The attempt to use deep learning to forecast the frequency of landslide hazards (Research period: FY 2017–2018)

Yamato Suzuki, Researchers Tomoyuki Noro, Head Joko Kamiyama, Senior Researcher
Hikaru Todate, Guest Research Engineer Sabo Risk-Management Division, Sabo Department

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1. Introduction

Triggers, such as rainfall and earthquakes, and factors, such as terrain and geological features, greatly affect the onset of landslide hazards. Studies have confirmed that differences in the factors, as well as the magnitude of external forces, or the factors, of course, would result in different conditions in the onset of landslides.

Forecasting of the scale of collapses in landslide hazards is extremely important in terms of both structural and operational measures in order to manage them. Specifically, operational measures to manage landslides are targeted across wide areas covering multiple river basins. Various landslide forecasting methods have been examined using different types of statistical analyses. Still, the statistical analyses reached limitations in properly extracting the characteristics of factors associated with the onset of landslides from factors based on complicated relationships among multiple elements.

Thus, this study started using deep learning as a new approach to categorize the characteristics of factors associated with landslide hazards. This paper introduces an outline of the study.

2. Content of this study

This study expresses the terrain and geological data as characteristics of the factors by adjusting and convoluting the permeation rate, colorations, and other factors and uses images in which all of Japan is divided into 1 km grids as learning data. Deep learning is conducted using convolutional neural networks without giving teaching data to form the clusters of the amount of characteristics seen in the learning data and to categorize the learning data based on whether they have similar characteristics of factors. The study then analyzes the scales and conditions of past landslides in the learning data, which are categorized into the same group to observe the characteristics of landslide hazards that may occur in association with the characteristics of factors for individual groups. For example, multiple hazards involving multiple debris flows in multiple valleys are categorized into the same group. In this case, the system forecasts the onset of multiple debris flows resulting in serious damage to communities located at the end of valleys if a similar record-breaking rainfall were to be observed in a different area categorized into the same group. The system is expected to produce similar forecasts when similar groups are formed for areas with frequent small-scale landslides and areas prone to massive deep-seated landslides.

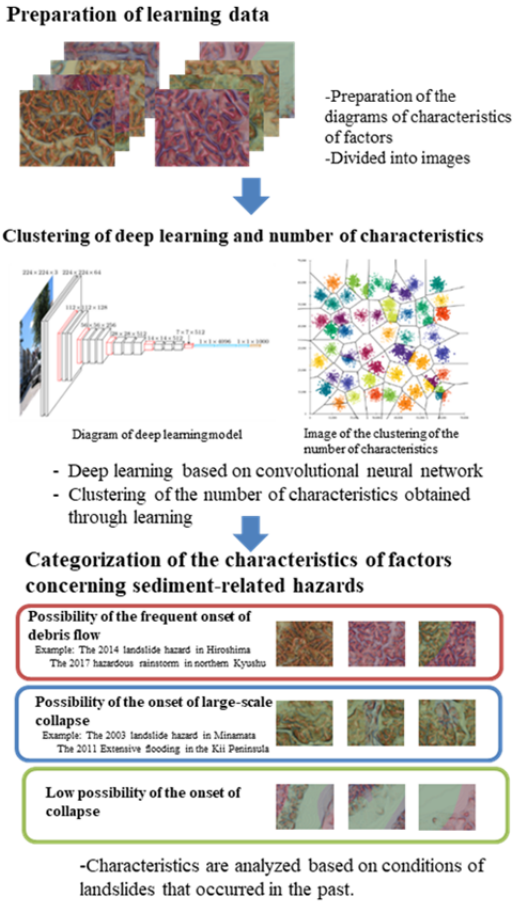

Figure: Categorization of characteristics of factors through deep learning

3. Future perspectives

Future studies will continue exploring methods to connect the types of landslide hazards, such as types of soil movement and their scales and specific ways to utilize quantitative forecasting results with the effective issuance of warning and evacuation orders along with the exploration of methods to prepare suitable learning data for extracting the characteristics of factors and learning models useful for forecasting the onset of landslide hazards.