8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

EARTHQUAKE EARLY WARNING FOR SARPOL-E ZAHAB EARTHQUAKE

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Keywords: Earthquake early warning systems, B-Δ method, Single station, Sarpol-e Zahab

Earthquake Early Warning System (EEWS) is issued by detection of P-wave, estimation of seismic parameters and decision to alarm. The EEWS provides advance warning of estimated seismic intensities and expected arrival time of S-waves. These estimates are based on prompt analysis of hypocenter location and earthquake magnitude using data observed by seismographs near the epicenter. In this study, the B-Δ method is examined to estimate an earthquake's magnitude and epicentral distance using only initial part of P-wave data (3 s) from a single station for application in EEWS. Fitting a simple function with the form of $f(t)=Bt\times exp(-At)$ to the first few seconds of the waveform envelope, coefficients A and B are determined through the least-squares method. B decreases with distance and shows independence from magnitude and $logB$ is inversely proportional to $log\Delta$, where Δ is the epicentral distance. B values are calculated on the basis of 65 vertical-component accelerograms of Sarpol-e Zahab earthquake (M_w *7.3*) with epicentral distances less than 80 km. The magnitude and an amplitude parameter P_{max} determined from the very beginning of P-wave, are important for EEWS, yet their dependence on source mechanism, focal depth and epicentral distance has not been fully studied (Figure 1). Envelope of seismic waves can differ depending on earthquake magnitude, focal depth, and epicentral distance; ground motion can be displayed on a logarithmic scale to determine these differences visually (Odaka et al., 2003). The noise levels (the small-amplitude initial portion of the P-phase) preceding the arrival of P-wave, and the large amplitude later phases (i.e. the S-phase) can then be recognized easily and the differences in waveform characteristics immediately understood (Figure 1). Odaka et al. (2003) described the amplitude of the large earthquake increases gradually with time, whereas that of the small earthquake decreases soon after the *P*-wave arrival, which is consistent with the observation by other researchers (Noda et al., 2012).

Using this method, we could estimate the epicentral distance by $log\Delta=-0.57logB+2.4\pm0.4$ and earthquake magnitude by $M_{est}=1.99logP_{max}-1.76logB+5.62 \pm0.3$. The greatest advantage of this method is its accuracy and rapidness.

We considered $V_p=6.5$ *km/s* and $V_s=3.5$ *km/s*. For Sarpol-e Zahab station ($\Delta=39$ *km*) P-time is *6 s* and calculation time is *4 s*. We need *10 s* for warning time whereas S arrival time is *11.2 s*, then we have only *1.2 s* time for the decision to alarm. Blind Zone, an area where S-wave and/or strong shaking has already reached, is *~35 km* from the epicenter at this time. For the stations near the epicenter, we will have more time to alarm and therefore small blind zone. For very near stations, there is not enough time to record *3 s* initial part of P-wave and S-waves arrive before *3 s*.

The EEW system issues several alarm messages during the course of one earthquake, improving the accuracy of the warning as the amount of available data increases. The EEW is transmitted to many kinds of devices and used for personal safety and automatic control. It is very important to observe strong motion in real-time using a dense network in order to improve the EEW system.

REFERENCES

Noda, S., Yamamoto, S., and Sato, S. (2012). *New Method for Estimation Earthquake Parameters for Earthquake Early Warning System*. Railway Tech. Res. Inst., Tokyo, Quarterly Reports, *53*(2), 102-106.

Odaka, T., Ashiya, K., Tsukada, S., Sato, S., Ohtake, K., and Nozaka, D. (2003). A new method of quickly estimating epicentral distance and magnitude from a single seismic record. *Bull. Seismol. Soc. Am.*, *93*, 526-532.

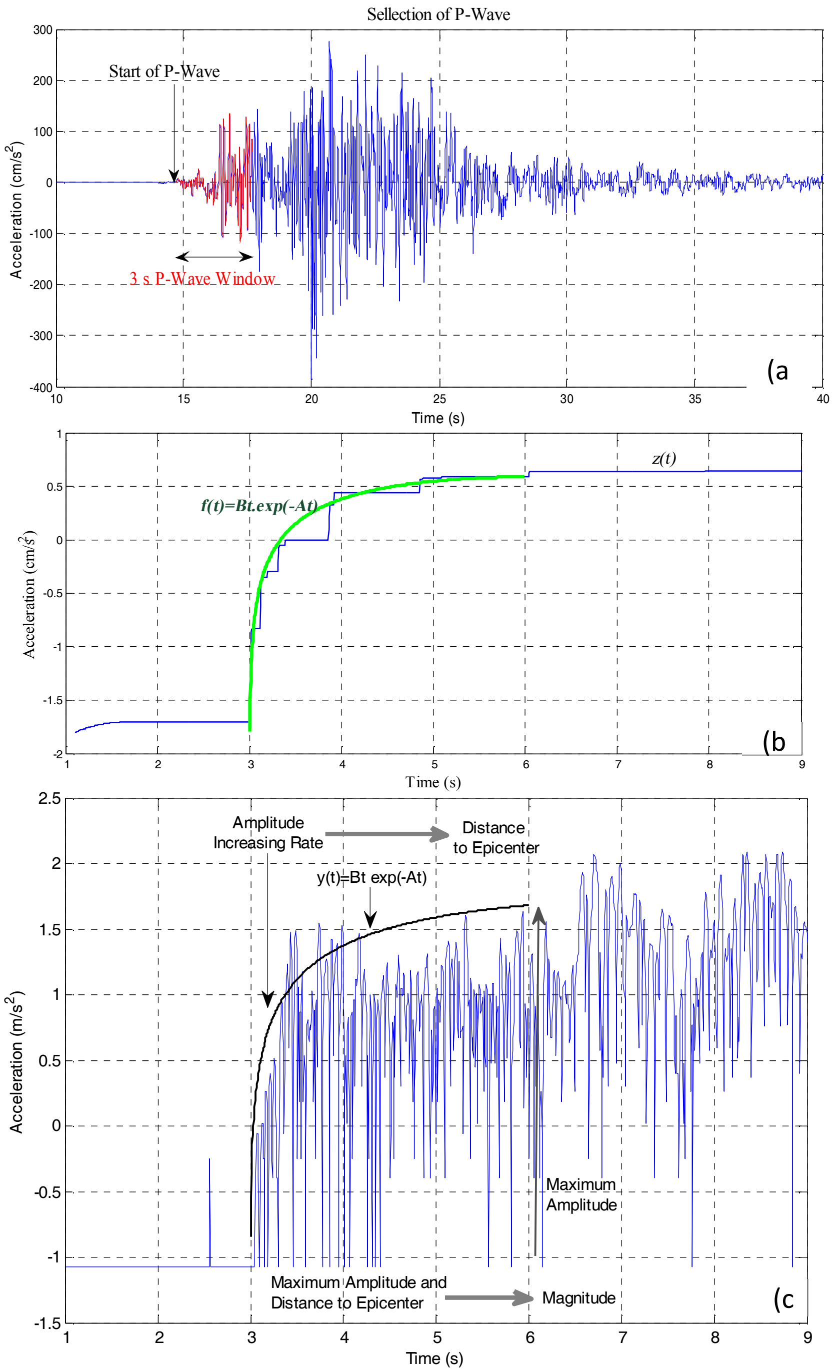

Figure 1. (a) Vertical-component accelerogram recorded Mw 7.3, (b) The envelope z(t) and f(t) and (c) logarithm of absolute values for the selected waveform. The continuous line indicates the fitting of function y(t)=Bt× exp(−At) to an envelope of amplitudes.