Forecasting ground-motion exceedance probability based on short-term earthquake occurrence probability information after a large earthquake

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After a large earthquake, further shaking caused by activated aftershocks affects the region around the source area, where damage has already been caused by strong motions due to the mainshock. In the initial phase after a large earthquake, disaster mitigation actions such as evacuation, rescue, and emergency response are undertaken. During this phase, there is a high demand for forecast information on short-term shaking prospects for the next few days. This study proposes a scheme to forecast the exceedance probability of ground motions caused by aftershocks following a large earthquake.

Because the quality and quantity of earthquake catalogs are significantly reduced after a large earthquake, it is difficult to directly apply the statistical forecasting methods used in normal times. Omi et al. (2013, 2016) proposed a scheme to cope with this incompleteness of seismic catalog immediately after a large earthquake; the seismic detection rate and the b-value of the Gutenberg-Richter law are simultaneously estimated using Bayesian estimation, and the earthquake occurrence probability is calculated based on the Omori-Utsu law. By applying it to the automatic hypocenter catalog data of NIED Hi-net, a system for automatic aftershock forecasting for the near future in Japan was developed (Omi et al., 2018). In this study, the short-term earthquake occurrence probability information obtained through this system is used.

The ground-motion prediction method follows that used in the current earthquake early warning system in Japan (JMA 2020). The target ground-motion index is the JMA seismic intensity. For simplicity, we assume that aftershocks will occur in the same location as the first large earthquake. Based on the probabilistic ground-motion prediction approach, we estimate the ground-motion exceedance probability where ground motions due to the aftershock activity exceed a threshold value of seismic intensity during the target period.

Application of the proposed method to real data shows that the forecast probability of ground-motion exceedance roughly reproduces the observed trends. We also found it necessity to take into account the spatial extents of aftershocks.

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