Statistical Distributions of Landslides Triggered by the 1968 M7.9 Tokachi-Oki Earthquake in Hachinohe, Japan

○Sixiang LING, Masahiro CHIGIRA

A comprehensive analysis of the distribution of landslides induced by the 1968 M7.9 Tokachi-Oki earthquake in pyroclastic deposits was conducted in Hachinohe, northeast Japan. 314 coseismic landslides were precisely identified through interpretations of high-resolution aerial photograph and 0.5m Light Detection And Ranging (LiDAR) data in a 50 km^2 area (Fig.1). The results indicate that landslide crown mostly occur near ridge crest or ridge shoulders.

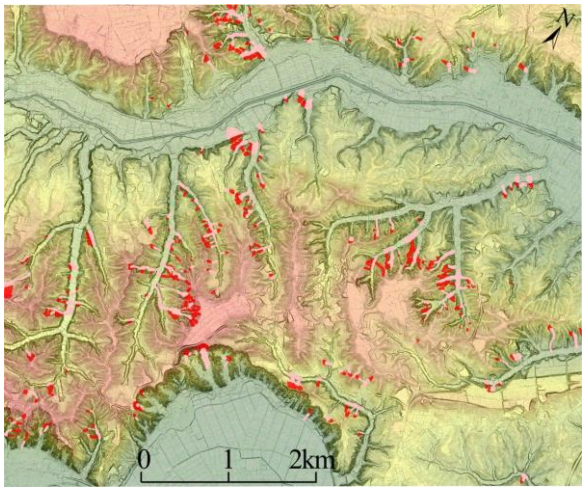

Fig. 1. Distribution of landslides triggered by the M7.9 1968 Tokachi-Oki earthquake.

Via GIS-based analysis on LiDAR map, geometric parameters of 314 coseismic landslides were obtained, including height, length, width, apparent friction angle (arc tangent of the height-length ratio), and length-width ratio. The fitting relationship of height and length from these data is H= 0.245L+1.970, with an average apparent friction angle of 13.8 °(Fig. 2). It is evident that landslides mostly occurred on gentle slopes lower than 30 ° with average slope angle of 26.4 ° (Fig. 3). It suggests that landslides are commonly mobile with low equivalent coefficients of friction, even for small-volume landslides (Fig. 4).

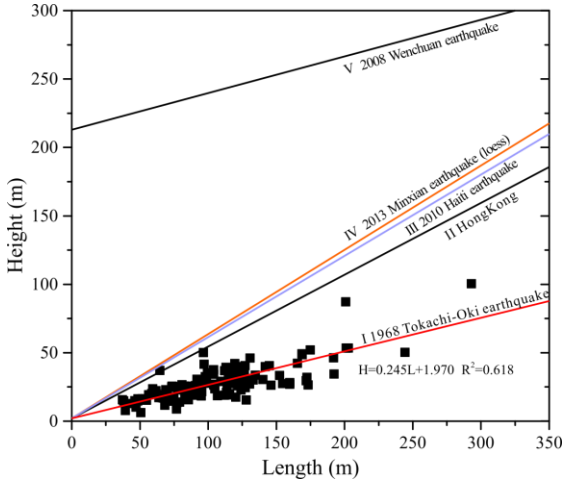

Fig. 2. Fitting curves of landslide height and length. *Curve I*: landslides of pyroclastic deposits (except channel type) induced by M7.9 1968 Tokachi-Oki earthquake; *Curve II*: landslides triggered by rainfall at Lantau Island, HongKong (Dai et al., 2002); *Curve III*: landslides triggered by the 2010 M_w 7.0 Haiti earthquake (Xu et al., 2014); *Curve IV*: landslides of loess induced by the M_w5.9 2013 Minxian earthquake (Tian et al., 2017); *Curve V*: long runout rock avalanches triggered by the M_s8.0 2008 Wenchuan earthquake (Qi et al., 2011).

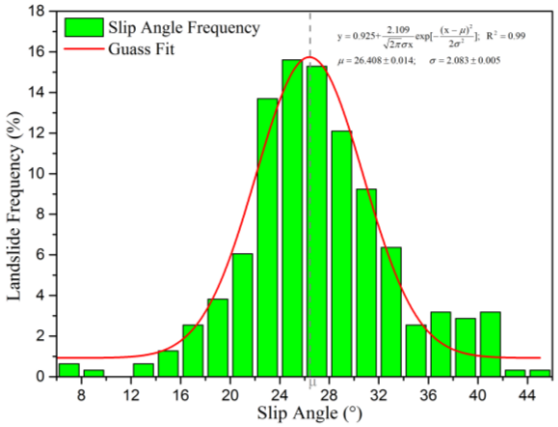

Fig. 3. The slope angles of the landslide source areas. Frequency of landslide source areas and its fitting function.

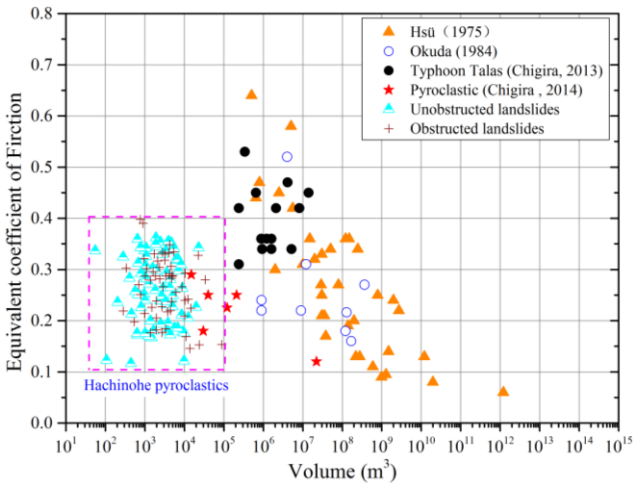

Fig. 4. Equivalent coefficients of friction plotted with landside volumes. Landslides of pyroclastic deposits are plotted far below the trend of the other landslides.

Statistics analysis of morphology of landslide and hillslope demonstrates that the cluster of landslide orientations tend to north-northeast-east, which appears to be related to the relative positions of the epicentes of the main shock and the aftershock (Fig. 5). Such phenomenon is likely caused by asymmetric amplification of oblique incoming seismic waves across mountain ridge crests or flank knick-points position. This study provides a framework for susceptibility investigation of earthquake-induced landslides in pyroclastic deposits materials.

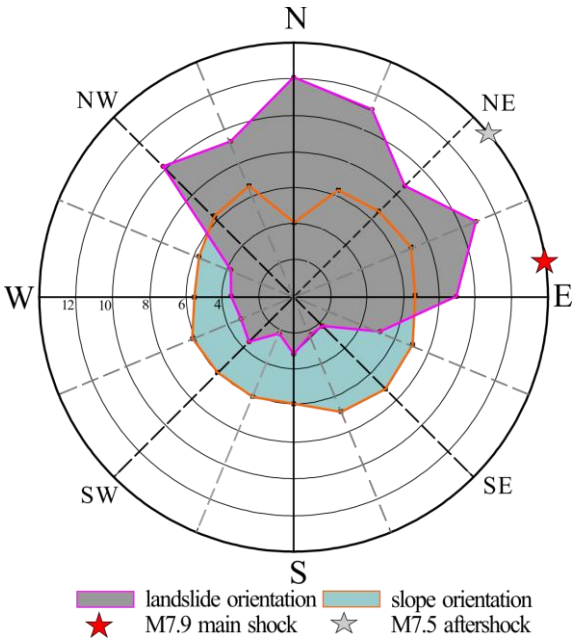

Fig. 5. Normalized distribution of orientation of the slopes (brown line) and landslides (purple line). Stars refer to the relative mean position of the epicenter in M7.9 mainshock (red) and M7.5 aftershock (grey).