Meramec Watershed Modeling Effort

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Project members

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Watershed hydrology

• Temperature, precipitation, and landscape characteristics regulate the flow and quality of water in rivers and streams

• These general flow patterns regulate physical and biological processes at smaller scales
The Meramec Watershed
A hierarchical perspective on watershed processes

Watershed hydrology

Reach-level processes

Site-specific processes
Project Focus

• Develop landscape-scale hydrologic models that predict the impacts of variable land use and climate on water quantity and water quality

  – Soil Water Assessment Tool (SWAT)

  – MIKE-SHE/MIKE-11
The Meramec Watershed
Changes driving hydrologic processes

Climate Change

Land Use Change

Change in Hydrologic Response and Water Quality

precipitation

root-zone

overland flow

infiltration

percolation

groundwater

Climate Change

infiltration

percolation

interflow

baseflow

runoff

very low flow

flooding
Effects of urbanization

- Increase peak runoff
- Increase rate to peak
- Decrease baseflow
- Increase in water demand
Big River Watershed
Hydrologic model - MIKE-SHE

• Deterministic, physically based, distributed watershed model

• Simulates the major processes (and their interactions) in the hydrologic cycle
MIKE-SHE validation at Brynesville (2005-2011)

Chu et al. (2013) *Journal of Hydrology*

Nash-Sutcliffe: = 0.82

R² = 0.82
(a) 2006: 6%
(b) 1x: 17%
(c) 2x: 24%
(d) 3x: 31%
(e) 4x: 38%
(f) 5x: 44%

Legend
- water
- urban
- bare
- forest
- agriculture

Chu et al. (2013) *Journal of Hydrology*
Changes in fish species richness due to urbanization

Knouft and Chu (2015) *Ecohydrology*
A dual model approach

• Soil Water Assessment Tool (SWAT)
  – Conceptual model focused on agriculture and land management

• MIKE-SHE
  – Deterministic, physically based, distributed watershed model
  – Scalable research objectives
Why use two watershed hydrologic models?

• Data inputs are similar, so both models can be developed simultaneously

• SWAT is well-suited to agricultural simulations

• MIKE-SHE provides the ability to scale down to reach and site level predictions of management and remediation activities
What can these models provide?

- Watershed scale
  - Flow, sediment, nitrogen, phosphorus, contaminants, water temperature
  - Climate change and land use change scenarios
  - Agricultural management
  - Habitat data for ecological models
  - Provide boundary conditions for reach-scale models
Extending the MIKE-SHE model

• Reach-scale and site specific studies require boundary condition inputs

• River modeling (MIKE11)
  – flooding, water quality, forecasting, sediment transport
What can these models provide?

- Site specific scale (MIKE)
  - Results of local management practices (e.g., sediment)
  - Hydraulics (MIKE21C)
  - Habitat data for ecological models
Extending the MIKE-SHE model

• River hydraulics and morphology (MIKE21C)
  – Simulated processes include bank erosion, scouring and sediment transport
Deliverables

• SWAT and MIKE-SHE hydrologic models for the Meramec River Basin with monthly mean outputs from 1980-2014

• Provide estimates of Total Suspended Solids (TSS), Nitrogen (N), Phosphorus (P), and Temperature (T), generated from each HUC-12/subwatershed unit (Keifer Creek).

• Produce model outputs (streamflow, TSS, N, P, T) that reflect HUC-12 environmental responses and economic (costs per practices) outcomes to various conservation actions throughout the watershed.
The Meramec Watershed
Questions?