第Ⅱ部門 **Flood Forecasting using 2D Dynamic Wave Model with Particle Filter**

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1. Introduction

Flood forecasting is necessary for reducing the risk to human lives and our properties by the flood. As a criterion to evaluate the flood risk, water stage data is very important information. It is generally obtained from the rating curve and the discharge simulated by a hydrological model. Various error sources exist in the process of the flood forecasting. Among them, rating curve based on steady flow involve large errors more than 15%[1].

As an alternative of using a rating curve, a hydraulic model can be utilized. Arico *et al.*[2] shows that estimated water stage can be varied according to utilized Manning's roughness coefficient. The Kim *et al.*[3] shows that consideration of time varied channel roughness can improve the prediction ability. In comparison to using a rating curve, hydraulic simulation may result in proper prediction since it considers the dynamic characteristics of the flow.

Above mentioned two factors induce the error for prediction, but we cannot get the accurate data for them. Therefore we try to consider the uncertainties of the inflow and channel roughness.

This study presents the method to predict water stage and reduce the uncertainty of flow condition, using a 2D dynamic wave hydraulic model based on a sequential data assimilation concept.

2. Methodology

The prediction algorithm largely consists of a particle filtering system (estimation process) and a prediction system. The prediction algorithm runs on results through an estimation process. The estimation process is composed of a perturbation step, an update simulation step, and a resampling step. First, the boundary condition, such as the upstream discharge and the downstream water stage, and model parameter values (channel roughness) are disturbed to consider their uncertainties at the perturbation step. Then, the state variables, which are calculated by the 2D dynamic wave model[4], and parameter values are sequentially updated in the resampling step according to the weight against the sequentially updated water stage. Next, the state variables and parameter values are transferred to the prediction process to reflect the current state more accurately after updating. The prediction process is calculated up to 6 hours, with the updated state variables and parameter values every hour.

The proposed method is applied to the Katsura River located in Kyoto, Japan. The reach length is about 2km and the study reach is covered with 500 structure grids in the calculation domain (**Fig. 1**). There are two water stage stations at both ends without tributaries, so the characteristics of the reach are good for application of the method since we neglect the lateral flow in consideration of discharge uncertainties. In addition, the flood plain exists on both sides of the main channel. The Kamo River joins at the upstream of the reach and the Uji River joins at the downstream of the reach.

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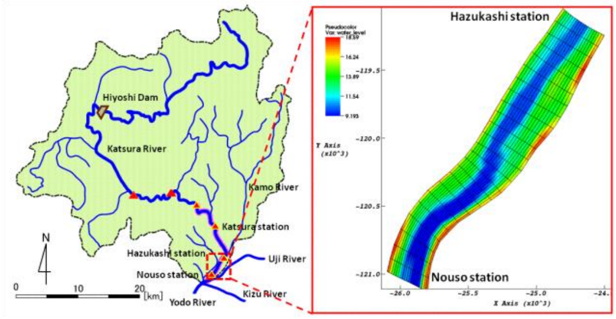
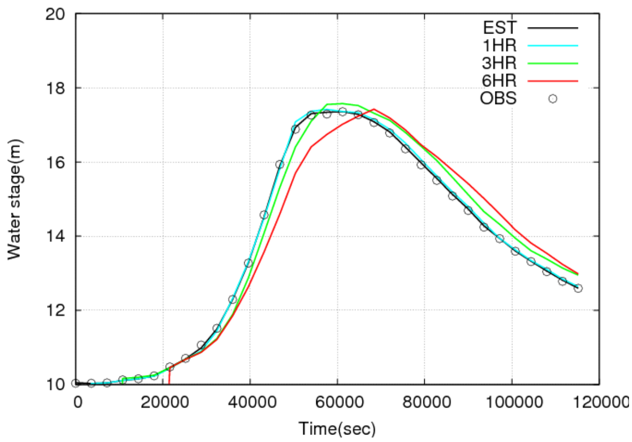
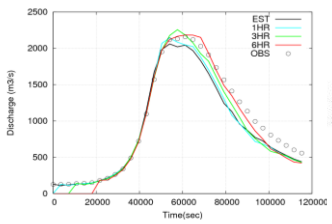
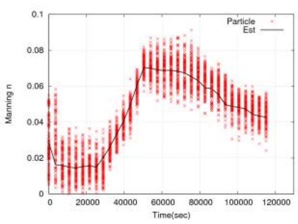


Figure 1. The study area and calculation domain



(a) Predicted water stage





(b) Discharge (c) Manning's roughness

Figure 2. Result comparison with observed data

3. Results and Discussion

The boundary condition is based on the real event, which occurs from 6:00 on October 20, 2004, to 15:00 on October 21, 2004, at the natural river reach from Hazukashi station to Nosou station. In the prediction process, Manning's roughness coefficient is fixed as the value chosen in the resampling step at the current time step, and the predicted inlet flows up to 6 hours are determined by the proportions of particle's inlet discharge against the given discharge at the current time step.

The prediction process performs up to 6 hours. Then the results at 1 hour (1HR), 3 hours (3HR), and 6 hours (6HR) are compared with the observed water stage and discharge (OBS) at Hazukashi station (**Figs. 2 (a), (b)**). EST indicates the average values with the weight, while the prediction results are averaged with even weight.

The estimated water stage and 1 hour ahead water stage shows good agreement with the observed one. With increased lead time, the accuracy of the prediction result is less than the 1 hour ahead prediction result due to the fixed roughness coefficient chosen in the resampling step, while the real channel roughness varies according to time.

In addition, the estimated Manning's roughness coefficient is plotted in **Fig. 2(c)** with the values of each particle. Manning's roughness coefficient is varied due to the flood plain and backwater increasing the channel roughness when flooding occurs. Finally, **Fig. 2(b)** also shows that the estimated discharges are similar to the observed discharges, even though there is some discrepancy at the peak point and the recession limb of the hydrograph.

4. Reference:

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