# Advanced Hazard Information and Methods for Appropriate Evacuation During Sediment Disasters

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## INTRODUCTION

In Japan, the recent sediment disasters have caused substantial damages. In August 2014, Tamba City, Hyogo Prefecture, and Hiroshima City, Hiroshima Prefecture, were affected by sediment disasters caused by heavy rainfall. Although the estimated volume of moved sediment in two disaster didn't show large difference, the total human damage in Tamba and Hiroshima was 1 and 74, respectively. In Tamba, local governments and communities have been working together toward disaster prevention, and therefore residents are highly aware of sediment disaster risks; during the rainfall, appropriate evacuation advice, namely vertical evacuation instead of moving to a shelter at the time of the flood in the night, was effective and minimized the damage comparing to Hiroshima. Therefore, for appropriate evacuation, it is necessary to provide residents useful hazard information on a routine basis and to develop high awareness of disaster risks.

## STUDY TARGET AND METHODS

Since 2015, we have conducted studies on sediment disaster risks and hazard information on several mountainside villages in Kyoto Prefecture, Japan. Currently, most of the hazard information for sediment disasters, such as time and place, can be forecasted using numerical simulations. We have suggested a multi-hazard simulator (SiMHiS) based on the landslide prediction model and water and sediment runoff model in the watershed scale (Yamanoi and Fujita, 2017). The system can spatially and temporally simulate the risk level of three of multi-hazard categories, namely rainfall, landslide, and flood (see **Fig.1** left). This system can provide a rough estimation of the time and magnitude of sediment disasters through the rainfall condition; however, it cannot provide details of the flooding/deposition area and distribution.

Moreover, we have developed and applied a GIS related debris flow simulation system called Hyper KANAKO (Nakatani et al., 2016). Using the system and by setting specific debris flow

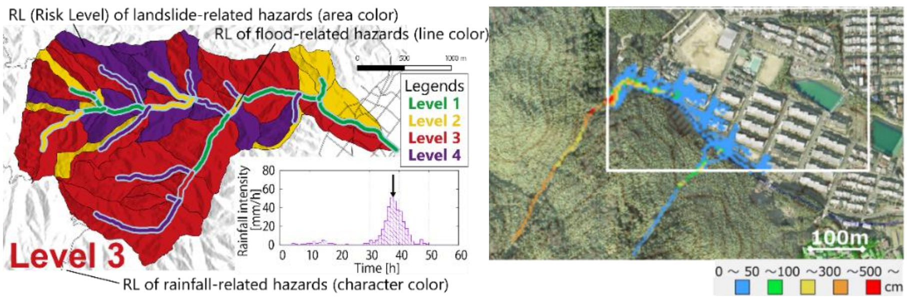


**Fig. 1** Simulation results of Kyoto Prefecture
(left: using SiMHis that considers multi-hazard; right: using Hyper KANAKO that considers debris flow deposition)

we can predict the details of the flooding/deposition area and distribution and indicate which residential area is at risk (see **Fig.1** right). However, users are required to set the specific input debris flow data, such as volume and time, due to the heavy rainfall.

Therefore, we have combined these systems and obtained advanced hazard information; if we set the initial rainfall data, the system will not only provide the occurrence time of sediment disasters but also indicate the flooding/deposition area and distribution. We verified the results of the combined simulation system in a village in Miyazu City, Kyoto Prefecture. For securing high accuracy and reliability to the target site, we conducted field survey and observation, and estimated some suitable parameters, then run simulations.

## PROVIDING EFFECTIVE INFORMATION

Numerical simulation systems are generally developed by researchers and experts with special knowledge and techniques. Therefore, non-expert residents face difficulties in intuitively understanding the input conditions and output results. Furthermore, the information that local government and communities require to develop evacuation methods might be different from what the researchers have suggested using simulations.

Therefore, we presented our simulation systems to local government engineers and discussed examples of input and output data. We obtained comments (see **Table 1**) and found that information both input and output data, is required to compare with recorded or experienced rainfall or disaster events.

For applying numerical simulations as effective information, researchers' side must consider the request, and set input conditions and also improve how to show the input and output that can be understandable for residents to realize the risk intuitively. Moreover, we must consider the target people, such as local people, voluntary disaster prevention groups, or local government engineers and to provide the information suitable for each standpoint and select necessary information with appropriate style.

**Table 1** Discussion results for providing effective information

| Data (input/output) | Comments |
|---|---|
| Rainfall (input) | Residents find it difficult to understand probable rainfall.<br>The disaster scale can be understood using the records of past maximum rainfall or of rainfall during other disasters. |
| Flooding/deposition area or distribution (output) | Residents will realize the risks when the flooding/deposition area or distribution results of the recent disaster are compared with the past disasters results.<br>Images or animation results on the GIS map will help residents realize the risks, but they might believe that the other scenarios may not occur. |

## REFERENCES

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