

# ICRM-CAT, Model Fact Sheet

## Singapore Earthquake

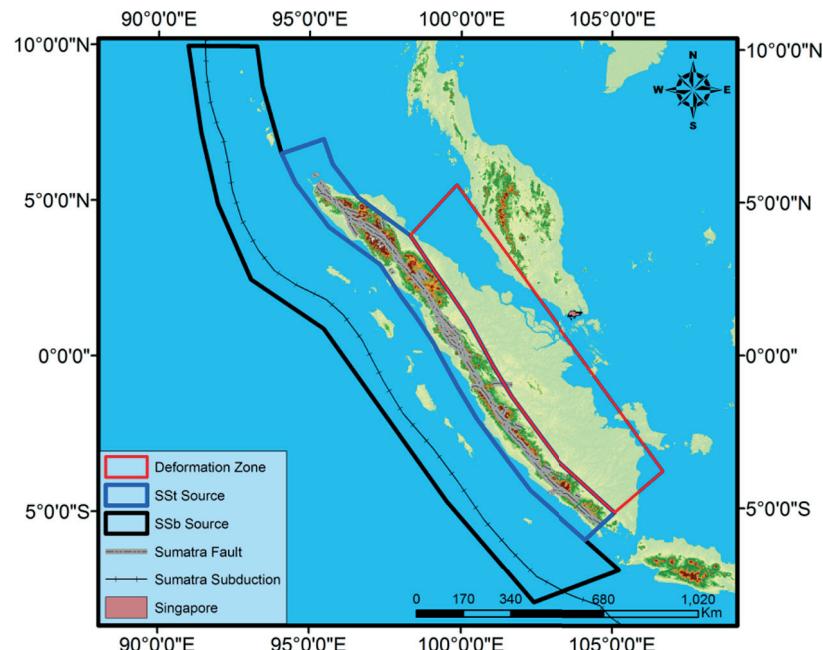
**ICRM-CAT** is a NatCat risk modeling platform introduced by ICRM in July 2015. It consists of two cat risk models developed by ICRM under funding by the Monetary Authority of Singapore (MAS), specifically a Jakarta flood risk (JKT FL) and a Singapore Earthquake (SIN EQ) risk assessment model. The models quantify the relevant hazards, assess the exposures and vulnerabilities from inputs provided by end-users, and compute the relevant loss risk metrics. This platform utilizes only open-source software components, specifically GIS, relational database and display/report generation components. Users can use the models by providing necessary exposure inputs and can visualize model outputs via map overlays, tables, charts and reports. An ICRM-CAT Users' Manual is further provided to facilitate ready use. ICRM-CAT is currently available to industry users for non-commercial use.

### Model Highlights

- Challenging model for a low seismicity region, seismic risk driven by faraway large magnitude sources, no seismic loss record, huge risk concentrations, special attention to treatment of uncertainty; Model built on extensive use of ICRM and NTU's research
- Model development funded by the Monetary Authority of Singapore (MAS) and Nanyang Technological University (NTU), Singapore
- Analysis options: Probabilistic and Scenario providing standard risk metrics at location and portfolio level
- Resolution: latitude/longitude planning area, postal sector (exposure weighted pre-compiled aggregate hazard)
- Lines of business: Residential Commercial, Industrial
- Coverages: Building, Content, no BI coverage
- Outputs: location and portfolio level risk metrics

### Seismic Sources

- Sumatra subduction zone – segments impacting Singapore
- Sumatra strike-slip zone – segments impacting Singapore
- Deformation zone – area sources in closer proximity to Singapore



Seismic source zones: Sumatra subduction (SSb), Sumatra strike-slip fault (SSt), and Deformation zone

### Ground Motion Modeling

- Seismic hazard measured in Spectral Acceleration (SA)
- Several ground motion models for all sources used to model ground motions on rock in Singapore to capture ground motion uncertainty and propagate it to loss level.
- Rupture simulation and seismic wave propagation to Singapore (synthetic ground motion in Singapore) (Megawati and Pan, 2002; Megawati et al., 2003; Megawati and Pan, 2010), as well as applicable attenuation models used.

### Site Amplification

- Very high resolution site conditions – 19,276 cells with a 200m x 200m grid based on 543 borehole data, ground type classifications from Singapore design code.
- Spectral acceleration at the surface simulated from the stiff rock time histories, including the weathered rock layers as applicable and detailed site profiles.

### Vulnerability Modeling

- Response spectra (SA) based fragility and vulnerability functions
- Used 18 recorded scaled up ground motions
- Extensive validation against analytical and empirical vulnerability and fragility published studies and references
- Structural models (mostly non-ductile detailing of RC frames with and without shear walls) defined on the basis of the high resolution Singapore National Inventory total number of buildings – 125,858, with detailed building specific information.
- Four height ranges (low-rise 1-3 stories, mid-rise 4 – 7 stories, high-rise 8 – 19 stories, tall 20 – 40 stories)

### Probabilistic Event Set

- Probabilistic events set consists of 36 subduction events, 27 strike-slip events, and 10 events in the deformation zone closest to Singapore
- Event set and model parameters discussed with and advised by EOS and leading GEM researchers

### Exposure

- Privileged access to Singapore National Inventory - total of 125,858 buildings (94,216 residential, 7,304 commercial, 19,257 industrial, and 5,081 other use). The replacement value of the inventory – 766 billion SGD (446 billion residential, 161 billion commercial, 87 billion industrial, and 72 billion other use).

### Financial Model

- Policy and portfolio level, no reinsurance included
- Ground motion and vulnerability uncertainty
- Detailed location level outputs by event accessible to the user for linking own Dynamic Financial Analysis (DFA) models

### Software Platform

- Minimum configuration requirements to run the Platform and the model: Windows 7; 4G RAM; 80 G hard disk space; Intel core i3 2.3 GHz
- Open source components and development platforms [.NET Framework 4.5; Microsoft Report Viewer 2012; Microsoft Visual C++ runtime 2010; Microsoft Access DB engine; PostgreSQL 8.4; PostGIS] – no additional license fees for the users.
- Front end, workflows, visualization, and back end exposure data implemented on RMSI's Safire Platform, available for non-commercial applications
- Indicative maximum number of locations on the minimum configuration (20,000)

### Model Accessibility

- Model and the deployment platform are freely available to the insurance industry in Singapore and insurance industry service providers (e.g. modeling vendors) – only for non-commercial use.

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