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Building an early flood warning system by soft-computing techniques for Kemaman River basin in Malaysia

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Flooding has been a major issue in the state of Terengganu, Malaysia. The Kemaman River basin, in particular, consistently suffers from annual flooding, bringing great damages and losses in life and property. Flood forecasting can provide early warnings with sufficient lead time to help residents in preparation of precautionary measures to flooding. This study proposes a hybrid ANN-based model for nowcasting regional flood inundation depths during extreme storm events. The model contains three main schemes: (1) constructing the self-organizing map (SOM) for producing a regional inundation topology under various hydrological conditions; (2) building a recurrent nonlinear autoregressive with exogenous inputs (R-NARX) for sequentially forecasting the average inundated depth (AID) in the study area during storm events; and (3) adjusting the AID of the constructed SOM by using the R-NARX based on the forecasted AID for producing a real-time regional flood inundation map. The proposed models are trained, validated, and tested based on a large number of inundation data sets (11,026 grids) collected in one (100 km2) of the regions with the most frequent and serious flooding in the Kemaman River basin, Malaysia. The results appear that the SOM topological relationships between individual neurons and their neighbouring neurons are visible and clearly distinguishable, and the hybrid model (SOM-R-NARX) can continuously provide 3-hour to 12-hour- ahead visible regional inundation maps with high resolution (75 m * 75 m) during storm events, which have relatively small RMSE values (<0.39 m) and high R2 (>0.96) as compared with numerical simulation data sets. We demonstrate that the proposed hybrid ANN-based model has a robust and reliable predictive ability and can be used for early warning to mitigate flood disasters.