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# Categorization of landslide-triggering rainfall focusing on the antecedent rainfall and its implication for landslide prediction

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In mountainous areas in the Republic of Korea, landslides occur primarily due to heavy rainfall in the summer monsoon season. While these landslides tend to occur seasonally in summer, the rainfalls that have triggered landslides are complex and varied. Temporal prediction of landslides based on the variables of rainfall events mainly uses two variables: intensity-duration or cumulative event rainfall-duration. However, it does not consider the antecedent rainfall, another critical factor that could characterize various complex rainfalls regarding landslide occurrences. Here, we first attempted to determine critical rainfall variables and their threshold values for landslide occurring using the decision tree method necessary to consider multiple rainfall variables simultaneously. We then classified landslide-triggering rainfall based on the identified critical variables using the K-means clustering method. We chose as the study area Chuncheon in the middle of the Korean Peninsula, an eroded granite basin surrounded by schist and gneiss mountains, since it has not been affected hardly by earthquakes and thus is suitable for studying rainfall-induced landslides. According to the decision tree analysis, cumulative rainfall and 5-day antecedent rainfalls were determined as critical variables, implying that considering antecedent and cumulative rainfall simultaneously is significant for landslide prediction. The K-means clustering analysis classified landslide-triggering rainfalls into four types: 1) low cumulative rainfall (198.6 ± 90.9 mm) with high antecedent rainfall for seven days prior to the landslide, 2) medium cumulative rainfall (308.3 ± 81.1 mm) with a gradual increase in antecedent rainfall for four weeks, 3) high cumulative rainfall (534.5 ± 85.7 mm) with low antecedent rainfall for four weeks, and 4) high cumulative rainfall (538.4 ± 59.8 mm) with a gradual decrease in antecedent rainfall for four weeks. In particular, the high cumulative rainfall after gradually decreased antecedent rainfall caused the most frequent landslides. Our results suggest that the threshold of cumulative rainfall varies with the antecedent rainfall pattern and that antecedent rainfall data of at least four weeks have meaningful information in forecasting and preparedness for landslide occurrence.