

HDS05-P03

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Interaction between river bed condition and debris flow in Ichino-sawa subwatershed of Ohya-kuzure landslide, Japan

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In recent years, there has been significant concern about large-scale sediment movements, such as deep-seated landslides, that are expected to occur more intensively due to changes in rainfall patterns. These landslides not only induce immediate sediment disasters downstream but also produce a large amount of unstable sediment that is transported gradually following the landslide. Most of the unstable sediment residing in a deep-seated landslide area is first discharged as debris-flow forms. Thus, after the occurrence of landslides, debris flows have a long-term affect on the watershed regime through their impact power, riverbed aggradation, and the production of turbid water, among other effects.

To facilitate better prediction of debris flows from landslide areas, this study investigated the interactions among topographic conditions, bed-material conditions, and debris flow events in a headwater catchment where a deep-seated landslide had occurred.

The study site was the Ichino-sawa subwatershed in the Ohya-kuzure basin, Shizuoka Prefecture, Japan. The basin experienced a deep-seated landslide about 300 years ago and is currently actively yielding sediment with a clear annual cycle. During the winter season, sediment moves from the hillslope to the channel bed because of freeze?thaw activity and weathering. In the summer season, the deposited sediment is discharged incrementally by debris flows related to storm events.

Topographical surveying and grain-size analysis were carried out several times between November 2011 and November 2013. Point cloud data were acquired during the topographical surveying, using a ground-based laser scanner, and used to create a high-resolution digital elevation model. Grain-size analysis was conducted in the upper, middle, and lower parts of the study site. A line-grid method was employed for the in situ analysis, and the fine particle fraction was determined by sieving the sampled materials. Debris flow occurrences were also being monitored in the same period by a sensor-triggered video camera. Rainfall was observed during the summer season for comparison with debris flow occurrence and magnitude.

Several debris flows with different magnitudes were observed during the study period. Although rainfall events in the early spring season altered bed inclination, the thickness of deposited sediment, and the grain-size distribution of the bed material, more significant changes were detected after the debris flows. While the initial grain-size distribution in early spring was roughly identical over the study site, the subsequent grain-size distribution changed differently, according to location. The source, transport, and deposition areas of the debris flows were different among different rainfall events, resulting in different transitions in geomorphic conditions at different locations. The lower part of the study site changed from a source area to a deposition area through the summer season.

A comparison of the topographic conditions, bed-material conditions, and debris flow events indicated that, in addition to the conditions of the triggering rainfall, topographic and bed-material conditions affected debris flow occurrence and magnitude. These interactions could be observed in the deep-seated landslide area, where a substantial and continuous supply of sediment prevents stabilization of the channel bed through exposure of bedrock or by armoring of bed materials.

Thus, to predict the long-term impact of large landslides, it is necessary to assess the subsequent debris-flow discharge considering the sediment dynamics and changes in topographic and bed-material conditions in the landslide area.

Keywords: debris flow, deep-seated landslide, topographic condition, grain size distribution