Insights from Physics-based Hydrologic Models and Stochastic Storm Transposition into the Underlying Assumptions of Flood Quantile Regionalization Techniques

Ricardo Mantilla\textsuperscript{1}, Gabriel Perez\textsuperscript{1}, Nicolas Velasquez\textsuperscript{1}, Daniel Wright\textsuperscript{2}, and Guo Yu\textsuperscript{2}

\textsuperscript{1}IIHR-Hydroscience & Engineering, The University of Iowa, Iowa City, USA
\textsuperscript{2}Department of Civil and Environmental Engineering, University of Wisconsin-Madison, Madison, USA

We use three hydrological models and the stochastic storm transposition (SST) framework to investigate the validity of implicit assumptions in the empirical methodology of regionalization of flood frequencies (RFF) for prediction in ungauged basins. In particular, we investigate the long-standing hypothesis that for a set of catchments physical homogeneity of meteorological and infiltration processes implies statistical homogeneity of flood peak distributions. Our modeling (theoretical) results do not support this hypothesis. We also show that power-law regressions (i.e. log-log linearity) do not seem to be an appropriate model to connect distributions across scales (either quantiles or distribution parameters). Finally, even though our results support the most fundamental hypothesis in RFF that the underlying distribution of peak flows is invariant under translation in the river network, our results do not support the simple-scaling or multi-scaling frameworks. First, we show that some moments of the distribution cannot be inferred from area alone, violating the definition put forward by Gupta et al. (1994). Second, the resulting scale invariant distributions that we identified are different from LP-III and GEV and cannot be rejected by data as valid distributions. Our framework provides a new avenue to test methods for flood data analysis and it opens the door towards a unified physics-informed framework for prediction of flood frequencies in ungauged basins embedded in gauged regions.