Advances to the GSSHA model

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System-Wide Water Resources Program (SWWRP)

- 7-year USACE R&D initiative designed to assemble and integrate the diverse components of water resources management

- The ultimate goal is to provide to the Corps, its partners, and stakeholders the overall technological framework and analytical tools to restore and manage water resources and balance human development activities with natural system requirements

https://swwrp.usace.army.mil
## SWWRP Program Structure

### USACE/National Water Resource Needs

<table>
<thead>
<tr>
<th>Region</th>
<th>Management</th>
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| Regional Water Management | *Watershed Hydrology Simulation*  
  *Riverine & Estuarine Simulation*  
  *Coastal Simulation*  
  *Water Processes & Assessments* |
| Regional Sediment Management | *River Basin Morphology, Modeling, & Management*  
  *Coastal Morphology, Modeling, & Management*  
  *Sediment Management Methods*  
  *Sediment Processes Studies* |
| Ecosystem Assessment & Management | *Landscape Assessment*  
  *Transport Modeling*  
  *Ecological Modeling*  
  *Ecosystem Response Forecasting*  
  *Ecosystem Processes* |

### Unifying Technologies

- Integrating Frameworks
- Data Management
- Geospatial Applications Development
- Regional Measurement and Monitoring
- Model Integration
- Decision Support and Knowledge Management
SWWRP

Watershed Hydrology Simulation

• 5 Research Areas
  – HMS development
  – GSSHA development
  – Uncertainty/parameter estimation/stochastic simulation tools for system-scale models
  – Regional flood prediction
  – Coupled, multi-dimensional groundwater-surface water interaction simulation
GSSHA

- Distributed, physically-based Gridded Surface Subsurface Hydrological Analysis (GSSHA) model
- Simulates 2D overland flow, 1D channel routing, 2D saturated groundwater flow, canopy retention, microtopography, 1D infiltration and ET using finite-difference and finite-volume methods
Distributed Hydrologic Parameters

- Uses Land Use, Soil Type Information
Cell-to-Cell Overland Flow

- 2D Overland Flow
Channel Routing

- 1D Stream Flow
Subsurface Flow

- **Infiltration**
  - Green & Ampt
  - Green & Ampt with Soil Moisture Redistribution
  - 1-D Richards’ Equation
  - Sacramento Soil Moisture Accounting

- **2D Groundwater**
  - Full interaction
Sources/Sinks

- Precipitation
  - Gage
  - Theissen
  - IDW
  - Radar

- Evapotranspiration
  - Long-term simulation
  - Soil Moisture Accounting
Hydrologic Elements/Options

- Lakes & Reservoirs
- Wetlands
- Hydraulic Structures – Culverts, Weirs
- Embankments
- Sediment Erosion and Deposition
- Contaminant Transport
- Storm Pipe, Tile Drain Network
Lakes
Wetlands
Wetlands

- Specify:
  - Retention Depth
  - Vegetation Height
  - Lateral Hydraulic Conductivity
  - Seepage Face
  - Vegetation
  - Fully Submerged Vegetation Roughness Coefficient
Wetlands

- Flow Through Seepage Face
  - Darcian, $Q = k_i A$
  - Hydraulic gradient from cell center to cell center
Wetlands

- Overtopping flow (Flow Through Vegetation)
  - Combination of Darcian, Manning’s

Manning’s Flow

Darcian Flow
How to Obtain GSSHA

- Fully supported in WMS version 7.x
GSSHA Simulation of the Coon Creek Watershed
Coon Creek Simplified Soils

- 8 Soil Types
- 3 Subsurface Layers
- Simplified by similar surface, subsurface characteristics
Coon Creek Land Cover (1999)

- 6 Classifications
  - Urban
  - Corn
  - Soybeans
  - Forest
  - Wetlands
  - Grassland
Project Goals

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

Coon Creek, IL

![Graph showing flow over time for different conditions with legend: No Wetlands, Wetlands 1, Wetlands 2, Wetland 3, Wetland 4.](Image)
Baseline AVI
Bonus: Storm Surge Modeling
Questions? Comments?

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