Rainfall Induced Slope Failure Risk Assessment in Nobori River Basin, Japan

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INTRODUCTION

The 2011 torrential rain events in Niigata and Fukushima featured unprecedented downpours in the Uono River Basin, an area under the jurisdiction of the Yuzawa Sabo Office. This rain induced repeated and simultaneous slope failures as well as accompanying sediment discharges throughout the basin.

Unprecedented torrential rain occurs every year at sites throughout Japan; preparation is, therefore, required to deal with similar damage in the future. Specifically, risk assessments of sediment movements that take into account past incidents of similar natural disasters as well as measures to prevent and counter such movements based on relevant priorities are desirable.

Therefore, this study will focus on the Nobori River Basin in the Uono River system. Furthermore, we will use a physical model for investigating a method of assessing the risk of simultaneous multiple shallow slope failures in a large-scale basin.

STUDY METHODS

（１） Measuring soil layer thickness

This study focused on the finding [1)] that the soil layer composition in a mountainous area differs according to the terrain’s degree of dissection. The study consequently divided the area into three regions based on the degree of dissection: gentle slopes near the summit (Gen-S), upper dissected slopes (Up-S), and lower dissected slopes (Low-S). Then, soil layer thickness was sampled in each geographical region and the results were applied to the areas at large.

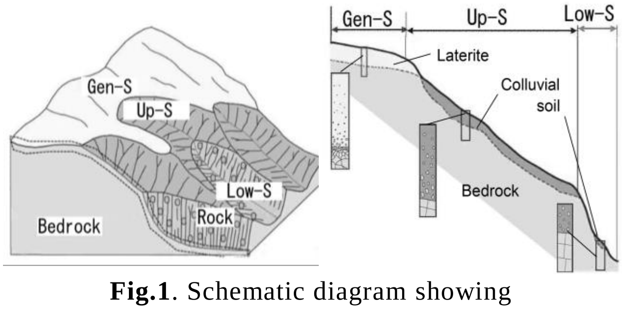

Fig.1. Schematic diagram showing the mountain denudation classification

（２） Method of assessing slope failure risk

The risk of slope failure was assessed using a simple model that combines slope stability analysis with a hydrological model that presumes a steady state (H-SLIDER method [2]). The H-SLIDER method assesses the risk of slope failure by dividing the area into a grid and assessing risk per cell using infinite slope stability analysis. It is presumed that when a point is found that has a stability ratio of 1.0, through infinite slope stability analysis, it is possible to calculate backward to find the smallest possible rainfall intensity (rc) that could possibly cause slope failure and assess the risk of surface failure for "rc" of all sizes.

RESULTS

（１） Results of the soil layer thickness survey

After the target area was geographically divided, it was found that the Low-S of the Nobori River represented the largest area and the greatest rate of dissection progression. When soil layer thickness was assessed in each division of the landform, it was found that soil layers were the thinnest on the lower dissected slopes and thickest on the upper dissected slopes, with soil layer construction differences dependent on the degree of dissection (**Fig.2**).

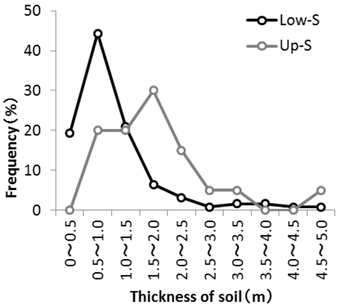

Fig.2. Results of soil thickness survey

（２） Assessing risk at slope scale

Using the soil layer thickness assessment results, an assessment of risk at the slope scale was conducted and its conformance with past slope failures was assessed. Soil strength, incorporating risk assessment, was evaluated using soil test analysis of samples collected from nearby basins of identical geology. As a result, cells where the risk of failure was high were distributed in landslide area, and conformity with actual past failures was high.

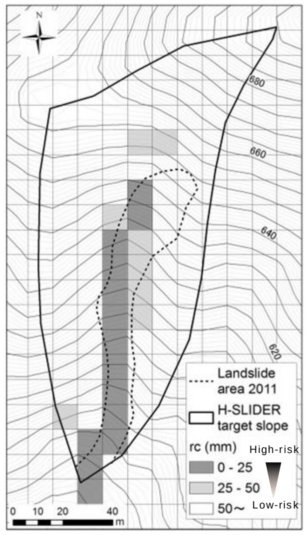

Fig.3 Results of risk assessment using the H-SLIDER method

CONCLUSIONS

This study suggests that division of the target landform (based on the degree of dissection and soil layer thickness in each section) allows for risk assessment, which reflects the soil layer characteristics of the basin, to be conducted. This method is considered to offer an effective means of assessing the risk for surface failures in a large-scale basin.

REFERENCES

[1] Matsuzawa, S. *et al.* (2015). *Topography*, 36(1), p. 23-48.
[2] Public Works Research Institute (2009). *Public Works Research Institute Samples*, No. 4129.

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