To reduce the risk of landslide damage

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1. Introduction

In the heavy rainstorm that hit northern Kyushu in 2017, hills collapsed and debris flow occurred simultaneously along the Akatani River in the right basin of the Chikugo River and other areas. The large amount of debris and driftwood flowed down rivers with increased water due to the torrential rain that was recorded as 511.5 mm in 12 hours (AMeDAS Asakura) and accumulated, causing massive damage that killed many people and damaged properties.

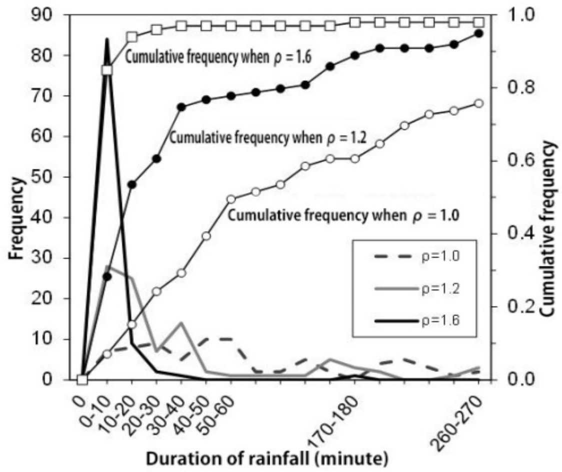
Extensive damage caused by the debris flow occurs almost every year in association with rainstorms, earthquakes, and volcanic activities, such as the Kumamoto Earthquake in 2016, landslide damage in Hiroshima and the eruption of Mt. Ontake in 2014, and massive flooding on the Kii Peninsula in 2011.

This document introduces representative examples of research and development conducted to reduce the risk of damage caused by debris flows that the Sabo Department is implementing.

2. Advancement of the investigation of debris flows and technologies to control them

As a result of analyzing conditions before and after the onset of debris flow using data with detailed time-space distribution, such as LiDAR (aerial laser survey) and precipitation measurements using radar, it was found that rainfall that would affect the amount of debris discharged in a debris flow lasted less than one hour.[1] In the conventional planning and design of debris flow control facilities and the setup of special warning zones for debris flows, the amount of debris discharged in a debris flow was estimated by multiplying 24-hour precipitation by sediment concentration by taking into account the discharge rate. From now on, we are going to further accumulate cases and analyses to consequently revise relevant technical guidelines.

In the debris flow that occurred in the Fukaminato River in Kagoshima in 2015, surveillance cameras captured the entire footage from the onset of the debris flow to its flow and accumulation. In addition, in the Illgraben valley in the canton of Valais, Switzerland, observation facilities of the Swiss Federal Institute for Forest, Snow and Landscape Research records data, such as the concentration and speed of debris flows down the valley. The use of these data and the improvement of debris flow calculation methods are enabling the reproduction of flow rates and debris concentrations, in addition to the range of debris flow deposits and overflow. We are going to continue research to reflect these findings in the design of debris flow control facilities and other necessary facilities.



Note) ρ: Pore fluid density of debris flow

Figure 1. Result of estimating the length of rainfall that resulted in debris flow

3. Technology to gather information on damage using satellite SAR data

Satellite synthetic aperture radar (SAR) is an effective wide-area observation method that remains available even when it is difficult to identify conditions using optical images, such as during heavy rains or at night. Regional Development Bureaus are developing observation and interpretation support tools and preparing interpretation manuals to use SAR as a standard investigation method to be used immediately after the onset of a massive disaster.

As the high resolution SAR conducts observations in high frequencies, and the past observation data accumulate, the opportunity to identify damage using two time periods, including before and after a disaster, has been increasing. The NILIM has been proposing interpretation investigations of massive soil movement using a single image captured after the onset of a disaster. From now on, the NILIM is going to verify the precision of the interpretation method using images captured before and after a disaster through joint research with JAXA. The outcomes will be reflected in the interpretation investigation guideline. The NILIM is also going to further improve the efficiency of interpretation investigation using image analysis method based on coherence among three periods (a certain period before, immediately before, and immediately after the disaster) and explore ways to apply the technique.

An example of interpretation conducted during an actual disaster was the disastrous rainstorm in Sri Lanka in May 2017 (Figure 2), the heavy rain in Shimane to which a special warning was issued in July 2017, and the heavy rain that hit northern Kyushu, Japan, in July 2017.[2] The NILIM is now providing technical support, such as providing the outcomes of interpretations to Regional Bureaus to be used during helicopter investigations in cooperation with the Sabo Department of the Ministry of Land, Infrastructure, Transport and Tourism and JAXA.

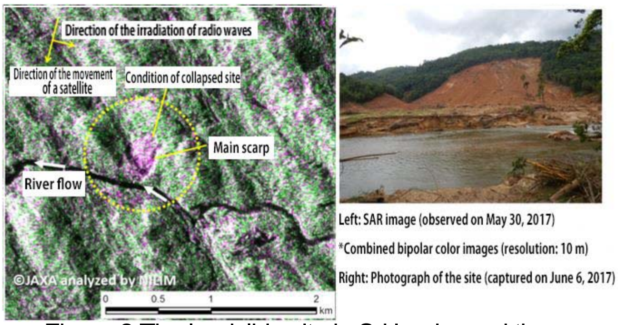


Figure 2 The landslide site in Sri Lanka and the outcome of SAR interpretation

4. Support for the improvement of technologies to respond to massive disasters by Regional Development Bureaus

The Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas was revised in 2011. The revised Act stipulates that in an eruption or the creation of a landslide dam, the national government would conduct emergency investigations and notify local governments of the areas and timing when a landslide might occur as emergency landslide information. To improve the ability of the officials of Regional Development Bureaus who perform this operation, chief-level officials of the Bureau have been also assigned to the NILIM since 2013 to participate in lectures, practices, and on-site training concerning the early detection and measurement of landslide dams, debris flow outflow simulations, surveillance and observation, and emergency constructions.

In addition, in the case of the onset of a massive landslide, they accompany experts dispatched from NILIM from immediately after the onset of the disaster to learn ways to respond to actual disasters, such as by organizing the results of investigations and observations about evacuation and emergency responses, providing technical advice to the heads of local governments in the area of the disaster, and participating in handling the mass media. A total of 38 officials have been participating in this program so far and worked at the actual sites of disasters along with dispatched experts in the disastrous heavy rain in Hiroshima, the Kumamoto Earthquake, and rainstorms in northern Kyushu.

5. Activities of the Technical Center for Large-scale Sediment Disaster Countermeasures

In the extensive flooding on the Kii Peninsula in 2011, deep-seated landslides occurred, and many landslide dams and debris flows occurred in Nara, Wakayama, and Mie that caused great damage. Therefore, the Kinki Regional Development Bureau installed Technical Center for Large-scale Sediment Disaster Countermeasures in Nachikatsuura Town, Wakayama, in 2014 to promote research and development concerning large-scale landslide damage. The NILIM has been assigning staff from the Sabo Department to this Center to support the investigation and research activities. Since 2017, one chief researcher from the NILIM has been stationed at the Center full time to engage in the following research jointly with the prefecture of Wakayama.

(1) Research concerning surface failure and debris flow

The team is conducting topographical, geographical, hydraulic, and hydrological investigations, geophysical explorations, and experiments using hydraulic models at the basin of the Nachi River where simultaneous landslides occurred in the extensive flooding on the Kii Peninsula to clarify the mechanisms of the onset of surface failure and debris flows, as well as the mechanisms of the accumulation and outflow of debris flows containing driftwood.

(2) Research concerning deep-seated landslide

The team is conducting hydraulic and water quality investigations of spring water and aerial electromagnetic explorations in the basins of the Totsu River and the Arita River to develop methods to evaluate the risk level of deep-seated landslides.

(3) Research concerning soil movement

The team is observing suspended sediment by water sampling and bedload using hydrophones in rivers in the mountains of Nachikatsuura Town and conducting research to identify the relationship between the timing of sediment production and the response characteristics of the changes in the amount of sediment transport.

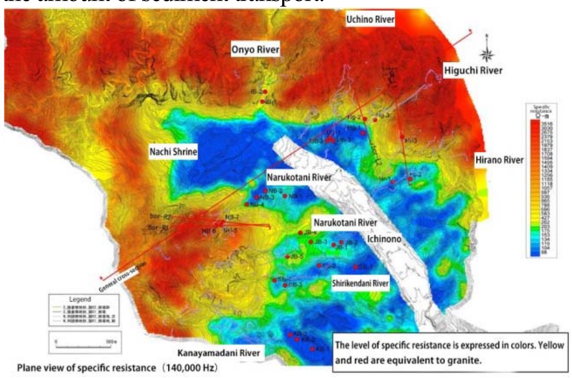


Figure 3 An example of specific resistance distribution found through aerial electromagnetic exploration

6. Summary

The NILIM is reinforcing its cooperative relationship with relevant organization, such as the Public Works Research Institute and Japan Society of Erosion Control Engineering, to promote research and development by incorporating the needs of organizations responsible for actual sediment control administration and operations, such as the Ministry of Land, Infrastructure, Transport and Tourism, Regional Development Bureaus, and individual prefectures.

☞For detailed information

1) Observation concerning rainfall indexes that regulate the amount of sediment outflow in debris flow using LP difference data and rainfall data measured by radar. Tsukasa Kudo et al., *Journal of Japan Society of Erosion Control Engineering*, Vol. 70, No. 3, p. 3-12. 2017

2) -Emergency interpretation of sediment damages using SAR loaded on artificial satellites (p. 189)