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The effect of step-pool development on sediment transport following blockage of a mountain gully by a landslide: An experimental study

○Ching-Ying Tsou[a], Su-Chin Chen[b], Chia-Ning Yang[c]

[a] Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji 611-0011, Japan

[b] Department of Soil and Water Conservation, National Chung Hsing University, Taichung 402, Taiwan

[b] Sinotech Engineering Consultants Ltd, 171 Nanking E. Rd., Taipei 10570, Taiwan

Streamside landslides often bury gullies with volume of mixed-size sediment, posing considerable risk to downstream reaches. To mitigate sediment-related problems, understanding the movement of sediment through channel systems is important. Mountain channels closely coupled to these landslide-prone hillslopes often develop a step structure by interlocking of coarse particles which spans the entire channel width and below which a plunging pool develops. We conduct flume experiment to examine the effect of development of step-pool bedform on sediment transport following blockage of a mountain gully by a landslide.

Flume experiments under various hydraulic conditions with a mixed-bed material are carried out and interpreted by statistical analyses. Results indicate that flume channels respond in a sequence of coarsening, bedform development, and slope adjustment regarding to the formation of vertical bedforms of rapids, cascades and steps. With the introduction of step-pool development coefficient, the degree of vertical bedform development was quantified and shows significant and positive relationships with, respectively, Manning's roughness coefficient and critical Shields number, suggesting the evolution of flow resistance with increasing development degree of step-pool system. The observation was inferred to contribute to bed stabilization supported by the measurements of sediment transport rate by showing that sediment transport rate can decrease effectively by increasing bed shear stress and the degree of step-pool development. A proposed simple sediment transport model at steady state, based on a dimensionless analysis, is proposed including the step-pool development coefficient, relative particle submergence (representing by mean water depth to maximum sediment diameter), modified bed slope, and discharge. These results well explain the significance of step-pool formation in heightening flow resistance, stabilizing the bed and reducing sediment transport following blockage of a mountain gully by a landslide.