Recent landslides by natural geologic hazards in Hokkaido

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This report describes characteristics of landslides that were caused by natural geologic hazards during the last decade in Hokkaido. A geologic hazard is a geologic condition or phenomenon, natural or brought about by human activity, that represents a threat to human life, welfare and property (Neuendrof *et al.*, 2005). The natural geologic hazards are such conditions or phenomena which can lead to losses through landslides, floods, earthquakes, coastal and beach erosion, faulting and so on. Hokkaido had 53 cases of landslides by natural geologic hazards from 2008 to 2019 (figure 1). The hazards such as rain, snow-melt, earthquake and flood caused a lot of landslides.

Firstly, landslides occurred frequently in a snowmelt season. The landslides in a snowmelt season are as much as in a rainy season. Both rapid snowmelt and rain often caused landslides.

Secondly, heavy rain by typhoon caused many landslides on paleo-periglacial slopes. Especially in 2016, four typhoons had hit or come close to Hokkaido from the Pacific Ocean for the first time. The typhoons caused heavy rain, and caused a lot of landslides on paleo-periglacial slopes. The periglacial slope had evolved under cold-climate conditions primarily by mass-wasting processes of solifluction in last ice age. Surface water eroded ill-sorted angular debris on the periglacial slope in the behind of the road.

Thirdly, the 2018 Hokkaido Eastern Iburi earthquake lead more than 6,000 landslides however landslides by earthquake were only two cases during the last decade. Numbers and collapsed area of the landslides were the most abundant in a history. A Ta-d tephra fall layer was a slip surface to cause the landslide. The Ta-d is a pumice fall layer, which had been erupted by Tarumae volcano about 9,000 years ago. It is considered that excess pore water pressure given by crushing the weathered pumices lead so many landslides.

A landslide is known to occur repeatedly at a same place by natural geologic hazard. Histories of the geologic hazards are the key to avoid and mitigate disasters.

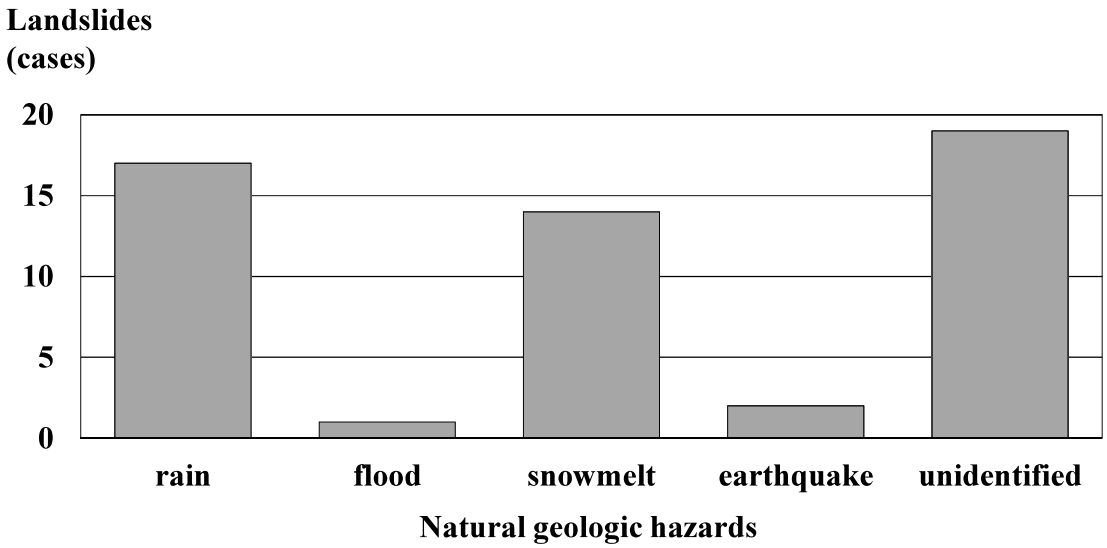

figure 1. 59 cases of Landslides by natural geologic hazards in Hokkaido from 2008 to 2019.

Heavy Rain and Landslide Disaster of July 2018 in Western Japan

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Heavy rains, mainly in western Japan in July 2018, caused widespread and catastrophic disasters. The seasonal rain front was stagnated for three days and squall lines were formed, resulting in record rainfall in various places. Areas of heavy rainfall ranged from Kyushu, Chugoku, Shikoku, and Kinki to the Chubu region. In Gifu, Kochi, and Tokushima prefectures, continuous rainfall exceeded 1,000 mm. Along with this, there were more than 2,500 landslide disasters, and many river inundations occurred. The number of dead and missing persons related to this disaster was 245.

After these disaster, the Japan Society of Engineering Geology (JSEG) immediately formed a disaster research team consisting of 76 people, conducted surveys in many fields such as detailed records of disaster, cause of disaster, recovery after disaster, and evacuation behavior, and compiled 29 reports. Here are some of the results.

In Hiroshima Prefecture, debris flow disasters occurred mainly in Higashi-Hiroshima City and Kure City. The disaster situation was understood over a wide area using satellite imaging, and the damage characteristics were analyzed. And, it was clarified that the characteristics of the debris flow and the damage situation were different depends on geology and topography. In addition, a comparative study was conducted with the debris flow disaster that occurred in the same area in 1945, and it was shown that the debris flow that occurred in the same valley had a different location of the collapse site as the source.

In Mabi-Town, Okayama Prefecture, a wide-area inundation disaster occurred downstream of the Oda River in the Takahashi River system. In the area where the inundation damage occurred, the changing of land use in about one century was clarified, and the state of transmission of past disasters records were investigated. And, by analyzing DEM data by LiDAR, topographical features such as differences in the height of the river embankment where overflowed or destroyed, and flooded areas were clarified (Fig. 1). In addition, we interviewed many residents about the inundation start time and showed how the inundation progressed on time line.

Many slides occurred in Uwajima City, Ehime Prefecture. The Study Team conducted

intensive surveys on these areas and identified topographical and geological features at many points. It was also suggested that the frequent occurrence of slide was related to mineral veins (laumontite) formed in the sandstone layer. It is known that the volume change of laumontite occurs due to dry and wet conditions, and it is reported that laumontite is often formed in the Shimanto group, which constitutes the geology of this area.

At JSEG, the results of these surveys were compiled as a report, and one year after the disaster, a debriefing session were held in Okayama University for citizens and researchers. We hope that these results will help all people to consider countermeasures for the upcoming disaster.

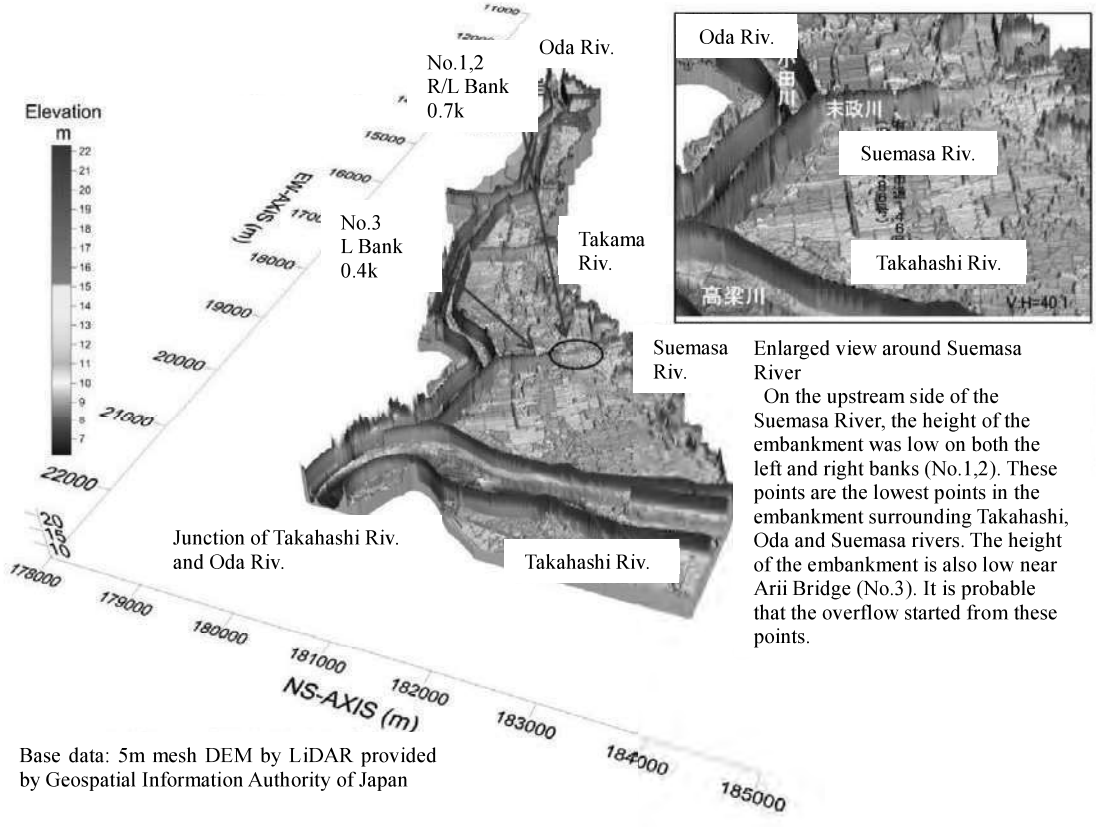

Fig.1 Bird view around the junction of Takahashi River and Oda River