Technical Study for Improving the Accuracy of Flood Forecasts --- Application of Particle Filter ---

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1. Introduction

Under Article 10 of the Flood Control Law, if a flood is likely to occur in a river under the direct control of the government or other large river, JMA and MLIT are jointly required to disseminate forecast information on water level, etc. from a base station ("flood forecast") to the prefectural governor and the public. It is, therefore, necessary to provide highly accurate flood forecasts to support flood fighting activities and minimize damage. However, the accuracy of flood forecasting models used for the rivers under the direct government control in direct control rivers is by no means adequate.

At present, it is difficult to determine a flood forecasting model with a parameter set that can calculate all floods to a satisfactory degree of accuracy. Given the circumstances, it is important to use real-time observation data on discharge, etc. to the extent possible, to estimate the best parameters in real-time and maintain the flood forecasting model suitable for the flood then likely to occur. (This process is called "real-time adjustment".) This paper introduces a flood forecasting calculation using particle filter, which is a real-time adjustment method based on the statistical theory and has often been used in recent years in the river management field.

2. Outline of Particle Filter

A particle filter generates multiple random quantities as statuses that are corrected in real-time (each random quantity is called a "particle"), and conducts simulations with the flood forecasting model for each of the particles to select the particles of high conformity between the calculation result and observed value. With this approach, the best parameters can be estimated in real-time for each flood.

3. Application example

Figure 1 compares the results of calculations using and not using the particle filter to forecast the discharge one hour after at the flood control point (B point). In this example, the roughness coefficient of the model is used as the target of sequential correction by the particle filter. As a result, the accuracy was higher in the case where the particle filter was applied than the case where not. Figure 2 shows the temporal changes in the optimal roughness coefficient estimated by the particle filter. Clearly, the particle filter enhances the forecasting accuracy of the flood forecasting model.

Figure 1: Forecast of One-Hour-After Discharge at B Point of River "A" Where Particle Filter is Applied

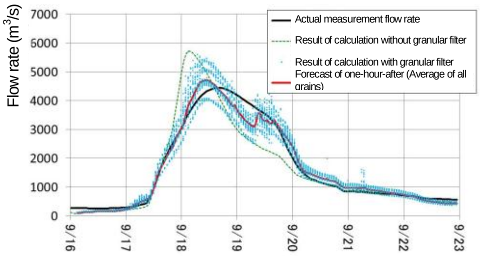
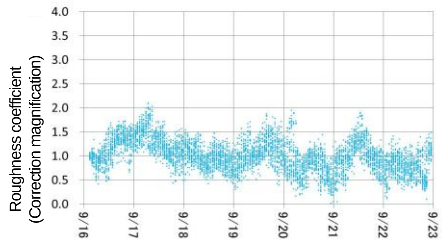


Figure 2: Temporal Changes in Roughness Coefficient



4. Conclusion and issues

As described, the particle filter estimates the optimal parameters for each flood through a process of repeating the calculations of the flood forecasting model the same number of times as the number of particles. It can be installed without substantially altering the flood forecasting model already adopted on site and is advantageous towards improving the accuracy of forecasts. For real-time operation, it is necessary to study the required calculation time and physical validity concerning temporal changes in the quantity of status. It is expected that particle filters will be widely used in on-site flood forecasting systems.