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Integrating Remote Sensing Data and Non-Parametric Bayesian Networks to Understand Process Interactions for Estimating Monthly Peak River Discharge

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Water resources management traditionally favors process-based hydrological models (e.g., non-linear reservoir models) to data-driven ones (e.g., artificial neural networks). Physical laws enable numerical representation of hydrological processes at the catchment scale providing the means for predicting the catchment response due to meteorological events or/and human intervention, such as urban development, especially in areas where observations are limited. However, such models require strong assumptions on catchment characteristics and dynamics (e.g., flow routing, infiltration mechanism, water storage) which are often not well known, but justified on the basis of similarities. Moreover, these models are computationally demanding, in particular at high spatial resolution.

The aim of this study is to investigate the ability of Non-Parametric Bayesian Networks (NPBN) to identify and understand the correlation structure between various interacting processes and to use that to estimate monthly river peak discharge in catchments with contrasting climates. NPBN is a graphical approach that models the joint probability distribution of dependent variables through copula functions. Here, we will explore the ability of the proposed statistical model to (i) investigate which interactions between hydrological variables are the most important for estimating river peak discharge at the catchment scale and in which climate, (ii) provide a robust alternative to distributed hydrological modes with reduced computational demand and modeling assumption on catchment dynamics, (iii) integrate information from remote sensing data to overcame the limitation of gauge coverage, and (iv) estimate river discharge in ungauged basin. The study will be developed as follows. Firstly, we will investigate interacting processes to identify the most significant ones. We then use these results to test the ability of the statistical model to reproduce peak discharge considering only intra-catchment hydro-climate variables. Finally, we will expand the model at the catchment scale such that the estimation of peak discharge will benefit from extra-catchment relationships between hydro-climate variables and catchment features.