

Topographic features of snowmelt-induced landslide locations with long travel distances in Japan

Shin'ya KATSURA^{1,*}, Takashi KIMURA¹, Kazuhiro HATADA², Kiyoteru MARUYAMA¹
and Kazuya AKIYAMA¹

¹ Snow Avalanche and Landslide Research Center, Public Works Research Institute, Japan

² Nippon Koei Co., Ltd., Japan

*Corresponding author. E-mail: s-katsura@pwri.go.jp

INTRODUCTION

In Japan, landslide disasters are common and often cause severe damage to human life, property, and infrastructure. One of the main causes of landslides is infiltration of snowmelt water into landslide blocks. Such snowmelt-induced landslides are often generated in areas along the Sea of Japan due to heavy winter snowfall. In some cases, landslide mass travels long distances, leading to large-scale sediment-related disasters. As a first step in predicting such disaster events, we analyzed the topographic features of previous snowmelt-induced landslide locations.

METHODS

Data of 76 snowmelt-induced landslides occurring from 1947 to 2012 in Japan was analyzed in this study. The data including date of occurrence, location, horizontal length of the collapsed slope ($L1$, in meters), and travel distance of the displaced mass ($L2$, in meters) was obtained from descriptions and figures in reports of disaster-related projects and/or previously published articles for each event. In the collected data, $L1$ ranges from 30 to 3,600 m and $L2$ from 0 to 6,500 m.

To examine the effect of travel path of collapsed materials on $L2$, the study area was divided in 10-m grid cells, which were further classified as headwater valleys, floodplains (including river beds), or slopes following the GIS-based procedure described in Kimura et al. (International Journal of Erosion Control Engineering; accepted). Using this classification, the 76 cases were divided into three categories based on their travel paths: landslides traveling along headwater valleys (HV), floodplains (FP), or slopes (SL).

Landslide slope category (primary or reactivated) of each landslide was investigated using the landslide distribution maps developed by the National Research Institute for Earth Science and Disaster Prevention. Landslides with area of the collapsed slope totally or partially overlapping the area of displaced mass shown on the maps were regarded as reactivated, and the others were regarded as primary.

RESULTS AND DISCUSSION

Fig. 1 shows the relationship between $L1$ and $L2$ for each travel path category. In this study, we define the landslides that had $L2$ greater than $L1$ (i.e., plotted above the 1:1 line in Fig. 1) as landslides with “long” $L2$.

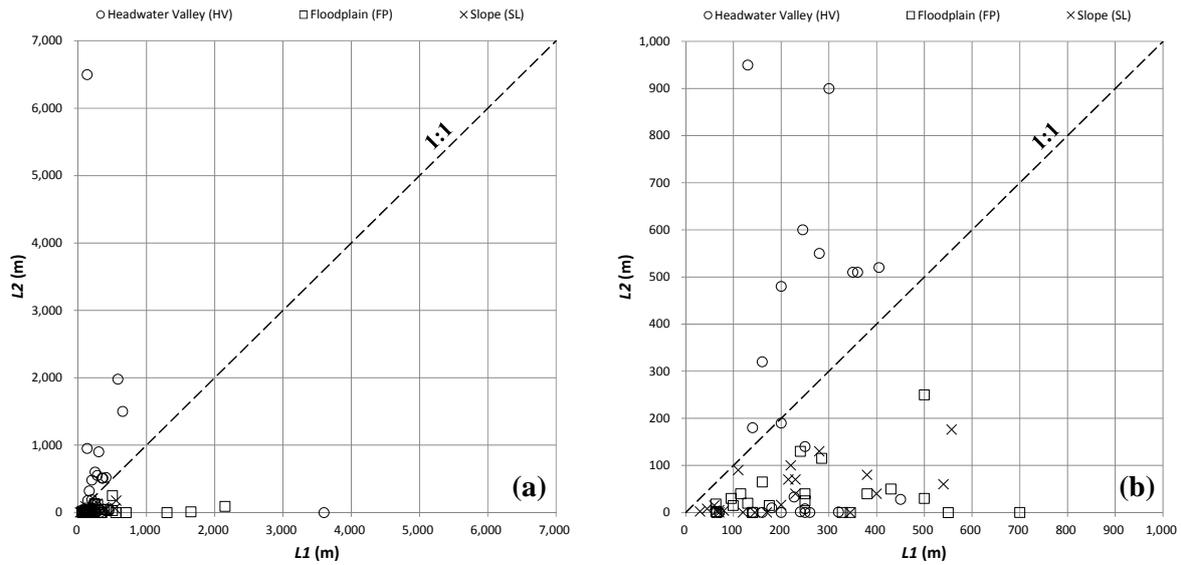


Fig. 1 Relationship between $L1$ and $L2$ for (a) all plots and (b) ranges of 0–1,000 m

Fig. 1 demonstrates that all plots for the FP and SL categories are below the 1:1 line, suggesting that $L2$ was not so long. Plots above the 1:1 line correspond to the HV category landslides. Detailed examination of these cases suggested that in these cases, landslide masses were liquefied and sometimes transformed into debris flow, hence travelling long distances along headwater valley.

Tab. 1 shows the numbers of primary and reactivated landslides for each travel path category. The percentage of reactivated landslides is >70% for all categories. The ratio for the HV category is highest in all categories at 89%. Eighty percentage of the total cases were reactivated landslides.

Tab. 1 Numbers of primary and reactivated landslides for each travel path category

Travel path Category	Primary	Reactivated	Total
HV	3 (11%)	25 (89%)	28
FP	7 (27%)	19 (73%)	26
SL	5 (23%)	17 (77%)	22
Total	15 (20%)	61 (80%)	76

CONCLUSIONS

This study analyzed the topographic features of locations of snowmelt-induced landslides with long travel distances in Japan. The results suggested that such landslides tend to have travel paths in headwater valleys (i.e., HV category) and occur at slopes that have experienced past landslide events (i.e., reactivated landslide). Future studies should be conducted to develop a method for predicting the area damaged by such landslides, which will hopefully contribute in preventing and/or reducing large-scale sediment-related disasters.

Keywords: snowmelt-induced landslide, travel distance, travel path, reactivated landslide