Assessment of Modeling Tools and Data Needs for TMDL Plan

Erie County, NY

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Problem Statement

In 1998, the New York Department of Environmental Conservation (NYDEC) placed Buffalo River on the state's 303(d) list and designated it as a priority for total maximum daily load (TMDL) development. The Buffalo River has also been identified as one of 43 Areas of Concern in the Great Lakes Region by the International Joint Commission. Sediment pollution in the river and its tributaries is a continuous and increasing concern. Recent surveys suggest that various sources of sediment are continuously being introduced due to suburban expansion and development activities occurring in the headwaters of the watershed (Irvine 2001, unpublished data). These new sources of sediment could complicate the remediation/mitigation of the existing contaminated sediments. Very little is known about how these new sediments might interact with contaminated sediment beds. Sediment, especially the finer fraction, provide a delivery mechanism for other pollutants such metals, nutrients and organics, which are transported in the adsorbed phase. Any management/mitigation plans that are targeted towards addressing existing contaminated sediments and/or other water quality problems in the Buffalo River will have to specifically account for the sediment pollution in the river.

Background

The BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) suite of models is one of the tools that is being recommended and actively supported by the U.S. Environmental Protection Agency (USEPA) for developing TMDL plans for the 303(d) list of priority waters (USEPA, 2001). Although comprehensive and promising, the BASINS tools have not been thoroughly tested and are being continuously refined and updated (with the latest version, 3.0, being released only a few months ago). The use of BASINS in TMDL planning is so new that the few studies that have used BASINS have been placed on the EPA website as "example TMDLs" for guidance. In that list we did not find a single Great Lakes study site!

Our interest in this project was to assess the use of BASINS models and their data needs in the development of the sediment portion of the TMDL plan. We will use the Buffalo River watershed as the study site. The Buffalo River watershed is typical of many of the Great Lakes watersheds in its distribution of urban areas near the watershed outlet and rural and/or agricultural landscapes in the upper headwater reaches. We will use the standard USEPA recommended GIS data and input information for the BASINS models. USEPA has made available all standard data for watersheds across the country on the BASINS web site. Hence, by evaluating the models and their data needs for the Buffalo River watershed, we propose to develop a

methodology which is transferable and will provide guidance for the use of the BASINS models in TMDL development across other Great Lakes watersheds.

We have already implemented the BASINS-SWAT (Soil Water Assessment Tool) and HSPF-NPSM (Hydrologic Simulation Program Fortran - Nonpoint Source Simulation Model) for the Buffalo River and its subwatersheds. SWAT and HSPF-NPSM are both watershed-scale water quality models, but differ in their use of algorithms for simulating water and pollutant transport. Current evaluations of the models have been limited to comparing simulated discharge predictions against the readily-available U.S. Geological Survey discharge data that are being collected at the outlet of the three main subwatersheds (Cazenovia Creek, Buffalo Creek, and Cayuga Creek) in the basin. Further evaluations of the models have been restricted due to lack of data, especially, high-temporal resolution sediment information.

Activities

For this project we propose to collect this critical additional sediment data which will enable us to test the sediment component of the models and proceed with development of the sediment portion of the TMDL plan. For this study we propose to focus on the Cazenovia Creek sub watershed in the Buffalo River basin. Of the three main tributaries, Cazenovia Creek has received the highest ranking with regard to water quality concerns (Erie County Water Quality Coordinating Committee, May 2000). By focusing on one subwatershed (as opposed to the complete Buffalo River basin) it will allow us to perform a more thorough assessment of the BASINS models and data requirements. Once a methodology for the Cazenovia Creek sub-basin is developed, it will provide us with guiding principles for developing TMDL plans for the other subbasins. Questions to be address include: (a) How robust are the SWAT and HSPF-NPSM predictions and what is the confidence associated with model predictions? (b) What is the level of spatio-temporal variation in measured sediment data,with what implications for model testing? (c) Do SWAT and HSPF-NPSM differ in their hydrologic and sediment simulations, and if yes, with what impact on the TMDL process? (d) How easily can sediment source/sink areas be targeted via the BASINS models? and (e) How realistic are the simulations of effectiveness of Best Management Practices?

Results

SWAT and HSPF can both be used as tools for assessment of sediment pollution. However, the SWAT model has a fewer number of parameters that need to be adjusted for model calibration and thus is easier to implement than HSPF. Measured data on discharge and sediment at multiple points in the watershed is critical for SWAT calibrations. Calibration of the model against sediment concentrations measured at the watershed outlet alone does not guarantee that the model predictions for component subbasins and stream reaches will be accurate. Monte-Carlo simulations should be conducted while implementing the SWAT model for a watershed. Monte-Carlo analysis gives a better appreciation of the range of parameter values that may be appropriate for the watershed. The level of detail/resolution and accuracy of the LULC layer is very important for accurate model predictions. Clear delineation and simulation of vegetative buffers along streams and drainage ways will improve model predictions of sediment yield.

Two poster presentations were made at the 2003 AWRA Watershed Management for Water Supply Systems Conference in New York City, June 29-July 3, 2003, and two presentations (one poster and one oral) were made at the 2004 IAGLR Conference in Waterloo, Ontario, May 24-28, 2004.

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