STONE ENVIRONMENTAL INC

Identification of Critical Source Areas of Phosphorus in the Missisquoi Bay Basin

LAKE CHAMPLAIN BASIN PROGRAM

MISSISQUOI BAY WATERSHED, VERMONT

JULY 2010—DECEMBER 2011

It is widely believed a small portion of the total land area of any watershed is responsible for the majority of the pollutants exported during wet weather events. This portion of the watershed can be termed a "critical source area" (CSA). It follows that watershed management strategies could be more cost effective if treatments were targeted to these CSAs.

Lake Champlain's Missisquoi Bay is a large, shallow bay that straddles the Vermont-Quebec border. The bay has one of the highest in-lake phosphorus concentrations of any segment of Lake Champlain and has long been impaired by eutrophication caused by excessive phosphorus loads from its watershed. Phosphorus loads to, and concentrations in, the Bay greatly exceed target levels designated by water quality criteria endorsed by the state governments of New York, Quebec, and Vermont.

Specific areas of the landscape and river channel system generate the vast majority of phosphorus load in a watershed. Identification of these CSAs will enable more effective implementation of practices to address the issue of excessive phosphorus entering the bay.

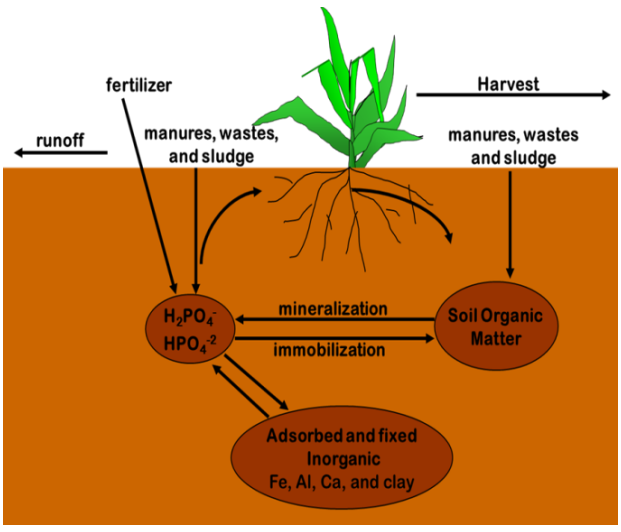
Study Goals and Objectives

- Identify and rank CSAs at multiple scales across the Missisquoi Bay Basin using the best available basin-scale geospatial data and the Soil and Water Assessment Tool (SWAT).
- Estimate phosphorus reduction potential from traditional vs. targeted best management practices.
- Assess the effects of predicted climate change on CSAs.

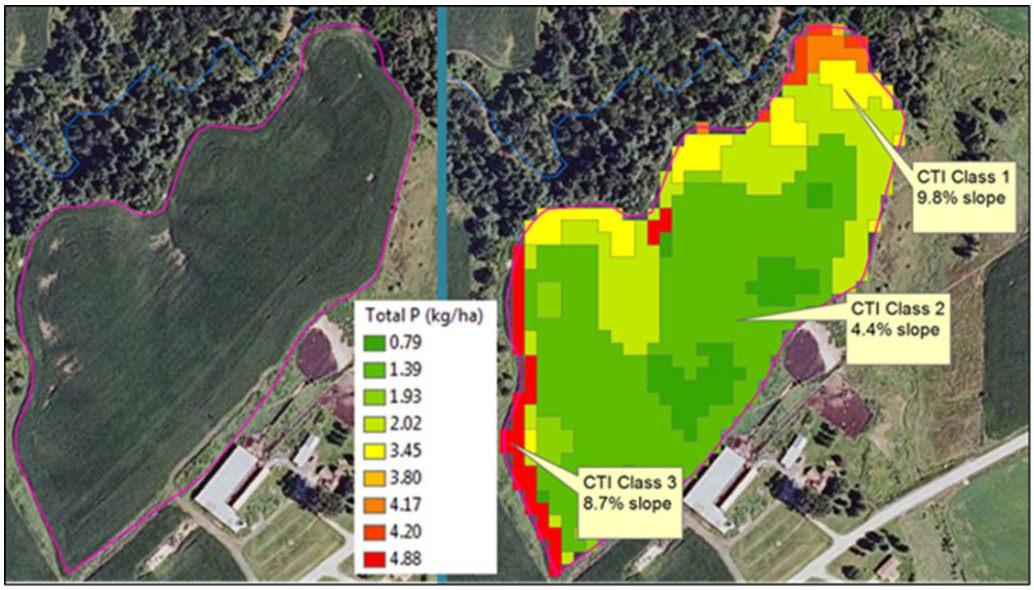
Soil and Water Assessment Tool

The Soil and Water Assessment Tool (SWAT) has proven to be an effective model for assessing water resources and non-point source pollution for a wide range of scales and environmental conditions, and is particularly well-suited to agricultural landscapes.

For the Missisquoi Bay watershed, Stone developed a unique implementation of the SWAT model that enabled simulation of phosphorus transport processes at a resolution never before done at the basin scale. The approach relied upon rigorous development of GIS datasets and their careful integration with SWAT.



Phosphorus cycling in SWAT.



Sub-field level identification of CSAs.

Data Development

Characterization of land use and cropping practices, as well as topographic characteristics influencing surface runoff generation were critical components to the development of the Basin SWAT model and identification of CSAs.

Model Calibration

The hydrology, sediment, and phosphorus transport was calibrated at nine locations throughout the watershed, providing confidence in the model's capability to identify phosphorus CSAs. As was anticipated, the model results found that just 10% of the land area in the Basin is contributing nearly 60% of the phosphorus load. Better yet, maps of the CSAs have been prepared and distributed to program managers and are being used to inform existing technical and financial assistance programs.

Results

The results from the Basin SWAT simulations allowed for the assessment of phosphorus loading at scales from major sub-watershed down to the sub-field level.

CSA Identification

The sub-watershed level results will be used to target areas of the Basin for more focused management, as well as more intensive future monitoring and modeling. The field and sub-field level results will be used to prioritize specific locations for allocation of resources to support implementation of practices—such as cover cropping and reduced tillage—aimed at reducing phosphorus loss and improving water quality.

Best Management Practices

The relative effectiveness of two possible approaches for implementation of best management practices (BMPs) were explored:

- Random implementation to 20% of eligible land
- Target implementation to those CSAs ranking in the highest 20%

The three BMPs evaluated included nutrient management, cover cropping, and a crop rotation shift to permanent hay. Targeted implementation of BMPs was shown to result in a 1.8 to 2.9 times increase in overall effectiveness compared to random implementation.

Online Link, Summary and Next Steps

The reports and online web mapping of the modeling results can be found at: http://lcbp.org/missisquoicsa.htm Vermont's Agency of Agriculture, the Natural Resource Conservation Service, and others are looking to the results of the Missisquoi Bay Basin project for guidance in targeting implementation of best management practices.

Efforts are underway to adopt approaches similar to those developed in the Basin in other high-interest sub-watersheds of Lake Champlain.

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