Examining the mobility of earthquake-induced landslides materials using small flume apparatus

*Rozaqqa Noviandi[1], Hefryan Sukma Kharismalatri[2], Takashi Gomi[3], Yoshiharu Ishikawa[3], Rasis Putra Ritonga[4]

1. Department of International Environmental and Agricultural Science, Tokyo University of Agriculture and Technology, Japan, 2. Institute of Global Innovation Research, Tokyo University of Agriculture and Technology, Japan, 3. Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 4. United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, Japan

The 2018 6.7 Mw Eastern Iburi Earthquake triggered more than 6,000 landslides on over 400 km^2 area in Hokkaido, Japan. Most landslides evolved into high mobility debris flow damaging infrastructures and agriculture lands. Because landslide mobility is one key factor for disaster risk reduction, we developed a two-segment flume apparatus representing hillslope and in-channel transport zones with 1/300 of geometric scale to quantify such mobility. Materials used in flume experiment were obtained from landslide deposits that mainly consists of less cohesive pyroclastic fall deposits derived from Mt. Tarumae (9 ka) and Mt. Eniwa (20 ka). The mobility of landslide materials was examined by combinations of various saturation (S=0-1.0) and soil types (andosol, pumice, and mixed materials). Velocity was measured from a high-speed camera with 0.2 s of shooting interval. Such a low cohesiveness caused the material to be progressively deposited during the motion. Hence, the kinetic friction coefficient was estimated based on the conservation of mechanical energy by considering progressive mass loss. The apparent friction coefficient, representing block movement, was measured by dividing total fall height over the run-out distance (H/L). Laboratory test characterized the material as coarse-grained or granular soils (D_{50} =0.5-5.4 mm). A threshold exists at under saturated condition altering the movement from low to high (hereinafter referred to as turning point, T_p), associated with inner-particle water absorption on pumice (S =0.56) and liquid limit on andosol (S=0.49). $S \leqq T_p$ inhibits the movement (e.g., velocity and run-out distance), and in contrast, enhances the movement when $S > T_p$. The apparent friction coefficient (0.26-1.0) that always lower than the kinetic friction coefficient (0.31-1.1) signifies that landslides with progressive mass loss have lower energy dissipation than those move as a block. Progressive mass loss on granular soils may allow the energy to be not thoroughly dissipated by friction. When some parts of kinetic energy are dissipated by friction resulting in deposition, the other parts are used for the movement. It causes the spread landslide mass to move further downslope. Moreover, variability in particle size distribution on mixed materials causes segregation, in which the finer and heavier particles segregate underneath the landslide mass, acting as a lubricant that enhances the movement. We found that soil characteristics are the most important factor for controlling the mobility of landslide materials by the Eastern Iburi Earthquake, followed by water content. We suggest that the variability in mobility might be associated with the variability of soil depth (stratigraphy) and initial water contents in sliding layers.

Keywords: earthquake-induced landslide, landslide mobility, flume experiment, granular volcanic soils

