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Estimating landslide-triggering rainfall thresholds using two conceptual models for soil water and potential landslide area indices with 30 years of hourly rainfall data

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This study used two conceptual models to examine the effects of variable, heavy rainfall conditions on shallow landslides: 1) the Soil Water Index based on a tank model, and 2) the process-based model. The process-based model used a digital terrain model with 10-m resolution to calculate the regional potential for shallow landslides, based on the distribution of shallow infiltration water, Darcy's law, and a safety factor estimated by an infinite slope stability analysis. We used this process-based model as a conceptual model, rather than as a physically based model, and defined the model output value of the total area of each cell with a safety factor less than one as the Potential Landslide Area Index. The two models were applied at the Funyu Experimental Forest of Utsunomiya University in Tochigi Prefecture, Japan. At the end of August 1998, a heavy rainfall event caused many shallow landslides in the study area, whereas other heavy rainfall events from 1979 to 2008 did not cause severe landslides. A response analysis of data collected hourly during heavy rainfall events with the Soil Water Index from 1979 to 2008 revealed a maximum value in the heavy rainfall events at the end of August 1998. In addition, the relative difference ratio of the Soil Water Index value of the second largest heavy rainfall event, on 11 July 2002, was 8%. Although the response analysis with the Potential Landslide Area Index also shows a maximum value with a heavy rainfall event at the end of August 1998, the relative difference ratio to the second largest heavy rainfall event on 11 July 2002 was 30%. This result suggests that Potential Landslide Area indices obtained from the modeling are useful for discriminating between rainstorms, with and without sediment-related disasters, similar to the Soil Water Index.