Nutrient and Sediment Modeling in Watersheds across an Urban-Rural Gradient

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Overview

- ❑ Project Motivation
- ❑ Study question and data sources
- ❑ Results
- ❑ Preliminary Conclusions

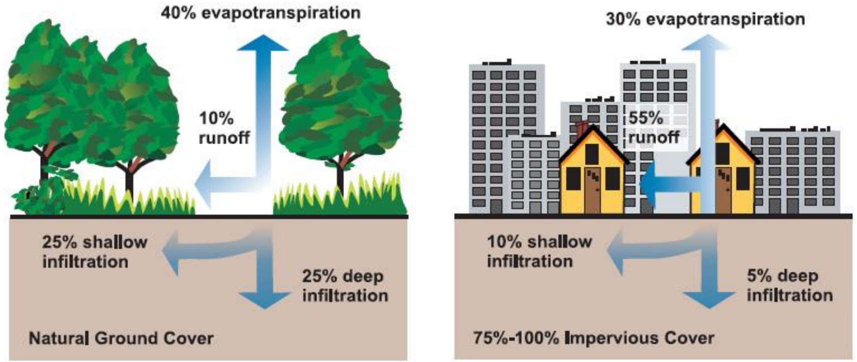
Project Motivation

- Watersheds provide ecosystem services
  - groundwater and surface flow regulation
  - erosion control
  - streambank stabilization

- Ecosystem service provision declines as land becomes more urbanized

- It is not feasible to preserve all land:
  - How do we prioritize land protection?

Wetland near Moscow, Open Access rights



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Study Question

Study Objectives:

- To use the more accurate model to evaluate the best land acquisition strategy for reducing sedimentation and nutrient loading in Hartford's reservoirs.

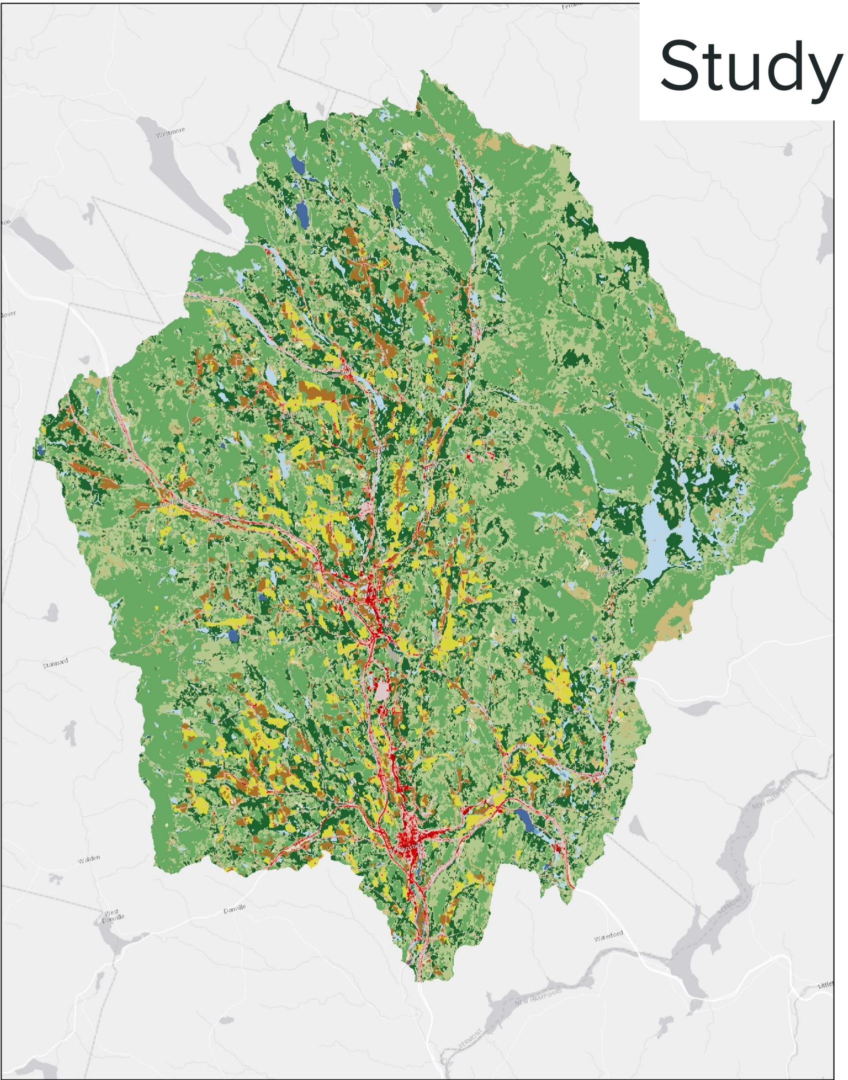
- To assess the accuracy of **two spatially explicit models** in predicting streamflow, sediment loading, and nutrient loading

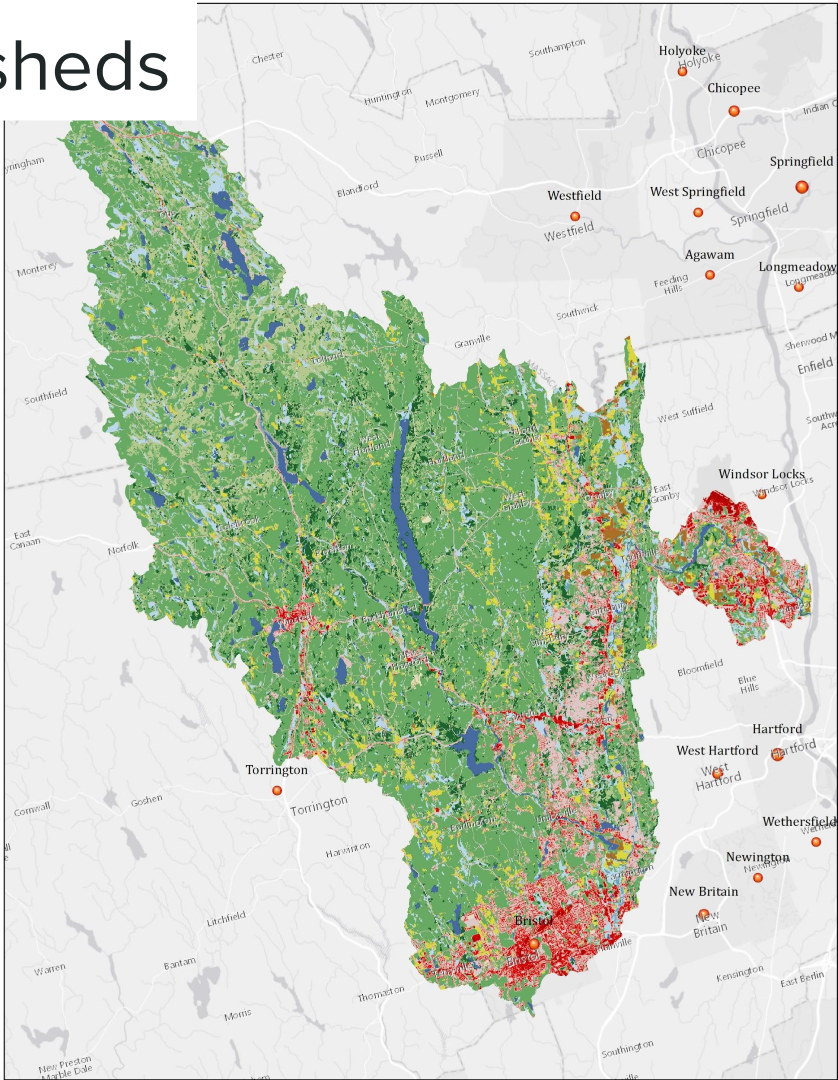
Hypotheses:

- The **InVEST model** will calculate reasonable annual sediment and nutrient values, but this will not give enough information about the seasonal variability of these pollutants.

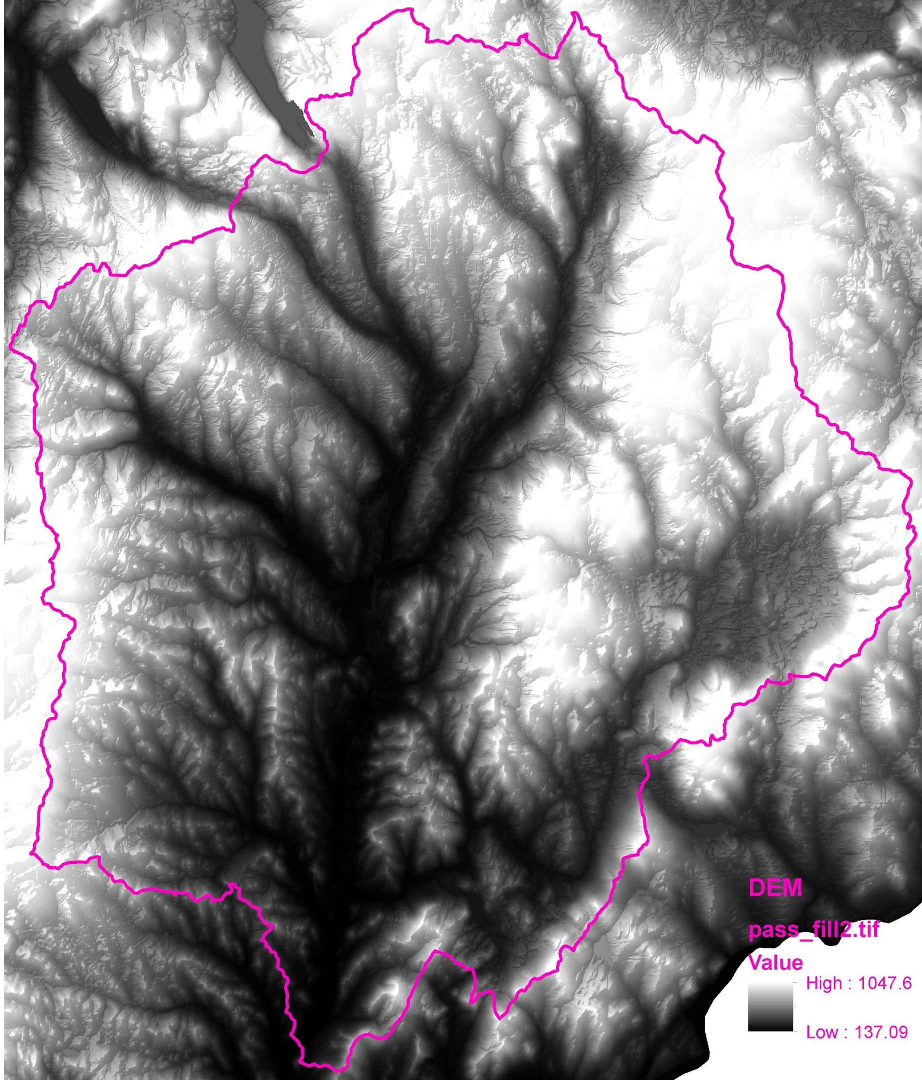
- The **SWAT model** will provide more information about each of the subwatersheds, leading to a more accurate prediction of the value of various management practices.

Study Watersheds



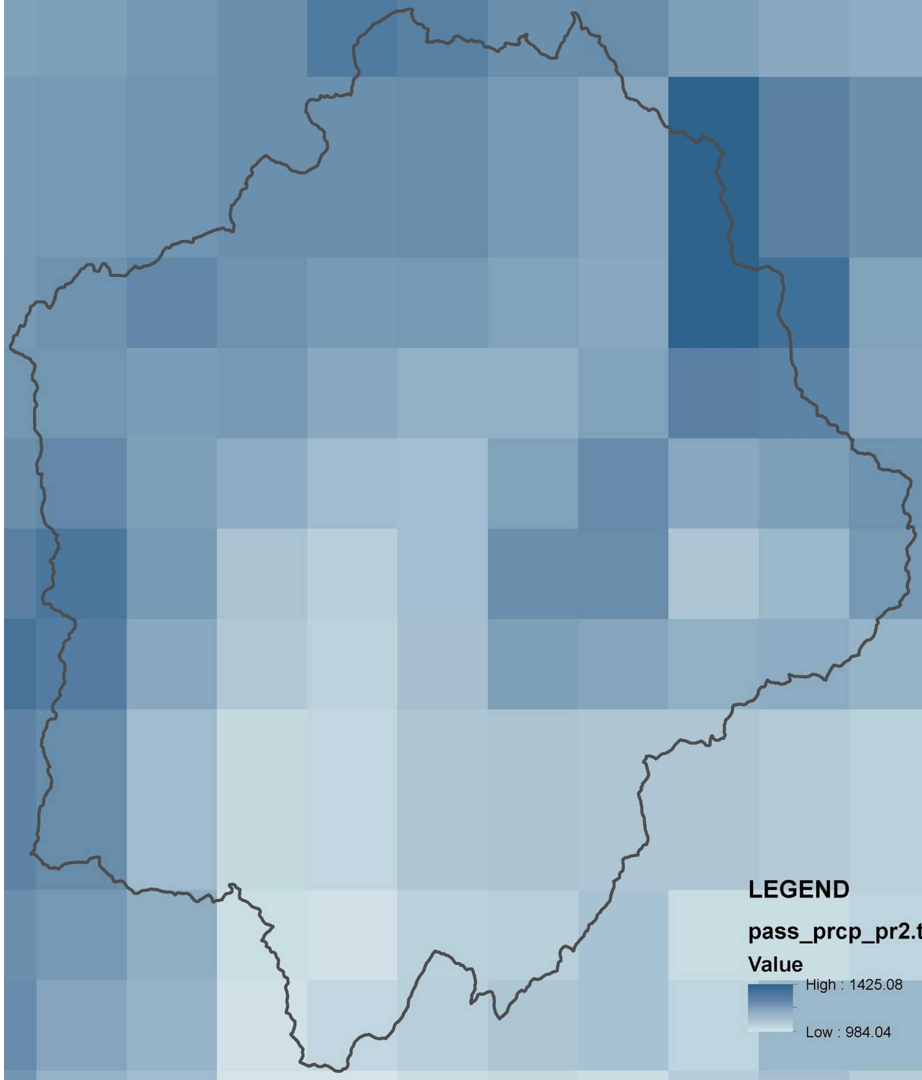


Model Inputs: DEM and Watershed

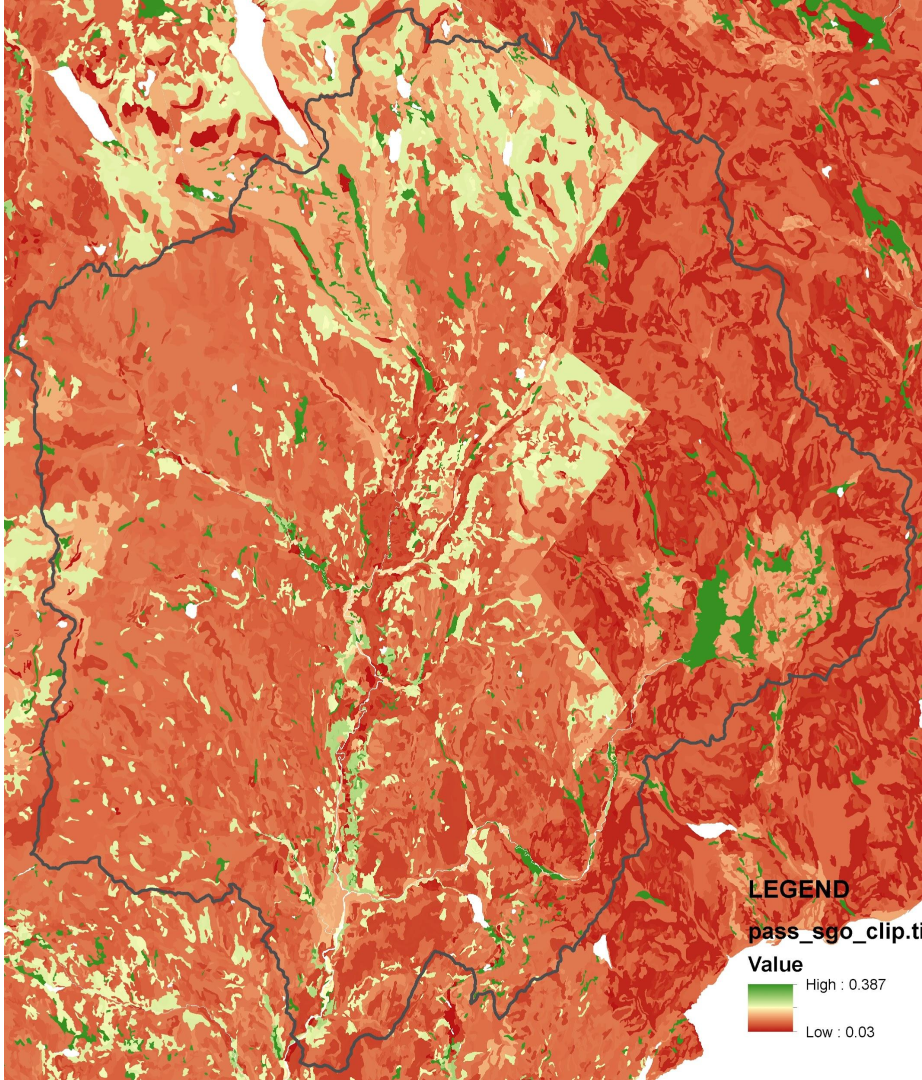


Model Inputs: Precipitation

Gage	Missing Days	Gage PRCP	PRISM PRCP
439099	1	1301.9	1223.630005
437054	0	971.9	1015.660034
433341	1	1056.3	1048.660034



Model Inputs: Plant Available Water Content

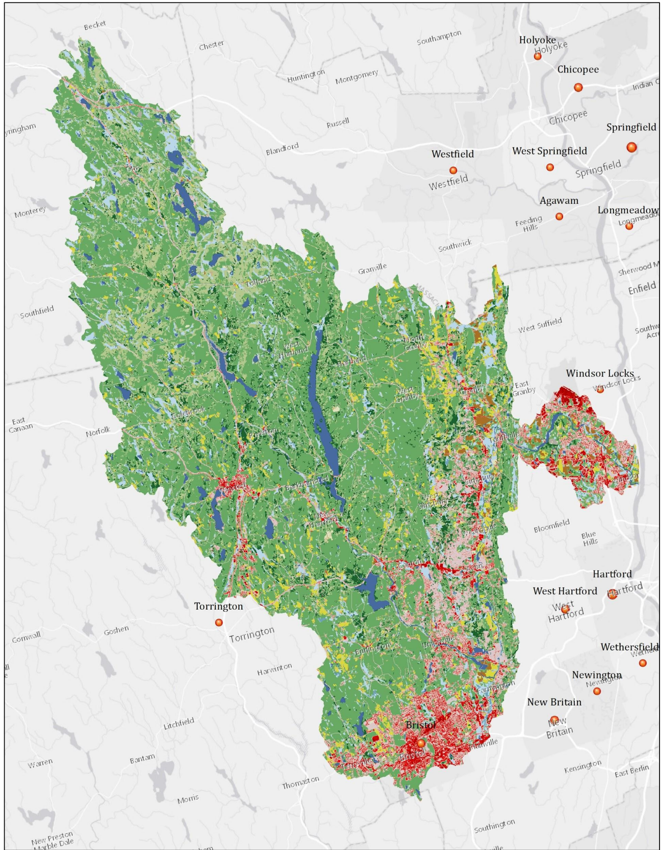


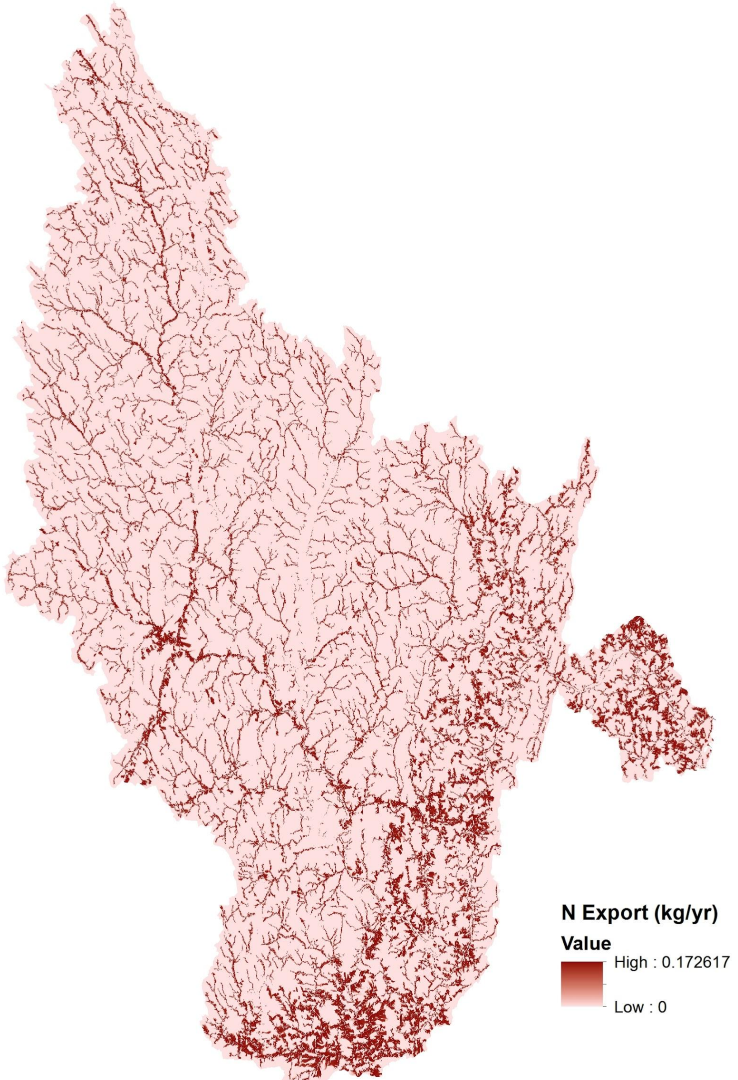
Validate model with data

Validate model with data

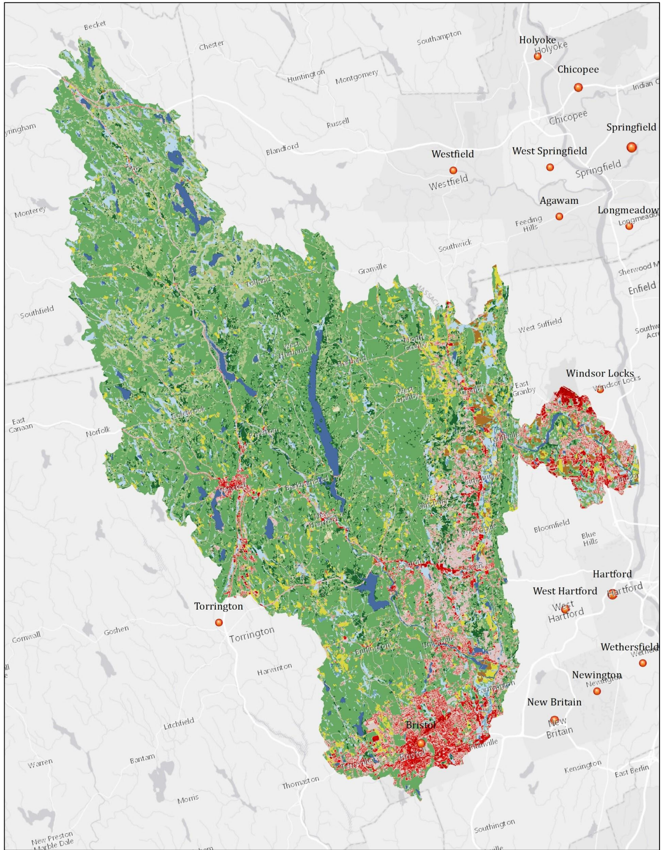
Moose River at Victory, VT (site #01134500)

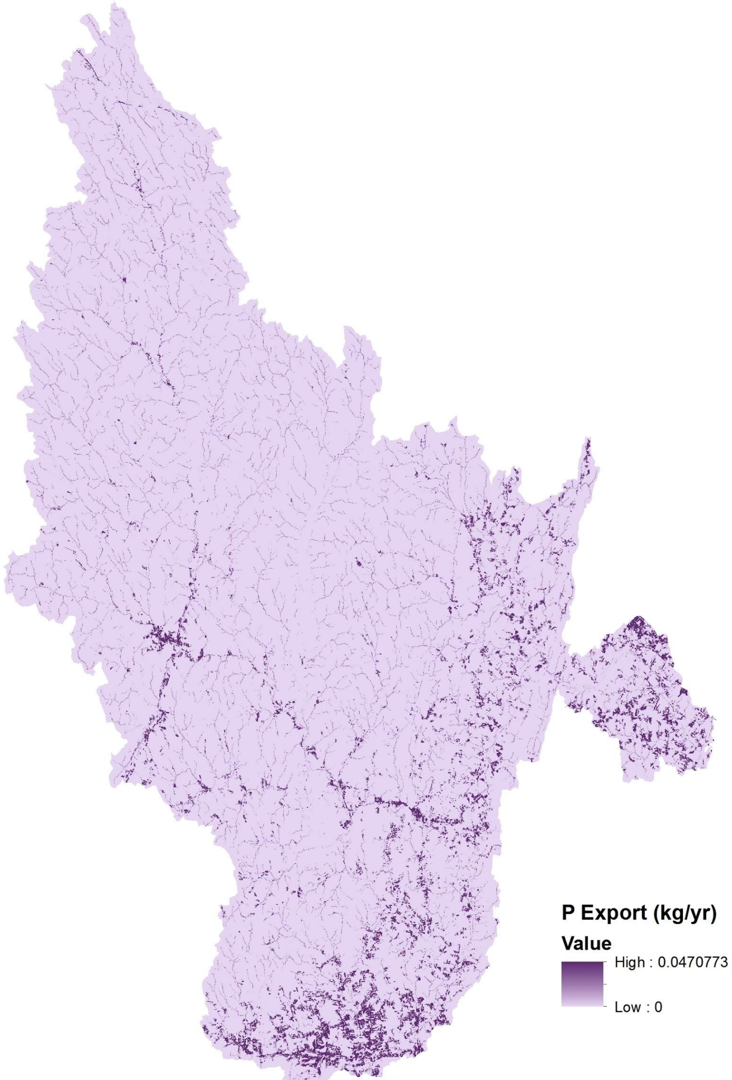
Results: Nutrient Retention





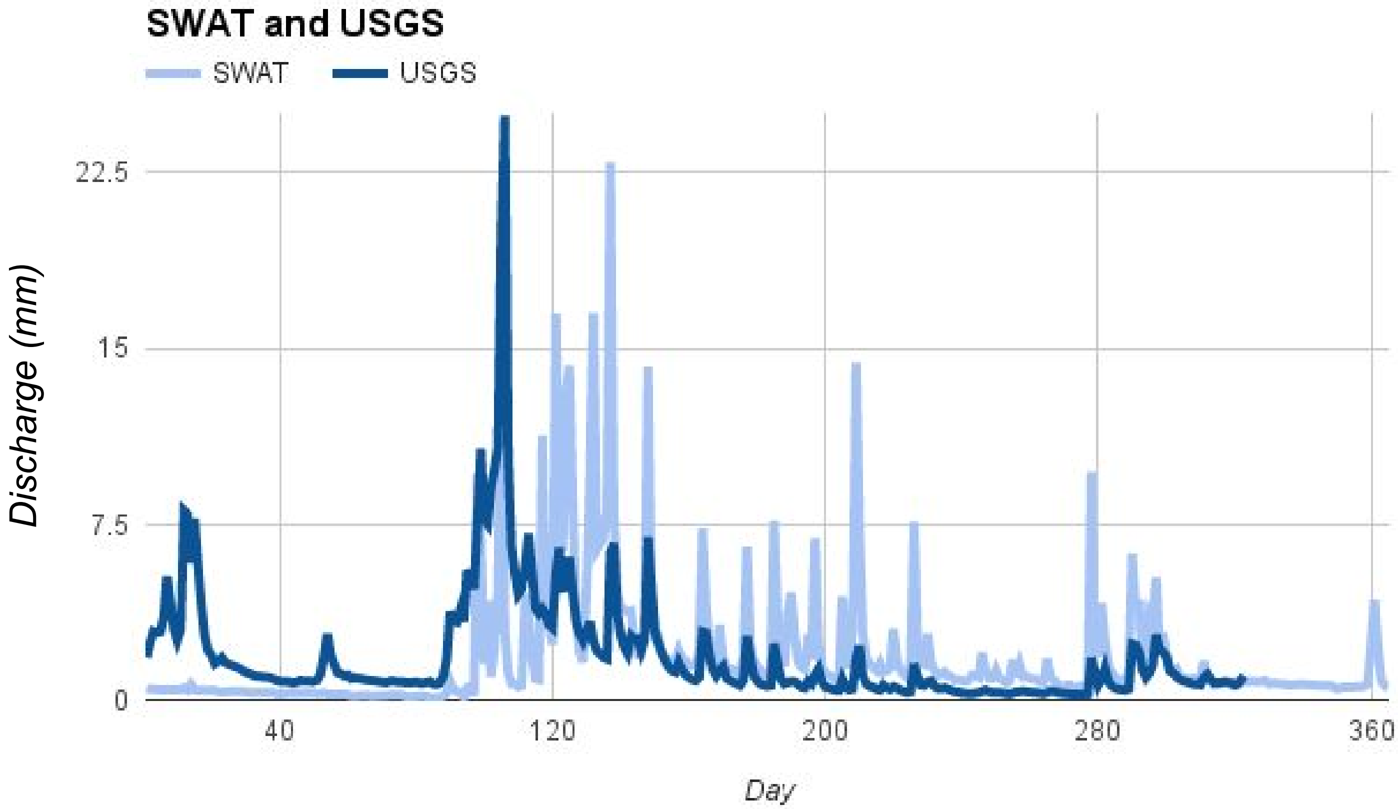
Results: Nutrient Retention





Results: Sediment Delivery Ratio

Ongoing: Data Validation



Preliminary Conclusions

- ❑ Urban areas do have a strong effect on P loading and N loading to a lesser extent
- ❑ Sediment loading is more driven by weather and soil type than urbanization
- ❑ Soil data is important!
- ❑ More work to be done...

SWAT Results	Passumpsic	Passumpsic/km^2	Farmington	Farmington/km^2
Total Annual NO_3 Export (kg)	24,763.2	21.9	81,570.32	52.3
Total Annual Organic P Export (kg)	41,647.2	36.9	12,549.28	8.0
Total Annual Sediment Export (m^3)	$6.46*10^7$	57,219	$8.99*10^7$	57,665

Questions?

InVEST Models: Water Yield

$$Y(x) = \left(1 - \frac{AET(x)}{P(x)}\right) \cdot P(x)$$

Water Yield

$$\frac{AET(x)}{P(x)} = 1 + \frac{PET(x)}{P(x)} - \left[1 + \left(\frac{PET(x)}{P(x)}\right)^{\omega}\right]^{1/\omega}$$

Water Yield for vegetated pixel, where

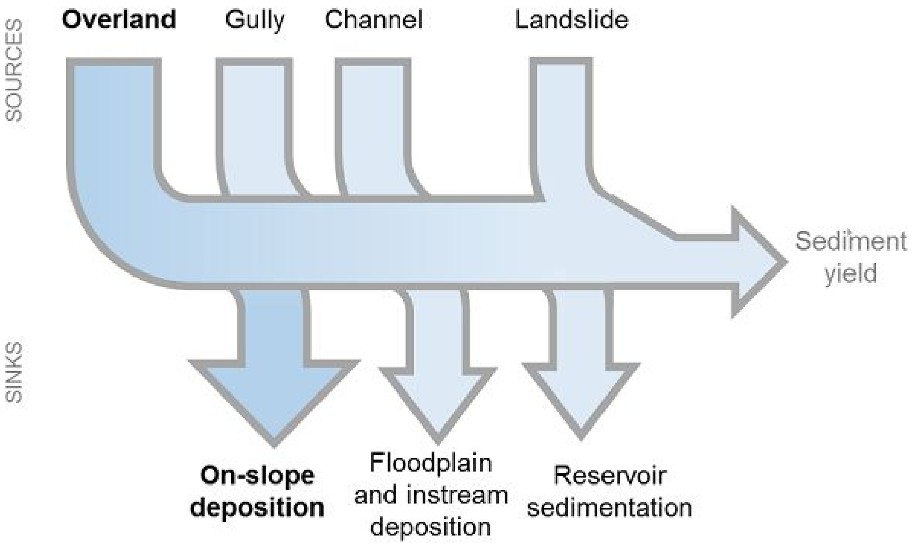
$$PET(x) = K_c(\ell_x) \cdot ET_0(x)$$

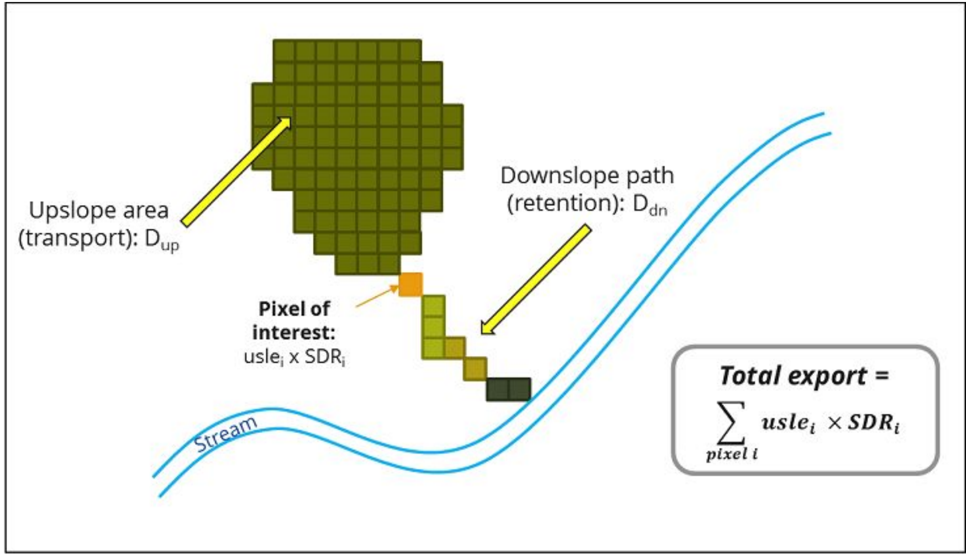
$$\omega(x) = Z\frac{AWC(x)}{P(x)} + 1.25$$

$$AET(x) = Min(K_c(\ell_x) \cdot ET_0(x), P(x))$$

Water Yield for non-vegetated pixels

InVEST Models: Sediment Delivery Ratio (SDR)





$$usle_i = R_i \cdot K_i \cdot LS_i \cdot C_i \cdot P_i$$

InVEST Models: Nutrient Retention

$$ALV_x = HSS_x \cdot pol_x$$

$$HSS_x = \frac{\lambda_x}{\overline{\lambda_W}}$$

Cell	Vegetation retention	ALV	Retained by Cell (retained)	Outflow quantity (OQ) from Cell (Gi=1-Ei)
1	E1	ALV1	0	ALV1
2	E2	ALV2	ALV1×E2	ALV1×G2+ALV2
3	E3	ALV3	((ALV1×G2+ALV2) ×E3	(ALV1×G2+ALV2) ×G3+ALV3
4	E4	ALV4	ALV1×G2×G3×E4+ ALV2×G3×E4+ ALV3×E4	ALV1×G2×G3×G4+ ALV2×G3×G4+ ALV3×G4+ ALV4