Effects of Conservation Practices on Phosphorus Loss Reduction from an Indiana Agricultural Watershed

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Presentation outline

• Objective
• Background
• Method
• Preliminary results
Objectives

- Evaluate phosphorus loss and effectiveness of BMPs for P loss reduction at field scale
  - Evaluate BMP effects with observed data
  - Evaluate BMP effects using APEX at both the field and Maumee River Basin scale
  - Develop online interface for APEX model
Background: Phosphorus loss is causing serious water quality problems

http://www.toledoblade.com/local/2014/08/03/Water-crisis-grips-area.html

Water crisis grips hundreds of thousands in Toledo area, state of emergency declared

By Tom Henry | BLADE STAFF WRITER

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Background: Lake Erie Basin is a heavily agricultural basin.
Background: Factors affecting excessive P loss

- Climate change
- Crop
  - Cropping systems
  - Crop nutrient efficiency
  - Roundup ready crops
- Ethanol production
- Fertilizer
  - Fertilizer placement
  - Fertilizer rate
  - Tri-state recommendations
  - Fertilizer source
  - Fertilizer timing
  - Manure
  - Nitrogen
  - Misconceptions about phosphorus loss
- Soil
  - Increased soil pH
  - Products sold to increase soil phosphorus solubility
  - Alteration to soil biology
  - Soil testing and analysis
  - Stratification of phosphorus
- Large farms
- Tillage
  - No-Till
- Tile drainage
- Social activity
  - Commodity prices
  - Rental agreement
- Lower levels of sediment in water
- Zebra Mussels
Background: Modelling efforts are focusing on large river basins

• Field scale information if missing with large scale model results
  – Missing the important processes of DRP loss
  – Generally aggregated, even though HRUs in the SWAT model could be smaller
Methods

– Evaluate BMP effects with observed data
  • Data availability
  • Analysis of data

– Evaluate BMP effects using APEX at field and Maumee River Basin
  • Calibrate and validate APEX at the edge of field
  • Simulate different BMPs using APEX model
  • Simulate all fields in the Maumee River basin

– Develop online interface for APEX model
Methods: Data availability (2004 to now)

• Flow:
  – Surface: 2 mins interval
  – Tile: 10 min normally and 1 mins at larger flow events

• Water quality
  – NH4, NO2, NO3, TKN, OP, TP, and others
  – Event based monitoring

• Climate:
  – Prcp, max and min temperature, solar radiation, wind speed, and relative humidity
  – 10 mins

• Management practices recorded by contractor.
Interpolating phosphorus load

\[ l_1 = f_1 \times c_1 \]
\[ l_5 = f_5 \times c_5 \]
\[ l_2 = a \times f_2 + b \]
\[ l_3 = a \times f_3 + b \]
\[ l_4 = a \times f_4 + b \]
Flow and phosphorus at daily level

- Sediment
- Surface Flow
- Total P
- Ortho P
- Tile flow
## Surface vs tile P loss

<table>
<thead>
<tr>
<th></th>
<th>Avg ratio Ortho P /Total P Load</th>
<th>Total P load growing season (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>0.58</td>
<td>0.59</td>
</tr>
<tr>
<td>Tile</td>
<td>0.35</td>
<td>0.36</td>
</tr>
</tbody>
</table>

![Graph showing load vs time for Ortho P-T, Total P-T, Ortho P-S, Total P-S](#)
Methods: APEX validation at the edge of fields

– Evaluate BMP effects with observed data
  • Data availability
  • Analysis of data

– Evaluate BMP effects using APEX at both the field and Maumee River Basin scale
  • Calibrate and validate APEX at the edge of field
  • Simulate different BMPs using APEX model
  • Simulate all fields in the Maumee River basin

– Develop online interface for APEX model
Modelling efforts

ADE 2009/03/10-11

ADE 2011/04/22-24

Flow (m³/s)

Hour

Simulated flow
Observed flow

Flow (m³/s)

Hour

Simulated flow
Observed flow

ADE2011

ADE2011

Q
ObsQ
QDR
ObsQDR

Apr May Jun Jul Aug Sep Oct

Apr May Jun Jul Aug Sep Oct
Conclusion and next step

• Conclusion:
  – Field data indicated that P loss through surface flow was doubled for those through subsurface flow during the growing season.
  – Ortho P contributed large portion (averaged 70% across events for P surface flow and 35% from tile flow in 2010) of total P.
  – Uncalibrated APEX model provided reasonable simulations for flow loss at the edge of field.

• Next step:
  – Continue data analysis, including the seasonal variations of P load and the effects of conservation practices, relationship between orthography P and organic P.
  – Model these practices using the APEX model.
  – Expand the research to Maumee River basin.