Earthquake Early Warning and the Loma Prieta Earthquake: First Experiment with a New Technology

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Presentation Objectives

- Identify the elements of an earthquake early warning system
- Describe the use of earthquake early warning for aftershocks in the Loma Prieta Earthquake
- Discuss efforts to develop and implement earthquake early warning since Loma Prieta
Early Warning ≠ Prediction

Earthquake Prediction:
- A Statement Including:
  - Magnitude
  - Location
  - Time
  - Probability Of A Future Earthquake

EQ Early Warning:
- EQ already underway
- Geographic distance
- Warning = few seconds
- Ground motion arrival
- Probabilistic statement
Potential Benefits

Even a few seconds of warning may be sufficient to:

- Address life safety: self-protective actions
- Implement rapid mitigation actions
Potential Barriers

- Warning times extremely short
- Longer warnings only available for rare large event
- May be false alerts and missed events
- Potential costs of implementation
- Acceptability in some sectors
Loma Prieta and EEW*

- Operated by the USGS
- Used portable low-gain sensors at 3 optimum sites
- To record aftershocks, including 20 of M≥4
- Alerts transmitted via radio directly to a central receiver site at Menlo Park then to site of S&R and later demolition at the Cypress structure
- System set to trigger an alert for M≥3.7, 2 of 3 sites must record event
- System triggered for 12 aftershocks M ≥3.7≤5.6
- Provided search and rescue teams and later debris clearance workers 20-35 seconds advance warning of the approach of ground motion
- Only one false alert due to electronic noise at the central receiver site
- System was in place for 6 months

Cypress Freeway Collapse
Earthquake Early Warning
Since Loma Prieta
System Development in Other Nations

- Mexico City’s Seismic Alert System (SAS)
- Japan’s Nationwide System 10-1-07
- Taiwan to Introduce Soon
- Limited systems in Turkey, Italy and Greece
Social Science Studies

- One of the objectives of the TriNet Project (1997-2002) in southern California was to develop a “pilot earthquake early warning project”

- Was not realized, but three studies were conducted to set the stage for the development of an earthquake early warning system:
  - A survey of 200 potential EEW users
  - A review of the social science literature
  - A policy review to identify opportunities and barriers to implementation

- Studies revealed potential user support for an EEW, provided guidance from social science research literature and some important policy issues (e.g. liability)
Early Warning in the US

- USGS is funding projects at UC Berkeley, Caltech and USC (SCEC) to develop methods to rapidly analyze an evolving seismic sequence.

- Several high profile sessions at the American Geophysical Union Meetings in recent years.

- In April 2009, scientists and emergency managers traveled to Japan for a workshop on the operation of Japan’s national earthquake early warning system.
Sam Blakeslee and AB 928

- Sam Blakeslee is a Republican Assemblyman from the San Luis Obispo Area
- He is also a UC Berkeley trained seismologist
- Sponsor of AB 928 that calls for the an earthquake early warning system for the CA high speed rail project
- Bill is currently dormant (last action 4-30-09)
Proposal to Tap Stimulus Funds

- 3 year project, $53.4 Million from CISN
- Would add 90 new seismic/GPS stations
- Upgrade older equipment
- Redundant communication paths
- Test algorithms
- Identify best practices for EEW
Summary & Observations

- The EEW system for aftershocks in Loma Prieta was an important (though unheralded) first implementation.
- Subsequent development in other nations.
- US efforts have set the stage but EEW still lacks a coordinated plan and sustained funding.
- Organization and management issues including identification of a lead agency are yet to be resolved.