A new methodology for Earthquake Early Warning (EEW) by a high-dense seismic network

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Many of current EEW systems issue estimated intensity distribution maps according to empirical attenuation relationships which require information of source parameters and focal distance. These information are determined based on point source model which is not applicable for finite source model of large earthquakes. EEW is essential for the source area of inland earthquakes where heavy damages are expected. In most cases, EEW is issued lately in the source area which described as a "blind zone". Seismic networks, in case of Japan, are deployed for the determination of hypocenter at about 20-30 km interstation distance. That span delays the detection of P-wave arrivals by about 3-4 s. It should be suitable for the real time monitoring of seismic phenomenon that transfer on about 2.7 km/sec of the rupture, 3.5 km/sec of S waves and 6.0k m/sec of P-waves velocities. In this study, we present a new methodology for EEW which uses peak ground acceleration (PGA) estimated from P wave portion, taking advantage of the differential velocity (i,e., ~1.73) and the amplitude ratio (i,e., ~1/5) of P and S-waves. The efficiency of this method suggests the distribution of a high-dense seismic network of 5 km interstation distance, considering a span distance less than that of velocity of P-wave (i,e., 6 km/s). The slowness analysis of P waves tells information of the rupture starting point and its depth. Firstly, peak ground acceleration (PGA) on free surface is estimated from the maximum P-wave amplitude in one-second time step until the arrival of S-wave at the first detected station, and then adjusted to that on the engineering base (PGA_E) by eliminating the site effect. The S wave detection is performed by the amplitude comparison method of the synthesized amplitude of the two horizontal components and the vertical component. Secondly, we estimate PGA_E on far site from a relevant attenuation relationship and adjusted to PGA considering site amplification. Finally, we issue real-time intensity map in every second time step till the declining of PGA. The described method is useful to improve EEW system and also to perform disaster estimation immediately after the occurrence of large event, in order to avoid data extrapolation and the time consuming waveform inversion analysis.

Keywords: EEW, PGA, PGAE, P estimation, blind zone, real time intensity

