

Gridded Surface Subsurface Hydrologic Analysis

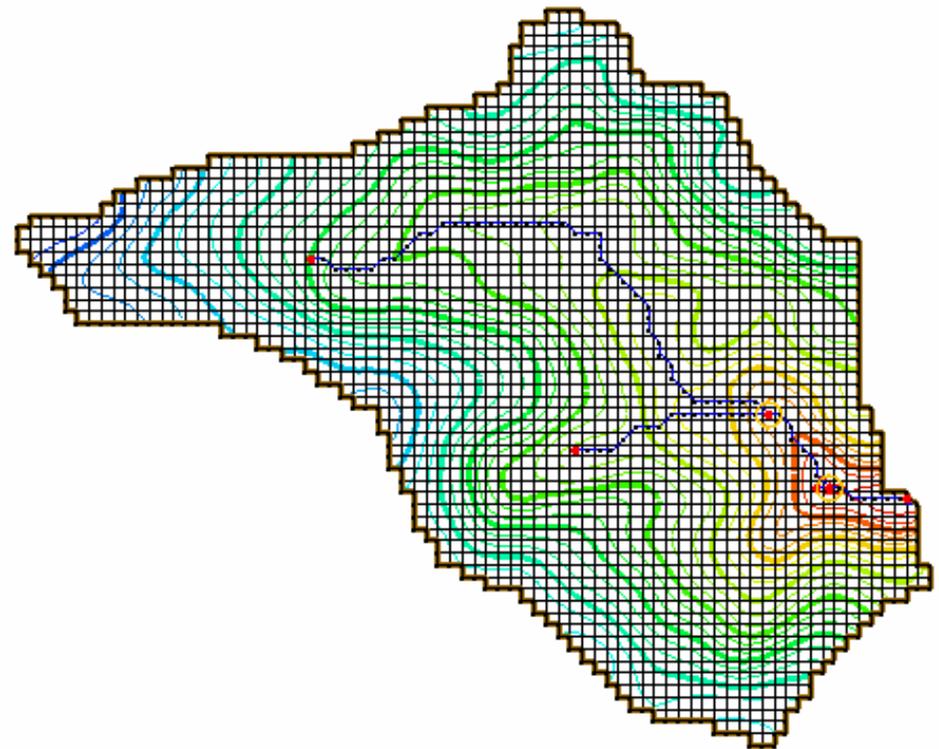
Aaron Byrd
Chuck Downer

Overview

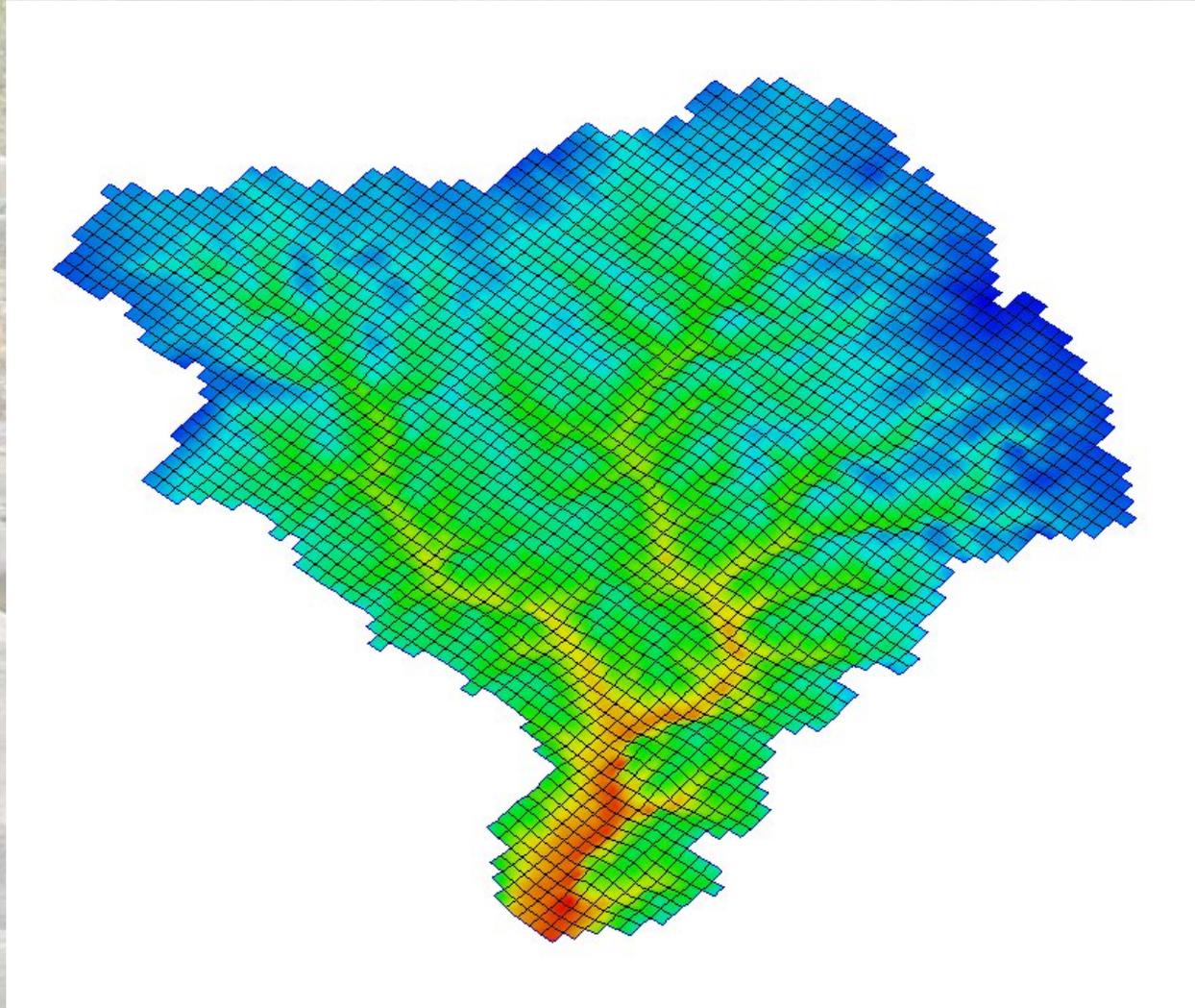
- GSSHA, WMS overview
- Recent, Current R&D
- Agriculture Related Projects

Gridded Surface Subsurface Hydrologic Analysis Model

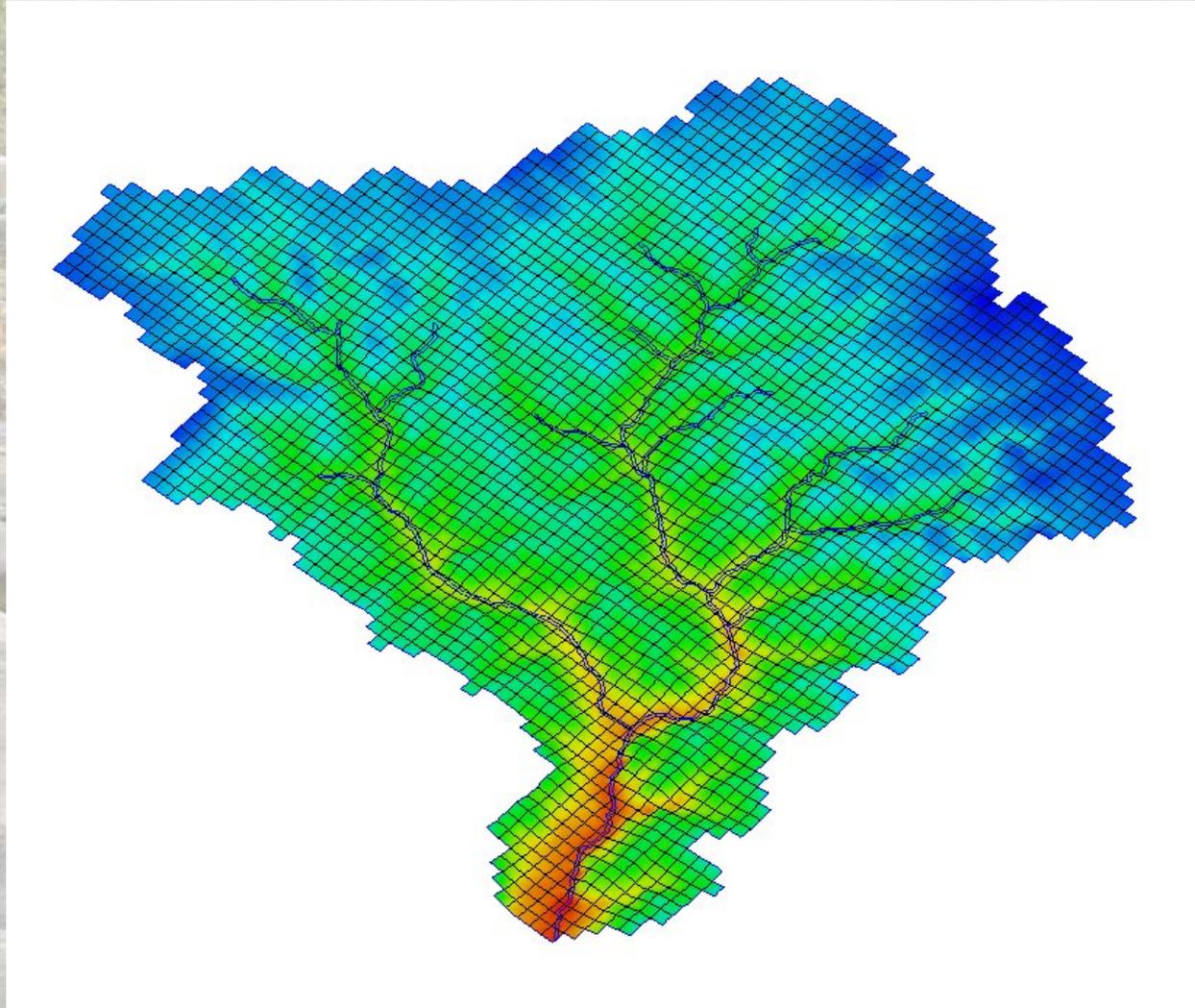
- Spatially distributed, physically based hydrologic model
- 2D Gridded Finite Volume
- Used on watersheds from $<1 \text{ mi}^2$ to $>1000 \text{ mi}^2$



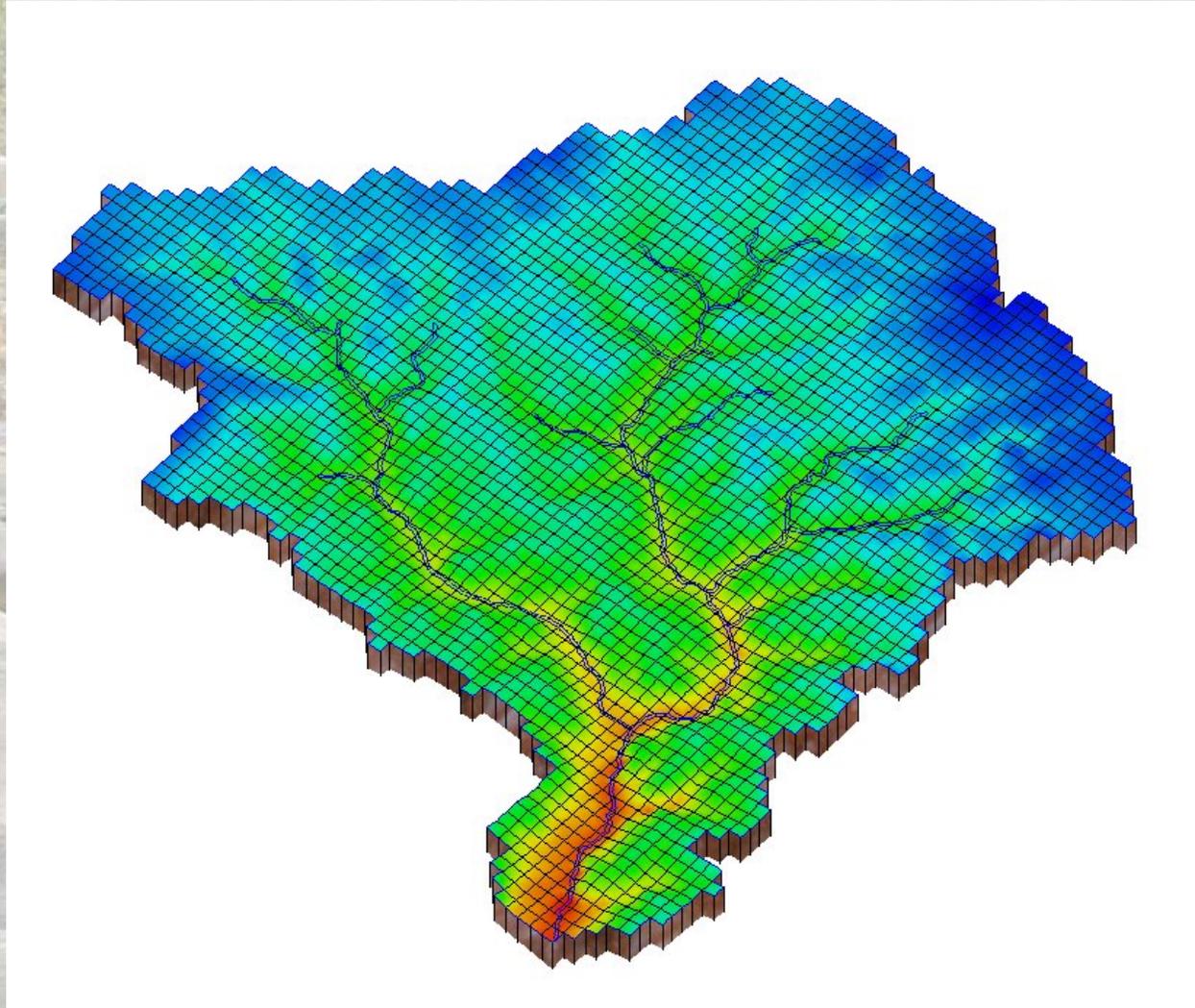
GSSHA Background



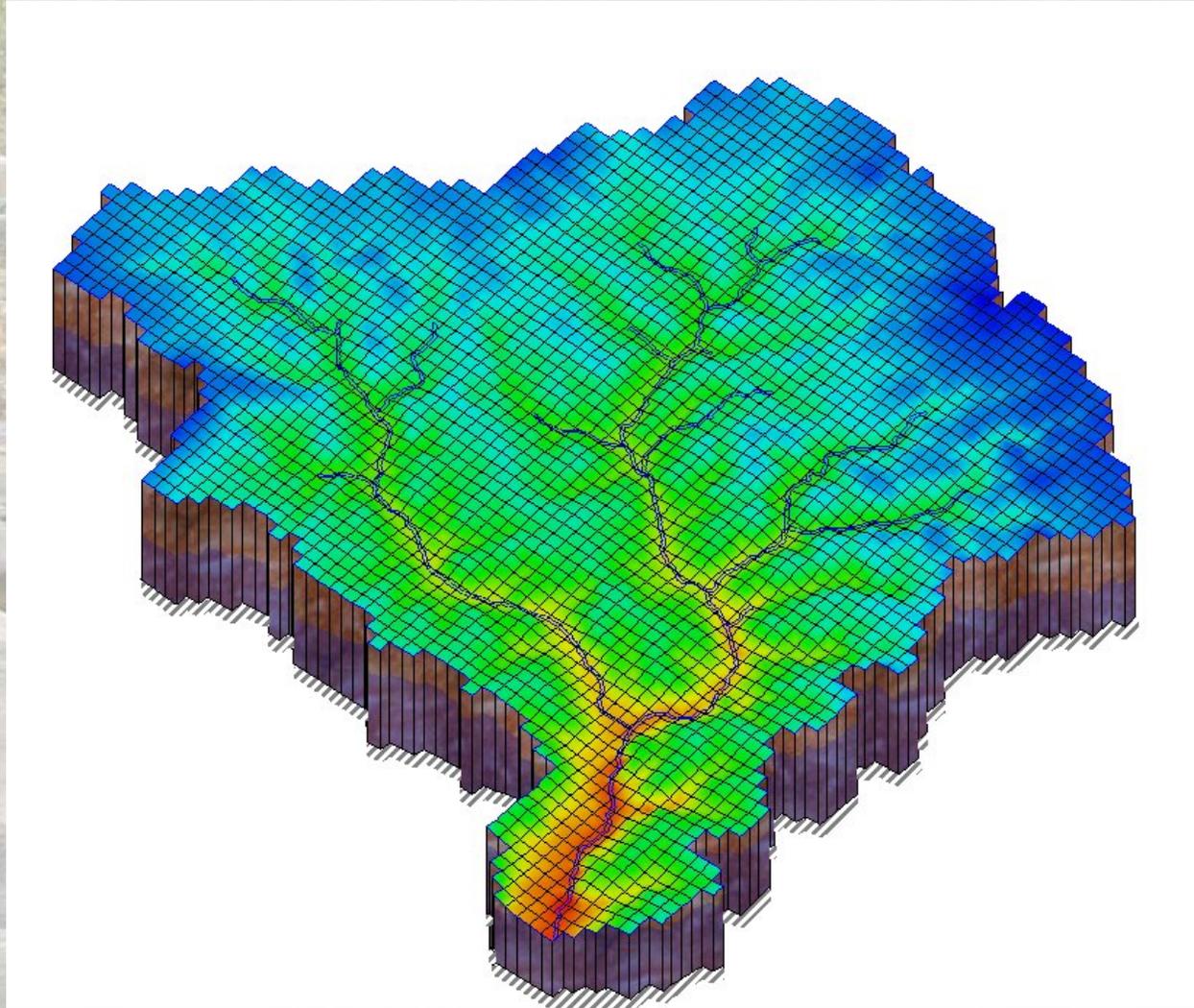
GSSHA Background



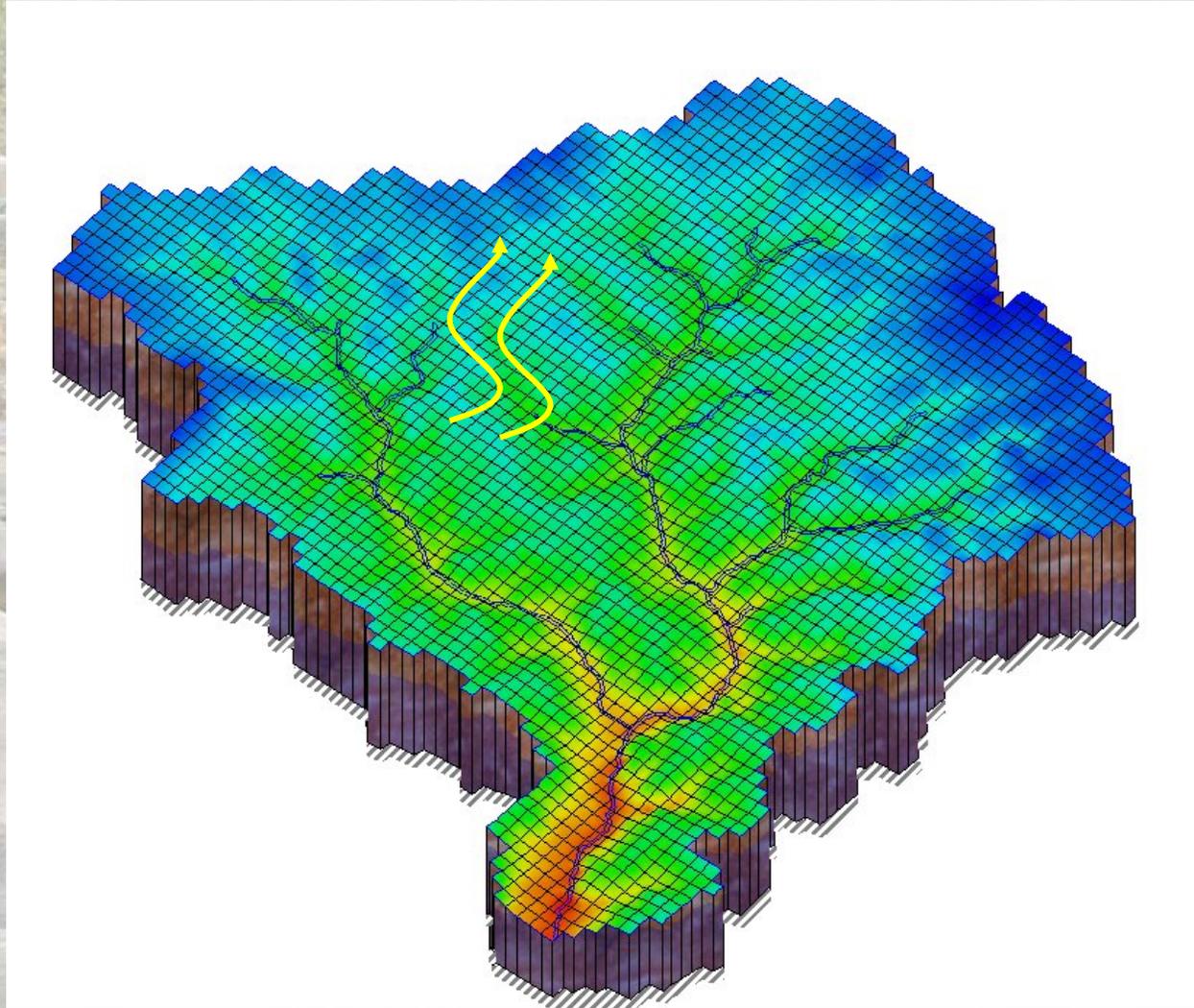
GSSHA Background



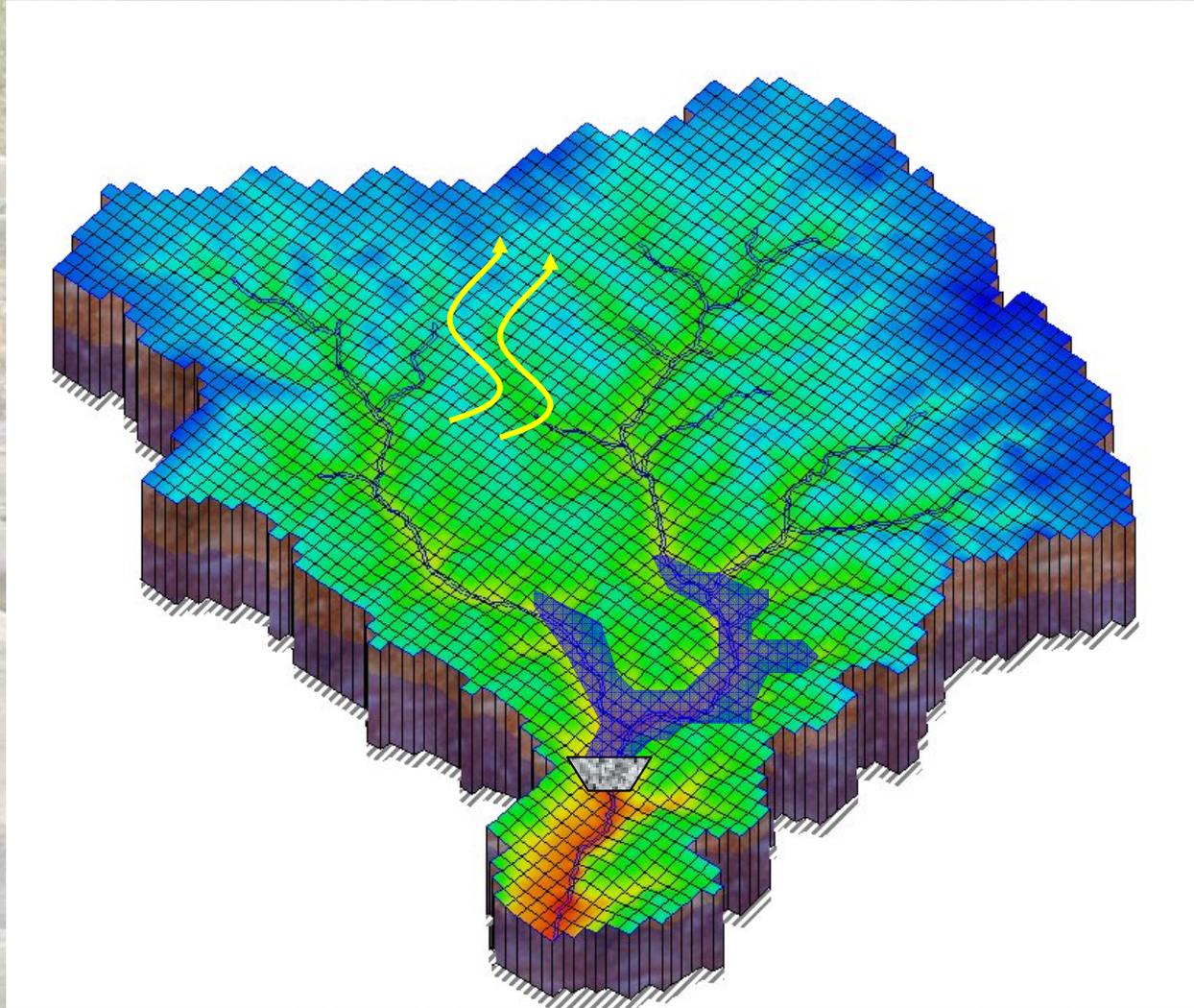
GSSHA Background



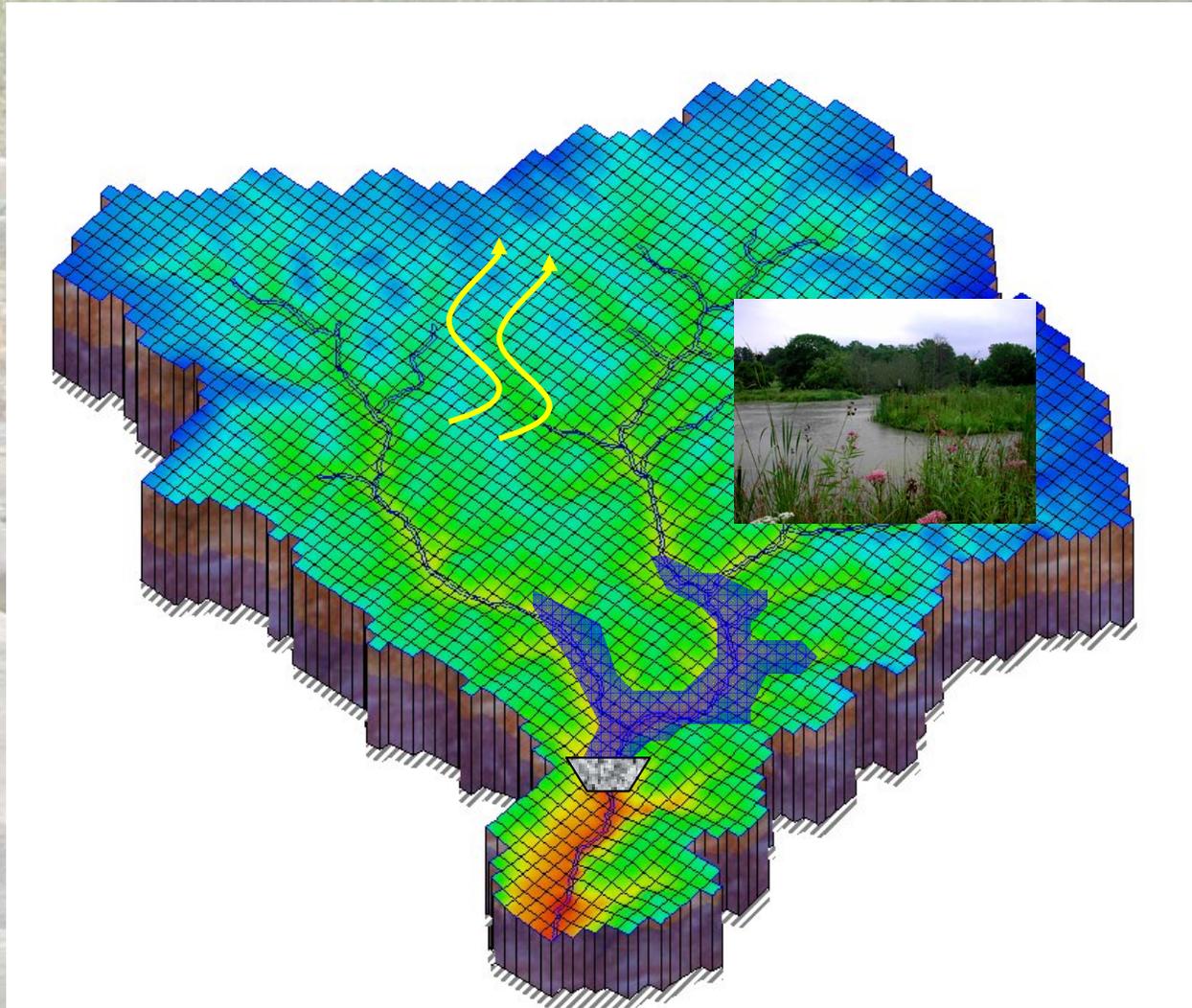
GSSHA Background



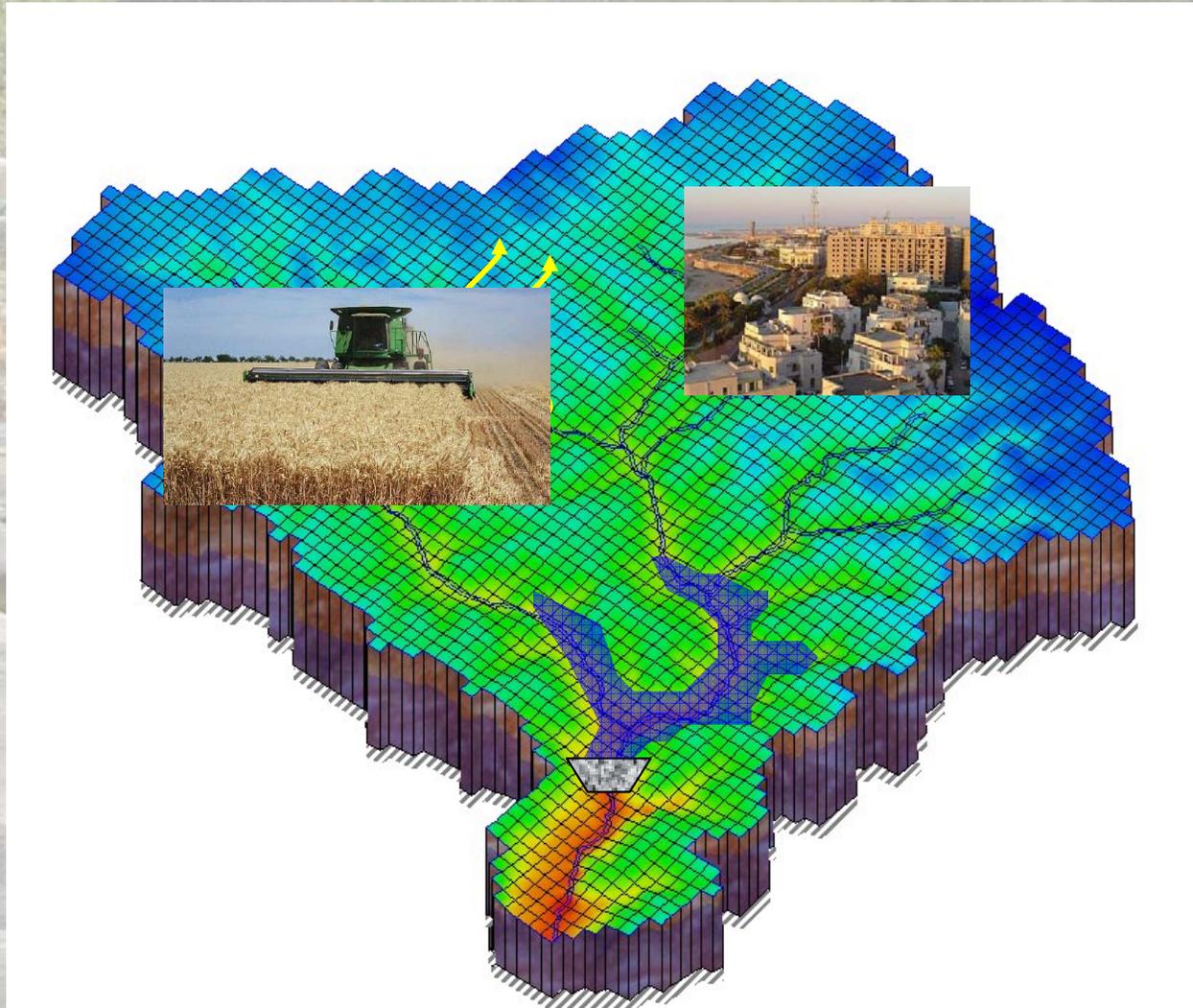
GSSHA Background



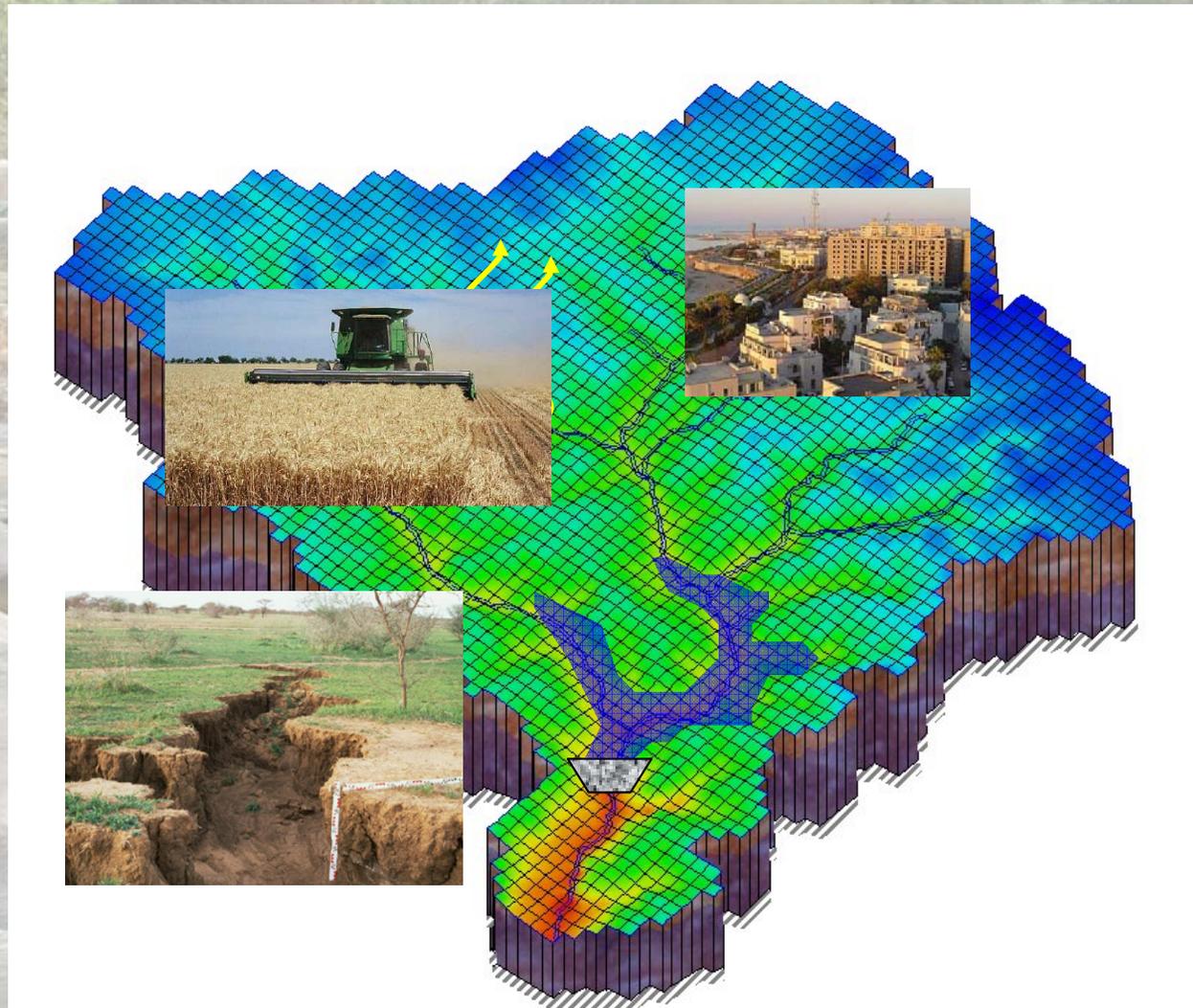
GSSHA Background



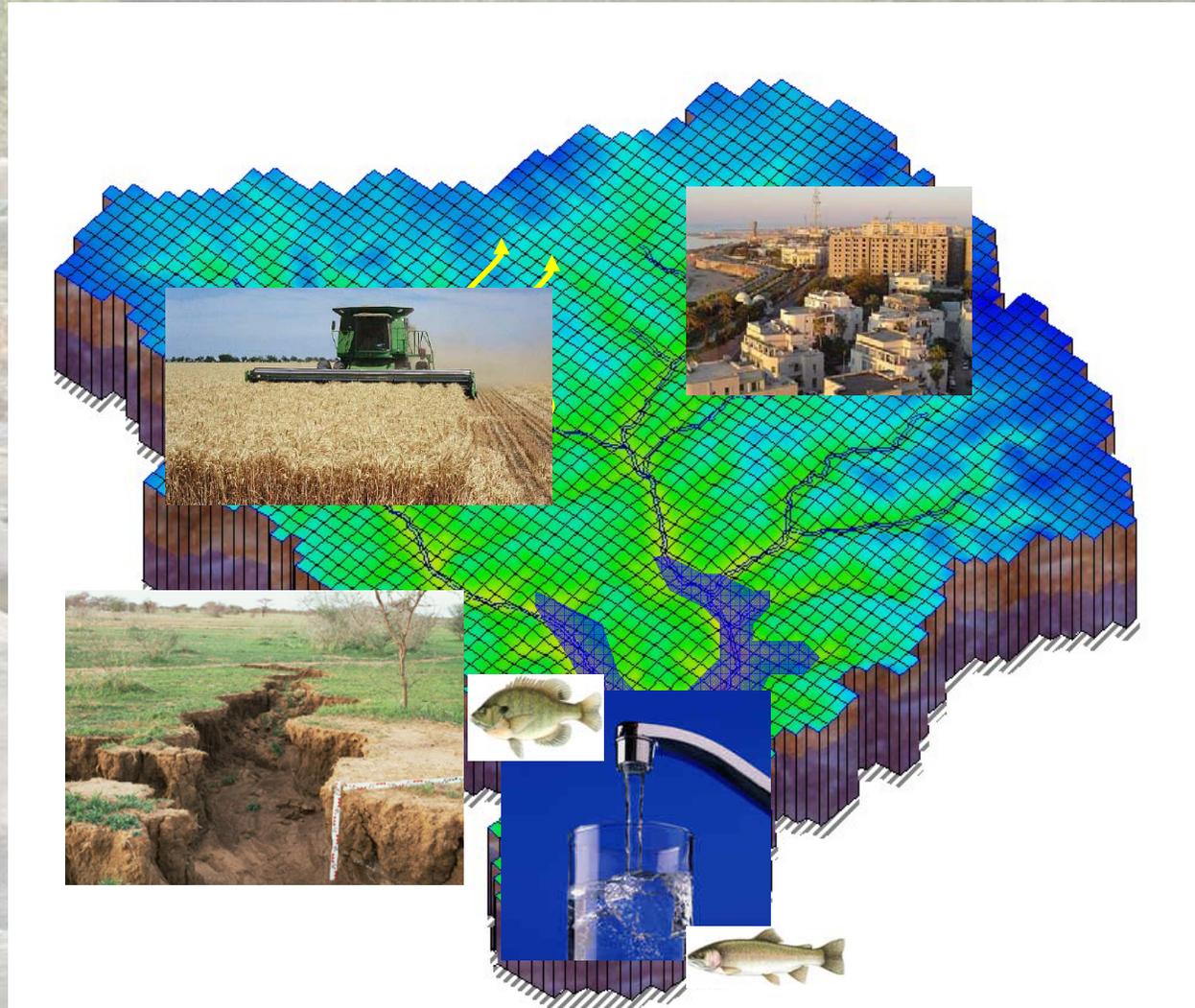
GSSHA Background



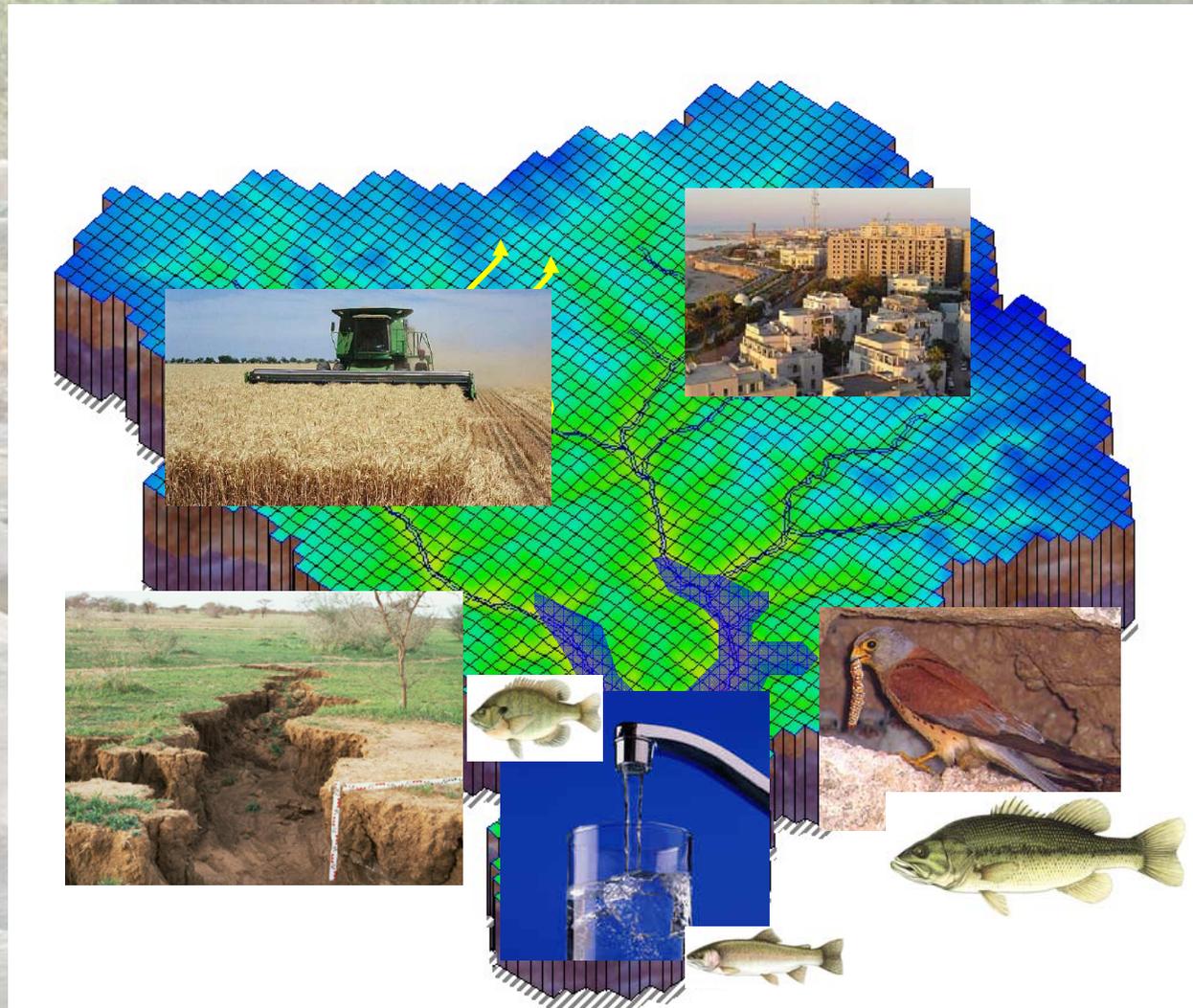
GSSHA Background



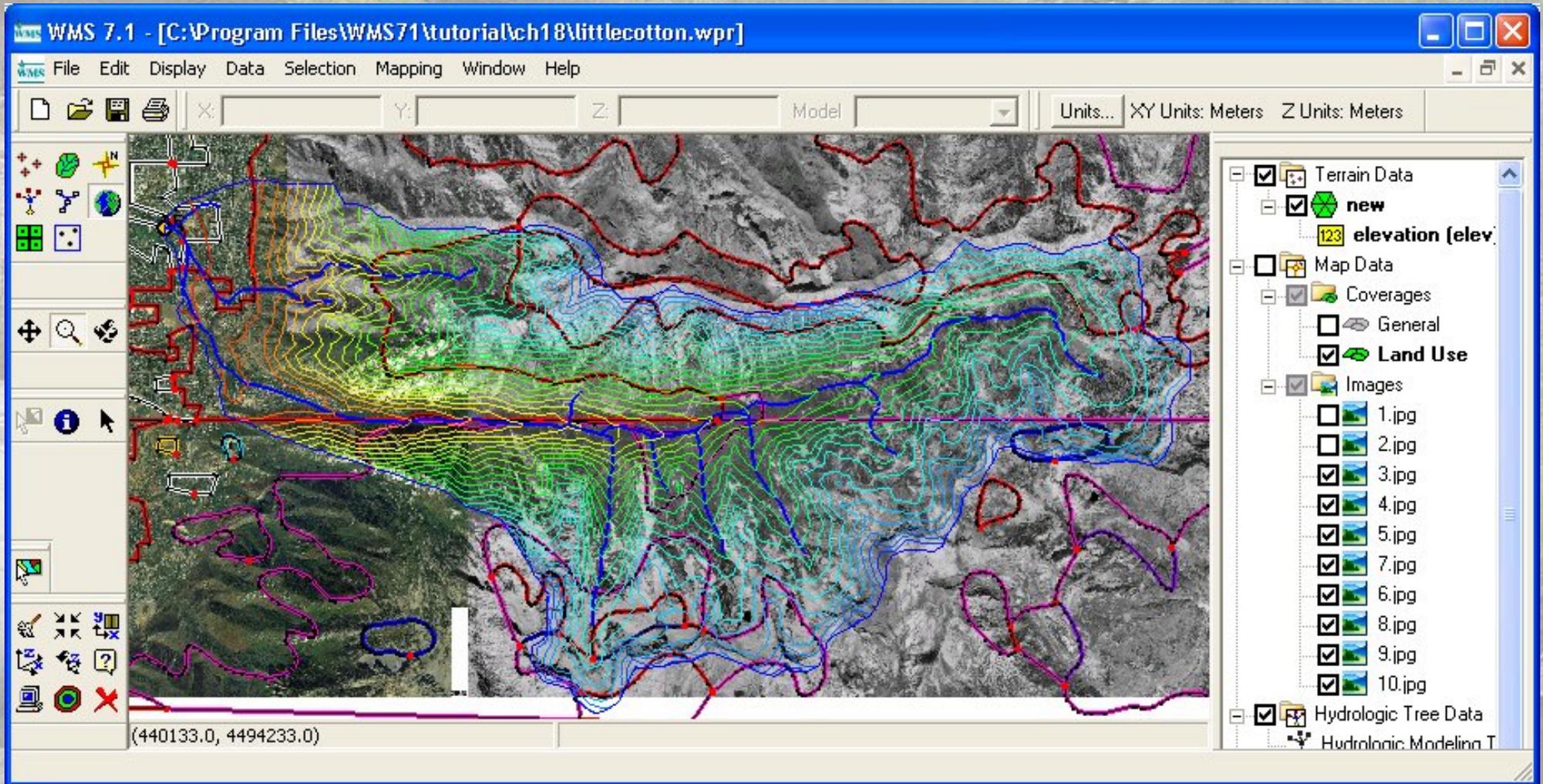
GSSHA Background



GSSHA Background

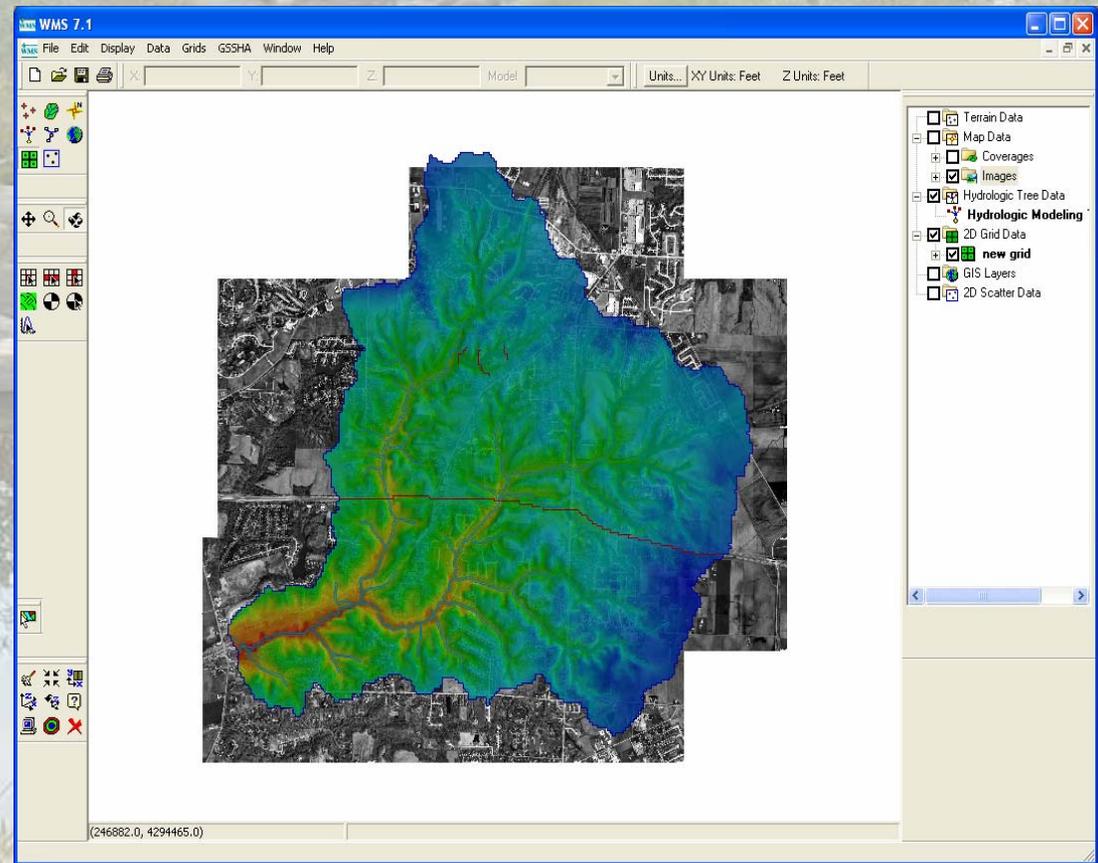


Watershed Modeling System



Watershed Modeling System

- Pre- and Post-processor for GSSHA, other models
- Used to set up models from GIS, DEM, etc. data.
- Link watershed, riverine, habitat models



Watersehd Modeling System

- Integrates multiple data sources to automate model parameter definition
- Supports lumped-parameter and spatial hydrologic models
- Integrates directly with ESRI's ArcGIS through ArcObjects
- Supported Models
 - NFF
 - TR-20
 - TR-55
 - HEC-1
 - HSPF
 - GSSHA
 - MODRAT
 - CE-QUAL-W2
 - HEC-RAS
 - HEC-HMS

WMS User Base

- 1400 Private users
- 12 State DOTs
(through FHWA)
- 300 DoD, DoE, EPA
- 71 Countries



(Click [image](#) to play video clip.)

Overview

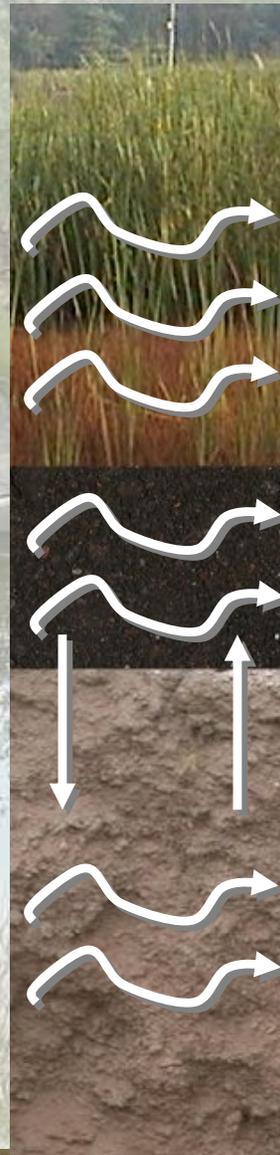
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Wetland Hydraulics Model

Lateral flow through, over vegetation

Lateral flow through peat / muck layer

Vertical infiltration, exfiltration, Lateral Groundwater



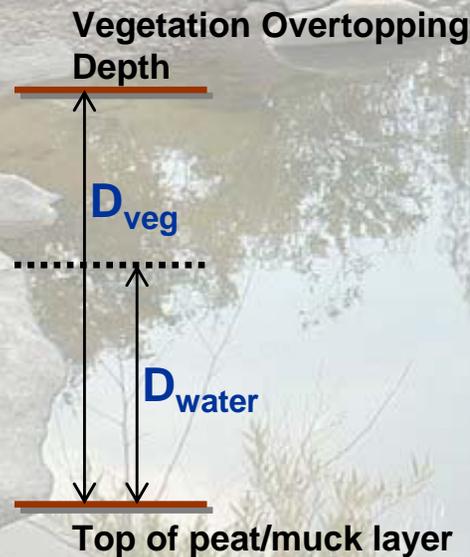
Bi-model flow:
Linear transition
from Darcian flow
at bottom to
Manning's flow at
overtopping level

Darcian Flow

Infiltration, 2D
Groundwater
models

Wetland Hydraulics Model

Bi-model flow:
Linear transition
from Darcian flow
at bottom to
Manning's flow at
overtopping level



◆ Compute q_{Darcy} and $q_{Manning}$
based on flow depth,
parameters

◆ Compute

$$r_{Darcy} = 1.0 - D_{Water} / D_{Veg}$$

◆ Compute

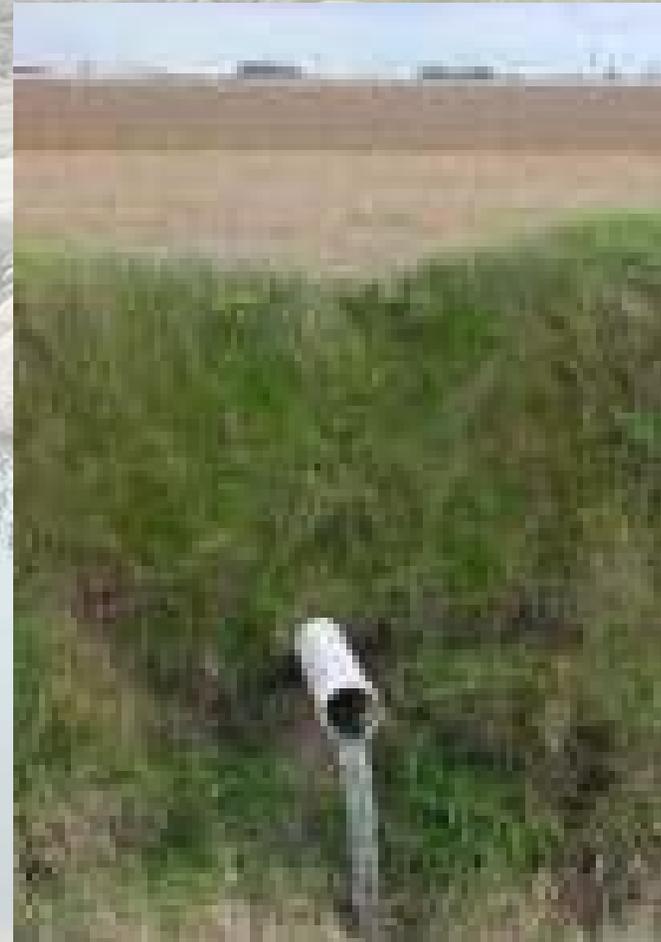
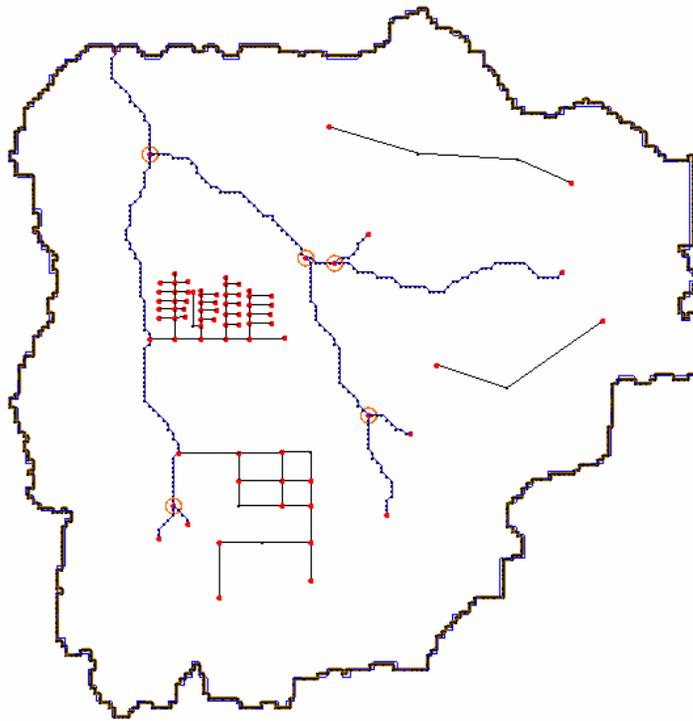
$$r_{Manning} = D_{Water} / D_{Veg}$$

◆ Compute

$$q_{veg} = r_{Manning} * q_{Manning} +$$
$$r_{Darcy} * q_{Darcy}$$

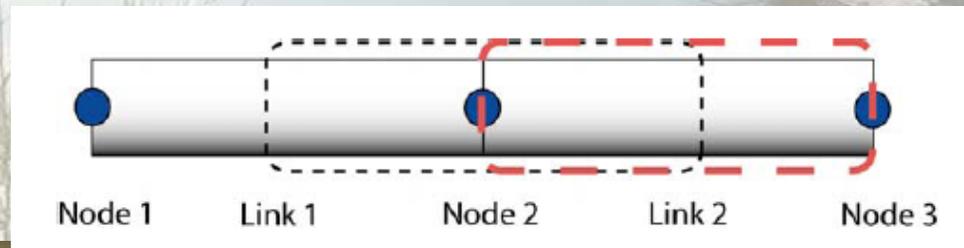
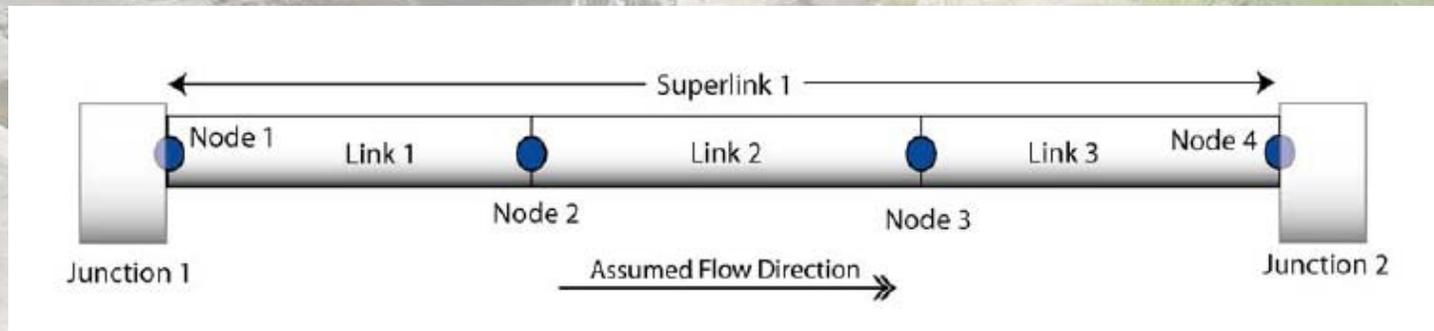
Storm & Tile Drains

- Urban Flooding
- Agricultural Runoff



Storm and Tile Drains

- Superlink model
 - Implicit pipe flow model
 - Use manholes as junctions
 - Use groundwater model to drive lateral inflow for tile drains

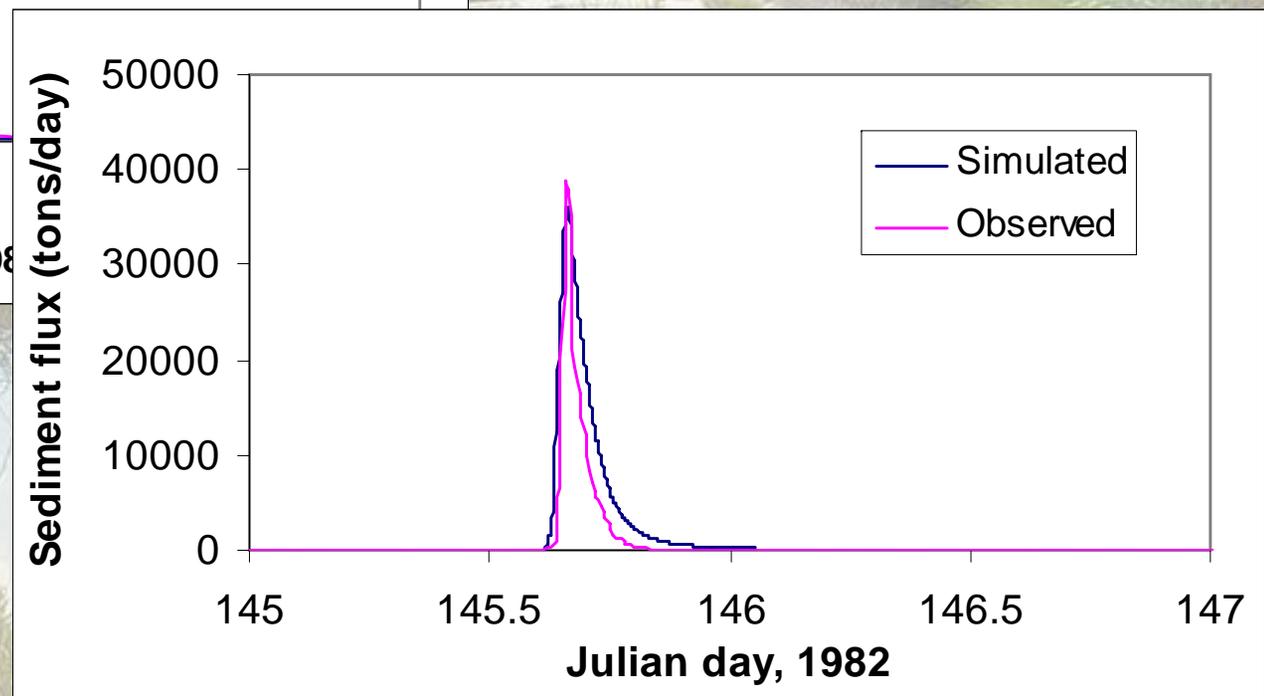
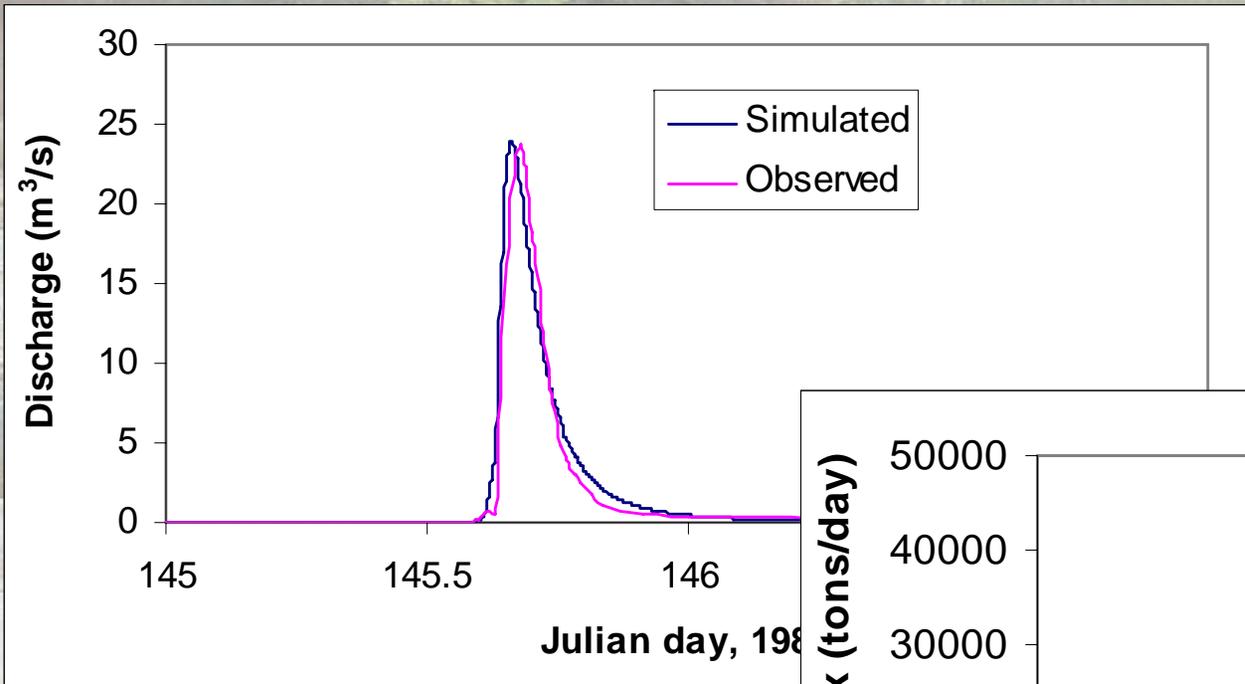


Overland Flow Boundary Conditions



(Click [image](#) to play video clip.)

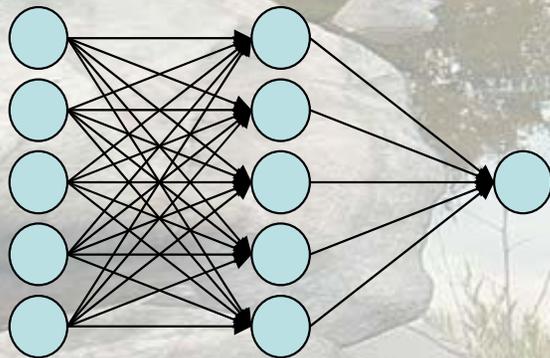
Improved Sediment Transport



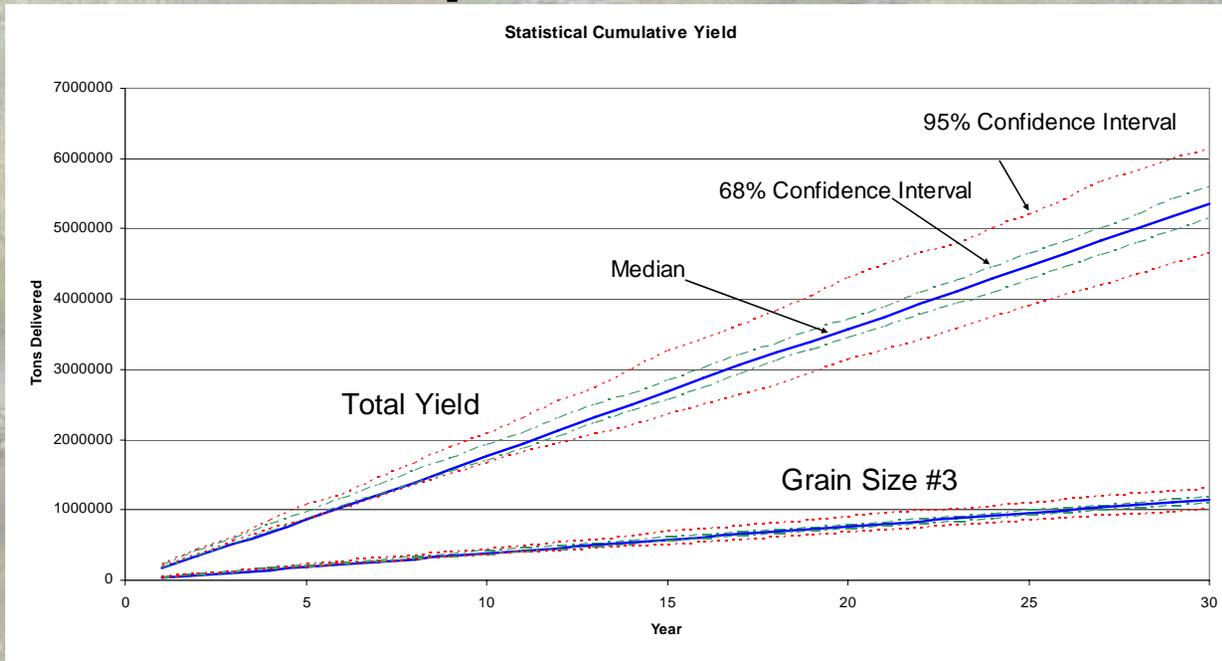
Framework of Yearly Stream Sediment Input

- Link spatial, temporal scales between models

Artificial Neural Network



Soil Moisture at Storm Beginning

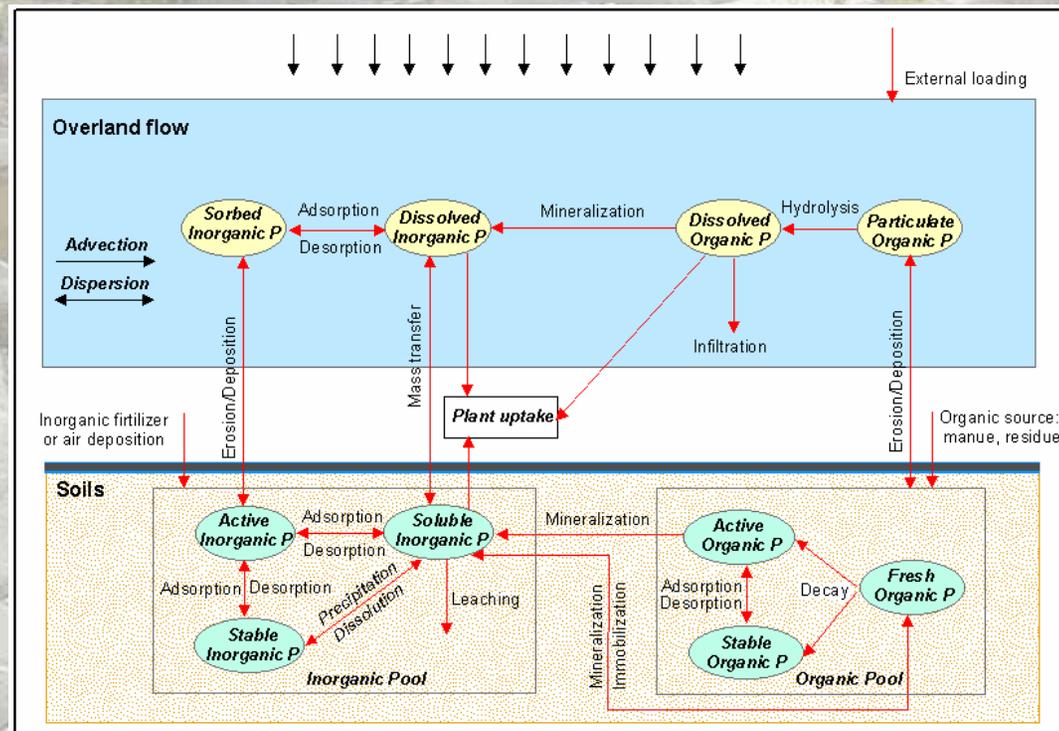


Generalized Neyman-Scott Rectangular Pulses Rainfall Predictor



Water Quality

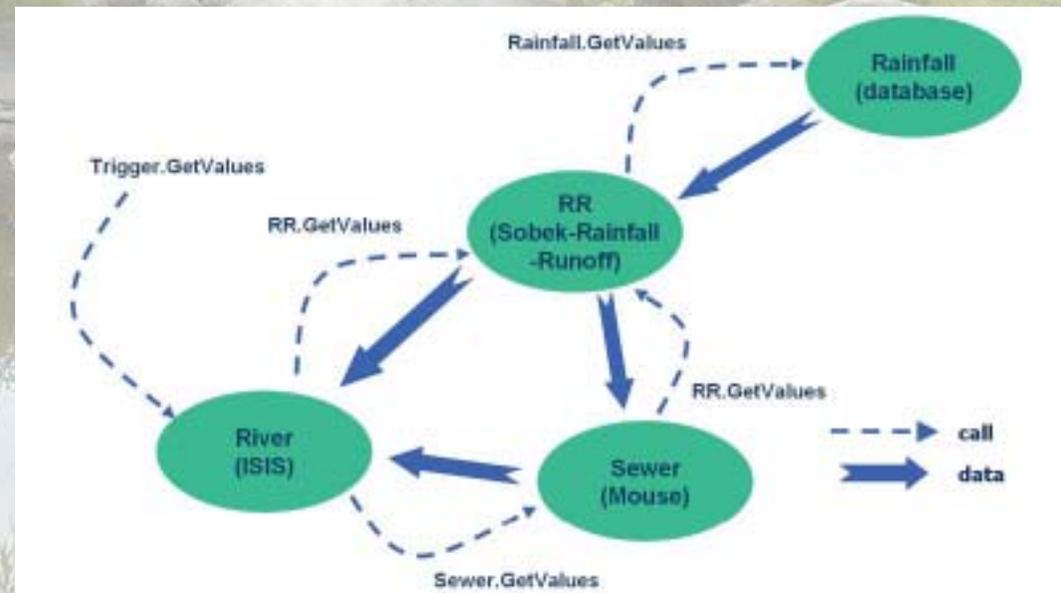
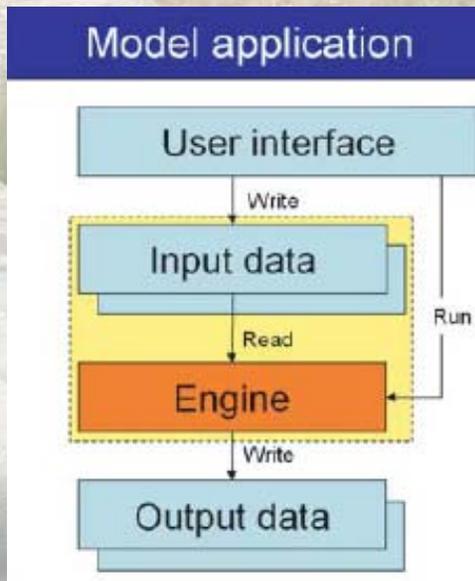
- Implement the Nutrient Sub Module from the System-Wide Water Resources Program.



Parallelization

- Tuning, OpenMP, MPI
- Batch mode runs
- 6 hour run \rightarrow 2.8 hour run

Model Integration



<http://www.openmi.org>

OpenMI Compliant Models

EU Models

- DHI
 - Mike Basin, 11, SHE, Urban
- WL|Delft
 - SOBEK, DelftFEWS, HYMOS, RIBASIM
- Wallingford
 - InfoWorks RS, CS, Isis, SULIS – 2D
- RIZA
 - DM, Mozart, Agricom

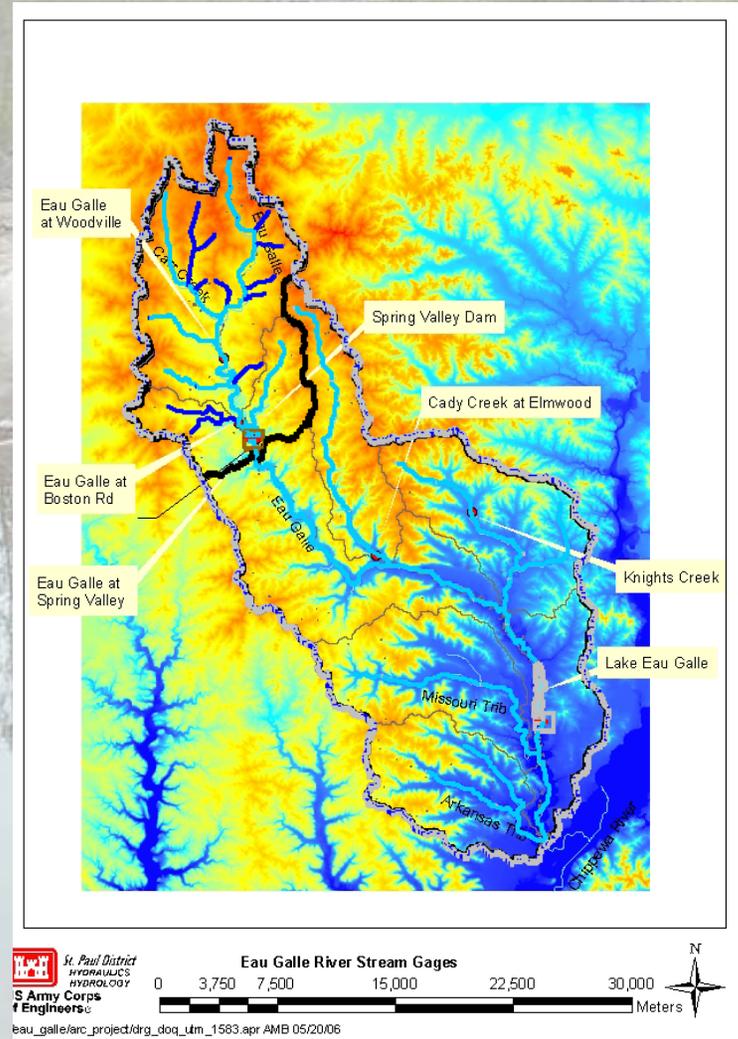
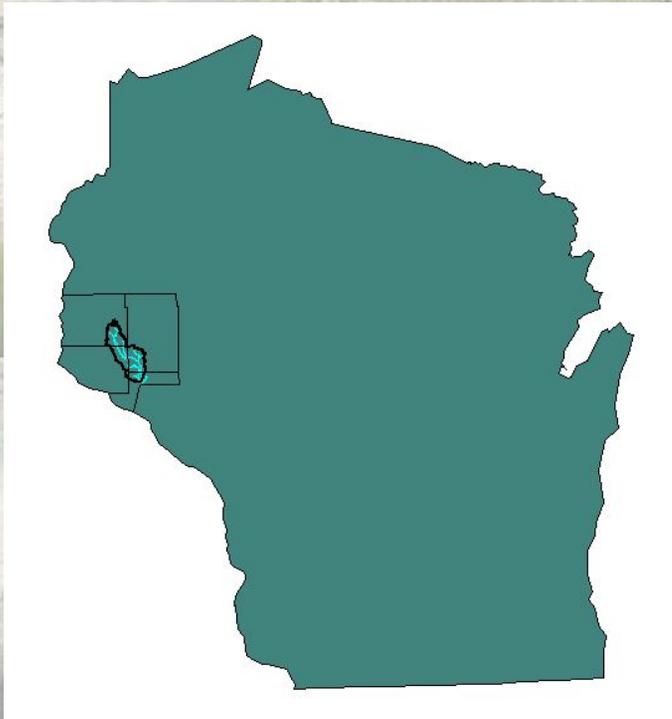
USACE Models

- GSSHA
- ADH
- *HEC-HMS*
- *HEC-RAS*
- *HEC-RESSim*
- *CE-QUAL-W2*

Overview

- GSSHA, WMS Overview
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- Agriculture Related Projects

St. Paul District – Eau Galle



Rock Island District - Kishwaukee

