

Evaluation of earthquake-induced landslide by using multivariate analysis

Bateer Hasi^{1*}, Kiyoteru Maruyama¹, Akira Nakamura¹, Tomoyuki Noro¹, Yoshifumi Hara¹

¹PWRI, Japan

Recent years, a series of strong earthquakes attacked Japan and surrounding regions, caused serious damages, such as destroyed lifelines and blocked rivers due to earthquake-induced landslides. The landslide susceptibility analysis is a method to reduce the landslide damage accompanying strong earthquakes. This study purposes to evaluate earthquake-induced landslide, by focusing on topographical factors using logistic regression analysis. We focused on pre-existing landslide topographies, according to the result that more landslides occurred within pre-existing landslide topographies by the Mid-Niigata earthquake (Has et al., 2009), and the landslide topographical interpretation data are available. In this analysis, we used the landslides data from the Mid-Niigata earthquake in 2004 and the Iwate-Miyagi Inland earthquake in 2008.

Logistic regression analysis is a type of predictive model can be used when the depend variable is categorical and dichotomous. In this study, the landslide occurred /non-occurred is categorical data as dependent variable, and the geomorphological factors that influence landslide occurring are independent variables. Here, we selected surface roughness (the largest value of elevation difference within landslide topography), marginal erosion ratio (the erosion condition around the landslide topography; see Suzuki et al., 2010), slope gradient, mean curvature, distance from ridge line as independent variables which considered to be the influencing factors for landslide induced by earthquake. In this study, we only selected geomorphological factors but did not select geological factors, because the considerable regional differences of the geological factors.

In the analysis, at first, we used 87 landslides occurred by the Mid-Niigata earthquake within pre-existing landslide topographies and randomly selected 87 pre-existing landslide topographies which did not moved by the earthquake. After logistic regression analysis, we selected the most influencing factors and calculated the coefficients. We used logistic regression method of multivariate analyzing software of SPSS Statistics Ver.19 (SPSS Inc.). After using stepwise method to select the topographical factors, surface roughness and marginal erosion ratio are acting as most influencing factors for landslide occurring. After validation, the result showed that 74.7% of landslides correctly predicted in the Mid-Niigata earthquake. Using by the coefficient from analyzing result of the Mid-Niigata earthquake data, we predicted the landslides by the Iwate-Miyagi Inland earthquake, and the accuracy is 77.2%. Based on this result, surface roughness and marginal erosion condition are considered to strongly influence the occurrence of landslide by earthquake. Therefore, we re-analyzed the data from both the Mid-Niigata earthquake and Iwate-Miyagi Inland earthquake; used 116 landslides occurred pre-existing landslide topographies and randomly selected same number of non-occurred pre-existing landslide topographies. The validating result showed, the predicting accuracy is 75.4%.

The result of above analysis suggested the, logistic regression method is useful method to evaluate earthquake-induced landslide. Using this method, we will conduct earthquake-induced landslide susceptibility mapping around active fault.

Keywords: earthquake, landslide, multivariate analysis, susceptibility evaluation, Mid-Niigata earthquake, Iwate-Miyagi Inland earthquake