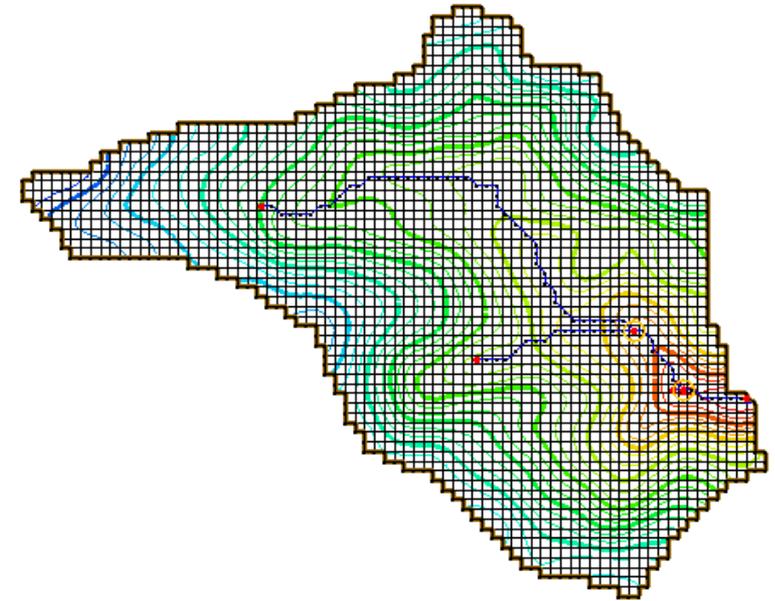




What is GSSHA?

- 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

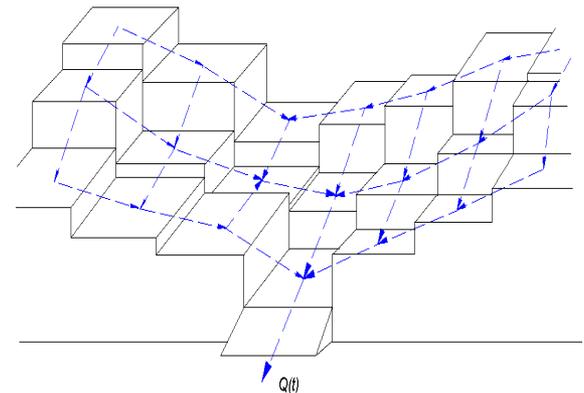
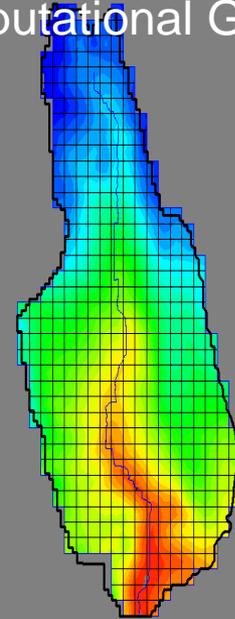




How does GSSHA Work?

- 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.

Computational Grid

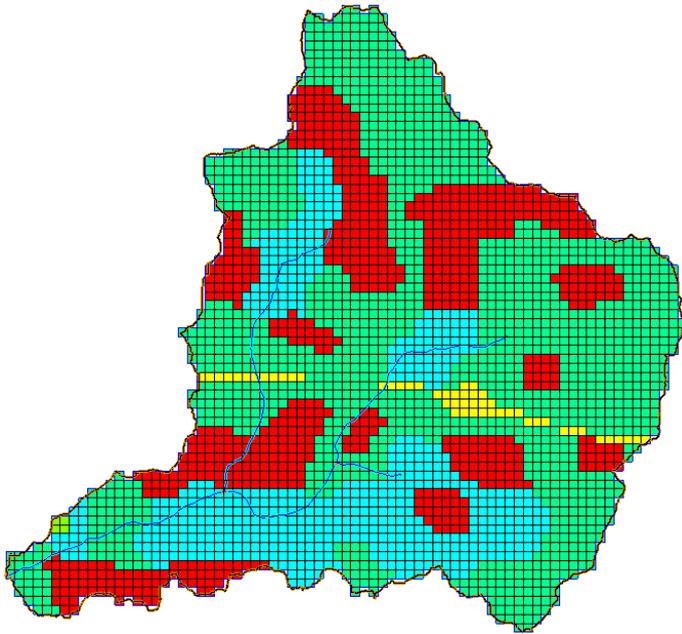




Why Does This Matter?

Spatial variability.

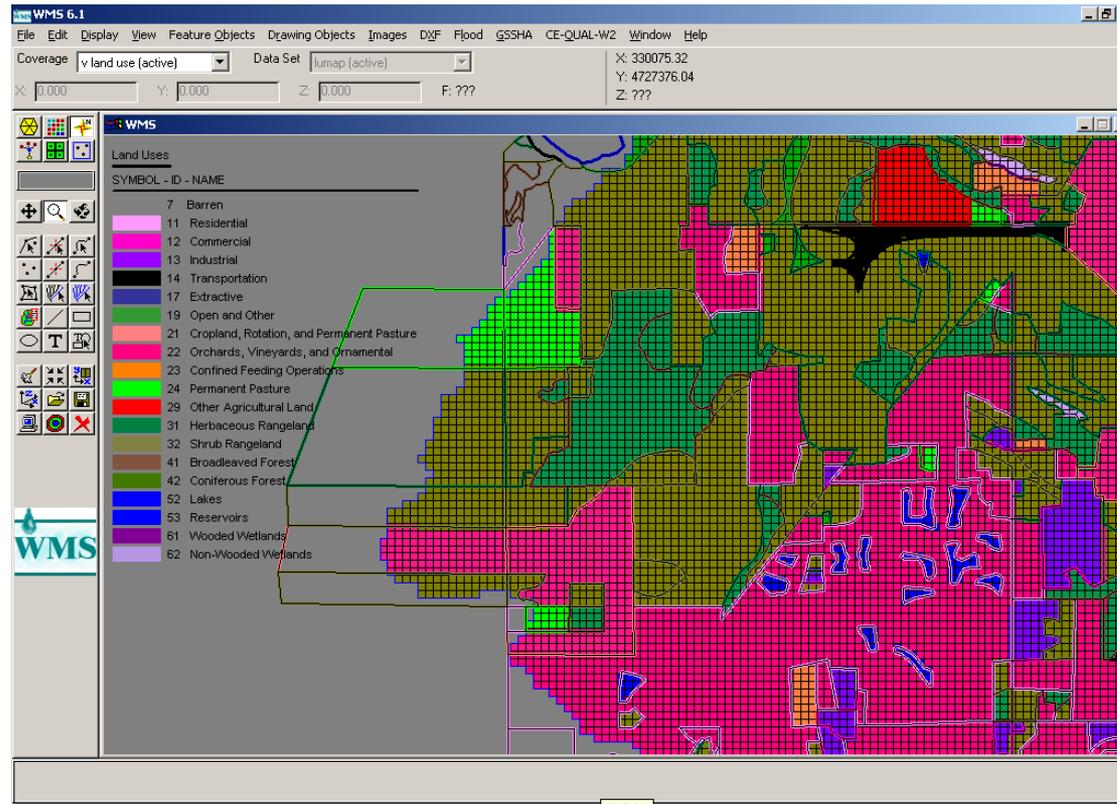
Physically based parameters.





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





Watershed Modeling Capabilities





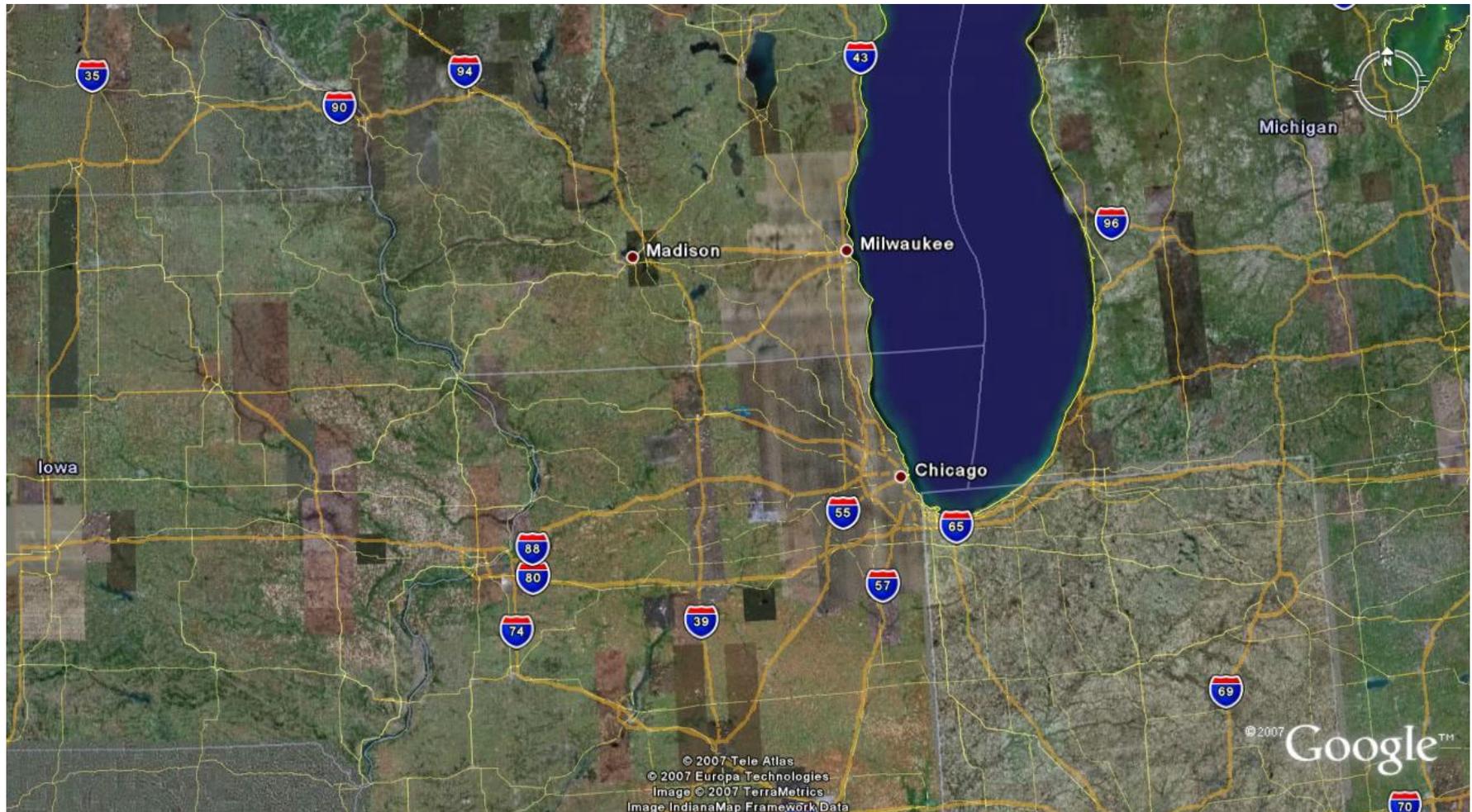
What make GSSHA Different?

- GSSHA is a fully integrated watershed model with overland flow, lateral groundwater and channel routing with sediment and contaminant transport all fully integrated.
 - Full integration of processes allows a higher level of analysis.
 - Feedbacks between overland, channels, reservoirs, and the groundwater.
- GSSHA routes water, sediments, and contaminants through the watershed.
 - For many processes flow path is important.
 - Sediment
 - Water quality
 - BMPs
 - Interaction with flow impediments
 - levees, dikes, roads, buildings, wetlands, detention basins, etc.





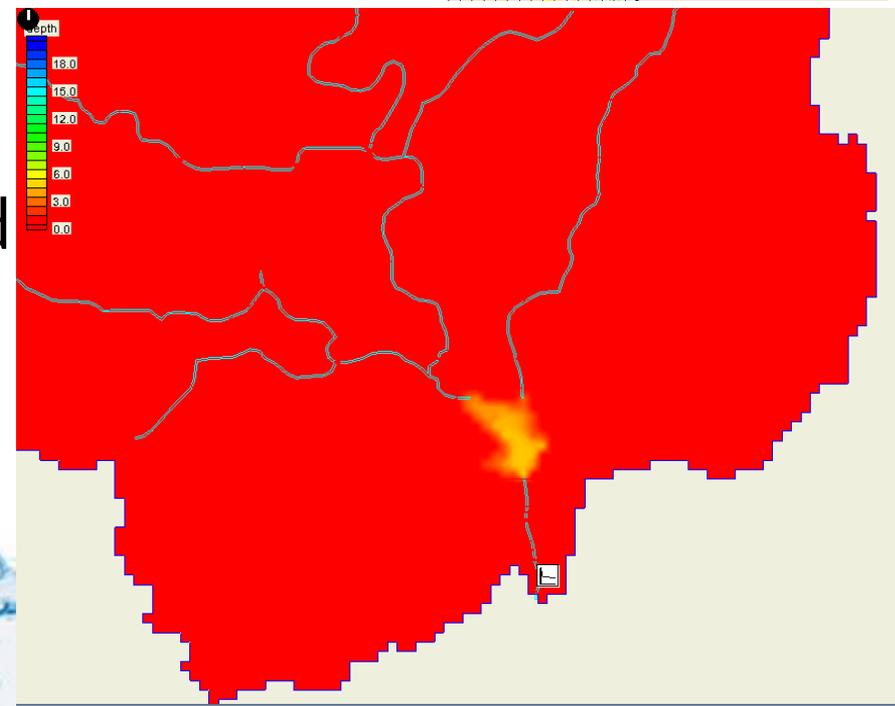
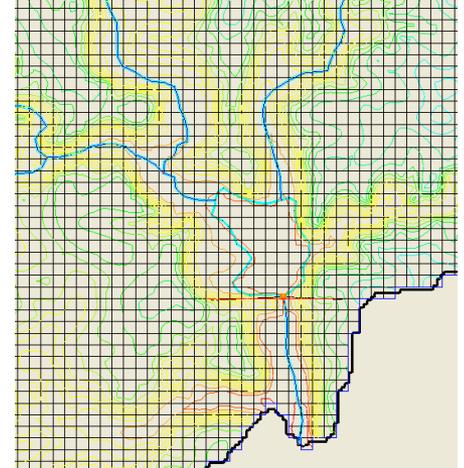
Central Kishwaukee Flooding





Reservoirs

- Reservoirs exist in the channel and on the overland flow domain.
- Reservoirs are dynamic and expand and contract on the overland flow plane and in the channel.
- Sediments can deposit and erode within the reservoir, depending on it's stage.





What Applications Can GSSHA be Used For?

- General hydrologic studies
- General hydraulic studies
- Urban hydrology
- Determining sediment load
- Determining constituent load
- Urbanization
- Ecosystem restoration
- Management practices



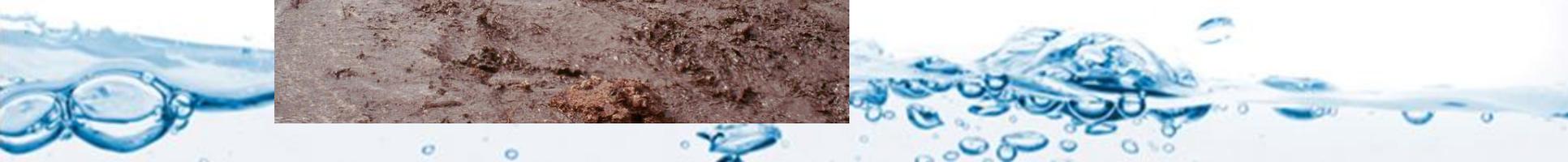
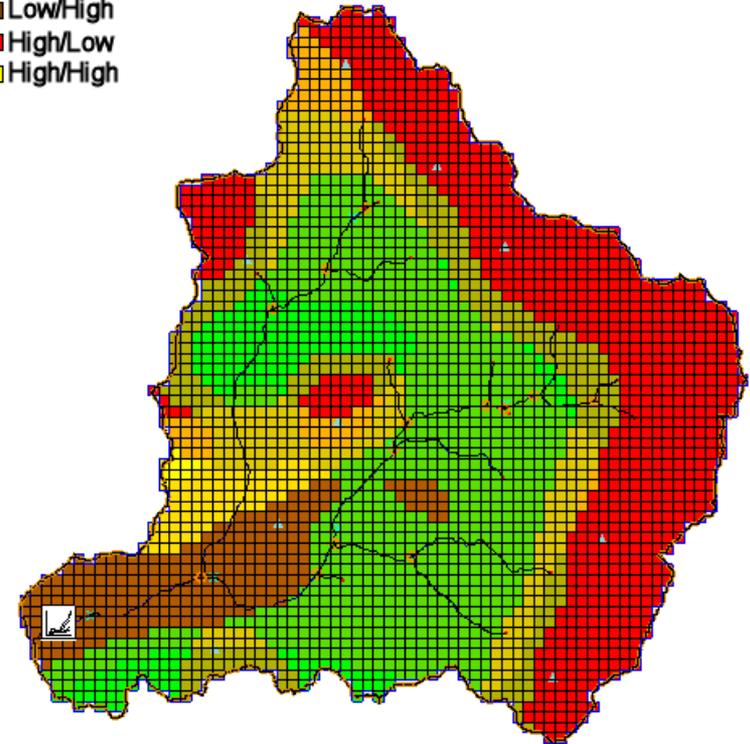


Sediment Transport

- Event based erosion and deposition model (not USLE-based)
 - Overland
 - Streams
- User-defined sediment properties

Erosion/Deposition

- Low/Low
- Low/High
- High/Low
- High/High





GSSHA Sediment Transport

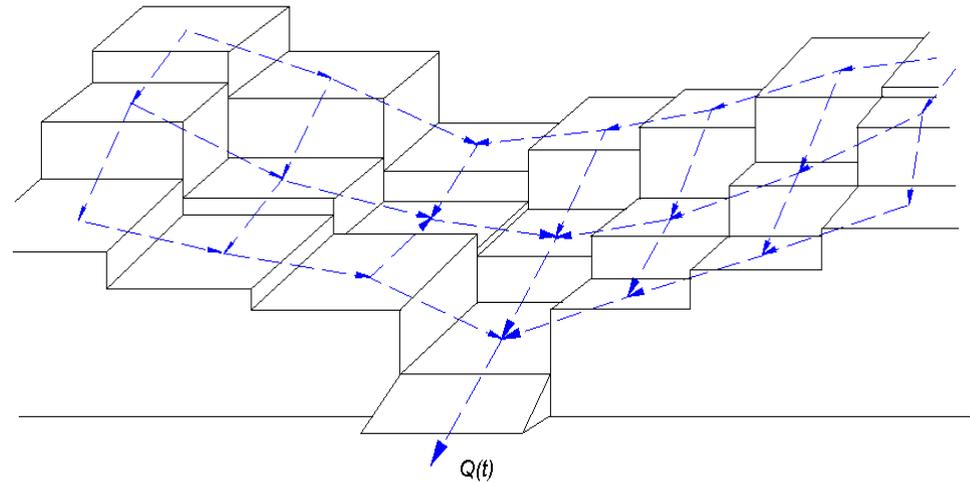
- GSSHA simulates sediment transport like you understand sediment transport with a physics based approach.
- Simulation of sediment erosion from the overland plane
- Transport across overland plane including deposition and re-entrainment
- Transfer into channels
- Channel routing of bed and wash loads
- Routing of sediments through reservoirs
- Landscape evolution with the capability to do multi-decadal simulations





Overland Sediment Transport

- Any number of sediment particles
 - Size
 - Specific gravity
- Sediment detachment
 - Raindrop impact
 - Overland flow limits
- Transport Capacity
 - Kilinc-Richardson
 - Engelund-Hansen
 - Multiple shear stress formulas
- Deposition



Cell to Cell Advection of Suspended Sediments

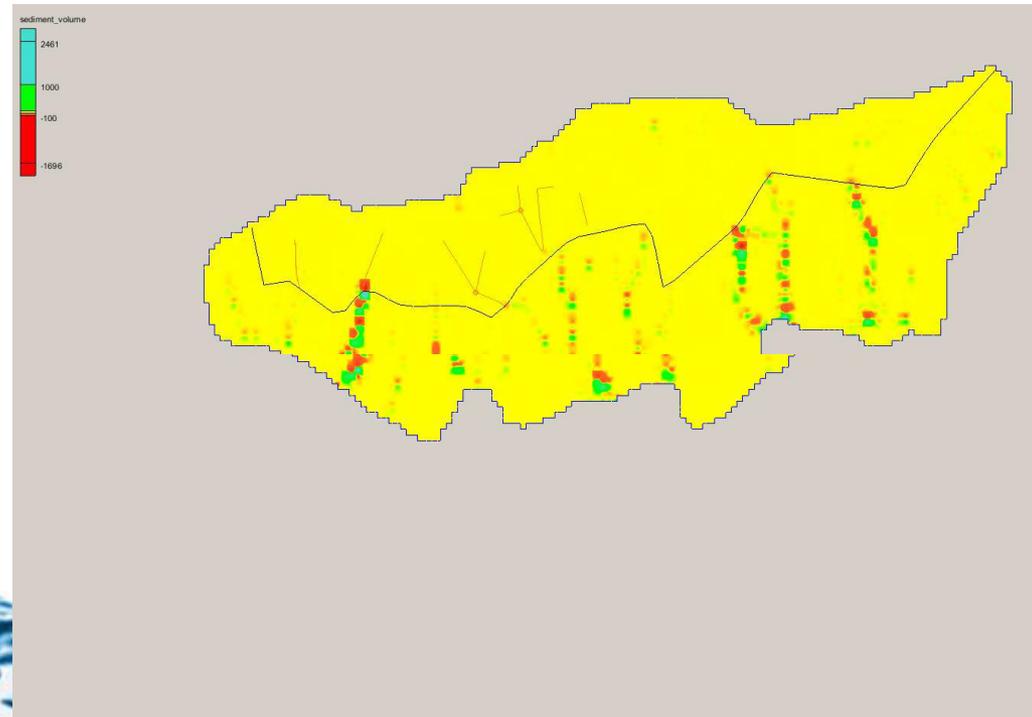
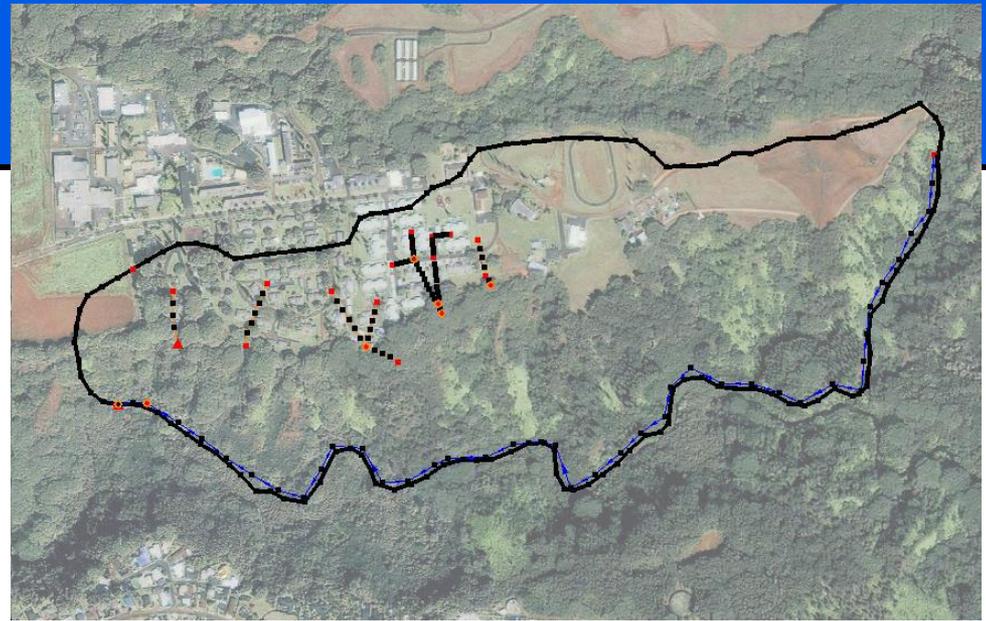




Overland Erosion Process in GSSHA

- Sediments are accounted for using three storages:
 - Parent material
 - Deposited materials
 - Materials in suspension
- Each pool has its own distribution of particles.
- Particle detachment
 - Rainfall impact
 - Overland shear.
- Deposited materials are assumed to erode first, then the parent material.
- If sufficient transport capacity is available, the eroded particles are transported to adjacent cells by advection.
- Deposition is computed with trap efficiency.
- Transport and deposition by particle size and density.
- Sediments reaching a stream segment are transported in the stream.
- Overbank flows can add sediments from the stream back to the overland.
- Elevations can be adjusted for erosion/deposition.







Factors Affecting Detachment and Transport Capacity

- Soil particle size – finer particles are more erodible.
- Cover conditions – any type of vegetative or manmade cover protects the particles from detachment and transport.
- Management actions – actions taken to prevent erosion, no-till, contour plowing, etc. lesson erosion.
- Erosive forces
 - Rainfall intensity
 - Discharge
 - Land surface or friction slope
 - Shear stress





Transport Capacity

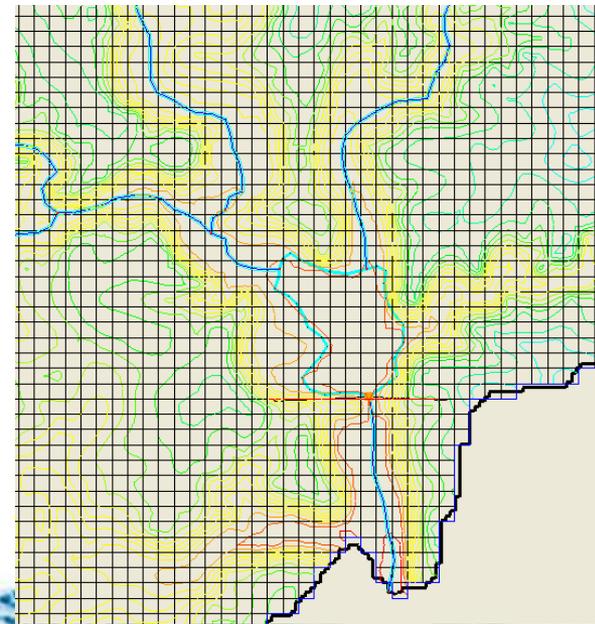
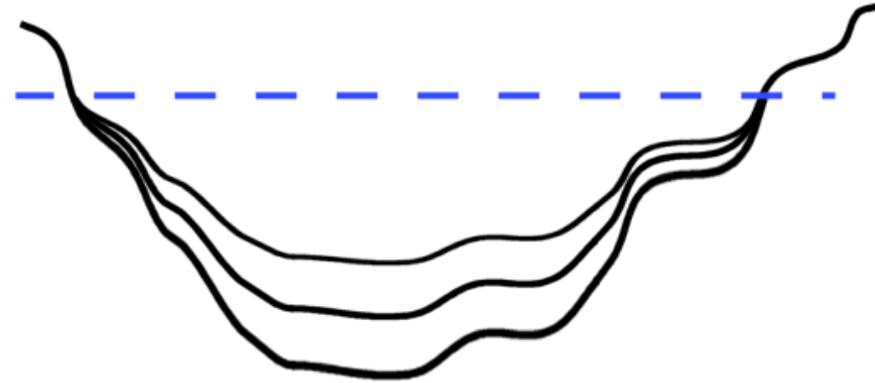
- Is the amount of sediment that the flow is capable of moving.
- The flow may not be capable of transporting all of the eroded material.
- The flow may be capable of transporting more than the eroded material.
 - In this case the transport capacity will not be satisfied.





Sediment in Streams

- Particles larger than sand (user specified) treated as bed load and routed with Yang's method
- Smaller particles treated as wash load – advection dispersion equation
- Stream cross sections adjusted for erosion and deposition
- Particles settle or can be passed through reservoirs





Interaction with Reservoirs

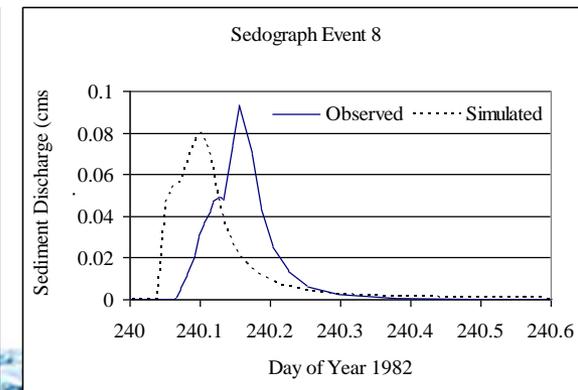
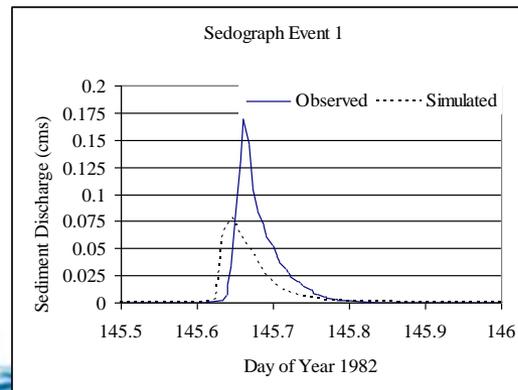
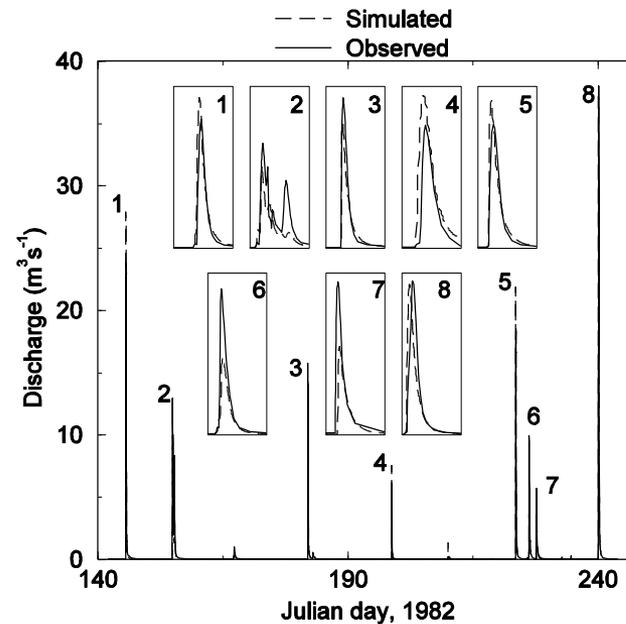
- Sands from overland plane into reservoir are deposited in boundary reservoir cells.
 - Reservoir boundary is dynamic.
- Sands from upstream channel network are removed from system and accounted for.
- Fines from overland and channels are accounted in reservoir, and can flow through.
- Reservoir is a completely mixed reactor.
- Fines settle in overland cells within the reservoir.
- Fines are discharged at the reservoir outlet.
- Since the reservoir is impeded in the overland flow grid regular erosion/transport/deposition occurs in exposed cells.





Continuous Simulations

- Simulates each event with memory of previous events
 - Erosion
 - Deposition
 - Changes in particle distribution
- Simulates events more than 4 orders of magnitude different without change in parameter values



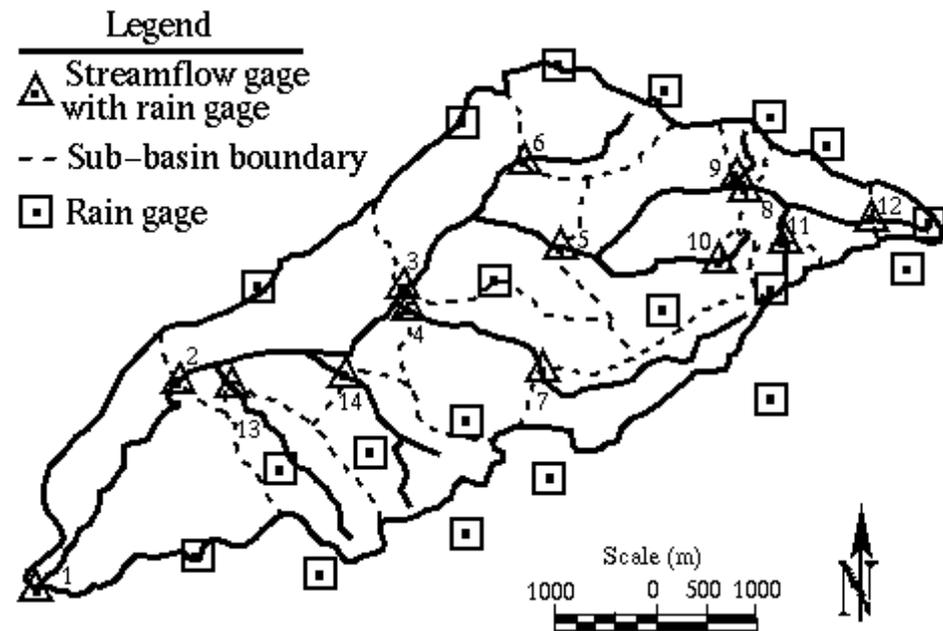
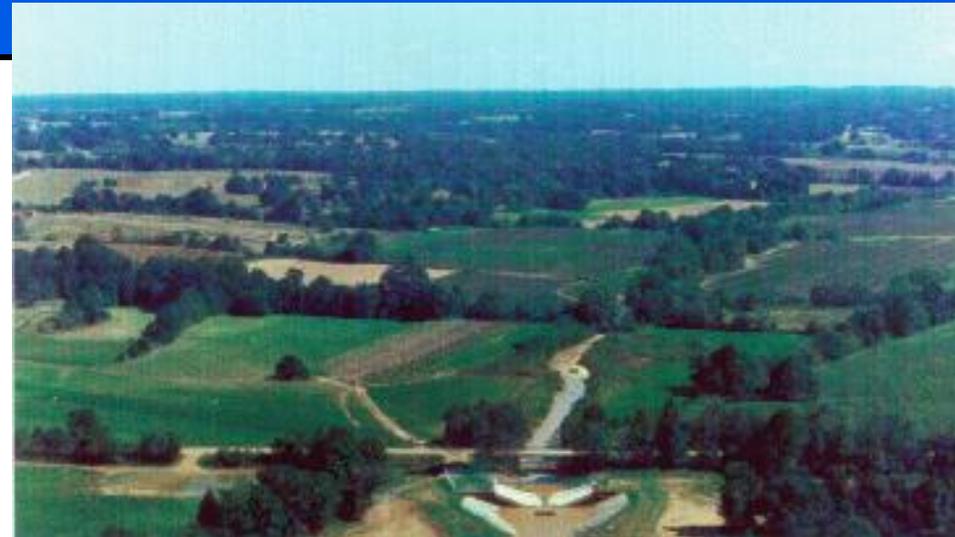


Example

Goodwin Creek
Experimental Watershed
near Oxford, Mississippi,
est. 1981.

Operated by:

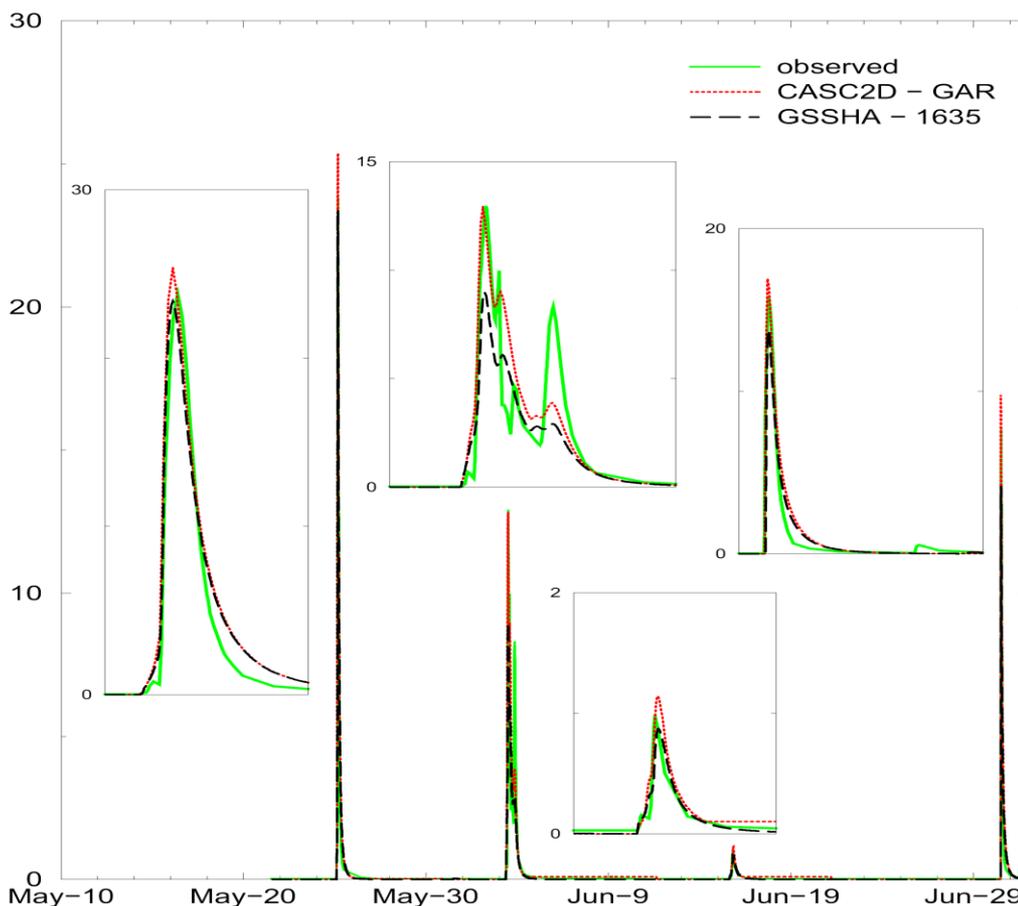
US Dept. of Agriculture,
Agricultural Research
Service, National
Sedimentation Laboratory





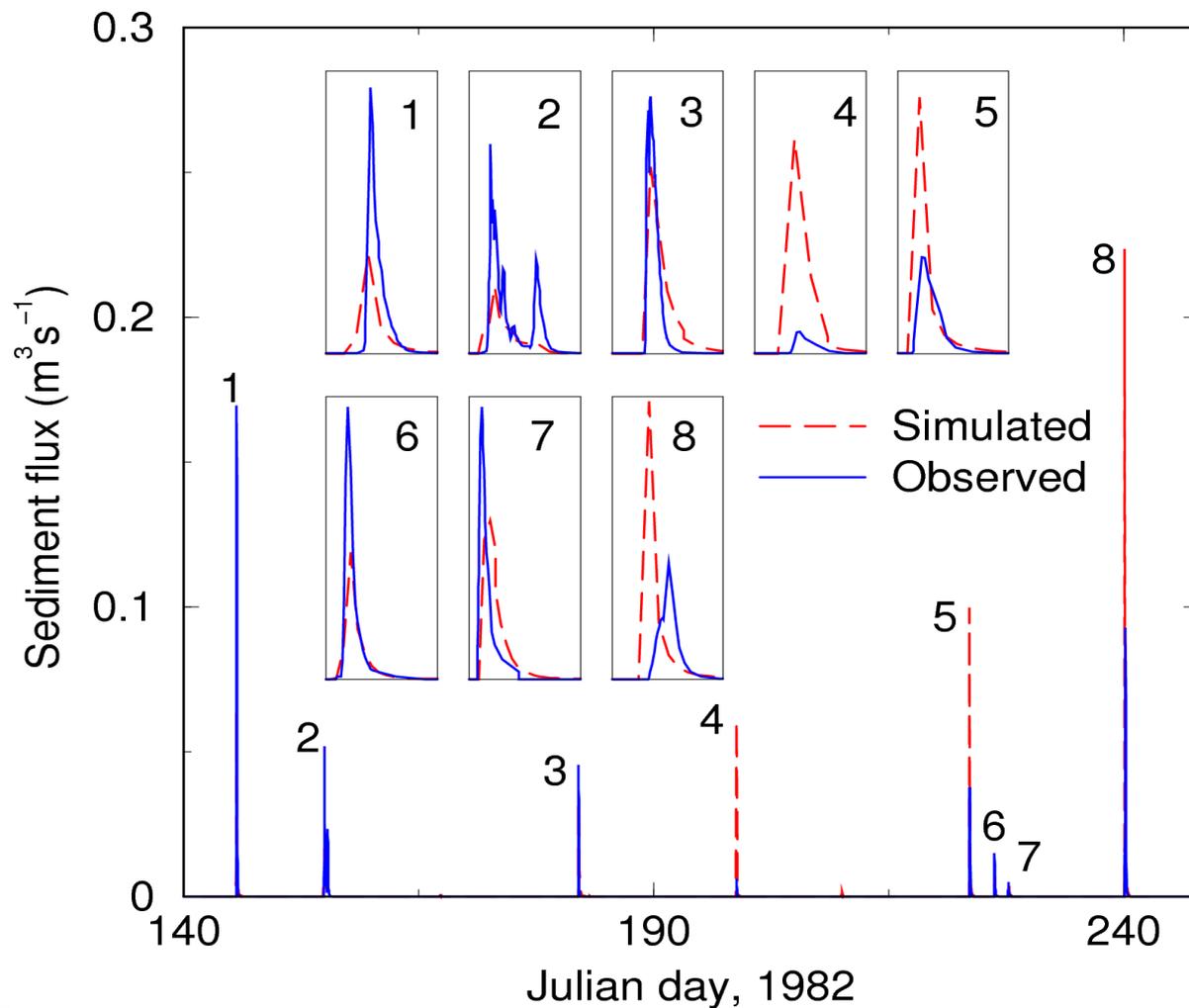
GSSHA Model Hydrologic Performance

Continuous calibration
on Goodwin Creek
Watershed Data Set
(Senarath et al. 2000,
Water Resour. Res.)





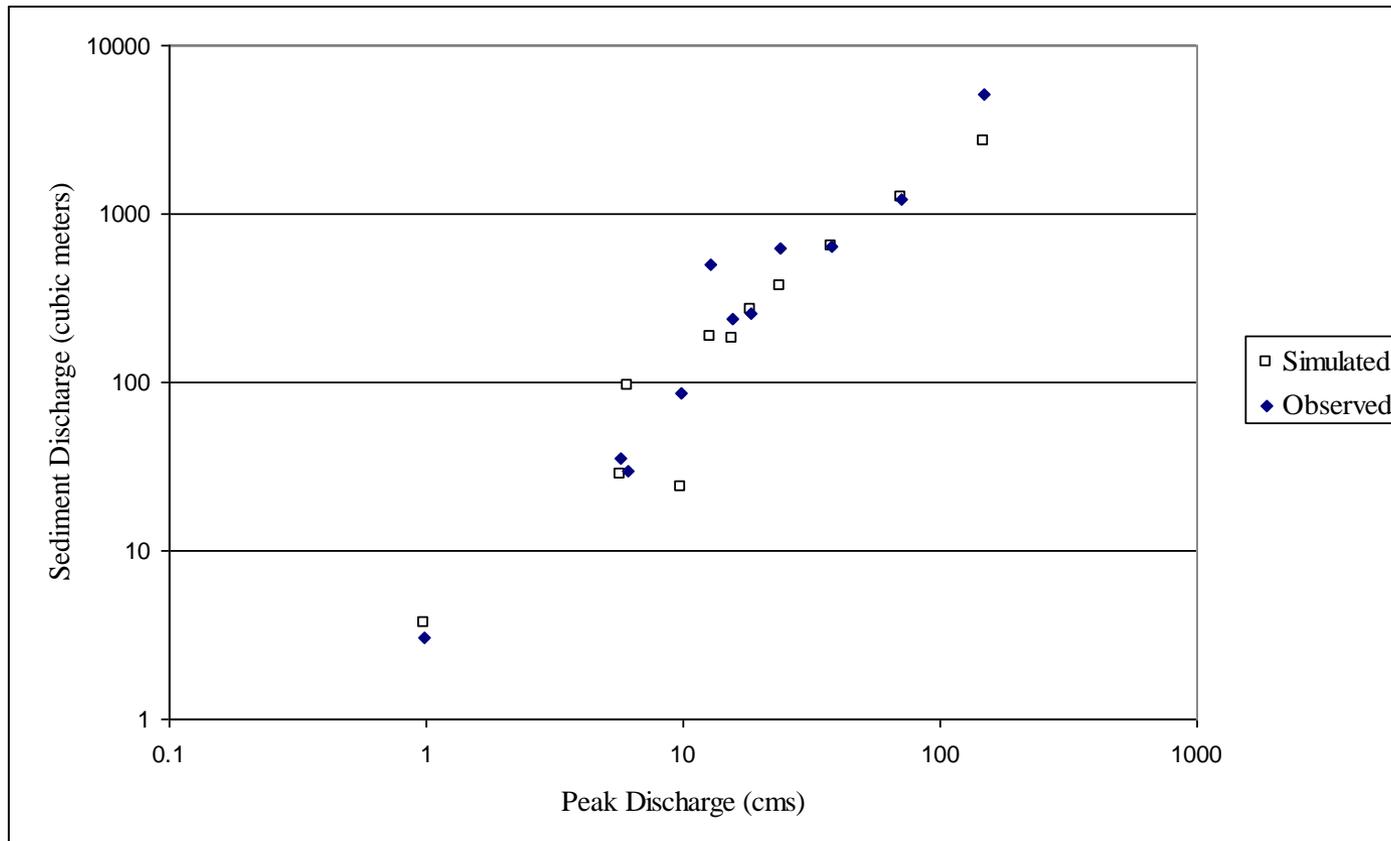
Suspended Sediment Calibration/Verification Results





Extended Simulations

- Model was capable of simulating events across 4 orders of magnitude in size.





Eau Galle River Flow and Sediment



2_EauGalle_1280x720.wmv



eg_sed_flux.wmv





Conclusions

- GSSHA is fully distributed, physics based watershed model that can be used for
 - Hydrologic analysis
 - Hydraulic analysis
 - Sediment transport
 - Water quality
- GSSHA fully integrates overland, channel, reservoirs, and groundwater and can simulate interactions and feedback between the domains.
 - Provides a higher level analysis that loose connections between models, like surface water hydrology to stream routing.
- GSSHA simulates the movement of sediments in this integrated format and can be used for many types of sediment studies.





Further Information

GSSHA reference materials:

<http://www.gsshawiki.com/>

<http://chl.erd.c.usace.army.mil/gssha>

Tutorials

Primer

Reference Manual

Download GSSHA Model

WMS reference materials:

<http://www.xmswiki.com/>

<http://chl.erd.c.usace.army.mil/wms>

The screenshot shows a web browser window displaying the GSSHA Wiki page. The page title is "Gridded Surface Subsurface Hydrologic Analysis" and it is noted as being redirected from the main page. The page content includes a welcome message and a detailed introduction to the GSSHA model and its documentation. A table of contents is visible, listing various documents such as the GSSHA Software Primer, User's Manual, Tutorials, and Utility Programs. The page also features a sidebar with navigation links for information, tutorials, utility programs, and primers.

Gridded Surface Subsurface Hydrologic Analysis
(Redirected from Main Page)

Welcome to the GSSHA™ Wiki!

The GSSHA™ Wiki is the best source for up to date information on the GSSHA™ model. In the last two to three years many new features have been added to the GSSHA™ model. Many of these features were developed or released after the publication of the primer and manual. One of the main purposes of the GSSHA™ Wiki is to keep the documentation up to date with the model development. Currently we are updating all the documentation and tutorials for the model on this site, such that the information on the site changes daily. Once the overhaul of the documents is complete, modifications will be made to the Wiki to keep up with further advances and releases. If you are an experienced GSSHA™ user you may still find some model features missing from the site. This site will cover only release versions of the code. Currently we are on release version 4.0. Release version 3.0b is supported by WMS 8.1, which can be downloaded below (under the Tutorials section on this page).

As many users may be aware, support of features in WMS typically lags behind development of GSSHA™. This is necessary in that we must settle on final GSSHA™ inputs and outputs before we ask them to be added to WMS. While we strongly encourage GSSHA™ users to use WMS for pre and post processing, users should be aware that many GSSHA™ models, especially GSSHA™ models with advanced features, must be at least partially developed outside of WMS. In addition to WMS, we have developed several utilities to assist in the development of GSSHA™ inputs. These utilities already are or will be added to the site as we get to them. The documents provided here describe the actual inputs to the GSSHA™ model and should be consulted when there are questions about inputs, whether developed from WMS or by other means.

This site is always being developed, so check back often for additional improvements, updates, and resources.

Chuck

Contents (hide)

- 1 Welcome to the GSSHA™ Wiki!
- 2 GSSHA™ Software Primer
- 3 GSSHA™ User's Manual
- 4 GSSHA™ Tutorials
- 5 Utility Programs
- 6 Obtaining Data
- 7 GSSHA™ Bibliography
- 8 Test Cases
- 9 Wiki Editing Guidelines
- 10 GSSHA™ Download
- 11 Disclaimer

GSSHA™ Software Primer

This document is a primer for use of the Watershed Modeling System (WMS) interface with the physically based, distributed-parameter hydrologic model Gridded Surface Subsurface Hydrologic Analysis (GSSHA™). The primary purpose of this primer is to describe how the WMS interface is used to develop inputs and analyze output from the GSSHA™ model. This primer also provides a brief description of the GSSHA™ model, including the overall model



Additional Information

- www.gsshawiki.com
- Chapter 10 of the User's Manual on the GSSHA wiki.
 - Formulation
 - Suggested values of parameters
- Improved Soil Erosion and Sediment Transport in GSSHA, ERDC-SWWRP-TN-10-3
 - Formulation
 - Implementation in GSSHA
 - Model testing

