

# **Stochastic Nonparametric Framework for Basin Wide Streamflow and Salinity Modeling: Application for the Colorado River Basin**

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## **Abstract**

The Colorado River system recently experienced the worst five year drought in the 100 years of measured streamflows. The vast network of reservoirs that sustain and fuel development were drawn below 50% of system capacity to historic lows. The dry period also impacted water quality, increasing salinity concentration as a result of low flows. Paleo reconstructions of streamflow in the basin indicate that such dry spells are not uncommon.

Given these factors, the key question for this research is how to plan for effective and sustainable management of water resources in the basin? This requires two key components, (i) a robust framework to generate realistic basin-wide streamflow and associated salinity scenarios and (ii) a decision support model to evaluate operating policy alternatives for efficient management and sustainability of water resources in the basin. To achieve this, three inter-related modules were developed including. (i) A stochastic nonparametric model for basin-wide streamflow generation based on historic observations conditioned on paleo reconstructed streamflow. This new model is data driven and improves considerably upon traditional approaches, besides being simple, robust and flexible. A nonhomogeneous Markov Chain based approach to combine hydrologic state information (i.e., wet or dry) from the paleo streamflow and flow magnitude from the historic data is a unique and novel method to combine the strengths of these two different data sets. (ii) A basin-wide stochastic model for generating salinity scenarios extending the nonparametric flow model for salinity simulation. (iii) A realistic decision model of the basin that evaluates policy alternatives under various flow and salinity scenarios.

This comprehensive framework provides the ability to generate scenarios of basin-wide streamflows and salinity that are statistically consistent, realistic and also incorporate paleo information. These scenarios are used in a long-term planning model of the Colorado River Basin to evaluate two alternate reservoir operation policies on various system risk and reliability estimates.