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

Synthesis System of Numerical Analysis for Current and Sediments in Rivers and Reservoirs

Background and Objective

In order to plan and judge an operation of sediment pass-through on hydropower dam reservoirs, it is necessary to consider the condition of the riverbed in the downstream of a dam and the influence on fishes. As such, the method of predicting sediment deposition in rivers and reservoirs is required in order to evaluate its influence and to operate rational dam sediment management. However it is difficult to make sufficiently accurate predictions of the behavior of sediments which are supplied from forests and deposited in rivers and reservoirs due to being unable to accurately estimate the erosion amount of river bed and stream banks.
In this project, a system predicting watershed sedimentation and water quality was developed based on a highly precise flood prediction model and a synthesis system of numerical analysis combined with a system of rainfall intensity and discharge prediction, then a practical method of sediment transportation prediction will be offered to each electric power company.

Main results

1 Estimation of sediment yield from upstream mountains

The amount of sediment expected from new collapses was estimated from quantified topographic change over four years using laser-profiler data to evaluate the sediment generation from a wide upstream area of dams (Fig. 1). On the other hand, the applicable condition of one of the popular cropland soil erosion assessment models, EUROSEM, to forests was confirmed through analysis of temporal change of turbid water and surface runoff at forest slope. Furthermore, we began observation and analysis of the actual soil erosion at a forest floor in dam basin by installing power-supply-free systems to measure soil erosion (Fig. 2).

2 A development of evaluation method for slope stability with heavy rainfall

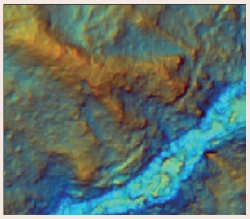
An evaluation method for slope stability with heavy rainfall developed in FY2012 (N12014) was applied to a slope field collapsed by the typhoon with the largest recorded rainfall. This was done in order to estimate slope stability change with a varying amount of cumulative precipitation. The result of the estimation showed that the total safety factor of the slope dropped and evaluated to be a slope failure during a time between 70 hours and 100 hours after the calculation and that the evaluation was approximately consistent with the real phenomenon (Fig. 3).

3 Construction of a system for measuring sediment transportation in rivers and reservoirs in real time

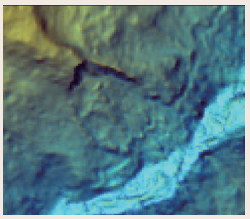
In order to clarify the dynamic state of sediment in the downstream of a dam, instruments able to observe the water quality of the river and the reservoir in real time were developed. These instruments require no electrification system as they utilize a solar panel and battery power, thereby making long-term observation possible. After such instruments were installed at 7 locations from a hydropower dam to a river mouth, continuous observation of water quality data began (V13007). The acquired data is transmitted to the server in our office by the mobile phone communication network. Data is stored automatically and water quality of the river can be seen from a remote location (Fig. 4). This instrument system has a function to sample the river water automatically if the preset turbidity is exceeded or an order is given from a remote PC. The human labor otherwise required to perform this observation can be decreased by using this system.

4 Synthesis System of Numerical Analysis for flood and sediment transportation

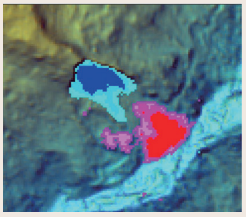
The watershed sedimentation in rivers and reservoirs at the time of a flood and the riverbank erosion effect due to a decrease in water level of reservoir were estimated using the predicted sediments flow analysis program (C-HYDRO-2D). Change in water temperature and DO over several days was able to be predicted by combining a water quality prediction system with this program. Operation of the whole prediction system for the rainfall intensity, discharge, and water quality was checked from this verification, and completion of a synthesis system of numerical analysis for sediment level and turbidity is expected.



(1) Topographical relief map (2009)



(2) Topographical relief map (2013)



Blue: Erosion
Red: Deposition

(3) Topographic change map for four years

Fig. 1: Estimation of sediment production and deposition by Laser profiler

Laser profiler data of from 2009 and 2013 has detected a new landslide located far from the road. We will conduct a field survey to estimate the sediment production and deposition by the this landslide.

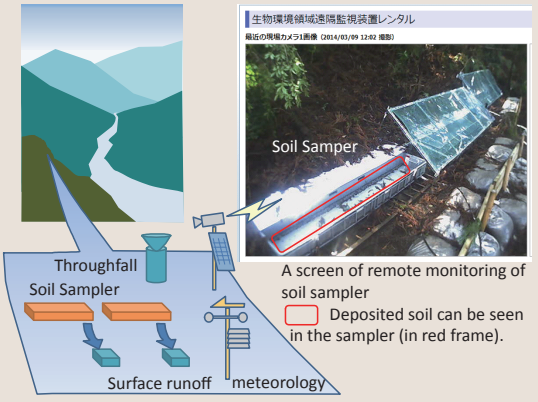


Fig. 2: Outline of the soil erosion measuring system

The soil erosion measuring system we had have developed (V11030) consists of the multiple soil samplers, the surface runoff meter and the meteorological station including rain gauges. In this study, rational decision of maintenance and data-collection timing has been made possible by remote monitoring of the soil samplers using webcams.

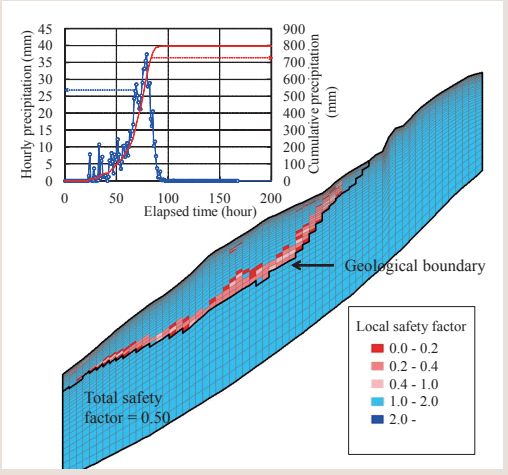


Fig. 3: Calculated results of mechanical stability for a slope field with heavy rainfall (100 hours after the calculation, total amount of rainfall was 800 mm)

Local safety factors in geological boundary between debris and bedrock decreased due to the rainfall infiltration and area of low safety factor connected 100 hours after the beginning of the calculation. Total safety factor of the slope was calculated as 1.25, 1.06 and 0.50 of the initial condition, 70 hours and 100 hours after the calculation, respectively by using the distribution of the local safety factors. This result showed that the slope collapsed during a time between 70 and 100 hours after the calculation.

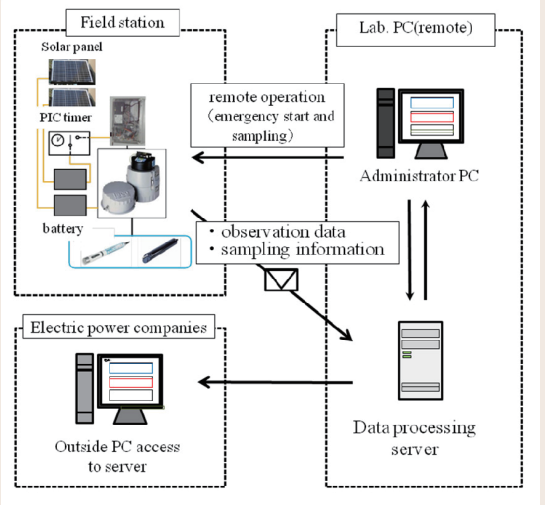


Fig. 4: Outline of the system for measuring sediment transportation in real time

Developed GUI software to facilitate real time monitoring of water quality. As a result, a large amount of data transmitted from seven points can be processed.
Moreover, the execution and cancellation of water sampling are possible while checking data on a remote PC.