Quake Prediction: Fact, Fiction, and the Future of Seismic Forecasting

Thomas H. Jordan
Director, Southern California Earthquake Center
Keck Professor of Earth Sciencs
University of Southern California
Los Angeles, CA 90089-0742

Seismic hazards change dynamically in time, because earthquakes release energy on very short time scales and thereby alter the conditions within fault systems that will cause future earthquakes. Owing to the chaotic nature of fault-system dynamics, reliable and skillful earthquake prediction—casting high-probability space-time alarms with low false-alarm and failure-to-predict rates—is not yet (and may never be) possible. However, statistical and physical models of earthquake interactions have begun to capture many of the spatiotemporal features of tectonic seismicity, such as aftershock triggering and seismic clustering. These models can be used to estimate changes in the probabilities of future earthquakes over short intervals, in some situations with probability gains of 100-1000 relative to long-term forecasts. Recent earthquake disasters around the world have underscored the public's need for authoritative information about time-dependent seismic hazards to help communities prepare for potentially destructive earthquakes, especially during active sequences. A variety of scientific and societal issues confront this type of "operational earthquake forecasting." I will summarize the performance characteristics of current forecasting methods, describe the medium-term gap in statistical models of seismic activity, and comment of the potential utility of earthquake simulators in closing this gap. I will also review the recent recommendations of the International Commission on Earthquake Forecasting regarding the validation and deployment of operational methods, emphasizing the role of prospective testing by the Collaboratory for the Study of Earthquake Predictability. In conclusion, I will briefly address the use of low-probability, short-term forecasts in decision-making related to civil protection and the appropriate role of scientists in this process.