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Transferring rainfall runoff model parameters to ungauged catchments: Does the metric by which hydrologic similarity is defined actually matter?

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Daily streamflow information is critical for solving any number of hydrologic problems. Because most of the world's stream reaches are ungauged, this data is commonly needed for rivers that have no readily available measurements of streamflow. One approach to estimating daily streamflow time series at ungauged catchments transfers a set of model parameters resulting from the calibration of a rainfall-runoff model at a gauged catchment (or set of gauged catchments) to an ungauged site of interest. Central to this approach is the selection of a gauged donor catchment that is considered hydrologically similar to the ungauged catchment. A number of published studies compare various methods to define hydrologic similarity, typically using distance between the catchments or similarity in catchments characteristics; however, no one metric of hydrologic similarity has been demonstrated to provide a consistent approach to select a suitable donor catchment. For 16 unregulated catchments in the mid-Atlantic United States, this study shows that the similarity metric matters little if the catchments are classified as good receivers, which we define as catchments having more than two donor catchments that result in reasonable models of daily streamflow. Rainfall-runoff models were calibrated at each of the 16 study catchments and then the study catchments were treated as ungauged and model parameters from each of the other 15 catchments were transferred to the ungauged catchment. For catchments that are good receivers, combining the model output from several donors – no matter whether the donors were selected using distance or similarity in catchment characteristics – resulted in estimated daily streamflow comparable to the observed streamflow at the ungauged location. However, none of the similarity metrics were useful for selecting a suitable donor catchment when the ungauged catchment is considered to be a poor receiver (defined as a catchment with only one donor catchment that results in a high efficiency value). This new catchment classification approach could explain the confounding results of previous similarity studies and provide a new framework for assessing hydrologic similarity among catchments.