

Evaluating Model Behavior for Hydrologic Forecasting in Gauged and Ungauged Watersheds

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Understanding hydrologic model behavior for different model structures (lumped vs. distributed) and under different data scenarios (gauged vs. ungauged) is critical to effectively take advantage of advancements in models and data sources and to appropriately apply models for specific circumstances. This dissertation presents multiple studies that evaluate hydrologic model behavior for specific cases in hydrologic forecasting, with an ultimate objective of identifying appropriate models and approaches for less-developed, data-sparse regions. The cases evaluated include (1) a lumped, conceptual model in gauged watersheds across a hydroclimatic gradient, (2) a distributed, conceptual model in a gauged watershed, and (3) a lumped, parsimonious model in ungauged watersheds. For the first case, a comprehensive, global sensitivity analysis is performed to investigate how model behavior varies across watersheds with different hydroclimatic characteristics. The results of the sensitivity analysis are then used to determine if the parametric dimensionality of the model can be reduced for multi-objective optimization, without significantly impacting model performance. For the second case, a series of synthetic rainfall events are used to investigate spatially-varying model behavior across the domain of a distributed model. Lastly, for the third case, an approach for ungauged hydrologic prediction is tested for a region of southern Africa and changes in the modeled streamflow response due to projections of climate change are assessed. Overall findings demonstrate that hydrologic model behavior is a dynamic variable that varies across watersheds, time periods, and the model domain (in the distributed case). Results also highlight the limitations of existing methods and need for new dynamic methods for model identification that take patterns of model behavior into account for both lumped and distributed modeling. And finally, results for the ungauged case extend the modeling approach to less-developed countries and project that annual runoff for the study area will increase in the future, thereby highlighting the importance of such studies for water resources and flood management.