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Weather models as virtual sensors to data–driven rainfall predictions in urban watersheds

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Weather and climate predictions are a key element of urban hydrology where they are used to inform water management and assist in flood warning delivering. Indeed, the modelling of the very fast dynamics of urbanized catchments can be substantially improved by the use of weather/rainfall predictions. For example, in Singapore Marina Reservoir catchment runoff processes have a very short time of concentration (roughly one hour) and observational data are thus nearly useless for runoff predictions and weather prediction are required. Unfortunately, radar nowcasting methods do not allow to carrying out long – term weather predictions, whereas numerical models are limited by their coarse spatial scale. Moreover, numerical models are usually poorly reliable because of the fast motion and limited spatial extension of rainfall events.

In this study we investigate the combined use of data-driven modelling techniques and weather variables observed/simulated with a numerical model as a way to improve rainfall prediction accuracy and lead time in the Singapore metropolitan area. To explore the feasibility of the approach, we use a Weather Research and Forecast (WRF) model as a virtual sensor network for the input variables (the states of the WRF model) to a machine learning rainfall prediction model. More precisely, we combine an input variable selection method and a non-parametric tree-based model to characterize the empirical relation between the rainfall measured at the catchment level and all possible weather input variables provided by WRF model. We explore different lead time to evaluate the model reliability for different long – term predictions, as well as different time lags to see how past information could improve results. Results show that the proposed approach allow a significant improvement of the prediction accuracy of the WRF model on the Singapore urban area.