Managing Phosphorus in Agriculture at the Field Scale.

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Introduction

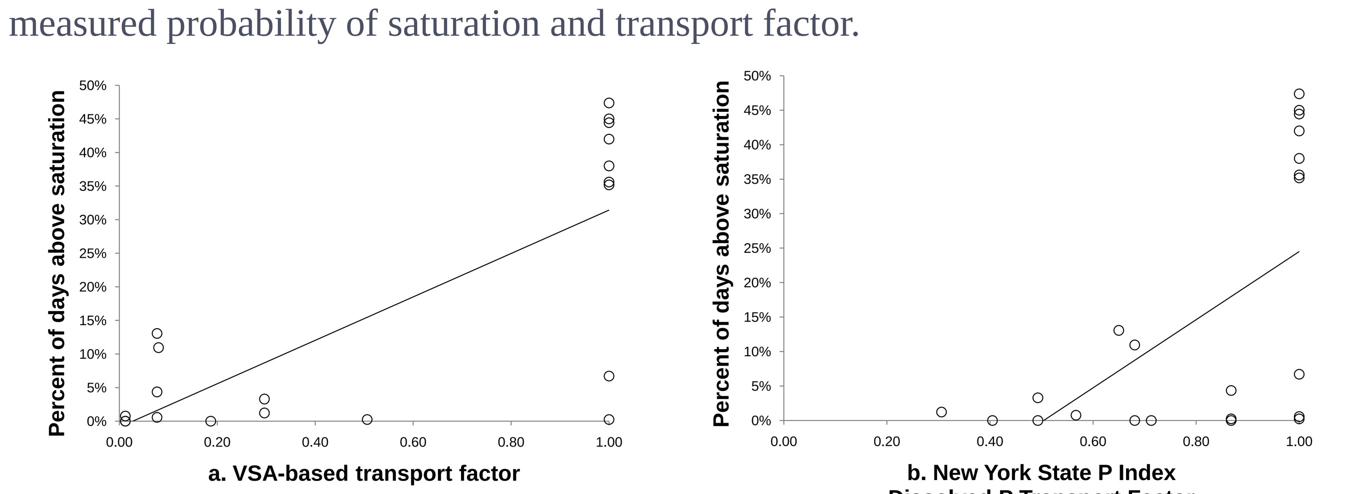
Phosphorus in agricultural runoff often contributes to eutrophication of streams and other fresh water systems. Management of phosphorus runoff from non-point sources has become an important focus for research and discussion. This poster highlights three studies aimed at evaluating and improving phosphorus management techniques. All of these projects were intended to produce results that would be immediately applicable in the field.

A P-Index transport factor based on variable source area hydrology

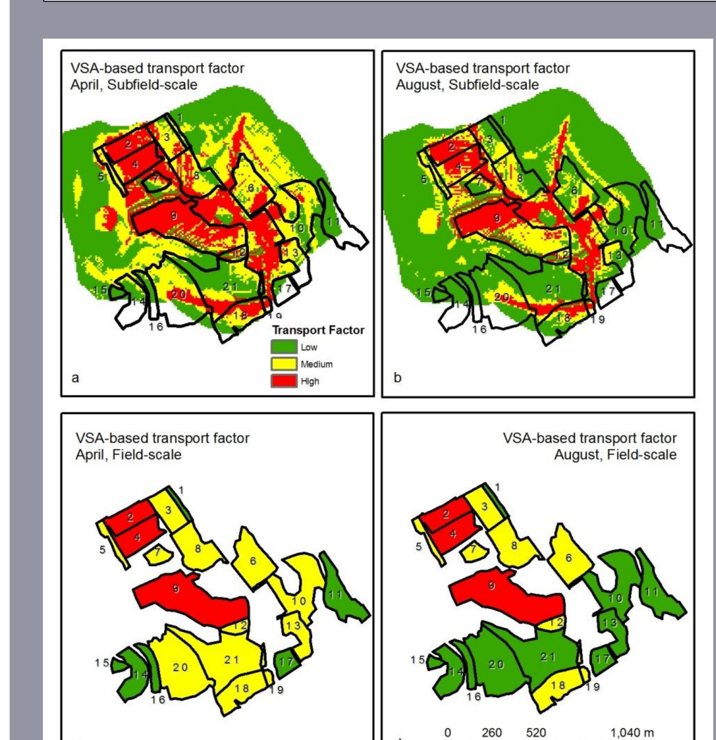
The P-Index is widely used for managing phosphorus (P) from non-point sources. It identifies fields or parts of the landscape that are most likely to produce P-enriched runoff. The New York State (NYS) Phosphorus Runoff Index (P-Index) consists of a transport factor and a source factor that are multiplied together to calculate the P-Index for a certain field.

In much of the Northeast US, runoff generating areas expand and contract seasonally and are referred to as variable source areas (VSAs). The NYS P-Index accounts for VSAs in its transport factor by rating areas close to streams as having a high risk of generating runoff. Many factors effect how likely a place is to generate runoff. The VSA-based transport factor shown here was developed using slope, soil properties, and the upslope contributing area at a point.

The VSA transport factor provided better estimation of actual saturation in test wells than the current P-Index transport factor. These graphs show the relationship between measured probability of saturation and transport factor.



Straight lines are linear regressions, $r^2 = 0.63$ and $r^2 = 0.40$ for (a) and (b), respectively.



If the planner looks only at the field scale, the entire field must be managed at the same level. The VSA transport factor would allow manure or fertilizer to be spread on lower risk areas of a field, while avoiding the higher risk areas. This graphic shows the spatial and temporal variations in high-risk areas.

Combined monitoring and modeling to evaluate water quality BMPs

Water quality problems associated with agricultural non-point source (NPS) pollution have prompted the adoption of a variety of "best management practices" (BMPs). It has proven difficult to assess their cumulative impacts and individual effectiveness in reducing NPS pollution. We combined long-term monitoring, paired-watershed analyses, and process-based watershed modeling to assess changes in phosphorus loading for a 160 ha agricultural catchment. A suite of BMPs were implemented in the mid-1990s aimed at reducing P loads.

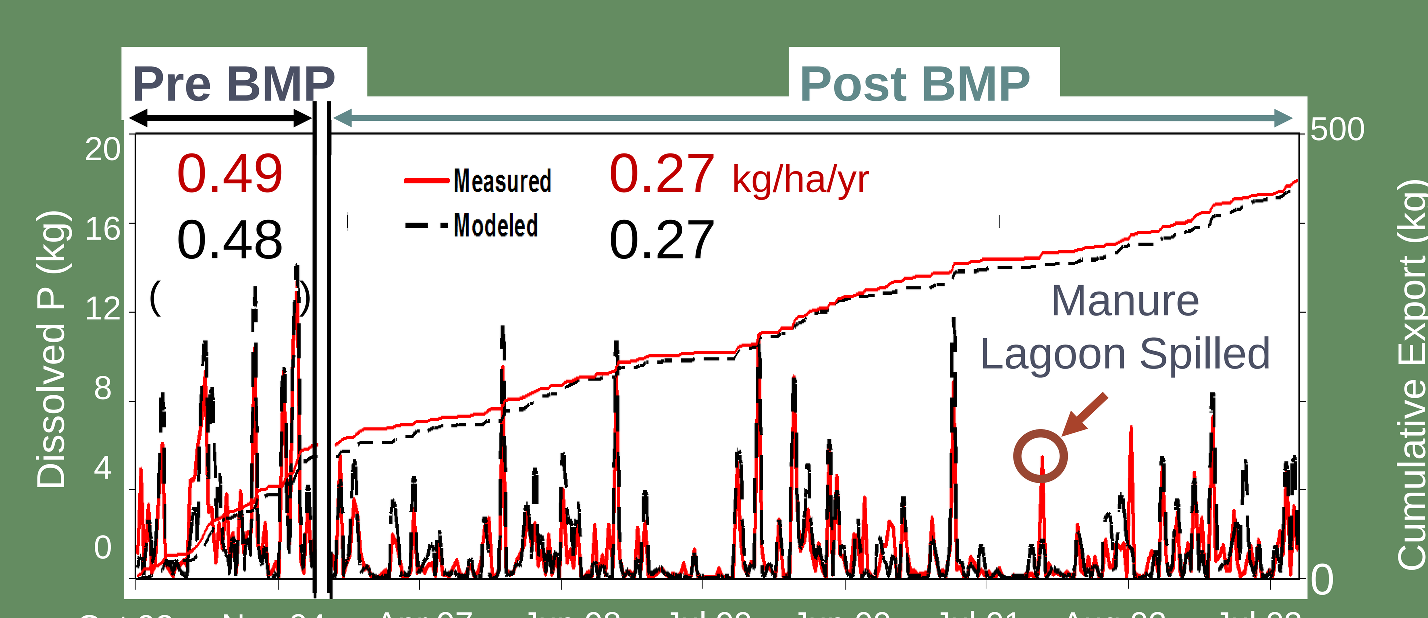
BMPs (mostly adopted 1995 - 96)

- Fenced buffer around water ways
- Various barnyard improvements:
  filter areas, runoff control, etc.
- Improved stream crossings
- Improved manure spreading schedule
  - Avoid variable source areas
  - Manure storage required
  - Access to distal parts of watershed improved
  - Some drainage modifications to keep fields dry
- Erosion control (strip cropping, better crop rotation)
- Precision feeding (adopted later)

Monitoring results

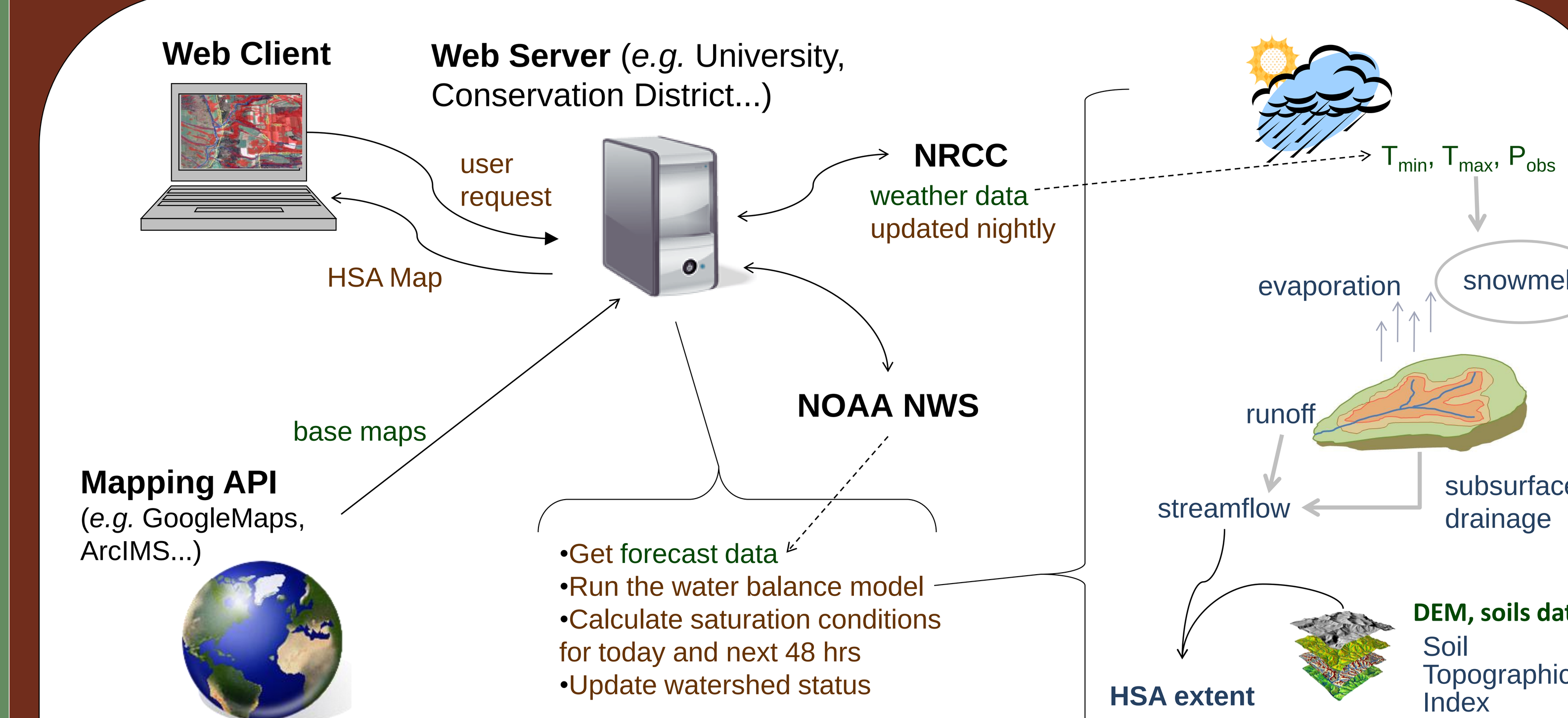
	Winter	Spring	Summer	Fall	Total
TDP reduction (%)	43	36	52	6	43
Adjusted R^2	0.89	0.83	0.89	0.92	0.89
PP reduction (%)	32	18	39	2	29
Adjusted R^2	0.89	0.79	0.82	0.87	0.77

Model: We developed the Variable Source Loading Function (VSLF) model (Schneiderman et al., 2007) to predict realistic distribution of soil moisture and runoff typical in watersheds where variable source area (VSA) hydrology dominates. Using the farmer's management records and the closest weather station, we modeled dissolved P from the watershed for a period spanning the pre- and post-BMP periods. The model correctly reproduced the reduction in dissolve P export after the BMPs were implemented. This model could therefore be used in situations where measurements were not available.

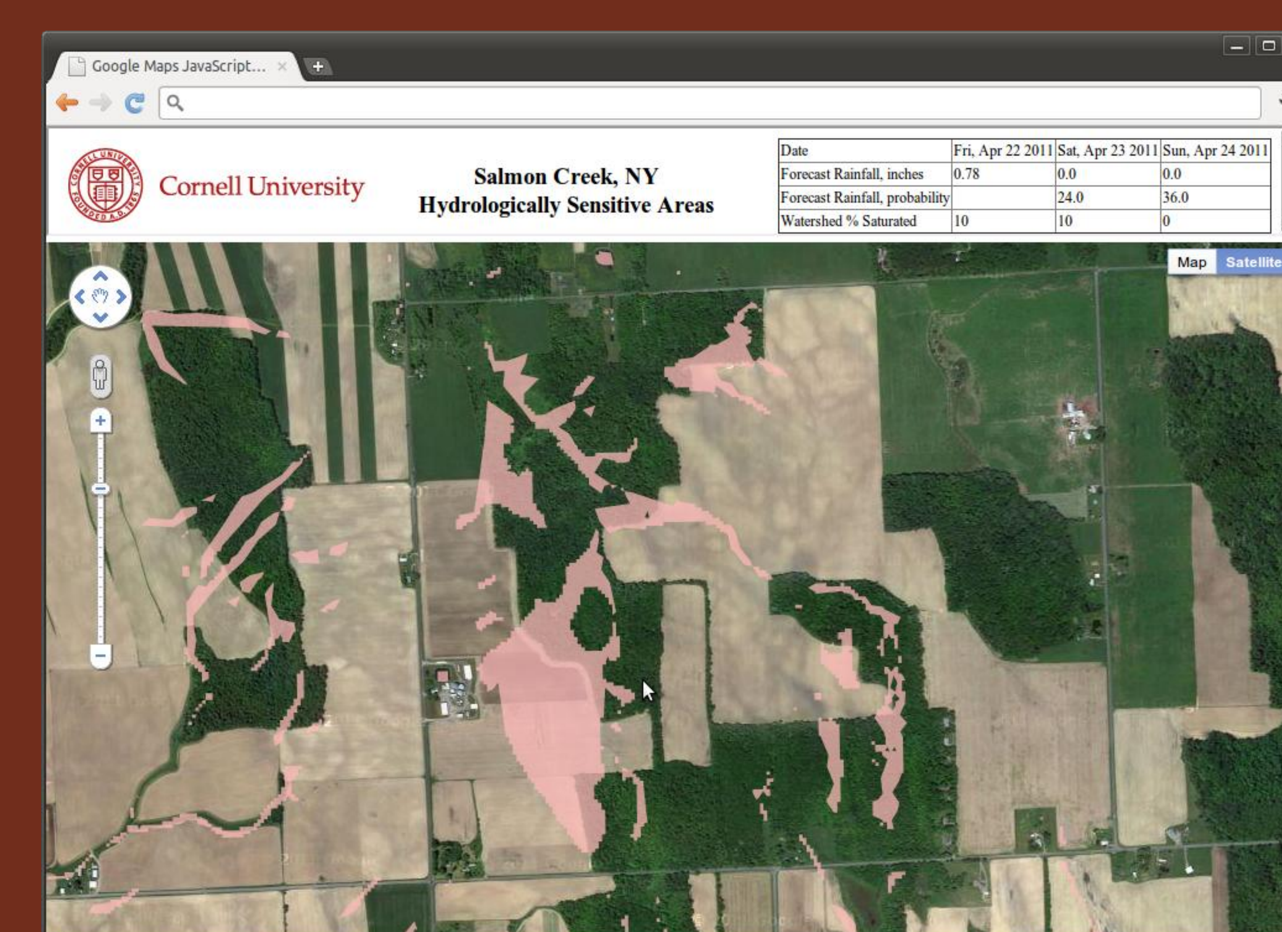


An interactive online tool to forecast spatially distributed saturation and runoff

The location of areas that produce runoff is important to water resource planning, including best management practices (BMPs). Areas that saturate frequently and move pollutants from source areas to streams are Hydrologically Sensitive Areas (HSAs). In practice it is difficult for BMP planners and local stakeholders to determine the spatial distribution of these saturated areas. To help simplify the BMP planning process, we developed an interactive web-based tool for Salmon Creek watershed, NY. The tool incorporates hydrologic and land management information and presents a map of HSAs online. This tool is being expanded to other watersheds in the region, and could be used anywhere that VSA hydrology applies.



The HSA tool retrieves weather data inputs, uses static spatial data to run a water balance model, and serves an HSA map to the user's browser.



The image above displays the saturated areas for the current day (red areas) for a sample region in Salmon Creek watershed. Predictions of future saturated areas depend on antecedent moisture conditions and the NOAA weather forecast. The script gives updated results daily based on hydrologic conditions.

We are working to make the HSA tool easy to set up and operate in any watershed where VSA hydrology is important. Our vision is that local entities (Soil Conservation Districts, watershed groups, extension offices) will be able to initialize the tool for their area, and serve it to their stakeholders.

References:
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Easton, Z.M., M.T. Walter, and T.S. Steenhuis. 2008. Combined monitoring and modeling indicate the most effective agricultural best management practices. J. Eviron. Qual. 37:1798-1809.
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