Assessment of Debris Flow Locations Using Shallow Landslide Prediction Model Incorporating the Effects of Saturation Overland Flow

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INTRODUCTION

In western Hiroshima Mountains, terrible debris flow disasters occurred twice in the late two decades (1999, 2014). In these debris flows, lots of sediment were yielded not only by the collapse of hillslopes, but also by sediment movement in channels. Therefore, for predicting the occurrence of these debris flows, we need the method which can predict both of them.

As one of the models which can predict both of them, Hata et al. [2014] proposed "Advanced H-SLIDER method" that is a shallow landslide prediction model incorporating the effects of saturation overland flow and confirmed the applicability.

Generally, the H-SLIDER method is applicable to a narrow area (i.e., single hillslopes), and the C-SLIDER method is applicable to a wider area (i.e., catchments). In the H-SLIDER method, we set parameters of the grid cells using field measurement data mainly. On the other hand, in the C-SLIDER method, we set parameters in consideration of spatial variability of them stochastically.

In this study, we applied the Advanced H-SLIDER method and new Advanced C-SLIDER method to Hiroshima Disaster 2014 and confirmed the applicability to predict debris flow locations.

METHODOLOGY

In Advanced H-SLIDER method, we classified sediment movement into three types (**Fig.1**) [Hata et al., 2014]. The first type is shallow landslide occurrence caused by subsurface flow (Type 1). The other two types are sediment yield caused by saturation overland flow on steep hillslopes (Type 2) and on relatively gentle hillslopes (Type 3).

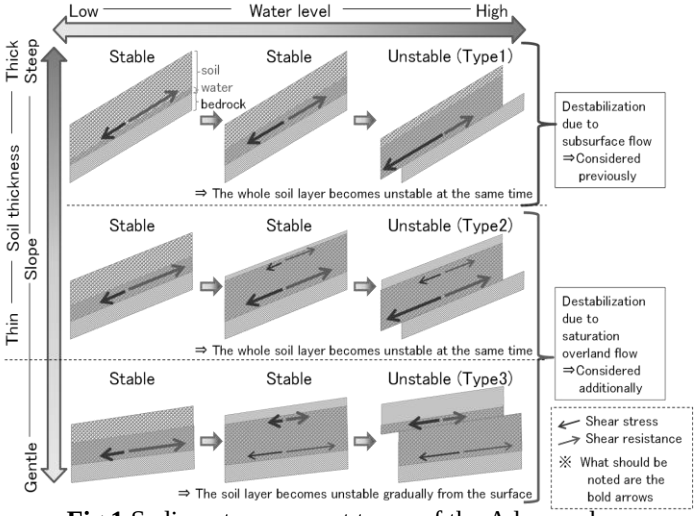

Fig.1 Sediment movement types of the Advanced H/C-SLIDER method

In Advanced H-SLIDER method, to assess the effects of subsurface flow on shallow landslide occurrence (Type 1), we applied the H-SLIDER method which combines infinite slope stability analysis and a steady-state subsurface flow model proposed by Uchida et al. [2011]. Also, we used the equation describing debris flow occurrence proposed by Takahashi [1991] to assess the effects of saturation overland flow on hillslope stability (Types 2 and 3).

However, still there is no enough information about spatial variability of input parameters, such as soil depth, soil strength etc. Thus, to assess debris flow susceptibility for relatively wider area (ca. several 10 km^2), we set parameters stochastically for each grid cell. We call our new stochastic method as the "Advanced C-SLIDER method". Also, we applied other stochastic method, C-SLIDER method which does not include processes of Types 2 and 3.

RESULTS AND CONCLUSIONS

We show the probability of debris flow occurrence in each grid cell by the C-SLIDER method and the Advanced C-SLIDER method in **Fig.2**.

Especially in granite area, the accuracy of debris flow prediction in channels is low when we use the C-SLIDER method. However, when we use the Advanced C-SLIDER method (incorporating the effects of saturation overland flow), the accuracy of debris flow prediction in channels is improved effectively. Therefore, we propose using the advanced C-SLIDER method to predict a relatively wide area of debris flow occurrence.

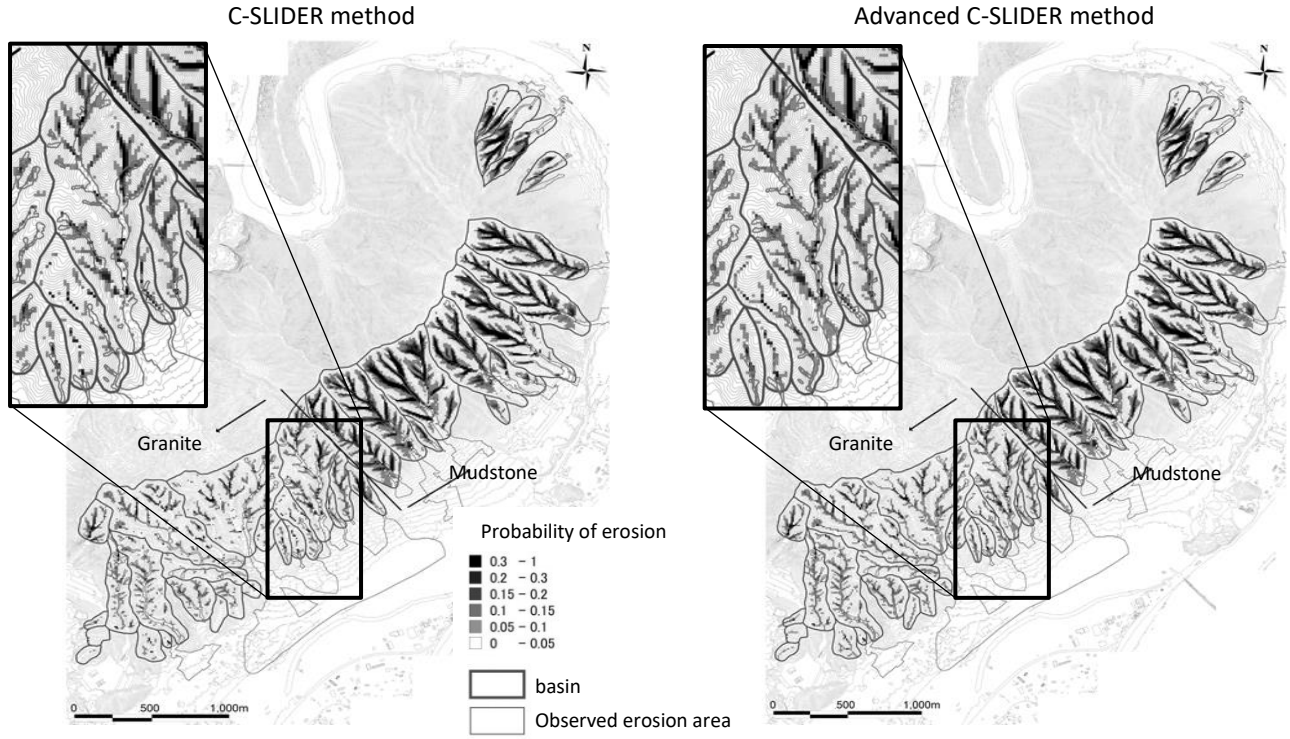

Fig.2 Unstable area predicted by models in Yagi, western Hiroshima Mountains

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