Sediment disaster related to the October 16, 2013 rainfall-induced landslides and associated lahars at Izu Oshima Volcano, Japan

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Abstract

The October 15-16, 2013 torrential rainfall, associated with the typhoon T1326, generated numerous landslides on slopes covered by tephra-rich superficial deposits at Izu Oshima Volcano, central Japan. The landslides were concentrated mainly in a 2-km^2 area located on the western slope of the volcano. Most of the landslides occurred on slopes steeper than 20°, and were shallow soil slips (<2 m thick) in unconsolidated fallout tephra layers overlying lava flows and pyroclastic rocks. The rupture surfaces of them were located near the base of Y1 tephra (AD 1777-1778) and/or the base of Y4 tephra (AD 1421). The Y1 and Y4 tephras differ from the underlying paleosols in permeability, grain size and degree of compaction. The saturated hydraulic conductivities of the paleosols were one to two orders of magnitude smaller than those of the overlying Y1 and Y4 tephras. These physical differences of tephra deposits above and below the rupture surfaces promoted the retention of rainwater in the upper layer, leading finally to failure and mobilization of the saturated mass.

The associated rapid-moving lahars rather than landslides themselves severely damaged inhabited areas and caused 35 fatalities. The water-saturated sliding masses rapidly disaggregated and mobilized directly into lahars by overrunning stream flow and mixing with flow from tributaries. Although the lahars eroded slopes and transported boulders up to 1 m in diameter and a large amount of woody debris, they contained more than 90 percent of sand-to-silt-size particles, similar in composition to the original sliding materials. This phenomenon resulted from moving materials comprising fine tephra-fall deposits. Sediment discharge volumes from three basins due to the landslide-induced lahars were estimated at 1.8-4.1×10^4 m^3/km^2, based on debris volumes trapped by sediment retention dams. These volumes are the same order of magnitude with those of the 1953 and 1990 similar landslide and lahar disasters at Aso Volcano, southwestern Japan. The characteristics of rainfall-induced landslides and associated lahars at Izu Oshima Volcano in October 2013 provide an important lesson about future non-eruption-related landslide and lahar hazards at tephra-rich volcanoes.