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Application of Data Assimilation and Ensemble Kalman Filter for Flood Forecast in Tamsui River, Taiwan

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Typhoon is the most frequent natural disaster that causes widespread damage during summer and autumn in Taiwan. On average, each year the island suffers four typhoons, which result in disastrous flash floods and losses in a short time because of steep terrains and intense rainfall. The Tamsui River Basin is located in northern Taiwan about 2,726 square kilometers and inhabited by eight million people. During flooding events, the emergency managers rely on accurate flood forecasting to take proper actions for damage reductions. The flood forecasting and warning system based on hydraulic models play an important role in flood risk management. This study first establishes river stage routing model based on dynamic wave theory. Then, both the real-time observed river stages and the least squares method are used to adjust the model currently flow conditions as the data assimilation. Finally, The Ensemble Kalman Filter method carries out the data correction with the computation of minimum error-covariance between the model prediction and the observation. The simulation results found the root-mean-square error of forecasted river stage using the data assimilation at the gauged stations of Taipei Bridge and Tudi-Gong-Bi for 1-3 hours lead time is 0.862m, 0.892m, 0.903m, and 0.281m, 0.326m, 0.345m, respectively. When the Ensemble Kalman Filter is added in the model, the root-mean-square error reduces to 0.191m, 0.375m, 0.612m, and 0.062m, 0.090m, 0.145m at described gauged stations. It is found that the data assimilation and the Ensemble Kalman Filter give reliable forecast water stages with a small root-mean-square error which successfully corrects the forecasted river stage at each time step of the flood routing process. The results reveal that the integrated model gains a better accuracy of the water-stage profiles with probabilistic uncertainties. The model provides reliable forecasts of the water-stage profiles for 1–3 hours lead time along the Tamsui River for specific locations in emergency response for flood risk management.