Annual Phosphorus Loss Estimator (APLE) Model Sensitivity Analysis

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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

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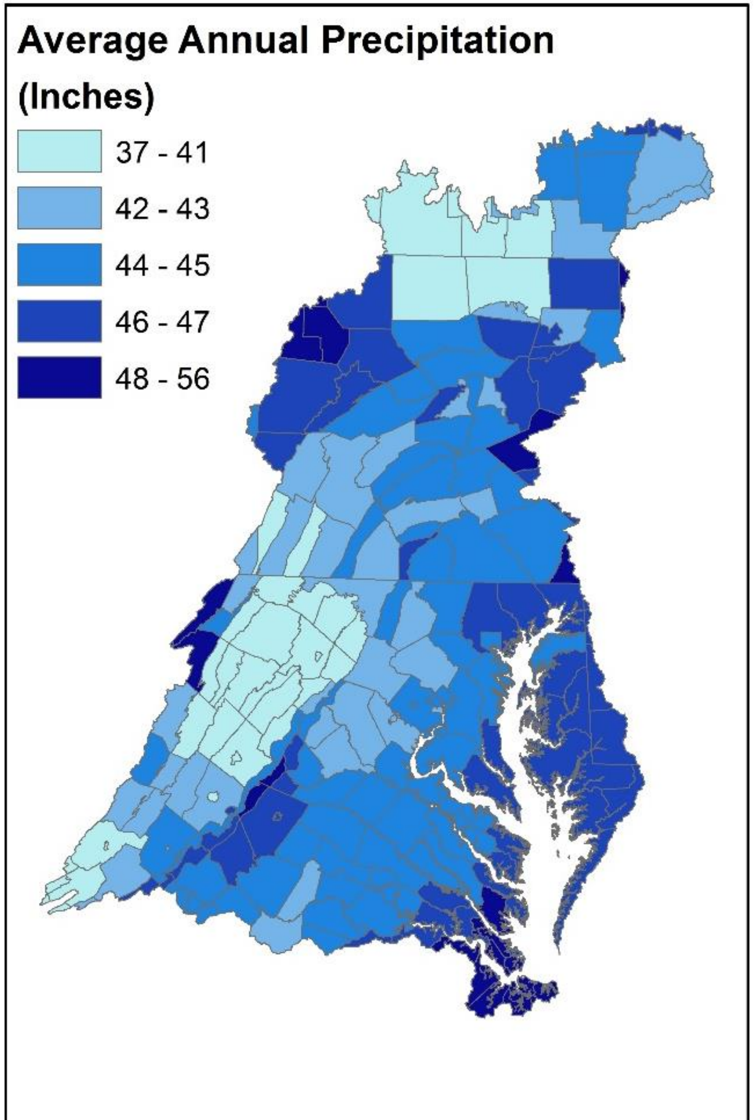
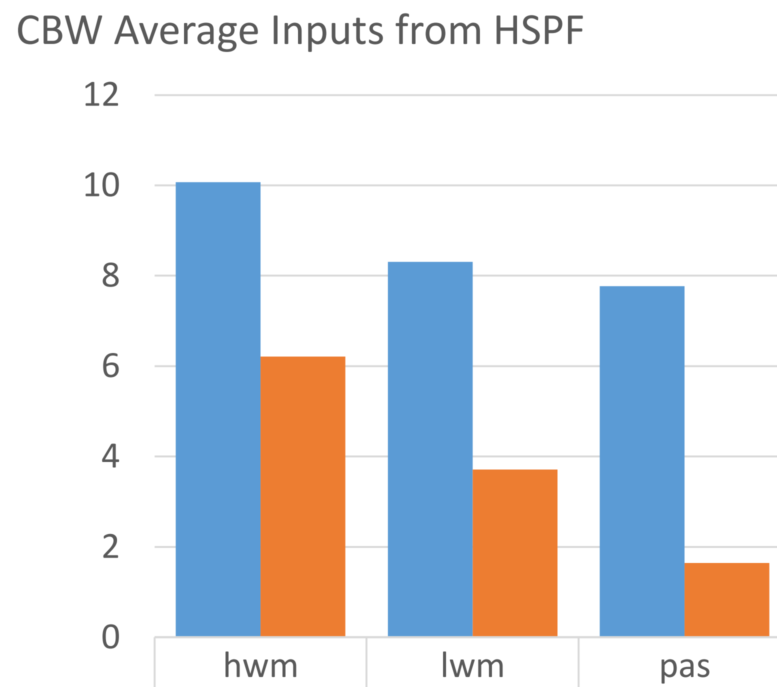
Objectives

- 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

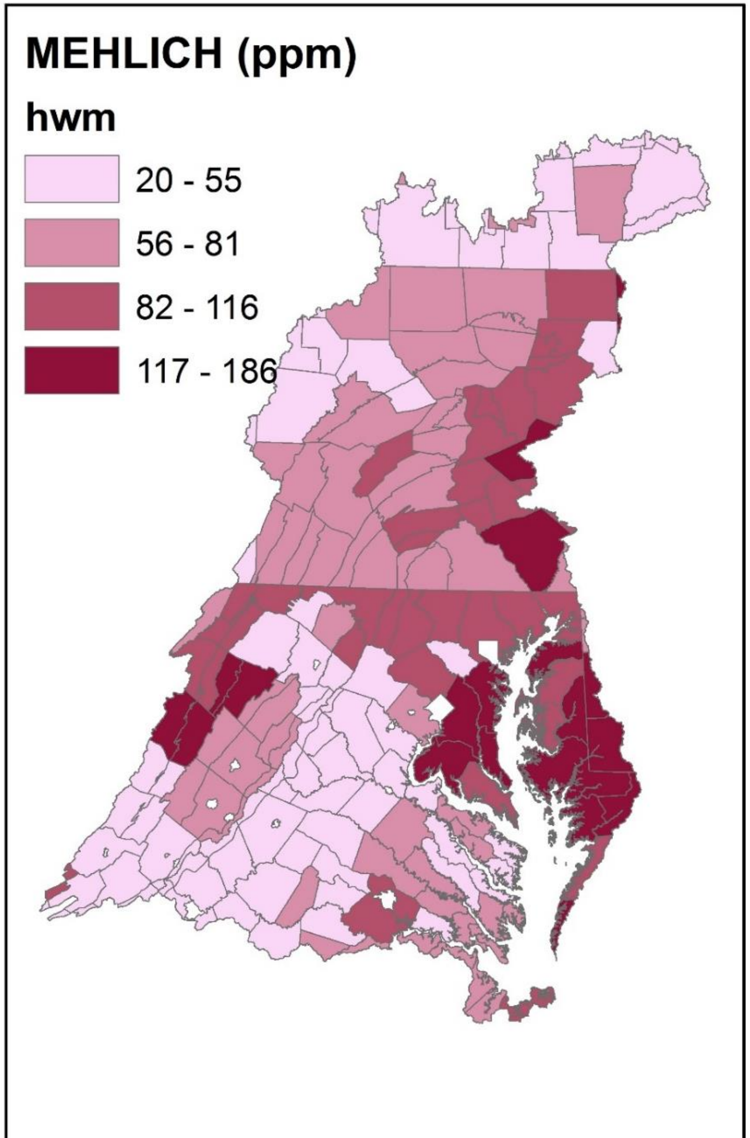
APLE Average Inputs (1992 - 2005)

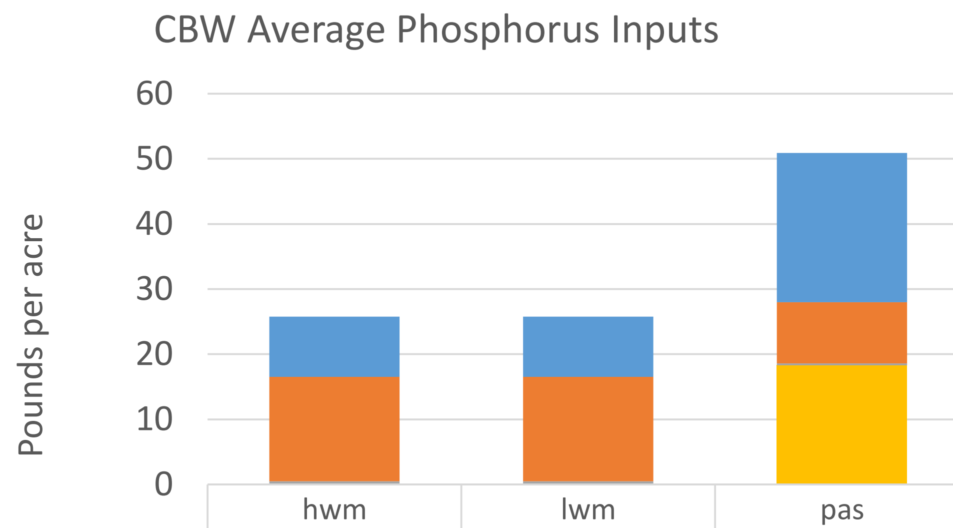




	hwm	lwm	pas
RUNOFF (inches)	10	8	8
SEDLOSS (ton/ac)	6	4	2

APLE Average Inputs (1992 - 2005)

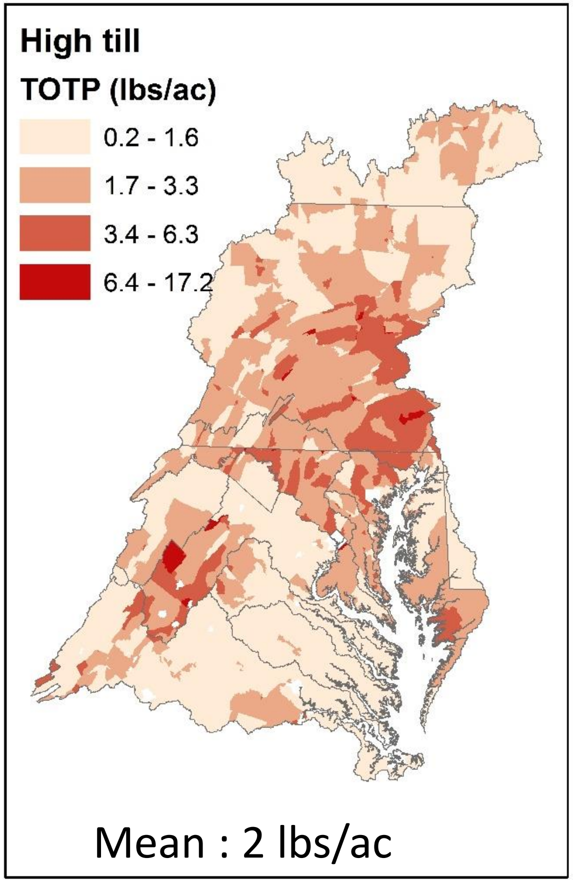


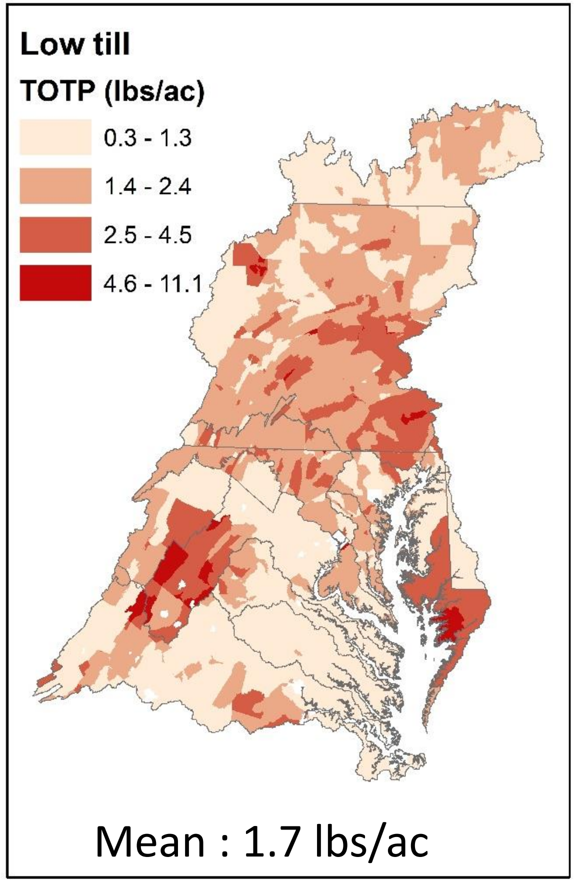


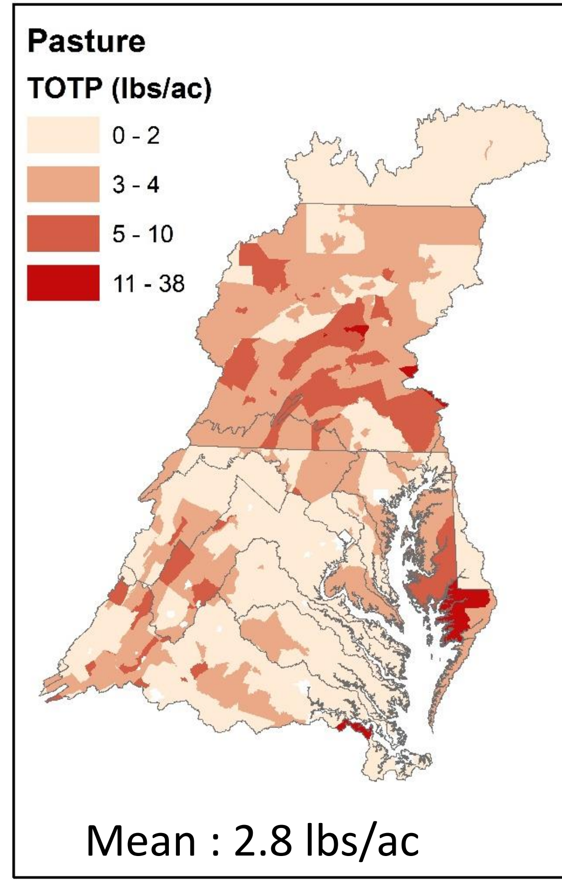
	hwm	lwm	pas
Manure	9	9	23
Fertilizer	16	16	9
Biosolids	0.5	0.5	0.3
Direct Manure			18

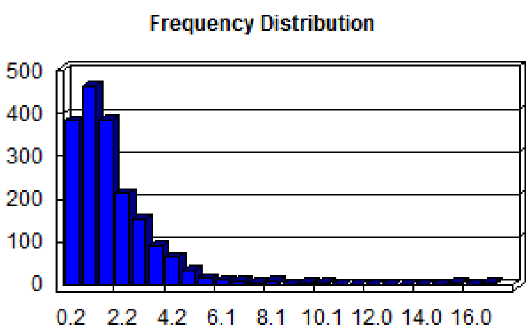
	MEHLICH	CLAY	OM	DEPTH 1	DEPTH 2	% INCORP	% MIXING	DEPTH INCORP
hwm	71	34	2	3	7	75	75	7
lwm	71	34	2	1	7	35	35	4
pas	69	34	2	1	7	0	12	0.5

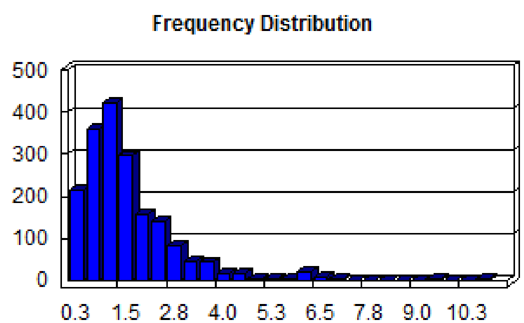
APLE Average Annual Total Phosphorus Loss(1992 - 2005)

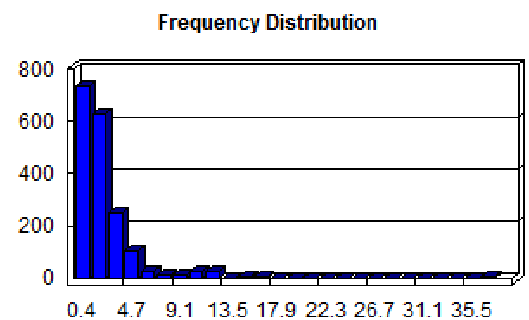




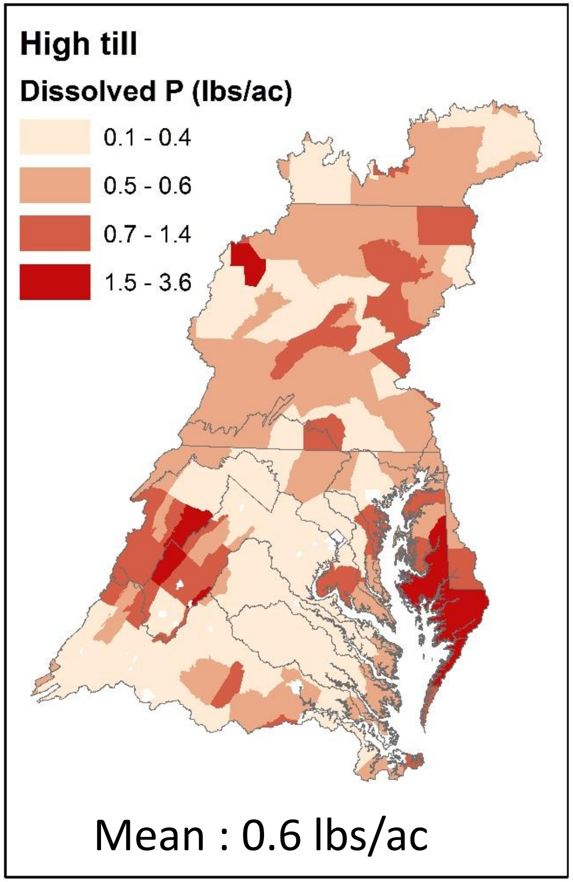


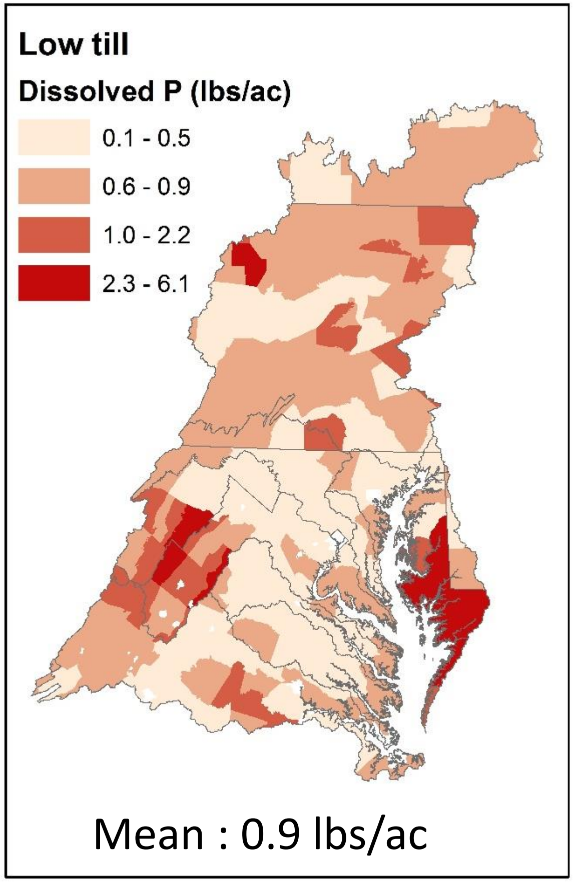


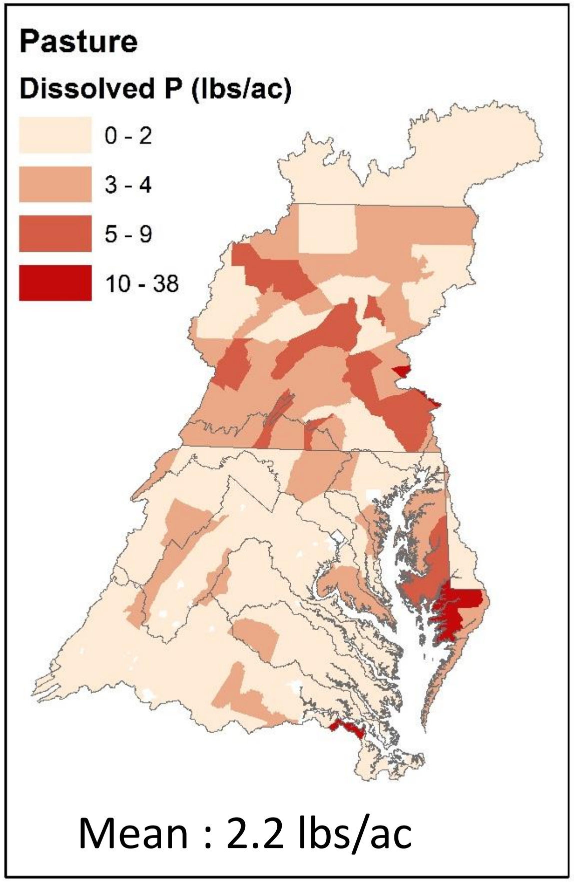


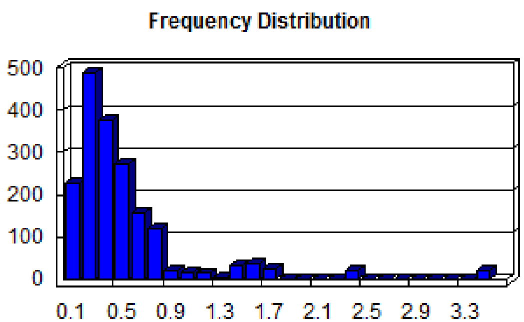


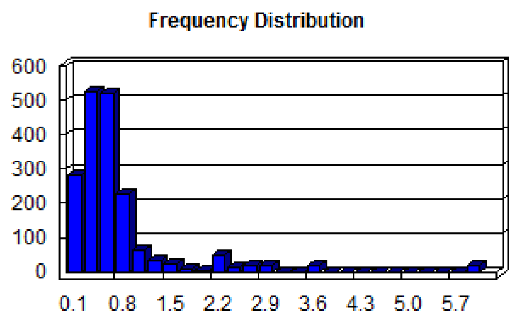
APLE Average Annual Dissolved Phosphorus (1992 - 2005)

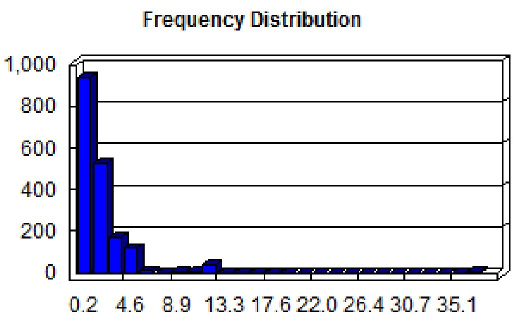




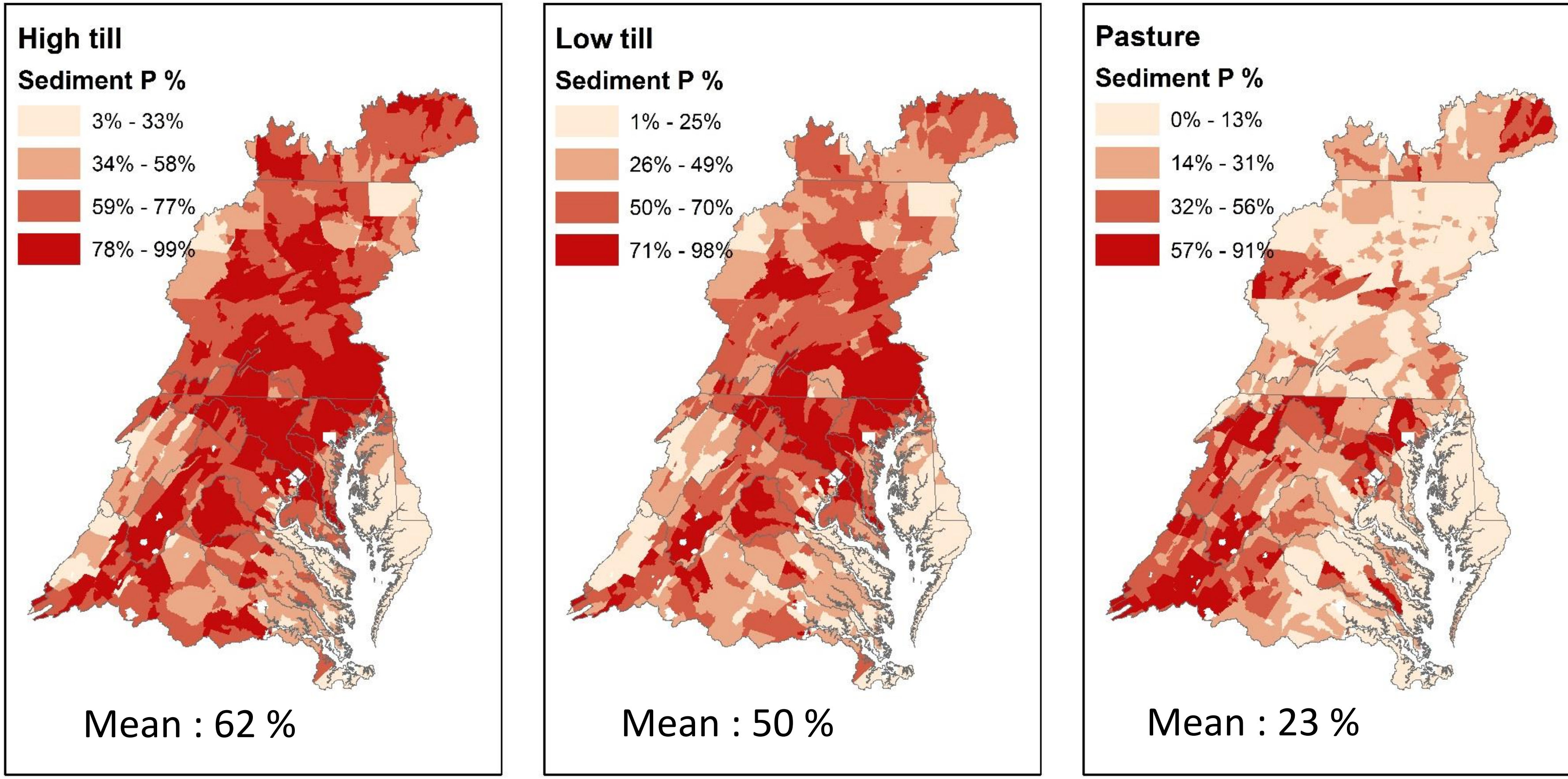








Sediment P Loss percent of Total Loss



APLE Summary Output

APLE Output (lbs/ac)	Sediment P Loss	Soil Dissolved P	Manure Dissolved P	Fertilizer Dissolved P	Total Dissolved P	Total P Loss	MEHLICH (ppm)
High till	1.40	0.42	0.13	0.06	0.61	2.02	77
Low till	0.90	0.49	0.28	0.11	0.87	1.77	83
Pasture	0.56	1.26	0.90	0.08	2.26	2.81	128

APLE Model Sensitivity Analysis

APLE Model Sensitivity due to Change in Inputs

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

Relative Sensitivity

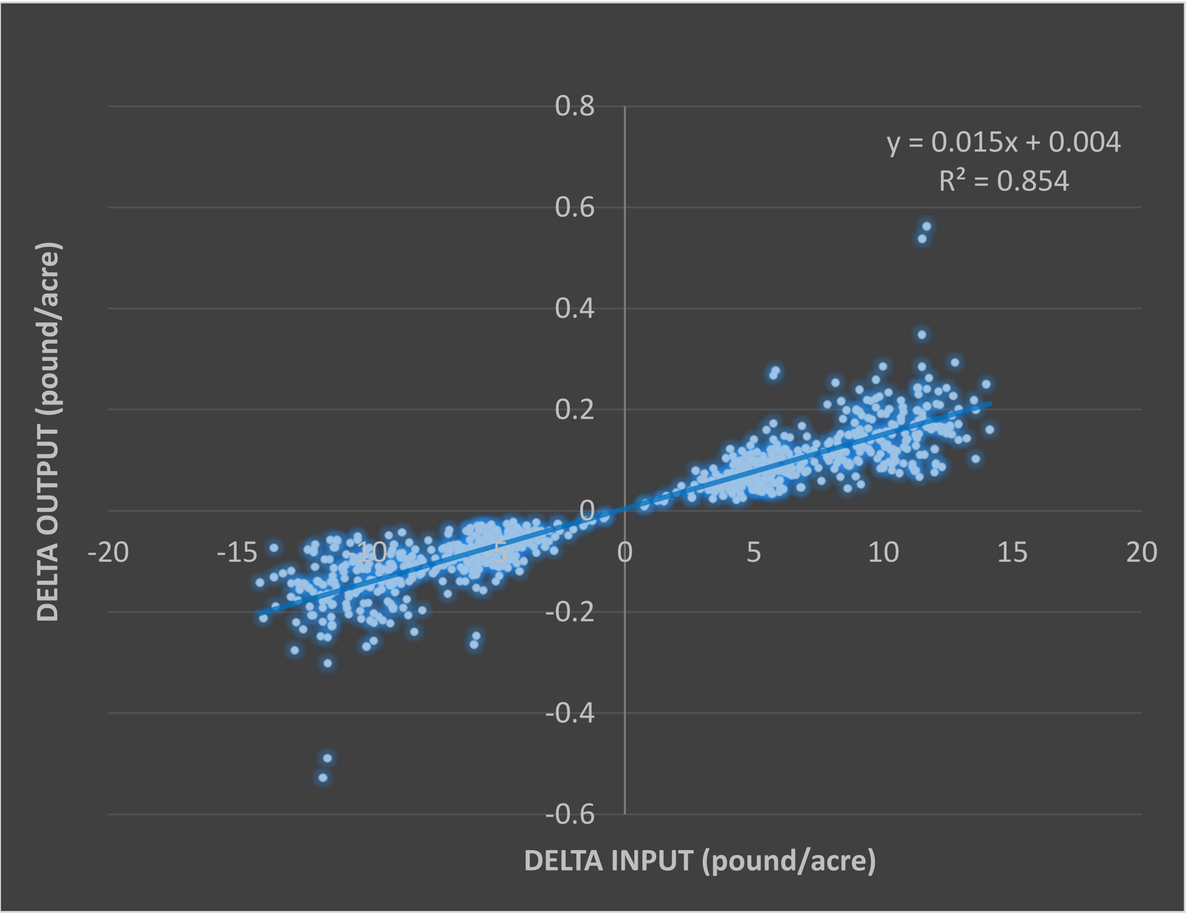
$$S_r = \left(\frac{O - O_b}{I - I_b}\right)\frac{I_b}{O_b}$$

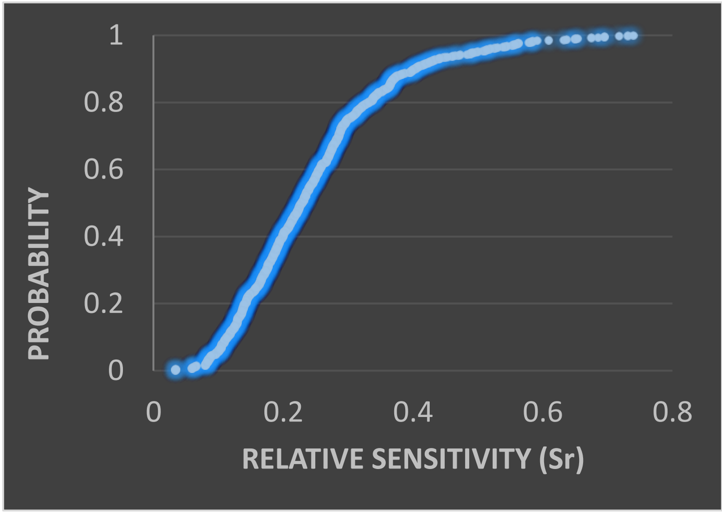
Where:
O = model output
I = model input
b = subscript represents the input and output value of the base scenario

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.

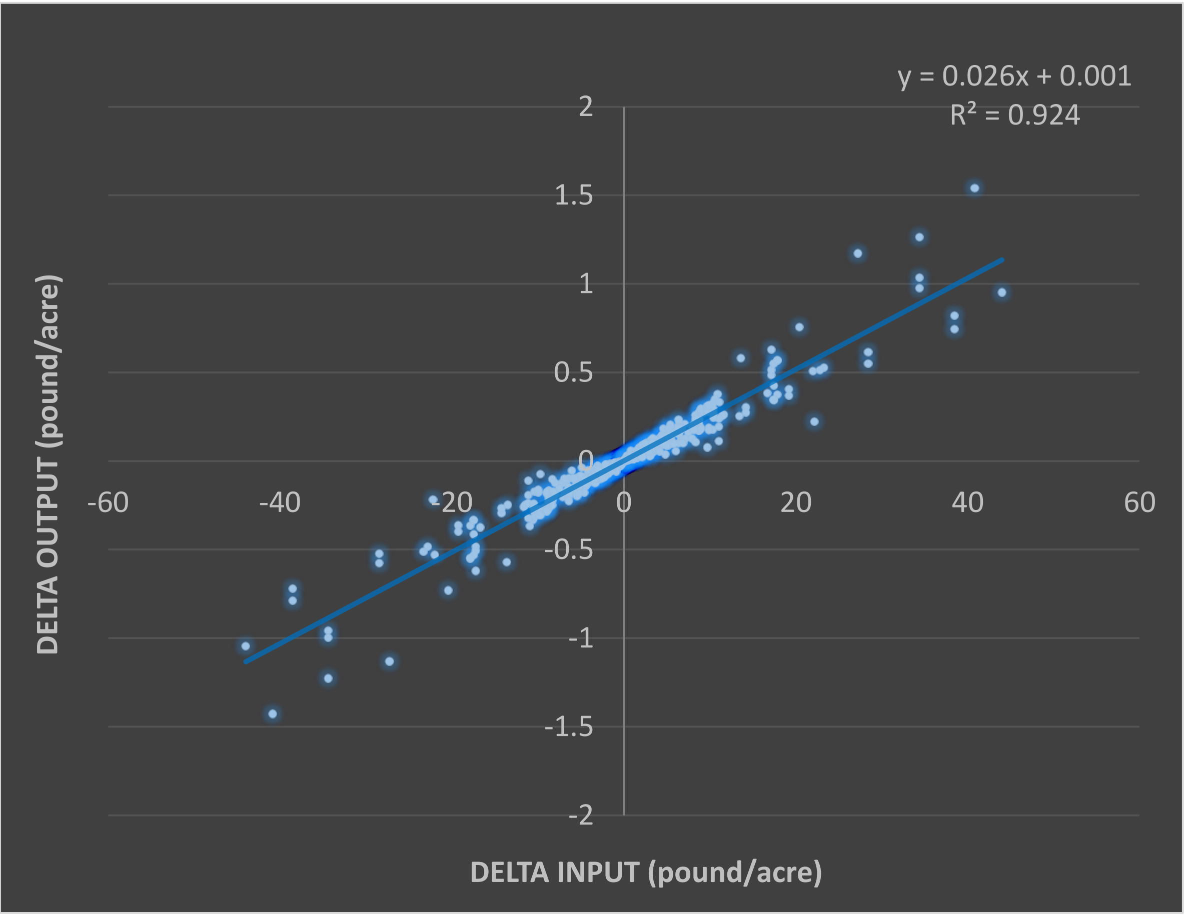
APLE Model Sensitivity due to Change in Fertilizer Input

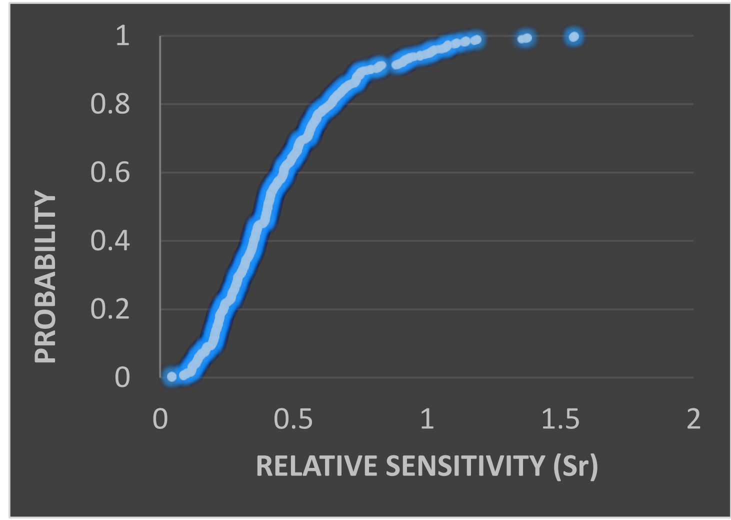




Relative Sensitivity	
Insensitive	Sr < |0.01|
Slightly sensitive	|0.01| ≤ Sr < |0.10|
Moderately sensitive	|0.10| ≤ Sr < |1.00|
Sensitive	|1.00| ≤ Sr < |2.00|
Extremely sensitive	Sr ≥ |2.00|

APLE Model Sensitivity due to Change in Manure Input





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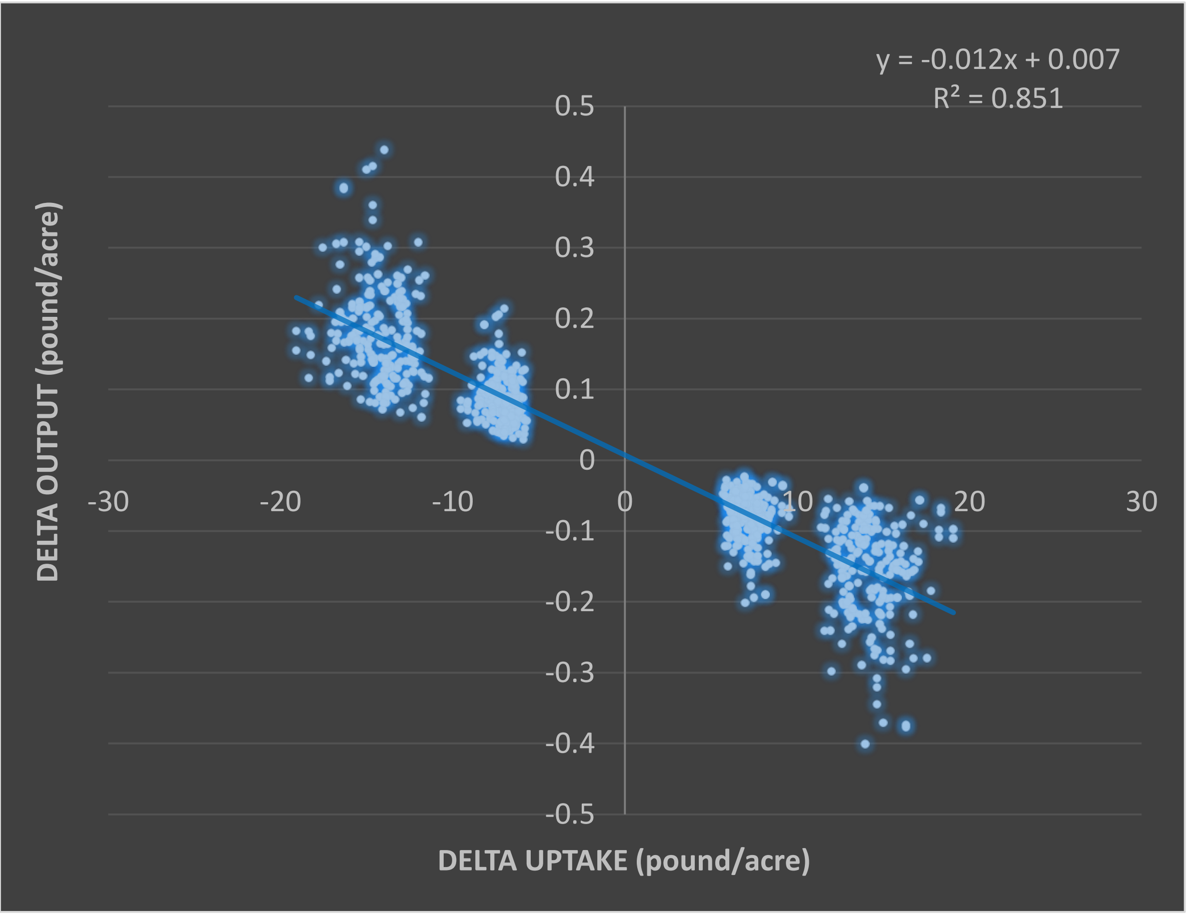
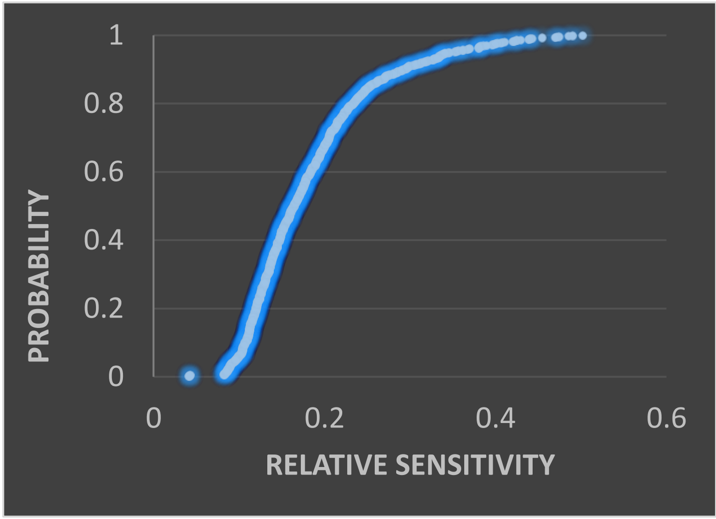
APLE Model Sensitivity due to Change in Uptake Input





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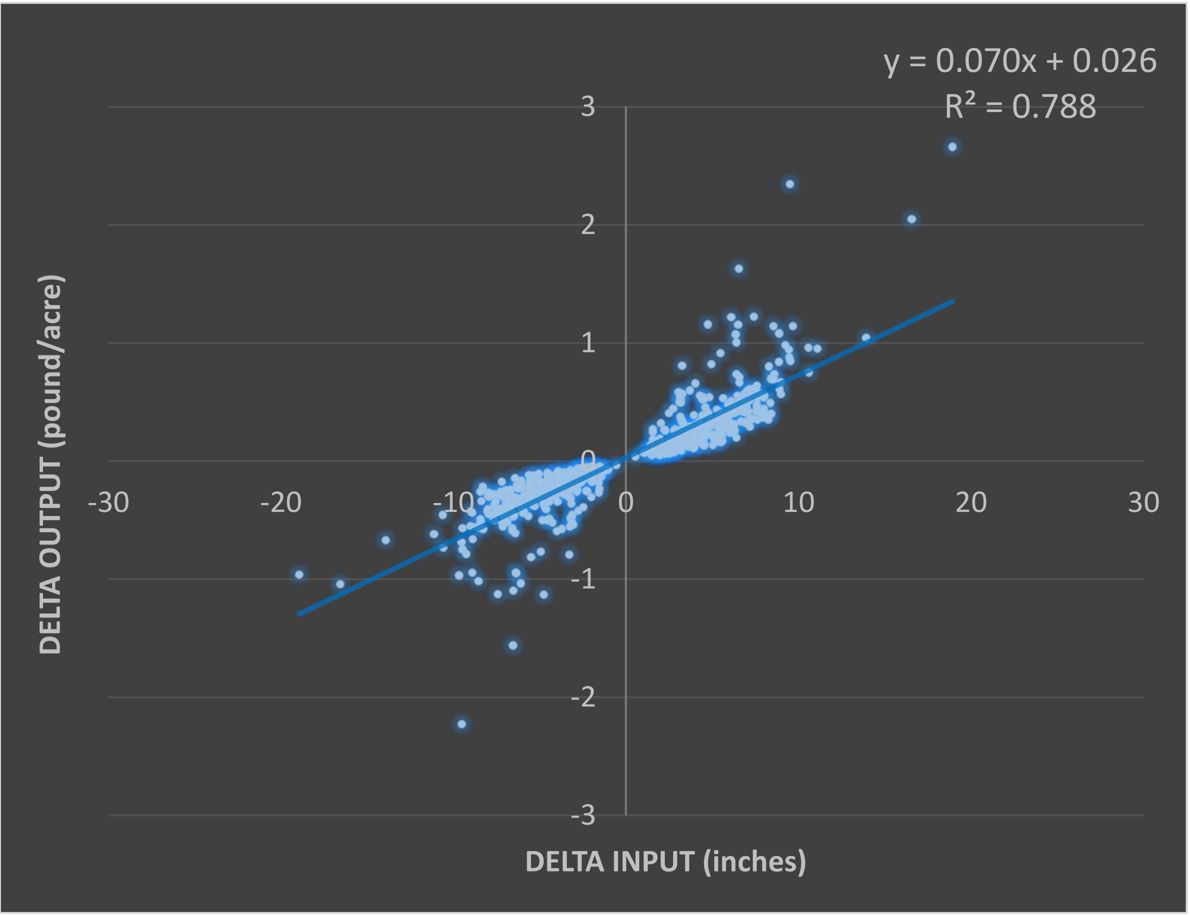
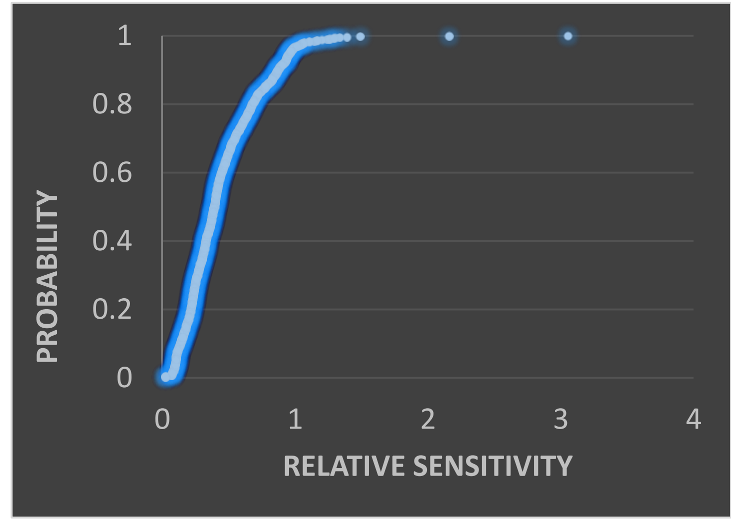
APLE Model Sensitivity due to Change in Runoff Input





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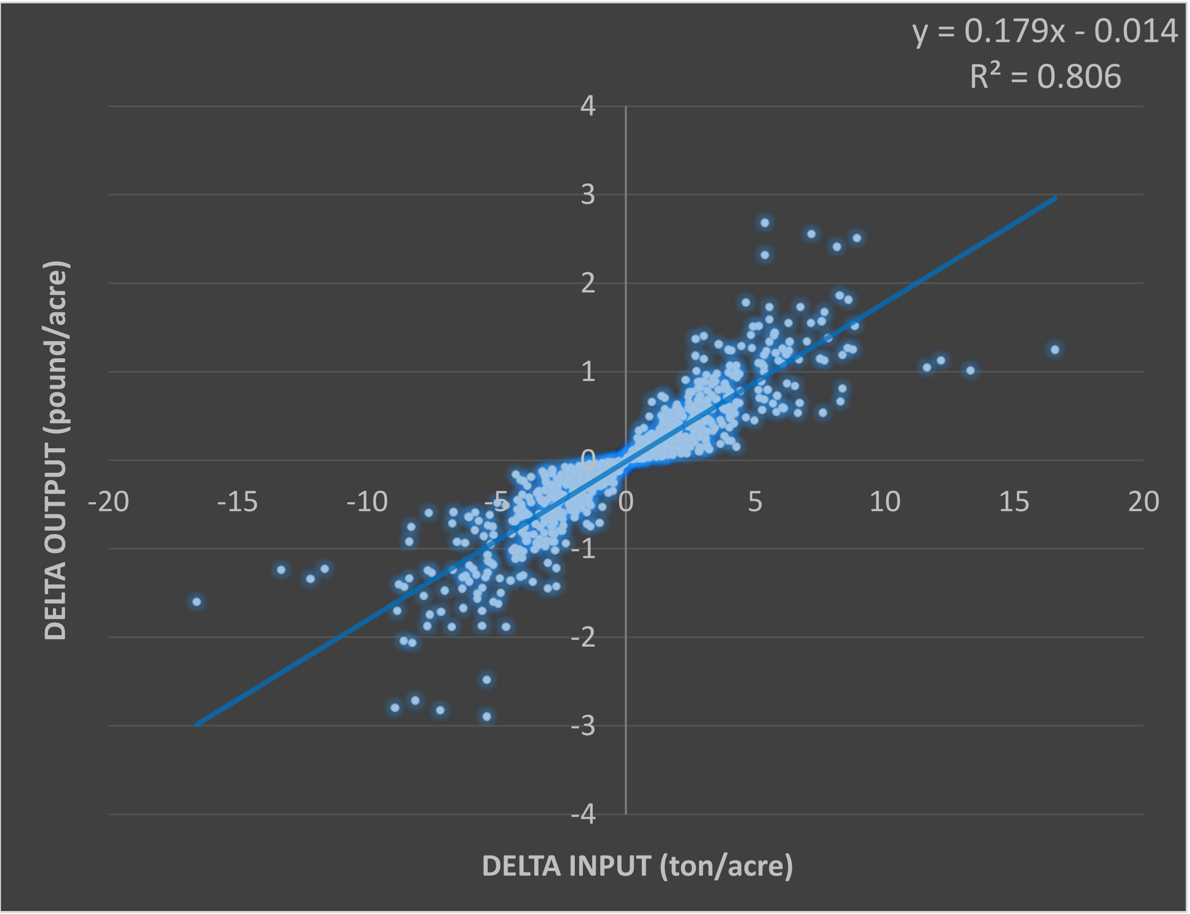
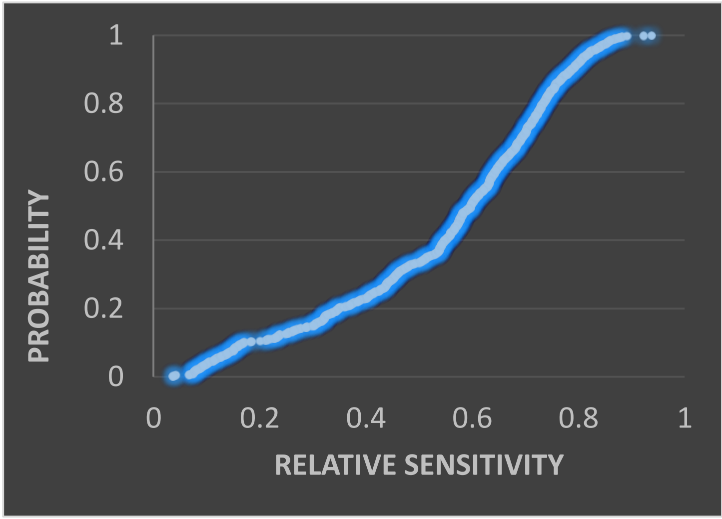
APLE Model Sensitivity due to Change in Sediment Input





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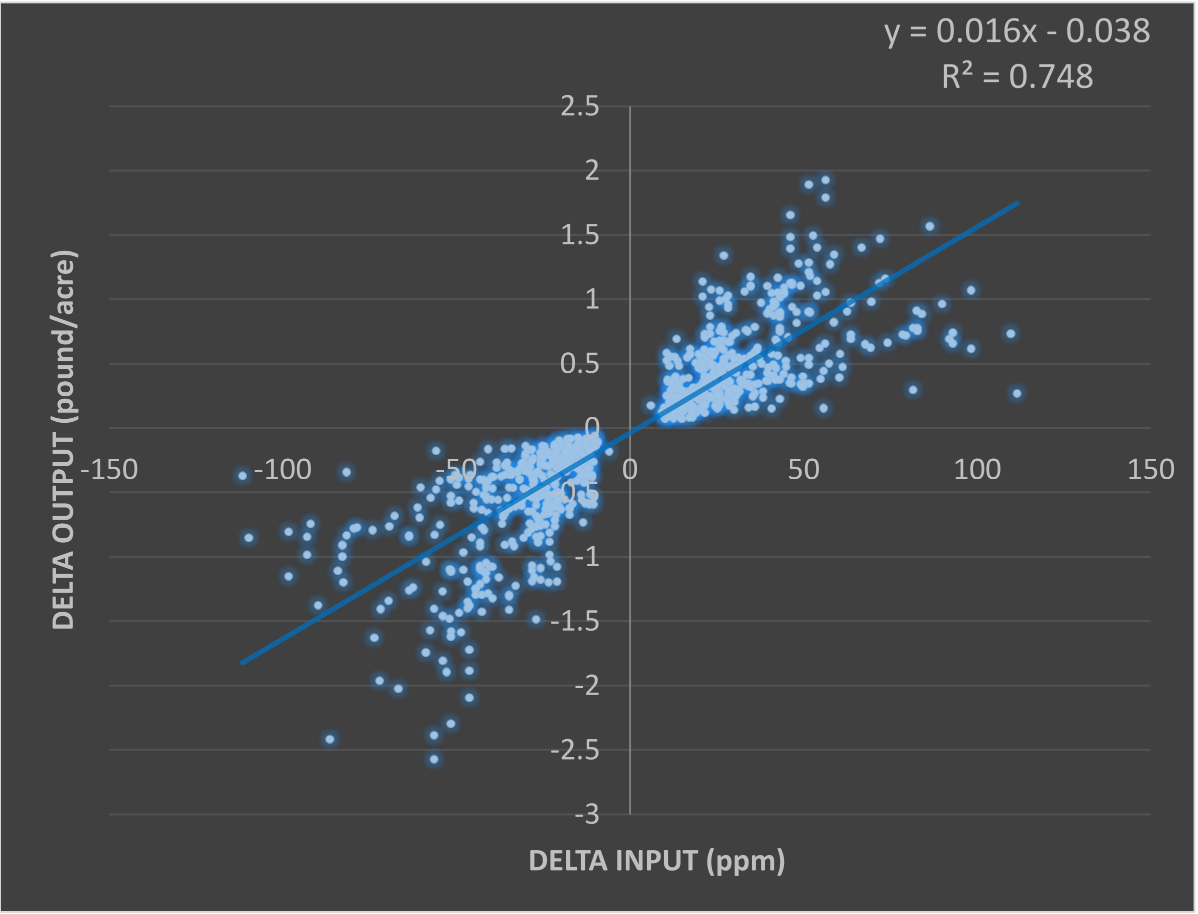
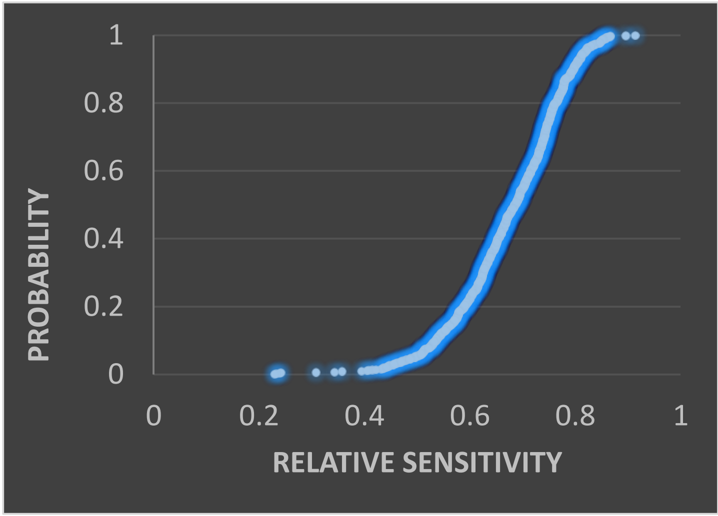
APLE Model Sensitivity due to Change in Mehlich Input





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High Till Landuse
APLE Model Sensitivity Analysis

Parameter	Slope (Sensitivity)	R^2	Median *Sr*	Max *Sr*	Min *Sr*
Mehlich (ppm)	0.016	0.745	0.685	0.914	0.230
Sediment (Ton/a)	0.179	0.805	0.598	0.938	0.036
Manure (lbs/a)	0.026	0.924	0.404	1.554	0.044
Runoff (inches)	0.070	0.784	0.396	3.055	0.027
Fertilizer (lbs/a)	0.015	0.853	0.229	0.740	0.034
Uptake (lbs/a)	-0.012	0.848	0.165	0.502	0.042

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

Pasture Landuse
APLE Model Sensitivity Analysis

Parameter	Slope units	Median Slope	Mean R2	Median Sr	Max Sr	Min Sr
Manure	lbs/lbs	0.042	0.997	0.787	2.063	0.155
Fertilizer	lbs/lbs	0.036	0.998	0.771	2.219	0.113
Direct Manure	lbs/lbs	0.037	0.999	0.731	2.345	0.131

APLE is more sensitive to ….

Next

- Phosphorus sensitivities are provisional and we'll continue exploring APLE.

- Extending the simulation period