New hazard estimates could downplay quake dangers

April 16 2008

The dangers posed by a major earthquake in the New Madrid and Charleston, South Carolina zones in the Midwestern and Southern parts of the United States may be noticeably lower than current estimates if seismologists adjust one of the major assumptions that go into calculating seismic hazard, according to a study presented at the Seismological Society of America.

The study revolves around this question: is it unlikely that one major earthquake will follow directly on the heels of a big quake, or are other major earthquakes equally likely to occur any time after a major quake" Hazard estimates for a seismic zone depend on which scenario seismologists choose to plug into their hazard calculations.

The present hazard maps for New Madrid and Charleston use the second assumption. However
when seismologist Seth Stein of Northwestern University and Northwestern senior James Hebden chose the first scenario—that a quake is unlikely to occur right after another quake, but that the likelihood of a new quake increases over time—they found that the seismic hazard maps of the New Madrid and Charleston areas looked a lot less dire than current predictions for the regions.

Their “time-dependent” model suggests that the likelihood of another earthquake is relatively low for the first two-thirds of the predicted average interval between earthquakes, after which the likelihood of another quake begins to climb.

The New Madrid and Charleston zones are still in the early years of their earthquake cycle, so the hazard may not be as great as suggested by the prevailing “time-independent” models that assume another quake is equally likely to occur at any moment, according to the researchers.

Stein says the idea behind the study is not to dismiss the risk of a major earthquake in the two regions, but to shed light on the assumptions that go into making hazard maps, which ultimately affect a region’s building codes and other costly preparations.

“We want to know how well we can predict that shaking. If we overpredict, communities could be spending enormous amounts of money [on earthquake preparation] that they could be spending on other things,” Stein said. “We look at it as whether you’re going to spend money putting steel in your schools that might be better spent hiring teachers.”

“What we’re saying is that this may be nowhere as serious a problem as you’ve been told, and you don’t need to prepare in St. Louis the way we do in Los Angeles, because that may be doing more harm than good,” he added.

The desire to prepare is understandable, given the devastation caused by the last major earthquakes in the New Madrid zone in 1811 and 1812, and in Charleston in 1886. The 1811-1812 New Madrid earthquakes uprooted entire forests and changed the course of the Mississippi River. The Charleston earthquake killed more than 60 people and caused damage to nearly every structure in the city, traces of which can still be seen today.

To prepare for the potential dangers of similar severe quakes in the future, seismologists construct hazard maps, which predict the extent of earthquake shaking that has a certain probability of occurring in a geographical area. The hazard maps take into account the possible magnitude of the next earthquake, the likely ground shaking, the time window in which the next quake is likely to occur, and whether earthquakes are time-dependent or time-independent processes.

It's an admittedly "squishy" calculation, Stein says, even in places like California's San Andreas zone that have experienced many more earthquakes in recent years and have been monitored by a blanket of instruments.

Stein and his colleagues have tested each of these variables, from magnitude to timing, to explore which factors may have the greatest effect on hazard mapping for the central U.S.. But he says that the question of time-dependent or time-independent earthquakes is "the meatiest scientific question" among the mapping variables.

The question goes to the heart of how earthquakes work. For instance, most seismologists think there is a buildup of elastic strain in the earth before a quake occurs, and that the strain is relieved for a time by the quake. Under this scenario, a time-dependent model of earthquakes might make more sense to use in hazard maps. But it's far from clear that the popular strain buildup model completely describes the physics of earthquakes, Stein says.

"It's actually kind of embarrassing that we don't know the answer to this," Stein jokes. "But when you do this kind of thing, you want to have a healthy humility in the face of the complexities of nature."

Source: Seismological Society of America