Geophysical Research Abstracts,
Vol. 11, EGU2009-8332, 2009
EGU General Assembly 2009

Earthquake early warning performance tests for Istanbul

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The Marmara Region is the most densily populated region in Turkey. The greater area of the mega-city Istanbul inhabits about 14 million people. The city is located in the direct vicinity of the Main Marmara Fault, a dextral strike-slip fault system intersecting the Sea of Marmara, which is the western continuation of the North Anatolian Fault [Le Pichon et al., 2001]. Its closest distance to the city of Istanbul ranges between 15 and 20 km. Recent estimates by Parsons [2004] give a probability of more than 40% of a $M \geq 7$ earthquake that will affect Istanbul within the next 30 years. Due to this high seismic risk, earthquake early warning is an important task in disaster management and seismic risk reduction, increasing the safety of millions of people living in and around Istanbul and reducing economic losses.

The Istanbul Earthquake Rapid Response and Early Warning System (IERREWS) includes a set of 10 strong-motion sensors used for early warning which are installed between Istanbul and the Main Marmara Fault. The system works on the exceedance of amplitude thresholds, whereas three alarm levels are defined at three different thresholds [Erdik et al., 2003].

In the context of the research project EDIM (Earthquake Disaster Information System for the Marmara Region, Turkey), the early warning network is planned to be extended by an additional set of 10 strong-motion sensors installed around the Sea of Marmara to include the greater Marmara Region into the early warning process.

We present performance tests of both the existing and the planned extended early warning network using ground motion simulations for 280 synthetic earthquakes along the Main Marmara Fault with moment magnitudes between 4.5 and 7.5. We apply the amplitude thresholds of IERREWS, as well as, for comparison, an early warning algorithm based on artificial neural networks which estimates hypocentral location and magnitude of the occurring earthquake. The estimates are updated continuously with proceeding time.

Applying the amplitude thresholds increase the number of alarms by 6.5% for alarm level 1, by 6% for alarm level 2, and by 4% for alarm level 3, mainly due to false alarms caused by earthquakes further away from Istanbul but closer to the additional stations. However, applying the neural network algorithm to the extended network increases the reliability of source parameter estimates by 8% already 2 seconds after the first station triggers, and by 19% after 5 seconds.

We analyse the effects of the network extension to the greater region and discuss possible advantages as well as arising problems.