Probabilistic Approach for HF-IS Hazard/Risk Map

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Conclusion

Wikipedia:
A hazard map is a map that highlights areas that are affected or vulnerable to a particular hazard.

Opportunity:
scientific discovery and technological innovation should impact our perception of hazard and risk.

Objective:
hazard maps as live documents that also guide risk-based life cycle management through scientific discovery and data acquisition.
What is Risk

One Useful Definition
Risk is the effect of uncertainty on objectives.

Hazard
How much induced seismicity?

Exposure
Who and what gets affected? and what is regulated?
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Hazard
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Exposure
Who and what gets affected? and what is regulated?
What are we Uncertain About?

Subsurface is not illuminated

Even if it were
we still lack understanding of how instabilities in subsurface nucleate and propagate and fluids are mobilized.
How Can Risk be Managed?

Knowledge reduces uncertainty and increases predictability hazard.

Technology reduces disruption to objectives.
How Can Risk be Managed?

**Knowledge** reduces uncertainty and increases predictability of hazard.

- **Information**: Monitoring.
- **Physics**: Interaction of thermal/mechanical/chemical/biological processes across multiple spatial and temporal scales.

As state of knowledge evolves our assessment of risk changes.

**Technology** reduces disruption to objectives.

- reduce hazard by
  - understand operational envelope (fracture nucleation, propagation, ...)
  - develop ability to steer system close to operational envelope without crossing it.
- reduce exposure through early warning systems.
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What is the Role of Probabilistic Risk Assessment

Package knowledge into actionable information

Transform knowledge into inference on Hazard
What is the Role of Probabilistic Risk Assessment

Package knowledge into a useful format

- Physics-based constraints
  - bounds on material property tensors,
  - behavior on multiple scales

- Observation-based constraints
  - Observations on multiple scales
  - Spatial variability
  - Statistics of extremes
  - ...
Material on decision-scale characterized from observations at another scale:
What is the Role of Probabilistic Risk Assessment

Transform knowledge into inference

- Propagate many plausible scenarios
- Characterize hazard as statistical object
- Formulate decisions that take advantage of quantified uncertainty in Hazard.
Computational Challenge

Displacement in x direction at (0.25, 0.00)

Probability density function

Full-Dimension
Reduced 1D Model

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0 0.02 0.04 0.06 0.08 0.1 0.12

0 5 10 15 20 25 30 35

Probability density function

0 0.02 0.04 0.06 0.08 0.1 0.12

Displacement in x direction at (0.25, 0.00)
Credible risk assessment should not introduce new assumptions (Gaussian/etc).

Good risk assessment should mirror advances in science (multiphysics/multiscale/high performance computing).

Good risk assessment can be used to optimize fracking.

Worth of information analyses can be carried out as part of a vulnerability analysis to reduce risk as part of a life-cycle management process.