Characteristics of Deep Catastrophic Landslides around the World: Occurrences and Distributions

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INTRODUCTION

Deep catastrophic landslides (DCL) had induced various subsequent disasters such as debris flow and natural dam formation. With failure depths that gernerally more than 10m, DCL have occured in many regions if the world (Korup et al., 2007). Estimating the magnitude and frequencies of DCL are one of the key components for developing their counter-measurement. Hence distributions, occurrences, and characteristics of DCL need to be analyzied comprehensively to understand patterns and thier magnitudes (Uchida and Nishiguchi, 2011) and their resultant damage. Therefore, the objectives of this study are to (1) gather information on the DCL that have occurred in Japan and around the world and (2) examine the distribution and occurrences of these DCL. This study primarily focuses on landslides with more than $10^4 m^2$ in area and 10^5 m^3 in volume.

METHODOLOGY

We collected data from previously published literature and developed a database in ArcGIS. In this database, we included a various technical terms such as “landslide”, “giant landslide”, “deep-seated landslide”, “rockslide”, and “catastrophic landslide”. We summarized latitude, longitude, altitude, country, year of occurrence (or period of years), area and volume, depth of mass movement, and triggering factors (i.e., rainfall, earthquake, or volcanic activates).

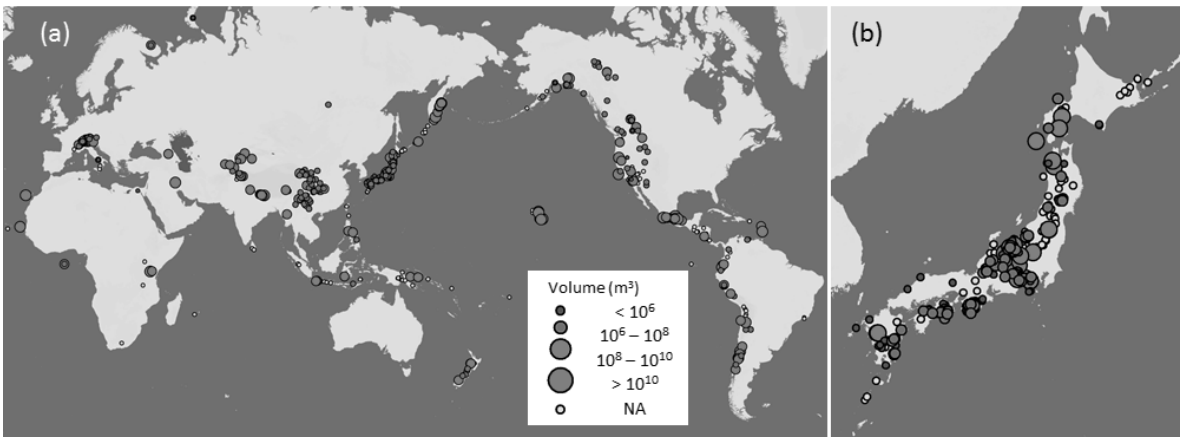

Fig. 1 Occurrences of deep catastrophic landslides (a) around the world and (b) in Japan. Sizes of circles indicate the volume of landslides.

DISTRIBUTIONS AND OCCURRENCES

We identified 482 DCL occurred worldwide since 1800. DCL with large volumes and areas occurred within tectonically active regions such as western Japan, Southeast Asia, New Zealand, the western part of the American continents, the European Alps, and the Himalaya (Fig. 1a). In Japan, DCL have occurred along the median tectonic line and in those parts of Hokkaido areas where in uplifting rates range from 1 to 5 mm yr^{-1} (Fig. 1b). Since 1900, the reported DCL have been increasing. The pattern of dataset indicated that large DCL have become much better known since intensive and detail investigations started being conducted after disasters. This may also relate to social awareness and increasing impact of DCL around the world. Other associated factors may include rapid population growth and land use changes around mountainous regions in developing areas.

CHARACTERISTICS AND TRIGGERING FACTORS

In Japan, most of the DCL volumes appear to range from 10^5 to 10^7 m^3. In the DCL volumes in the global dataset show a peak at $10^8 m^3$. Differences in triggering factors of DCL may also affect DCL volume (Fig. 2). Rainfall-induced DCL are dominated by volumes ranging from 10^5 to 10^6 m^3, whereas DCL triggered by earthquakes and volcanic activities have volumes ranging from 10^6 to 10^8 m^3, and more than 10^9 m^3, respectively.

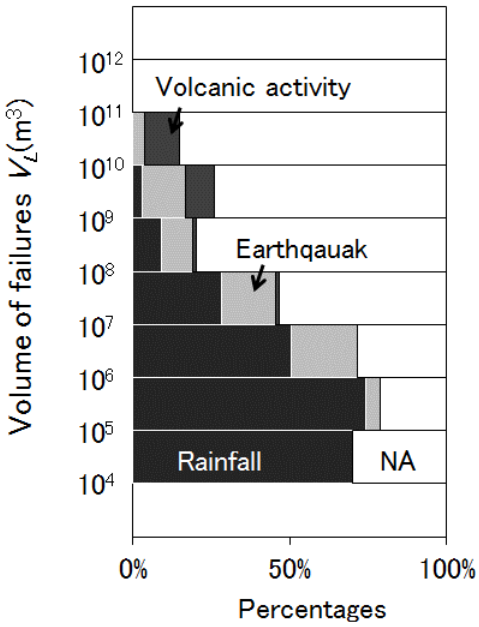

Fig 2 Triggering factors of deep catastrophic landslides.

SUMMARY AND CONCLUSIONS

Comprehensive perspectives and analysis from small to DCL are important for determining their characteristics (Klar et al., 2012). With frequency information for DCL, the spatial and temporal patterns of sediment movement can be characterized, and it may be possible estimate the resultant disasters and damages. These worldwide database and shared information will aid the development of a platform for international cooperation in sediment management related to disasters and mitigation.

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