Uncertainty in earthquake rates and implications for long-term hazard and risk

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Since the mid-1980s, the National Seismic Hazard Model (NSHM) has been developed using probabilistic seismic hazard assessment (PSHA) techniques. PSHA is an algorithmic technique and recent models have been constructed by developing an earthquake source model by combining component models based on earthquake catalogue data and active fault data; these models forecast the size, location and magnitude of future earthquakes. These sources are generally assumed to be random and independent. To forecast the hazard (e.g., ground shaking), the source model is coupled with ground-motion prediction equations (GMPEs). In recent years, the international community has had considerable progress and improvement in understanding of the uncertainties inherent to GMPEs, but less attention has been given to uncertainties in modelling of the earthquake sources. In our current work, we are investigating how uncertainties in some of the fundamental assumptions in the NSHM propagate through to the end uses of the model. One major end-use is in the national building design standards. Some of the uncertainties we are exploring are those resulting from a paucity of earthquake occurrence data (e.g., in the Auckland region) and from different methods that can be used to model the seismic sources. Additionally, seismic sources are generally assumed to be a stationary Poisson process and earthquake clustering is ignored. A key component of our work is to understand how the uncertainties affect the spatial resolution of the model and how we may optimise this spatial resolution for the downstream applications of the model. For example, current design standards are directly coupled to the output of the NSHM without a buffer inbetween. It is likely that including these uncertainties and determining an optimal risk-based spatial resolution of the model will lead to more robust estimates of the design standard and also more robust estimates of risk for use by industry.