Item VIII

GLOBAL EARTHQUAKE MODEL
working together to assess risk

"Beyond Button-Pushing": Impact of Assumptions on Earthquake Model Results

project proposal from the Global Earthquake Model (GEM) Foundation to the California Seismic Safety Commission
May 9, 2013

This project benefits Californians with increased post-quake economic resilience, because added transparency to earthquake models can lead to better preparedness.

Problem

After an earthquake, the inflow of funds will be a fraction of what's needed to rebuild and recover, due to the low proportion of California homeowners and businesses who are prepared (financially or otherwise). One root of the problem is that proprietary earthquake models used to estimate earthquake risk are not well understood. In short, lack of model transparency is preventing a resilient California.

There are too few past earthquakes to use history as the only judge of underlying seismic risk. Instead, computer simulation models are used. However, these models are protected intellectual property, containing countless assumptions and methods that are disclosed only as necessary; otherwise, models are 'black boxes.' Model users can 'push buttons' (vary the input) to produce results, but the effect of each 'button' remains mostly hidden.

Proposed Solution

This project will allow model users to interpret and gain trust in model results, and understand risk more clearly. With deeper insight into the drivers of risk, a higher proportion of Californians would be able to make financial preparations, ultimately leading to greater economic resilience for California. Increasing the inflow of post-earthquake 'economic stimulus' (cash) will speed recovery.

Project Scope

This project will quantify and discuss the impact of each assumption on earthquake model results, particularly the treatment of uncertainty, and identify the most influential factors. This insight will help model users "ask the right questions" when evaluating model results.

This project will use OpenQuake, the only available open-source earthquake model, developed by the GEM Foundation. OpenQuake features 'plug-and-play' capabilities, where an expert user can individually select or substitute every model component, data, and assumption. In particular, this project will:

1. Establish representative sets of exposure (policy locations).
    - Worldwide
    - San Francisco Bay Area
    - Southern California region affected by the Shakeout scenario
2. Choose specific results (loss metrics) to use as a basis of comparison
3. Produce 'baseline' results from OpenQuake, using a 'control' set of assumptions
4. Re-run OpenQuake multiple times, each time varying one assumption or parameter, such as:
    - Earthquake probabilities (seismicity, slip rates, strain, or a combination)
    - Shaking Intensity (attenuation relation selection)
    - Damageability of individual buildings (vulnerability curves)
    - Statistical treatment of uncertainty and correlation

Deliverables

The specific project deliverable is a report that quantifies the effect on model results of each assumption and discusses implications for interpreting results of other models or for other exposure sets. The report would serve as a 'best practice' document summarizing factors that model users should consider when evaluating if model results are appropriate. The report will include:

- A description of the methodology and exposure sets
- Details of each parameter and assumption that was varied, and its measured effect on results
- Implications for interpreting model results

Beneficiaries

We understand that this project will be part of an integrated a set of projects, which, together, will be used by the Commission to recommend actionable, measurable policy to the Governor and Legislature for helping the regional economy rebound after an earthquake.

This project will also benefit diverse stakeholders, beyond the Commission. For example:

- **Insurers** stand to benefit because they will better understand of variability in losses to, better distinguish "good risks" from "bad risks," and spur innovation.
- **Consumers** stand to benefit with more clarity on how to become financially prepared.
- All **Californians** stand to benefit because an greater transparency can generate a larger inflow of post-quake funds, leading to faster and more complete recovery.
- **Regulators** stand to benefit by having an objective, third-party "common ground" to increase trust and collaboration with insurers.

Budget and Timeline

The funding request for this project is $181,000, allocated as shown below. This request represents approximately 75% of the total project budget of $240,000. The remainder will be supplemented with matching funds. The project timeline is 18 months.

Item	Description	Budget and Proportion		Target Completion[1]
1.	Establish exposure sets	$10,000	5.5%	Dec. 2013
2.	Select Loss Metrics	$5,000	3%	Dec. 2013
3.	Generate baseline results from OpenQuake	$10,000	5.5%	Sept. 2014
4a.	Propose parameters to vary and associated methodology	$80,000	44%	Sept. 2014
4b.	Generate interative results from OpenQuake	$20,000	11%	Dec. 2014
5.	Prepare Report discussing implications of assumptions	$20,000	11%	Dec. 2014
	Expenses not associated with specific scope activities:			
	• project team meetings / coordination	$9,000	5%	
	• overhead / administration	$27,000	15%	
	Total:	**$181,000**		

Matching Funds

This project leverages approximately $60,000 of direct matching funds and a $300,000 indirect match. This project will expand a $300,000 investment by GEM allocated to testing and evaluation of its

[1] Assuming an October 2013 start date

OpenQuake software. In addition, should this project be funded, GEM Foundation will directly supplement Commission funding with 33% matching funds, to reach a total project budget of $240,000.

Receiving Institution and Personnel

All funds will be disbursed to Institute for Advanced Studies (IUSS, Instituo Universitario di Studi Superiori), the 'honors college' and graduate program within the University of Pavia, the second-oldest public university in Italy. Together with the Global Earthquake Model (GEM) Foundation, IUSS is part of the Pavia Risk Centre, a knowledge hub of organizations with a common aim to understand risk and reduce its consequences. The Commission is an Associate Participant of GEM, serving as a non-voting, non-sponsoring member of GEM's Governing Board and an active collaborator.

The project will be managed by IUSS faculty and carried out in collaboration with GEM scientists and developers. Specific human resources will be assigned upon project authorization.

About the GEM Foundation

The GEM Foundation serves the moral and economic imperative to reduce the loss of lives and livelihoods from earthquake. GEM is a global non-profit providing organisations and people with open resources to assess earthquake risk anywhere in the world. By pooling data, knowledge and people, GEM acts as an international forum for collaboration and exchange, and leverages the knowledge of leading experts for the benefit of society. Through global projects, open-source development, and partnership among more than ten regions, GEM contributors are developing common datasets, best practices, and models for seismic hazard and risk assessment. GEM Foundation is supported by public institutions representing national governments, as well as private companies. Guided by the needs and experiences of collaborators and citizens at large, GEM works in continuous interaction with the wider community.

GEM is supported by participants from both the public and private sector:

GEM Public Participants		GEM Private Participants	
Total contributions 2009-2013: **$11.8 million**		Total contributions 2009-2013: **$16.8 million**	
Australia	Norway	Munich Re	Hannover Re
Chile	Singapore	Zurich Insurance Group	Willis
Ecuador	Switzerland	AIR Worldwide	RenaissanceRe Risk
Germany	Taiwan	EUCENTRE	Nephila Capital Ltd.
Italy	Turkey	FM Global	NLIRO Japan
Japan	United Kingdom		
New Zealand	United States		

Additional Background

Earthquake models perform computer simulations that estimate losses from past or future earthquakes. Model results are used for actuarial purposes to estimate earthquake risk. To perform calculations, models simulate tens or hundreds of thousands of earthquakes, over up to a million years of time.

When such large numbers of earthquakes are combined with the tens or hundreds of thousands of policies, models churn literally terrabytes of data, and take multiple days to produce results. If models incorporated all available scientific complexity and statistical uncertainty, day-long calculations would become month-long calculations, even on the fastest computer cluster. Thus, models used in practice make simplifying assumptions ('shortcuts') that allow the model to produce appropriate results on average, at a fraction of the computational expense (computer run-time). But, as one example, there are tradeoffs between mathematical completeness and computer run-time. The effect of shortcuts on results remains hidden, thereby stifling innovation and volume of financial preparedness.