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Extremely rapid debris slide - debris flows induced by extreme rainfall on Aso volcano caldera slope in July 2012

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An extreme rainfall affected Kyusuh Island of western Japan in July and induced hundreds of fluidized landslides claiming tens of casualties. Especially on the Aso volcano caldera cliff, a number of extremely rapid debris slide ? debris flows were induced and affected the downslope communities. Measured trigger precipitation was recorded by the nearby ground-based station of the AMeDAS network (Automated Meteorological Data Acquisition System) as about 80 mm/h for consecutive 4 hours. Analysis of Radar Rain-gauge Analyzed Precipitation operated by the Japan Meteorological Agency showed landslide affected area almost coincided with the ones of heavier precipitation. Most of the landslides were initiated on the boundary of strongly weathered soils, which used to be new volcanic accretion materials. Outstanding features of these landslides are: (1) This area had been affected by similar heavy rainfall decades ago, however, again a number of landslides took place in the nearby past scars; (2) Many of the soil slide bodies are shallow less than 5 meters deep and possibly immediately transformed into debris flows or mud flows and traveled long distance to reach the downslope communities; (3) Visual observation of the sources showed the high possibility that some of the slides were apparently induced by liquefaction. Similar cases were reported of past 2 landslide disasters in Japan. This strongly suggests that excessive rainfall can trigger numerous mud flows of unexpected reach. We conducted close field study at a typical soil slide - mud flow site. It originally initiated as debris or soil slide on a thin steep bedding plane of about 34 degrees consisting of coarser accretion materials. Needle penetration test showed comparatively weaker strength in the layer. It is underlain by a layer of finer materials. Such a higher permeability contrast could contribute to higher susceptibility of excess pore pressure generation. We took soil samples from the vicinity of sliding surface and conducted pore-pressure-controlled ring shear test. We increased pore pressure at constant rate

until failure after applying normal/shear stresses of certain ratio representing the steepness of the sliding surface for the normally consolidated (of 100 kPa) specimen prepared by disturbed samples. Immediately after failure took place, we observed quick and large drop of shear resistance in a few seconds. Although the applied normal stress of this test is larger than the actual one, this implied strongly the occurrence of the sliding surface liquefaction. The resultant shear resistance was so small and it can explain the mechanism of those long run-out and low apparent friction angle of those landslides.

Keywords: extreme rainfall, landslide, debris flow, excess pore pressure, caldera cliff