Robust Hazard and Loss Assessment Through Robust Simulation

Yajie (Jerry) Lee, Zhenghui Hu, William P. Graf, Charles K. Huyck, Michael T. Eguchi
ImageCat Inc., Long Beach, CA

1. Abstract

Catastrophe modeling of natural disaster events is essential for hazard reduction, risk mitigation and insurance pricing. The typical approach utilizes multiple models with a logic tree to represent the scientific uncertainty in assessing future hazard or risk. The assessed outcome, however, is conventionally represented as a single solution (such as a mean hazard curve or single “EP” curve), with a high level of precision. Although a single representation is certainly desired, hazard or risk may be misunderstood and underestimated without a proper understanding and characterization of the uncertainty embedded in the modeling approach. Presented with the illusion of precision, decision makers may be left with a false sense of security facing future catastrophe losses. In this study, we present the work by the authors (Lee et. al., 2014; Taylor, et. al., 2013) in which we utilize the USGS 2014 National Seismic Hazard Mapping (NSHM) models for robust seismic hazard analysis and loss assessment of spatially distributed building portfolios with the Robust Simulation technology. A more complete picture of the uncertainty is revealed through multiple scientifically credible models and characterized in hazard or risk outcome.

2. Complexity in Modeling the Epistemic (or Model) Uncertainty

- “Aleatory” uncertainty – Randomness, the odds of each outcome is known in advance
- “Epistemic” uncertainty – Lack of knowledge, the possible outcomes and/or their governing probability are unknown in advance
- Epistemic uncertainty is more difficult to quantify and manage. The chance of failure is greatly increased when epistemic uncertainty is treated as known statistic variant.

3. Weaknesses with the conventional approach for Hazard and Loss Assessment

- Illusory precision: a single solution (mean Hazard or loss curve) is provided without a proper uncertainty characterization
- Blackbox: model implementation is hidden - difficult to check and verify
- Oversimplification: complex financial loss distributions are oversimplified with simple assumptions – Lognormal, Beta, Gamma, Pareto, etc. - potential gross inaccuracy
- Computational inefficiency: inefficient in (or even incapable of) handling complex statistical calculations

4. What is A Robust Simulation Approach?

Representation of future risk through simulation of an ensemble of views that integrates valid scientific disagreement and stochastic modeling of unknown variables.

A Robust Event-set for Hazard and Loss Assessment

Event-sets are commonly used in catastrophe loss assessment. A robust event-set is defined as:

- A stochastic equiprobable event catalog and the associated random intensity fields that robustly characterize the scientific uncertainty in the hazard for a region
- Preserves model coherency, integrity and traceability

5. Robust Hazard Assessments

- Hazard Mapping (NSHM) models for robust seismic hazard analysis
- Loss assessment of spatially distributed building portfolios with the Robust Simulation technology
- More complete picture of the uncertainty revealed through multiple scientifically credible models

6. Robust Risk Assessments

- A Robust Estimate of Risk Uncertainty
- Portfolio losses with and without considering spatial correlation of shaking intensity
- More useful in identifying the “black swan” cases that are typically hidden with the conventional approaches.

7. Advantages with Robust Simulation

- Robust uncertainty estimates: characterizes the uncertainty of future risks through simulation of an ensemble of views for more robust decision making
- Transparency: preserves model coherency, integrity and traceability
- Non-parametric statistics: minimizes need for complex classical statistical calculations
- Computational efficiency: propagates uncertainty through efficient statistical sampling
- Extreme risks: more useful in identifying the “black swan” cases that are typically hidden with the conventional approaches.