

After the damages: Lessons learned from recent earthquakes for ground-motion prediction and seismic hazard assessment (C.F. Gauss Lecture)

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Recent damaging earthquakes (e.g. Japan 2011, Nepal 2014, Italy 2016) and associated ground-shaking (ground-motion) records challenge the engineering models used to quantify seismic hazard. The goal of this presentation is to present the lessons learned from these recent events and discuss their implications for ground-motion prediction and probabilistic seismic hazard assessment. The following points will be particularly addressed:

- 1) Recent observations clearly illustrate the dependency of ground-shaking on earthquake source related factors (e.g. fault properties and geometry, earthquake depth, directivity). The weaknesses of classical models and the impact of these factors on hazard evaluation will be analysed and quantified.
- 2) These observations also show that events of similar magnitude and style of faulting are producing ground-motions which are highly variable. We will analyse this variability and show that the exponential growth of recorded data give a unique opportunity to quantify regional or between-events shaking variations. Indeed, most seismic-hazard evaluations do not consider the regional specificities of earthquake or wave-propagation properties. There is little guidance in the literature on how this should be done and we will show that this challenge is interdisciplinary, as structural geology, neotectonic and tomographic images can provide key understanding of these regional variations.
- 3) One of the key lessons of recent earthquakes is that extreme hazard scenarios and ground-shaking are difficult to predict. In other words, we need to mobilize "scientific imagination" and define new strategies based on the latest research results to capture epistemic uncertainties and integrate them in engineering seismology projects. We will discuss these strategies and show an example of their implementation to develop new seismic hazard maps of Europe (Share and Sera FP7 projects) and Germany.