Road blockage detection due to landslides using Sentinel-1 intensity images

*Keisho Ito[1], Yohei Kinoshita[1]

1. Tsukuba University

When natural disasters such as earthquakes and heavy rains occur, roads may be blocked due to rapid landslides. These road blockages can cause isolation of the community and delay of rescue and evacuation, leading to serious damage in both human and economics. Therefore, it is necessary to detect disaster-affected areas quickly after the disaster occurrence. The satellite synthetic aperture radar (SAR) has the ability to get information about affected areas by observing the ground surface over wide area regardless of time of day and the existence of clouds. This study proposed a new method to detect landslides and road blockages using Sentinel-1 intensity images.

This study used backscatter intensity difference between the time-averaged images in the pre-disaster stage and a single intensity image immediately after the disaster occurrence to detect anomalous signals associated with landslides. We analyzed several past landslides and found that these landslides caused large increase of backscatter intensity after the sediment collapse. Based on the above analysis, we set the threshold of the anomaly detection as 4dB intensity increase and created a landslide detection method using the decision tree technique composed of several kinds of thresholds with regard to radar intensity and topographical information such as the hill slope. The landslide detection in our proposed method was performed for square areas with several hundred meters on a side, because there were a lot of small noises in the raw-resolution image and the detailed shape and size of each landslides is not so important in practical use for administrations and municipalities. Then, we detected road blockage areas based on the information of detected landslides and an empirical model to estimate the mass flow length due to landslides. The detection accuracy of the proposed method was evaluated on two cases, the 2018 Hokkaido Eastern Iburi Earthquake and the 2017 heavy rain event in Northern Kyushu.
In the case of 2018 Hokkaido Eastern Iburi Earthquake, our proposed method could detect part of landslides, most of which were relatively large-size landslides. The accuracy of landslide detection for square areas of 400 meters on a side was 2.7% for the false detection rate and 85.2% for the undetected rate. Similarly, nearly half of the roadblock areas were detected by the proposed method. On the other hand, there were many false landslide detections in 2017 heavy rain event in Northern Kyushu, possibly due to sudden surface change of scatter characteristics due to the strong rainfall. The failure of the landslide detection also led to many failures in the road blockage detection. However, the proposed method might capture the areal concentration of landslides, which may showed a potential to roughly detect the damaged area under a heavy rainfall situation.

Keywords: SAR, Landslide, Road blockage, Sentinel-1, Intensity image

