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REAL-TIME FLOOD FORECASTING USING ECMWF ENSEMBLE PRECIPITATION FORECAST IN THE UPPER NAN RIVER BASIN, THAILAND

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Introduction

The upper part of the Nan River Basin frequently experiences heavy rainfall events influenced mainly by tropical storms. Combined with the steep slope condition of the topography, the basin is vulnerable to flash flood disasters. To mitigate the extensive damage and disruption to societies caused by the disaster, flash floods need to be predicted over a wide range with a long forecasting lead time. Incorporating weather forecasts may improve the efficiency of decision-making. However, the forecast has limitations in accuracy (forecast uncertainty) with increasing forecast lead time. Instead of deterministic forecasting, probabilistic forecasting with Ensemble Prediction System (EPS) has advanced in the last decade. In this study, the medium-range ensemble precipitation forecast conducted by the European Centre for Medium Range Weather Forecasts (ECMWF) was employed with a hydrological model to predict the real-time river discharge of the study basin which locates in a tropical climate with a distinct wet and dry season. The objective of this study is to evaluate the performances of the forecast scheme during the case study of the severe flood event in 2017 (the tropical storm Talas) by comparing the forecast results with the observation.

Methodology

Using the forecast information with the hydrological model is a well-known approach for a long-lead-time of flood forecasting. For this study, the ECMWF (51 precipitation forecast members) was used with the improved 1K-DHM (Meema and Tachikawa, 2020). However, using medium-range ensemble precipitation forecast with a distributed hydrological model to predict the real-time river flow in a tropical climate basin with a distinct wet and dry season, the initial conditions of the model largely influenced the forecast results (Meema *et al*., 2020). For this purpose, the assimilation approach has been adopted to determine the initial states of the model before performing the flow forecasting. Ensemble Kalman Filter (EnKF) considering spatial correlation that improves the flood prediction (Kaniya *et al*., 2020) was applied. Not only adopting forecast rainfall during the forecast period, the observed rainfall was also utilized considering as a perfect rainfall forecast for evaluating the performances of the real-time forecast scheme. The scheme was applied to the case study in the tropical storm event in 2017 (Talas) with 20 continuous times of the initial forecast regarding each updated 12-hour of ECMWF with 15 days of forecast lead time. The real-time flood forecast scheme started the simulation from 11 July 2017 00:00 UTC (7 days before the peak of flood) to 20 July 2017 12:00 UTC. The forecast scheme has been evaluated the performance by using the Root Mean Square Error (RMSE) that represent the error between the forecast ensembles and the observation for each lead time of forecast.

Result and discussions

Fig. 1 presented the result of the 15-day (360 hours) in advance forecast flood hydrograph for the initial forecast time of 15 July 2017 12:00 UTC (3 days before the peak of flood) at the N.1 station of the Nan River. The box plot showed the distribution among the flood forecast members. For this initial forecast time, the flood discharge forecasts have a large distribution among the members due to a large difference among the precipitation forecast members. On the other hand, between the 25th and 75th percentile of forecast members could represent satisfaction in the possibility of severe

storm and flood occurrence compared to observation. **Fig. 2** presented the comparison of RMSE among all forecast members, 25th, 50th, 75th percentile, and the use of observed precipitation (perfect forecast) for different 20 forecast initial times. The results showed the large uncertainties in flood forecasting compared to the use of observed rainfall, especially during the high rainfall intensity. This indicated the high challenges in precipitation forecast with long-lead time for the severe storm events. On the other hand, considering the ensemble precipitation forecasts could represent the possibility of flood in advance.

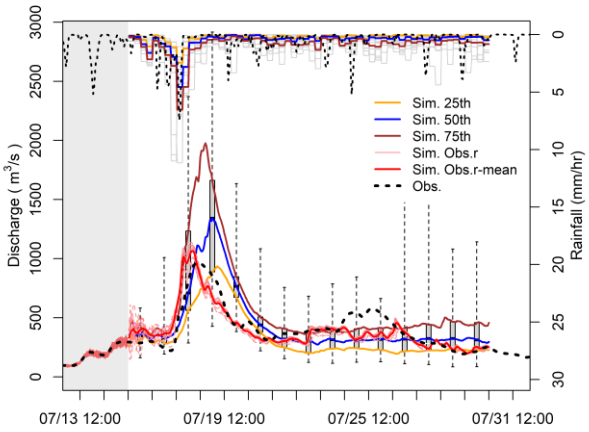

Fig. 1 The 15-day in advance forecast hydrograph for the initial forecast time of 15 July 2017 12:00 UTC (Obs.; observation and Sim. Obs.r; forecast simulation using observed rainfall).

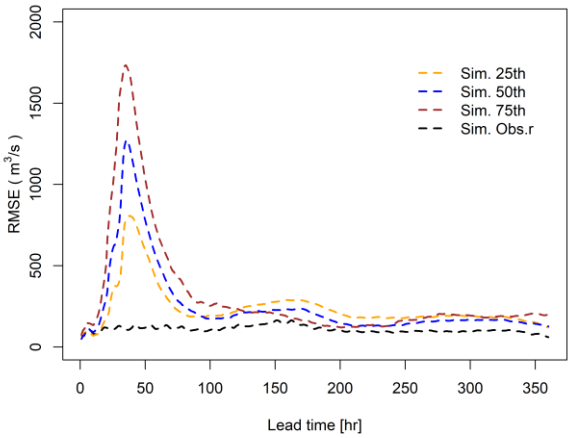

Fig. 2 The comparison of RMSE between forecast results and observation for each lead time of flood forecasting for 20 different initial forecast times between 11 July 2017 and 20 July 2017.

Conclusions

This study demonstrated that the use of ensemble forecast technique in the real-time flood forecasting scheme could predict the occurrence probability of the flood events during the severe storm in advance. This information will be useful for the decision-making on mitigation responses against flood events, which may be adapted to other basins in the study region.

References

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