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The role of soil thickness on shallow landslide initiation

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Predicting where and in what rainfall conditions are likely to trigger landslides is a key element in prevention of natural disasters. Recently, several studies used physically-based models for predicting the landslide susceptibility and showed that physically-based model have a powerful potential as a way to evaluate the probability of shallow landslide. Most of these studies are commonly based on the assumptions that; 1) soil thickness is not varied in space, 2) surface topography is equal to bedrock surface topography, 3) effective soil strength and hydraulic parameters are equal to the value measured by small soil samples. However, effects of these assumptions on the result of the prediction of the landslide susceptibility have not been fully tested. In this study, we test these assumptions.

We used the model linked a simple hydrological model and the infinite slope stability model to predict spatial pattern of critical steady-state rainfall required to cause slope instability. We measured soil thicknesses at about 150 points in the catchment using a knocking pole test and conducted hydrometric observations in three headwaters in western part of Japan. We used two soil strength and hydraulic parameters for model input data: one is evaluated by using small soil samples and the other is back calculated by using landslide geometry and hydrometric observation data.

When we used the data about spatial distribution of soil thickness and the back calculated soil strength and hydraulic conductivity, the model successfully identified shallow landslide location triggered by the heavy rainfall of June, 1999. However, if the data about soil thickness was not available, the landslide location could not be predicted. Moreover, if we used the small sample soil hydraulic conductivity, we cannot explain the landslide triggered rainfall intensity. Here we emphasized that the detailed field investigation about spatial variability of soil thickness and effective soil strength and hydraulic conductivity can dramatically improve the estimation of landslide location, although the model is very simple.