

When Seattle shakes from quakes, it's going to slide, too

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With its coastal bluffs, roller coaster hills and soggy weather, Seattle is primed for landslides even when the ground isn't shaking. Jolt the city with a major earthquake, and a new study from the University of Washington suggests many more slopes could collapse than previously estimated.

A powerful earthquake on the fault that slices under the city's heart could trigger more than 30,000 [landslides](#) if it strikes when the ground is saturated, the analysis finds. More than 10,000 buildings, many of them upscale homes with water views, sit in areas at high risk of landslide damage in such a worst-case scenario.

"Our results indicate that landsliding triggered by a large Seattle fault earthquake will be extensive and potentially devastating," says the report published this month in the *Bulletin of the Seismological Society of America*.

Coming on top of widespread damage to buildings and infrastructure caused by the quake itself, landslides would compound the city's problems and slow its recovery, said lead author Kate Allstadt, who recently earned her doctoral degree in seismology.

"I think the message is that we need to pay much more attention to these earthquake-induced landslides," she said.

The Puget Sound-area landscape is pocked with scars from slides

triggered by ground shaking, but the worst of them occurred long before cities existed here. The last quake on the Seattle Fault, about 1,100 years ago, shook the ground so hard that entire hillsides slumped into Lake Washington, carrying intact swaths of forest with them. Tree-ring dating from some of those submerged firs helped establish the quake's date. Scientists estimate its magnitude at about 7.5.

Researchers studying lake-bottom sediments have also unearthed a record of as many as seven landslide episodes linked to earthquakes in the past 3,500 years.

Even the relatively modest Nisqually earthquake in 2001 - which occurred during an unusual winter dry spell - set off about 100 landslides.

Allstadt, a New York native, became intrigued with landslide risk soon after she got her first look at Seattle's up-and-down terrain and learned about the region's seismic history. Though the city has good maps of landslide zones, most of the emphasis has been on the garden-variety slides caused by wet ground.

"Because so many landslides were triggered by the last earthquake on the Seattle Fault, it was really surprising to me that no one had looked in detail at what would happen today, when those hillsides are covered with houses," Allstadt said.

She and colleagues John Vidale, of the University of Washington, and Art Frankel, of the U.S. Geological Survey, set out to answer that question by simulating the effects of a magnitude-7 quake on the Seattle Fault. The fault, which is actually a wide band of subterranean fissures, extends from Bremerton to the Cascade foothills, crossing under West Seattle, Puget Sound and South Seattle.

Thanks to modern computing power and new insights into the way seismic waves bounce around in the sedimentary basin that underlies much of Seattle, Allstadt was able to create a very detailed picture of how shaking would vary across the city, said Tim Walsh, geologic hazards chief for the Washington Department of Natural Resources.

"It represents a huge effort," he said.

Allstadt then factored in topography and soil type, along with what's already known about the stability of landslide-prone slopes.

Not surprisingly, when she allowed her scenario to play out under dry conditions, the number of potentially destructive landslides was much lower: about 5,000, compared with the 30,000 predicted when the ground is sopping wet.

But Allstadt was surprised that about a third of the simulated landslides in both wet and dry conditions struck in areas that aren't on the city's landslide hazard maps. That includes some inland areas, where the threat of landslides has been assumed to be low.

In general, landslide damage was much more severe in neighborhoods close to and south of the fault, where shaking is expected to be strongest. That includes much of West Seattle, Beacon Hill and Mount Baker - though if a big quake hits when the ground is wet, Allstadt's simulations predict lots of slides in North Seattle as well as along all of the region's coastal bluffs.

The new study looks at only one possible quake and two sets of soil conditions: Bone dry and sopping wet. To help the city improve its hazard mapping, it would be necessary to consider multiple earthquake magnitudes and varying moisture levels, Walsh pointed out.

The UW study also didn't examine the landslide consequences of a coastal megaquake, like the one that struck the Northwest in the year 1700 - and which is certain to happen again. Measuring magnitude 9 or more, coastal megaquakes are far more powerful than those the Seattle Fault can generate.

But for the city itself, a large quake on the hometown [fault](#) would be more destructive, because the force is concentrated directly under the urban area.

Geologists still don't have a good handle on how frequently the Seattle Fault ruptures, but they have uncovered evidence of at least three powerful quakes in the last 2,500 years.

According to one scenario, a magnitude-6.7 quake on the Seattle Fault could kill 1,600 people and cause \$33 billion in damage. That analysis glossed over the damage caused by landslides, but in major quakes, collapsing hillsides can cause as much - or more - destruction than the shaking itself, Allstadt pointed out.

More than half of the damage in Alaska's 1964 Good Friday earthquake was due to landslides. In China's 2008 Sichuan earthquake - notable for widespread damage to schools - more than 60,000 landslides were responsible for tens of thousands of deaths.

Allstadt's analysis also shows that utility lines and roads in the Seattle area - including Interstate 5 where it passes along Beacon Hill - are at risk from landslides.

"There's a kind of haunting precedence that tells us that we should pay attention to a large earthquake on (the Seattle Fault) because it happened in the past," she said.

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