Can we detect the acceleration of long-term gravitational deformation on steep slopes before catastrophic events? -A case study on two large-scale rapid landslides in Kii peninsular, Japan-

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1. Introduction

Landslides are the combined effect of the risk and trigger mechanisms. To clarify the collapse process, collecting and analyzing multiple cases should be collected, analyzed, observed, and evaluated over a long period of time. The 2011 typhoon talus that hit the Kii Peninsula in Japan, along with the accompanying heavy rainfall, triggered several large and rapid landslides with volumes larger than 105 m^3 (Chigira, 2013).

2. Method

Table 1 shows the target sites, some of which had been observed several times from 1948 to May 2012, after the disaster. We recorded qualitatively the surface deformation on the high and steep slopes through field survey and “sequential-comparative air-photo analysis” using aerial photographs obtained during five seasons.

3. Result

3.1 Akatani

Figure 1 shows Area B already shows a clear decay surface in the 1948 aerial photograph. Aria B's moving bodies have been lost because of collapse. This area corresponds to the undercut slope of Akatani, and side erosion by rivers is considered to have caused past collapse.This Area received heavy rain together with the previous deformation from 1994 to April 2011.Consequently, the entire C became unstable and slid along with the upper Area A. This reasoning is clear in the following points of the 2011 aerial photograph. The collapse of Area C occurred, and the upper bare-land area increased.

3.2 Nagatono

This deep-sheeted landslide can be divided into nine areas (A to I). Each area is surrounded by a thick broken line inside the main scarp, which shows the sliding cliff that is the outermost part of the 2011 collapse. The deformation structure is a cliff-like steep slope with a small displacement at the head of Area A. The lower part of the slope was displaced downward using this steep cliff as a sliding cliff. Area C is a valley with a depth of 370 m, and its lower part reaches the riverbed of Nagatono Area D has repeated small-scale collapse.

4. Discussion and Conclusion

To predict the location of the deep-sheeted landslide, we performed a comparative interpretation using the aerial photographs taken during the five periods before the disaster. Therefore, we found some displacement and deformation in the microtopography that was a precursor to the heavy-rain disaster of September 2011.

In the future, we will expand the survey area both locally and temporally to clarify the development process and try to make it compatible using quantitative methods, such as the aviation laser measurement data method.

Reference

Chigira, M., Tsou, C.-Y., Matsushi, Y., Hiraishi, N., and Matsuzawa, M.(2013) Topographic precursors and geological structures of deep-seated catastrophic landslides caused by Typhoon Talas, Geomorphology vol.201, pp.479-493.

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Table 1 Using date of sequential-comparative air-photo analysis

No.	date	Planning organization	Photograph	Scale
①	Nov./1948	U.S. Army	monochrome	1/40,000
②	June/1976	Geographical Survey Institute	color	1/15,000
③	May/1994	Nara Prefecture	monochrome	1/16,000
④	May/2004	Nara Prefecture	monochrome	1/16,000
⑤	April/2011	NTT GEOSPACE CO.,LTD.	color	1/10,000
⑥	May/2012	NTT GEOSPACE CO. **LTD.**	color	1/5,000

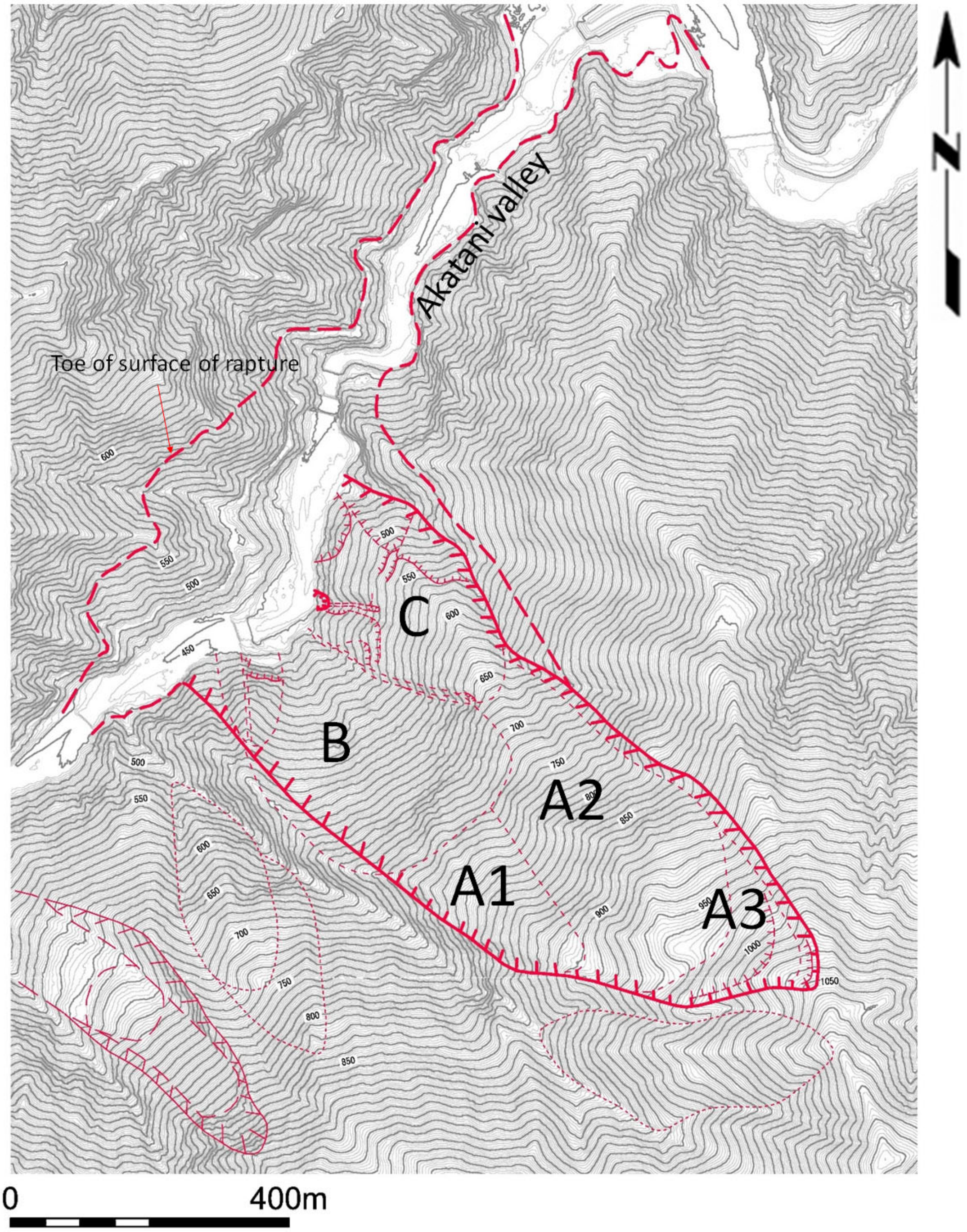

Fig-1 Distribution map of topographic features changes owing to the slope failure of Akatani.

