Annual Phosphorus Loss Estimator (APLE) Model Sensitivity Analysis

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04-22-15

A Review of Agricultural P-dynamics in the Chesapeake Bay Watershed Model

A Workgroup Report from the Chesapeake Bay Program Scientific and Technical Advisory Committee

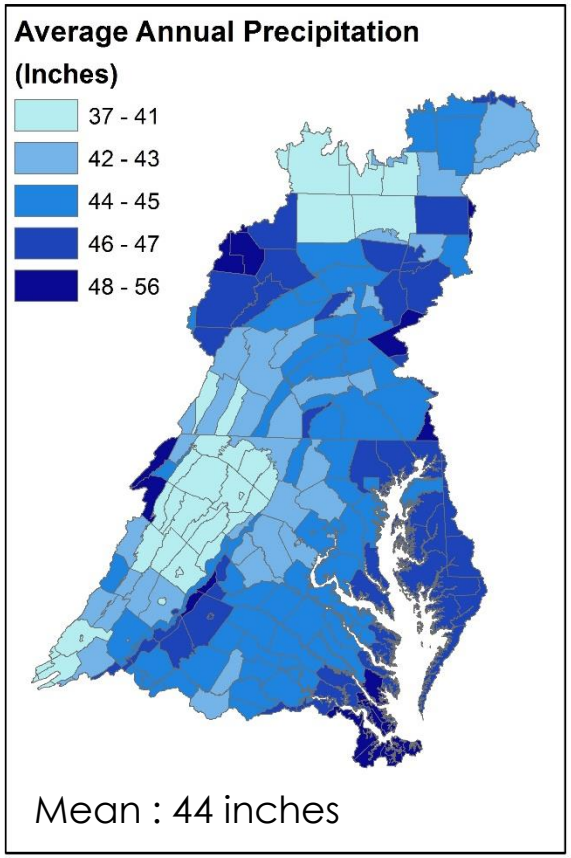
August 2014
STAC Publication 14-005

Objectives

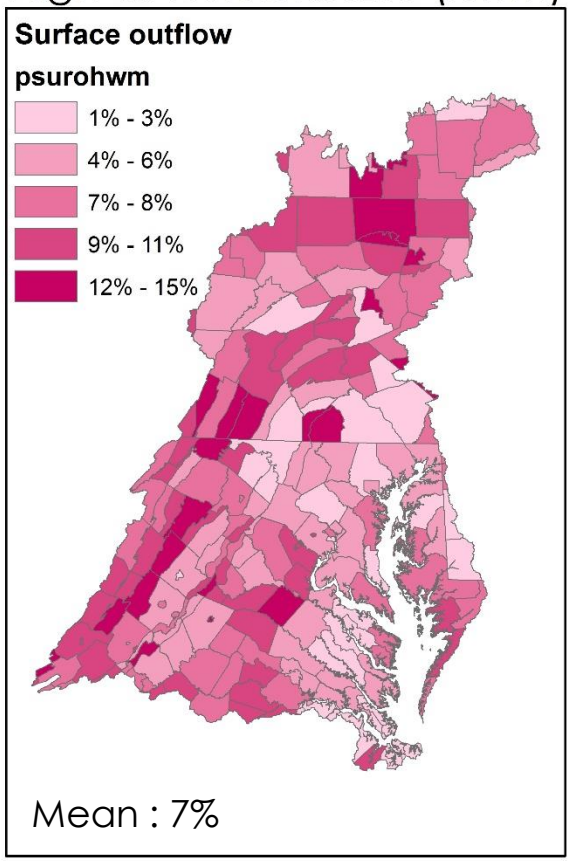
- To implement APLE 2.4 in our suite of models
- To estimate APLE model sensitivity to change in phosphorus inputs in the Chesapeake Bay Watershed
- To decide Phase 6-PQUAL phosphorus sensitivities

APLE 2.4 Implementation

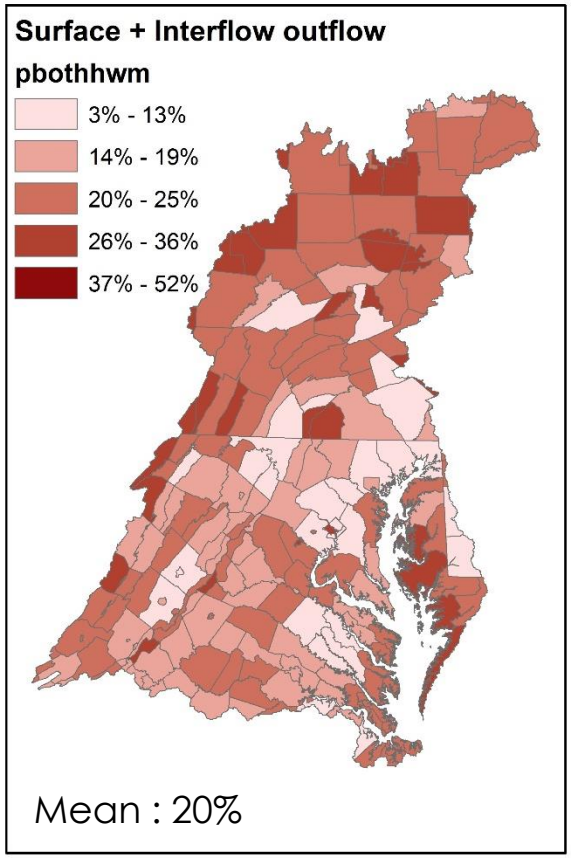
Mean Percentage of Rainfall Resulting in Runoff (1984-2005)
- High-till with manure (hwm)



Mean : 44 inches



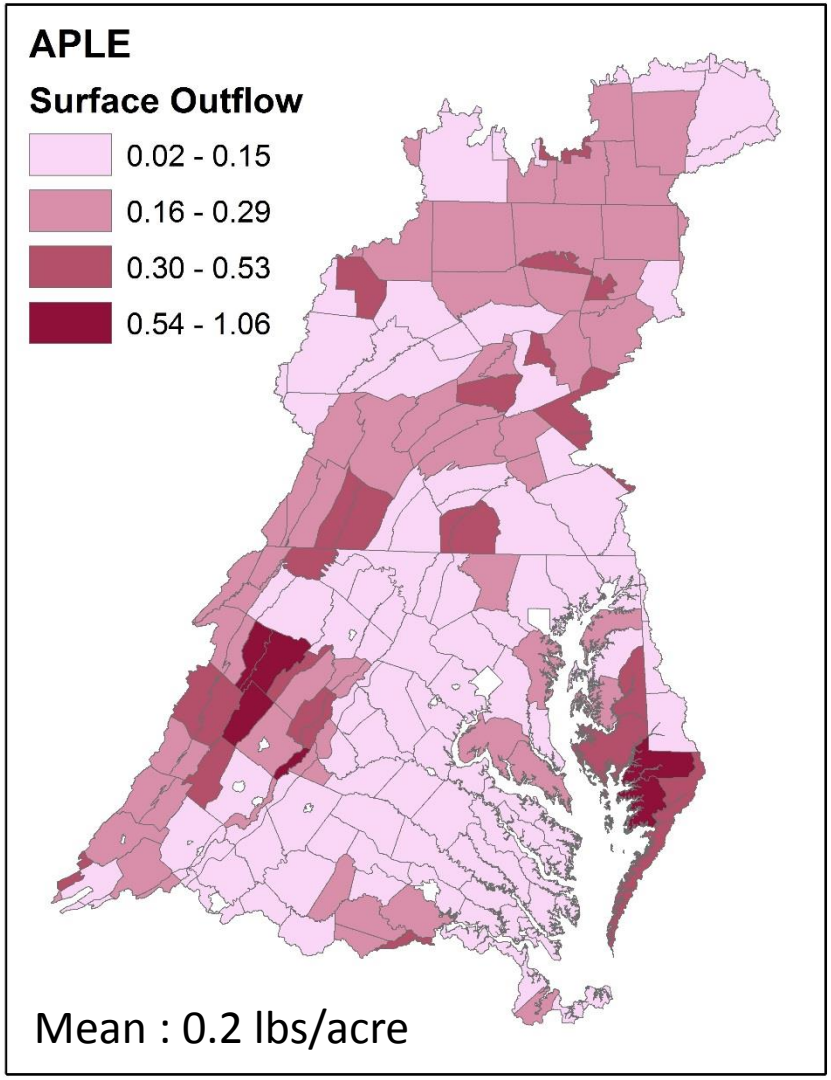
Mean : 7%

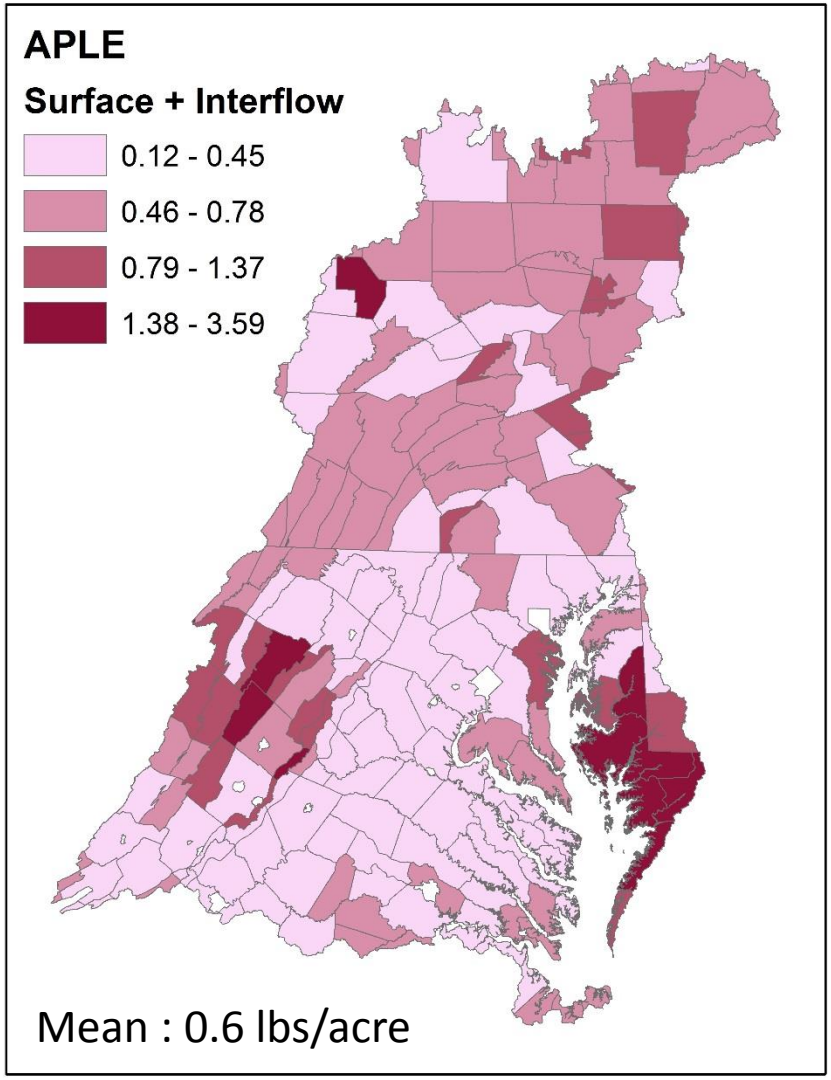


Mean : 20%

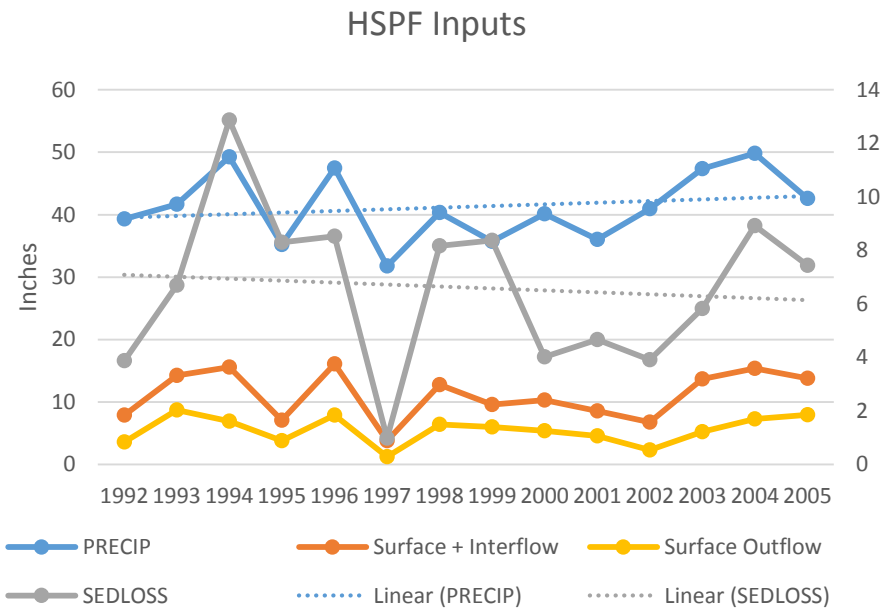
According to Vadas (2013), for poorly drained soils, annual runoff may be 30-40% of total annual precipitation. For well drained soils, annual runoff may be only 5-10% of annual precipitation.

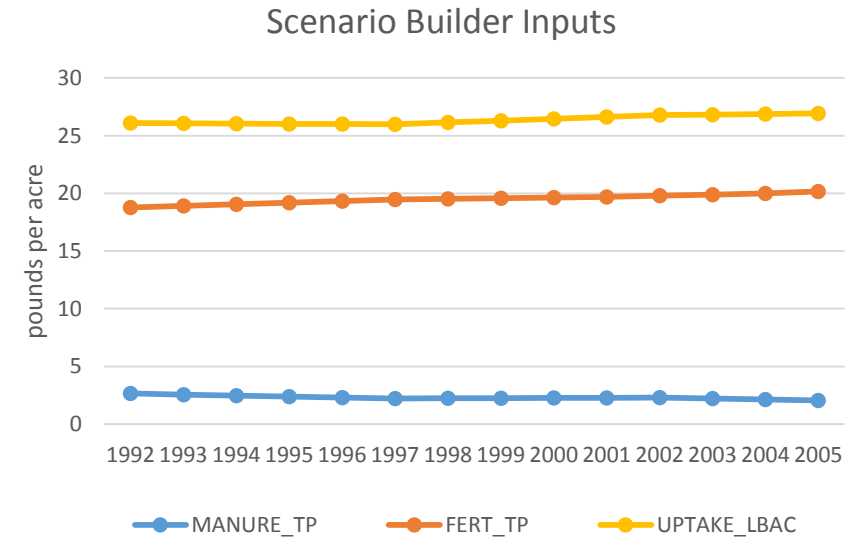
APLE Total Dissolved Phosphorus - High-till with manure (hwm) Edge of Field (lbs/acre)





Bradford PA – high till with manure





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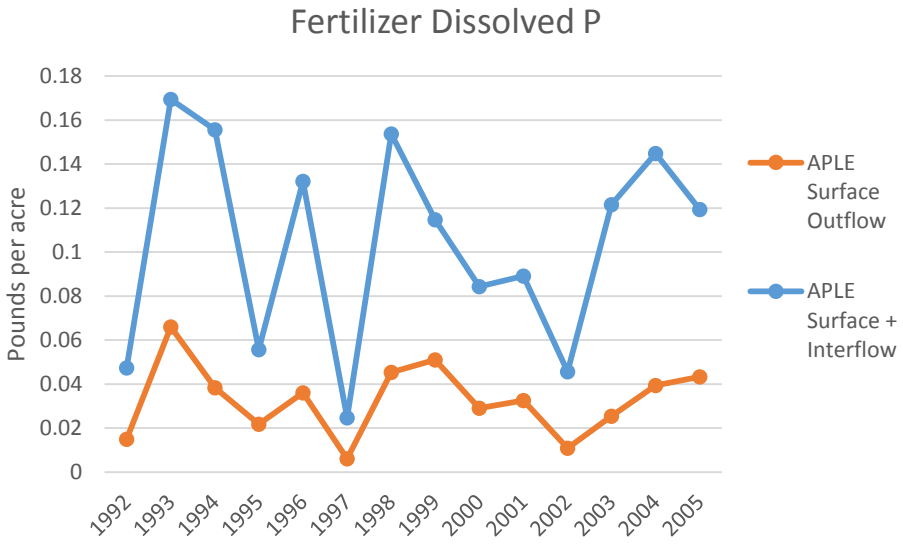
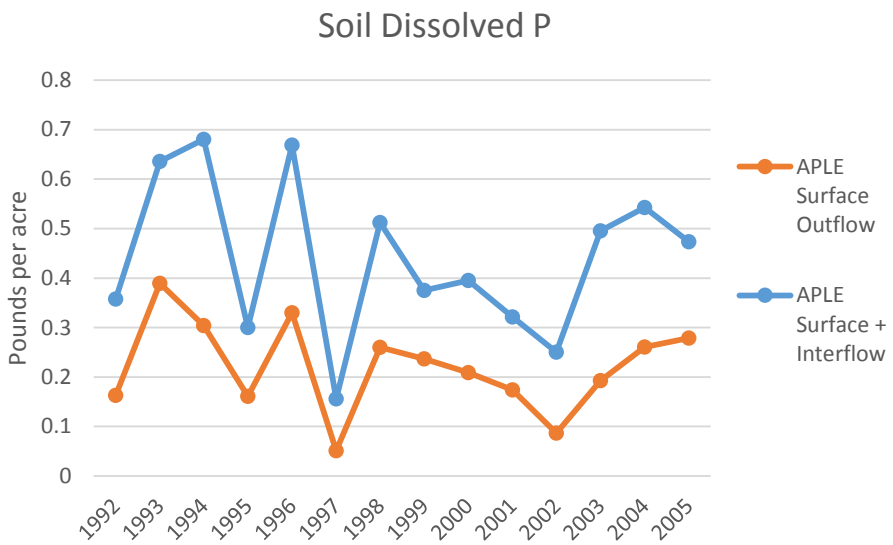
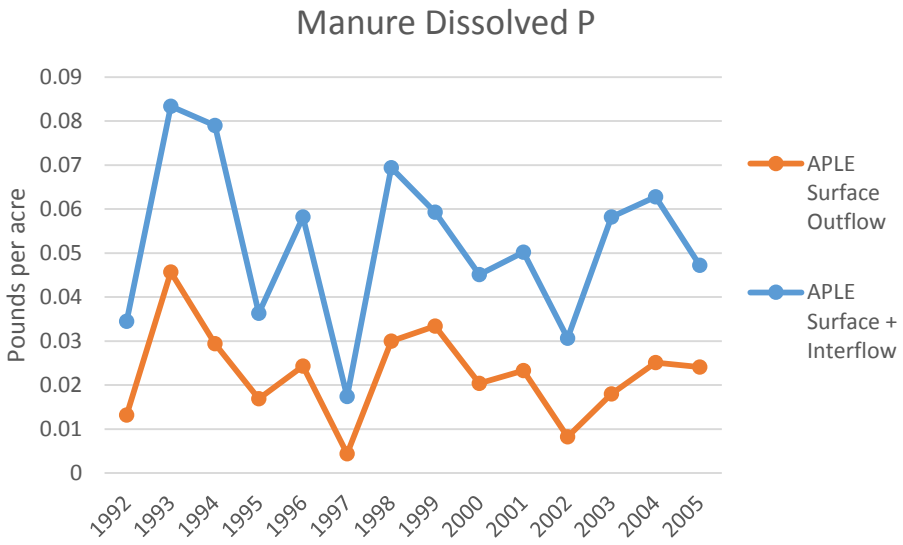
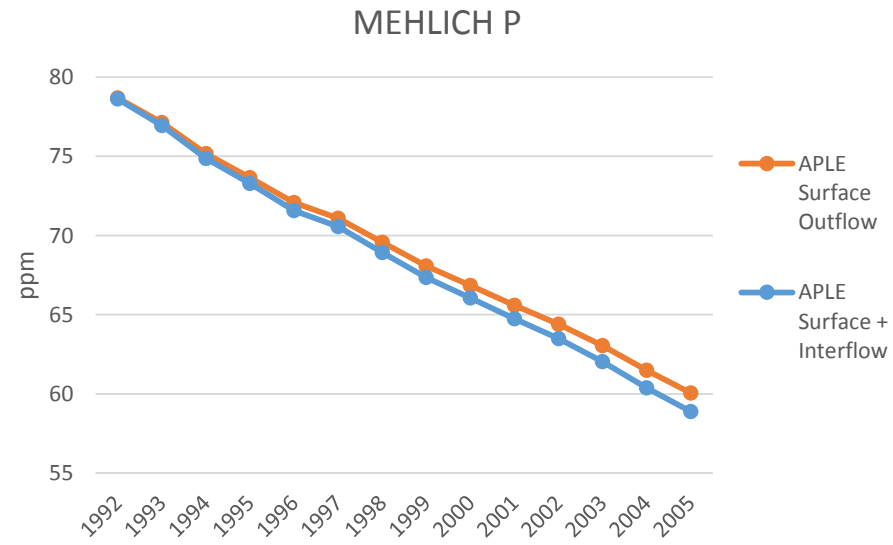
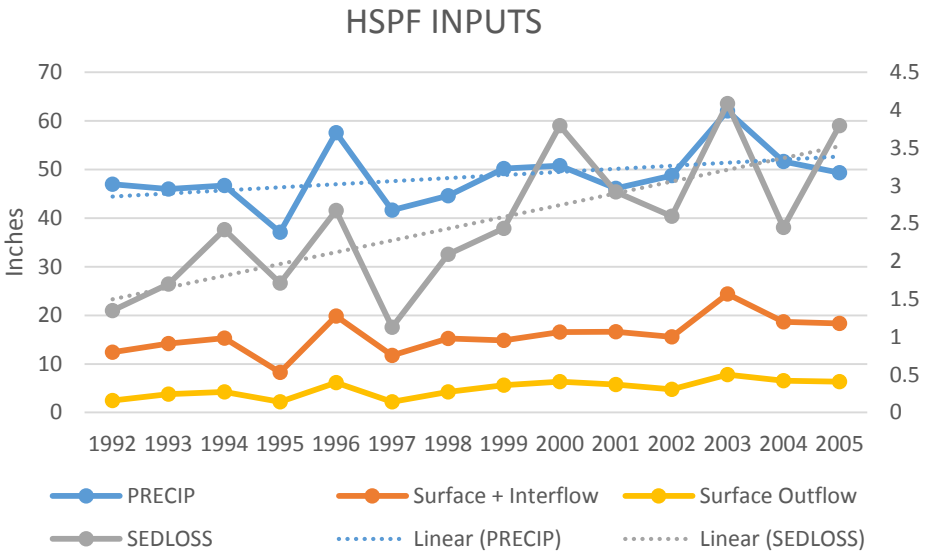


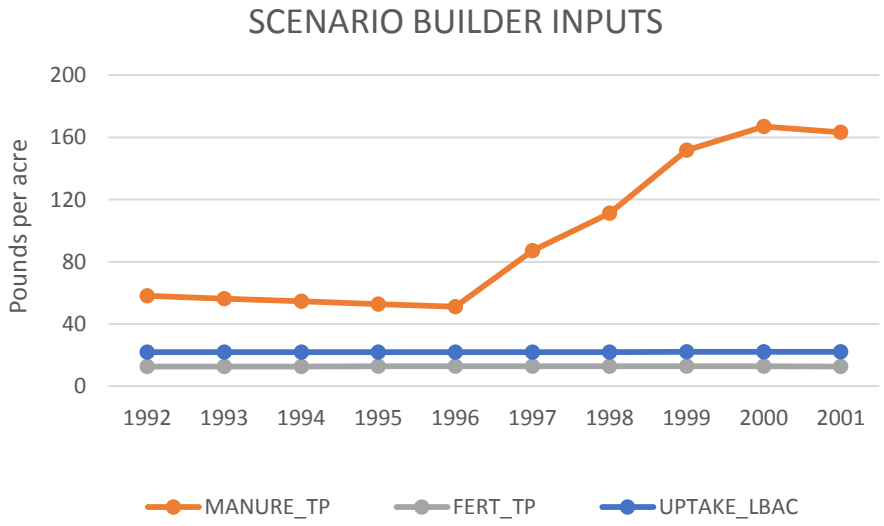






Somerset MD – high till with manure





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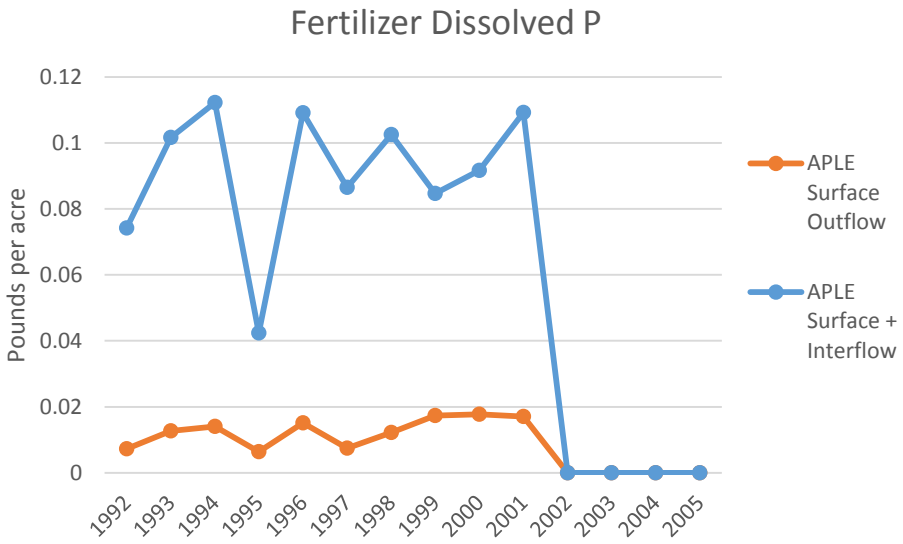
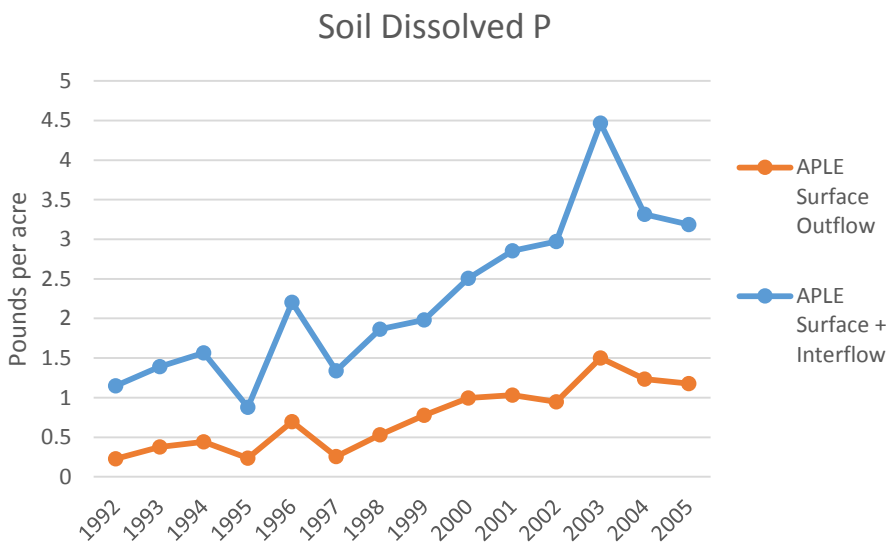
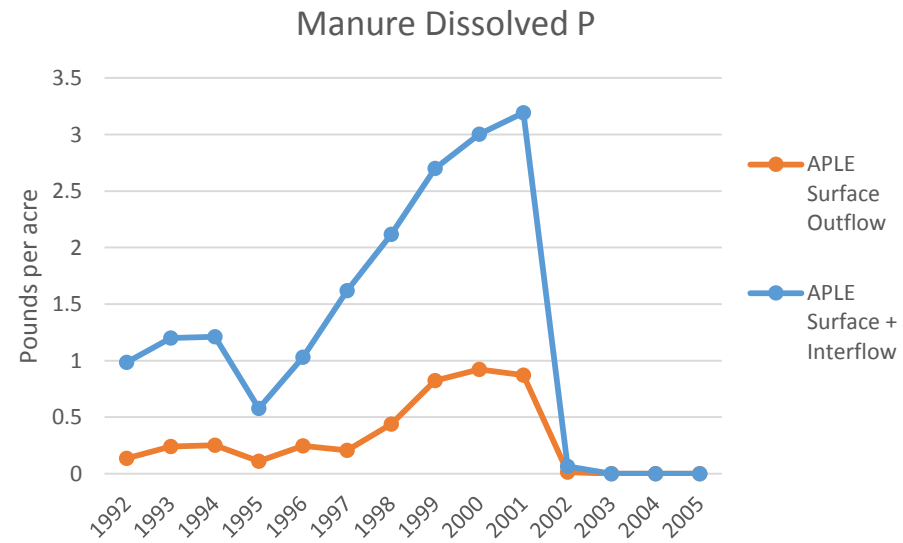
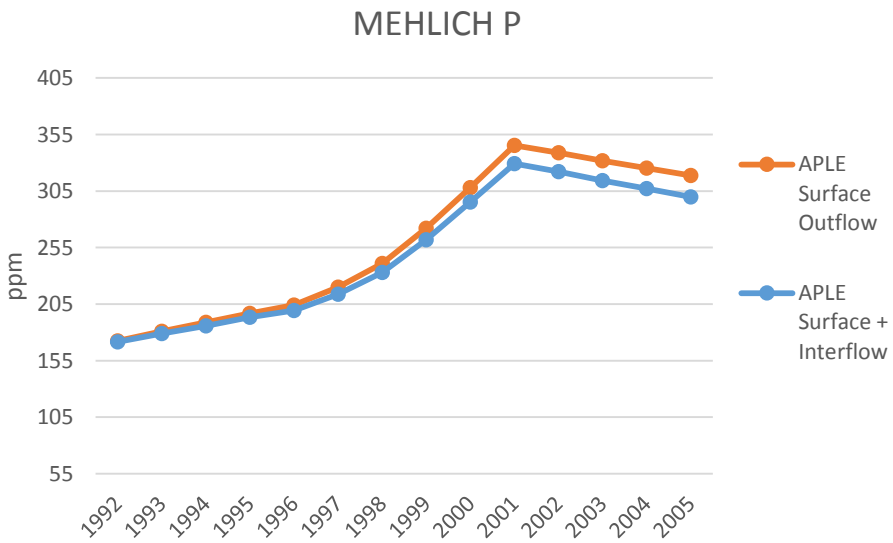
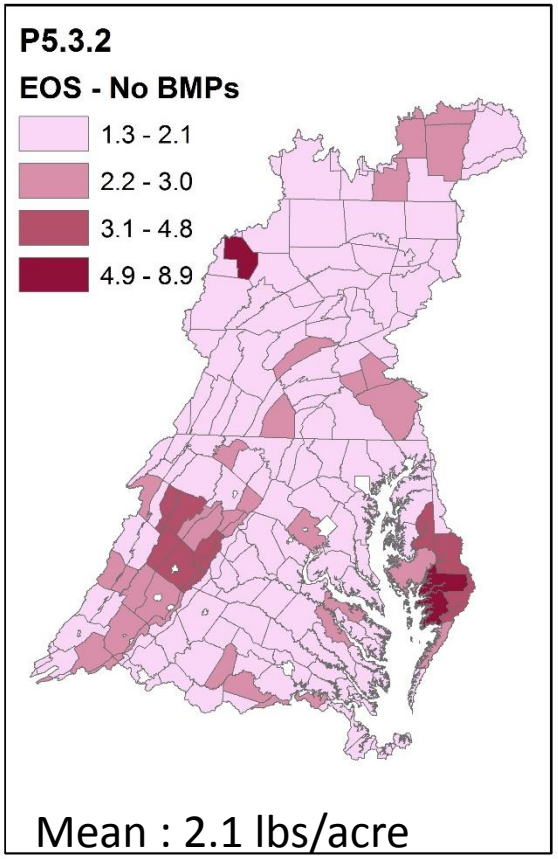




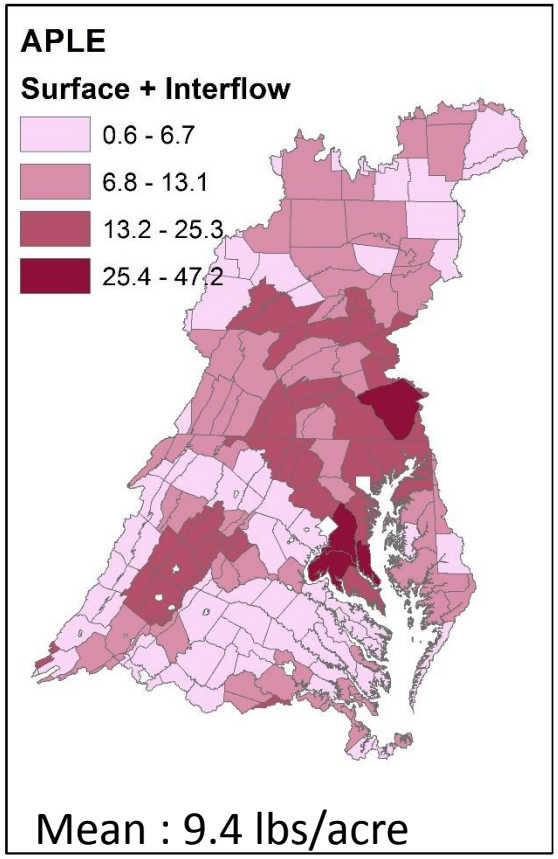




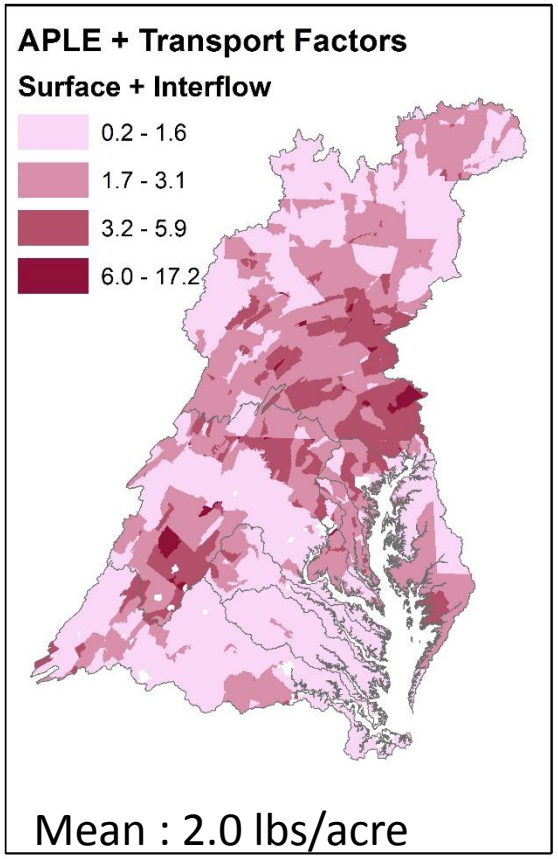
Total Phosphorus Export - High-till with manure (lbs/acre)



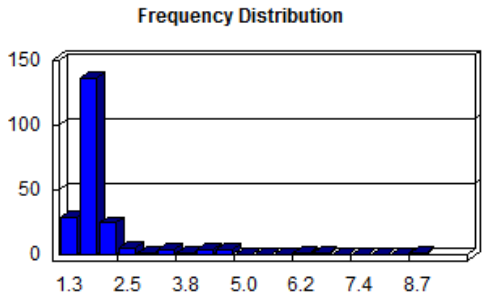
Mean : 2.1 lbs/acre

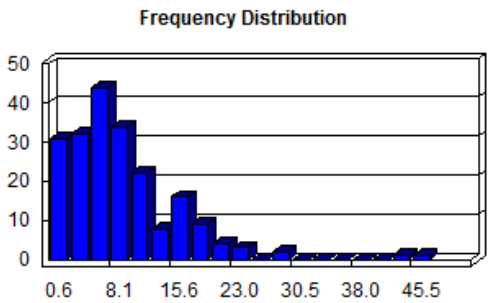


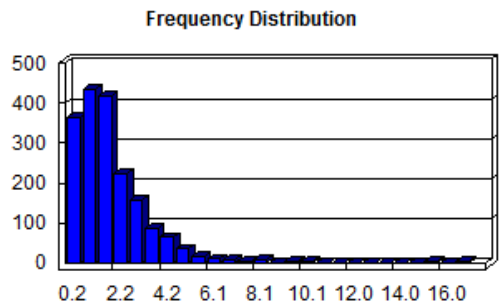
Mean : 9.4 lbs/acre



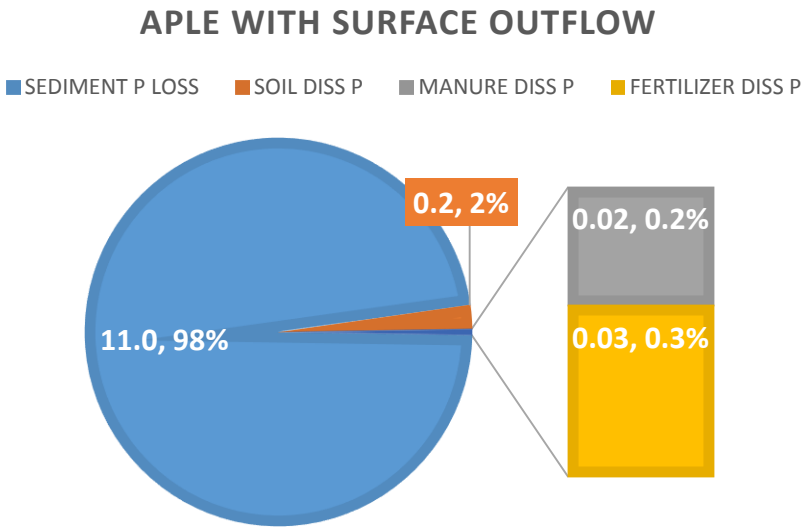
Mean : 2.0 lbs/acre

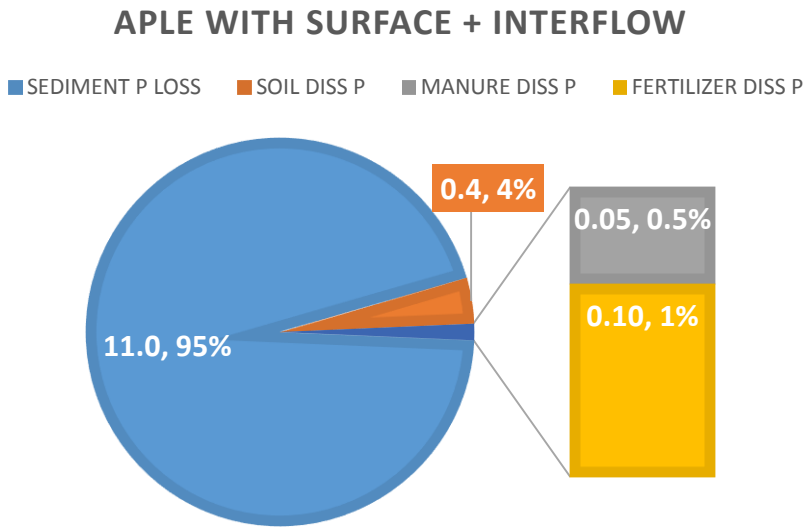


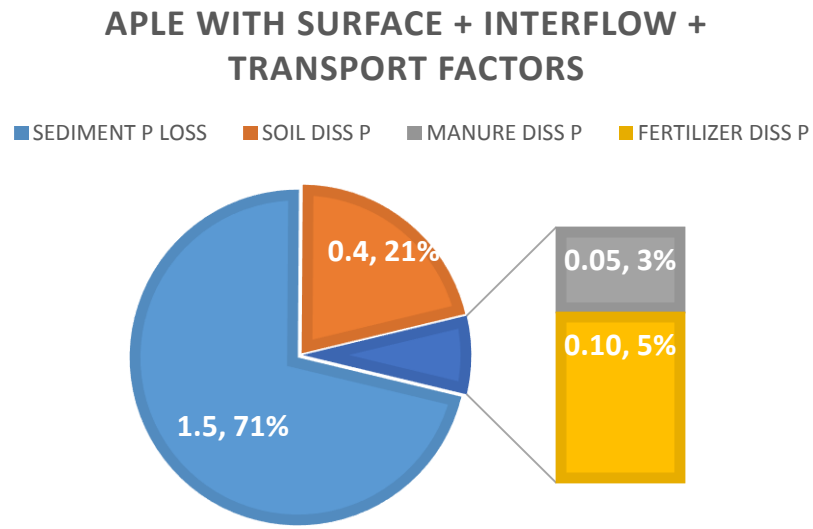


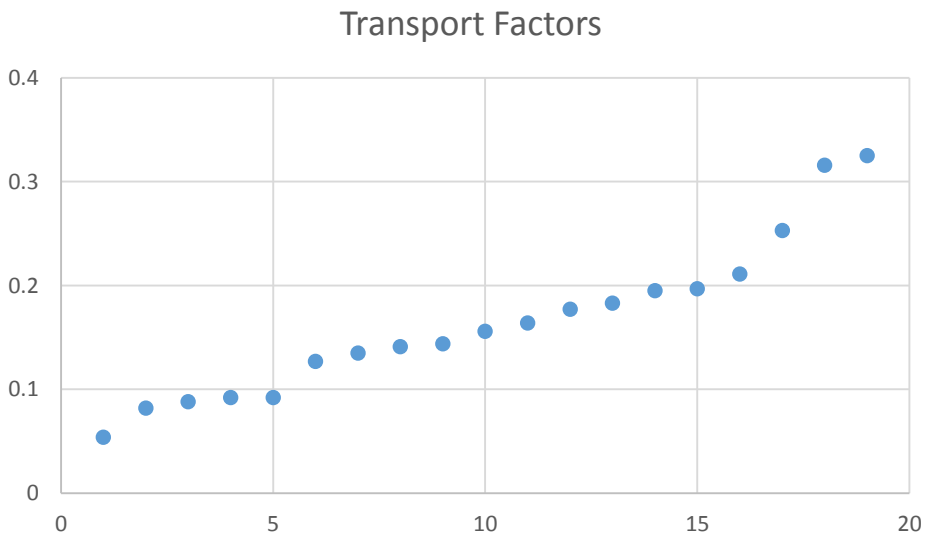


Bradford PA – high till with manure

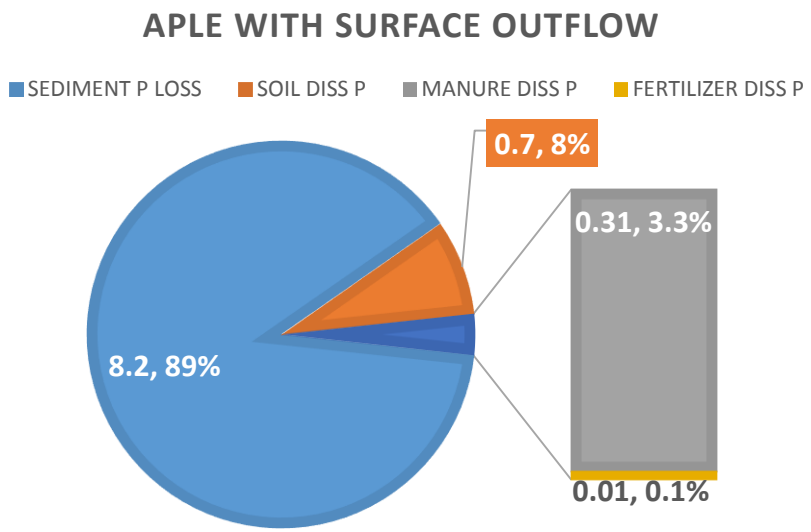


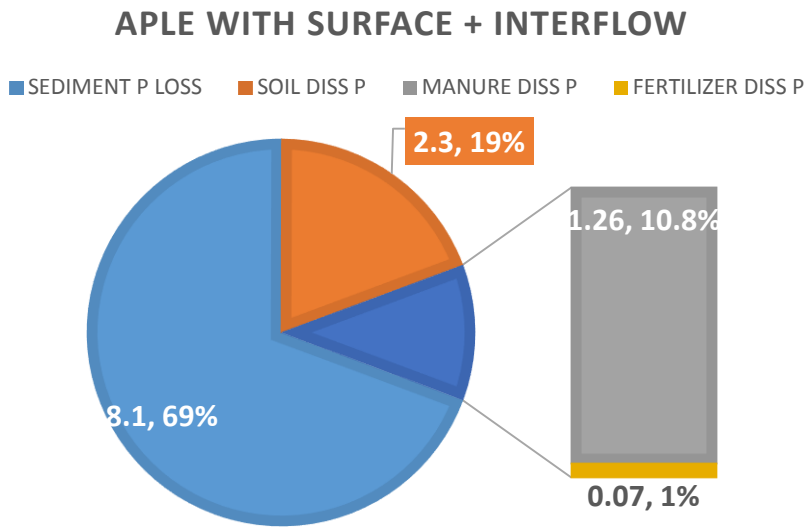


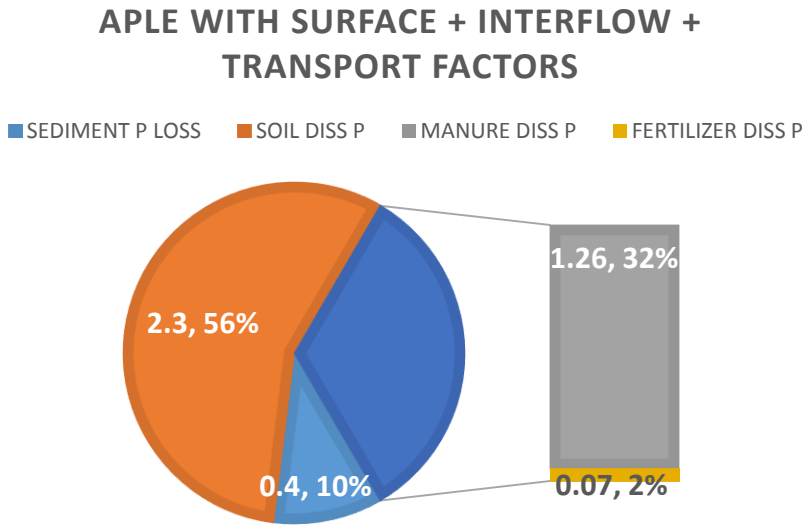


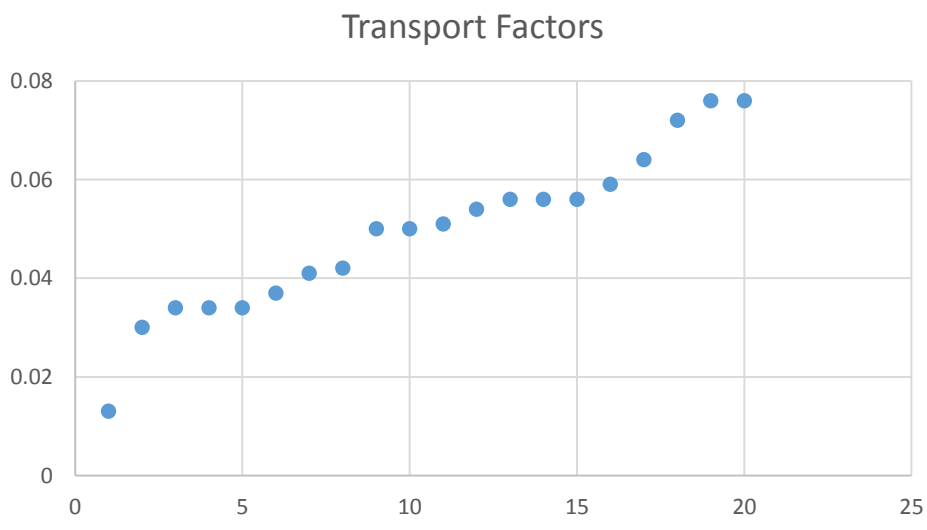


Somerset MD – high till with manure

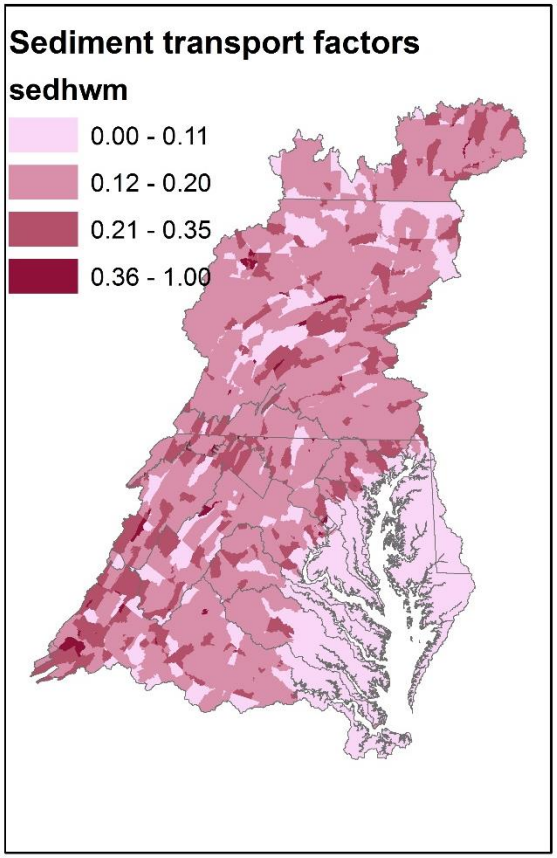


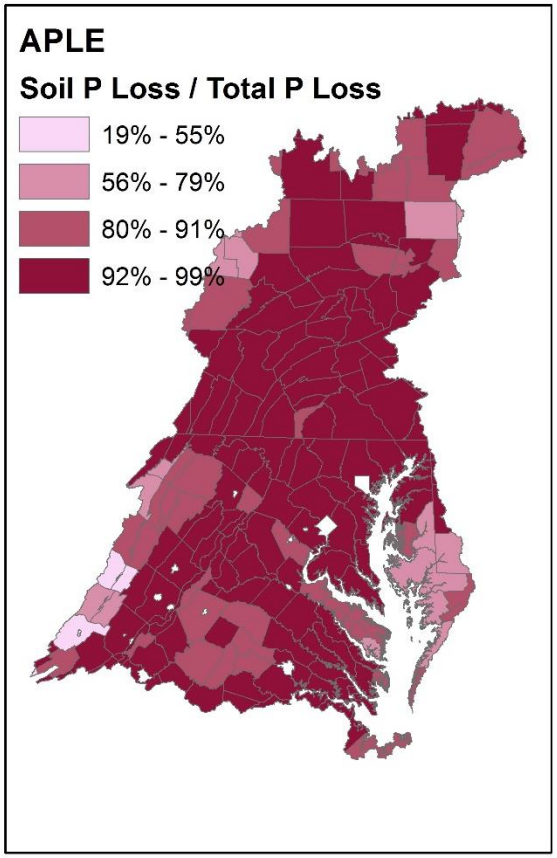


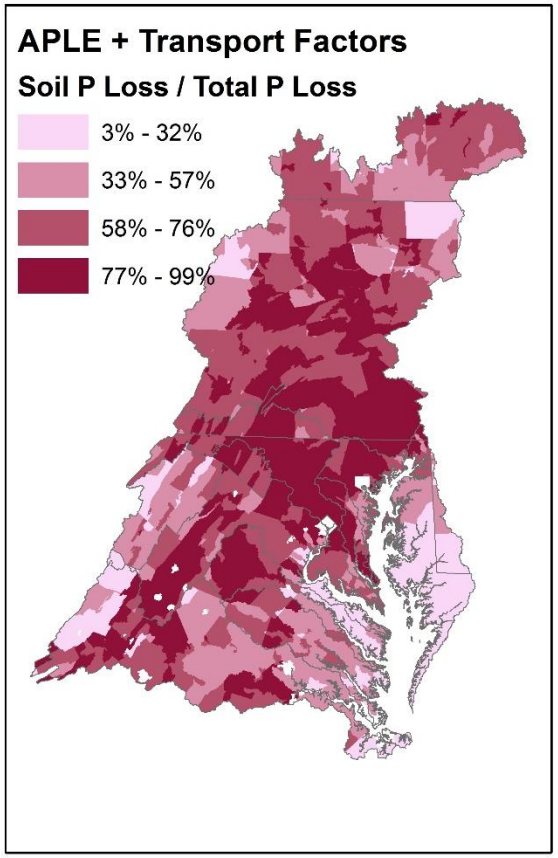


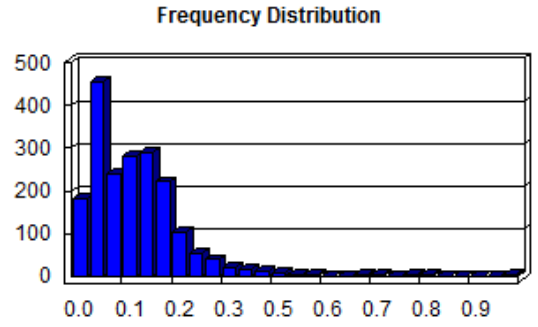


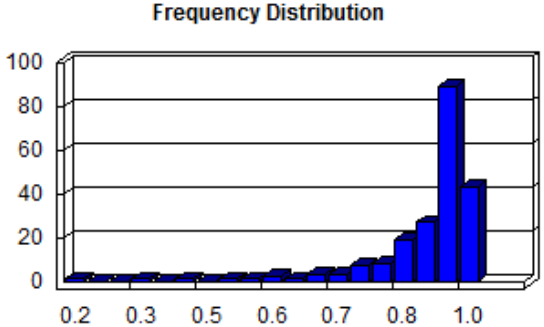
Sediment P Loss percent of Total Phosphorus Export - High-till with manure

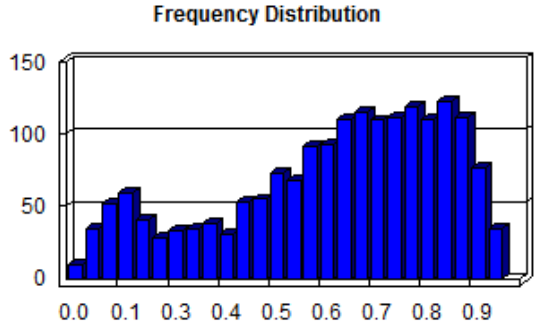












APLE Model Sensitivity Analysis

APLE Model Sensitivity due to Change in Inputs

- Base scenario 1992-2005
- High till with manure, low till and pasture
- Fertilizer, Manure, Uptake, Precipitation, Runoff, Sediment, Mehlich
- -60% -30% 0% +30% +60% (4)
- All land segments (~300)

Relative Sensitivity

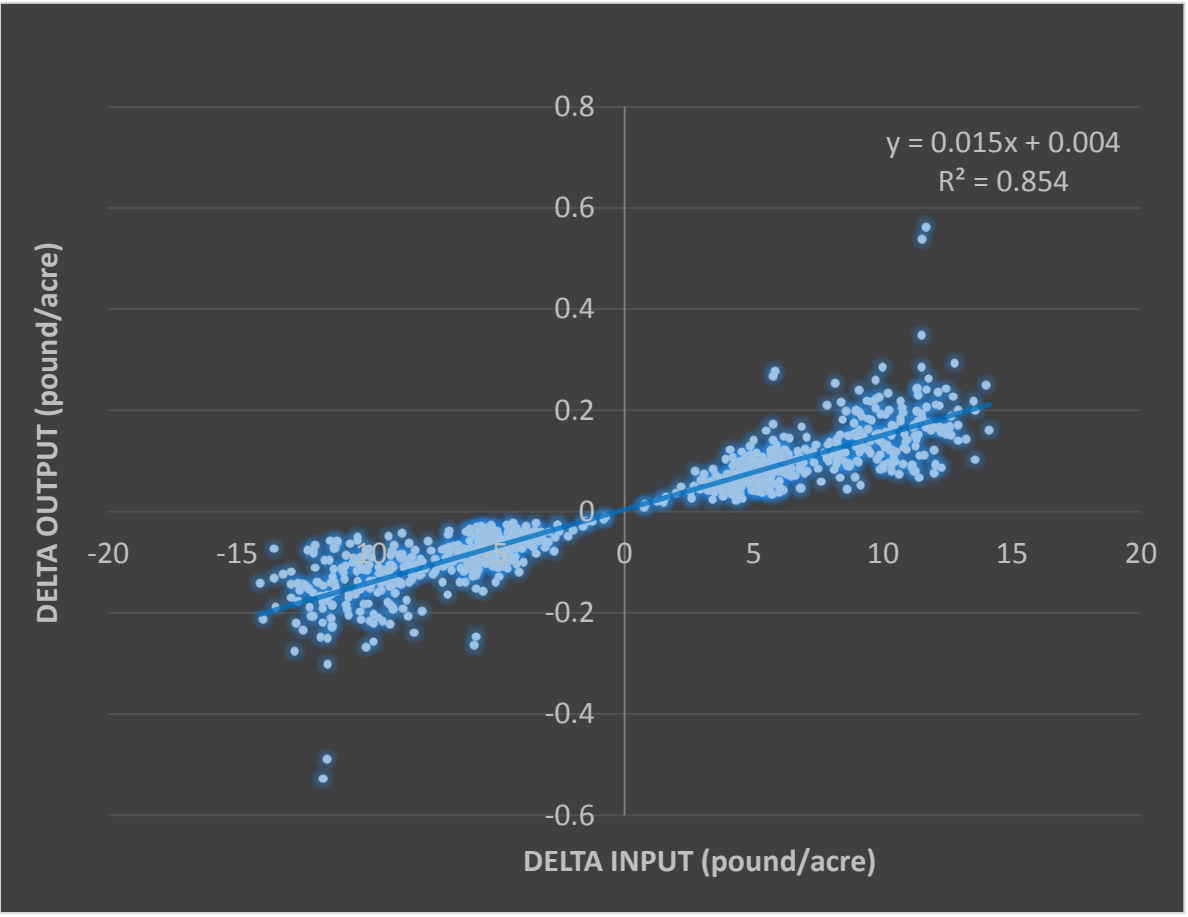
$$S_r = \left(\frac{O - O_b}{I - I_b}\right)\frac{I_b}{O_b}$$

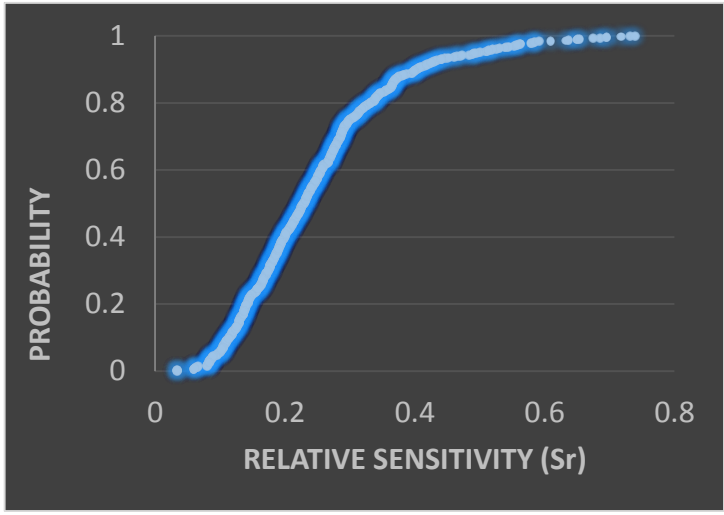
Where:
O = model output
I = model input
b = subscript represents the input and output value of the base scenario

Relative Sensitivity	
Insensitive	$Sr < \|0.01\|$
Slightly sensitive	$\|0.01\| \leq Sr < \|0.10\|$
Moderately sensitive	$\|0.10\| \leq Sr < \|1.00\|$
Sensitive	$\|1.00\| \leq Sr < \|2.00\|$
Extremely sensitive	$Sr \geq \|2.00\|$

Storm,D. ,T. Dillaha, and S. Mostaghimi. 1986. Modeling phosphorus transport in surface runoff. *ASAE* 31(1):117-127.

APLE Model Sensitivity due to Change in Fertilizer Input





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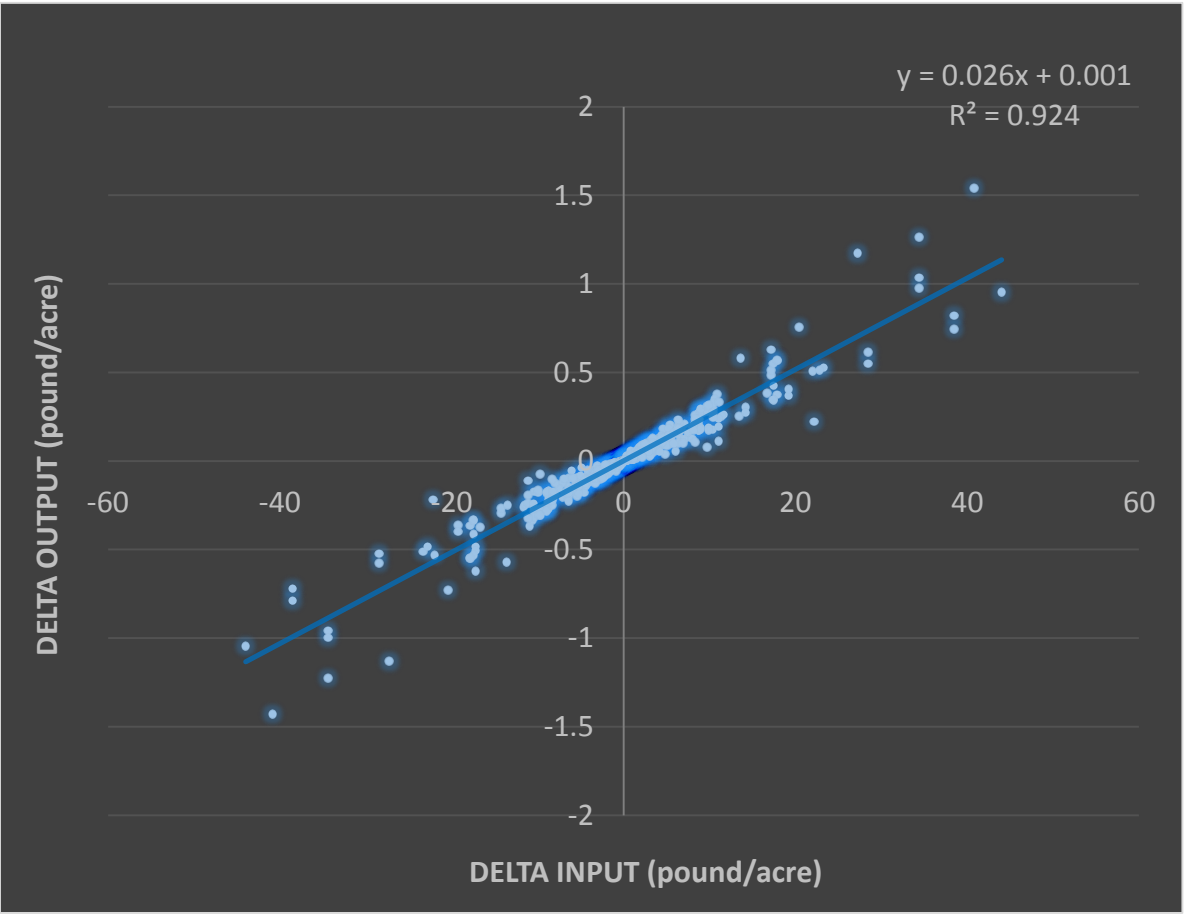
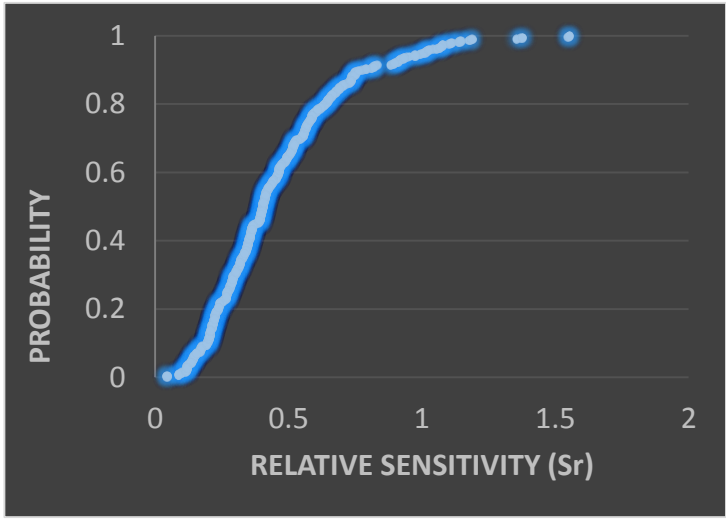
Extremely sensitive	$Sr \geq \|2.00\|$

APLE Model Sensitivity due to Change in Manure Input





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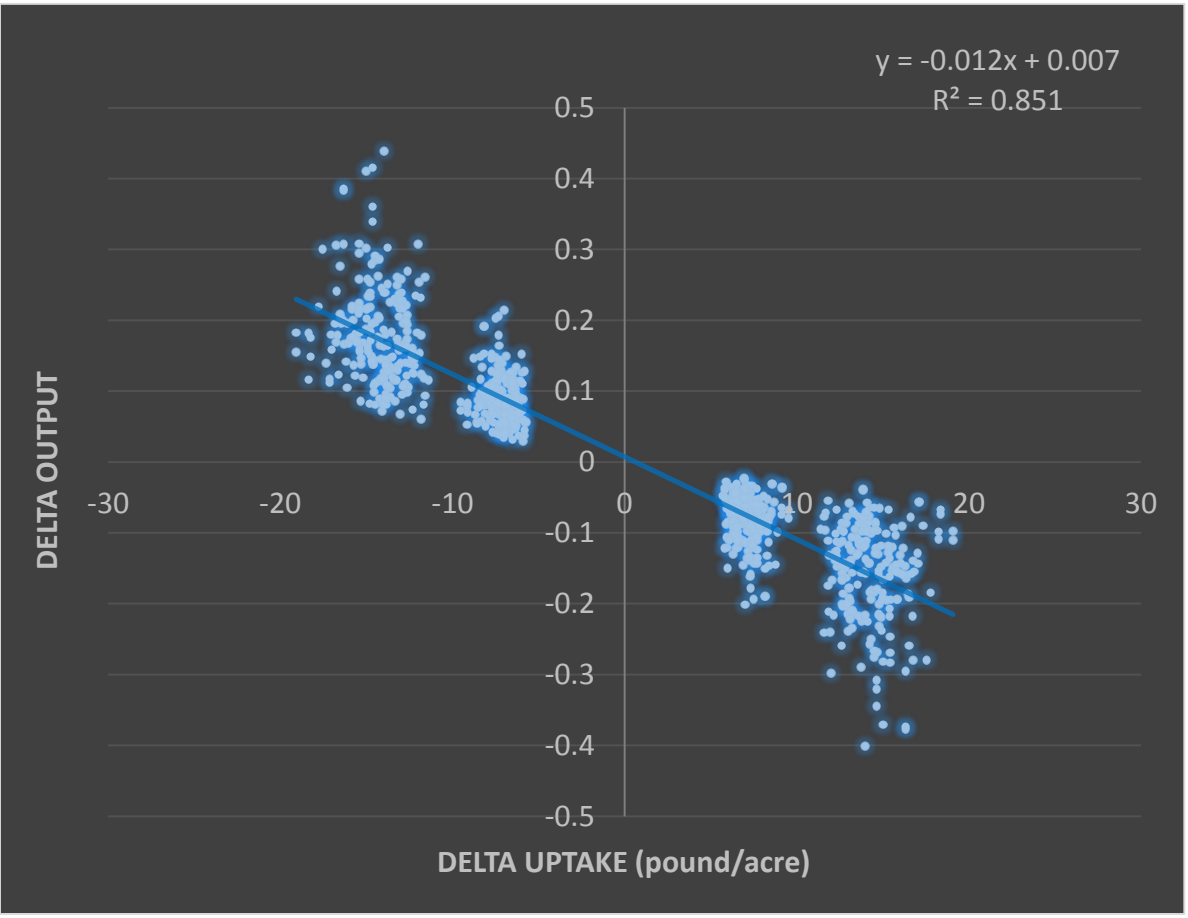
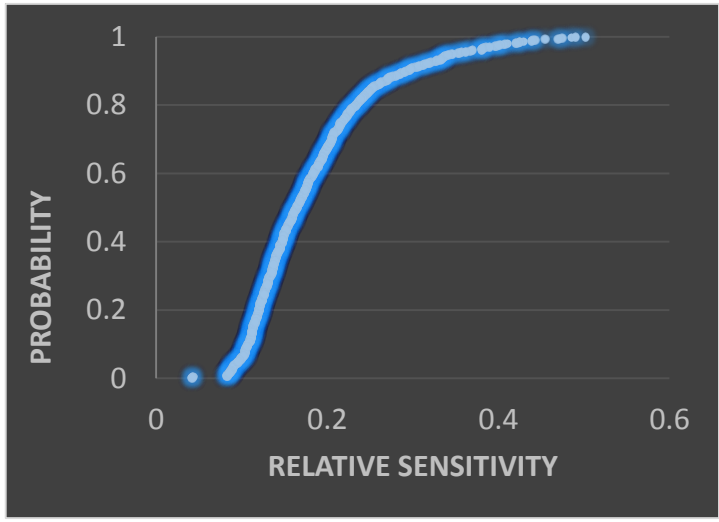
Extremely sensitive	$Sr \geq \|2.00\|$

APLE Model Sensitivity due to Change in Uptake Input





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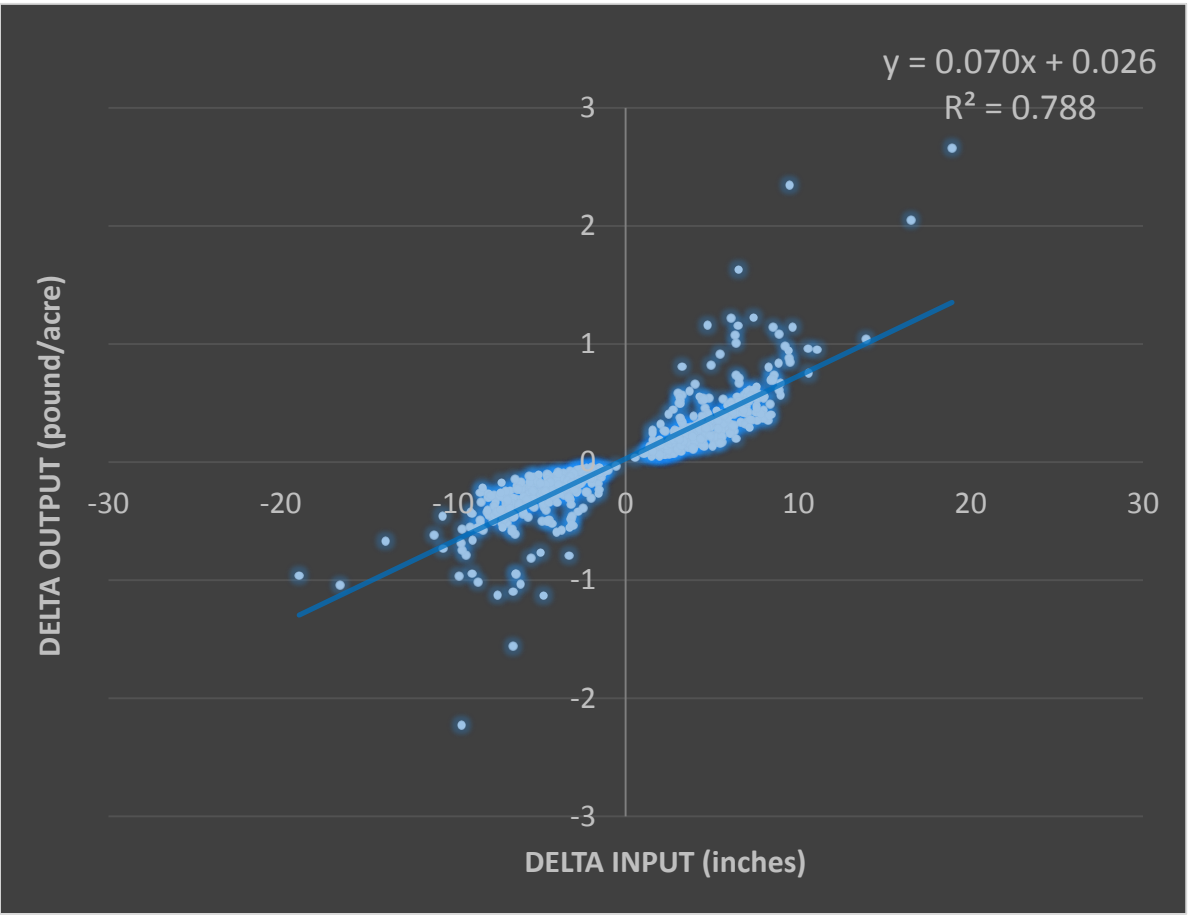
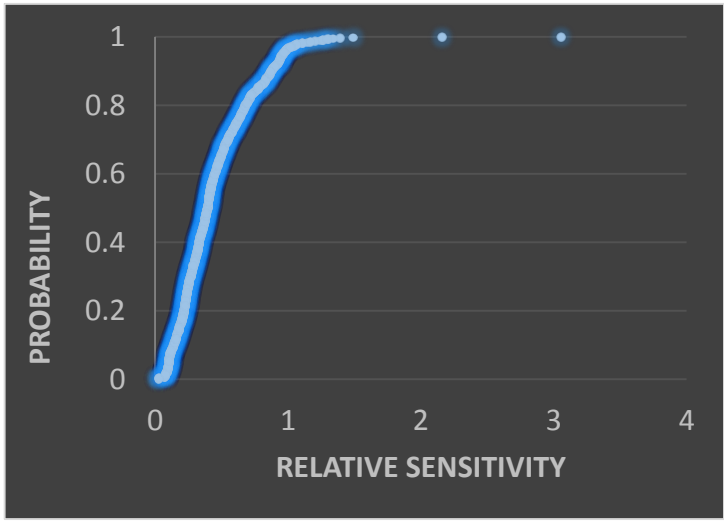
APLE Model Sensitivity due to Change in Runoff Input





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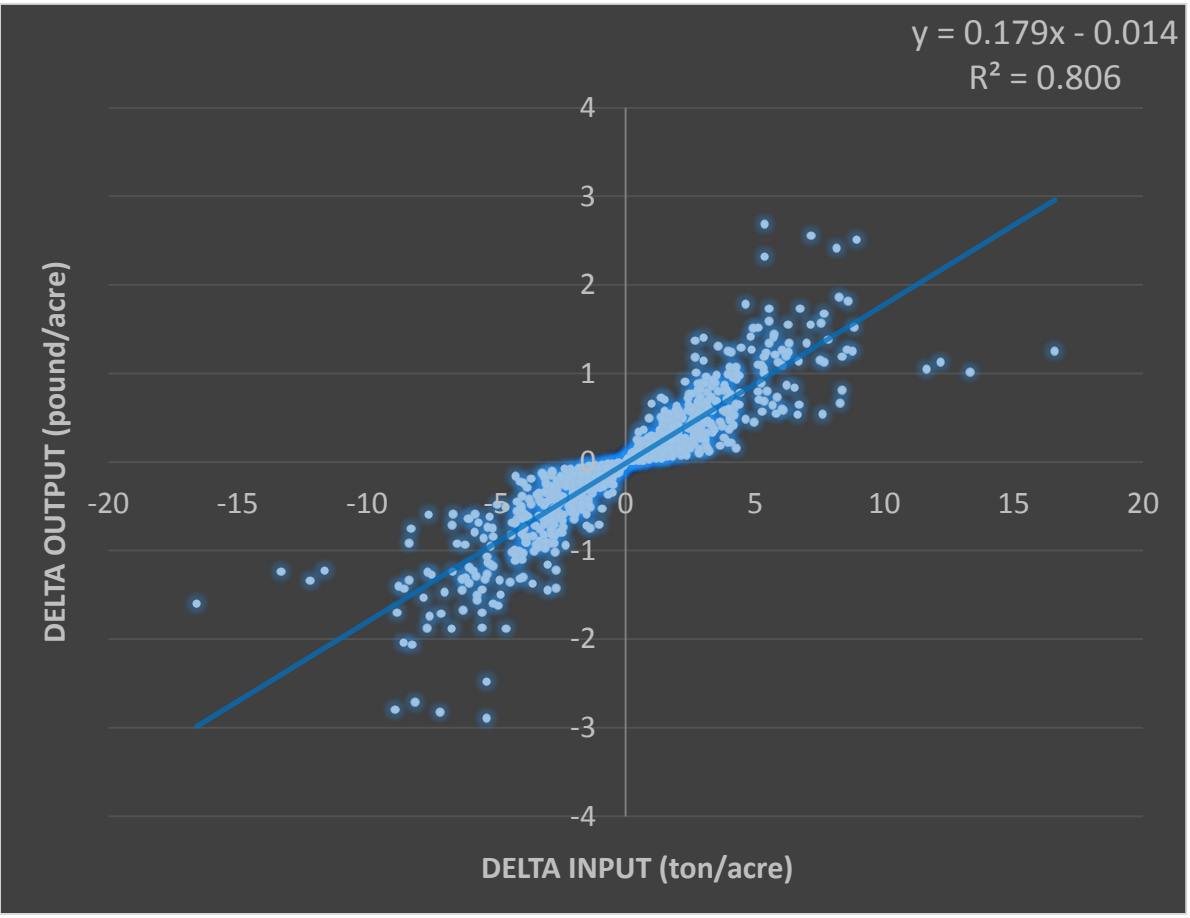
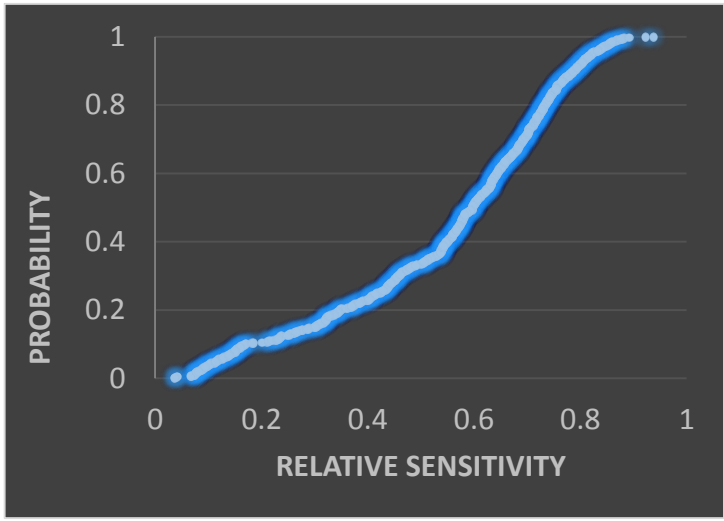
Extremely sensitive	$Sr \geq \|2.00\|$

APLE Model Sensitivity due to Change in Sediment Input





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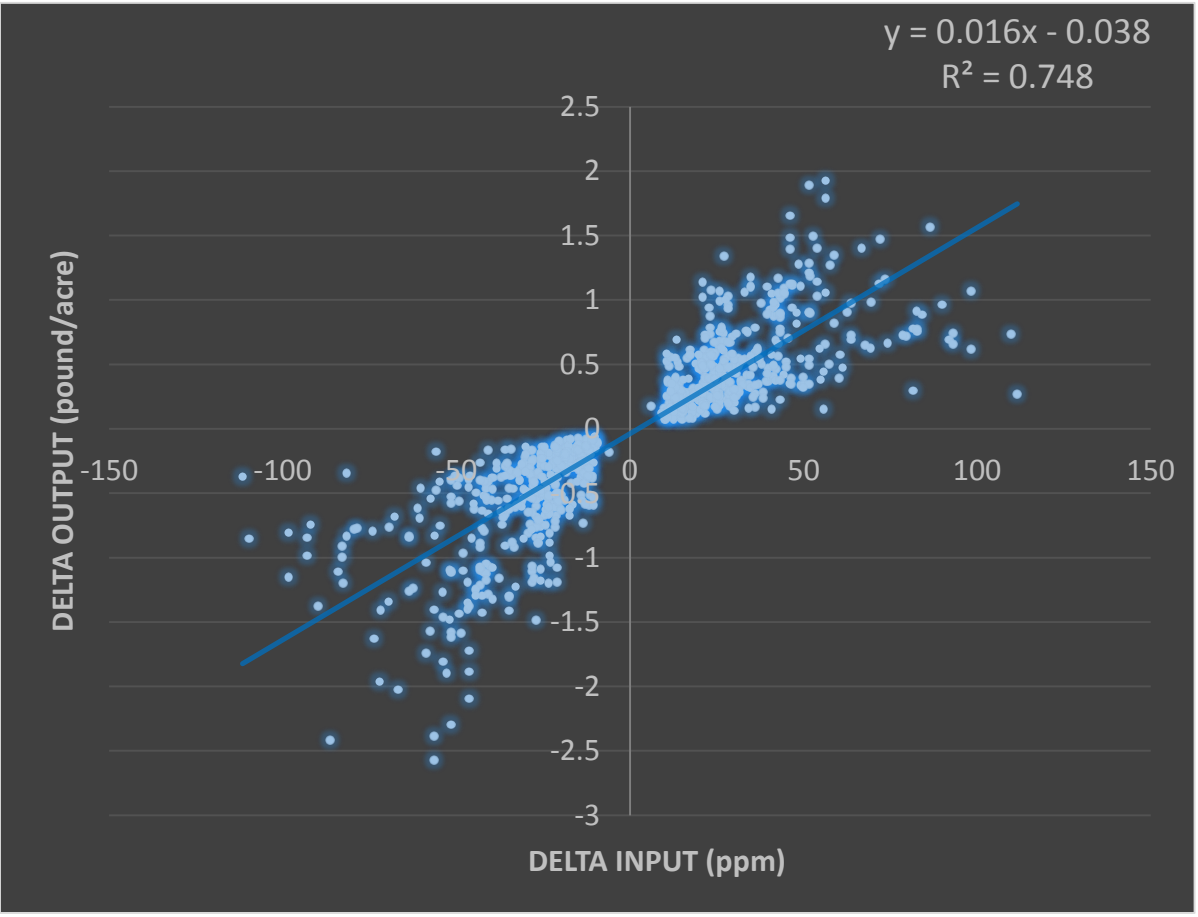
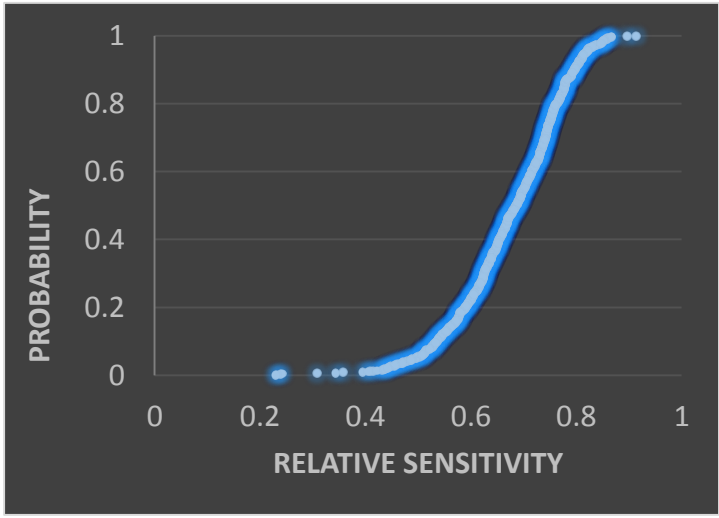
Extremely sensitive	$Sr \geq \|2.00\|$

APLE Model Sensitivity due to Change in Mehlich Input





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Extremely sensitive	$Sr \geq \|2.00\|$

APLE Model Sensitivity Analysis Results

Parameter	Slope	R^2	Mean *Sr*	Median *Sr*	Max *Sr*	Min *Sr*
Mehlich	0.016	0.748	0.674	0.685	0.914	0.230
Sediment	0.179	0.806	0.549	0.598	0.938	0.036
Manure	0.026	0.924	0.457	0.404	1.554	0.044
Runoff	0.070	0.788	0.455	0.396	3.055	0.027
Fertilizer	0.015	0.854	0.247	0.229	0.740	0.034
Uptake	-0.012	0.851	0.184	0.165	0.502	0.042

APLE is more sensitive to mehlich, sediment, manure, and runoff than to fertilizer and uptake

Next

- Include new soil P data
- Phosphorus sensitivities are provisional and we'll continue exploring APLE.