Estimating Climate Change Impacts on Water Temperatures for Philadelphia's Water Supply

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Background/Objectives. The Philadelphia Water Department has two major drinking water intakes on the Schuylkill River within the city limits. In recent years, there has been growing concern about the impacts of climate change on the quality of source water. Potential considerations include the increased likelihood of higher organic carbon sources causing disinfection byproducts, changes to chemical application procedures, and taste and odor problems. Both an increasing nutrient load as well as a higher water temperature contribute to this concern. Understanding the potential for the temperature of the Schuylkill River to increase due to increasing temperatures in Philadelphia, caused by climate change, prompted a study to develop a practical approach to projecting future water temperature in the river.

Approach/Activities. Models based primarily on air temperature do not require the extensive and expensive meteorological and hydrological data that are needed by more sophisticated stream and river temperature simulations using energy budget and heat transport calculations. Because of the complexity of the complete heat transfer equation, simple regression methods (e.g., a simple linear regression model, or the nonlinear Sigmoidal-shape curve [logistic] models) have been the dominant method of relating air temperature to water temperature in streams and rivers.

This particular study developed a regression model of river water temperature, examining both air temperature and flow as potential explanatory variables. Elements of the study included:

- Selection of the most appropriate air temperature data
- Selection of the most appropriate climate model temperature output
- Examination of air–water temperature regressions with and without time lags
- Regression of water temperature to both air temperature and flow.

Results/Lessons Learned. The selected regression was highly successful in estimating daily water temperature and provided an effective model for taking global climate model temperature projections and assessing expected changes to river water temperature between now and the end of the century. Results projected significant increases of water temperature by the end of the century. The output from this analysis provides the necessary temperature input to assess future risks, including implications for meeting receiving water quality standards such as aquatic life use water quality designations, and potential considerations to maintain effective treatment operations.