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Application of Ensemble Kalman Filtering to the Flood Prediction of Chao River Basin in North China

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With the promotion and development of the South-to-North Water Diversion Project, a flood forecasting of the Chao River Basin in Miyun is crucial. Many hydrological researchers have done little research in the northern China, especially Chao River Basin. Because of the climate and environmental factors in the Chao River Basin, the watershed often has more rainfall but no runoff flow, which exacerbates the difficulty of northern flood forecasting. With the rapid development of technology in surface observation and remote sensing technologies, data sources have been enriched. Today, how to improve algorithmic techniques and how to use multi-source data to reduce the uncertainty on the flood forecasting have been paid more and more attention.

The data assimilation method can improve the timeliness and the accuracy of numerical forecasting, which has been applied widely and developed rapidly in the hydrology field. In this paper, the ensemble Kalman filter algorithm was used for assimilation prediction.Considering that the watershed underlying surface caused by human activities changes frequently, the parameters are not static. In order to ensure the authenticity and accuracy of the study, the parameters were added into the variables, serving as the state variables to be estimated simultaneously, and the observed flow data were updated and corrected in real time considering the uncertainty of the model itself, the model parameters and the observed data, and the ensemble Kalman filter and the Xin'anjiang model were coupled and assimilated. As the Xin'anjiang model is based on the theory of full-scale production, it is mainly applied in the humid and semi-humid areas, while the Miyun basin is semi-humid and semi-arid climate. The Xin'anjiang model was modified to a saturated storage and excess infiltration mixed model, and data assimilation used multi-sources of soil data and streamflow, which can improve the accuracy of flood forecasting.

The Chao River Basin consists of three hydrological stations, which are Dage Station, Gubeikou Station and Xiahui Station from the upstream to the downstream. According to return period or frequency, the flood grades were divided into small floods, medium floods and large floods, which were compared with non-assimilation, streamflow assimilation-only, combined assimilation of streamflow and romote sensing soil data, combined assimilation of streamflow and correct soil data. Results showed that the accuracy of multi-source data assimilation of small floods after adding streamflow and soil data was increased, while the precision of medium floods and large floods was high enough when the floods were streamflow assimilation-only. And from the perspective of assimilation results, small floods were better than medium floods and large floods,

and the effect of upstream assimilation was better than downstream. In order to study the influencing factors of the assimilation effect, the Gubeikou Hydrological Station was taken as an example to analyze the effects of parameter mean, variance, the number of samples and the correlation between parameters and variables on the assimilation processes. This study can provide reference for different levels of flood assimilation prediction methods and related assimilation processes.