

# Landslides and Subsequent Debris Flows Occurrence on May 2017 at Iiyama, Nagano, Japan

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## INTRODUCTION

On 19 May 2017, landslides occurred and a landslide dam formed at Idegawa River watershed, Iiyama city, Nagano prefecture. After three days interval, debris flows occurred several times at Idegawa River then some of them reached Chikuma River. Although there were no loss of lives or property damage, an evacuation advisory was issued on 20 May, and then it was changed to evacuation order on 22 May. After 23 June, this area had been under evacuation advisory again until November 20. After the disaster, The Shin-etsu Branch of Japan Society of Erosion Control Engineering immediately organized research team. In this paper, magnitude and the generation processes of landslides and subsequent debris flow occurrence were described based on a field survey, weather observation data and the airborne laser scanning and videos.

## OUTLINE OF LANDSLIDE SITES

Idegawa River is a tributary of Degawa River in the Iiyama, Nagano, Japan. Degawa River flows into Chikuma River, which is the upstream part of Shinano River. Landslides occurred on the 30 degree slope at the elevation between 720-800m (Figs. 1 and 3). Geology around the landslide sites is Nonomigawa pyroclastic rock (Pleistocene series in the Quaternary Period). This area is a heavy snow area. When the landslides occurred, the ground surface around the landslide site was still partially covered by the snow. Based on the snow depth record at Sasagamine monitoring station operated by NIED(N36°52'5", E138°4'42", 1,310m alt.), it was estimated that snowpack was melting rapidly at the rate of 89mm /day during May 12–18, due to the increase of the temperature, and that much snow melting water supply triggered landslides and subsequent debris flows.

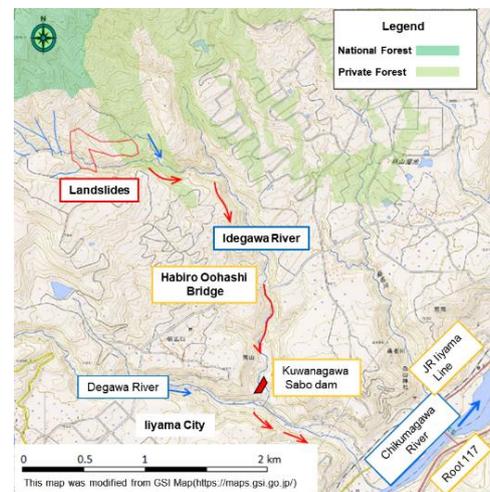


Fig. 1 Location of the landslides



Fig. 2 Orto-image of landslides (created by JCE Co. Ltd., July 3, 2017)

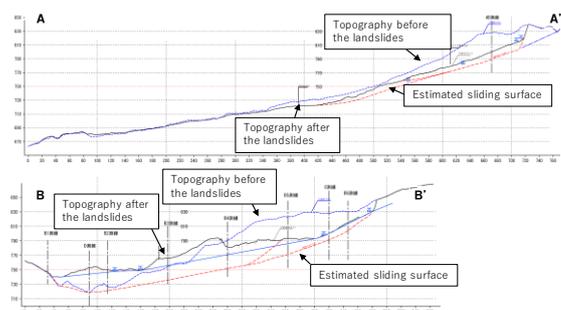


Fig. 3 Longitudinal profile of landslides

## LANDSLIDES AND A LANDSLIDE DAM

Considering the results of our field survey and analysis using aerial video images, it was estimated that two landslides took place around 6 o'clock on May 19. The shallow landslide occurred on the slope A and flowed down along the main stream of Idegawa River. The rotational type landslide occurred on the slope B, blocked the right tributary of Idegawa River and formed a landslide dam (Fig. 3). The length and height of the landslide dam is 310m and 25m. At the upstream side of the landslide dam, five landslide-dam-lakes (LSD A-E) were formed. The LSD A, which located at the most upstream, was the largest (length 100m, area 3000m<sup>2</sup>, depth 10-12m). Others were small (depth 2-3m). Nagano prefecture installed a water level gauge and an IP camera at the LSD A to monitor the water level change and 10 inclinometers to monitor movement of landslide dam. At the record breaking rainfall event (accumulative rainfall 173mm, maximum 24 hours rainfall 162mm) from Jun 30–July 2, the downstream part of the landslide dam body collapsed (Fig. 4). After the collapse, the water level at the LSD A decreased by 70cm and its area decreased. The area of LSD B also decreased and the LSD D & E disappeared.

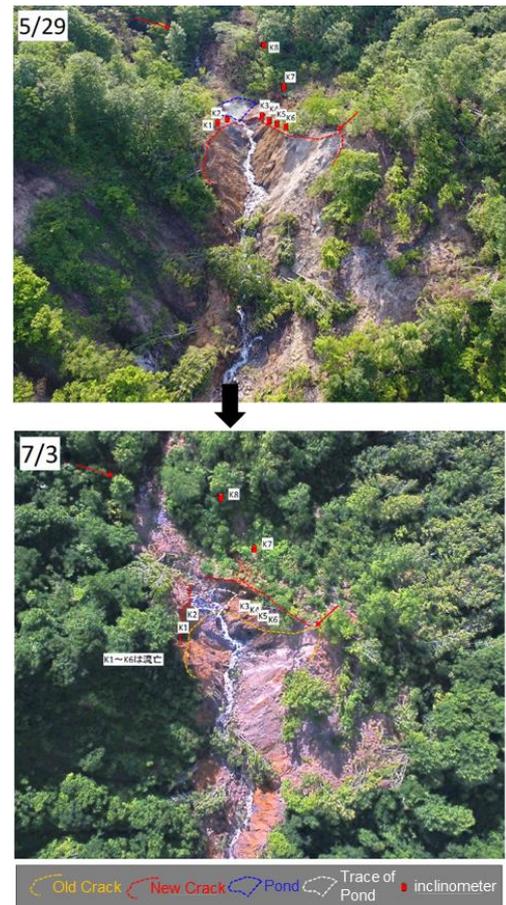
## DEBRIS FLOWS CAUSED AFTER THE LANDSLIDES

During 10 days period after the landslides, debris flows occurred frequently without any rainfall. At 6:00, May 19, when the landslides were estimated to occur, people living downstream area of Idegawa River reported that the river water was extra ordinary turbid. At 16:00, May 19, Nagano prefecture confirmed that upstream side of the Kuwanagawa Sabo dam was almost empty then. At 11:00, May 20, the half of pocket of the Sabo dam was filled with the deposition of sediment. These facts suggest that sediment supplied from the landslide A deposited once at the river channel between landslide site and the Sabo dam and were gradually transported to downstream. On May 22, 6 debris flows were observed at the Kuwanagawa Sabo dam during a short time period from 13:38 to 14:45. The fifth debris flow observed at 14:40 at the dam was the largest among 6 debris flows. The estimated velocity and discharge of its front part at the Habiro-Ohashi bridge (river bed gradient 1/9, width of the river 35–40 m) was 11m/s and 468–535 m<sup>3</sup>/s respectively. Nagano prefecture installed an IP camera at the slope A, two IP camera and a wire-sensor at the middle reach of the Idegawa River and an IP camera at the lower leach of the Idegawa River and have been watching the occurrence of the debris flow since May 21.

## CONCLUSIONS

For rainfall triggered landslides and debris flows, the early warning system based on the rainfall information have already developed and widely used in Japan. However, for snow melt triggered sediment disasters, it was not developed yet. It is very important to find the controlling factor of snow melt triggered sediment movements and to develop the method to set the early warning criteria for snow melt triggered landslides and debris flows.

**Keywords:** landslide, landslide dam, debris flow, Idegawa watershed, Snow melt



**Fig. 4** Topographical change of the landslide dam