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Uncertainty in Drinking Water Supplies: Exploring Stochastic Source Water Quality Generation Methods

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Abstract: This work explores stochastic source water quality generation methods to aid in the characterization of uncertainty in water treatment planning. Water treatment plants (WTPs) are tasked with providing citizens safe and reliable drinking water; however, variability of surface water quality due to seasonal fluctuations and extreme events (e.g., flooding and wildfires) can overwhelm a WTP's capacity to do so. By characterizing source water uncertainty and creating realistic water quality scenarios, decision makers can adjust operating policies and make infrastructural changes to improve the reliability of their system. Building on methods from stochastic streamflow generation, including, autoregressive moving average models, vector autoregressive models, and k-nearest neighbor resampling, we have identified a suite of models viable for water quality applications. In general, these models attempt to simulate the seasonal and annual autocorrelation for each water quality parameter and maintain the joint correlation across all water quality parameters. To test this modeling suite on a range of source waters, we have compiled several monthly time series datasets of alkalinity, pH, temperature, total organic carbon, and UV absorbance at 254 nm from utilities across the United States. By analyzing each dataset via the modeling suite, we evaluate the strengths and weaknesses of different models based on site-specific factors, such as source water type, length of dataset, and stationarity or non-stationarity of the data.

Keywords*:* uncertainty, water quality, time series, statistics