Delta Risk Management Strategy Seismic Fragility Analysis

Lessons & Questions

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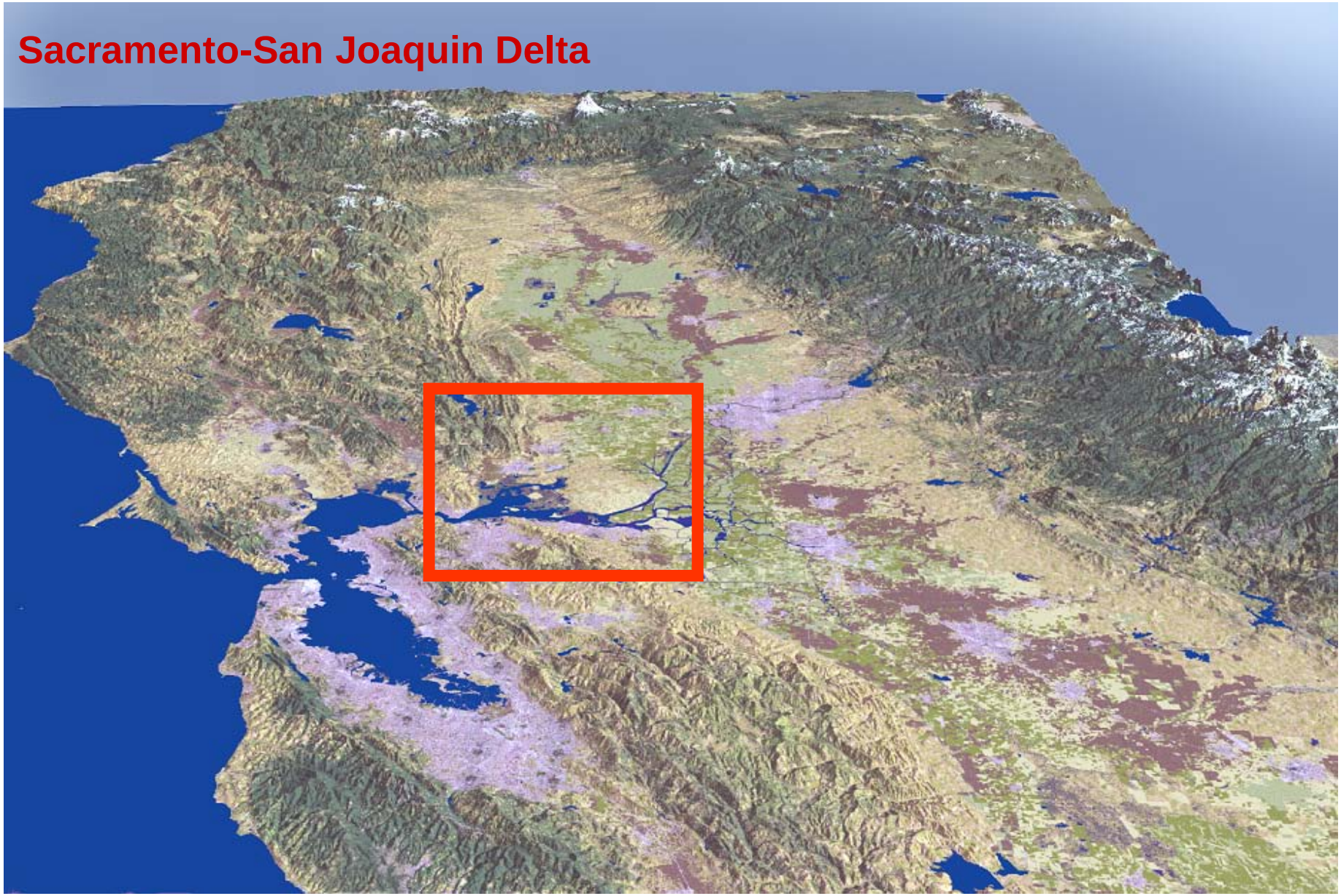
Presented at

PEER Annual Meeting
Berkeley, California

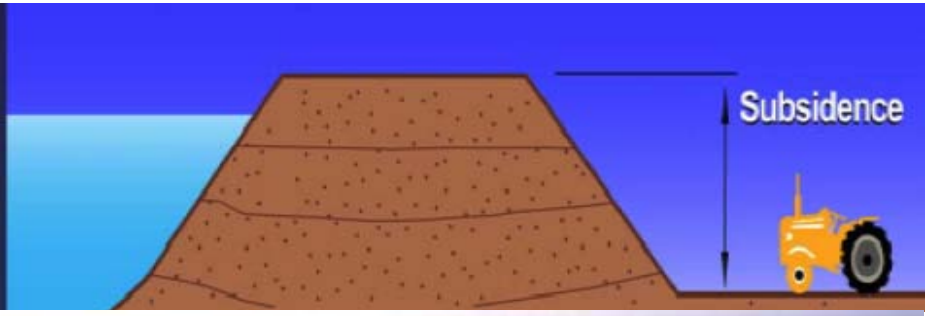
October 1, 2011

Sacramento-San Joaquin Delta



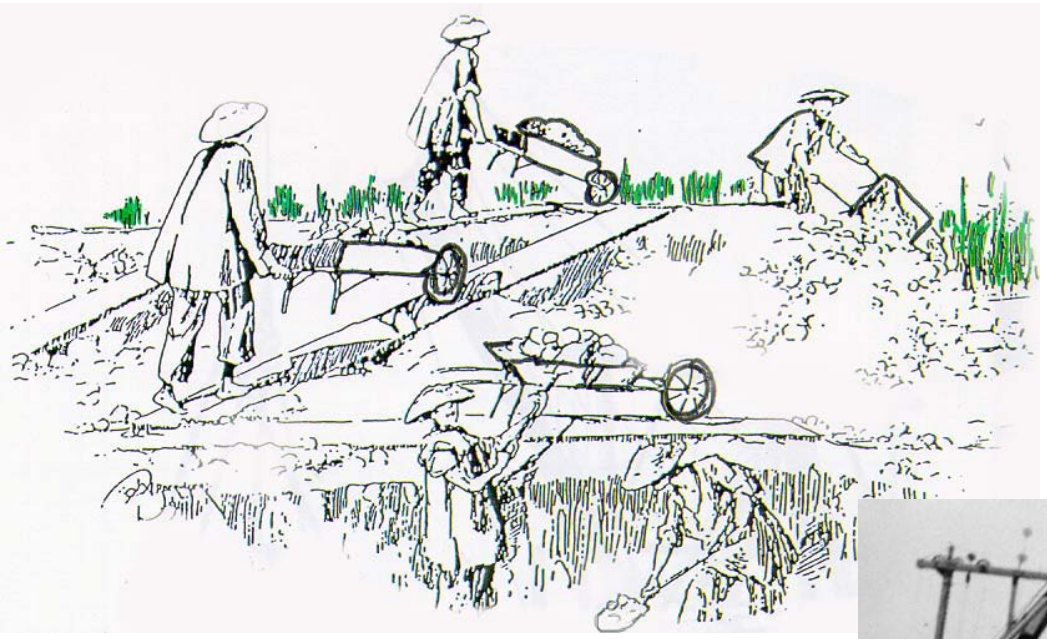
Delta Levees

Delta ~~Levees~~ Dams

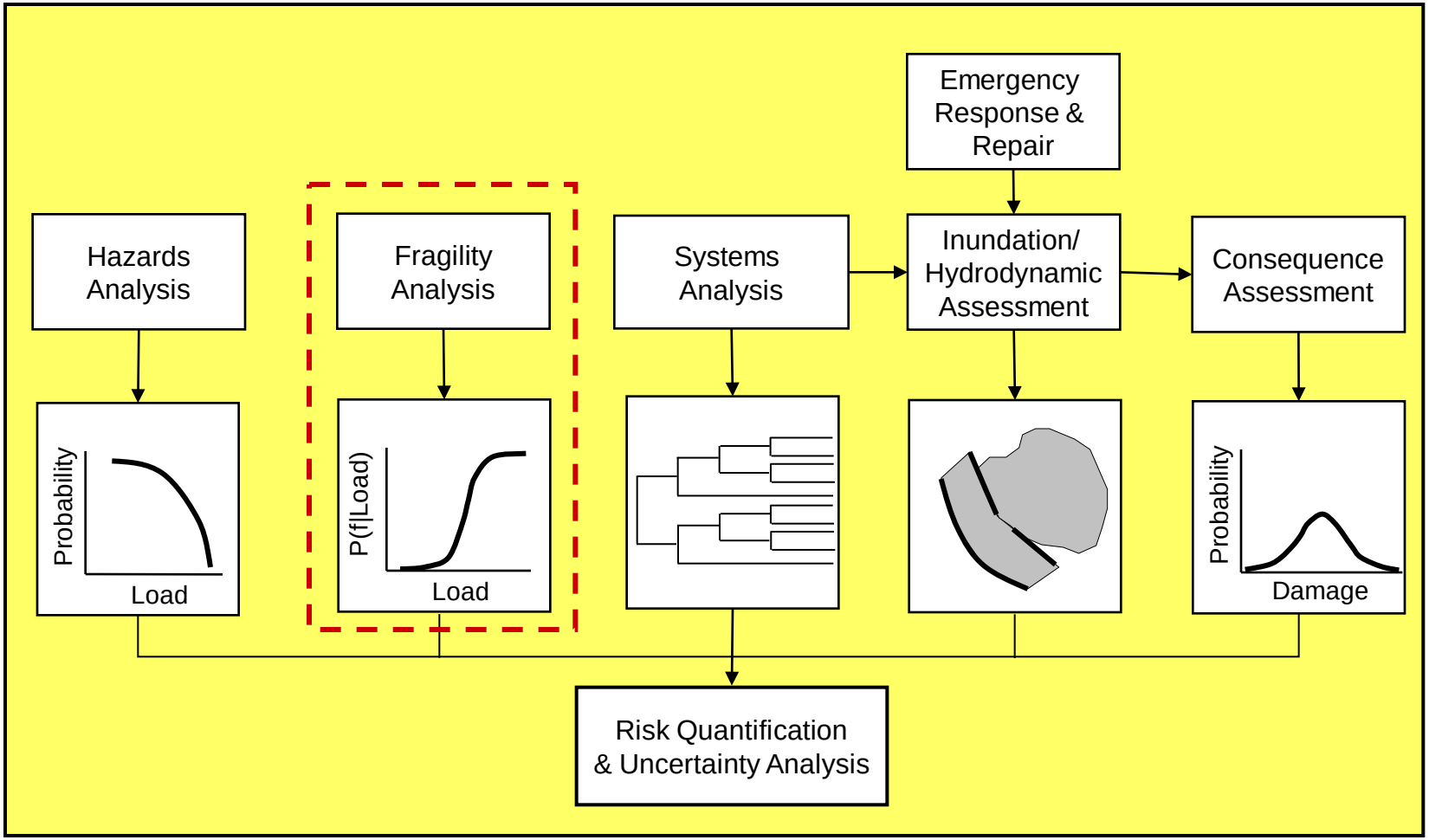


- Imagine a ‘dam’ 1,110 miles long
- Large fraction of the total length has blow counts of 20 or less; 80+ % liquefiable material
- What is the seismic fragility/ reliability of the ‘system’?
- How many ‘breaches’?
  - Number, or
  - Per mile
- How confident are we in the results?

Levee 'Design' & Construction

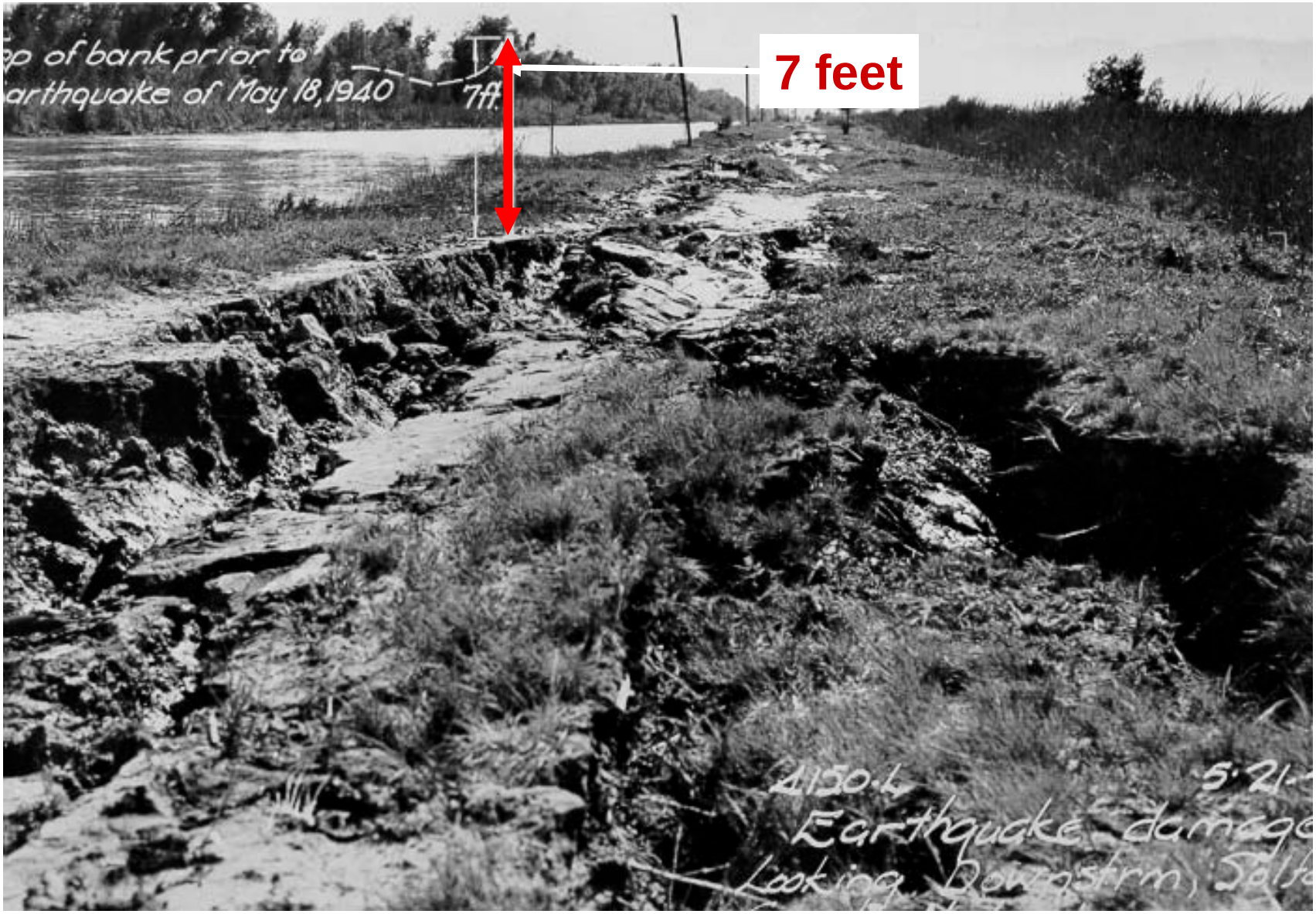


Elements of a Seismic Risk Analysis

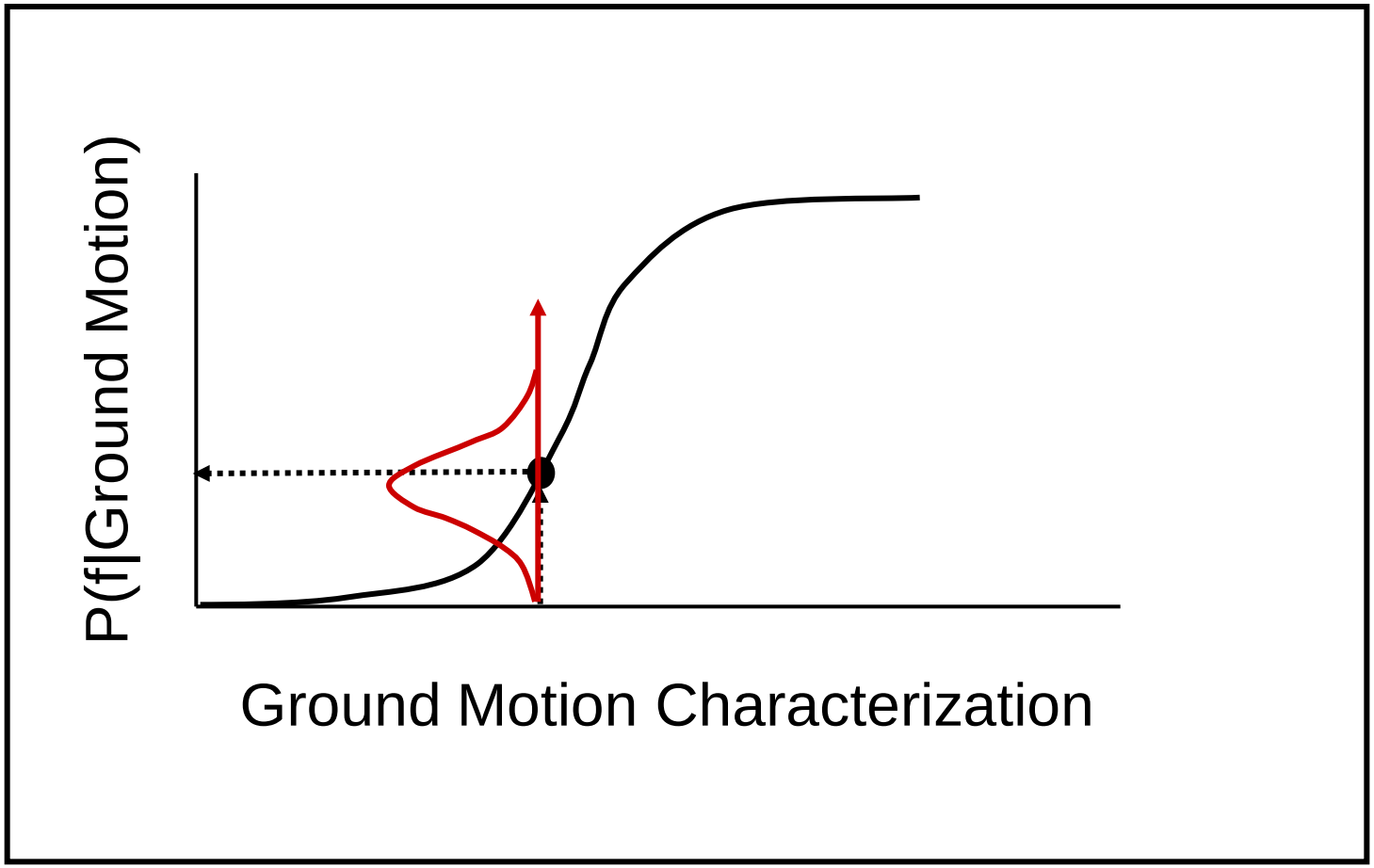


What We Want to Predict: Breaching

We Also Want to Predict: Non-Breach Damaged



Fragility Representation

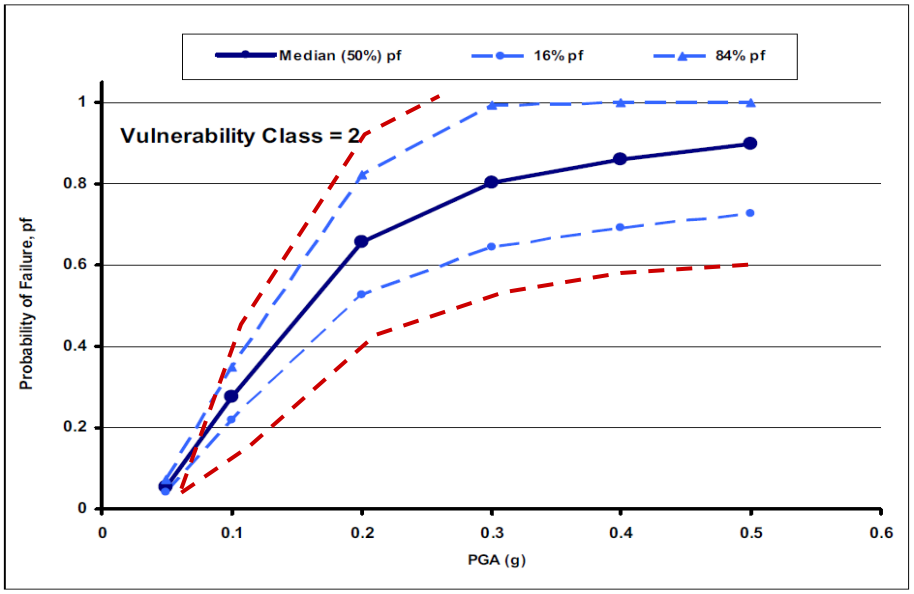


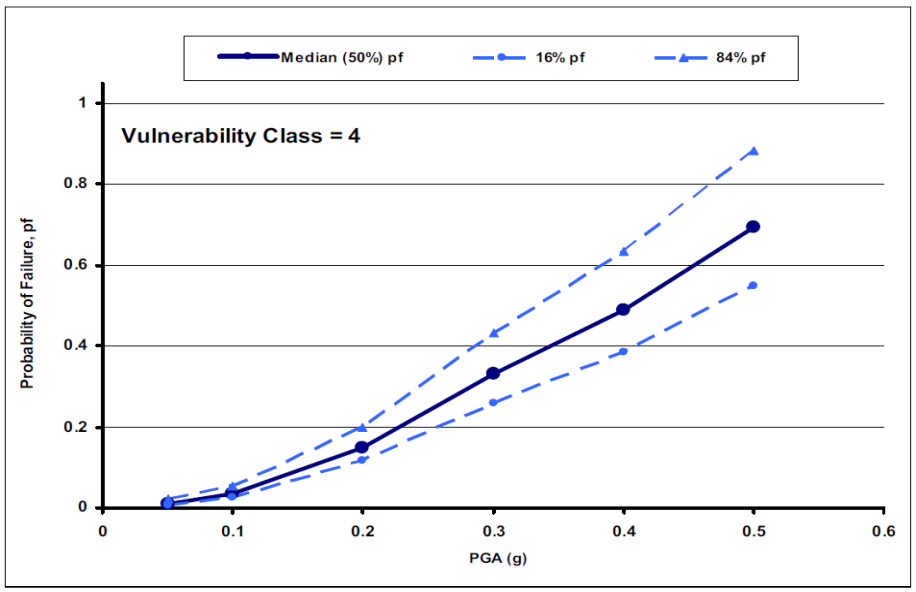
Levee Fragility Analysis

- Fragility analysis estimates the conditional probability of failure as a function of a loading parameter (ground motion; elevation)
- For earthquake and flood (geotechnical) failures there is considerable uncertainty in estimating when failure occurs and how likely it is to occur
- Sources of uncertainty:
  - Defining the failure/performance state
  - Model uncertainties (modeling the ‘real’ world)
  - Estimating model parameters (prior to and at failure)

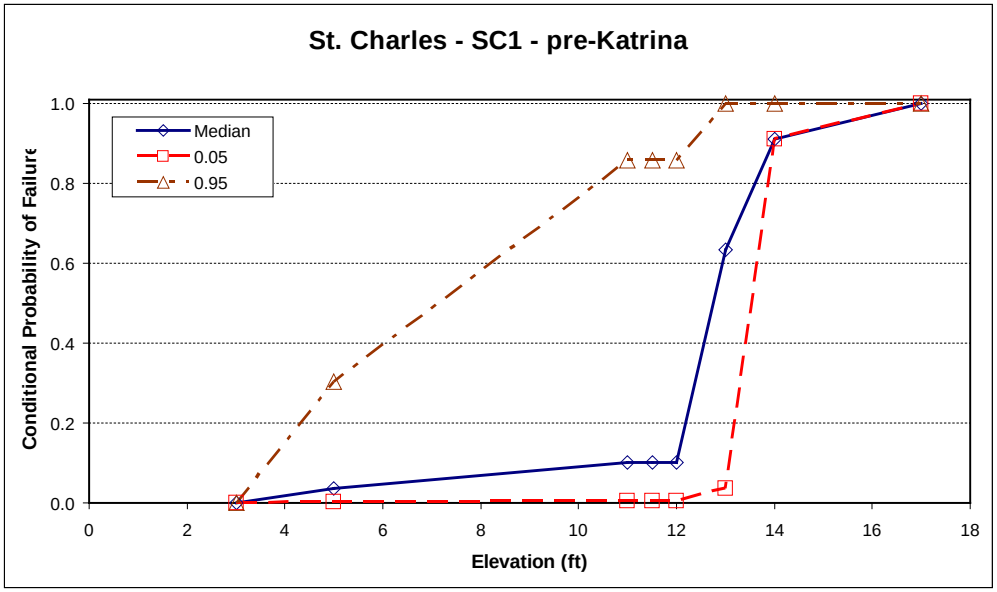
Fragility Results

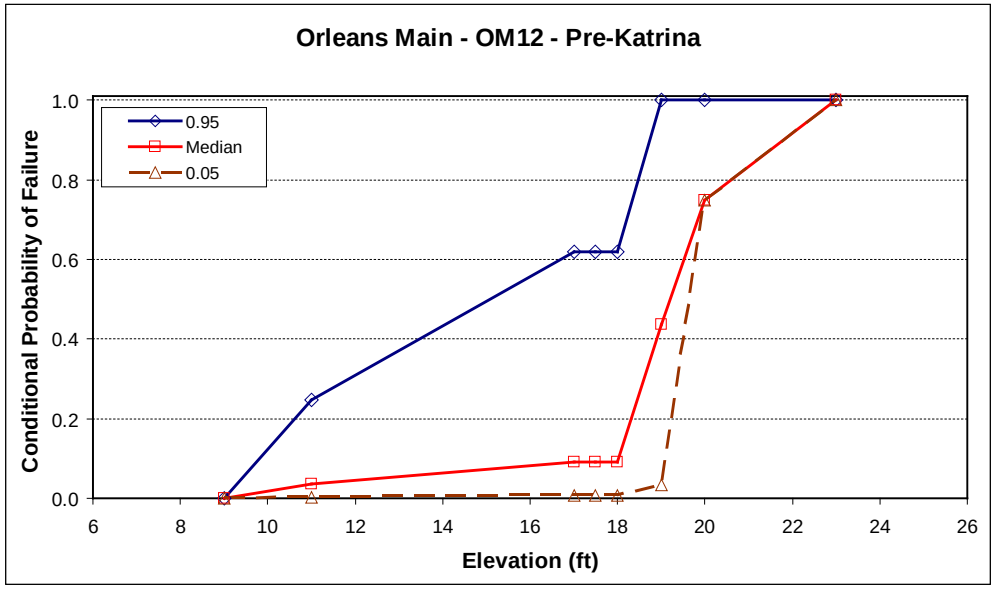
Delta





New Orleans

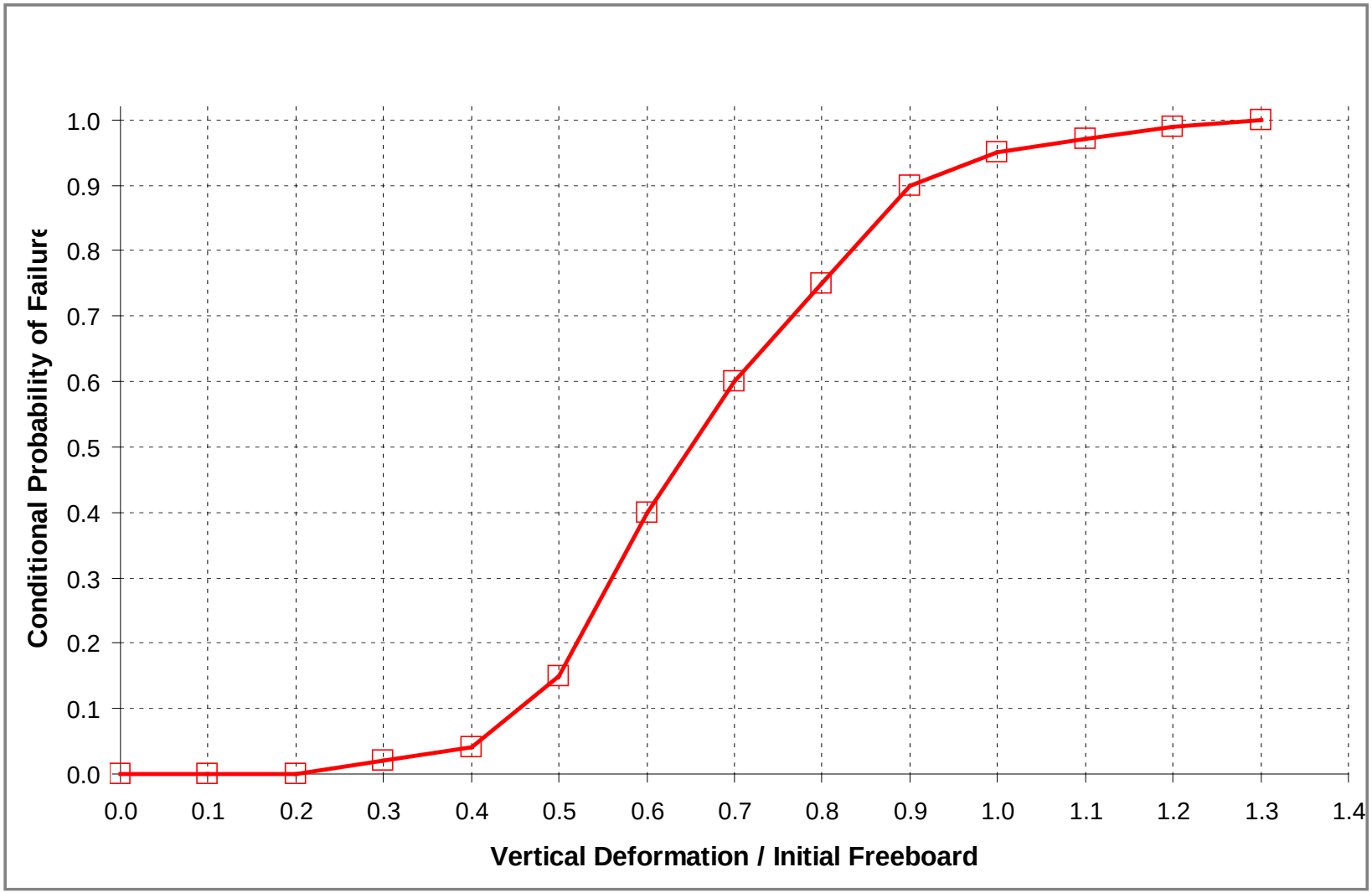




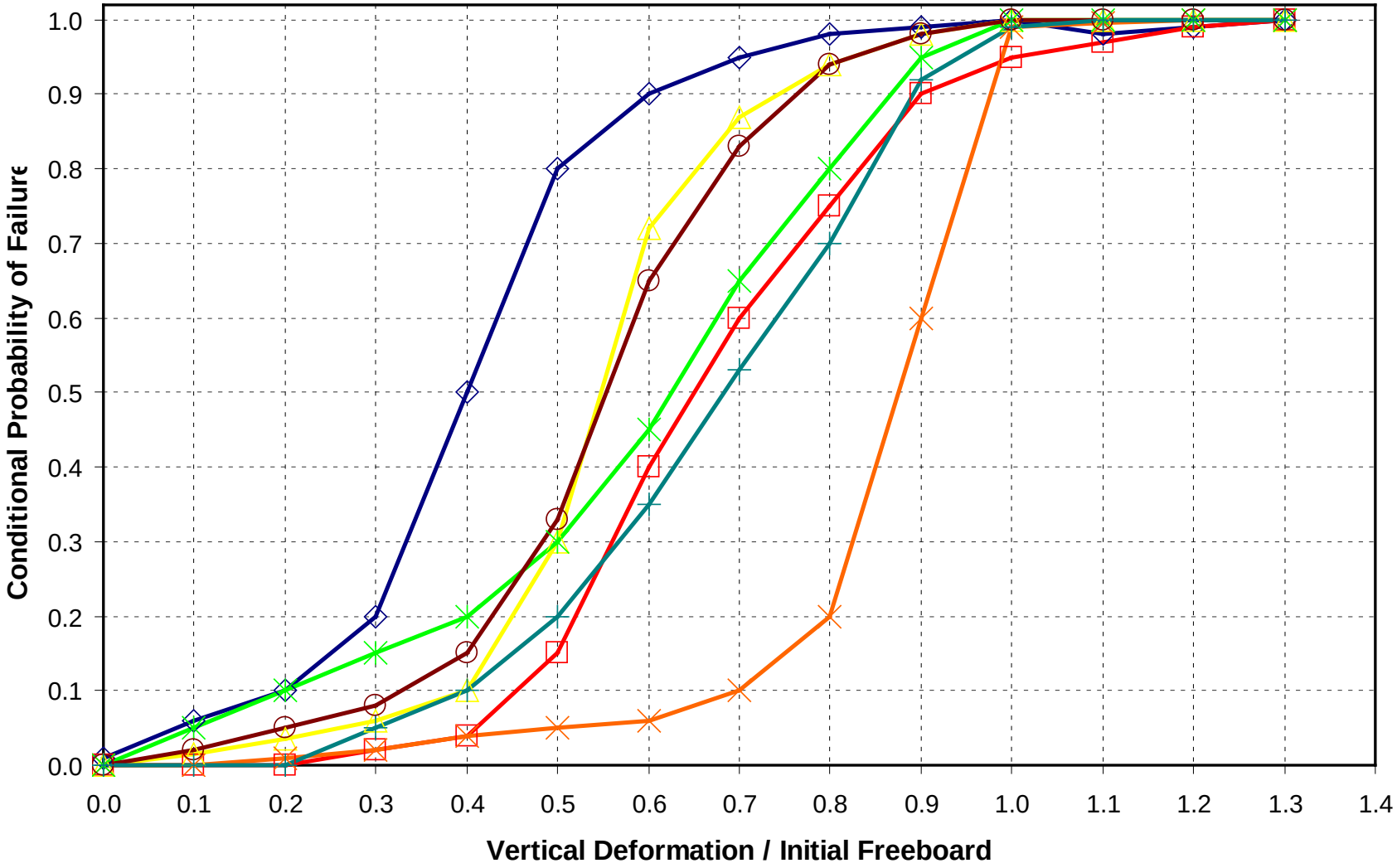
Defining Failure / Estimating the Fraction of Times It Occurs
(Aleatory Uncertainty)

- Given calculated vertical deformations, when does failure occur?
- What fraction of the time will it occur?
- How certain are we?

One Experts Results

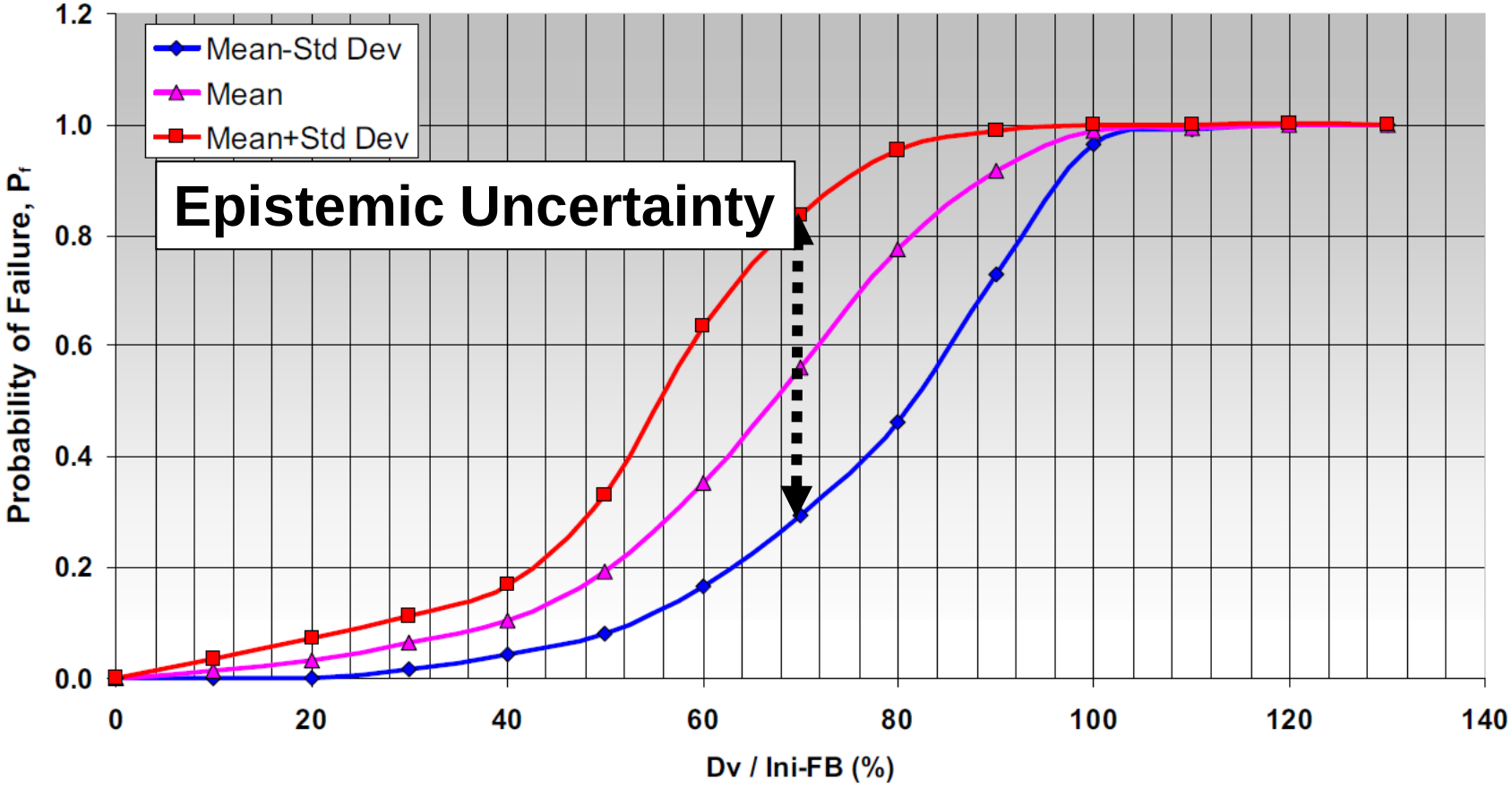


Expert Results



Probability Distribution in the Displacement Fragility of Levees

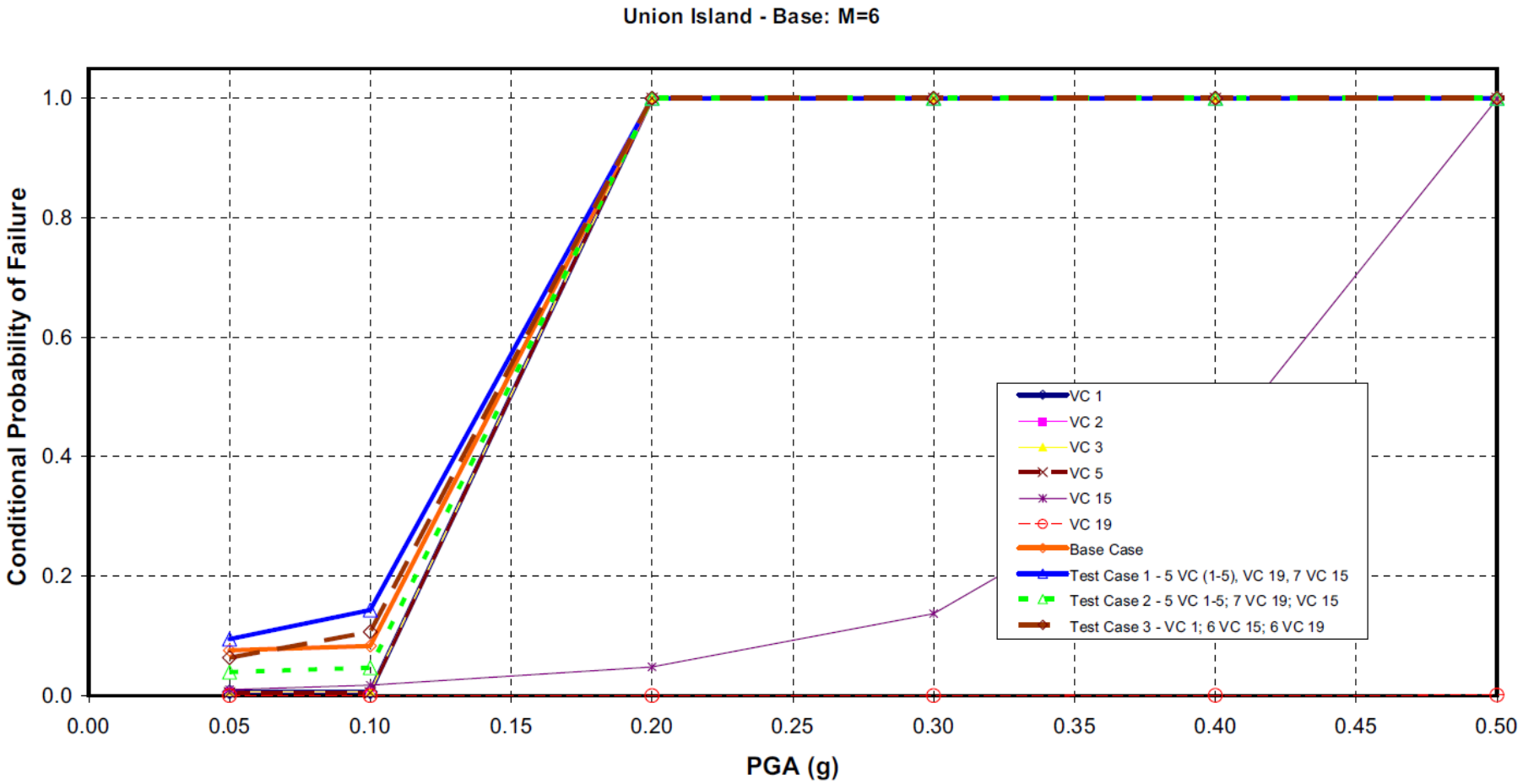
(Epistemic Uncertainty)



Sensitivity Evaluation

- Union Island – located in the south Delta
- Modeled as a series of 13 ‘independent’ levee reaches defined by their physical characteristics (vulnerability classes)
- Issue – Looking at the ‘raw’ data, there seems to be different interpretations for the characterization of the levee reaches into different vulnerability classes

Sensitivity Evaluation Results



Lessons & Questions

(from DRMS and Other Experience)

Lessons

- Evaluation of uncertainties; both aleatory and epistemic
  - Require a clear taxonomy of the types of uncertainty and their meaning
  - Experts need to be educated; Ask and you shall get an answer is not an expert elicitation process
  - Typically underestimated (cognitive short-coming; over-confidence)
  - Process should be formal;
    - What is being elicited
    - Expert interaction
    - Expert ‘defense’ of their interpretations
  - Interpretations/evaluations documented

Lessons & Insights (cont.)

- It's a 'system' (ASCE, 2009)
- Fragility analysis provides unique insight to 'system' performance
- Risk Analyst Role
  - Modeler, Quantifier (run the numbers)
  - Trainer, Psychologist

Questions

- Probabilistic analysis:
  - Better indexing system (Don’t believe the numbers); a relative measure only, or
  - A more absolute measure of events of interest (chance of breaching), or
  - A framework (rules) for identify and evaluating uncertainties (aleatory & epistemic).
- Believe the numbers?

Questions (cont.)

- ‘Length Effect’ Problem
  - The ‘length’ effect; spatial correlation of properties & performance
- System modeling
  - How does the system really perform
  - As a simple series system

Element	Epistemic	Aleatory
Modeling	Uncertainty about a model and the degree to which it can predict events. Model, epistemic uncertainty addresses the possibility that a model may systematically (but not necessarily predictably), over- or under-predict events/results of interest (i.e., deformations).	Aleatory modeling variability is the variation not explained by a model. For instance, it is variability that is attributed to elements of the physical process that are not modeled and, therefore, represents variability (random differences) between model predictions and observations.
Parametric	Parametric epistemic uncertainty is associated with the estimate of model parameters given available data, indirect measurements, etc.	This uncertainty is similar to aleatory modeling uncertainty. However, this is variability that may be due to factors that are random, but have a systematic effect on model results.