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EEW Significance of Predicting the Generation and Arrival Times of Long Period Seismic Waves in Istanbul Metropolitan Area, NW Turkey

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KOERI (Kandilli Observatory and Earthquake Research Institute) operates a seismic network in Marmara Sea region (NW Turkey) consisting of 40 broadband, 30 strong motion and 3 borehole stations with sensors at different levels. The station distribution pattern is suitable for regional EEW studies. Moreover, 10 strong motion stations are distributed in a layout to constitute groups of stations utilized for decision making on an onsite EEW declaration based on certain threshold levels. The threshold level is target sensitive.

Real time waveforms from KOERI stations provide an excellent coverage for precise and fast location of the earthquakes taking place in NW Turkey and the Northern Aegean. The continuous online data from these stations is used to provide real time warning for emerging potentially disastrous earthquakes.

The Virtual Seismologist, PRESTo and ELARMS2 are the EEW applications that have been setup at KOERI data center to generate an EEW signal. The seedlink server module of SeisComP3 data acquisition program is the common waveform provider for the three algorithms. The early warning signal is communicated to the appropriate servo shut-down systems of the recipient facilities, that automatically decide proper action based on the alarm levels. Marmaray, IGDAS and a number of highrise buildings utilize the EEW signal.

An earthquake with Mw=6.9 in Northern Aegean on 24 May 2014 was located approximately 30 km north-west of Gökçeada (Imbros) Island which generated strong ground motions in Istanbul Metropolitan area. The event was widely felt in the Marmara Region.

Despite the 300 km epicenter distance, the shaking duration of tall buildings was significantly high exceeding 10 minutes. Owing to the offshore epicenter, the EEW routines declared the event location and size within 35 seconds of the origin time. The travel time of the long period waves from the epicenter to the metropolitan area of Istanbul is about 85 seconds providing 50 seconds warning time. Although, the amplitude of the strong motion waveforms were small, the long period and the long duration of the velocity waveforms were acquired at more than 100 strong motion stations within the city, which explains the causatives of the long shaking duration of tall buildings.

The 1985 Mexico City and the 2011 Tohoku earthquakes are good examples showing how the long period seismic waves can be effective at long distances causing both structural and non-structural damages in high rise buildings or structures with periods close to the periods of the propagating waves.

The present EEW algorithms are mainly utilizing P-waves attributes in predicting the large amplitude motions, mainly because of short leading times. However, the large leading times of the long period seismic waves generated by distant earthquakes, makes plausible for the EEW studies to utilize later arrivals in the seismograms.