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The Climate Assessment Tool for the BASINS modeling system: new capabilities for evaluating the vulnerability of hydrologic end points to climate variability and change

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1. Introduction

During the last century, much of the U.S. experienced warming temperatures, increases in precipitation, and increases in the average intensity of precipitation events. Projections of future climate suggest these trends are likely to continue, and in many cases intensify. Water resources and aquatic ecosystems are highly vulnerable to these changes with possible effects including increased occurrence of floods and droughts, water quality degradation, channel instability and habitat loss, and impacts on aquatic biota.

Most water managers face significant challenges associated with the impacts of landcover change, increases in water demand, ecosystem degradation and other stressors. They recognize that climate change could impact their systems; however, it is rarely explicitly considered because of the lack of information about the scope, magnitude, and timing of potential effects. An improved understanding of climate change impacts would enable water managers to better evaluate risk and make informed decisions about meeting supply needs, complying with water quality regulations, and protecting aquatic ecosystems over a range of time scales.

The BASINS Climate Assessment Tool:

EPA's Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multipurpose environmental analysis system designed for use by regional, state, and local agencies performing watershed and water quality-based studies. This system makes it possible to quickly assess large amounts of data in a format that is easy to use and understand. BASINS integrates environmental data, analytical tools, and modeling programs to support development of cost-effective approaches to watershed management and environmental protection. The current release of BASINS, version 4.0, is the first to be primarily based on a non-proprietary, open-source GIS foundation. The BASINS modeling system thus offers a unique platform upon which to develop additional tools useful to stakeholders concerned with climate change.

In this presentation we discuss the design and capabilities of a new Climate Assessment Tool released with BASINS 4.0 that facilitates the assessment of the influence of climate variability and change on a range of hydrologic and water quality endpoints. As used here, an endpoint is any hydrologic or water quality characteristic that can be calculated using output from the watershed models in BASINS. Examples include mean annual streamflow, annual water yield, a 100-year flood event, a Q7-10, mean annual nutrient concentration, annual nutrient or sediment load, and maximum daily contaminant concentration. The Climate Assessment Tool also facilitates the assessment of adaptation strategies (*e.g.*, BMPs) for increasing the resilience of different endpoints to climate variability and change.

Specific capabilities of Climate Assessment Tool include the ability to modify historical climate, generate synthetic weather time series, and conduct systematic sensitivity analyses for specific hydrologic and water quality end-points using the BASINS models. For example, users can manipulate climate variables to change long term mean, variability, monthly or seasonal characteristics, and the occurrence of individual "design" events. These changes in climatic parameters are then converted to modified meteorological time series, either through manipulation of historical observations or simulation using an embedded weather generator. Meteorological time series can be exported or used to drive BASINS hydrologic models, including HSPF.

In addition, the Climate Assessment Tool provides a capability to operate in an iterative mode to conduct systematic sensitivity analyses for specific hydrologic end-points. In this capacity, the tool iteratively manipulates the meteorological inputs, runs the hydrologic model, and manages output. The result is a profile of hydrologic responses to changes in two-dimensional combinations of climatic variables such as temperature and precipitation. This information will help water managers and other stakeholders understand the sensitivity of specific endpoints to prospective changes in climate. An understanding of sensitivity is a necessary foundation for conducting watershed-scale vulnerability analyses.