A coupled hydro-mechanical mobilization analysis for extreme rainfall induced debris flow

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Abstract

Korean peninsula receives about two third of the annual rainfall during summer season. The extreme rainfall pattern due to typhoon and heavy rainfall results in severe mountain disasters among which 55% of them are debris flows, a major natural hazard especially when occurring around major settlement areas. An extreme rainfall event in July 2011 resulted in more than 40 catastrophic debris flow events in Umyeon mountain, Seoul mobilizing large volume of debris which paralyzed the capital city and killed several people. Thus it is important to conduct a detailed investigation in to the triggering and mobilization factors causing the rapid flowing debris flow in the Korean peninsula to improve the predictive capability for hazard mitigation. The basic hypothesis for debris flow or a flow slide initiation on an unsaturated slope is attributed to slope failure due to wetting depth progression, with the failed mass undergoing liquefaction under an undrained condition if it's a contractive soil or the transformation of dilative into a contractive due to topographical effect under drained condition.

In order to model the entire process of debris flow there's a need for coupling the prefailure hydrological influence on the slope failure and mobilization with the post failure run out of the mass for risk modelling. Most of the existing hydrological coupled models like TRIGRS, SHALTAB etc. ([1], [2]) usually overestimates the landslide areas and cannot determine if the slope failures will mobilize into a debris flow, flow slide or a slump for coupling with run out models like DAN-3D ([3]).

Hence in this study we have used Mein Larson infiltration model coupled with infinite slope stability and a mobilization scheme to predict if the area of shallow slope failure under different initial conditions will transform into a debris flow, rapid flow slide or a slump. The mobilization scheme based on critical state framework is implemented in a GIS environment. The slope instability is calculated on a cell by cell basis and the mobilization scheme is applied to each unstable cell. The resulting final volume along with the appropriate rheological model will be used as input in the run out model. This coupled analysis scheme will be validated against the 2011 Umyeon san event.

REFERENCES

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