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Shallow Landslide Modeling: Application to Takora Basin Japan

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For an assessment of how hydrologic processes influence the location and timing of landslide or to assess how landslide risk might change in response to changed landuse pattern, some sort of mathematical model is needed, which can incorporate all triggering factors explicitly. There are many methods for the landslide hazard assessment such as statistical analysis and field based observation etc. But they are useable only if there exists some recorded history of the landslide events or there should have been extensive field investigation. So such models cannot be widely used and they are unable to be used especially in ungauged basins. Another method which can be used in the gauged/ungauged catchments is process based model. Such process based models provides the terrain stability mapping after integration of hydrologic model with slope stability model. A new physics model based on the Richards equation for the ground water flow simulation with assumptions of three layer soil matrixes was prepared for this study. In order to assess the importance of transient rainfall on landslide, the model was made capable to explicitly calculate the change in pore pressure in response to transient rainfall. Infinite slope failure was assumed for the slope stability module.

Most of the water induced landslide disasters are caused by the high intensity and short duration rainfalls. Proposed landslide model explicitly analyzes the effect of high-intensity and short-duration rainfalls on development of pore-water pressure. The numerical solution of the unsteady pore-water pressure was experimentally verified by the physical experiment. van Genuchten equation was used for establishing relationship of matric potential and pressure head. The parameters of van Genuchten were derived from the data of the experiment using multivariate regression analysis.

The model was further developed to a landslide simulation model. It was used to simulate the landslides occurred in 1973/10/26 at the Takora basin located upstream of Kizu river basin. The model is able to predict the timing and location of the shallow landslides.

Comparison of the result of transient rainfall model and steady state model was done by applying both transient response and steady state model to simulate the landslide produced by rainfall of 1973/10/26 on the same basin. Steady state model seems to be unable to simulate the transient pore pressure change in such conditions, which is vital for slope failure prediction. Also, it is found that in a case of such high-intensity short duration rainfall, a model with capacity of transient pore water pressure simulation performs better.

Sensitivity analyses of some of the model parameter were also done. The sensitivity analysis also indicates that the soil parameters such as depth of the layers, angle of repose of soil and soil density have great influence on the stability of the soil domain. Correct representation of their values and their proper spatial distribution are vital to enhance the performance of the model output.

The result of infiltration modeling and landslide modeling both proves the applicability of the model and encourage for the future development of more generalized model incorporating more factors that influence landslide.