Times-Standard
Times-Standard / Humboldt Beacon

Not My Fault: The 1992 Cape Mendocino earthquake changes earthquake Intensity mapping

Lori Dengler/For the Times-Standard
Posted April 16, 2022
https://www.times-standard.com/2022/04/16/lori-dengler-92-cape-mendocino-quake-changed-intensity-mapping/

When the Cape Mendocino earthquake struck on April 25, 1992, magnitude was not the only parameter of interest to seismologists. Until Charles Richter developed a magnitude scale, the primary method of describing earthquake size was intensity. Intensity is a qualitative measure of shaking strength based on damage, felt area, and human perceptions of shaking.

Almost everyone has heard of Richter and the Richter Scale. In 1935, Richter published a paper that proposed using the height of wiggles on a seismogram to rank the size of an earthquake. Whenever a large earthquake occurs, you are bound to find "Richter magnitude" used in several media articles. I cringe because we haven't used Richter's method of magnitude determination in decades, but the name persists.

Far less well-known is Robert Mallet. Mallet, an Irish geologist in the 19th century, was the first to develop an earthquake scale, nearly eighty years before Richter. In studying the Great Neapolitan Earthquake in 1857, Mallet observed that the pattern of damage and people's descriptions of shaking strength or intensity varied in a systematic way. The most heavily damaged buildings were concentrated in a small central zone and the relative damage and strength of shaking decreased in roughly concentric zones moving away from the center. He coined the term "intensity" to describe the relative shaking strength, put a point in the center of his strongest zone and called it the epicenter. He was the first scientist to use the term.

Over the next seventy years, many variants of the intensity scale were proposed. Giuseppe Mercalli, a volcanologist and Catholic priest, developed the most widely used. Mercalli mapped out the spatial impacts of volcanic eruptions including the 1906 eruption of Vesuvius and paid close attention to both the physical eruptive characteristics such as ash thickness, and impacts on human structures. That work would become the basis of the Volcanic Explosivity Index (VEI), still used to rank the power of eruptions today.

In the late nineteenth century, Mercalli turned his interest to earthquakes, examining shaking related impacts. His ten-point scale proposed in 1902 is still the basis of intensity mapping today. Adding two additional levels, the USGS adopted it as the Modified Mercalli Intensity (MMI) Scale in 1931. The levels were designated by roman numerals and were described in qualitative terms such as "Felt by many people inside, although not always immediately recognized as an earthquake" for intensity III and "Felt by all; frightens most; most find it difficult to stand or walk" for intensity VII.

MMI became the USGS standard for describing earthquake impacts. The procedure was to send out a questionnaire to postmasters in the areas where the earthquake was likely to be felt. The questions included perceptions of shaking strength and damage. For major quakes, a team of scientists/engineers would be sent to map out damage to structures. The information would be compiled in "isoseismal maps," contouring areas of equal shaking strength.

I had learned about MMI in graduate school but gave the scale little thought as magnitude seemed a better measurement. Then came the November 1980 M7.2 offshore Trinidad earthquake. I was teaching geophysics at the time and the earthquake provided a nice hands-on field experience for students. I directed them to interview people and collect intensity data. We used a similar survey to the USGS postmaster form and ended up with stacks of qualitative descriptions. There were general agreements as to what was stronger, or weaker but considerable variability and I found it very unsatisfying. After similar exercises for other North Coast earthquakes, I decided 1992 was going to be different.

Kathy Moley, a geology student at the time, and I revised survey questions so that each answer had a numerical value. Surveys were printed in this paper and distributed in schools. We had over a thousand responses. The first question was simple – Did you feel it? 'Yes' got a one and 'No' got a zero. We had questions about perceptions of shaking strength, reaction, whether they heard noises, if heavy furniture shifted, structural damage etc. Then we tallied up the numbers. We wanted to end up with values that were roughly the same as the MMI scale – a 3 should still be light shaking and a 7 relatively strong.

We weighted the responses, summed them up and calibrated them by comparing them to the USGS values for

the same communities. After many attempts we came up with a system that seemed to work pretty well. We could crank out a numerical calculation of intensity for a particular community that didn't involve any subjective determination. For the method to work, we needed at least ten responses for a particular area.

The USGS was skeptical of our approach at first but Jim Dewey, a grad school friend of mine, was leading their intensity group. When the 1994 Northridge earthquake hit, we worked together to test the validity of my approach. At the same time, I was working on intensity, Dave Wald of the USGS was developing Shakemap, a quantitative method of mapping ground shaking based on accelerometer data and modeling seismic wave propagation. But many areas have few instruments and when he became aware of our survey method, he quickly adapted the methodology to the internet, and it became the foundation of the "Did You Feel It" Community Internet Intensity that is now in standard use today. I think this became the first use of crowdsourcing in the earth sciences.

Using the inputs from both Shakemap and Did You Feel It, Dave took a step further in 2010 with the development of PAGER (Prompt Assessment of Global Earthquakes for Response), a method of estimating the impacts of earthquakes within minutes of occurrence. Using population and structure databases, PAGER uses the ground shaking parameters to forecast likely casualties and economic losses. The purpose is to direct governments and responders to areas of the worst impact. It's a far cry from 1992 when it took a half hour to get a reasonable magnitude estimate and weeks to collect damage information. And I like to think the 1992 earthquakes played a small part in its development.

If you remember your experience of the 1992 earthquake, Did You Feel It can still use your input: https://earthquake.usgs.gov/earthquakes/eventpage/nc269151/dyfi/intensity

---

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times-Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email rctwg@humboldt.edu for questions and comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."