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Estimating slope stability conditions for rainfall-induced shallow landslides in a changing climate. An example from Otta, Central Norway.

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The effects of future changes in precipitations on stability conditions for shallow landslides are analysed by comparing the probability of failure at present and future climate scenarios. We used a coupled hydrological-stability model to simulate shallow landslide triggering for a wide range of precipitation regimes, which take intensity, duration of the extreme events and two different antecedent precipitation values into consideration. Eleven future scenarios were determined using results of down-scaled meteorological models. To account for the uncertainty in the soil parameters, we used the Monte Carlo approach, and we calculated probability of failure resulting from 5,000 trials for each precipitation scenario. In unstable areas, the probabilities of failure at present and future conditions were compared using a bootstrapping method. Finally, we performed sensitivity analysis to understand how variations in input parameters influence the output of the selected model.
The results show that the uncertainties in the predicted extreme precipitation events, soil parameters, and antecedent precipitation conditions do not allow any accurate estimation of changes in stability conditions for shallow landslides. The eleven scenarios of future climate show a wide range of variation for the projected climate and, as a consequence, changes in stability conditions due to climate change fall in a wide interval. Accounting for antecedent conditions further increases this uncertainty. We conclude that an accurate quantification of changes in stability conditions for shallow rainfall-induced landslides is not feasible, since the uncertainty in slope hydrologic and in slope stability conditions is higher than the climatic change.