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Earthquake-Induced Landslide Susceptibility Mapping of Sindhupalchowk District Using Random Forest Ensemble Model

Suchita Shrestha and Tae-Seob Kang

Pukyong National University, Institute of Environmental Geosciences, Department of Earth Environmental Sciences, 45 Youngso-ro, Nam-gu, Busan 48513, Korea, Republic Of (suchitashrestha@gmail.com)

Abstract

The Gorkha earthquake (Mw 7.8) occurred on April 25, 2015, with its epicenter at Barpak in the central part of Gorkha District, Nepal. The sequence of the Gorkha earthquake and its aftershocks triggered thousands of landslides in the exceedingly steep topography of Nepal. The Gorkha earthquake along with earthquake-induced landslide caused more than 9,000 deaths, injured more than 24,000 and loss of huge properties. The casualty and loss of property due to the earthquake and earthquake-induced landslide may increase in coming years because of rapid urbanization with the growth of population in the study area. Among the fifteen affected districts, Sindupalchok is the worst one and has most of the number of deaths and injuries. The main goal of this study is to generate an ensemble-based map of earthquake-induced landslide susceptibility of Sindhupalchowk District using model comparison and combination strands. A total of 2,194 earthquake-induced landslides was identified and was randomly split into 1,536 (∼70%), to train data for establishing the model, and the remaining 658 (∼30%) for the validation of the model. For the ensemble, various types of famous bivariate models such as a frequency ratio (FR) method, evidential belief function (EBF) method, and weight of evidence (WOE) method were applied and compared, by using 11 different causative factors (CFs) related to the landslide susceptibility. Peak ground acceleration, epicenter proximity, fault proximity, geology, elevation, slope, plan curvature, internal relief, drainage proximity, stream power index and topographic wetness index were the causative factors used in this study. The success rate and prediction capability were critically compared using the area under the curve (AUC) of receiver operating characteristic curve (ROC). Considering the accuracy and the precision evaluations, the ensemble model represents considerably the most realistic prediction capacities (91%) when compared with the frequency ratio (81.2%), evidential belief function (83.5%), and weight of evidence (80.1%). If the susceptibility class in separate maps is closely similar or identical, the ensemble model shows more powerful results than others because the ensemble model refers to the combination of susceptibility class obtained from a different model.