



## Beyond direct losses in large earthquakes

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Many factors contribute to the total economic loss in an earthquake. In general, if the event is moderate in size, direct losses due to ground shaking constitute the largest proportion of loss. However, if the event is great enough to trigger large-scale secondary effects such as massive landslides, tsunamis, dam failures, etc., losses from these secondary perils may potentially exceed the direct consequences of the ground shaking. Quantifying these secondary effects and estimating total losses from such large events, which we will call "Super Catastrophes or Super Cats", is a challenging task. A Super Cat, in the context of this presentation, is a large earthquake (generally  $M > 7$ ) characterized by: 1) containment failures (such as water containment problems from dam failures, or hazardous material containment problems), 2) widespread long term evacuations, 3) systemic macroeconomic impacts. Super Cats by definition occur where there is high concentrations of population and exposure, and where there is potential for escalation of secondary effects. From an insurance/reinsurance perspective, impact of a Super Cat on the overall losses is coverage specific and the largest impact is on the business interruption coverage.

The process for modeling a Super Cat event is broken-down into two steps. First, the losses directly associated with ground shaking are evaluated using RiskLink, a proprietary insurance loss-estimation tool (see Nyst et al). Secondary effects are then identified for a given scenario and modeled by a generalized, quantitative procedure. This procedure will be illustrated by an example for an earthquake Super Cat impacting a major European city.