# Proposal of a method to visualize the risk of a landslide dam disaster

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## INTRODUCTION

In recent years, numerous landslide dam disasters have occurred in Japan. Although mitigation plans for such disasters have been developed, in the current context of global warming and an ageing population, more effective measures are necessary. However, few people have experienced a landslide dam disaster, either directly or indirectly, and the majority of people and the public officials who plan disaster countermeasures find it difficult to visualize such an event. Furthermore, landslide dam disasters change in form over the course of the event. When a landslide occurs, its soil mass may crush houses and destroy roads, and other structures. The mass of soil and debris blocks the river, and houses and infrastructure in the upper area of the dam sink. If the landslide dam subsequently bursts, the area downstream is flooded. The varied and unpredictable form of these events makes it difficult to formulate effective landslide-dam disaster-prevention plans.

We have researched various simulation models and developed a simple method to predict the landslide-dam disaster phenomenon. The LADOF model is a simulation model that predicts the hydrograph of run-out flow when a landslide dam bursts [Mori et al., 2010]. The LSFLOW model is a simulation model that predicts the shape of the soil mass formed by a landslide, and we applied this model as a tool to predict the shape of a landslide dam blocking a river [Sako et al., 2014]. We also proposed a simple method to predict when a landslide dam will overflow [Chiba et al., 2014]. These three methods are useful for visualizing a landslide dam disaster and developing an evacuation plan and other countermeasures.

In this paper, we propose a landslide dam visualization method that uses these simulation models, and introduce the features of the method.

## METHOD

A landslide dam disaster can be divided into three stages. In the first stage, a landslide occurs, and the mass of soil and debris creates a dam that blocks a river. Second, the water level of the dam reservoir rises. In the third stage, the dam reservoir becomes full, the dam bursts, and flood flow travels downstream. The method presented here is divided into three parts related to these three stages (Fig. 1).

First, we predict the shape of a landslide dam by using the LSFLOW model. The area of collapse and its depth of movement are used as input data. The model provides the shape of the soil mass that results from the collapse as an output. We can thereby predict the height of the landslide dam and the area covered by sediment soil. Often, no data on the landslide are available, so we use generic values for the depth and other parameters. We can show the area at risk of being directly damaged by the soil and debris. Based on the shape of the landslide dam, we can determine the position of the weakest point, the position of the lowest point of the dam, and the volume of the dam reservoir.

Next, we use a simple method to estimate the amount of rainfall required for the landslide dam to overflow by using the relationship between the amount of rainfall and the loss of water, based on the water level of the dam reservoir or other data for rainfall and the amount of run-off for the flow. In mountainous areas, rainfall amounts and flow are not measured over large areas; therefore, we propose using data from nearby areas or other Japanese rivers.

Based on the shape of the landslide dam, we can also calculate the flood discharge resulting from overflow erosion. We use the LADOF model in this third stage. Using a debris flow simulation system that we developed [Terunuma et al., 2012], we can predict the area at risk of flooding, calculated from the flood discharge. The method includes several uncertainties in each calculation step, such as rainfall volume, the depth of movement of the landslide, and the internal composition of the landslide dam; this limits the accuracy of predictions. However, our ultimate objective is to improve the disaster-prevention awareness of residents, and to do so simplicity and visualization are as important as accuracy. The method controls for uncertainties at a practical level by using suitable parameters.

## CONCLUSION

With the aim of visualizing landslide dams and improving evacuation systems and other countermeasures, various existing model programmes were integrated to simulate the components of a landslide dam. We were able to produce useful data for each stage of a landslide dam disaster. Although we may not be able to predict the situation accurately because of the inherent variability of landslide dams, our method can demonstrate the various forms of the possible risks of a landslide dam disaster. The method is especially useful for residents, public officials who plan disaster countermeasures and others who find it difficult to visualize a landslide dam clearly.

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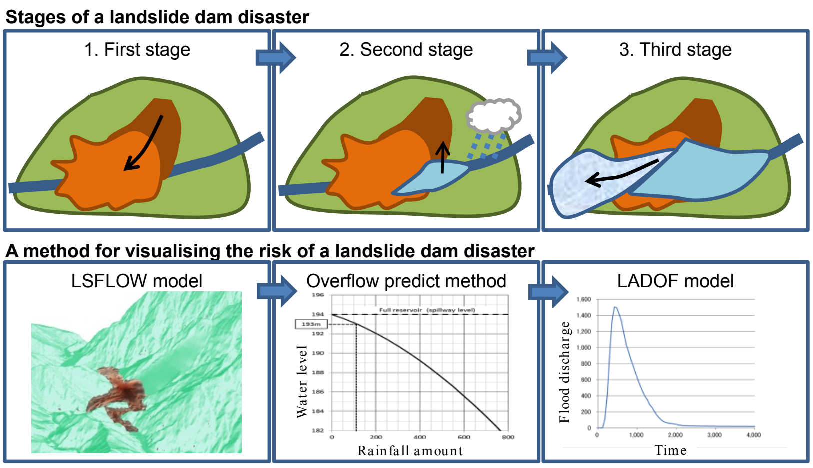


Figure 1: Overview of a method for visualizing the risk of a land

## KEYWORDS

natural landslide dam; dam breach; risk analysis

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