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

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

Background and Objective

The proper maintenance and operation of hydropower facilities owned by electric power companies are important in terms of provisions for stable electric power supply and renewable energy utilization. In recent years, forests along 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 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 Estimation of sediment yield from upstream mountains

We measured sediment yield within forested slopes in a Japanese cypress and a nearby Japanese cedar with no shrubs. The sediment yield increased as the amount of precipitation in both slopes increased, and that in Japanese cypress with poor forest floor cover was approximately one order higher than in Japanese cedar (Fig. 1 top). Forest height, canopy interception rate, understory interception rate and ground interception rate was measured by laser profiler data. We prepared a map of raindrops kinetic energy, that control rain-drop erosion of soil, to estimate the sediment production from upstream mountains (Fig. 1 bottom).

2 Modified risk evaluation method of slope failure for slopes in a widespread area

A risk evaluation method of slope failure was modified to reduce input parameters which included an inclination and length of a slope, a depth of bedrock and a rainfall pattern assuming that hydraulic properties and mechanical properties were similar for the same geological unit (Fig. 2). The method was also modified to represent a water collection structure, a surface runoff, an existence of a forest road and a water level variation in a downward river/pond which could affect infiltration phenomena (N14016). The modification made it possible to enhance the prediction accuracy of the method and to create a hazard map of slopes in a widespread area. Estimation of the amount of sediment using this method enables an evaluation of sediment increases caused by abnormally heavy rain.

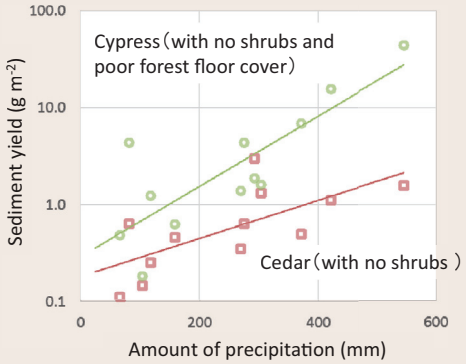
3 Wash-load and turbidity real-time observation using a river environmental monitoring system with a mobile communication device

A real-time river environmental monitoring station was constructed in five points between the immediate-downstream of the dam planned for sluicing operation and river mouth and one point in the tributary. The system sends the information of the river environment (i.e. water quality, turbidity and water level) every thirty minutes by mobile communication device. In addition, we are able to command an auto sampler in this system to collect river water at our discretion. Turbidity and wash-load in water samples in five events with a seasonal rain front and seven events with typhoons were analyzed. Sediment diameter distribution changed depending on the merging tributary. The tributary has a smaller catchment area (63.2 km^2) than mainstream (884.1 km^2), nevertheless the sediment supply from the tributary is important to determine the quality of the suspended sediment composition in the river before sluicing operation.

4 Synthesis system of numerical analysis for flood and sediment transportation

A synthesis system of numerical analysis for flood and sediment transportation was developed in order to estimate flow condition and sediment movement in floods from the upper reaches of a river to its mouth (Fig. 3). The system was applied to a river under the operation of cascade dams to facilitate sediment sluicing. The quantitative impact on deposition and scoring of river beds, as well as the water levels of rivers and reservoirs were estimated for the largest recorded flood. The system may be applied to flood risk analysis and river environmental assessment of dam basins.

* Wash-load is fine sediment under 100-200 μm.



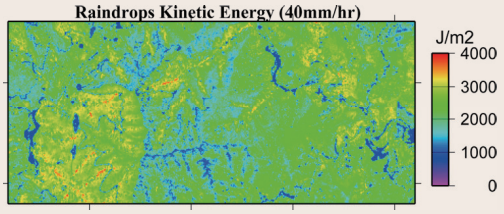


Fig. 1: Technological development for estimation of sediment yield from upstream mountains

The top half of Fig. 1 indicates the relationships between the sediment yield and amount of precipitation. The bottom half shows the raindrop energy distribution that triggers sediment production.

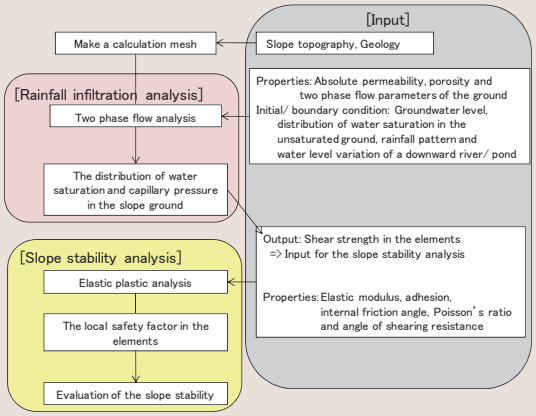


Fig. 2: Calculation flow diagram of the risk evaluation method of slope failure

The distribution of water saturation and capillary pressure in a slope is calculated by a rainfall infiltration analysis with a rainfall pattern. The modification was conducted in FY 2014 to represent a water collection structure, a water level variation in a downward river/ pond and an influent rainfall from a forest road. A local safety factor is calculated by using the water saturation and the capillary pressure varying from hour to hour and a risk of the slope failure is evaluated.

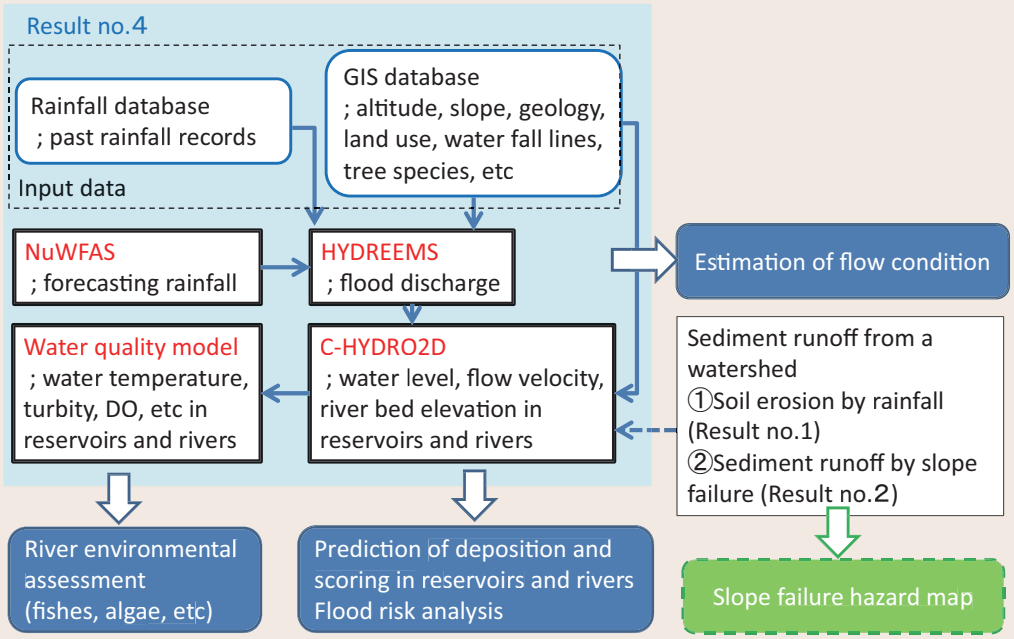


Fig. 3: Flow chart of the synthesis system of numerical analysis for flood and sediment

The system with the NuWFAS, HYDREEMS, C-HYDRO-2D and water quality model predicted future river bed and water quality. Past rainfall records or the predicted rainfall using the NuWFAS were used. HYDREEMS and C-HYDRO-2D use GIS data and can easily be adapted to all areas.