Variability of Sediment and Nutrient Fluxes within an Agricultural Watershed

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The Ohio State University

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Today's Presentation

- Background and Motivation
- Model Development
- Results
- Needs and Future Plans

Maumee River Watershed



Watershed Management Challenges



How to allocate BMPs to improve water quality?

Changing Characteristics of Precipitation (Spring)



Rate of change (%)

- Increase in heavy precipitation in spring
- Spring runoff critical for algae blooms



- Illuminate the role of climate variability within the watershed
 on nutrient delivery to Lake Erie
 - ✓ At daily time step
 - ✓ Spring (Mar-Jun)

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Model Development

- Soil Water Assessment Tool (SWAT) at daily time step
- <u>252</u> watersheds delineated; <u>2,200</u> HRUs
- Crop rotations to represent current practices
- Tile drainage
- Point sources

Input Data

Variable	Source
Topography	USGS 30x30m DEM
Land use / crop rotation	USDA, OSU Extension Faculty
Soils	USDA
Climate (NLDAS-2, 1980 to present)	NASA, Hourly time step, ~4 days behind real time
Point sources	EPA
Stream flows	USGS
Water quality	Heidelberg University

Model Development

- Stream flows: Calibrated and validated at the outlet and internal gages (n=13, 2000-2014)
- Nutrients Sediments, Total and Soluble P and nitrates



Model Development

- Calibration: 2000-2010
- No. of gages = 13
- Objective Function set to achieve
 - ✓ NSE 0.6
 - ✓ PBIAS ±10%
 - ✓ VE 0.5
- Spring (Mar-Jun), Summer (Jul-Sep) flows considered separately



Model Performance Monthly Flows, 2000-2014

Name	USGS_ID	NSE	PBIAS %	R2
St. Joseph River Near Newville, In	04178000	0.86	-1.8	0.87
Cedar Creek Near Cedarville, Ind.	04180000	0.83	-2.2	0.83
St. Joseph River Near Fort Wayne, In	04180500	0.87	-2.3	0.87
St. Marys River At Decatur, Ind.	04181500	0.79	-15.6	0.82
St. Marys River Near Fort Wayne, Ind.	04182000	0.79	-17.6	0.82
Maumee River At New Haven, Ind.	04183000	0.85	-13	0.88
Tiffin River At Stryker Oh	04185000	0.83	-11.8	0.84
Auglaize River Near Fort Jennings Oh	04186500	0.79	-13.9	0.81
Fish Creek At Hamilton, Ind.	04177720	-3.78	151.2	0.8
Bean C At Powers Oh	04184500	0.65	2.2	0.71
Blanchard River Near Findlay Oh	04189000	0.77	-9.8	0.78
Auglaize River Near Defiance Oh	04191500	0.81	-7.3	0.82
Maumee River At Waterville Oh	04193500	0.77	-7.2	0.78

Performance rating: Good or Very Good

Moriasi, et al., 2007

Model Performance Spring Flows (daily, 2000-2014)



Model Performance

Total Phosphorus Flux at Watershed Outlet (kg/day)



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Potential Source Areas





Spring Loading (2000-2014)

1.5

1.0

0





Nutrient delivery is largely driven by precipitation



Precipitation Characteristics Spring, 2000-2014



Precipitation Characteristics Spring, 2000-2014

Precipitation (mm)



No. of events > 10mm



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Potential Source Areas



Findings so far...

- P loading and variability are higher in <u>ALL, except</u> <u>Blanchard</u>
- Precipitation variability is higher in St Joseph's, St Mary's and Tiffin compared to Auglaize and Blanchard
- Extreme events are the highest in St Mary's
- Linkage between climate and loading

Watershed Management Challenges



- Target BMPs:
 - Physical and management characteristics
 - ✓ Climatic variations (e.g. extreme events)

Thank You

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Ohio Supercomputer Center An OH·TECH Consortium Member



Coupled Human-Natural Systems Response



Calibration / Validation

Sediment Flows at Watershed outlet



- Similar performance in other years
- Similar performance at <u>Blanchard</u>
- Weaker performance at Tiffin

Today's Presentation

- Update analyses from line 804 onwards in read_SWAT_daily_outputs_v1.R
- Process new output.rch/sub and plot NSE values

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Abstract

Approximately 50% of suspended solids and nutrients are delivered to Western Lake Erie from the agriculturally dominated Maumee River Watershed (MRW). Cropping patterns, soils, subsurface drainage, changing weather patterns and runoff potential have been identified as major natural and human factors impacting nutrient delivery to the Lake. Although, nutrient dynamics at the MR outlet are well-studied and documented through monitoring and modeling, the spatial and temporal dynamics within the MRW are poorly understood. Spatial variability in soils, cropping and local storm patterns heavily influence runoff potential from various sub-watersheds. Identifying areas, or sub-watersheds, with high runoff potential that are a major source for suspended solids and nutrients, would be extremely helpful to guide the application of best management plans (BMPs). For this reason, we performed a multi-site calibration and validation of a MRW Soil Water Assessment Tool (SWAT) model to evaluate the spatial and temporal variability of water a nutrient fluxes within the MRW. Flow calibration was completed at nine stream flow locations and validated at thirteen locations within MRW. Water quality parameters (suspended solids, total and reactive phosphorus and nitrate-nitrogen) were calibrated at the outlet of MR and validated at three internal locations. Initial results indicate that the interannual variability of stream flows are greatest at gage locations that drain high-runoff

	rch_76	rch_117	rch_128	rch_201	rch_163	rch_138	rch_43	rch_184	rch_48	rch_42	rch_19	rch_150	rch_104
NSE	0.58	0.62	0.73	0.62	0.62	0.71	0.67	0.48	0.65	-3.42	0.41	0.42	0.53
PBIAS %	-1.7	-2.2	-2.2	-15.6	-17.6	-13	-11.7	-13.9	-5.4	151.3	2.2	-9.9	-7.3
Monthly flow GOF													
	rch_76	rch_117	rch_128	rch_201	rch_163	rch_138	rch_43	rch_184	rch_48	rch_42	rch_19	rch_150	rch_104
NSE	0.86	5 0.83	3 0.87	0.79	0.79	9 0.85	5 0.83	3 0.7	9 0.7	7 -3.73	8 0.65	6 0.77	0.81
PBIAS %	-1.8	3 -2.2	2 -2.3	3 -15.6	6 -17.6	5 -13	3 -11.3	8 -13.	9 -7.	2 151.2	2 2.2	-9.8	-7.3

Daily flow GOF

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- St Joseph's and Tiffin ~ 23% catchment area
- St Mary's and Auglaize ~ 50% catchment area

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- Click to add bulleted text right here

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BIG WORDS AND PHRASES

"Notable quotes Will go right here, yes right here."

Firstandlast Name

Optional title line



Analyzing the Variability of Water, Sediment and Nutrient Fluxes within an Agricultural Watershed to Identify Nutrient "Hotspots"

> Noel Aloysius, Marie Gildow and Jay Martin Ohio State University

Calibration / Validation



