Application of "Hyper KANAKO," a Debris Flow Simulation System Using Laser Profiler Data

Kana Nakatani[1*], Eiji Iwanami[2] , Shigeo Horiuchi[3], Yoshifumi Satofuka[4] , and Takahisa Mizuyama[1]

[1] Dep. of Erosion Control, Graduate School of Agriculture, Kyoto University, Japan
[2] Nakanihon Air Service Co., Ltd, Japan
[3] Pasco Corporation, Ltd, Japan
[4] Department of Civil Engineering, Ritsumeikan University, Japan
[*]Corresponding author. E-mail: kana2151@kais.kyoto-u.ac.jp

BACKGROUND

Laser profilers (LPs) with a standard data format have been widely applied to survey Sabo works in Japan. The LP data provide detailed topographic information on areas prone to sediment related disaster. Therefore, the widespread use of these data is expected in crisis management situations and Sabo research work. The authors have developed "Hyper KANAKO," a system using the debris flow simulator Kanako 2D equipped with a GUI, in which a user can easily produce appropriate landform data for simulation using standard LP data. Furthermore, the system uses a geographical information system (GIS) to visualize the results. In the Hyper KANAKO system, the range of the simulation target is first chosen in a GIS, after which the users run the simulation, and the results are returned to the GIS as an image.

APPLICATION OF HYPER KANAKO SYSTEM

We applied the Hyper KANAKO system to several sites. To assist with disaster prevention and management efforts, we simulated several cases of sediment disaster scenarios and also flooding in mild slope area. We used two different data formats of landform data: one was the LP data, which is the standard format of Sabo works in Japan; the other was 10 m mesh digital elevation data provided from the Geospatial Information Authority of Japan (GSI), which has a wide field of application. For scenarios of debris flow initiation, we considered debris flow occurring from an unstable soil mass (Himekawa basin) and debris flow occurring from a landslide dam collapse caused by landslides (Tenryugawa basin). A major objective for the Hyper KANAKO system is the simulation of debris flow in steep areas of mountainous rivers. However, the Hyper KANAKO system can also simulate aspects of mild slope areas on mountainous rivers, such as the bed load area. We applied the system on a mild slope area to study flooding processes.

STUDY ON TENRYUGAWA BASIN

We applied the Hyper KANAKO system to the Tenryugawa basin. Here, we considered a scenario of debris flow occurring from a landslide dam collapse caused by a deep-seated landslide. The landslide dam was set to be 70 m high, and the upstream and downstream slopes of the landslide dam were set at 20°. The simulation area was approximately 11 km

long, and the slope of the riverbed ranged from 2-4°. A hydrograph from upstream was set using a two-dimensional riverbed variation calculation. Landform data were acquired from LPs. Here, Sabo dams are set in the basin, so we simulated two cases; one with and the other without Sabo dams. The results indicate that deposition occurs at the foot of the slope, mainly at 1–2 km downstream of the landslide dam, because the inclination of the slope drastically changes from 20° to an average of 3°. The results showed that the deposition area and thickness was smaller downstream of the Sabo dams for the case with the Sabo dams than for the case without the Sabo dam (Fig. 1).

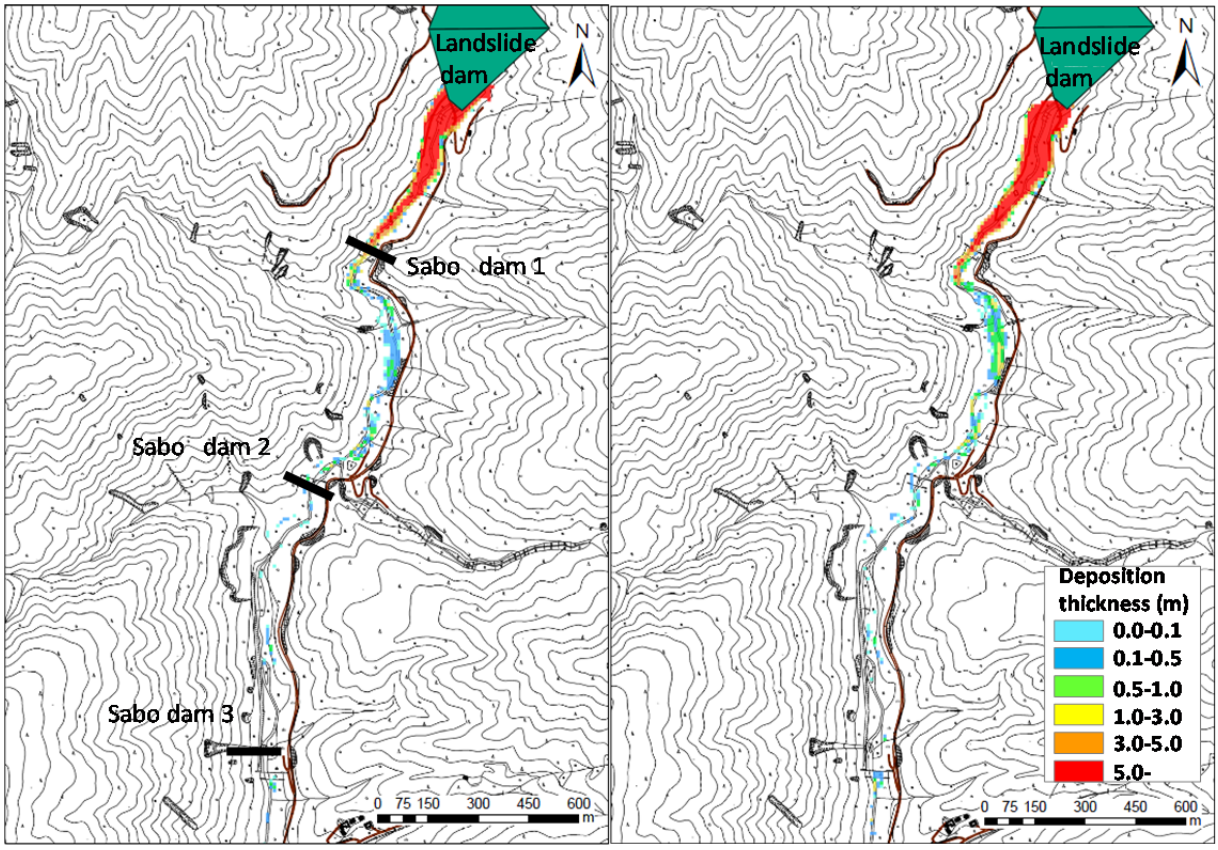

Fig. 1 Deposition result on Tenryugawa basin (left: with Sabo dams, right: without Sabo dam)

CONCLUSIONS

We ran several conditions of debris flow and sabo dams in the simulations to determine differences in the results and discuss effective mitigation works. Because the system can easily create an image, return it to GIS, and then register and manage the resultant image in the GIS, the system is easy to work with. Objectives for future work include developing tools for inputting mild-slope area real river bed elevation data, determining the proper grid size for the two-dimensional (2D) area, determining the best method of setting the 1D and 2D areas, and being able to set several debris flow torrents or inflow points of the 2D area.

Keywords: Debris flow, numerical simulation, Hyper KANAKO, laser profiler data, GIS