Modeling the Influence of Agricultural Practices on Watershed Export of Phosphorus

Rem Confesor Jr., Ph.D.
Sr. Research Scientist
NCWQR, Heidelberg University
310 E. Market St., Tiffin, OH
rconfeso@heidelberg.edu
Voice: 419-448-2204

8th Lake Erie Millennium Network Meeting
Windsor, Ontario, CA, February 21-23, 2017

The Soil and Water Assessment Tool (SWAT)

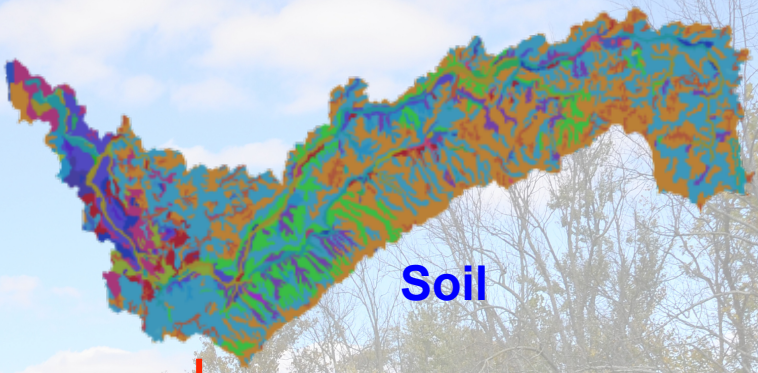
- Needs spatially-based data (nutrient sources, N, P, and flow data, etc.)
- Simulates the physical processes such as crop growth, sediment and nutrient transport, erosion, tile drain flow, etc.
- Processes at a sub-hourly to daily time step and output summarized monthly or annually.
- Can identify critical source areas and their contributions.

The Soil and Water Assessment Tool (SWAT)

- Simulate the effects of changes in management: tillage method, fertilizer application, changes in crop rotation, changes in landuse.
- "RELATIVE" changes of nutrient and sediment exports due to the management changes (scenarios).
- Garbage in, garbage out…

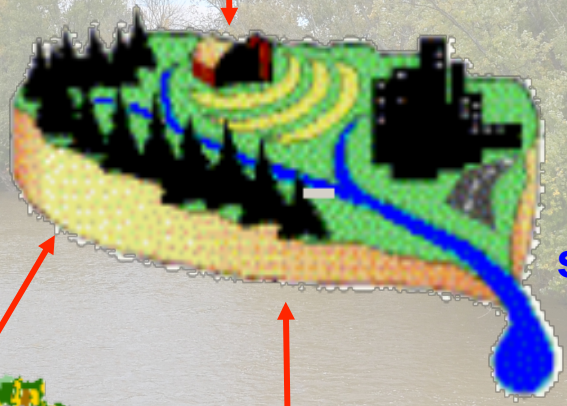
Main SWAT Components

Terrain

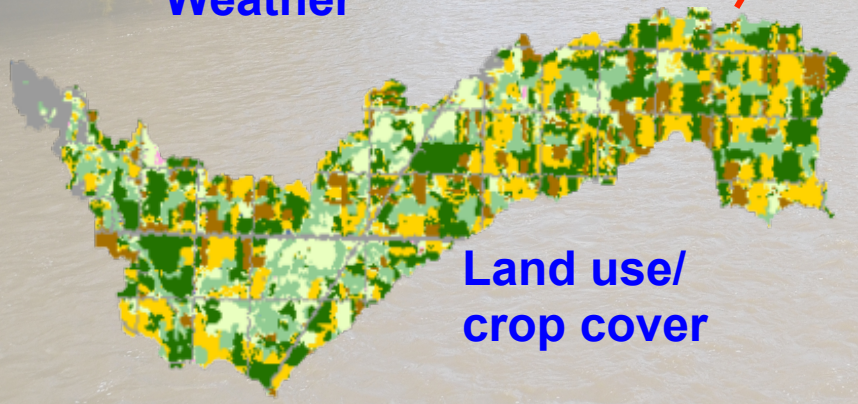


Soil

Weather

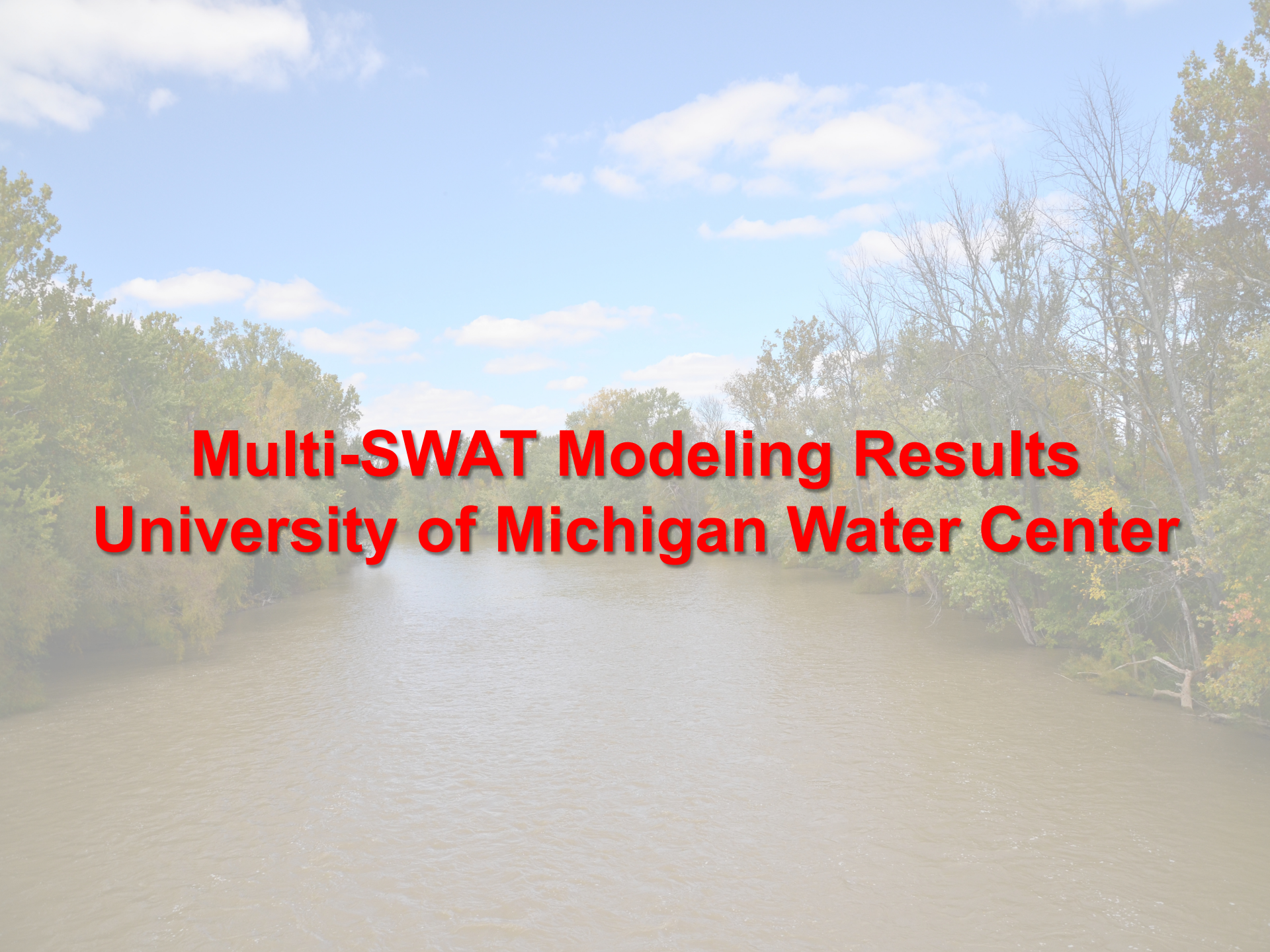


Flow, sediment, nutrients (N & P), etc.



Land use/ crop cover

Agricultural practices & mgt.: tillage, fertilizer, etc.


Multi-SWAT Modeling Results
University of Michigan Water Center

Management Strategy	40% Reduction
50% reduction in P application, with fall subsurface application in 100% of watershed.	DRP
50% reduction in P application, subsurface application, continuous no-till, medium-quality buffers each on a different 25% of cropland across the watershed.	DRP & TP
Subsurface application, cereal rye cover crop in the winters without wheat, medium-quality buffers on 50% (targeted) of high P-loss cropland.	DRP & TP
Subsurface application, cereal rye cover crop in the winters without wheat, medium-quality buffers applied together on random 50% of cropland.	TP
An alternative corn-soybean-wheat rotation with a cereal rye cover crop in winters without wheat randomly spread on 50% of watershed	TP
Wetlands and buffers on 25% of highest P-loss cropland (intercepting half of overland and tile flow	TP

(Scavia et. al., 2016)

The devil is in the details…

- BMP implementation: What? Where? How?
- Fields are unique from each other.
- "There is no magic bullet…"
- " Reducing stratification by a one-time soil inversion has the potential for larger and quicker reductions in DRP runoff risk than practices related to drawing down agronomic STP levels." (Baker et. al., 2016)

Best Option: Field Scale Models

Agricultural Policy/Environment eXtender (APEX)

Nutrient Tracking Tool (NTT)

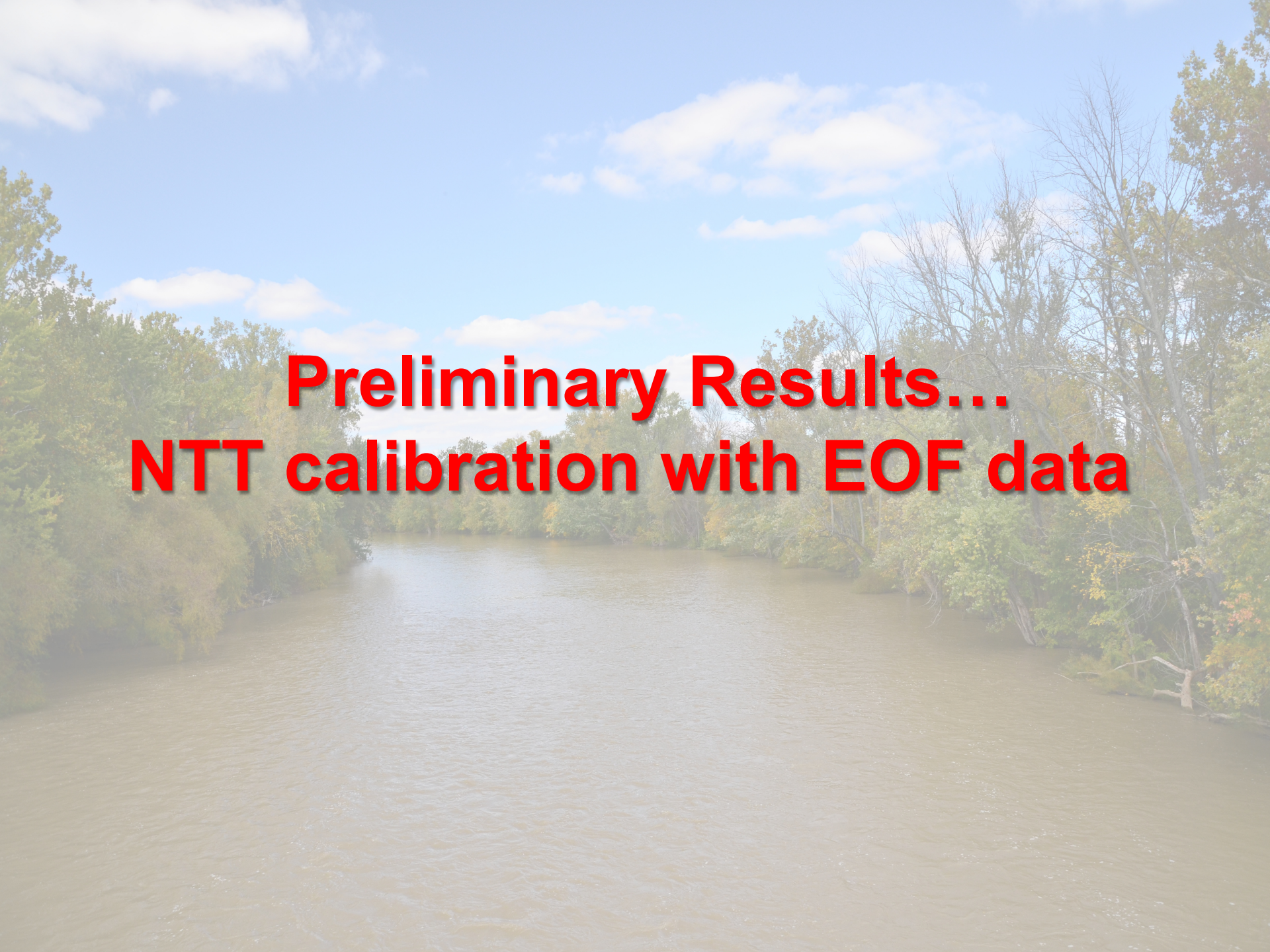
What is NTT?

- Uses Agricultural Policy Environmental eXtender (APEX): nutrient and sediment losses and runoff from agricultural fields
- A web-based program that requires no software installation.
- Required data (e.g., weather, soils, and RUSLE2 management data) for major portions of US are provided.

Practices evaluated by NTT

- Structural CPs
  - Filter strips
  - Stream channel stabilization
  - Grass waterways
  - Wetland, reservoir, and ponds
  - Riparian forest
  - Fencing
  - Terracing, and land leveling
  - Land use change (e.g., Forest)
  - Contour buffers
  - Tile Systems
  - Pads and Pipes
  - Furrow Dike
- Cultural CPs
  - Nutrient management
  - Tillage operation
  - Irrigation and fertigation
  - Grazing operation
  - Manure management

A. Saleh 2015


Preliminary Results…
NTT calibration with EOF data

Test Fields

Edge-of-field (EOF) site:

Paired field (2.6 and 1.5 ha fields)

The same management practices in both fields.

Surface Runoff and Tile drainage measurements for each field.

Automatic samplers

Water samples analyzed for nitrate, NH4, total N, total P, and DRP.

Crop yield monitored for each year (2013-2015).

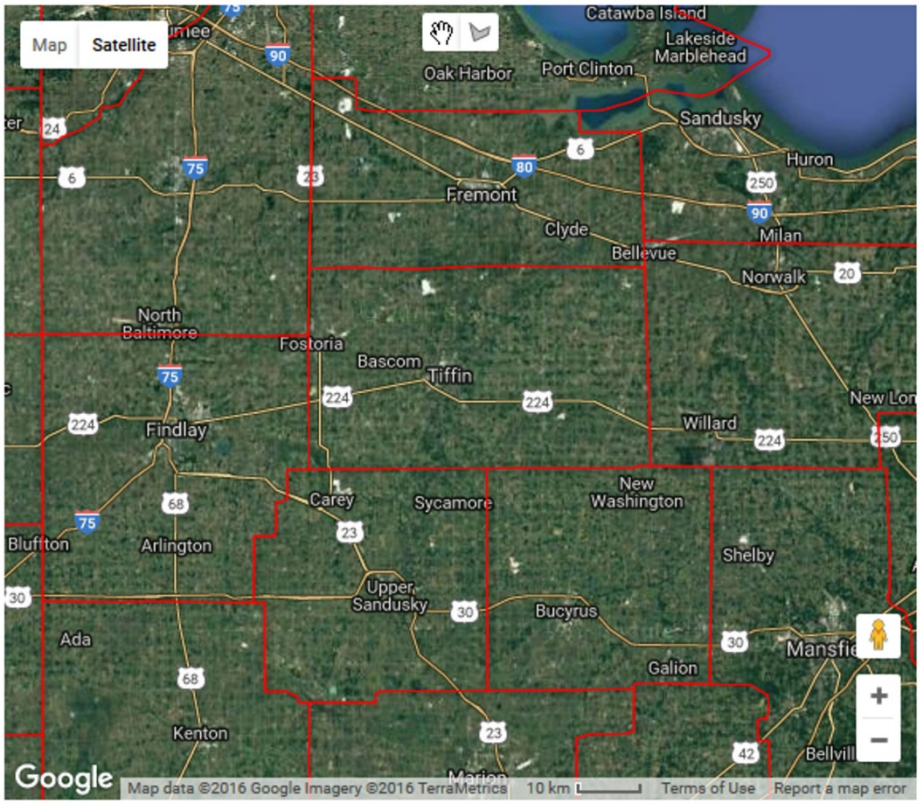
Field Layout from Kevin King

NTT
Nutrient Tracking Tool
2nd Generation

Project Name: RemFieldDay

Select Location From Map or State/County

Mapping System | State/County | User Input



Upload Shapefile

Map Navigation

Farm Field Tools

To add a new farm or field, select farm or field radio button, then click the corresponding icon in the map and then click on the map to draw the parcel or field boundaries, finally enter the farm/field name.

To edit a farm of field, select the famr/field clicking on the polygon, then drag the vertices to edit the boundary as you want it.

To delete a polygon, select the polygon and then click the remove button.

Click the Submit button to process the fields and to get the soil information.

Editing Options

(•) Farm ( ) Field

Remove | Submit

If you want to copy a field from a farm and there are fields in this map they will be removed and a new field equal to the farm polygon will be created.

New Field [ ] Copy Farm as Field

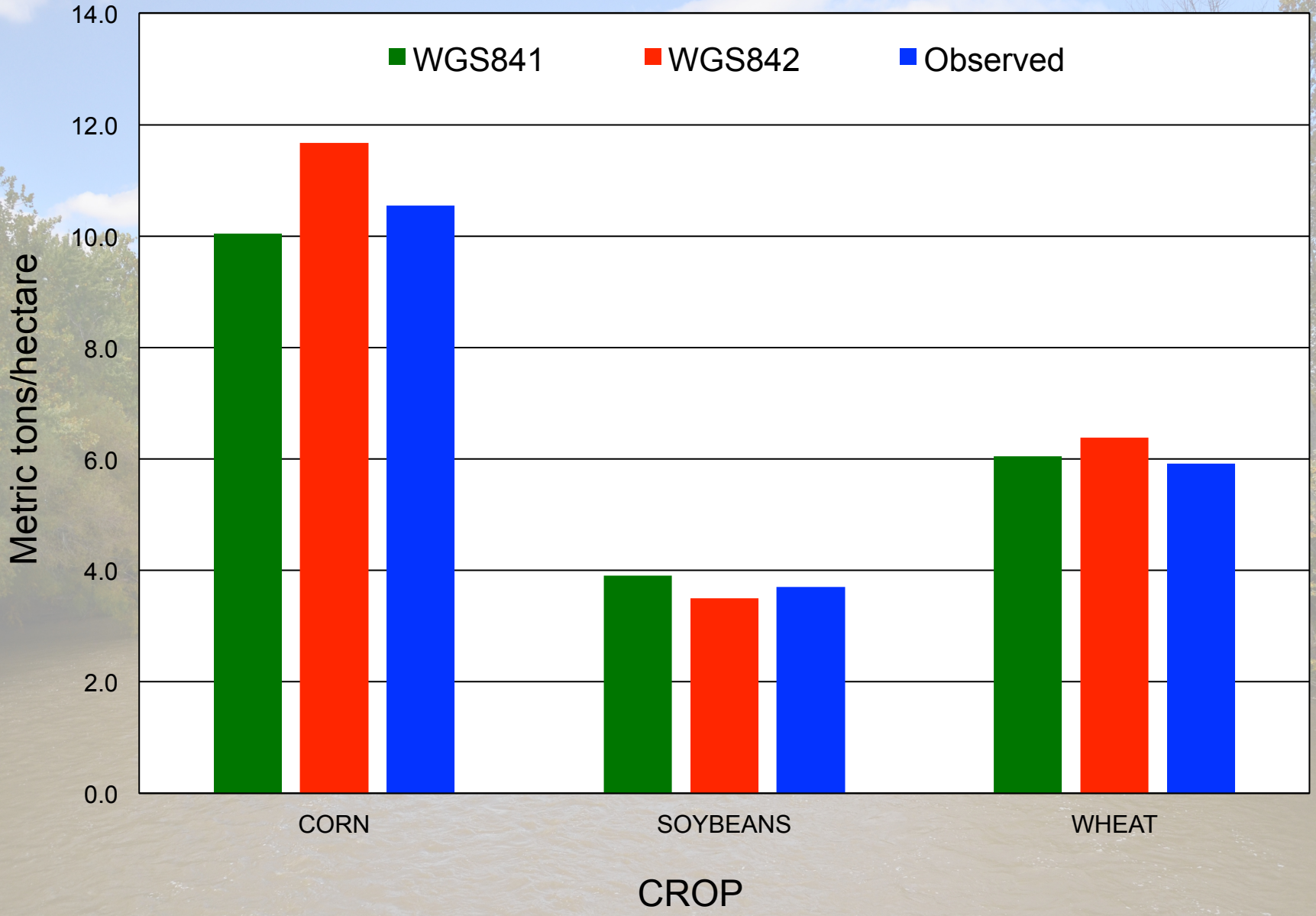
Select Scenario | Baseline | Delete Scenario | | Add New Scenario | Rename Scenario

Management Operations

Add New | Delete Selected | Show Grasses

									Nutrient Composition (fraction)				
Select	Crop	Operation	Year	Month	Day	Fertilizer	Amount(lbs/ac)	Depth(in)	NO3	PO4	Org N	Org P	NH3
	CORN	Tillage	1	5	3	CHISEL PLOW LE15F	0	0	0	0	0	0	0
	CORN	Fertilizer	1	5	7	Commercial Fertilizer	106.7	0	0.28	0	0	0	0
	CORN	Fertilizer	1	5	7	Commercial Fertilizer	56.5	0	0.1	0.34	0	0	0
	CORN	Planting	1	5	23	Plant with drill	34200	0	0	0	0	0	0
	CORN	Fertilizer	1	6	10	Commercial Fertilizer	400	0	0.46	0	0	0	0
	CORN	Fertilizer	1	6	10	Commercial Fertilizer	100	0	0.21	0	0	0	0
	CORN	Harvest	1	10	7	HARVEST	0	0	0	0	0	0	0
	CORN	Kill	1	10	7	KILL	0	0	0	0	0	0	0
	SOYBEANS	Planting	2	4	24	Plant with drill	160000	0	0	0	0	0	0
	SOYBEANS	Kill	2	10	5	KILL	0	0	0	0	0	0	0
	SOYBEANS	Harvest	2	10	5	HARVEST	0	0	0	0	0	0	0
	WINTER WHEAT	Planting	2	10	14	Plant with drill	1600000	0	0	0	0	0	0
	WINTER WHEAT	Fertilizer	3	4	6	Commercial Fertilizer	175	0	0.46	0	0	0	0
	WINTER WHEAT	Fertilizer	3	4	6	Commercial Fertilizer	100	0	0.21	0	0	0	0
	WINTER WHEAT	Harvest	3	7	8	HARVEST	0	0	0	0	0	0	0
	WINTER WHEAT	Kill	3	7	8	Select One	0	0	0	0	0	0	0
	CORN	Tillage	3	9	30	CHISEL PLOW LE15F	0	0	0	0	0	0	0

Crop Yield


14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
WGS841
WGS842
Observed
Metric tons/hectare
CORN
SOYBEANS
WHEAT
CROP

Total field exports, kg/ha

	TotP lbs/ac	TotN, lbs/ac
WGS841	0.80	15.07
Observed(2015)	0.74	22.38
WGS842	1.38	12.06
Observed(2015)	1.09	15.24

Observed data from Kevin King

Tile drain exports, kg/ha

	DRP lbs/ac		Tot N lbs/ac
WGS841	0.53		13.47
Observed(2015)	0.72		22.33
WGS842	0.88		9.62
Observed(2015)	0.55		12.90

Observed data from Kevin King

Summary

- Several BMP suites can achieve 40% P reduction
- Widespread adoption is necessary
- Targeting vs. random placement
- Subsurface P application
- Not all combinations meet both TP and DRP targets
- Actual implementation: “the devil is in the details”
- Field by field basis of implementation.
- APEX/NTT is a potential tool to guide implementation.


THANKS!!!
Rem Confesor Jr.
National Center for Water Quality Research
Heidelberg University
310 E. Market St., Tiffin, OH
rconfeso@heidelberg.edu
Voice: 419-448-2204
rbcjr_20121008