Potential accuracy of water quality estimates based on non-calibrated SWAT simulations

Claire Baffaut
D. Todd Farrand, Verel W. Benson

FAPRI
At the University of Missouri
Food and Agricultural Policy Research Institute

College of Agriculture, Food and Natural Resources
UNIVERSITY OF MISSOURI-COLUMBIA

The Reality of Model Calibration

- Most parameters have a suggested range of values, not one definite value.
- Their final value is determined during the calibration process by comparing measured and simulated flow values and pollutant concentrations.
- Flow and water quality data are not always available.
- Crop yields are estimated for all U.S. counties.

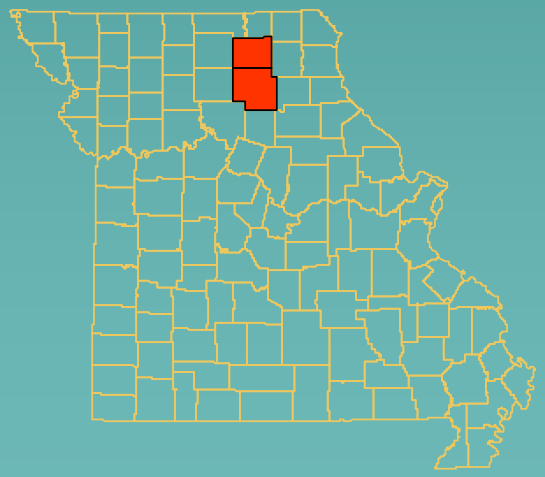
Question

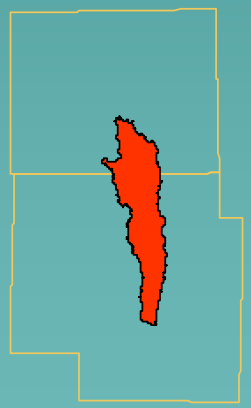
Can we use SWAT
to evaluate BMPs impacts
at the watershed level
when few data are available
to calibrate the model?

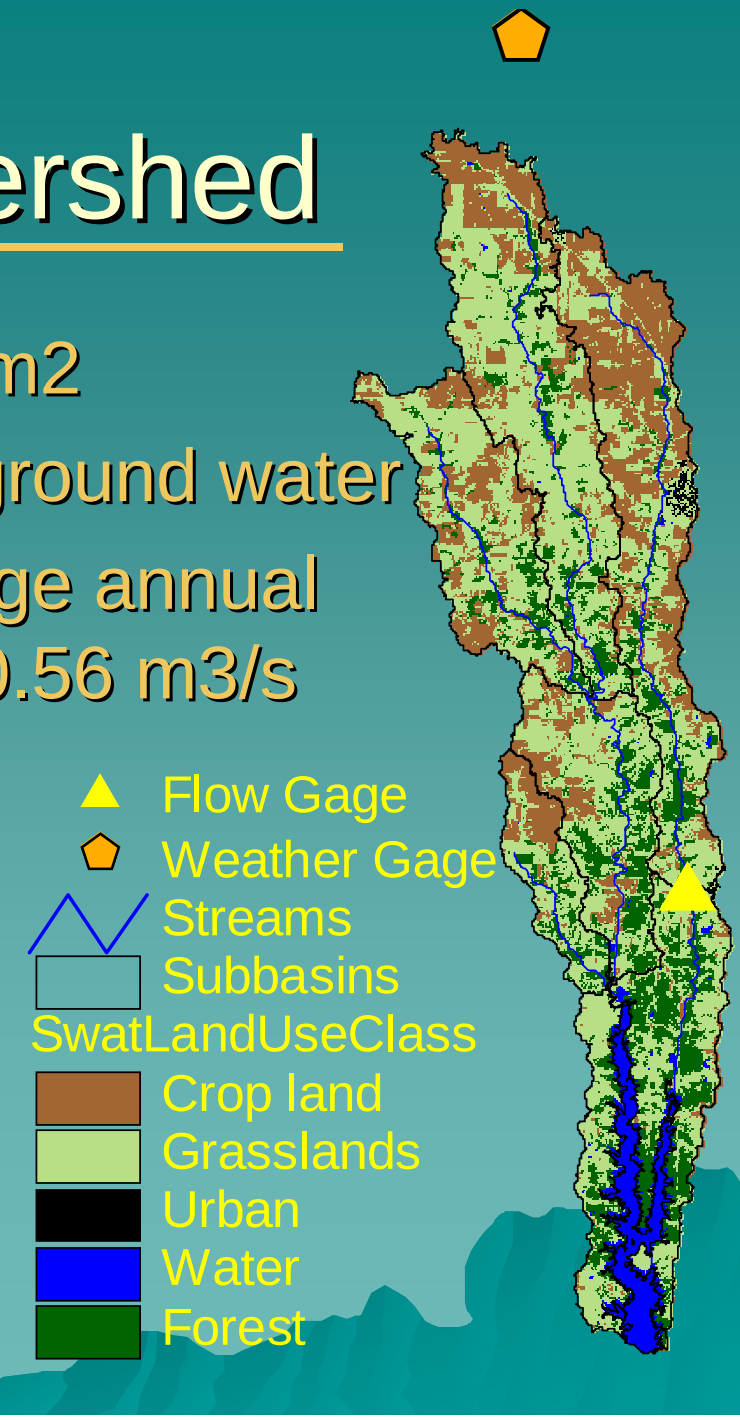
Long Branch Watershed

- Grassland 39%
- Crop land 29%
- Forest 27%

- 271 km2
- 17% ground water
- Average annual flow: 0.56 m3/s



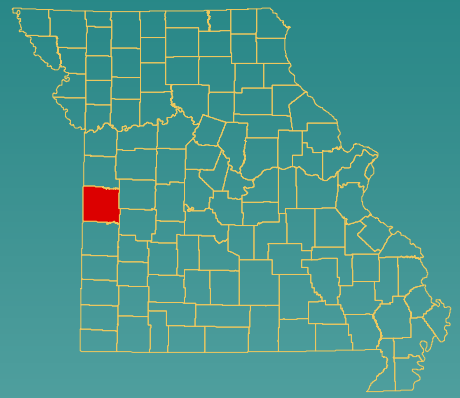


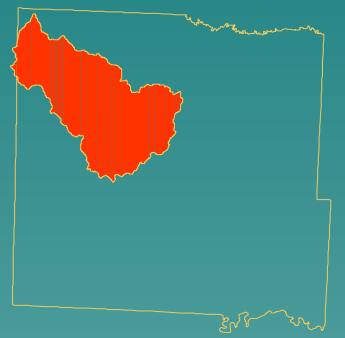


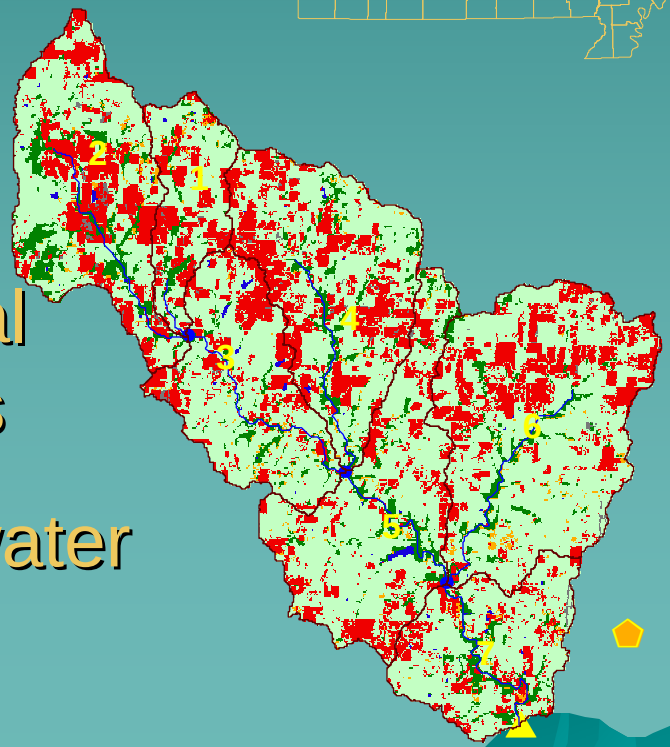
Miami Creek Watershed

- Grassland 66%
- Crop land 26%
- Forest 8%

- 350 km2
- Average annual flow: 0.90 m3/s
- 13 % ground water







Subbasins
Streams
Weagages
Outlets
Subasin outlet
Flow gage
SwatLandUseClass
Crop land
Forest
Warm grasses
Urban
Water
Pasture

Process

- Develop a model with SWAT2000 using best estimates of parameter values.
- Yield calibration based on crop yields and regional runoff values.
- Run alternatives.
- Calibrate the model with flow data.
- Run alternatives again.

Comparisons

- Compare stream loadings from the yield and flow calibrated models.
- Compare load reductions from alternative management with both models.
- Compare concentration reductions from alternative management with both models.

Data Sources

- 30 m grid Digital Elevation Map
- 30 m grid soil map
- Soil survey (SSURGO) data for soil characteristics
- 30 m grid land use map (MoRAP)
- Stakeholder information for crop rotations and crop management
- Missouri Agricultural statistics for annual county crop yields from 92 to 2000
- Regional flow data

Yield Calibration

- Curve numbers
- ESCO
- Soil characteristics (Ks, BD, AWC)
- Groundwater parameters (REVAP and GWQMIN)
- Match average crop yields
- Match average total flow estimate based on downstream flow values and watershed size

Flow Calibration

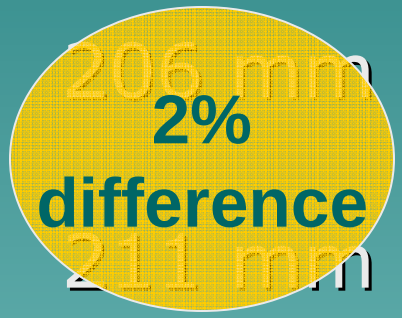
- Previous parameters
- Groundwater alpha_bf
- Groundwater delay
- Snow melt parameters
- Soil crack potential
- Surface runoff storage parameter (SURLAG)

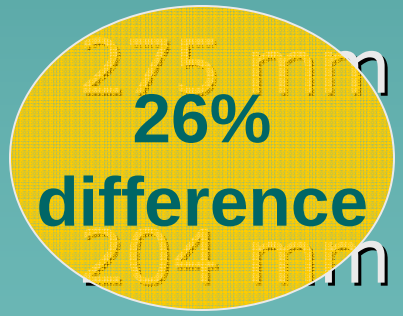
Model Fit

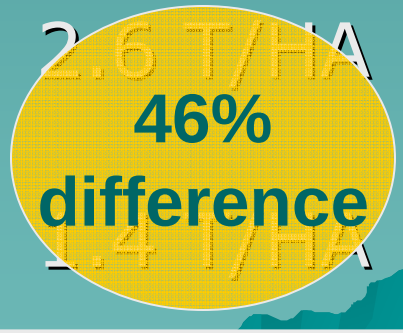
	% error surf Q	% error GW	% error total Q	Monthly Nash-Sutcliffe
Long Branch yield calibrated	-26%	65%	-7%	0.78
Long Branch flow calibrated	-8%	45%	6%	0.93
Miami yield calibrated	9%	-24%	6%	0.56
Miami flow calibrated	-4%	7 %	1%	0.62

30-year Loadings to the Stream

	Water yield	Sediment
Long Branch yield calibrated	206 mm	3.2 T/HA
Long Branch flow calibrated	211 mm	4.5 T/HA
Miami yield calibrated	275 mm	2.6 T/HA
Miami flow calibrated	204 mm	1.4 T/HA







30-year Nutrients to the Stream

	Org N KG/ha	Org P KG/ha	N SurQ KG/ha	SolP KG/ha
Long Branch yield calibrated	7.3	2.3	1.8	0.26
Long Branch flow calibrated	8.9	2.7	2.4	0.26
Miami yield calibrated	7.3	1.62	2.65	1.64
Miami flow calibrated	4.2	0.96	2.43	1.25

20% difference

35% diff.

10% diff.

40% difference

8% diff.

25% diff.

Alternative Practices

- Miami
  - No-till practices on soybeans and wheat: Tillage operations before and during soybeans and wheat growth are removed, residue cover is increased, and soil properties are left the same.
- Long Branch
  - Two-pass herbicide application: Frontier is applied at planting, and a reduced atrazine application (50%) is applied in June.

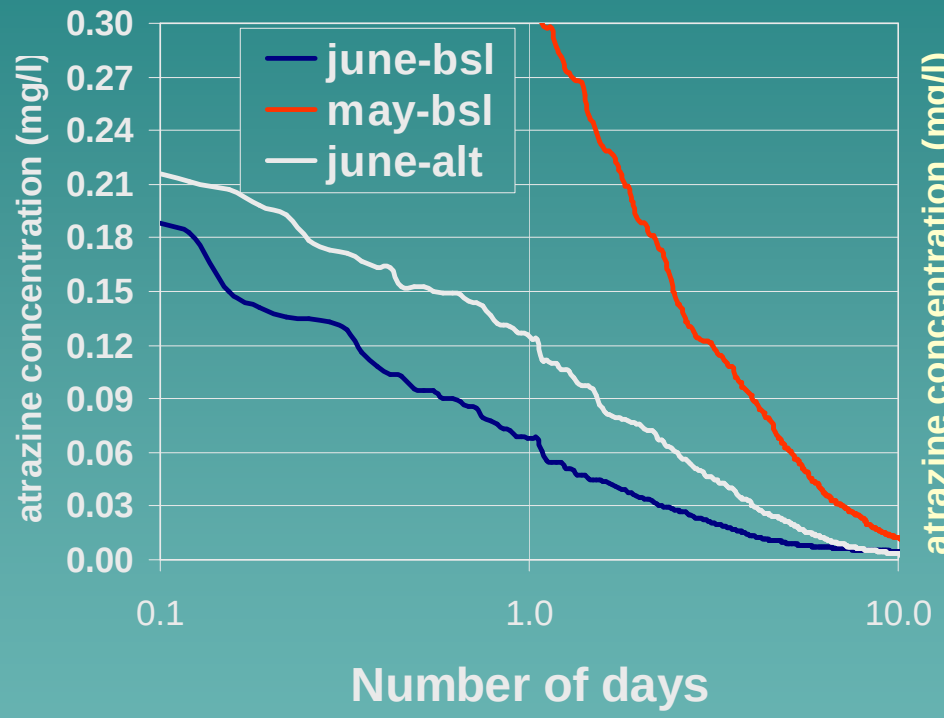
Load Reductions in Miami Creek

	Sediment (Tons)	Total N (Tons)	Total P (Tons)
Yield Calibrated Model	-16%	-7%	+12%
Flow Calibrated Model	-14%	-6%	+14%

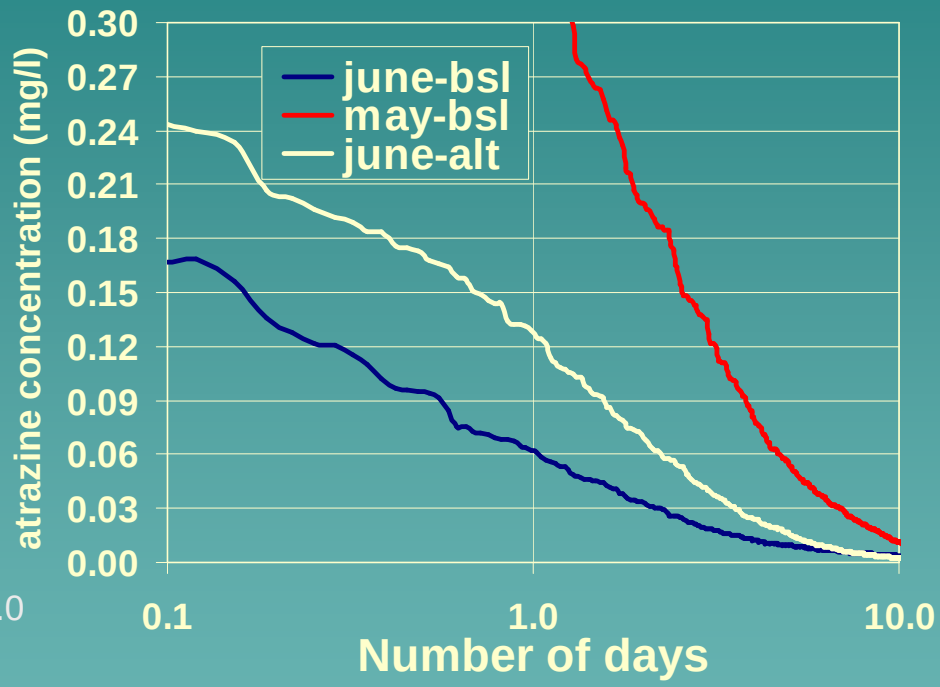
Load Reductions in Long Branch

	Runoff	Atrazine (Kg)
Yield Calibrated Model	0%	-27%
Flow Calibrated Model	0%	-45%

Concentration Reductions in Long Branch



Yield calibrated model



Flow calibrated model

Conclusions

- Absolute results are different between the yield and flow calibrated models.
- Load reductions were similar when the BMP did not introduce a timing effect.
- Load reductions were different when the practice did introduce a timing effect.
- Concentration reductions were similar.

Recommendations

- Calibrate with flow and water quality data when available.
- Based on these results, a yield calibrated model can be adequate to estimate the impact of practices that are not season related.
- In the absence of calibration data, a SWAT model may still be the best option to estimate the impact.