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Slope failures caused by heavy rain and volcanic activity: a case study around Esan volcano, in Hokkaido

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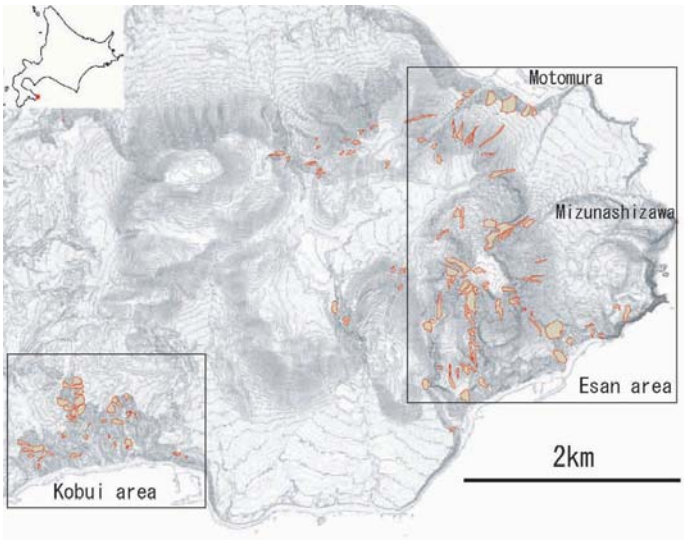

Heavy rain caused landslide disaster during the phreatic eruption of Esan volcano in 1846. The landslide disaster killed 53 people, the most victims in Hokkaido, by slope failures and debris flows. Landslide disasters repeatedly occur around Esan also after 1846. We consider the mechanism of the landslide caused by volcanic activity and climatic condition in 1846.
Takeshiro Matsuura illustrated debris flows around Esan volcano in "Ezo Nisshi " diary, when he visited in Esan in the next year of the landslide disaster. He drew larger debris flows in eastern Esan and Kobui than the others. Slope failures concentrate in Esan area and Kobui area (see the above map), which are the upper area of the debris flows, by aerial photos. Because alluvial cones develop the mouth of these valleys in both areas, raised bed rivers stand side by side along the coastline.
The volcanic ash of 1846 eruption spread east of Esan. Slope failures occurred in Esan area, because surface stream on the volcanic ash with low permeability concentrated in valleys in heavy rain. Mizunashizawa collapse is the greatest in these slope failures. The collapse discharged the lobes of debris flows. One of them flowed to the upper Motomura River. Though the debris flow deposit is not distributed in Motomura village, located at the mouth of the river, this village is most heavily damaged in this disaster. Therefore, flash flood with low-density sediments would strike this village. In the other hand, because the volcanic ash of 1846 eruption is not distributed in Kobui area, the cause of the slope failures is not the volcanic ash. The slope failures occurred from marine sand gravel layer to Es-P3, pyroclastic flow deposit, distributed in this area. Es-P3 is cap rock of the sand gravel layers. Because Es-P3 is low permeability, surface stream predominates and erosion activity is strong along valleys by heavy rain in Kobui area.
The 1846 landslide disaster in Esan was caused by low permeability materials, the volcanic ash of phreatic explosion and Es-P3 pyroclastic flow deposit. Because rain water flowed on the surface of the slope and in the subsurface layer on the materials, the slope erosions and the slope failures occurred by the heavy rain in Esan area and Kobui area.

Keywords: slope failure, heavy rain, permiability, phreatic explosion, pyroclastic flow deposit, Esan volcano