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New Software Gauges the Size of Imminent Earthquakes

By KENNETH CHANG

New computer software can detect the onset of an earthquake and sound a warning before a quake's most destructive shaking arrives, scientists are reporting today.

If the system is put into effect, the warning will be short — tens of seconds at most — but it may give workers and students time to duck under desks, air traffic controllers the chance to wave off landing planes and officers a few seconds to lower barriers to keep cars off bridges and overpasses.

For now, though, experts are unsure just how they will use the warnings and acknowledge that false alarms may create problems. "Just ringing a bell can cause a lot of panic," said Dr. Richard M. Allen, a professor of geology and geophysics at the University of Wisconsin.

Writing in today's issue of the journal *Science*, Dr. Allen and Dr. Hiroo Kanamori, a professor of geophysics at the California Institute of Technology, describe a computer algorithm that analyzes seismic data gathered from 150 sensors already deployed around Southern California and continuously sent to a computer at Caltech.

Similar systems could also be put in place in other earthquake-prone areas. Dr. Allen said that he and Dr. Kanamori were currently researching whether a sparser and less expensive network of sensors would still provide useful warning.

"If we can do that, we can go to the regions that don't have the resources," Dr. Allen said. "I would argue these kinds of systems could be very useful in places like Turkey."

Earthquakes shake rocks in two different ways. The warning system focuses on one type of seismic wave that moves quickly — 3.5 miles a second — but causes little damage, resembling the waves that travel along a Slinky toy when one end is pushed and pulled quickly. The slower, more destructive waves resemble the waves when a Slinky is shaken side to side.

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The computer program, running on the computer at Caltech, detects the onset of an earthquake in the faster-moving seismic waves, and within seconds, calculates the epicenter and estimates the magnitude. A warning can then be issued. A location 35 miles from the epicenter will get about a 15-second warning before the slower, damaging seismic waves arrive.

The technology appears to be arriving before emergency officials have had time to think through how warnings should be issued and who should receive them. Also unresolved are questions like who would issue the warnings.

"When you start thinking about the next step, it really is a quagmire," said Dr. David Wald, a seismologist with the United States Geological Survey. "Most people don't know what to do with that information. We're not ready for it."

The researchers are considering a system that will send out the warnings via the Internet.

Patrick Small, the computer programmer installing Dr. Allen and Dr. Kanamori's algorithms, said he hoped to finish a prototype of software by the end of the summer that would run on personal computers and receive and display earthquake warnings from the Caltech computer.

Mr. Small is also working to speed up his computer program. Zooming in on the epicenter now takes 15 to 40 seconds. "I think we can get it down to about 5 seconds," he said.

The researchers will begin an internal test phase to evaluate the accuracy and effectiveness of the warnings.

"What I'm working on is definitely not for the public," Mr. Small said, meaning that it is not ready for practical use.

While the technology is unfinished but progressing quickly, the policy decisions have hardly begun.

"We've thought about it," said Dr. John Filson, manager of the earthquake hazard program at the Geological Survey. "And it's a difficult issue. To turn it into an operational system is going to take some thoughtful planning with the local emergency response officials."

At first, the warnings may be most easily used in controlled environments like schools and hospitals, where false alarms would probably not be more than a nuisance. "We could possibly avoid injuries in our schools by training our children to get beneath their desks and away from the windows," said James Goltz, a research specialist in California's Office of Emergency Services.

It would eventually be possible to design "smart" buildings that upon receiving a warning could take actions like moving elevators to the nearest floor and opening the doors to prevent people from being trapped.

Mr. Goltz said he thought that if an agency started issuing earthquake warnings, it would be hard to restrict that information to a limited group of people. "I think as this technology become available, we do have an obligation to promote its availability to groups that can

use it, everyone ultimately," he said.

Earthquake warning systems already exist in a few areas, including Mexico City. There, the system is simpler, because the earthquake originates from faults nearly 200 miles to the southwest of the city and seismometers can easily detect the rumblings before they reach Mexico City. The system has generated some false alarms.

In the Los Angeles area, faults crisscross through the populated areas. Even with a fully functioning system, people at the epicenter would receive almost no warning.

"Early warning is not a panacea for earthquake losses," said Dr. Wald of the Geological Survey.

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