

## Rapid magnitude determination from peak amplitudes for tsunami warning

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Rapidly determining the magnitude soon after a great earthquake is necessary for issuing effective tsunami warnings, as demonstrated in the great earthquake off Tohoku district in Japan on March 11, 2011. The earthquake magnitude for the first tsunami warning was underestimated due to magnitude saturation.

We present an empirical method to determine magnitude rapidly from peak velocity and displacement of long-period seismic waves up to 100 seconds at local stations. When waveform data at local stations are available, the magnitude from S-wave peaks is expected to be determined faster than that from only P-wave peaks. Velocity/displacement records are obtained from strong-motion acceleration records with numerical integration. Processing with recursive digital filters makes it possible to observe magnitude value change soon after the hypocenter determination.

It took about 140 second to estimate a magnitude of about 9 for the March 11, 2011, earthquake, which enables us to issue the first tsunami warning within three minutes after the same type of earthquakes. It was also possible to get a magnitude value of 8.8 for the 2010 Chile Maule earthquake within three minutes from the origin time.

Correction for epicentral distance is applied for the magnitude determination. Effect of the hypocenter location on magnitude value was estimated for the events on March 11, 2001. Magnitude values were calculated with assumed hypocenter locations within the source area, and the magnitude differences were no more than 0.1 in a large part of the source area. Focal mechanism also affects the observed peak amplitudes. Effect of focal mechanism is considered to be slight for local events, and it could be considerable for the case of observing events near Kuril Islands on Japanese islands.

We used data obtained by Japan Meteorological Agency, University of Chile, and National Research Institute for Earth Science and Disaster Prevention.

Keywords: rapid magnitude determination, peak amplitude, tsunami warning