Automated Geospatial Watershed Assessment (AGWA): A GIS-Based Hydrologic Modeling Tool for Watershed Assessments

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Project Background & Acknowledgements

- **Long-Term Research Project**
  - **EPA Landscape Ecology Branch**
  - **EPA Office of Water**
  - **8 years**
- **Interdisciplinary**
  - **Watershed management**
  - **Landscape ecology**
  - **Remote sensing**
  - **GIS**
- **Multi-Agency**
  - **USDA – ARS**
  - **US – EPA**
  - **University of Arizona**
  - **University of Wyoming**

** ***2000 CSREES Grant provided genesis for Internet Version of AGWA: DotAGWA***

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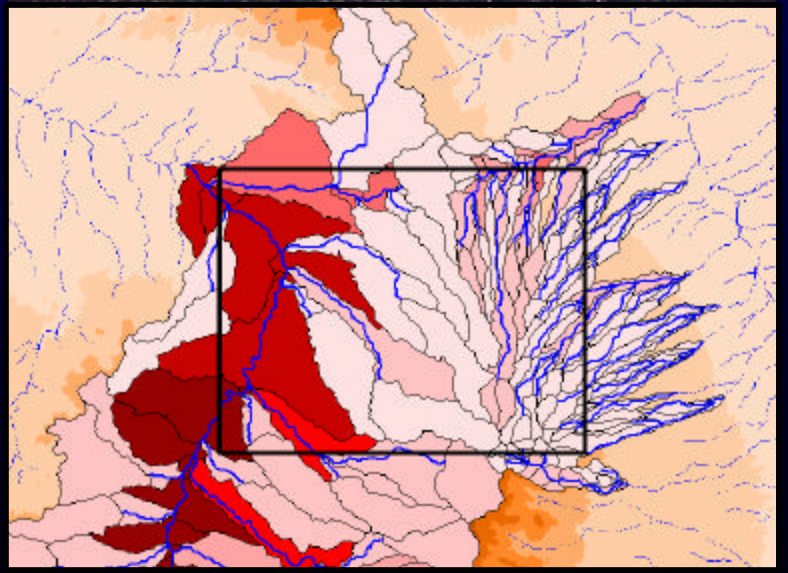
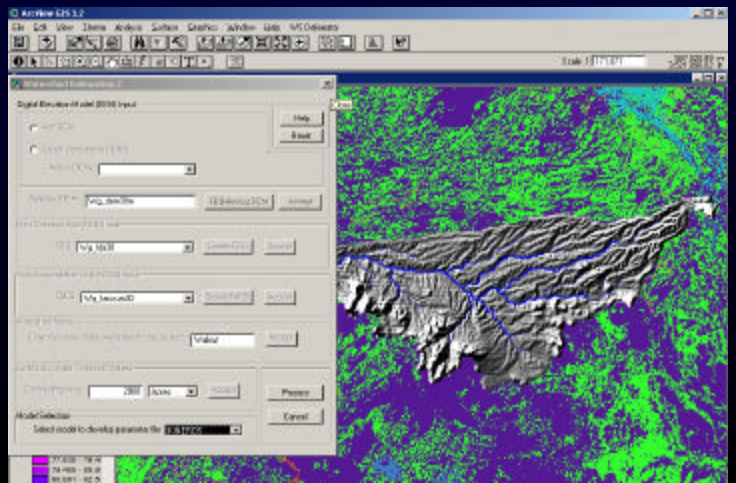
OVERVIEW

- AGWA Background
- System Features with emphasis on new functionality to broaden range of watershed assessment capability
- Selected case studies
- Future Directions



Objectives of the AGWA tool

- **PC-based GIS tool for watershed modeling**
  - **Can accommodate multiple hydrological models (*modular*)**
- **Investigate the impacts of land cover change, and management practices, on runoff, erosion, water quality**
- **Targeted for use by research scientists, management specialists**
  - **Ease of use**
  - **Widely applicable**

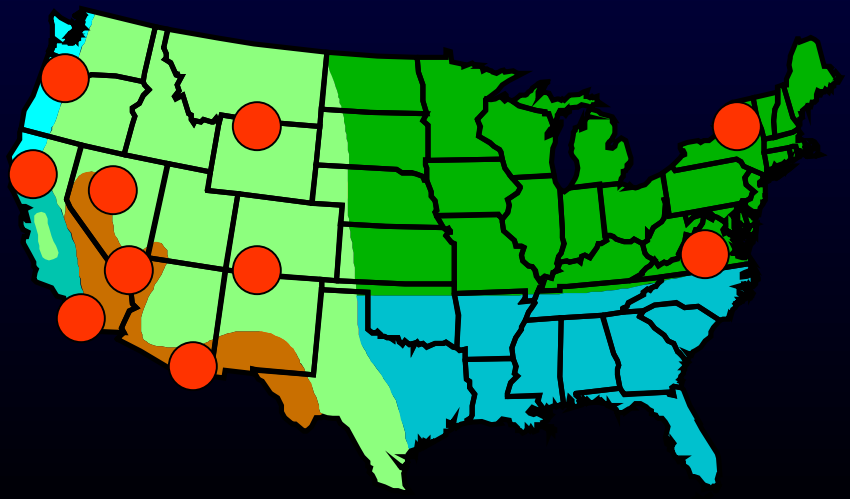


Objectives of the AGWA tool

- **Simple, direct method for model parameterization**
- **Provide accurate, repeatable results**
- **Require basic, attainable GIS data**
  - **30m USGS DEM (free, US coverage)**
  - **STATSGO, SURRGO, FAO soil data (US and global coverage)**
  - **US-EPA NALC, MRLC, and GAP landscape data**
- **Useful for scenario development, alternative futures simulation work, and watershed assessments**
  - **Provide *relative change* when validation data is insufficient**

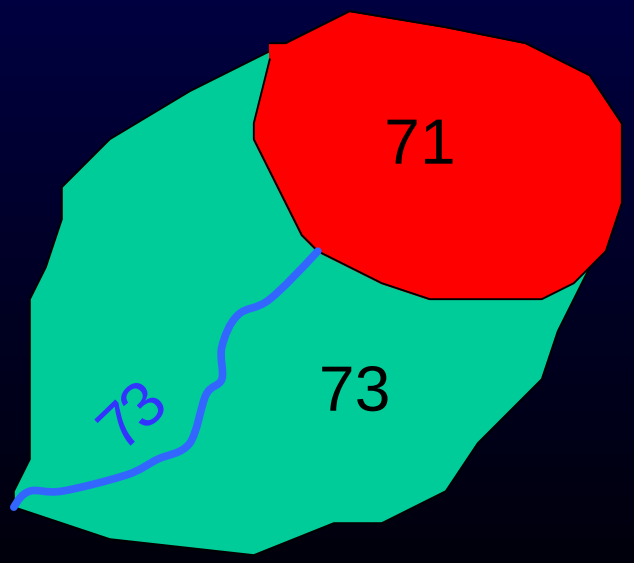
Modeling the Impacts of Land Cover Change and Best Management Practices

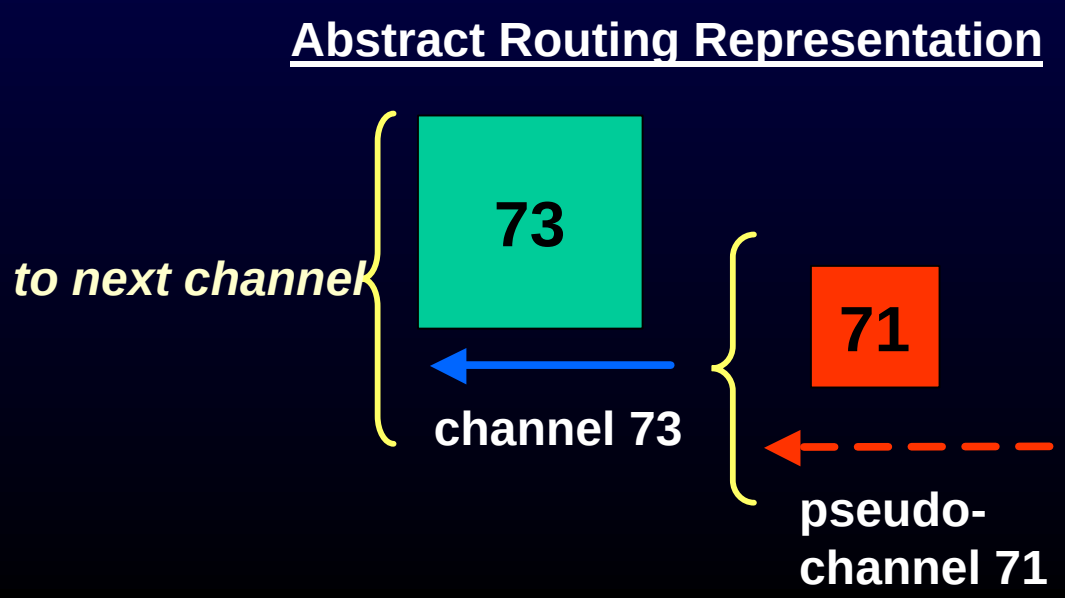
- **Two models utilized to account for a range of space and time scales**
  - **KINEROS (smaller basins, events – design storms)**
  - **SWAT (Large basins – daily/annual)**
- **AGWA used for assessing flooding, water supply, and water quality**
- **Has been applied across a range of landscape, precipitation regimes**



Soil Water and Assessment Tool (SWAT)

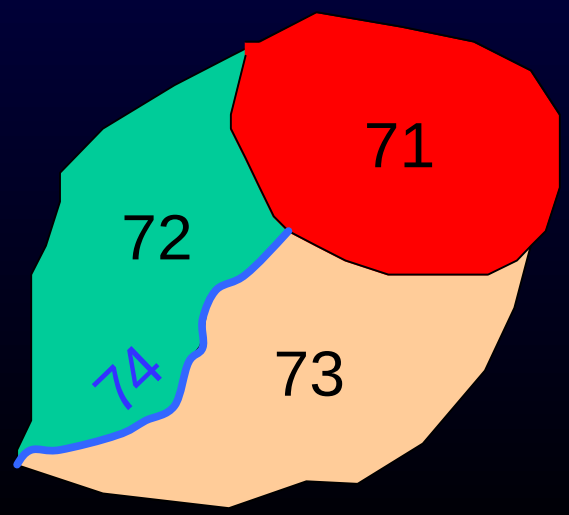
- Daily time step
- Distributed: empirical and physically-based model
- Curve-number based infiltration
- Hydrology, sediment, nutrient, and pesticide yields
- Larger watersheds (> 1,000 km^2)



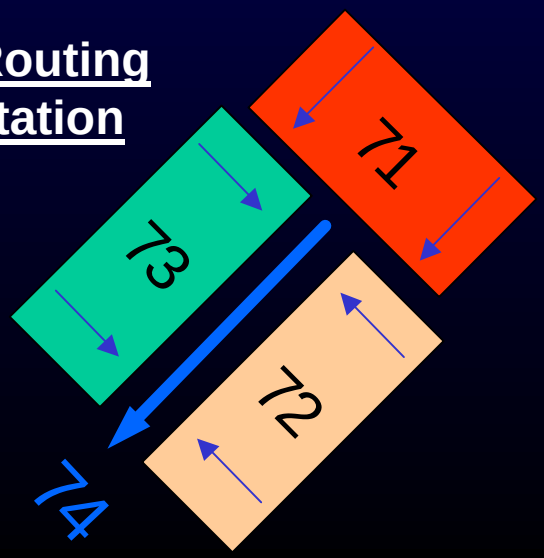


Kinematic Runoff and Erosion Model (KINEROS2)

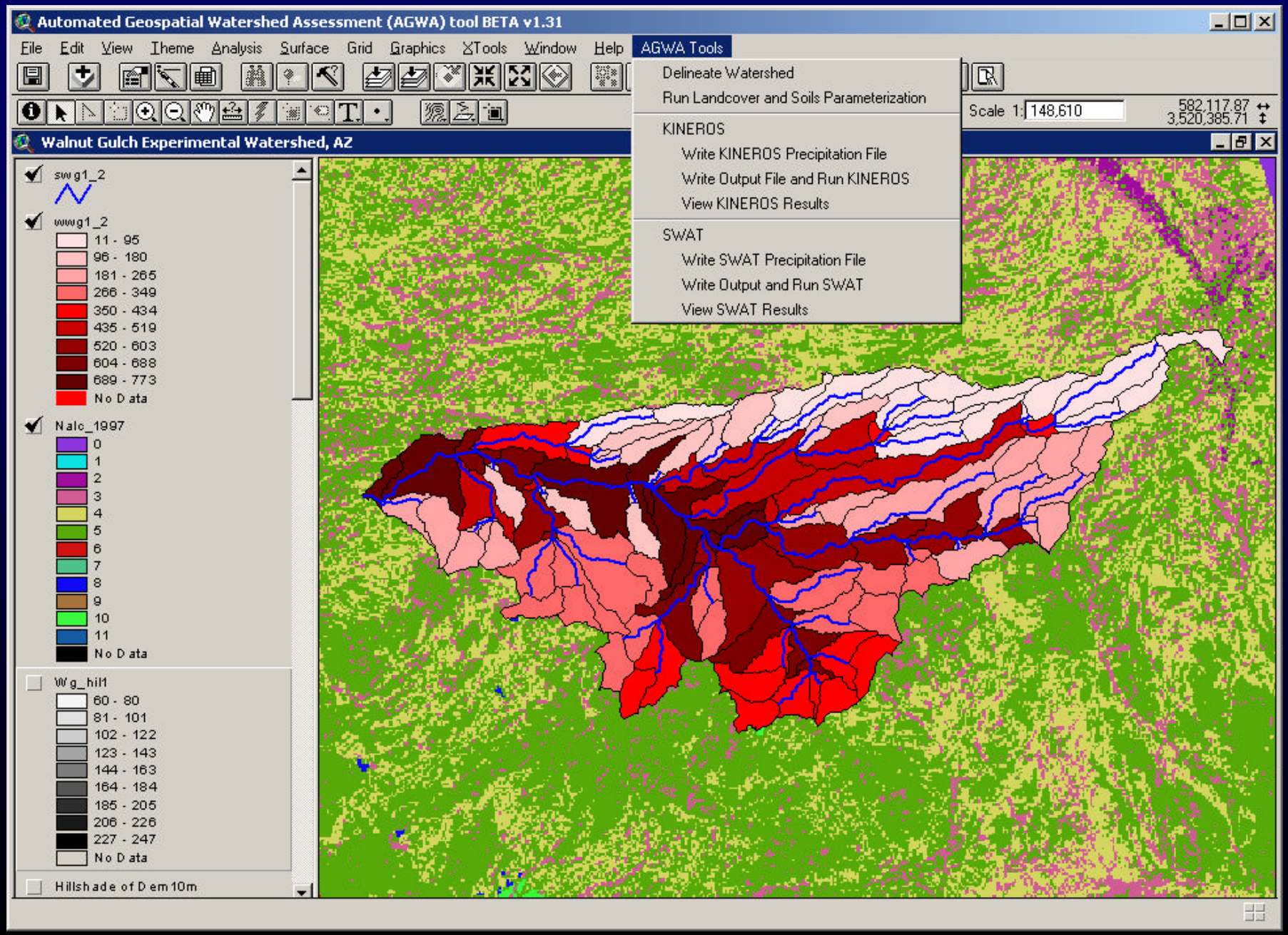
- **Event-based (< minute time steps)**
- **Distributed: physically-based model with dynamic routing**
- **Hydrology, erosion, sediment transport**
- **Typically applied to smaller watersheds (100-200 km^2)**
- **Enable direct tracking of BMPs / land use on downstream impacts**



Abstract Routing Representation



AGWA 1.4 ArcView Interface – As in BASINS 3.1



Conceptual Design of AGWA

PROCESS

GIS Database
(Soils, GAP, DEM)

↓

Discretize Watershed
f (topography)

↓

Characterize Model Elements
f (landcover, topography, soils)

↓

Derive Secondary Parameters
look-up tables

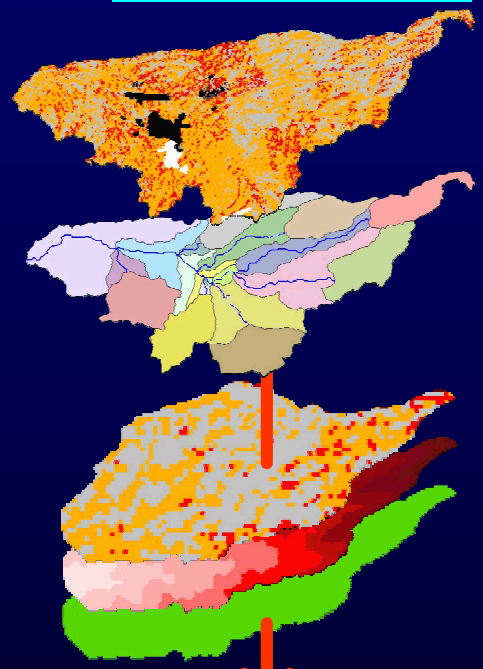
↓

Build Model Input Files

↓

View Model Results
link model to GIS

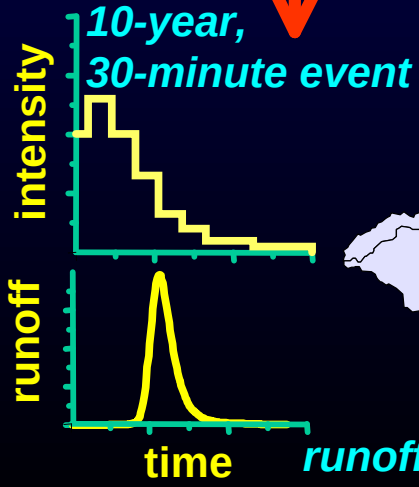
PRODUCTS



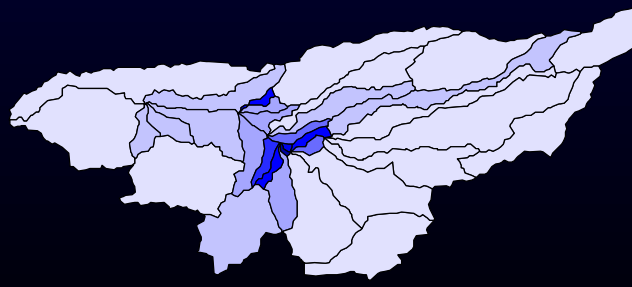
STATSGO, FAO
NALC, MRLC, GAP
USGS 7.5' DEM

Contributing Source Area

Gravelly loam Soil
- **Ks = 9.8 mm/hr**
- **G = 127 mm**
- **Por. = 0.453**

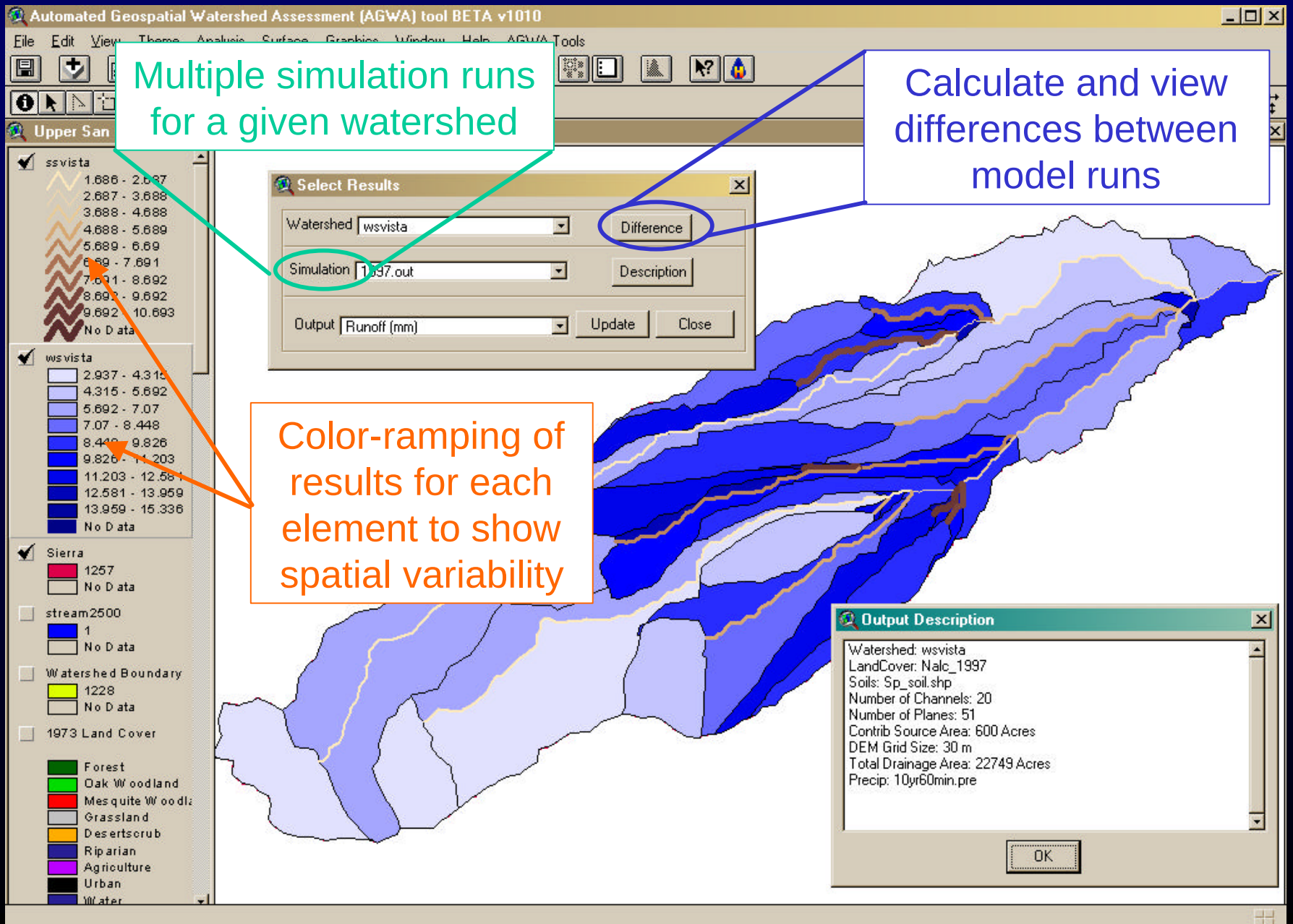


Spatially Map Back Model Results



runoff, sediment hydrograph

Visualization of Results

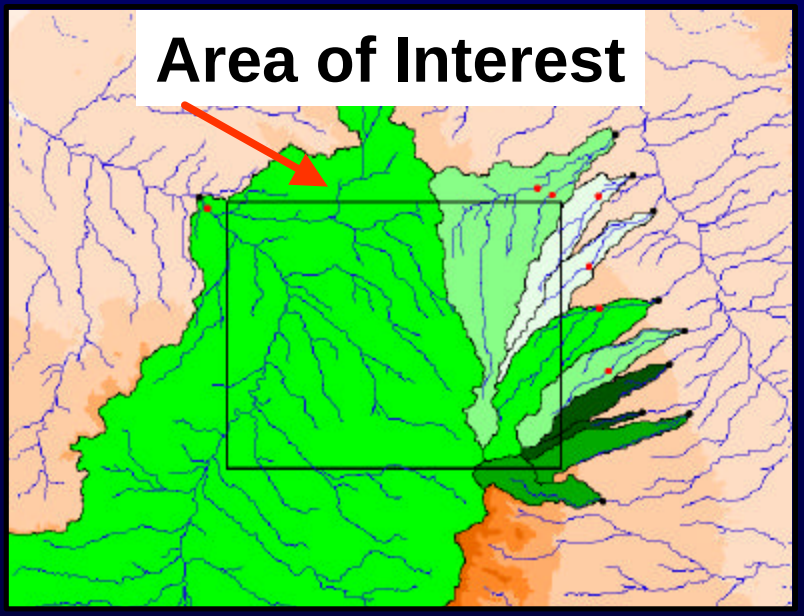


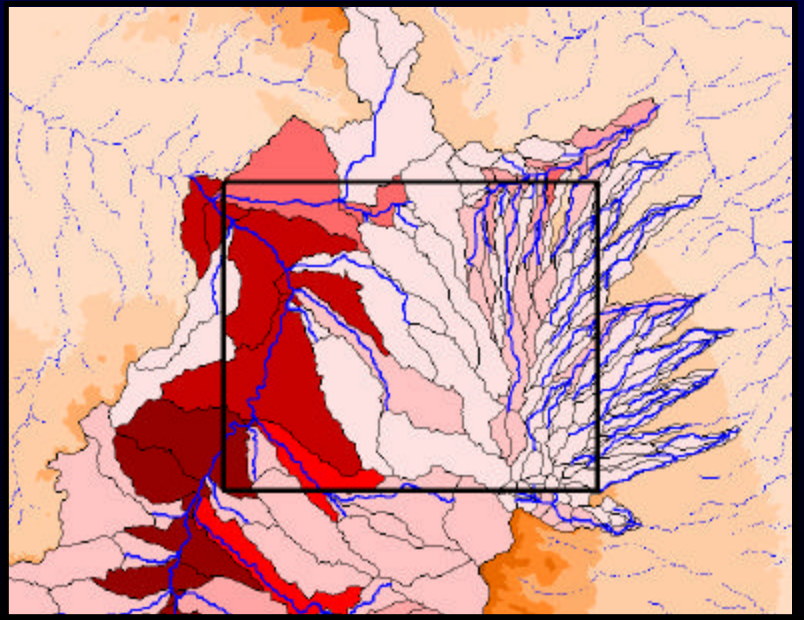
New Tools to be released in: AGWA 1.5 (ArcView); AGWA 2.0 (ARCGIS and BASINS 4.0); and, DotAGWA (Internet)

- **“Area of Interest” simultaneous multiple watershed analysis**
- **Multiple internal gauges**
- **KINEROS stream buffer strip tool**
- **2 new land-cover modification options**
- **BMP land Cover modification using NRCS state and transition models**
- **Post-fire watershed assessment**

Area of Interest Multiple Watershed Analysis

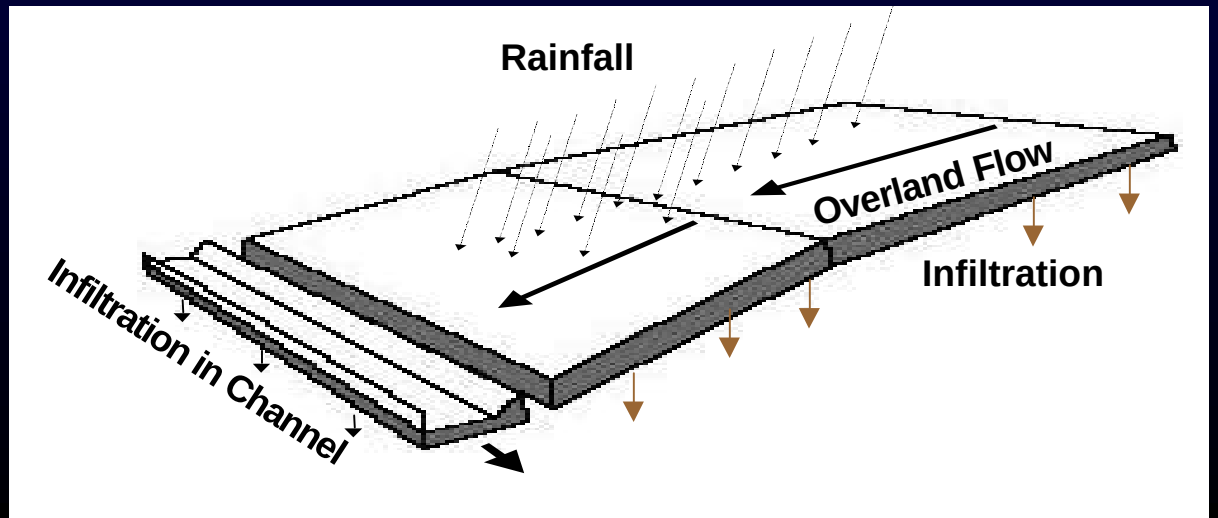
- Interactively locates multiple watershed outlets
- Outlet ID uses the stream network & boundary polygons
  - Attempts to cover the area with the fewest, and smallest, watersheds necessary
- Discretized watersheds form a watershed group that is parameterized and simulated as one unit

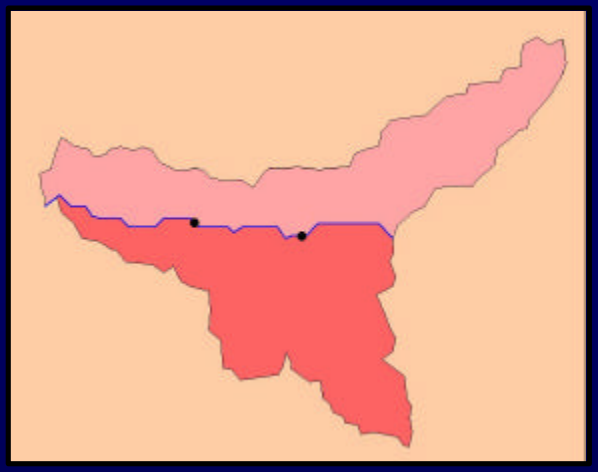


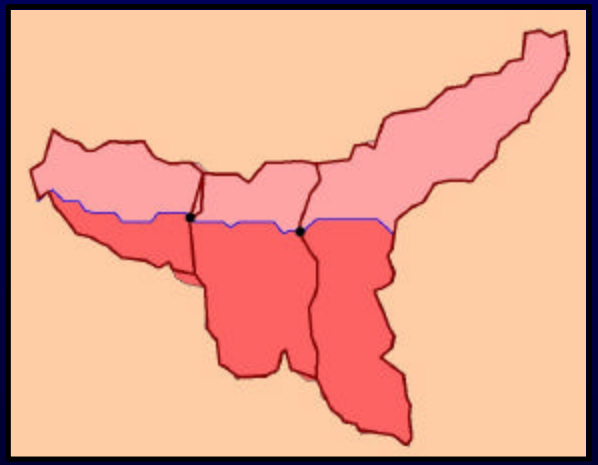


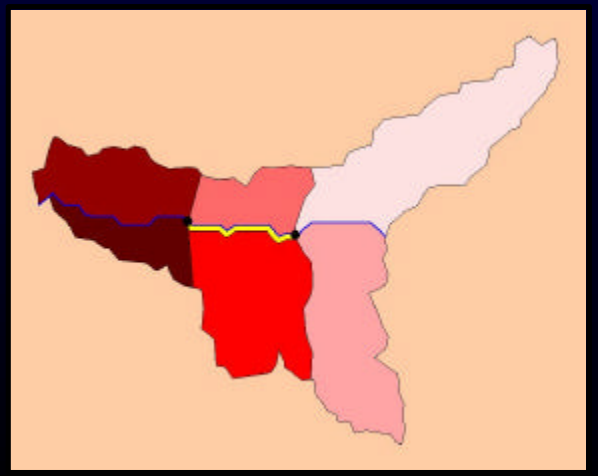
KINEROS Stream Buffer Tool

- User-defined geometry (length and width) for each buffer on the watershed
- Can be parameterized for pre- and post-treatment scenarios
  - Post-treatment scenario allows users to select a new landcover and slope for the buffer element
- Simulation models the runoff-runon process via interactive infiltration in KINEROS



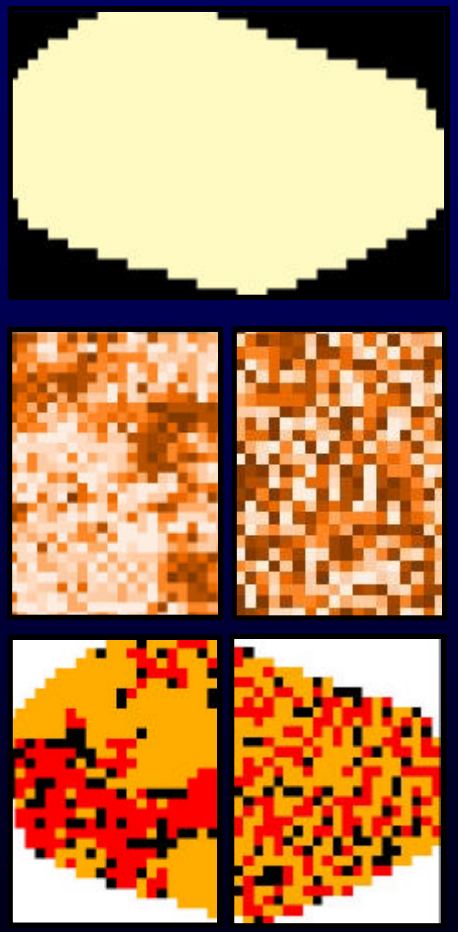






Land Cover Modification Tool

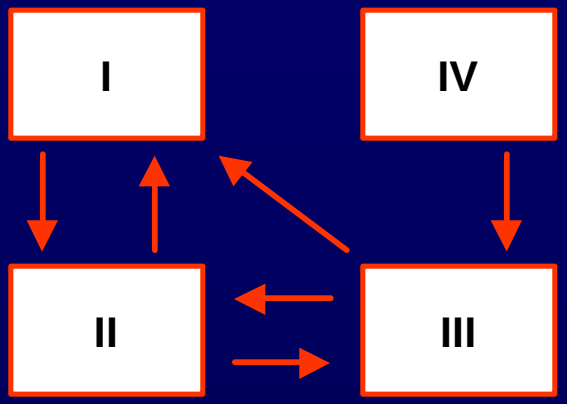
Allows users to examine the effects of different management practices on water quantity and quality at the watershed scale



Options

- **Uniform Change – existing option: User-defined polygon change from one land cover class to another**
- **For more realistic surface change a choice of two random surfaces is provided:**
  - **Allows change of an area to a new landcover or landcovers**
  - **Randomly distributed landcover patches - Two-dimensional midpoint displacement multifractal surface**
  - **Completely spatially random surface**

BMP Modification Tool

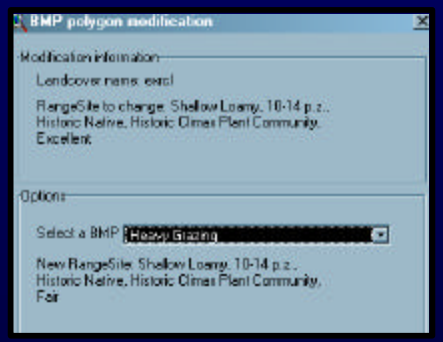


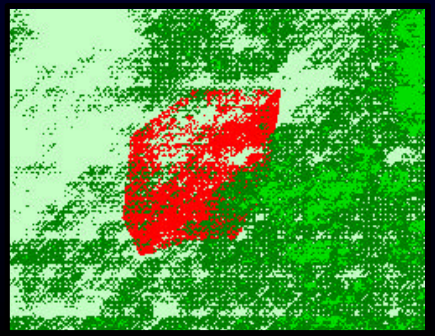
- Utilizes NRCS RangeSite Database to describes state and transition pathways for various plant communities (two pathways: succession or regression)

- Transitions are defined by the BMPs defined for the selected plant state

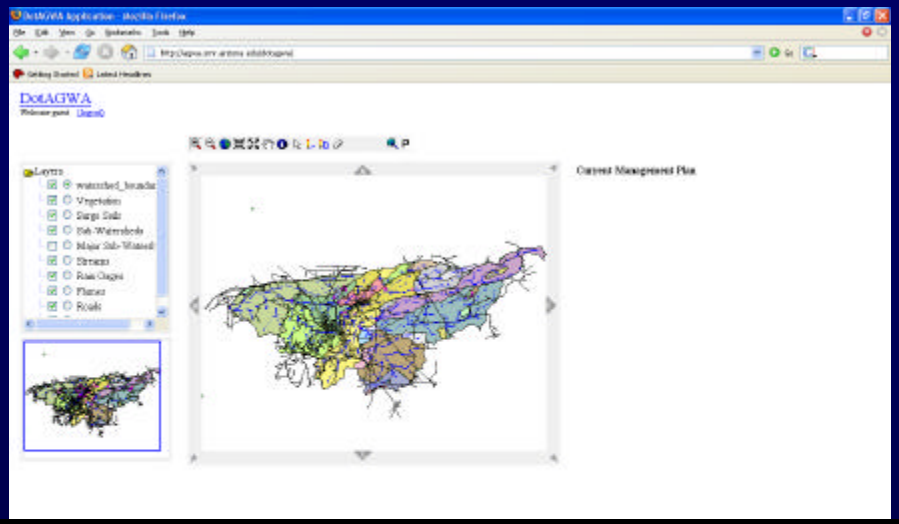
- BMPs include:
  - Prescribed fires
  - Grazing regimes
  - Invasive species control

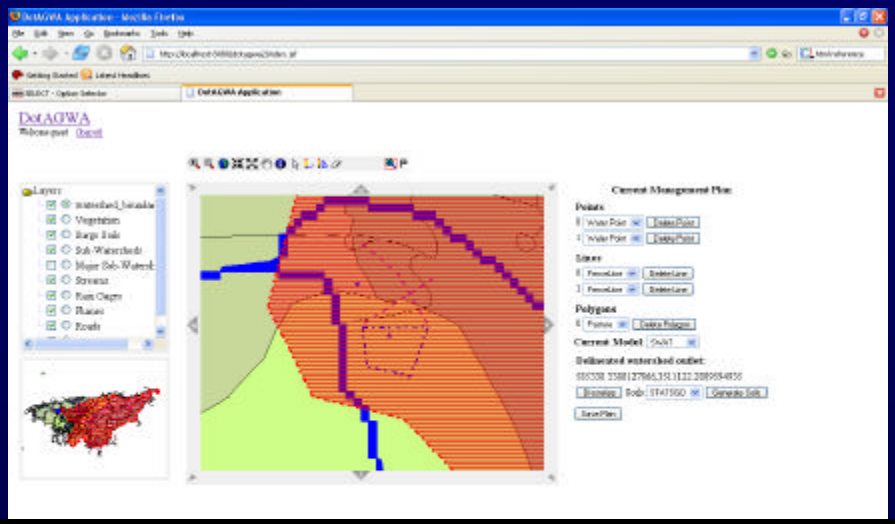
- Users can also select the success rate of a BMP, creating a randomly distributed patchy surface of the original plant state and the new plant state





DotAGWA - Beta





DotAGWA Main Interface

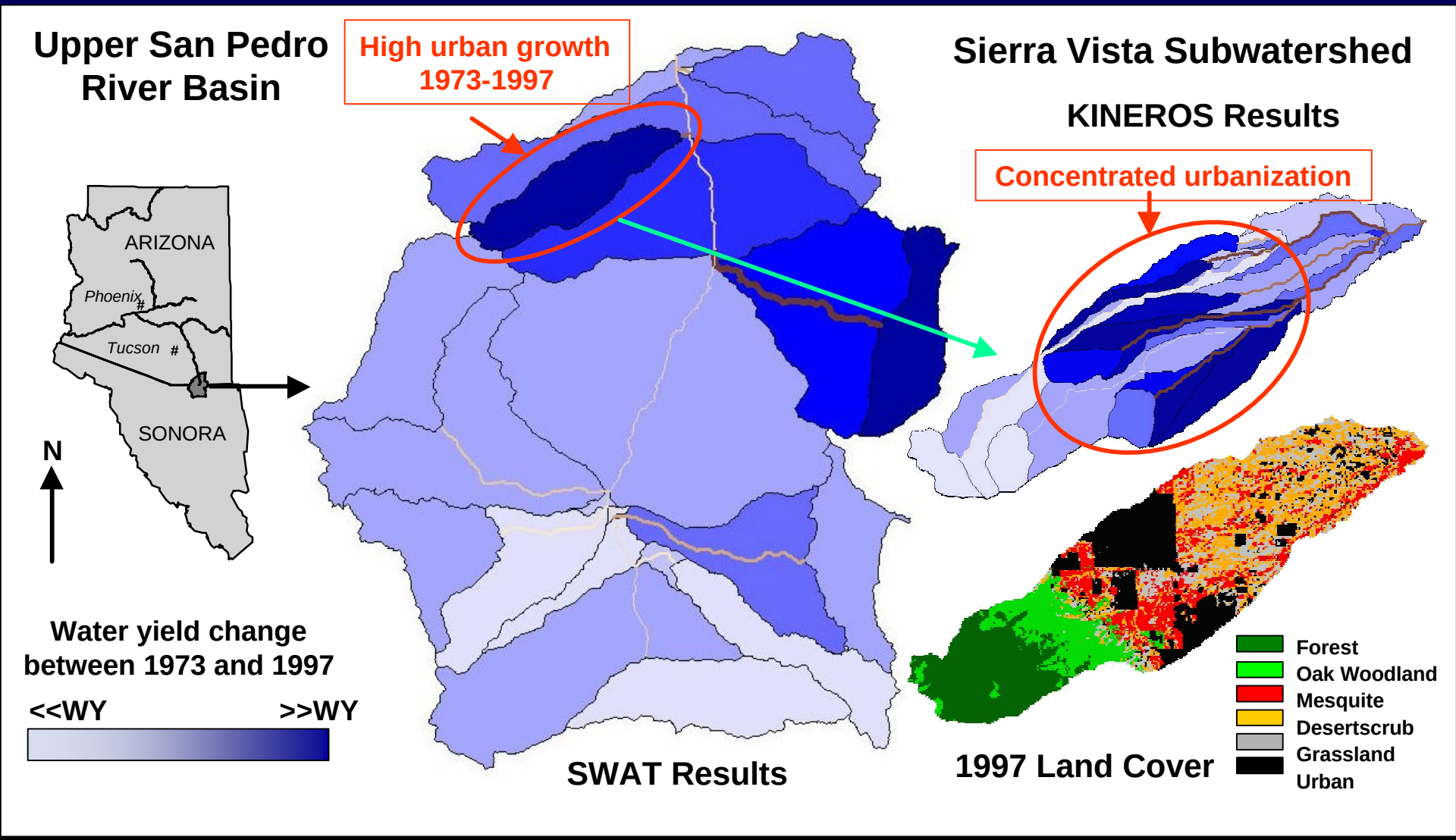
- Legend and Reference map
- Mapping tools (zoom, pan)
- Plan development tools (add water point, add fence line, add exclusion zone (polygon)
- Tools for delineating a watershed and running the discretizer

Management Plan Interface

- User has defined a plan with points, lines and polygons
- User has delineated the watershed
- User has run the discretizer to prepare input for models
- User selected model(s) run in background
- Model output presented to user and user can select type of output (under development)

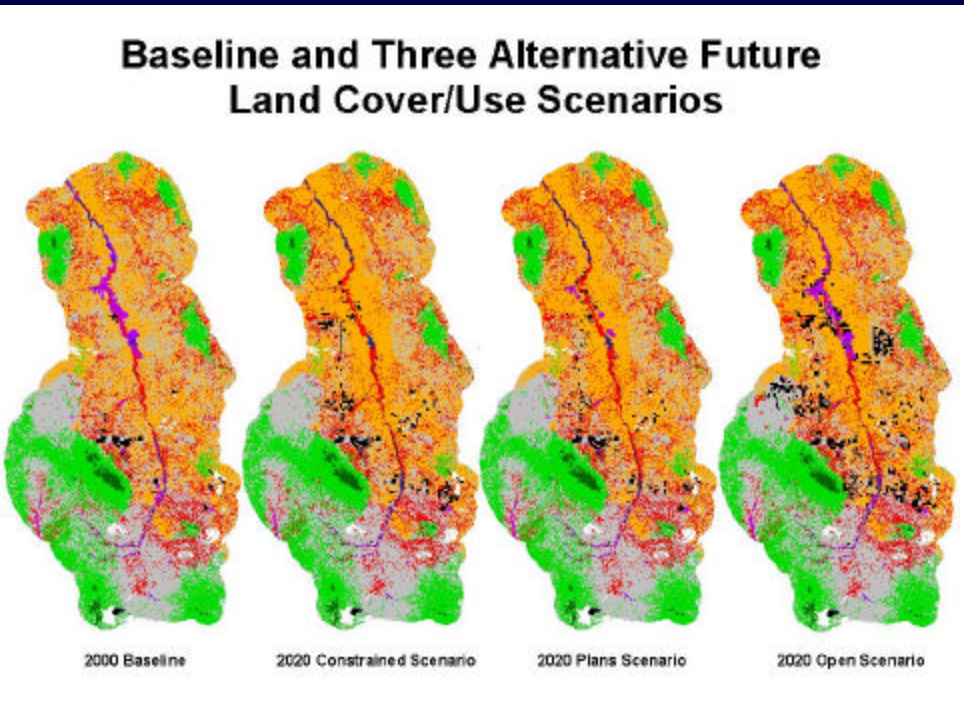
Urbanization – Multi-Scale Application

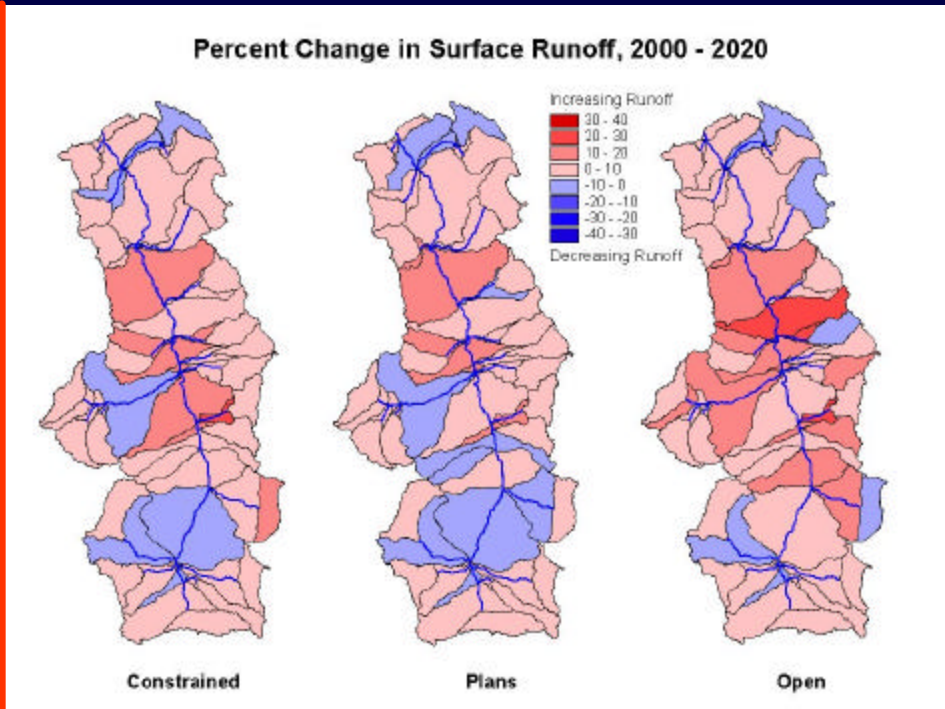
- Using SWAT and KINEROS for integrated watershed assessment
- Land cover change analysis and impact on hydrologic response



Alternative Futures Example

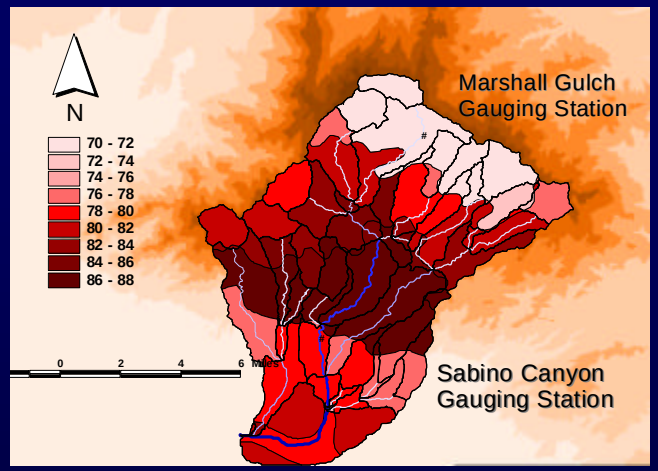
1. *Methodology:*
   - *Focus Groups to define stakeholder preferences*
   - *Acquire spatial data*
   - *Model the future landscape*
   - *Apply AGWA for each Alternative Future, Visualize and Compare Results*
2. *Development Plans: OPEN, EXISTING "PLANS", and CONSTRAINED*



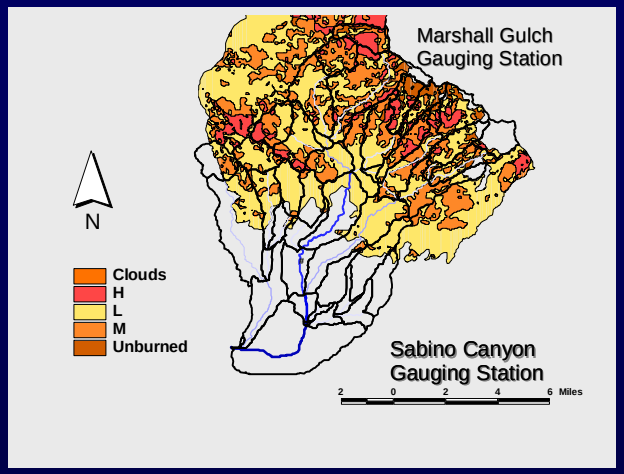


AGWA-SWAT Aspen Post-Fire Assessment

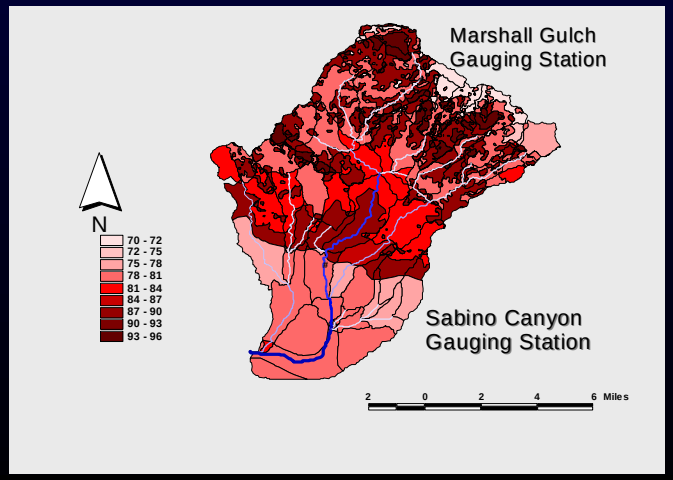
Pre-fire Est. Curve Numbers f(Hydro. Soils Group, Cover Type)



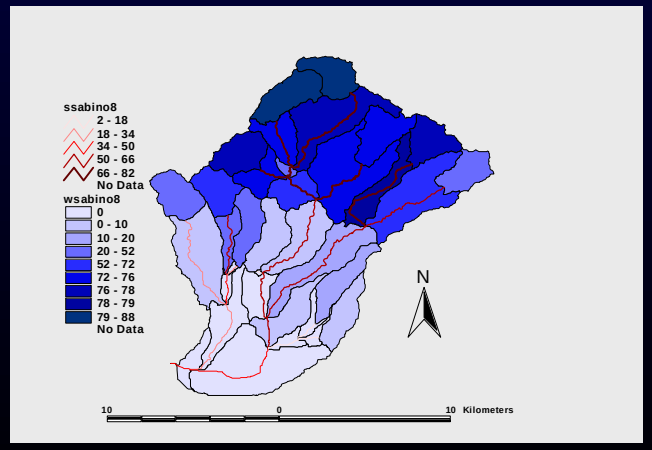
Overlay Burn Severity Map



Post-Fire Curve Number Map f(Hydro. Soils Group, Cover, Burn Severity)



Estimated Percent Change in Water Yield in First Year Following Aspen Fire



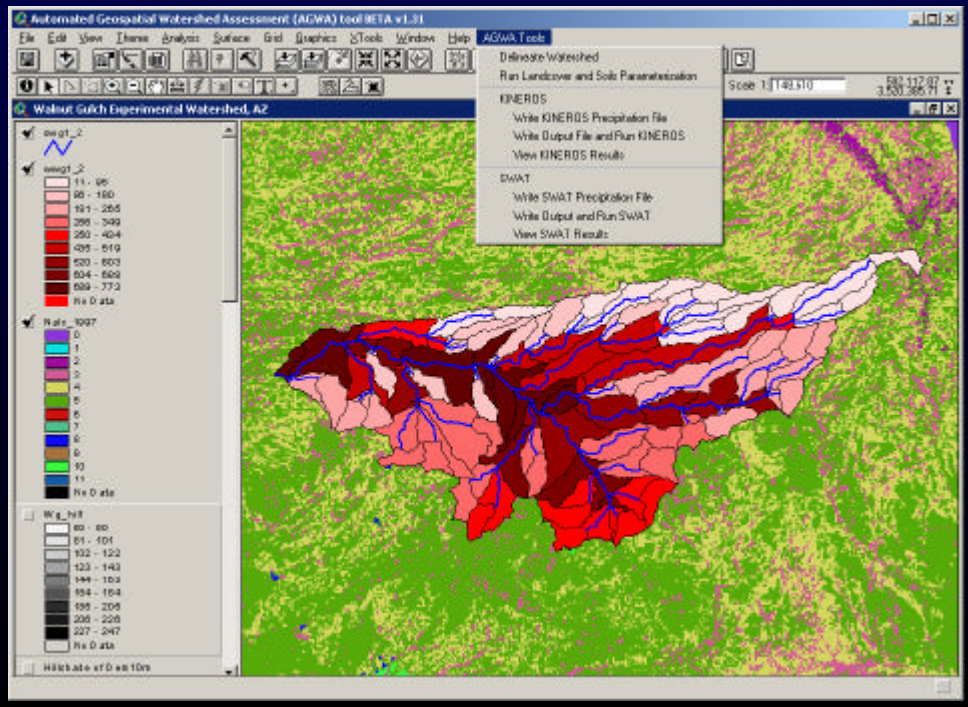
Future Directions

- 1-D Dynamic geomorphic model – channel erosion / deposition
- Enhanced ground-water parameterization for SWAT
- N and P capability enabled for SWAT in AGWA
- Mult. hydraulic-geometry relations for channel characterization
- Incorporation of WEPP erosion relations in KINEROS
- KINER-OPUS Coupling underway
  - OPUS simulation model for transport of non-point source pollutants
  - Continuous, plant growth, nitrogen, phosphorus, carbon, snow, and management
- Coupling AGWA / KINER-OPUS to MODFLOW with riparian ET
- Release ARC View AGWA 1.5 at FIHMC – April 06
- AGWA 2.0 (ARCGIS 9.0 and Dot AGWA - Beta versions to be completed March ’06)
- AGWA 2.0 incorporation into BASINS 4.0

AGWA Information

- **AGWA Web Pages:**

  http://www.epa.gov/nerlesd1/land-sci/agwa/

  http://www.tucson.ars.ag.gov/agwa/

(includes documentation, software, and related publications)