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Assessment of rainfall-induced shallow landslide susceptibility using a probabilistic approach and the bootstrap method

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Physically based landslide susceptibility analysis method, which can consider landslide occurrence mechanisms, has been widely used since it has high predictive capability. This method considers the geometric characteristics of slope and the geotechnical characteristics of slope material as input data in the analysis. However, since the uncertainties were involved in input parameters due to limited information and spatial variability of slope materials, the probabilistic analysis has been adopted to deal properly with uncertainties in input parameters. In the probabilistic analysis, the accurate statistical parameters (mean, standard deviation and probability density function) of input parameters were required. However, it is difficult to obtain sufficient information for the statistical parameters in the landslide susceptibility analysis for regional area, which means that the reliability of probabilistic analysis would be adversely affected. Therefore, in this study, the bootstrap method that could effectively deal with uncertainties caused by limited data was proposed for regional landslide susceptibility analysis. Especially, the bootstrap approach was combined with the point estimation method (PEM) because the previous bootstrap method did not provide a single value of the probability of failure as a result, which means that the results could not be presented in the form of the susceptibility map. The proposed bootstrap-PEM method was applied to the practical case to evaluate landslide susceptibility, and the analysis results were compared with the probabilistic approach using Monte Carlo (MC) simulation. The bootstrap–PEM method showed better performance than the MC simulation. In addition, the proposed approach has the advantage of readily handling the cross-correlation between variables that significantly affects the analysis results from insufficient data.