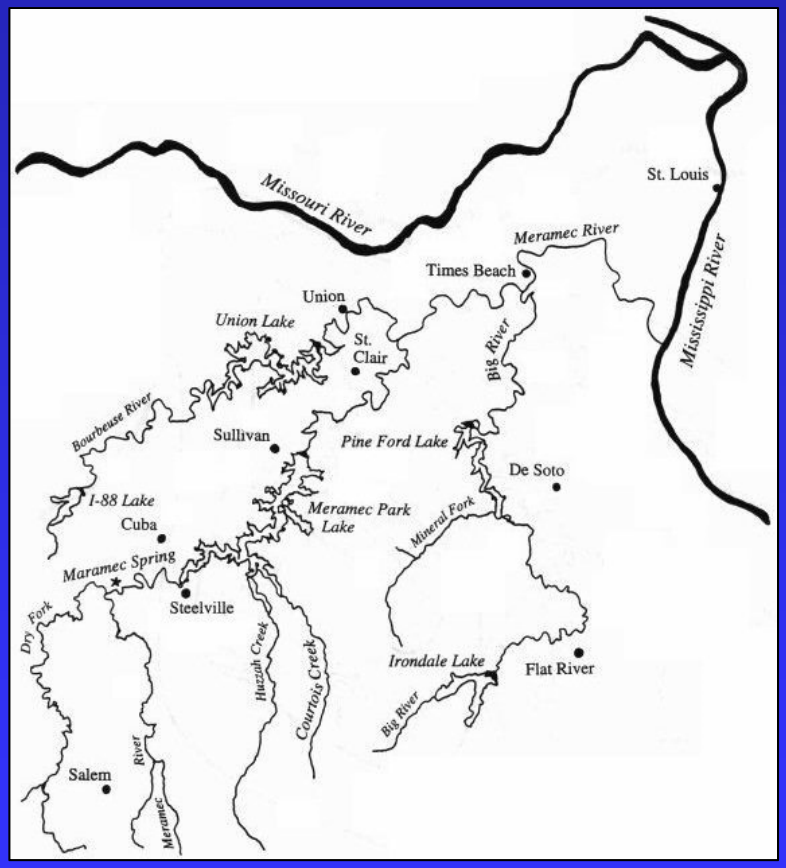
Meramec Watershed Modeling Effort



Jason Knouft

Department of Biology and Center for Sustainability, Saint Louis University

Project members

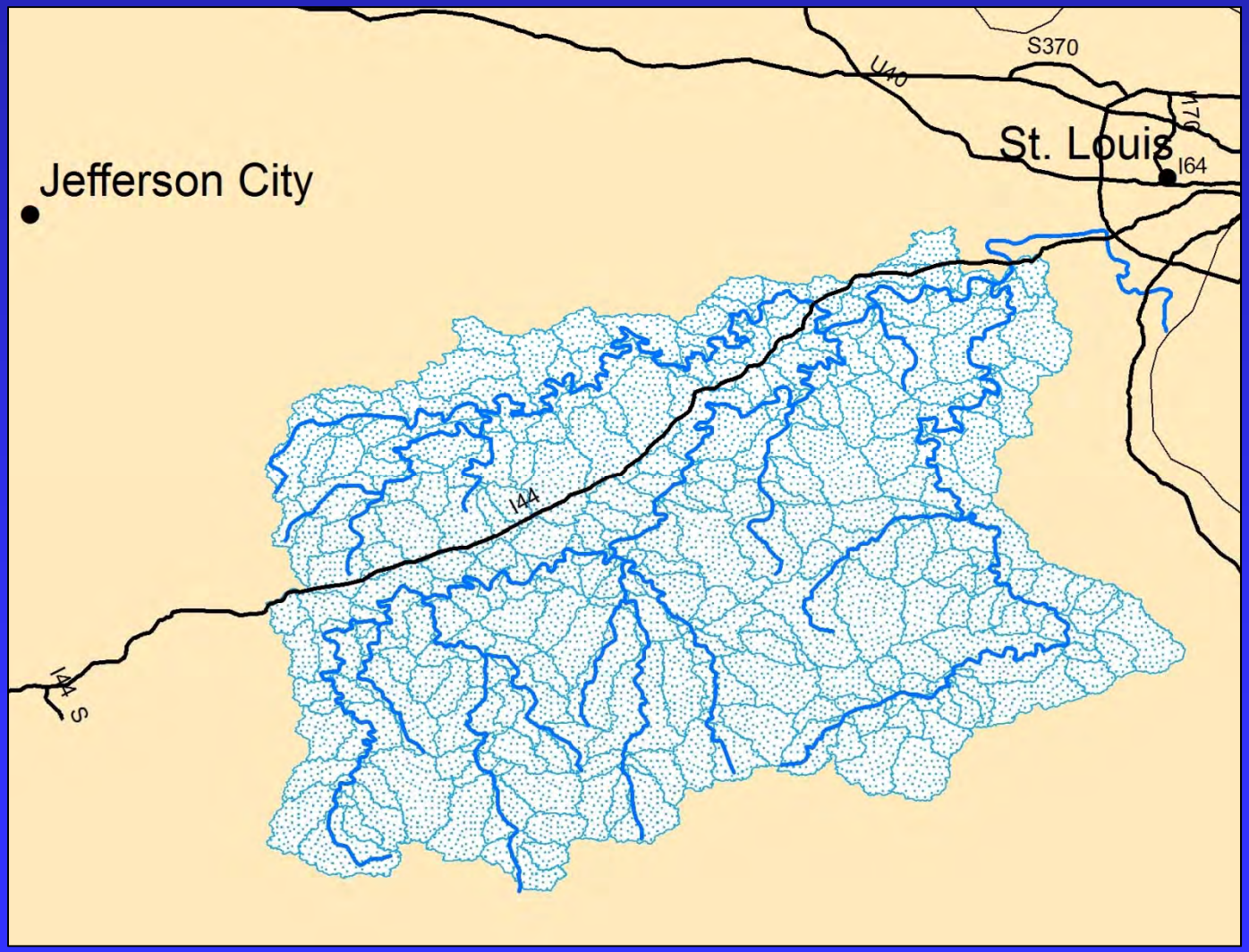
- Saint Louis University
  - Dr. Jason Knouft
  - Dr. Wasit Wulamu
  - Dr. Vincent Wu
- University of Illinois, Urbana-Champaign
  - Dr. Maria Chu

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

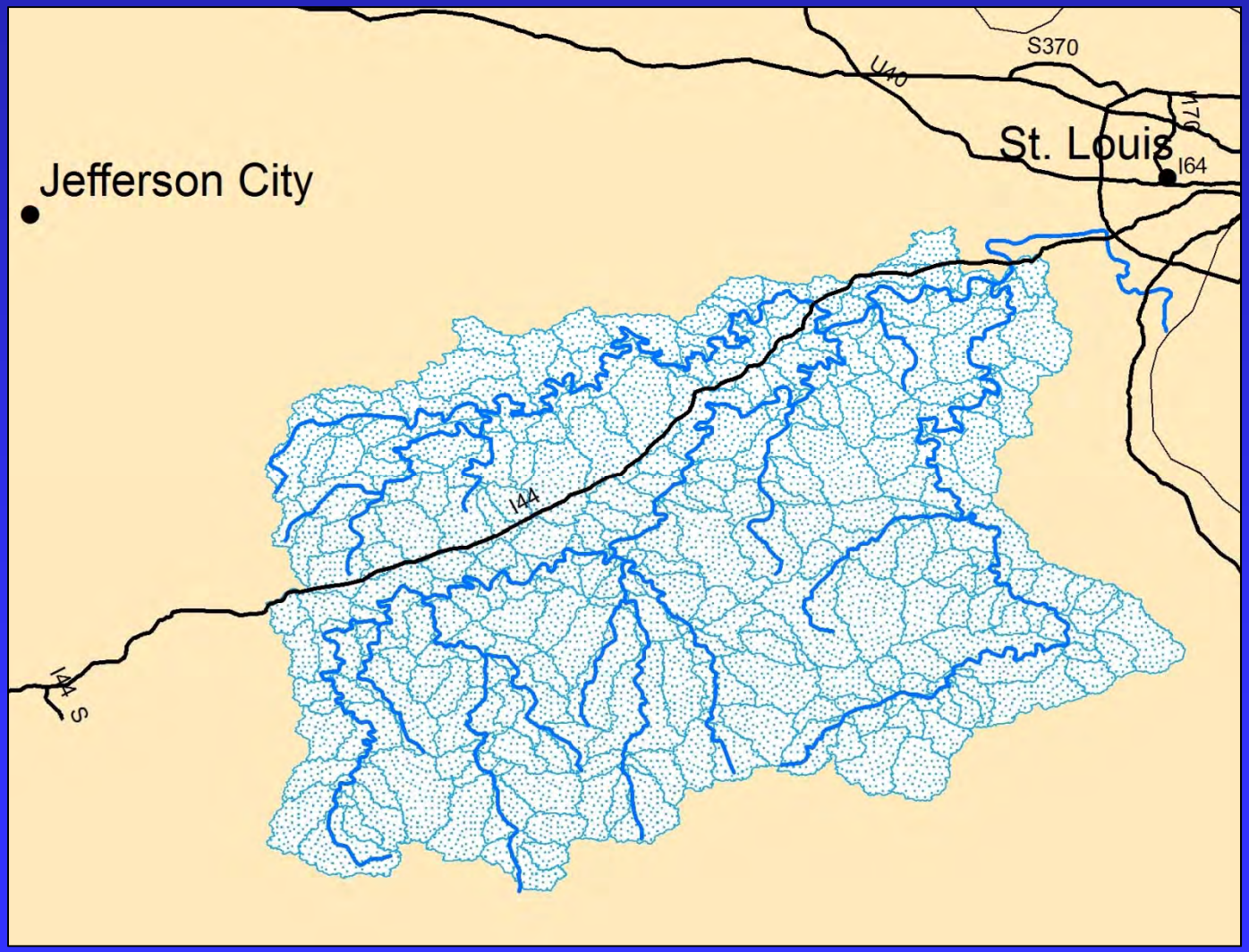
↓ ↓

Site-specific processes

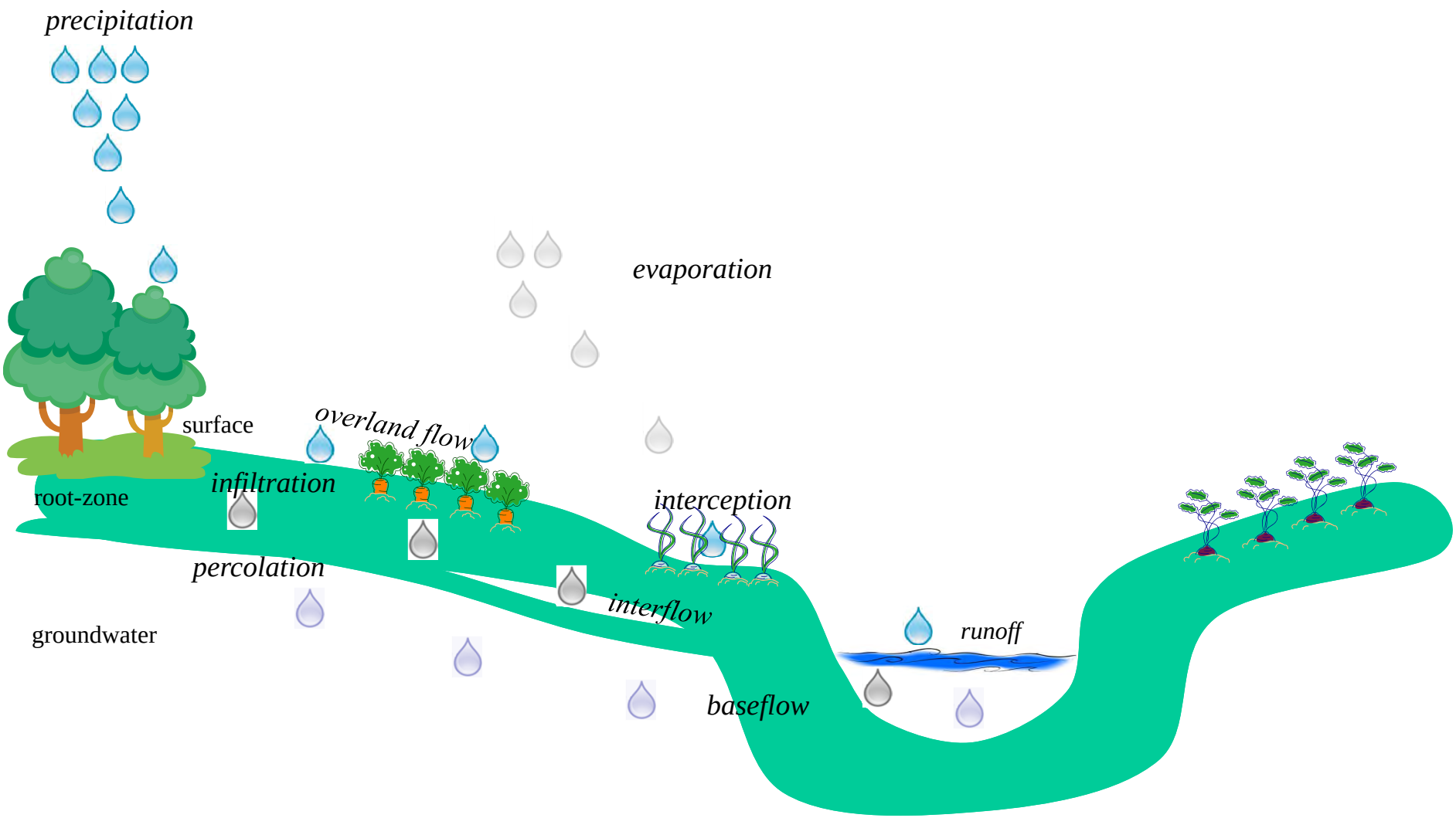
Project Focus

- 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

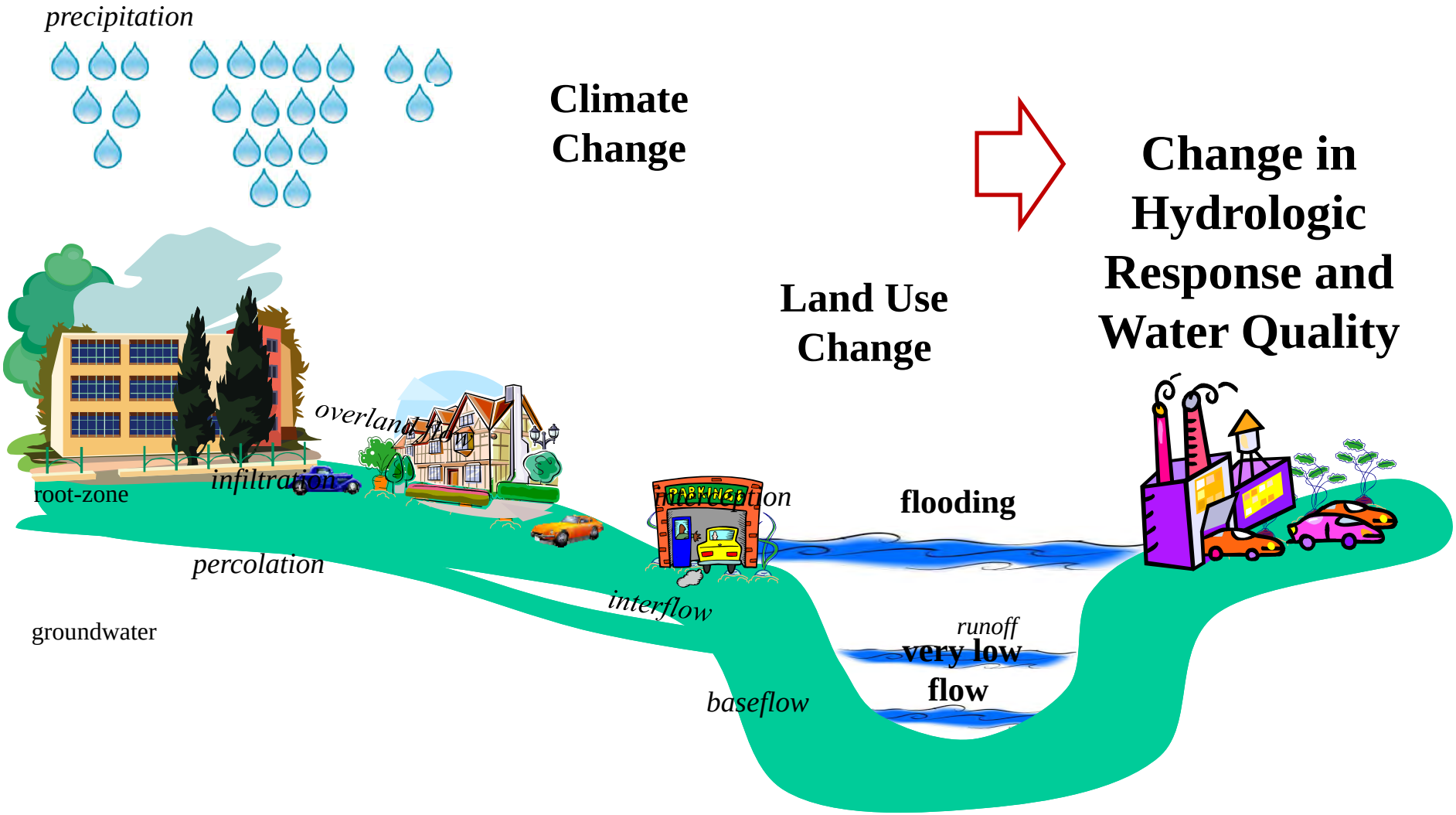
The Meramec Watershed



Hydrologic processes

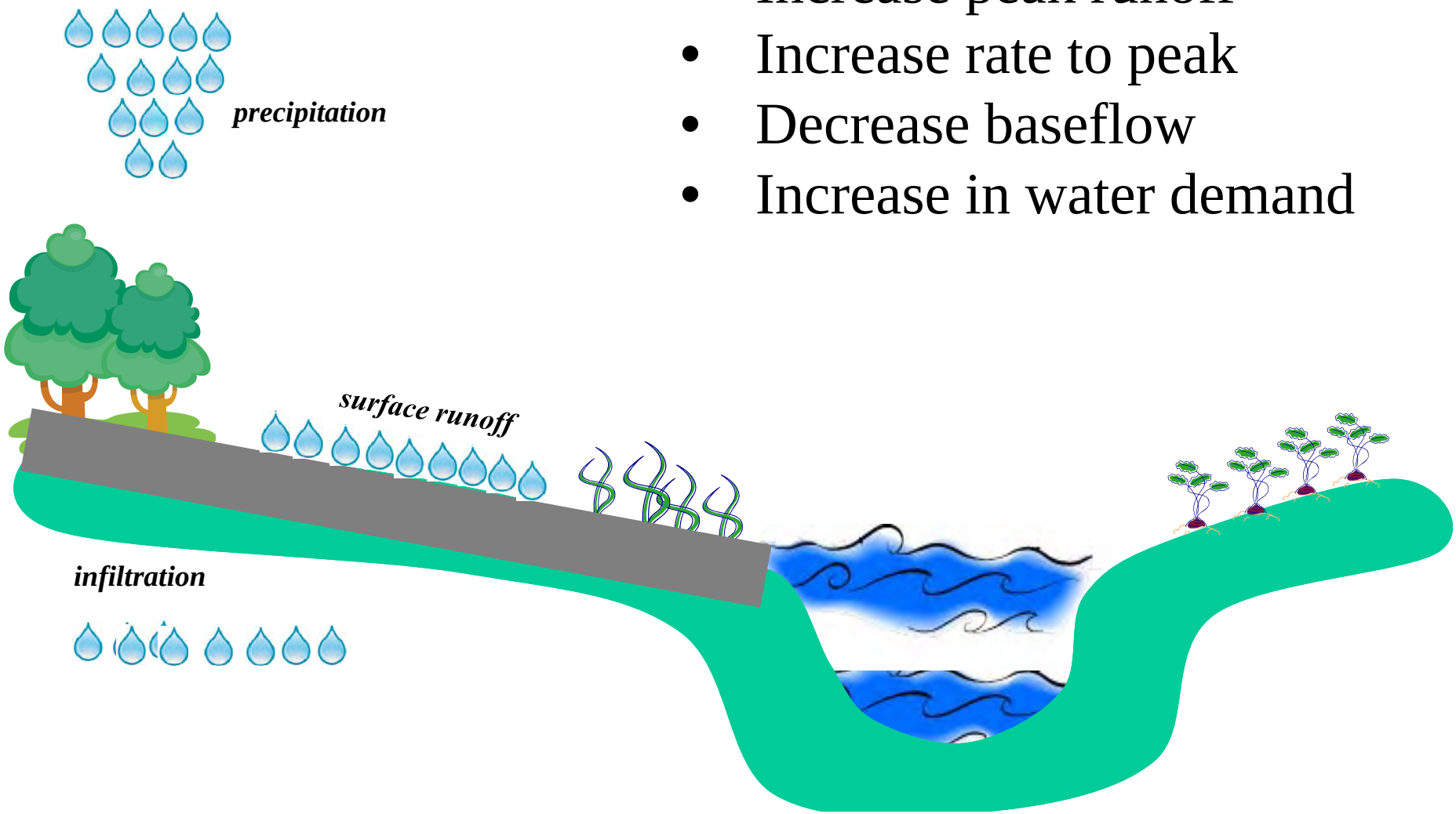


Changes driving hydrologic processes



Effects of urbanization

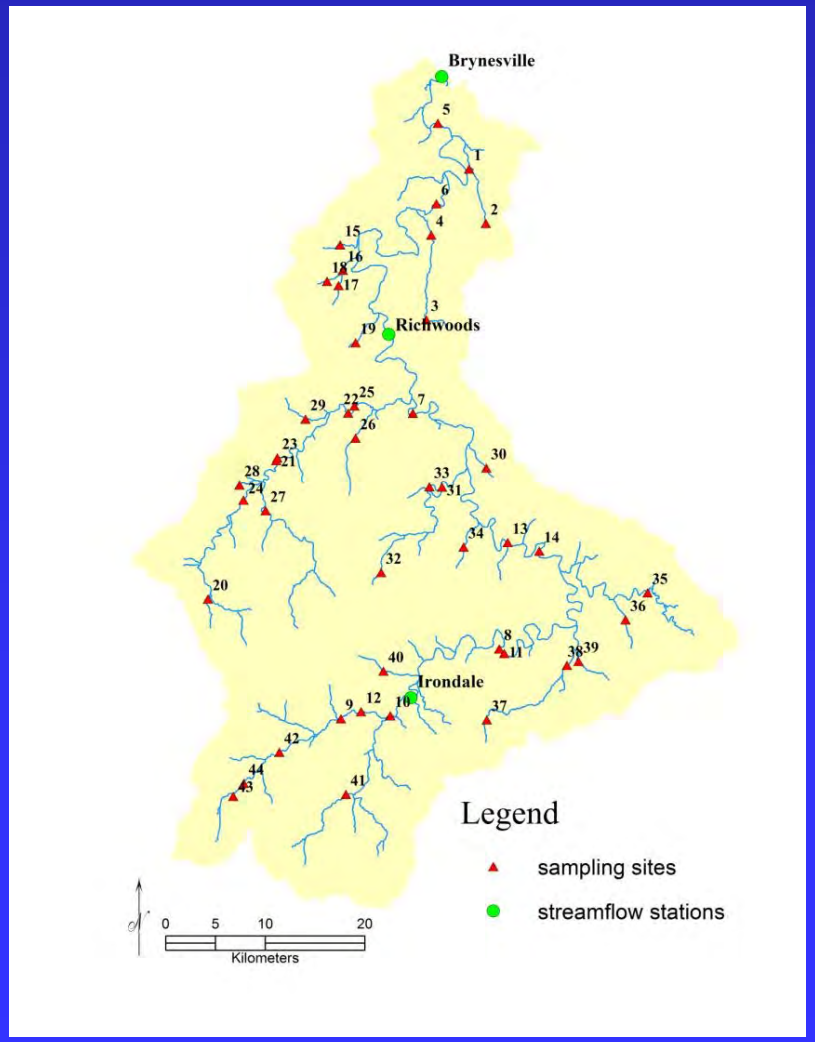
- Increase peak runoff
- Increase rate to peak
- Decrease baseflow
- Increase in water demand



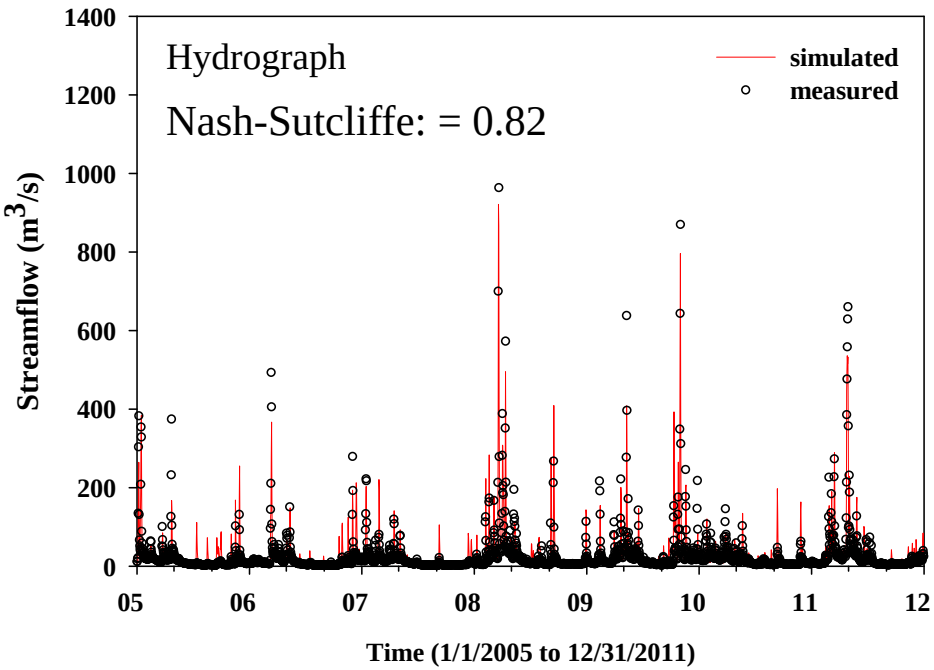
Big River Watershed
Hydrologic model - MIKE-SHE

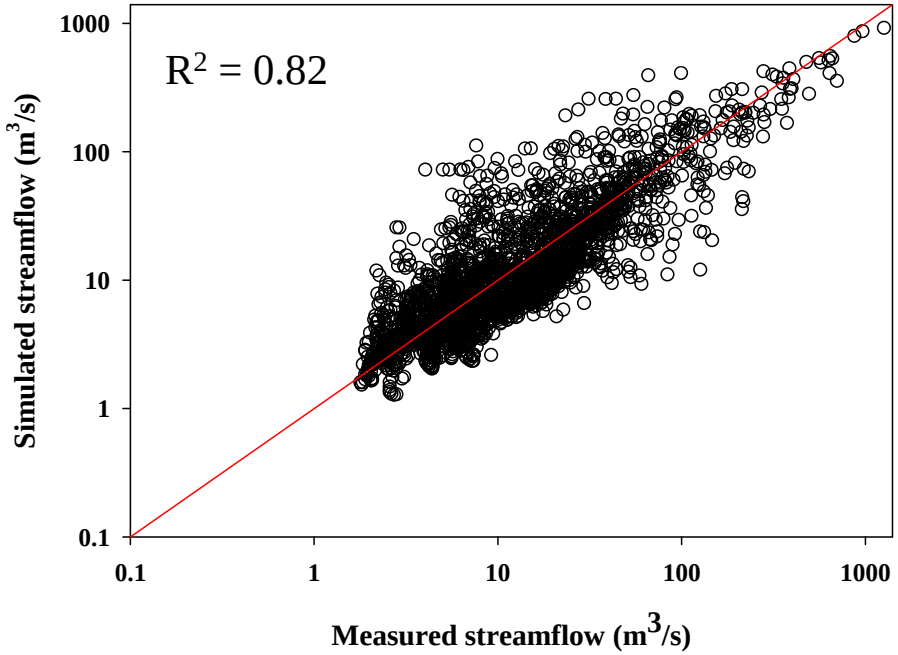
- Deterministic, physically based, distributed watershed model

- Simulates the major processes (and their interactions) in the hydrologic cycle

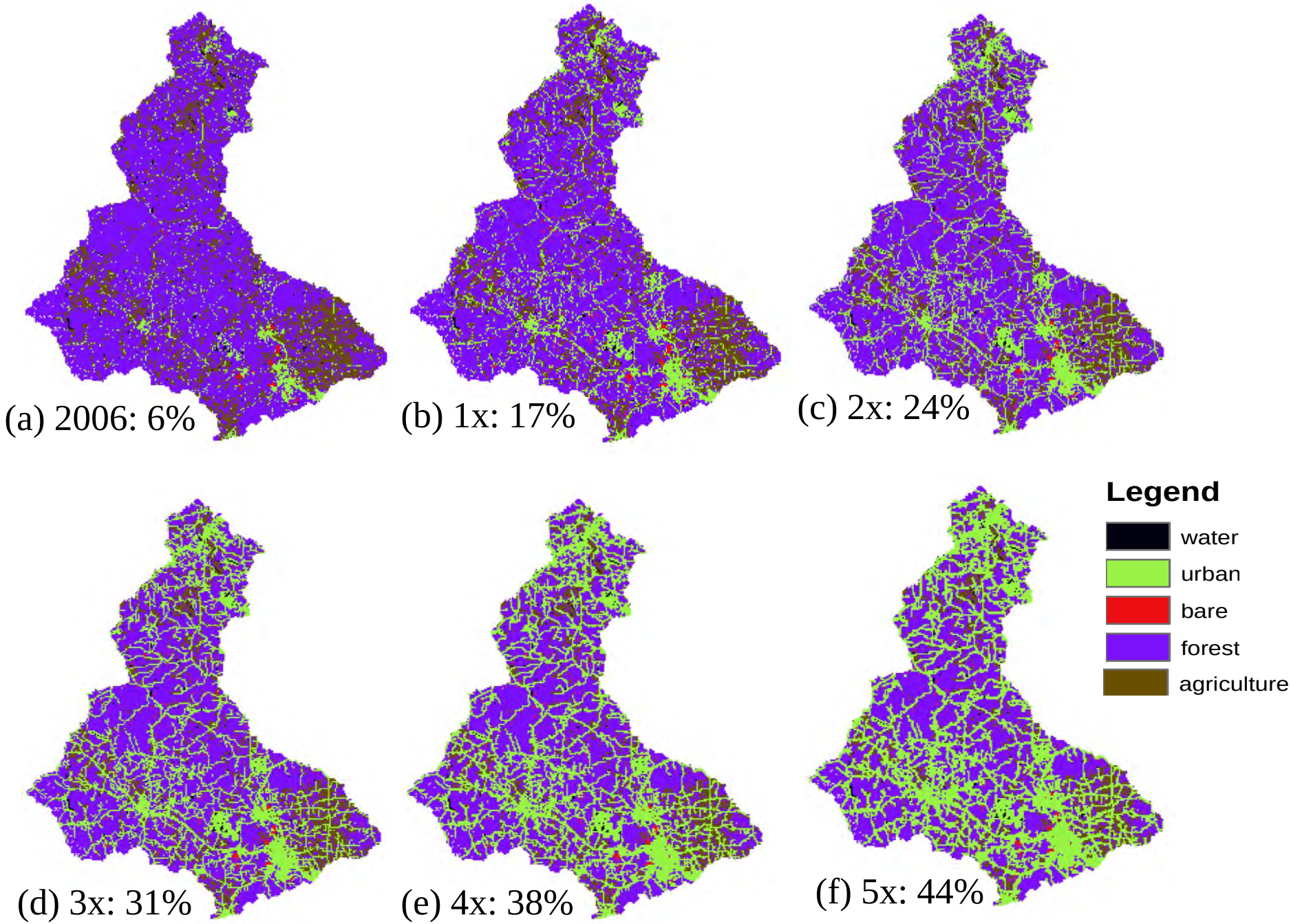


MIKE-SHE validation at Brynesville (2005-2011)

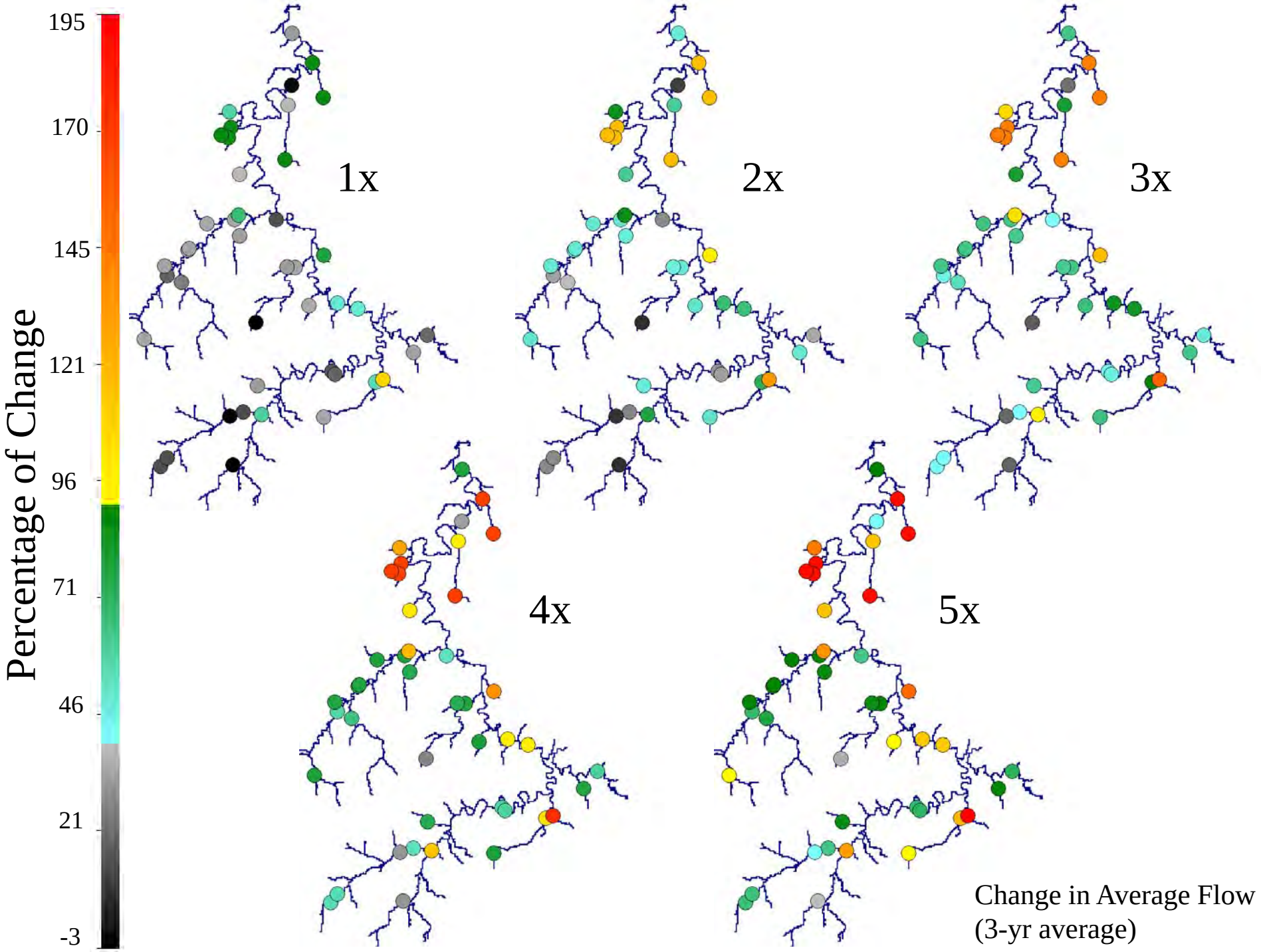




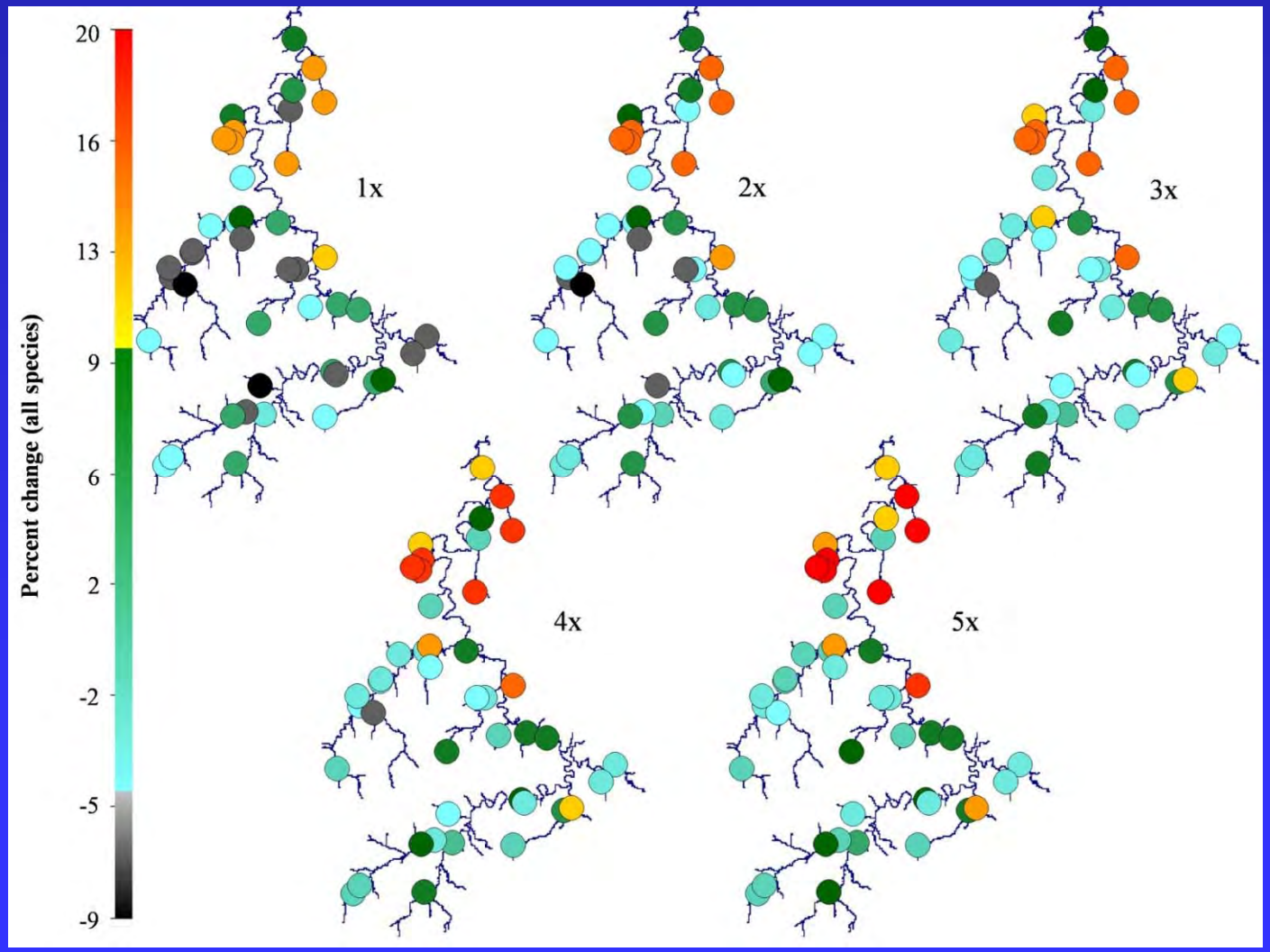
Chu et al. (2013) *Journal of Hydrology*



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


Percentage of Change
195
170
145
121
96
71
46
21
-3
1x
2x
3x
4x
5x
Change in Average Flow
(3-yr average)

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

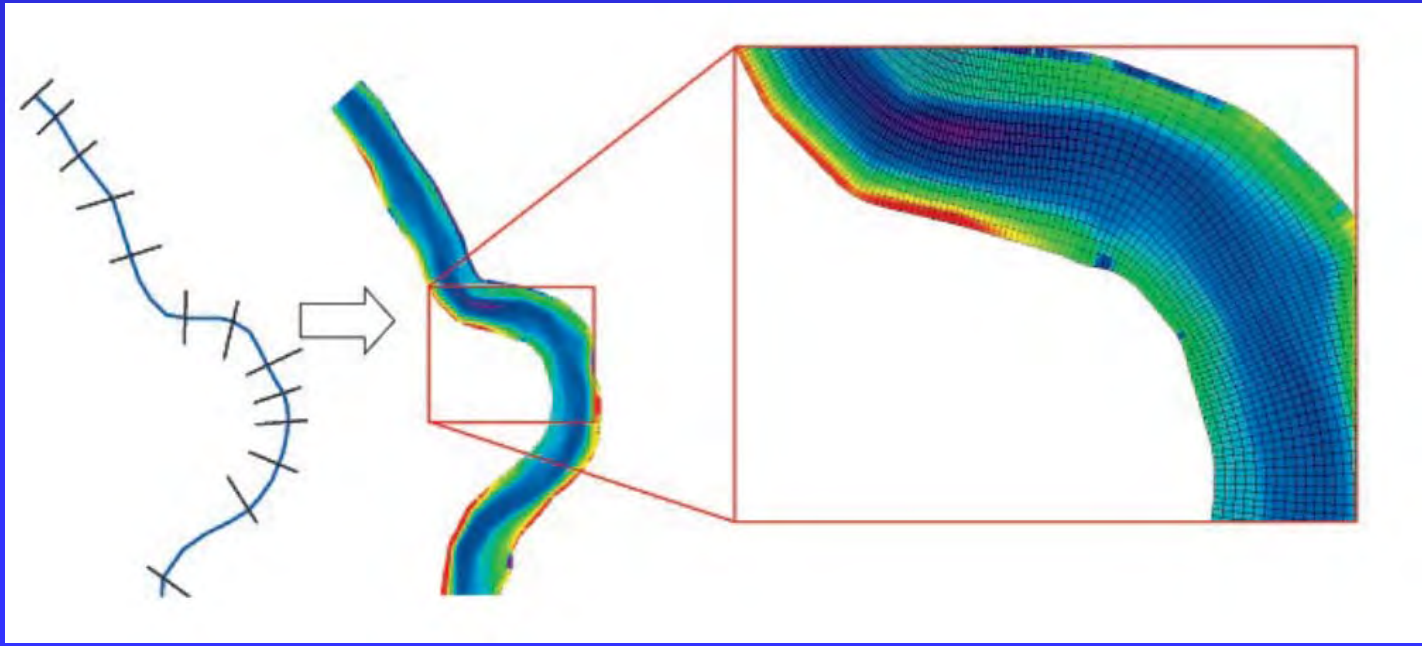
- Reach-scale and site specific studies require boundary condition inputs
- River modeling (MIKE11)
  - flooding, water quality, forecasting, sediment transport

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

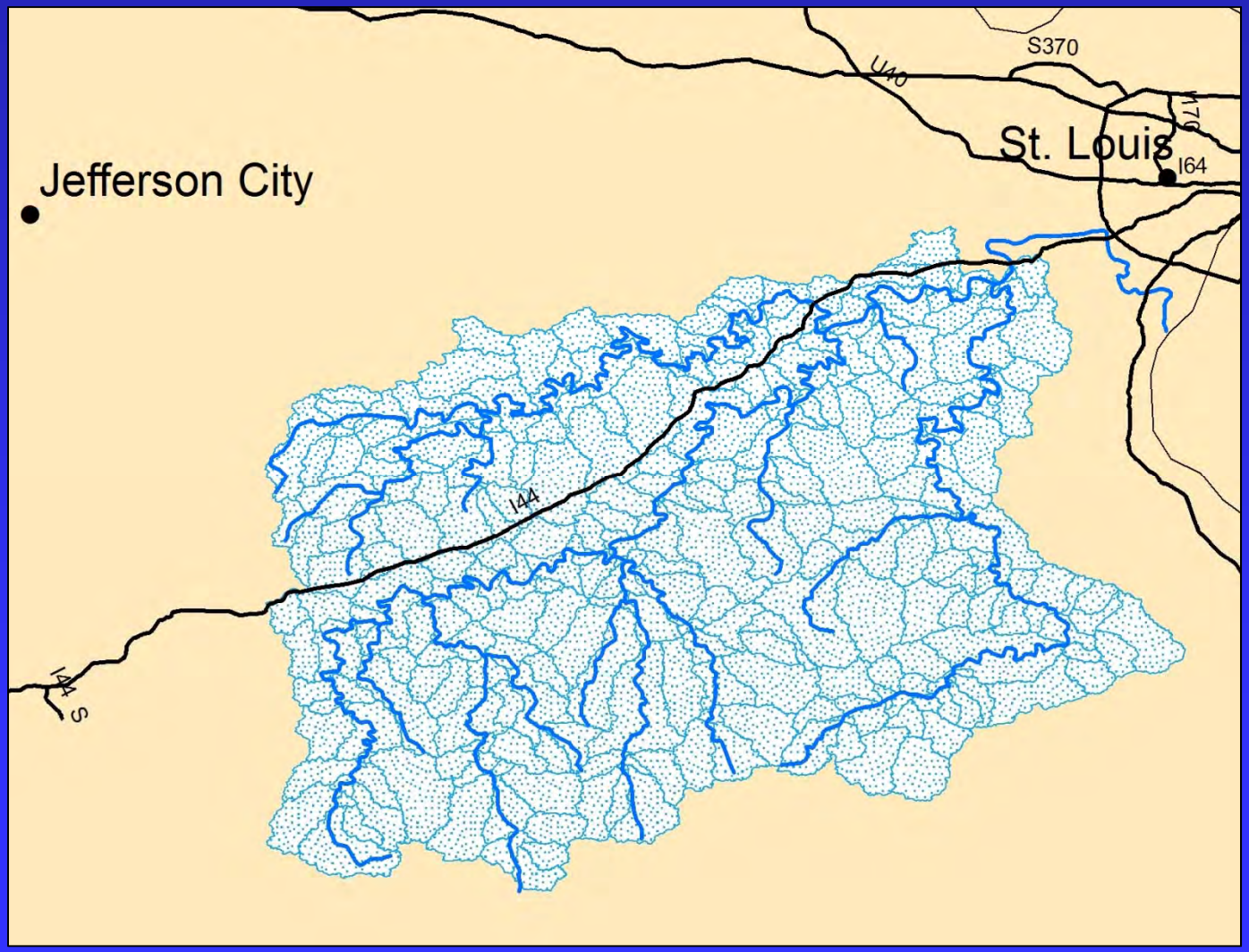
- River hydraulics and morphology (MIKE21C)
  - Simulated processes include bank erosion, scouring and sediment transport



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?