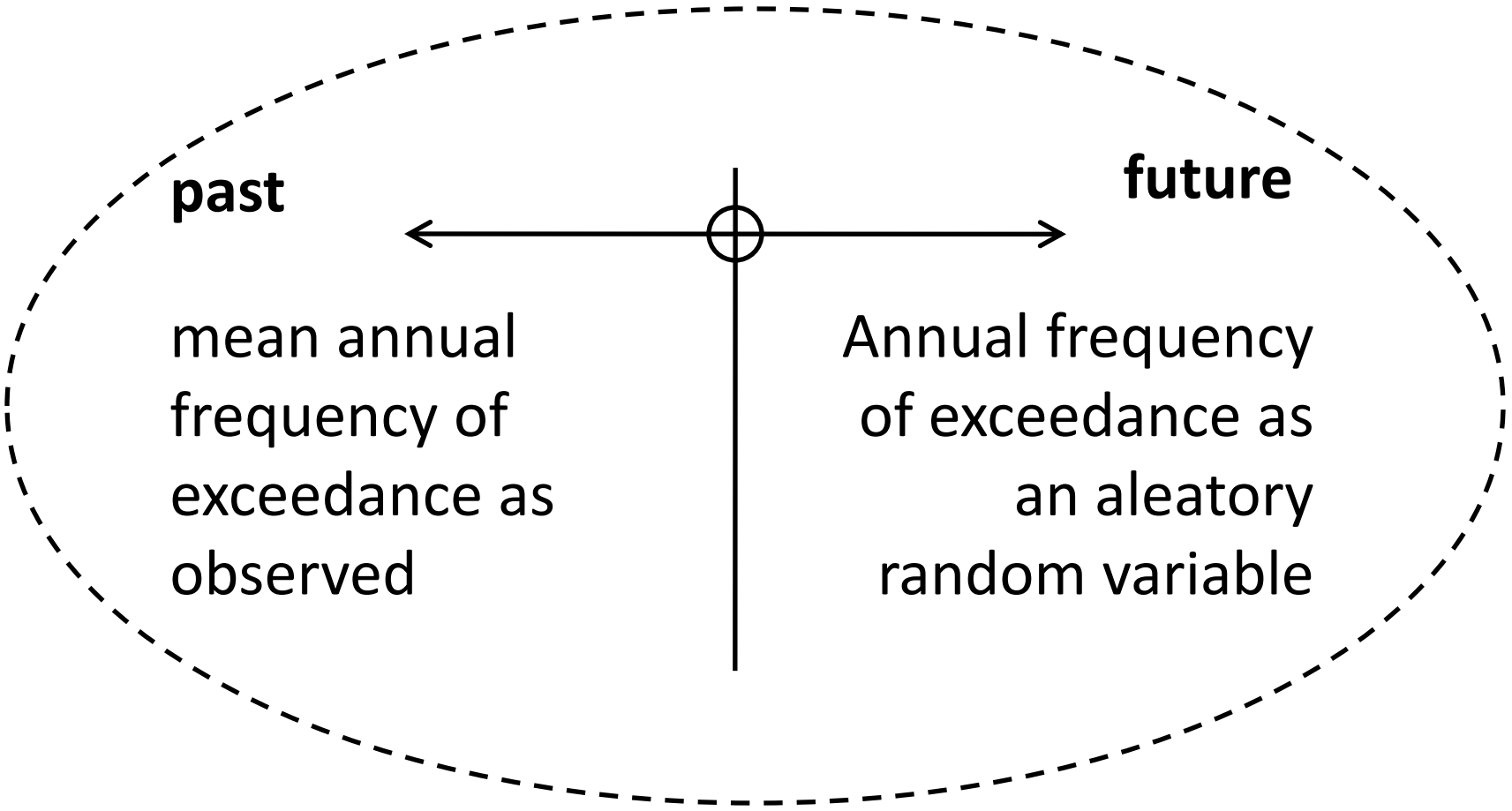
Introduction



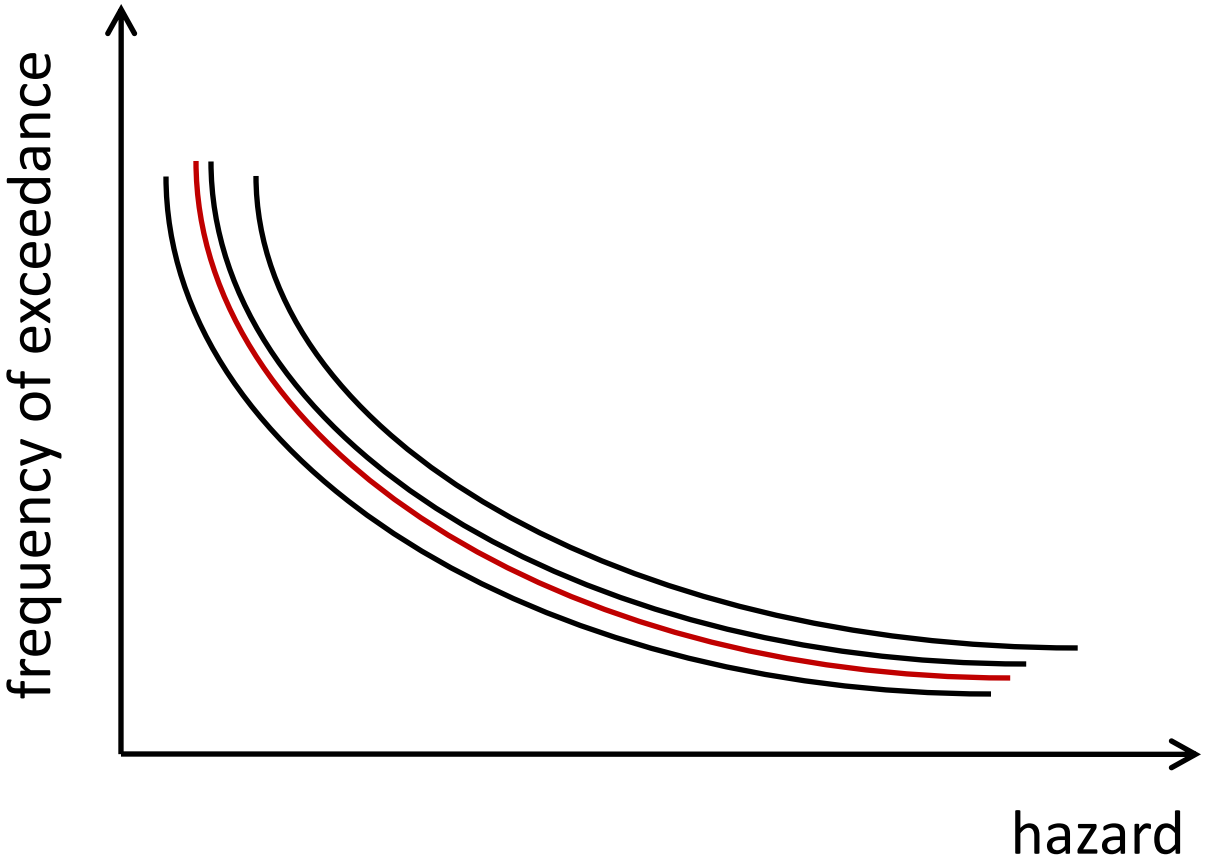
hazard curve as result of hazard analysis

Introduction



epistemic uncertainty in assumptions, models, parameters… must be included!

Introduction



epistemic distribution of hazard curves

If only one single number is required:

Use the mean hazard curve!

(the mean estimate of the mean annual frequency of exceedance)

1st theoretical argument

Bayesian view of probability:

no distinction between aleatory and epistemic uncertainty

→ application of the total probability theorem

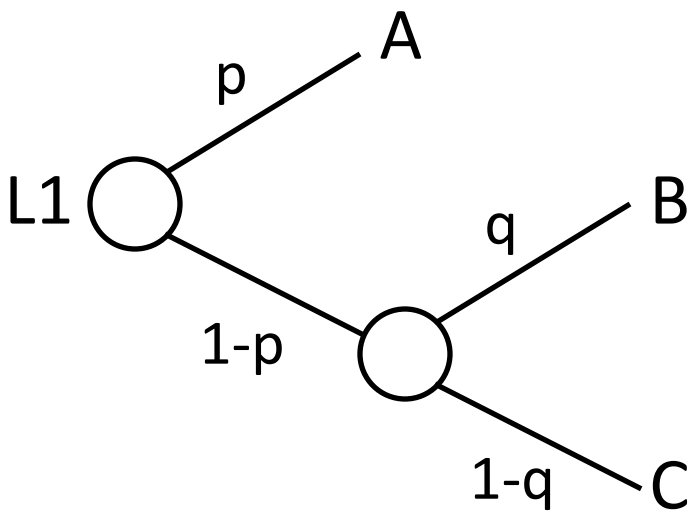
$$\underbrace{P(A)}_{\text{unconditional probability}} = \underbrace{\sum_{i=1}^{n} P(A|E_i)}_{\text{hazard estimate given model } E_i} \cdot \underbrace{P(E_i)}_{\text{probability that model } E_i \text{ is right}}$$

⇩

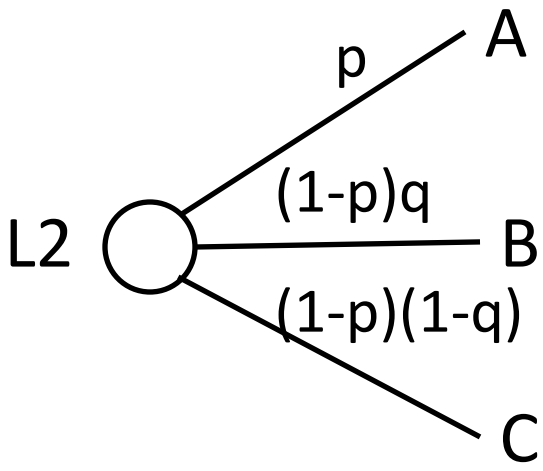
mean estimate of the mean aleatory probability

Decomposition axiom in decision theory

Lottery 1



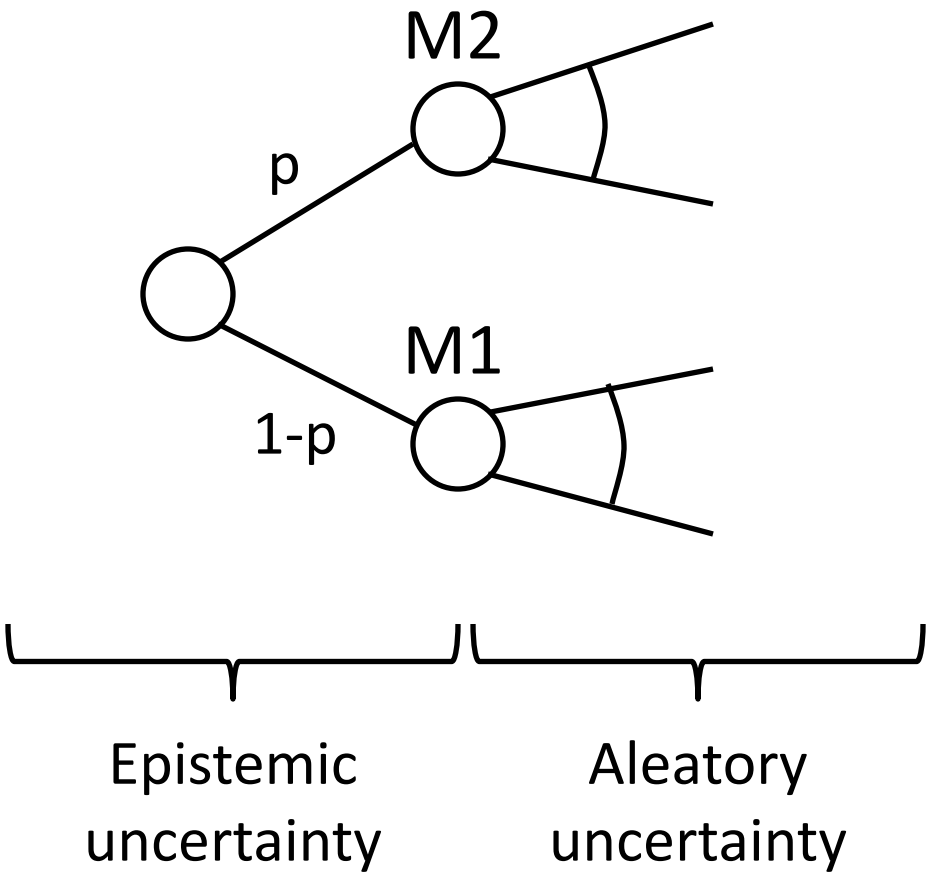
Lottery 2



$$U(L_1) \approx U(L_2)$$

2nd theoretical argument

Hazard analysis as a 2-stage lottery



The aleatoric-epistemic distinction

Distinction between aleatory and epistemic uncertainty is not always obvious

→ adopt decision methods that are insensitive to alternative interpretations

Mean estimate of the mean annual frequency ✓

10% quantile estimate of the mean annual frequency ✗

Epistemic uncertainty

Aleatory uncertainty

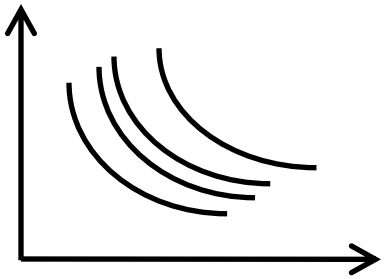
The use of hazard estimates in risk analysis

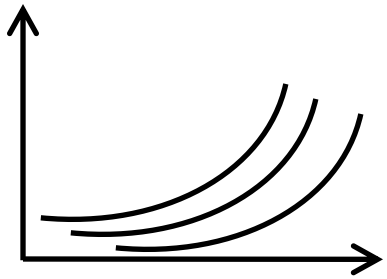
Hazard
Frequency of occurence of a specific hazard level

X

Fragility
Conditional failure probability given a specific hazard level

Epistemic uncertainties





2nd practical argument

Risk analysis and cost-benefit approach

→ comparison of expected (mean) economic losses:

$$E[p_f \cdot C]$$

failure probability consequences

⇩

risk depends on the mean probability of failure
→on the mean estimate of the hazard curve

Some contra arguments…

- The mean is overly sensitive to extreme interpretations
- The weights associated to the competing models cannot be treated as probabilities
  - Models not collectively exhaustive
  - Models not mutually exclusive

Summary

For effective decision-making, epistemic uncertainties in hazard analysis need to be accounted for in a consistent and transparent way.

If one single hazard curve is required:

use the mean estimate of the mean annual frequency of exceedance