Abstract of the talk

Paleoseismology; Has it Reduced Seismic Hazards, and if not, How Do We Change Course?

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Recent deadly earthquakes have shaken public confidence in the PSHA (probabilistic seismic hazard assessment) method for assessing seismic hazard (e.g., 2009 L'Aquila earthquake in Italy; 2011 Tohoku earthquake in Japan). In both countries seismic hazard assessment is sophisticated and uses paleoseismic data to ensure that low-probability earthquakes are adequately considered. Yet despite that, we are still experiencing deadly "surprises", which suggests that there is a flaw somewhere in our methodology.

THE MAIN REASONS WHY PSHAs <u>UNDERESTIMATE</u> THE HAZARD

1. Unknown active faults are close to the site and generate unanticipated Mmax earthquakes:
2. Active faults are known close to site, but their return time is underestimated, and/or their conditional probability of rupture was never calculated. Most PSHAs ignore the position of a fault within its seismic cycle, and assume that the probability of Mmax is time-independent (i.e., the same within every year of the cycle). Conditional Probability says that the annual probability of Mmax is time-dependent (i.e., it increases as the fault reaches the end of its seismic cycle of strain accumulation and then release).
3. Active faults are known close to site, but their Max is underestimated. Large underestimates occur when Mmax earthquakes break multiple segments, and the PSHA assumed only single-segment ruptures:
4. Active faults are known close to the site, and their Mmax and recurrence times are correctly known, but the secondary damaging effects are underestimated:

I suggest paleoseismologists should do the following to better estimate the true hazard:

A. Use new imaging tools (e.g. LiDAR, geophysics) to discover presently-unknown blind or low-slip-rate faults near cities and critical sites.
B. Increase the precision of measuring the mean recurrence time of a fault and its elapsed time (time since the Most Recent Event). This would include dating long sequences of paleoearthquakes to measure the variability in recurrence and any possible clustering in time, and the causes of clustering (random versus deterministic).
C. Use the new information above to calculate the Conditional Probability of future Mmax ruptures, and put that information into the PSHA.
D. Develop a new comprehensive PSHA that includes all hazards from earthquakes (surface rupture, ground motion, and ground failure). The first two methods already exist, although Probabilistic Fault Displacement Hazard Analysis currently is subject to large uncertainties, due to lack of data on secondary coseismic faulting. There is currently no formal method of PSHA for ground failure, which tends to be very site-specific (i.e., for many sites the probability of ground failure is zero, regardless of the ground motion).

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