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Landslide properties Controlled by the Denudation degree on Granite area in Japan

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In 2009, numerous shallow landslides were induced in a cretaceous granite region by heavy rainstorms in the area of the city of Hofu, Yamaguchi Prefecture, in western Japan. Fourteen people were killed by the debris flow. This area has a widely distributed plantation surface, and topography formed by denudation processes such as the 2009 landslides. The plantation surface area is known for the frequent occurrence of landslides in the past. However, the relation between the landslide properties and the degree of mountain denudation, which is important for predicting the landslide risk, has not been clarified. We examined the relation between the degree of mountain denudation and the shallow landslide properties [landslide density (number/km^2), landslide form, and soil layer structure].

First, we classified the slopes based on the degree of mountain denudation and interpretation of the 2009 landslide scars, using 1-m resolution DEMs, aerial photographs, and field surveys. As a result, the slopes were classified into three types as follows: (1) lightly denuded slopes (L-slope), (2) moderately denuded slopes (M-slope), and (3) heavily denuded slopes (H-slope). The landslide numbers were 23, 54, and 21 in the L-slope, M-slope, and H-slope regions, respectively. Next, we analyzed the landslide properties using ESRI ArcGIS10. The landslide densities were 77/ km^2, 115/ km^2, and 41/ km^2 in the L-slope, M-slope, and H-slope areas, respectively. The investigation area experienced heavy precipitation (about 250-300 mm per day). The landslide average volumes were 423 m^3, 401 m^3, and 173 m^3 in the L-slope, M-slope, and H-slope areas, respectively. The landslide average angles were 28.5°, 33.2°, and 40.4° in the L-slope, M-slope, and H-slope areas, respectively. Finally, we surveyed the landslide form and soil layer structure using detailed field surveys. The landslide form in the L-slope and M-slope areas was that of an “arc shape type”, and in the H-slope area was that of a “flat plate type”. The L-slope area was covered by thick weathered residual soils. The M-slope and H-slope areas were covered by colluvial soils. The M-slope area had a thick soil layer. In contrast, the H-slope area was dotted with rocks, and the soil depth was, therefore, low.

We found that these differences in landslide density and form, according to the soil layer structure and slope angles, were controlled by the degree of mountain denudation. In other words, the M-slope area was distributed in regions of thick soils and steep angles, causing landslides to occur most frequently. The H-slope area had steep angles but the soil depth was thin, so landslides occurred infrequently. These results suggested that classification of the slopes based on the degree of mountain denudation contributes to effective landslide risk assessment.