PROBABILISTIC METHOD FOR ASSESSING DISASTER RISK DUE TO DEEP-SEATED CATASTROPHIC LANDSLIDES IN JAPAN

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Key Points

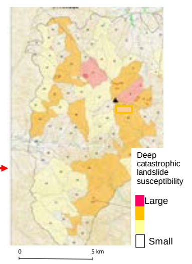
- We proposed a new simple risk assessment method for disasters due to deep - seated landslide for each village.
- We expect that local government and municipality can evaluate the risk of deep-seated landslide disasters for each village by themselves, since our method is simple,

Background

- In Japan, soil and weathered bedrock have the potential to slide simultaneously. These landslides often move rapidly, triggering debris flows and dam formation. Such landslides are referred to as "deep-seated catastrophic landslides" or DCLs.
- In 2011, we published the "Deep Catastrophic Landslide Frequency Map of Japan". We also developed a new method to estimate DCL susceptibility for many small catchments (ca. 1 km2) (Uchida et al., 2011) and applied this method in a nationwide DCL susceptibility assessment.
- However, it remains difficult to assess (1) the probable scale of a future DCL and (2) the areas prone to DCLs.

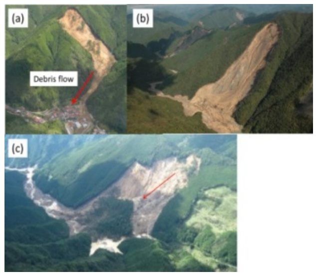
DCL Frequency Map of Japan

Regional scale DCL Susceptibility Map

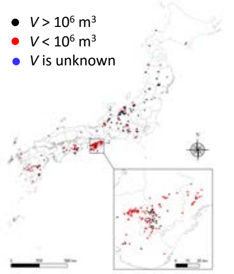


What is DCL?

In this study, landslides with $V>10^5$ m^3 or $A>10^4$ m^2 were compiled. Landslides that turned into debris flows (Photo a), slide in many fragments (Photo b) were included. If more than half the volume of landslide runout from landslide scar, this landslide was also included (Photo c). We excluded slow failures of a more chronic nature.



Recent DCLs in Japan

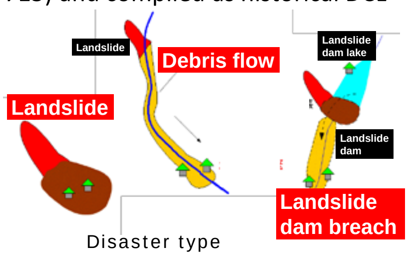


Location of historical DCL

Data analysis

A literature search identified about historical300 Japanese DCL-induced disasters (since AD 715) and compiled as historical DCL inventory database.

We quantify the distance from the DCL to the lower end of the damaged area (travel distance) and landslide area and clarified disaster type.



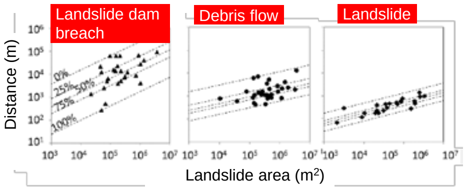
Disaster type

Travel distance

An empirical method for assessing the probability that DCL-induced sediment flows or flooding would reach a village.

We examined the relationship between travel distance and the landslide size for each disaster type using the historical DCL inventories..

We found that the travel distance was affected by disaster type and landslide area. We proposed a probabilistic relationship between travel distance and landslide area

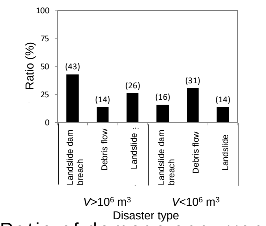


Relationship between travel distance and landslide size. Lines in figures indicates probability of damage occurrence

Disaster type

We examined ratio of damage occurrence due to each disaster type to all DCL-induced disaster using the historical DCL inventories.

We found that disaster types was affected by landslide volume.



Ratio of damage occurrence due to each disaster type

Method for risk assessment

We proposed a probabilistic method for assessing the risk of disasters due to a DCL.

We evaluated the risk of disasters due to a DCL for each village (R) using the following equation

$$R = P_l \times P_t \times P_a$$

where P_l, is probability of DCL occurred in the upper area from the village, P_t, is probability of given disaster type induced when DCL occurred, and P_a is probability that DCL-induced sediment flows or flooding would reach a village

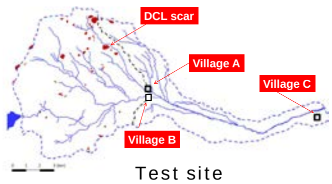
We surrogate P_l, as the number of ancient DCL scars in the upper area (n) So, we calcuratedas R as follow

$$R = \sum_{i=1}^{n} P_L P_a$$

Example

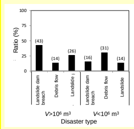
We mapped the spatial pattern of ancient DCL scars mapped from stereoscopic aerial photo.

We plotted the relationship between distance from the village to DCL scar and scar area to quantify P_a.

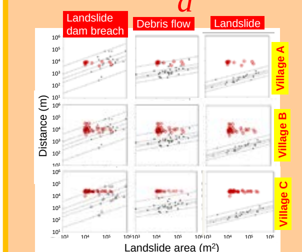


Test site

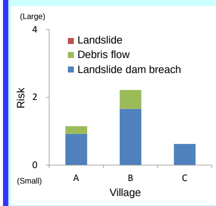
P_t × P_a = R



Ratio of disaster type



Relationship between distance from the village to DCL scar and scar area



Results of risk assessment

Reference Uchida, T., et al.(2012) - Assessment for susceptibility of deep catastrophic landslide induced disasters in Japan. Proceeding of 12th INTERPRAEVENT, 1, 609-618.