Science for Environment Policy
DG Environment News Alert Service
European Commission

18 September 2008

When seconds matter: improving early earthquake detection

Earthquakes are a serious threat for many European countries, particularly those around the Mediterranean Sea. A new system[1] has the potential to add vital seconds to earthquake warnings, giving extra time for action to be taken. Early warning systems can play an important role in reducing the negative impact of these catastrophic events on densely populated areas and in mitigating the damage to strategic structures and lifelines.

Destructive waves from a large earthquake can take several tens of seconds to travel from the earthquake source region to distant populated areas and sensitive infrastructure.

Actions following a warning can include:

- Shutting down critical systems such as industries, highways and railways
- Activating control systems to protect crucial structures
- Supplying information to support decision making for the rapid response of emergency management services (e.g. ground shaking maps, continuously updated damage scenario estimates, aftershock hazard).

Modern earthquake warning systems comprise of arrangements of motion sensors spread throughout a region. Rapid communications systems and computers collect the sensor readings and the computers are programmed to detect the likely location and strength of the quake source.

The researchers developed a new way of programming the computers which uses a real-time earthquake location methodology. Immediately after the earthquake occurrence, this new computational procedure looks at the spatial pattern of triggered sensors and those where activity has not yet been detected to pinpoint the source of the earthquake underground (the hypocenter). The methodology is based on a formula known as equal differential time (EDT) which has advantages over other methods in the event of outlier data – sensor triggers that do not fit the general pattern.

The researchers tested their procedure on real earthquake data, and found that in an earthquake-prone area where detection stations are about 10km apart, there is enough data to activate an early warning system 1-3 seconds after the quake is first detected. In a further simulation using data from an earthquake in Greece where stations were around 100km apart, the system allowed scientists to home in on the hypocenter 10-12 seconds before a standard method (a non-real time algorithm), giving much greater scope for an effective early warning.

The new system is always as good as or better than standard processes, and in the majority of cases offers real practical benefits in the event of an earthquake to safeguard lives and resources. Europe is covered by numerous high quality seismic networks, managed by national and international agencies, including local networks specifically designed for seismic early warning around large cities such as Bucharest, Istanbul and Naples.

1. This project is part of Europe's SAFER project (Seismic eArly warning For EuRope) and was supported by the European Commission's Sixth Framework Programme under the theme Global Change and Ecosystem, Priority 6.3.IV.2.1: Reduction of Seismic Risks. www.saferproject.net

Source: Satriano, C., Lomax, A. and Zollo, A. (2008). Real-Time Evolutionary Earthquake Location for Seismic Early Warning. *Bulletin of the Seismological Society of America*. 98(3): 1482–1494.

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Themes: Environmental technologies, Risk assessment