Priority Subjects — **Further Improvement of Facility Operations and Maintenance Technologies**

# Synthesis System of Numerical Analysis for the Currents and Sediments in Rivers and Reservoirs

## Background and Objective

The proper maintenance and operation of hydropower facilities owned by electric power companies are important in terms of providing a stable electric power supply and the utilization of renewable energy. In recent years, forests adjacent to rivers and reservoirs are remarkable, and the preservation of facility environments including sediment management has become an important subject. In this project, the total management of watershed-sedimentation techniques that estimate the points/places of sediment yield in dam basins and that observes the behavior of sedimentation and turbidity in rivers and reservoirs will be enacted, along with a synthesis system of numerical analysis that predicts sediment level and turbidity.

## Main results

### 1 A development of evaluation methods for soil runoff from upstream and slope stability

A method to evaluate rainfall infiltration and slope stability of ground (Fig. 1) was developed to estimate the amount of soil runoff when a landslide is caused by heavy rain, which has been seen frequently in recent years. A result of the application of this method to a slope field in a typhoon passage showed that the increase of rainfall caused a rise in saturation and decrease of the local safety factor of the ground (N12014). This method will be applied to a slope with past slope failure to calculate the critical cumulative rainfall for slope maintenance and to estimate the soil runoff in the slope failure caused by heavy rain.

### 2 Construction of a system for measuring sediments transportation in rivers and reservoirs in real time

In order to increase the practicality of numerical model analysis for predicting the sedimentation and scouring in rivers and turbidity behavior after sediments have begun flowing from a dam, the behavior of sediment in rivers and reservoirs was measured, and the data was used for verification purposes. In addition to the mobile flow and sedimentation measurement devices constructed to date for measuring the flow velocity and height of river beds, in 2012 instruments capable of determining turbidity, water quality, and other factors from the dynamic state of sediment in a river were installed at 7 locations from a hydropower dam to a river mouth, and experimental operation commenced (Fig. 2). During the passage of a typhoon in September 2012, data were collected on turbidity and water quality and were analyzed to determine the relationships between the increase or decrease in flow rate and the turbidity and water quality. The composition of the suspended matter at each location was analyzed (Fig. 3).

### 3 Development of an integrated system for predicting and estimating rainfall intensity, discharge, river flow, water quality, sediment transport and deposition

We will develop a new integrated system, which includes methods for predicting and estimating rainfall intensity, discharge, river flow, water quality, sediment transport and deposition, in order to plan and judge an operation of a sediment pass-through on hydropower dam reservoirs. In 2012, we combined a new prediction model for the water level of reservoirs, which estimates operational routing of the hydropower intake rate, the dam spillway discharge and the reservoir volume, with a prediction model of rainfall intensity and discharge (NuWFAS and HYDREEMS) in order to estimate the effect of water level on the sediment pass-through. Furthermore, resolution satellite remote sensing data was applied to estimate the potential sediment production.

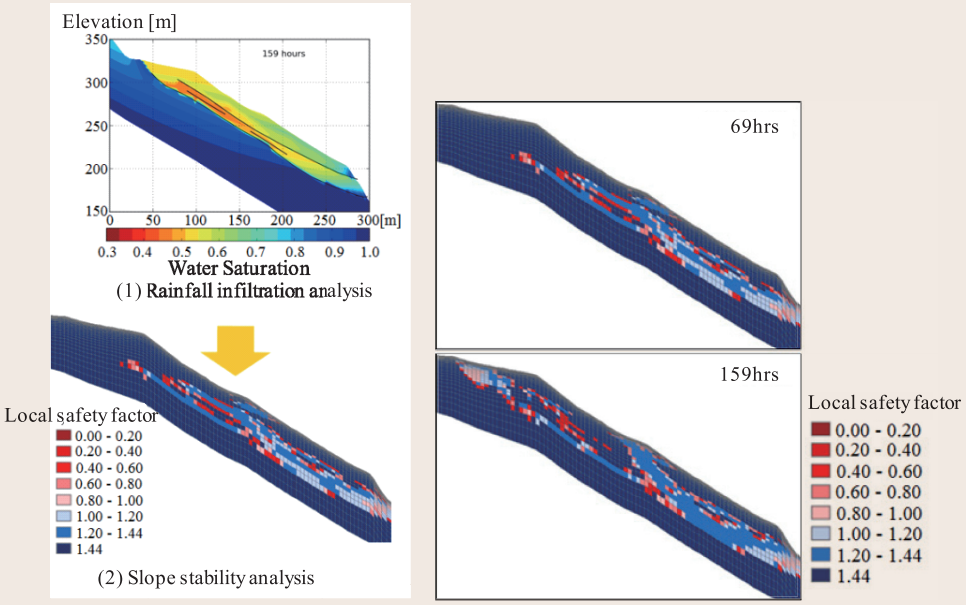


Fig. 1: Conceptual diagrams of a newly constructed rainfall and slope stability estimation method (left) and results of the application to a slope field (right). (a) Conceptual diagrams of a rainfall and slope stability estimation method, (b) Results of application to a slope field

First, a rainfall infiltration analysis given a change in rainfalls as input data calculates saturation and capillary pressure distribution in the ground (left figure (1)). Second, a slope stability analysis calculates distributions of stress, strain and local safety factor of the ground using the saturation and the capillary pressure data and evaluates a risk of slope failure by a total safety factor computed the stress balance in the ground (left figure (2)). The figures on the right show the results of the estimation method applied to a slope of collapsed sediment in the Shimanto zone which is a characteristic geologic structure in southwest Japan. A slope stability analysis conducted using saturation distribution in the ground acquired by rainfall infiltration analysis given the typhoon 15s' rainfall in 2011. Results show that the safety factor of the ground would decrease locally as time passed from the beginning of the rainfall infiltration.


Fig. 2: Outline of instruments for measuring the dynamic state of sediment in a river

To determine the changes in time and location of the dynamic state of sediment in a river during flooding and transport of sediment, a water quality meter, turbidity meter, and automatic water sampling device were installed downstream. A system was constructed to determine turbidity and sediment composition downstream in real time, in order to provide feedback on sediment transportation and a comprehensive model for the downstream area.

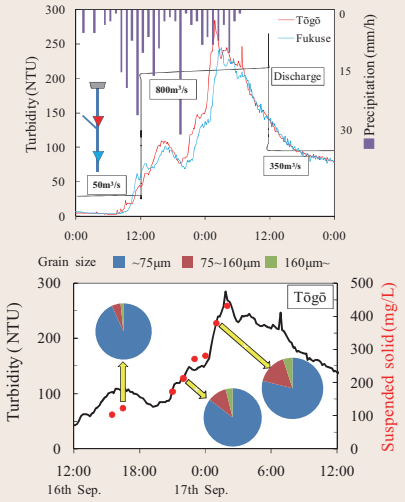


Fig. 3: Results of a sediment dynamic state measurements in the river during the system trial operation and during the passage of a typhoon

Confirmation of real-time data transmission by the measuring instruments as well as monitoring of the change in water quality during the passage of a typhoon in September 2012 was carried out on the Mimikawa River, a second class river system in Miyazaki prefecture, and it was confirmed that the system was functioning sufficiently. The sampled turbid water was analyzed in our laboratory for sediment grain size distribution and mineral composition, as well as water quality properties. Among several factors, the cohesive properties were investigated regarding fine sediment particulates which change in the process of flowing downstream and the origins of the particulates.