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

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Large-scale sediment movements, such as a deep-seated landslide, not only induce immediate sediment disasters but also produce a large amount of unstable sediment upstream. Most of the unstable sediment residing in the upstream area is discharged as debris flow. Hence, after the occurrence of large-scale sediment movement, debris flows have a long-term effect on the watershed regime. However, the characteristics of debris flow in upstream areas are not well understood, due to the topographic and grain-size conditions that are more complicated than the downstream area. This study was performed to reveal the relationship between such a riverbed condition and the characteristics of debris flow by field observations. The study site was Ichinosawa-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 is deposited on the valley bottom by freeze-thaw and weathering. In the summer season, the deposited sediment is discharged incrementally by debris flows related to storm events. Topographical survey and grain-size analysis were performed several times between November 2011 and November 2014. High-resolution digital elevation models (10 cm) were created from the results of a topographical survey using a terrestrial laser scanner. A grain-size analysis was conducted in the upper, middle, and lower parts of the study site. Debris flow occurrences were also monitored in the same period by a sensor-triggered video camera and interval camera. Rainfall was observed during the summer season for comparison with debris flow occurrence. Several debris flows of different magnitudes were observed during the study period. Although heavy rainfall events altered the bed inclination, the thickness of deposited sediment, and the grain-size distribution, more significant changes were detected after the debris flow. While the initial grain-size distribution in early spring was roughly identical across the study site, the subsequent changes in the grain-size distribution differed according to location. The source, transport and deposition areas of the debris flows differed among rainfall events, resulting in different transitions in topographic conditions at different locations. Furthermore, surges of debris flow not only induced erosion-deposited sediment but also suspended and deposited sediment in the same area during one typhoon event. A comparison of the results indicated that, in addition to the conditions of the triggering rainfall, topographic and grain-size conditions affected the debris flow occurrence and magnitude. These interactions also showed that the magnitude and form of the succeeding debris flow could be dominant, depending on changing riverbed condition by past debris flows in upstream areas.