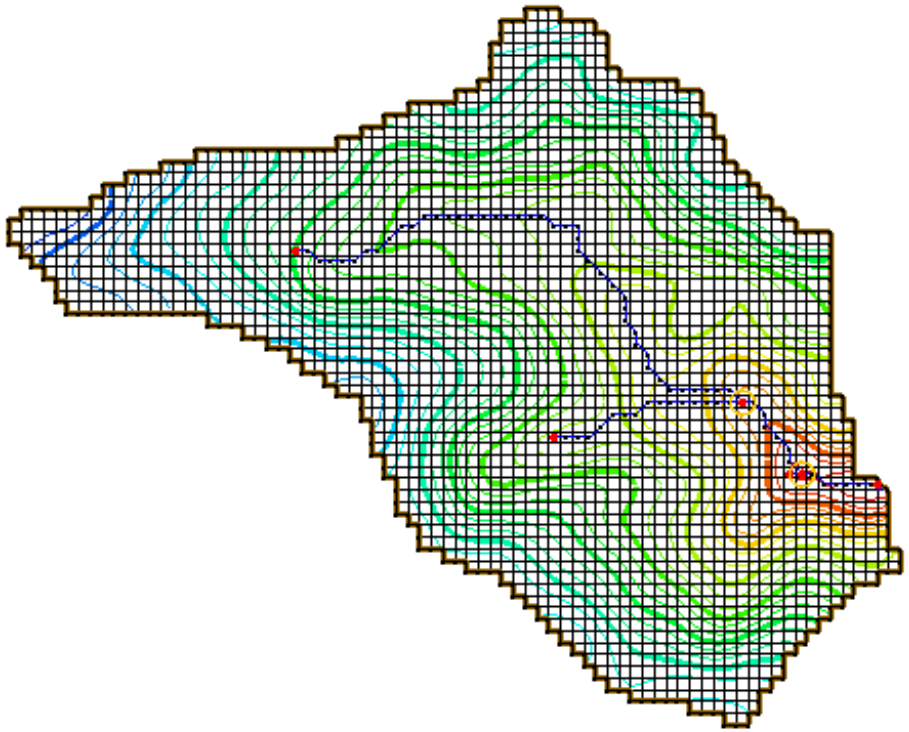
Gridded Surface Subsurface Hydrologic Analysis

Overview

What is GSSHA?

- GSSHA is a complete watershed simulation and management model used for hydrologic, hydraulic, sediment and quality simulation and management.
- GSSHA is a fully distributed, physics based model that utilizes a grid to represent the watershed.
- GSSHA is a product of the US Army ERDC
  - Maintained
  - Supported
  - Distributed
- GSSHA is a direct descendent of the surface water hydrologic model CASC2D developed at Colorado State University.
- The original version of GSSHA is the result of Chuck's dissertation work at University of Connecticut.

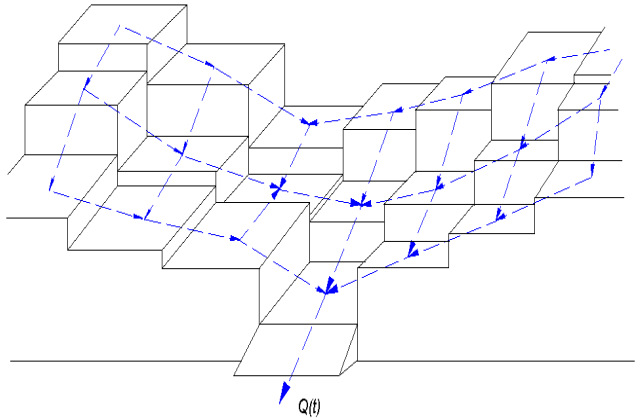


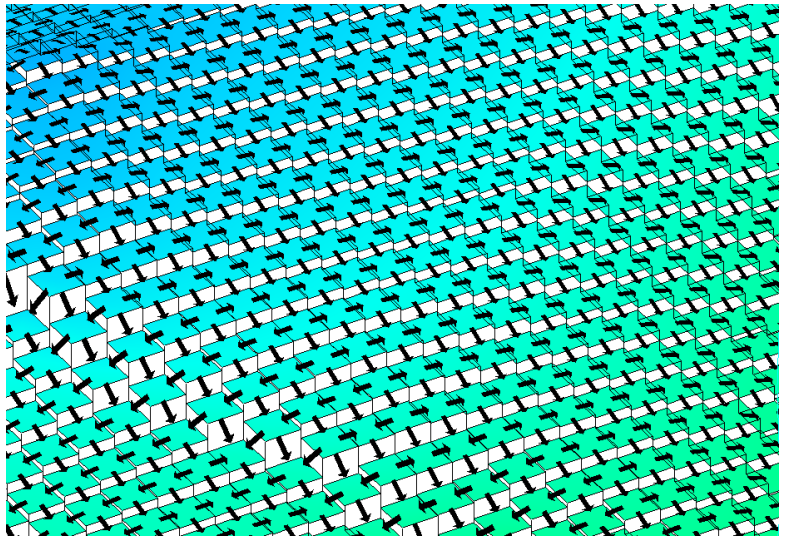
Downer, C. W. *Identification and Modeling of Important Stream Flow Producing Processes in Watersheds,* PhD Dissertation, University of Connecticut, 2002.

How does GSSHA Work?

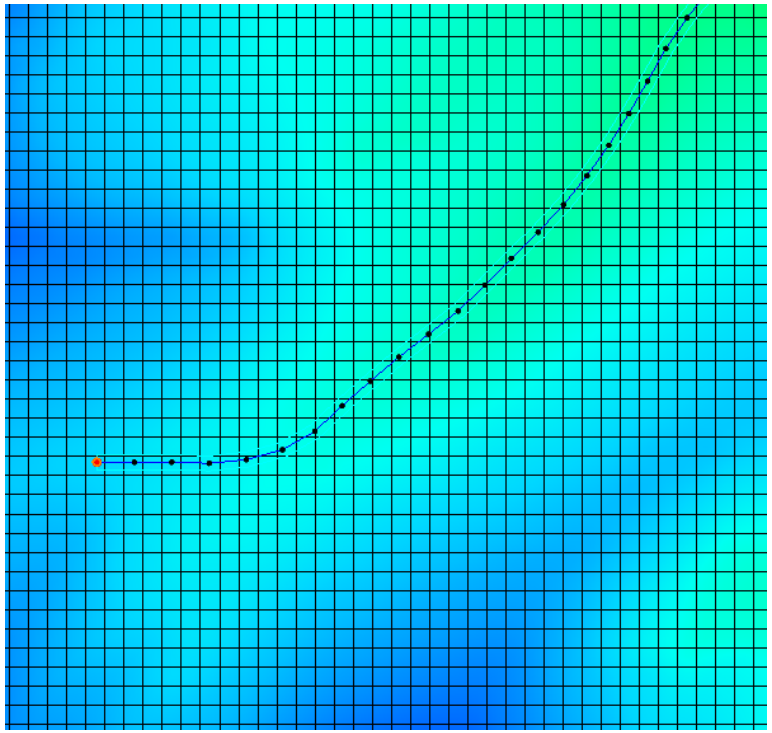
- GSSHA works on a uniform spatial grid.
- Basic equations of mass, energy, and momentum conservation are solved with finite volume and finite difference techniques.
- Point processes are solved at the grid level.
- Point responses are integrated to get the system response.

Cascading planes in two dimensions – CASC2D



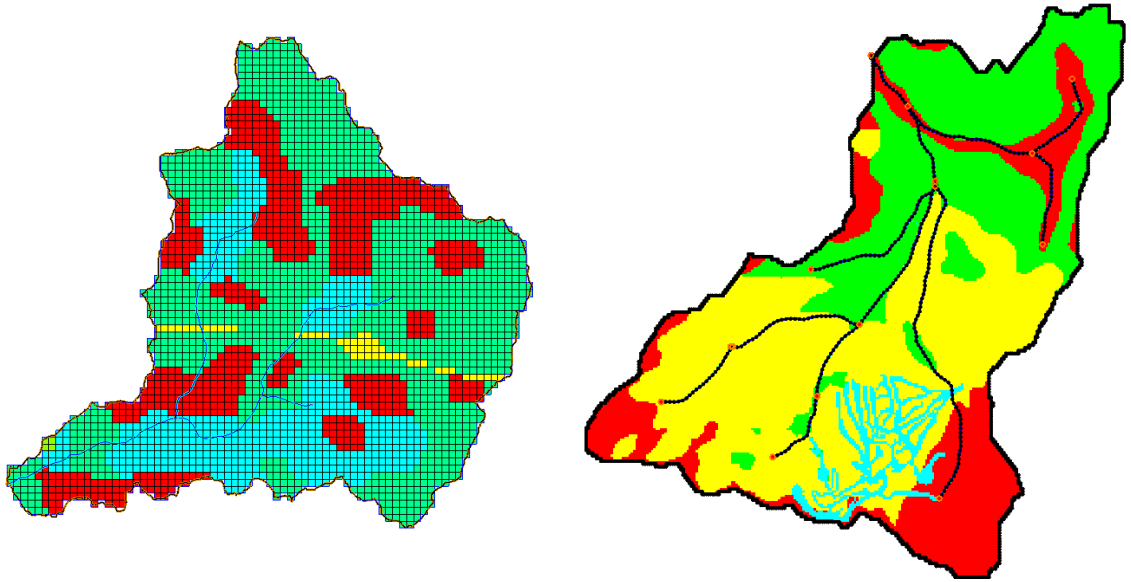


Computational Grid



Why Does This Matter?

- Spatial variability.
- Physically based parameters.

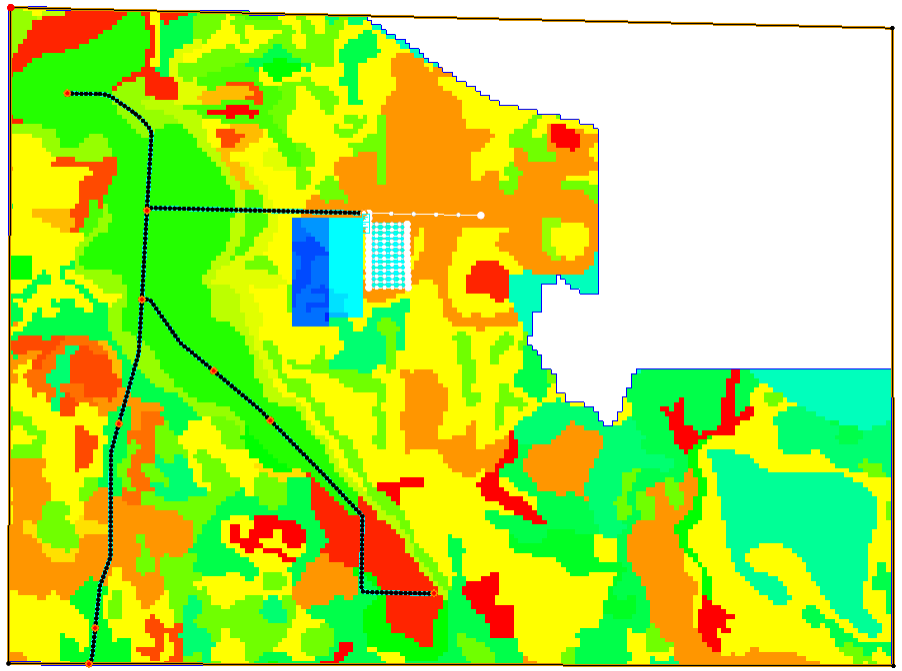


More Accurate Model Results

Allows for better representation of future alternatives

Spatial Variability

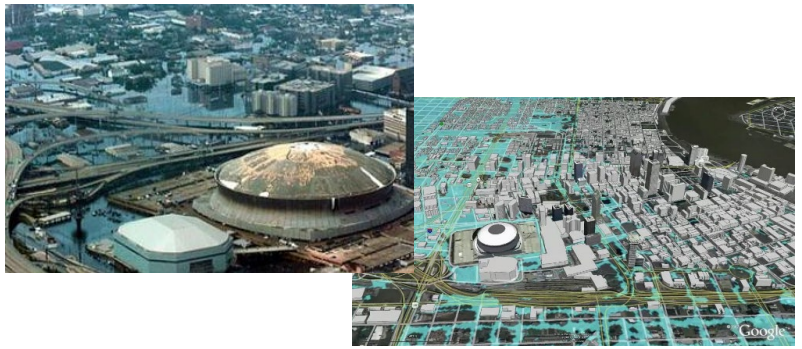
- Explicitly include spatially heterogeneous features, such as varying land use, source areas, BMPs, etc.



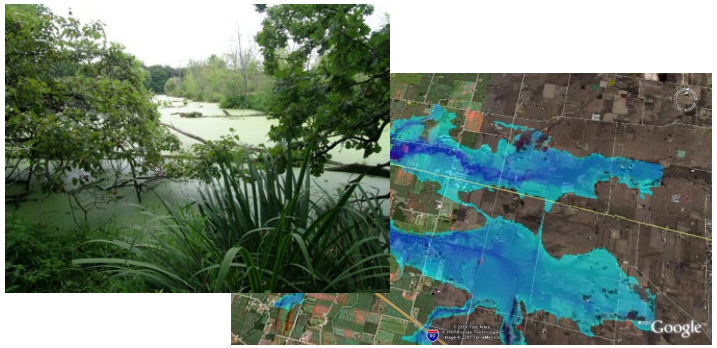
Physically Based Parameters

- Values are based on physical conditions in the computational element.
  - requires less calibration data
  - extendible beyond calibration range
- The tie to physical conditions provides a means to logically alter parameters based on changing conditions.
  - land use changes
  - project alternatives
  - climate change

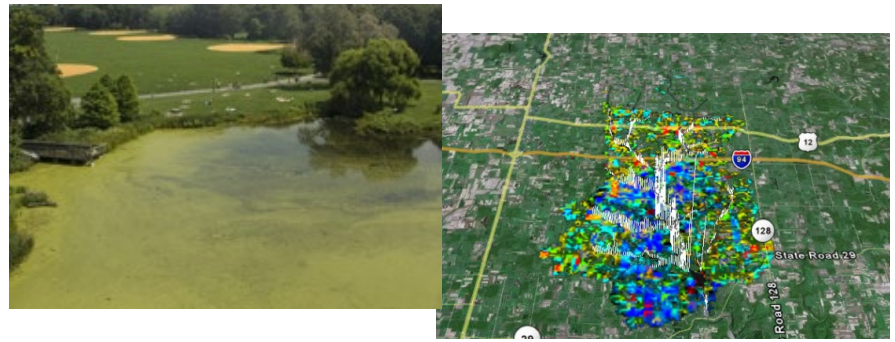
What GSSHA Can Do?



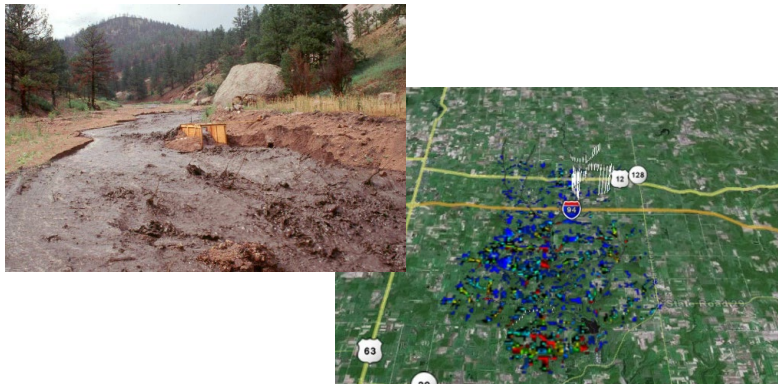
Surface water hydrology



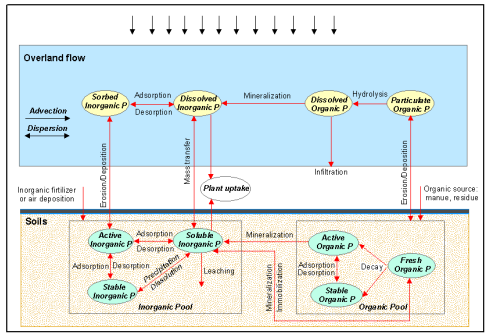
Surface Water/Groundwater Interaction



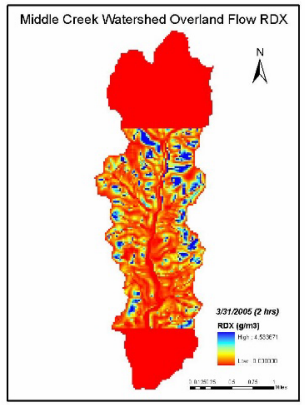
Surface water quality and TMDL's



Sediment Management



Contaminant fate/transport in surface water and groundwater and related health risk assessment



Watershed Modeling and Management

GSSHA Capabilities

Why use GSSHA?

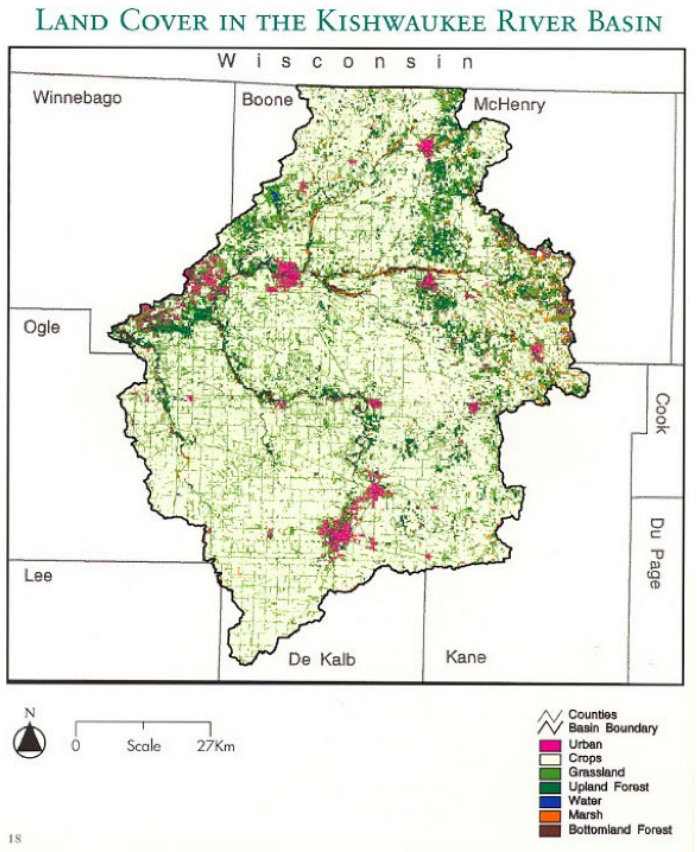
- Model floods, water balance, and ecological flows
  - Flexible processes selection tailored to watershed and project characteristics
- Integrated Process Modeling
  - Changes in one process affect other processes
  - Coupled groundwater, soil moisture, stream, and overland flow models
- Spatially explicit formulation: can evaluate impacts of *where* changes occur
  - Location of wetlands addition
  - Location of land use change
- Physical Process-driven model: can simulate fundamental changes in processes such as
  - tile drain removal,
  - addition of wetlands, and
  - changes in land use

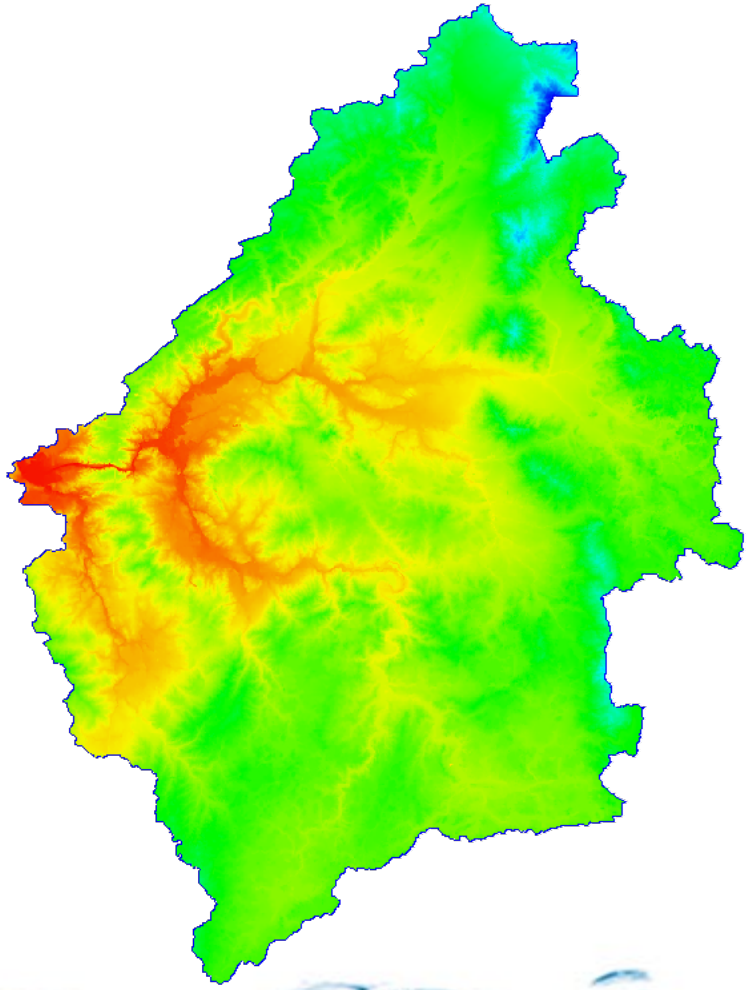
Allows for more accurate and scientifically defendable model predictions due to changes in landuse, soil amendments, terrain, best management practices, and forcing functions!

Why use GSSHA?
Modeling changes in physical processes

- Converting from tile drained fields to wetlands is a change in the fundamental runoff mechanisms
- GSSHA simulates the actual runoff processes in their spatial context
- By simulating the physical processes we are able to model changes to the watershed that include
  - Precipitation events outside the calibration range
  - Changes in fundamental runoff generation mechanisms
  - Changes in runoff transport mechanisms
  - Resulting impacts to nutrient and sediment production and transport

Urbanization and Wetlands Creation in the Kishwaukee Watershed

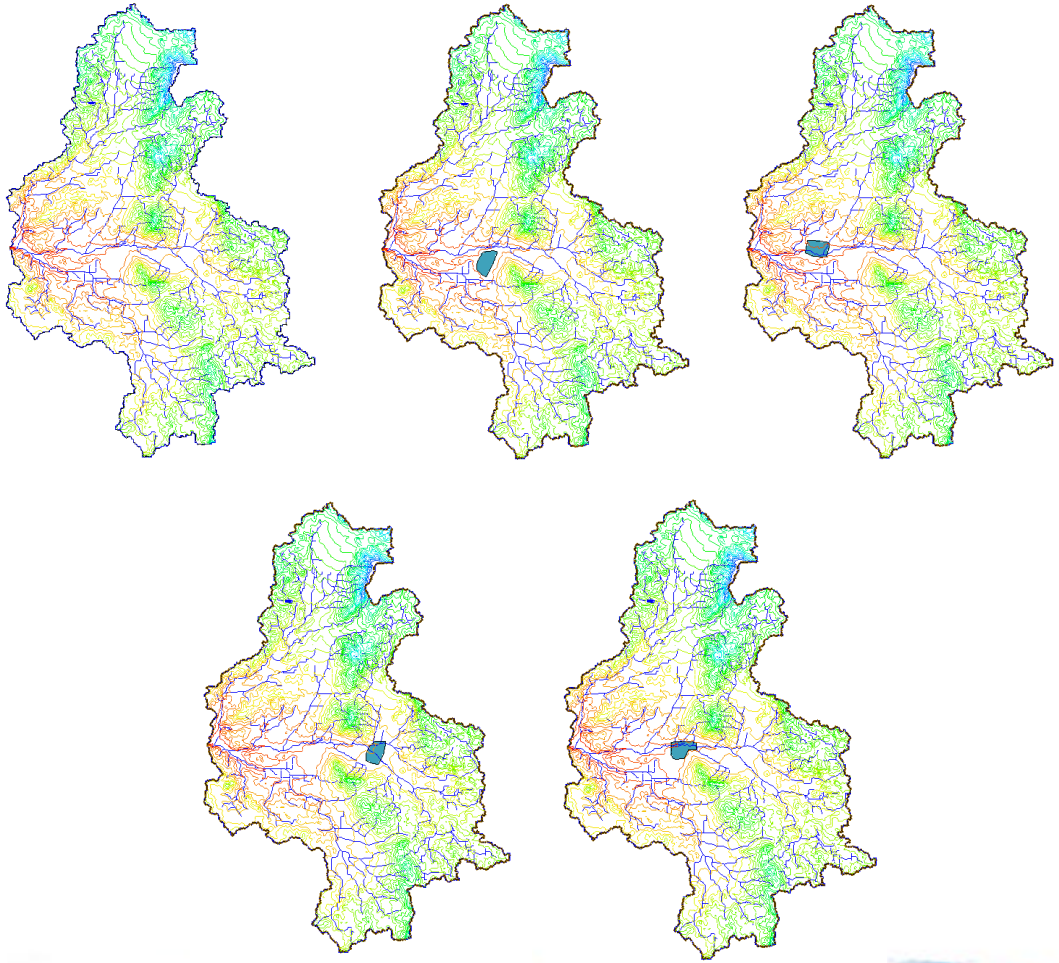




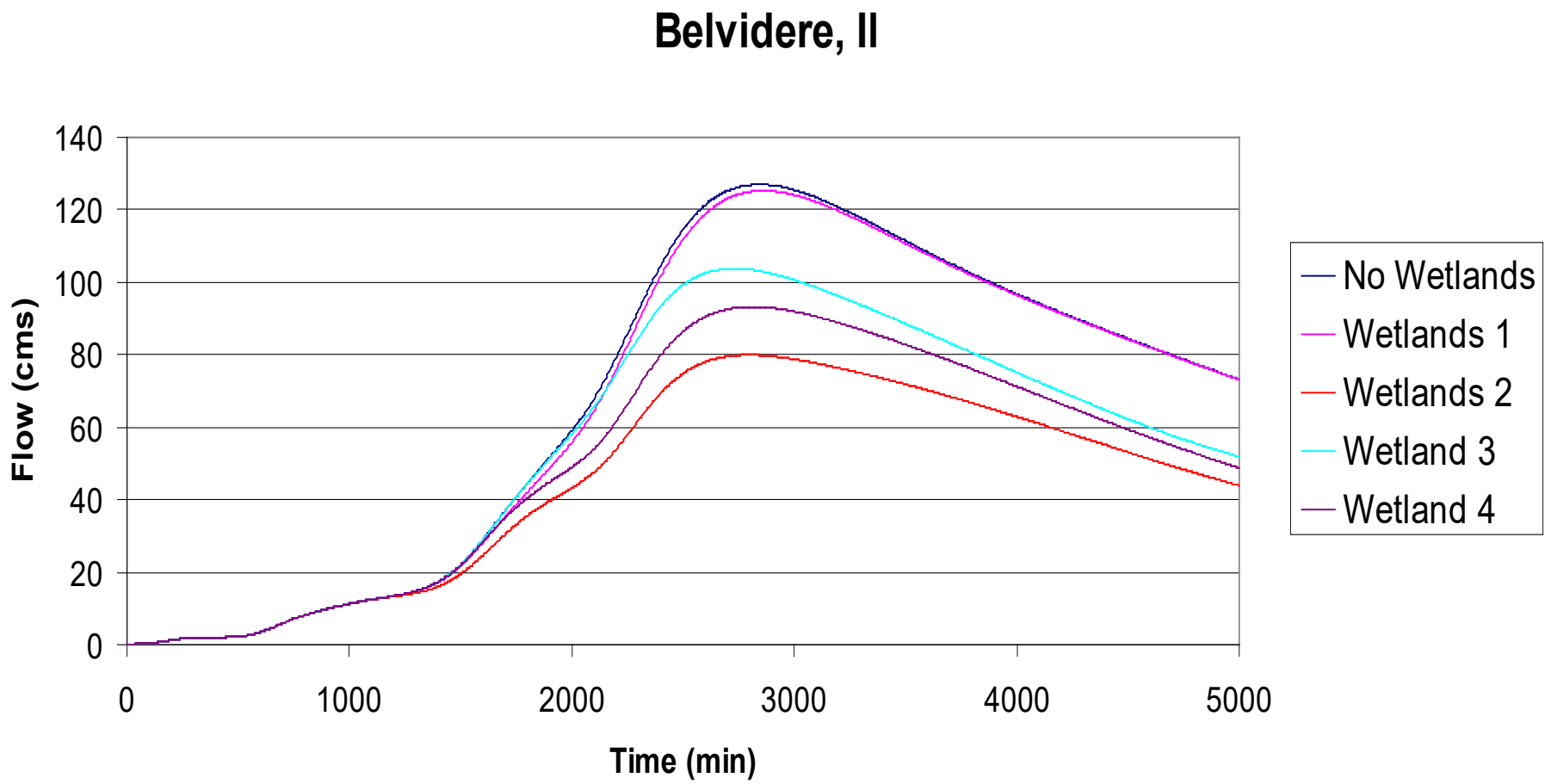
Project Goals

- Develop Watershed Management Plan
  - Placement of 1600 ac of wetlands
  - Removal of tile drains
  - Assess impacts of future land use

Impacts of Spatial Location: Wetlands Location Study

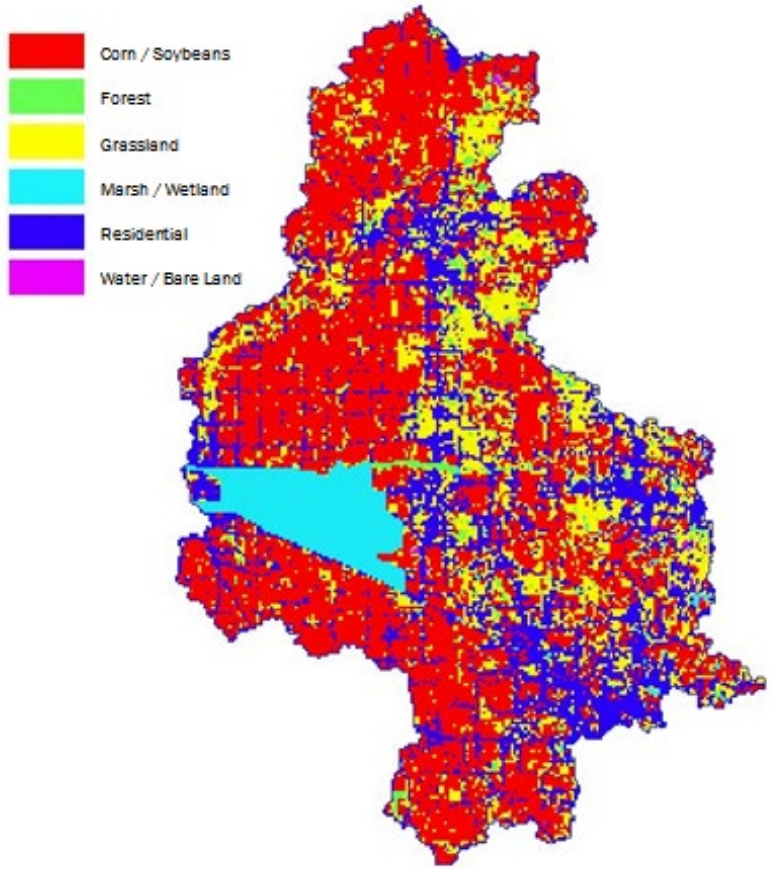


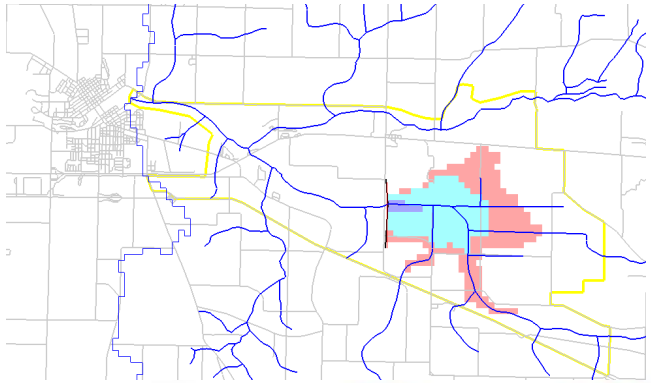
Wetlands Location Results



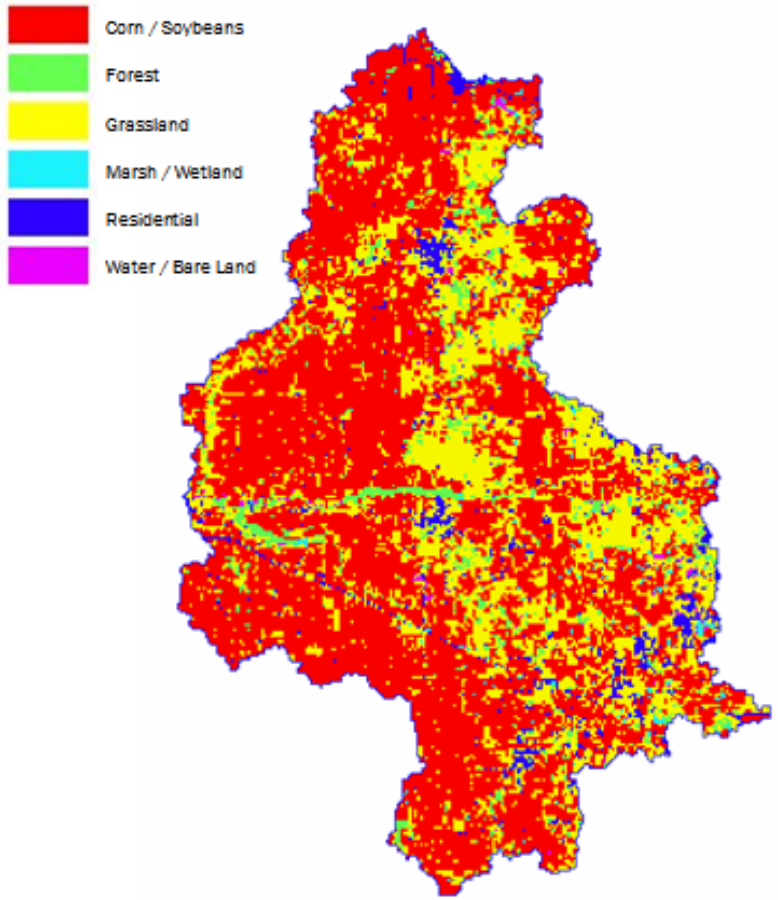
Spatial Hydrology: Dealing with Runoff Processes Changes

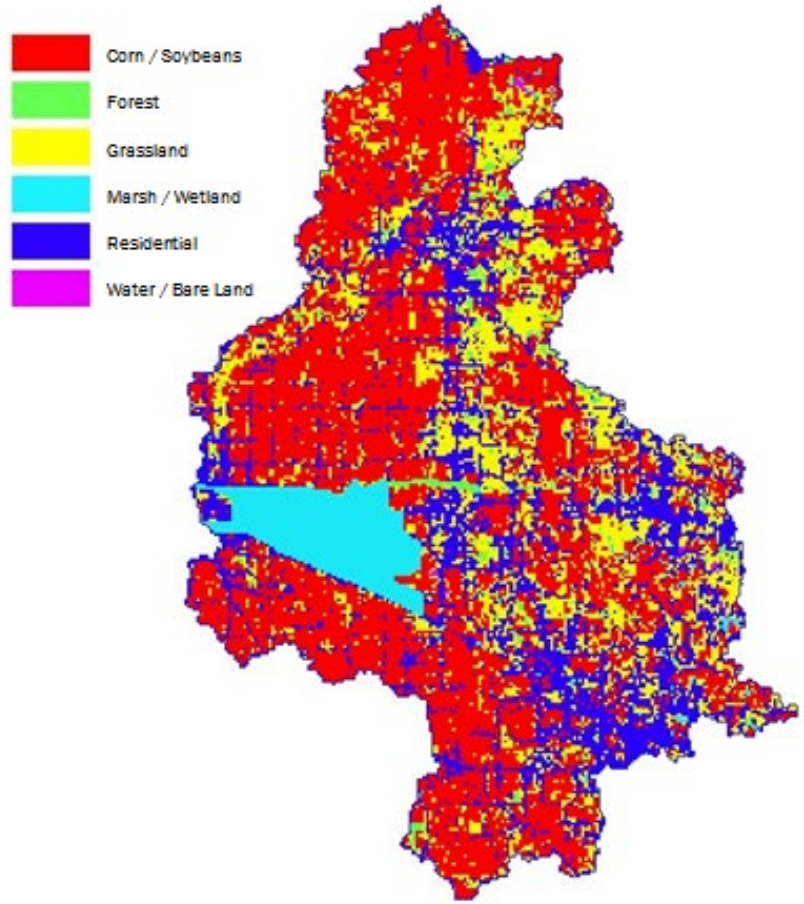
- Spatial effects of land use changes
  - *Where* you put a commercial zone, detention basin, or wetland changes the hydrology
  - Include engineered wetlands
  - Include detention basins
  - Planning and after-the-fact land use changes





Urbanization: Kishwaukee Watershed





Urbanization: Kishwaukee Watershed Results