

An aerial photograph of a large farm or ranch complex. The central part of the image shows a cluster of buildings, including a large white barn-like structure, several smaller white buildings, and a long, low building with a dark roof. There are parking lots with cars and trucks. The surrounding area consists of various fields: some are green, some are brown (possibly harvested or fallow), and some are dark (possibly water or very dark soil). A road or highway runs horizontally across the middle of the image, with a curved section on the right. The overall scene is a mix of developed land and open fields.

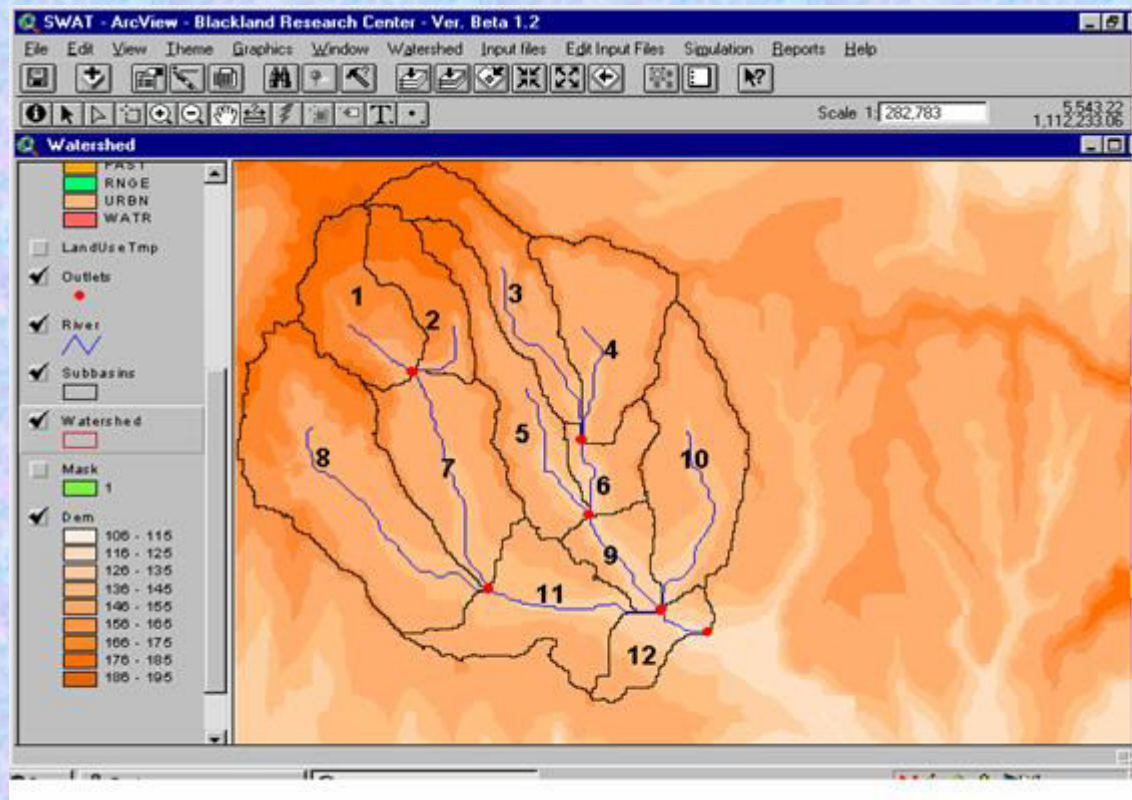
# Watershed Modeling and GIS Applications

**Jeff Arnold**  
**ARS- Temple, Texas**



# Possible Configurations

- Subwatersheds
- Hydrologic Response Units
- Output from other Models - EPIC, SWAT
- Point Sources - Treatment Plants

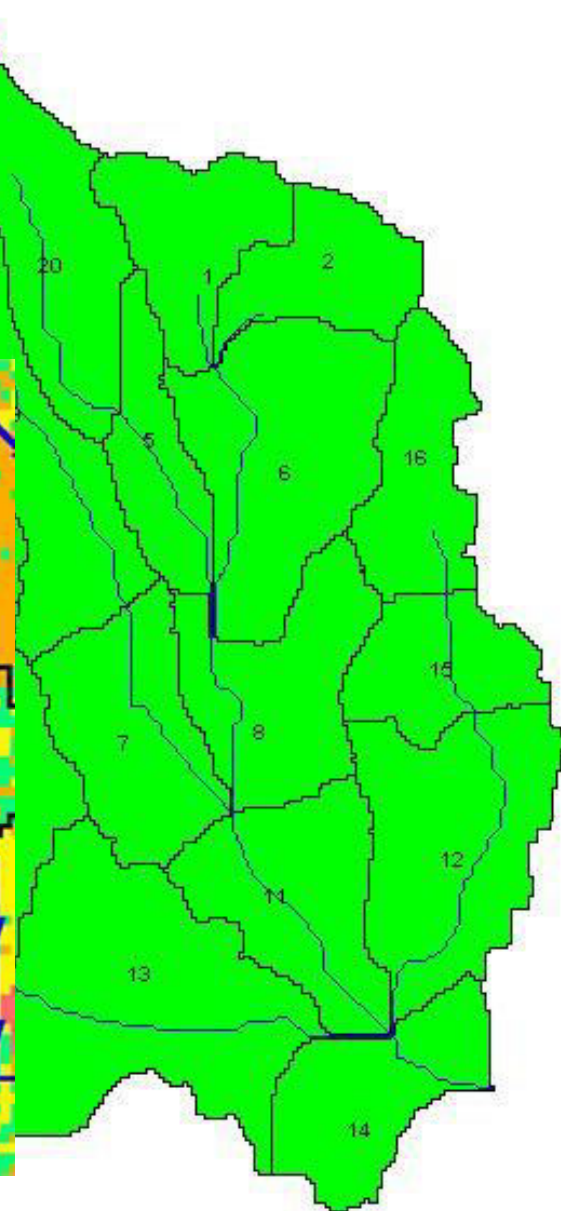
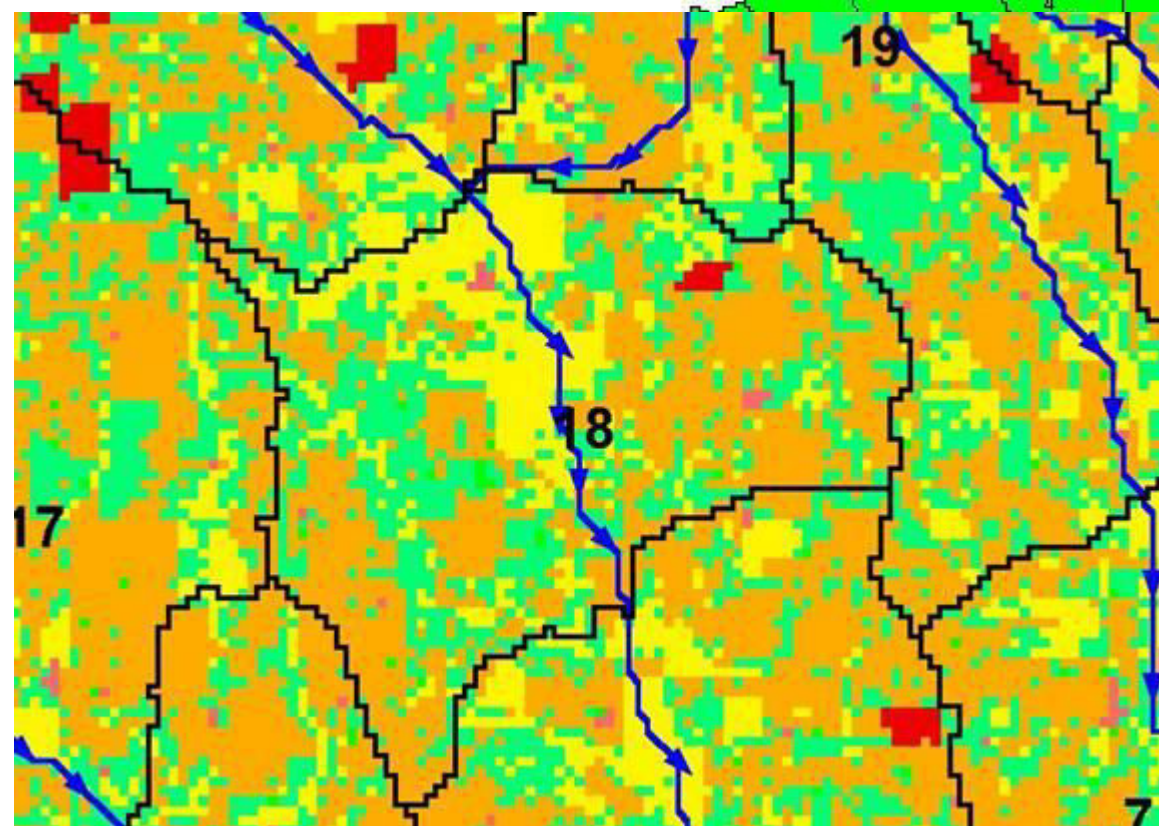




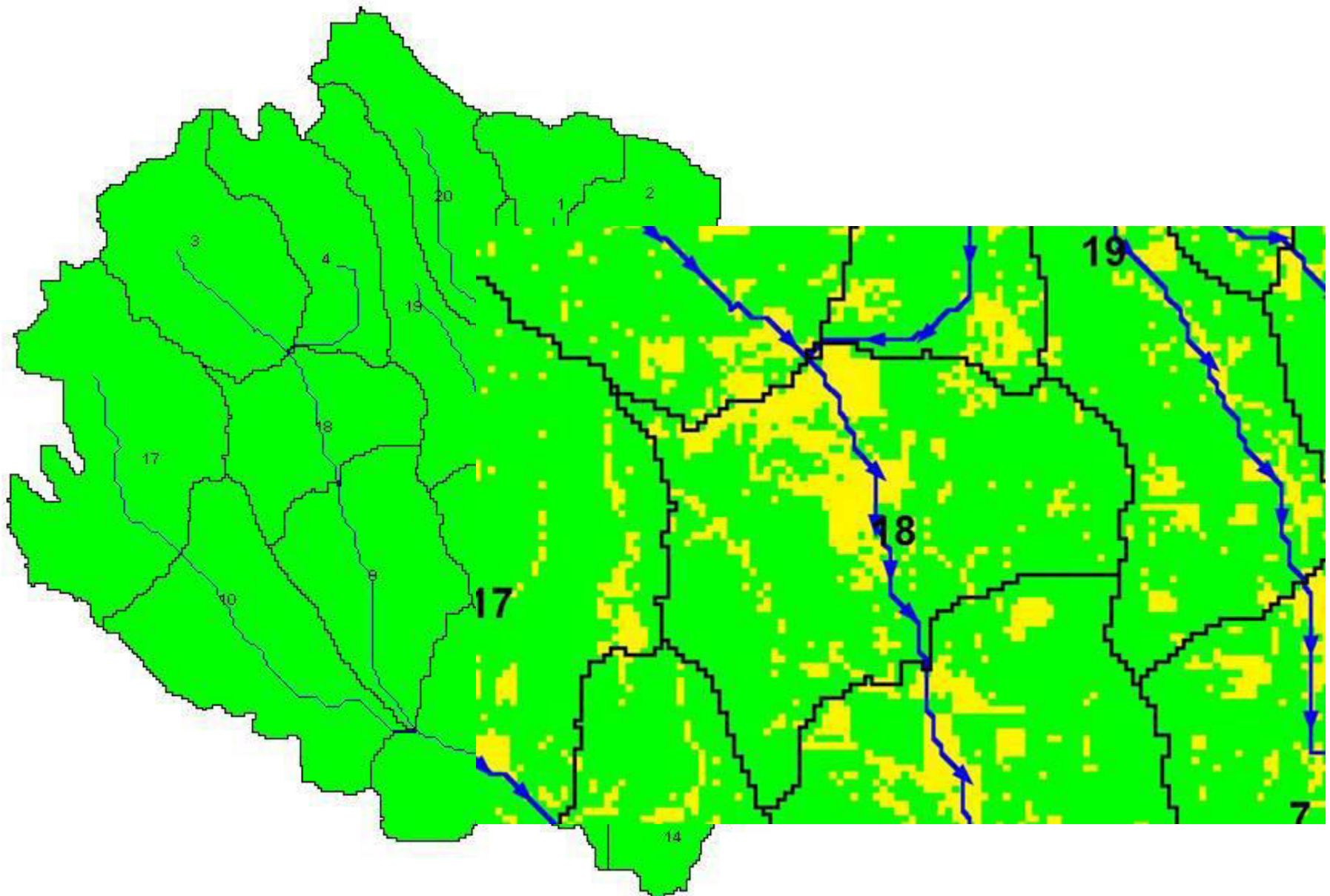
## HRU's

- 28% Range-Sandy
- 51% Pasture – Silt
- 16% Forest – Sandy
- 4% - Agriculture - Silt

## Subbasins and Streams



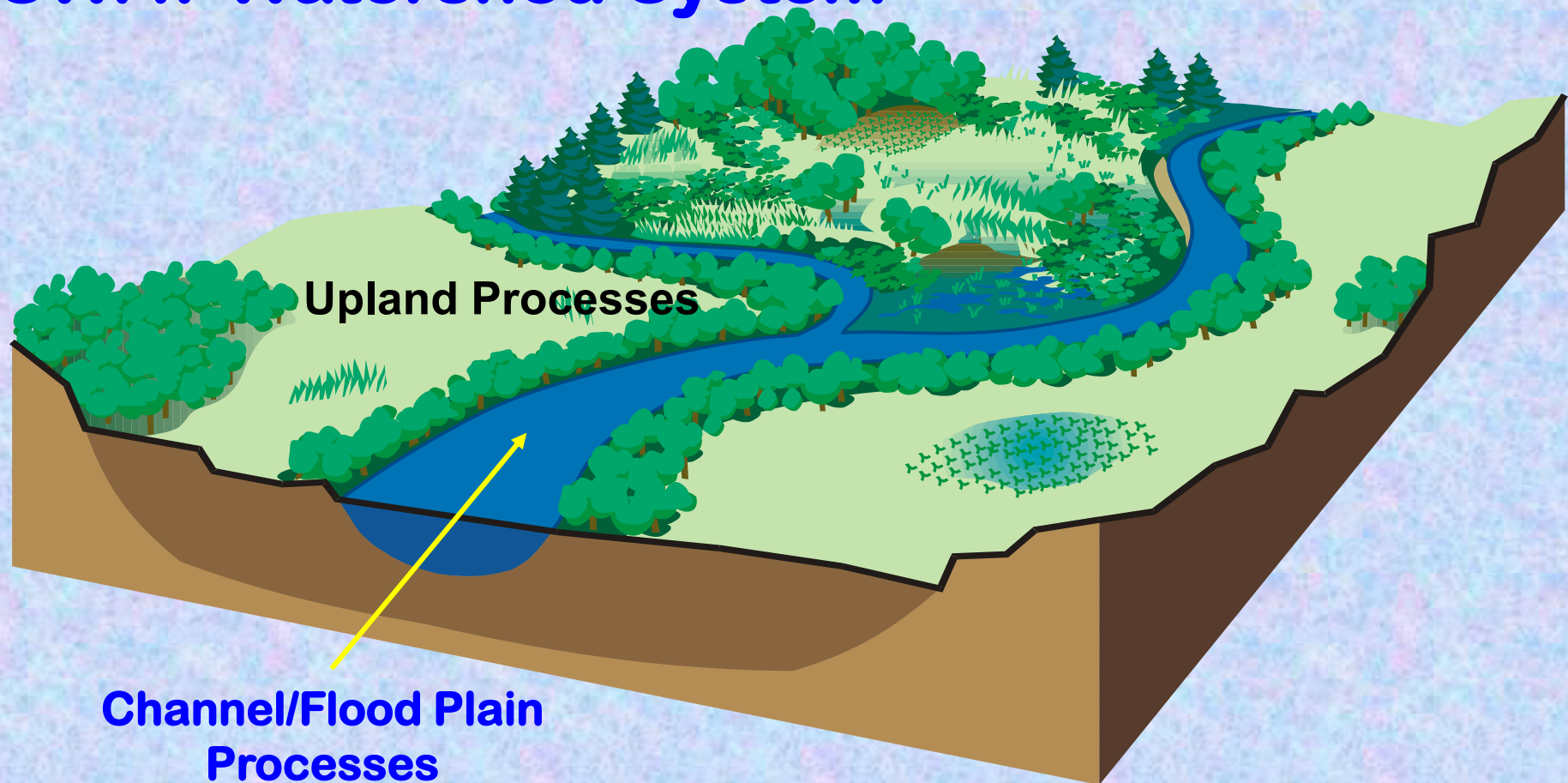
# Subbasins and Streams







# SWAT Watershed System



Upland Processes

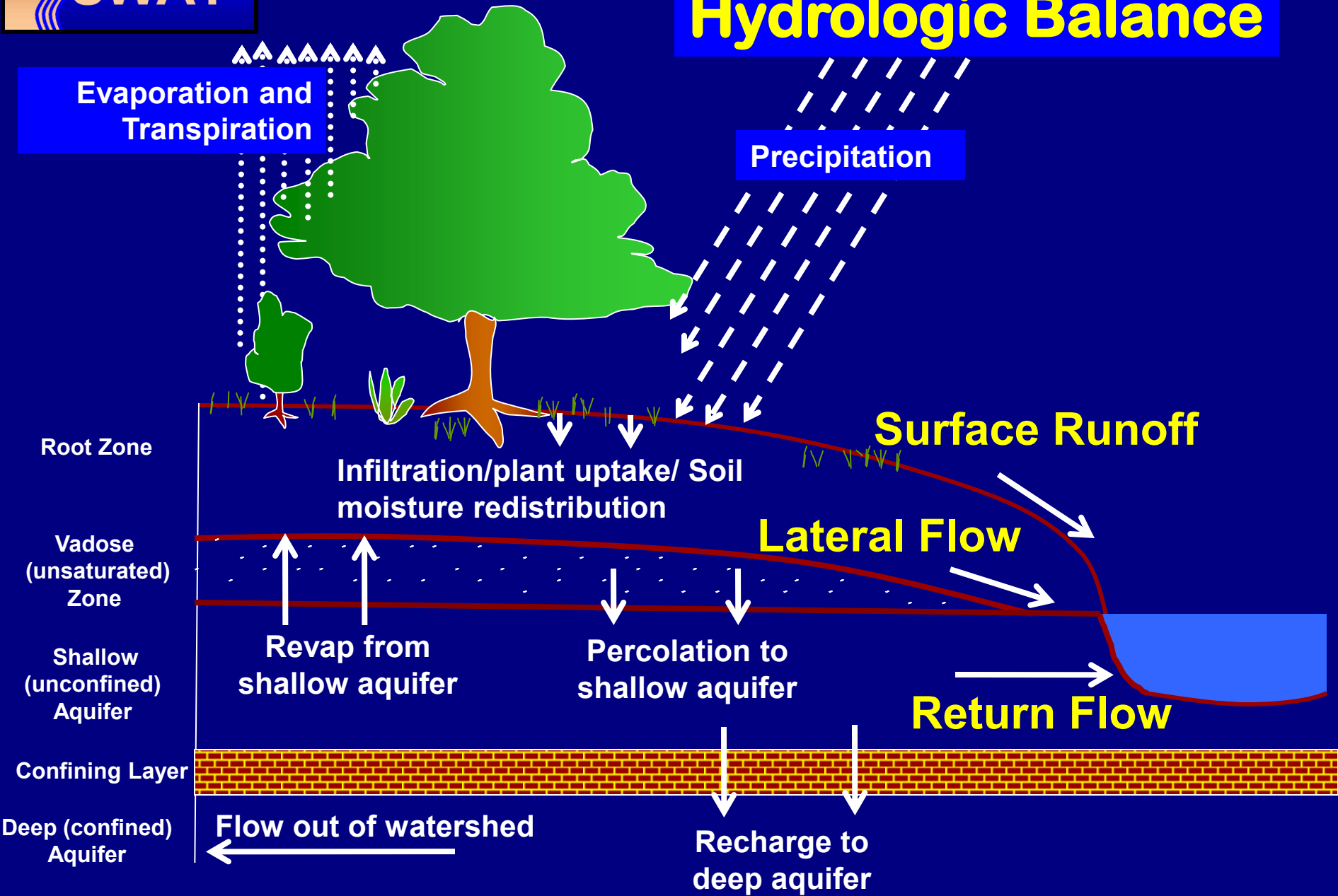
Channel/Flood Plain  
Processes



# Hydrologic Balance

Evaporation and Transpiration

Precipitation

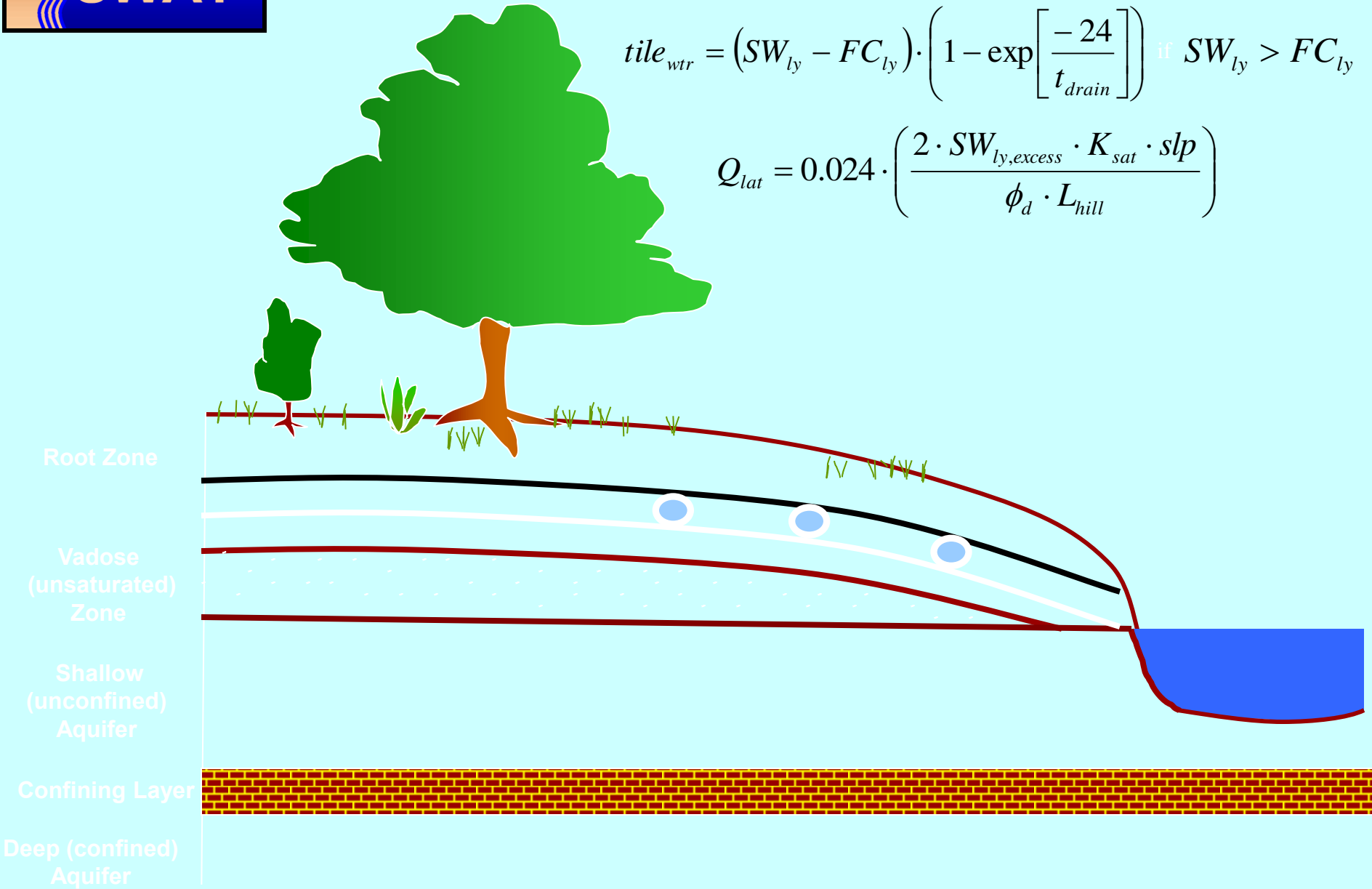




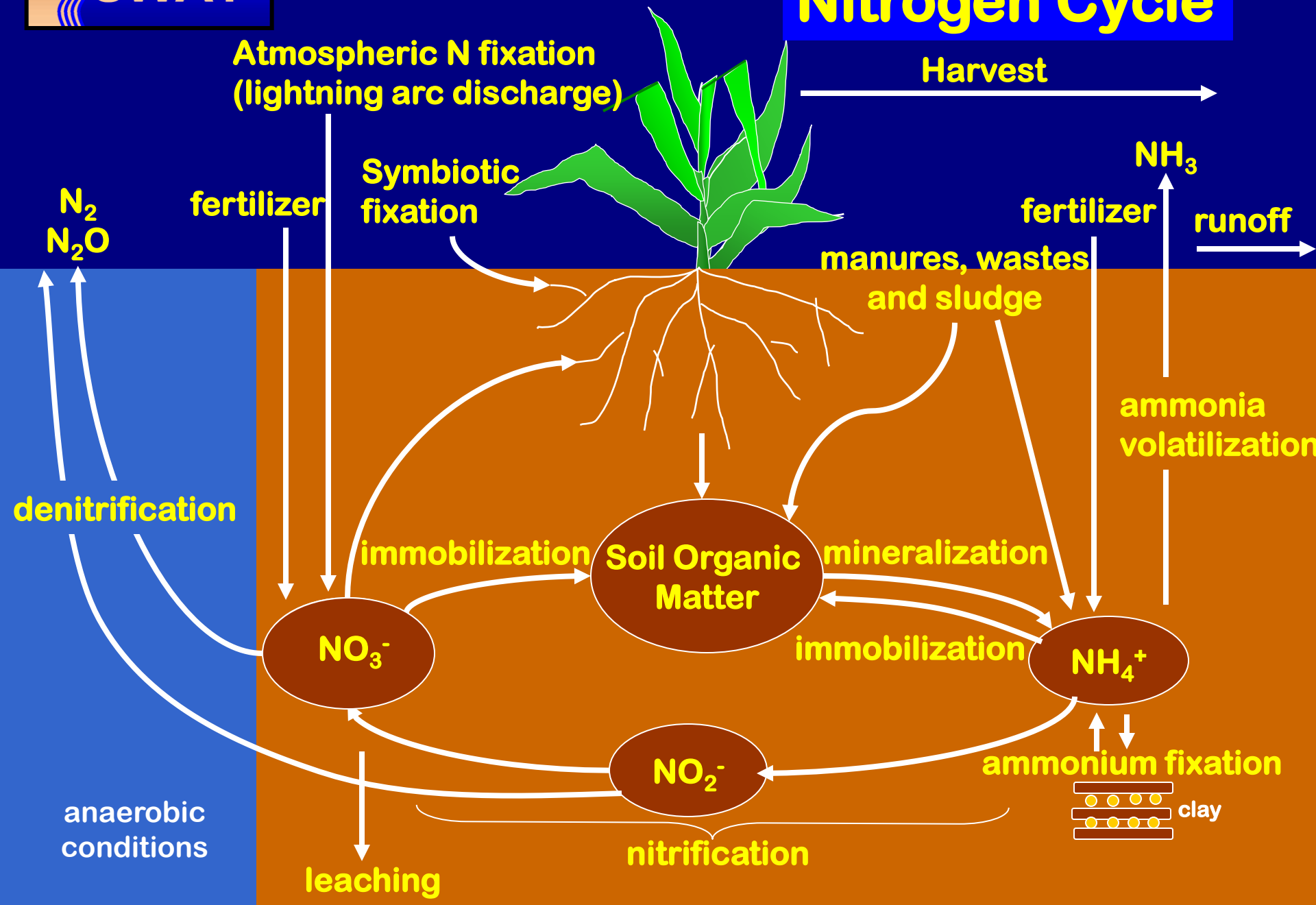
## Tile Flow

$$tile_{wtr} = (SW_{ly} - FC_{ly}) \cdot \left( 1 - \exp \left[ \frac{-24}{t_{drain}} \right] \right) \text{ if } SW_{ly} > FC_{ly}$$

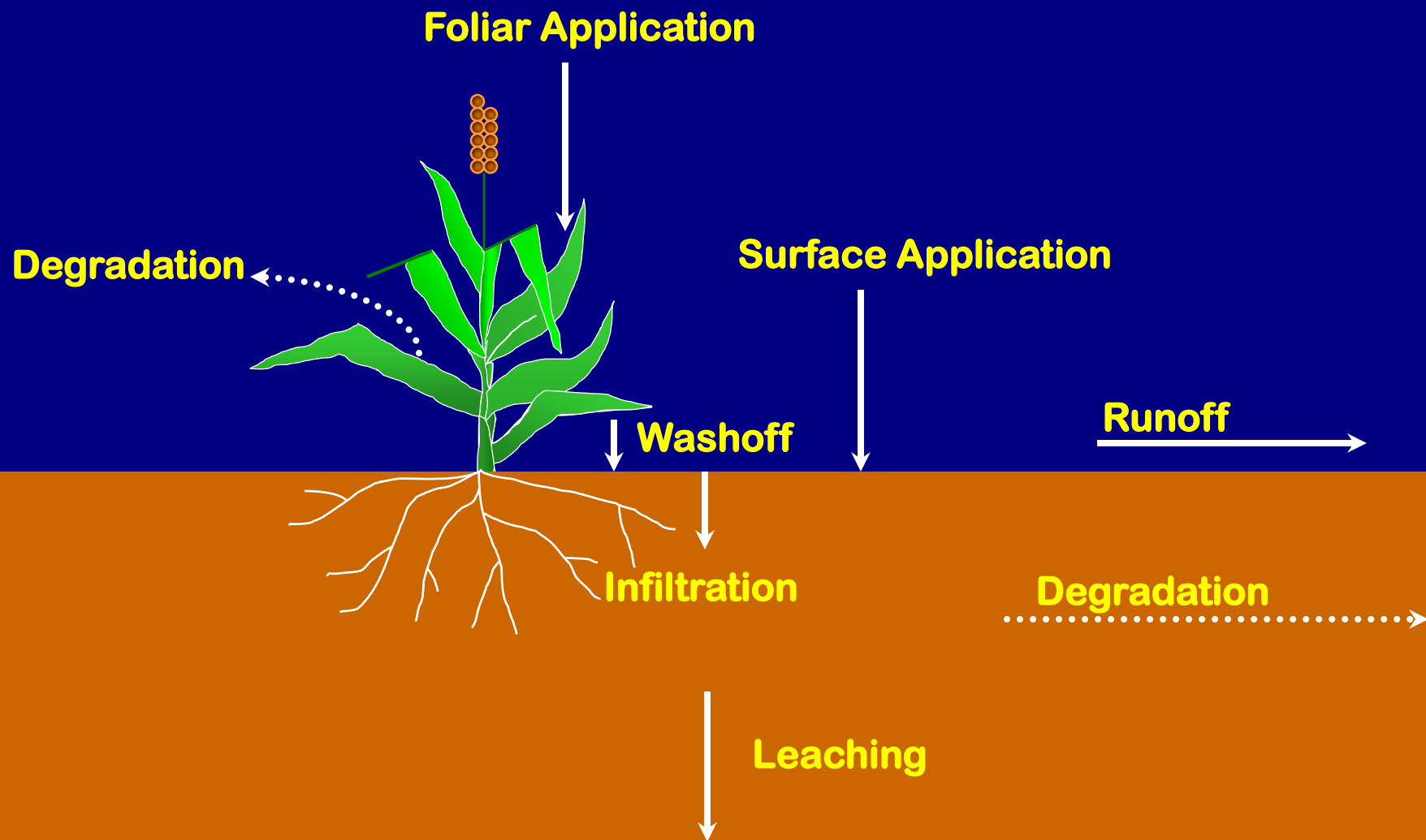
$$Q_{lat} = 0.024 \cdot \left( \frac{2 \cdot SW_{ly,excess} \cdot K_{sat} \cdot slp}{\phi_d \cdot L_{hill}} \right)$$



# Nitrogen Cycle







## Yield Prediction

Harvest Index – Water Stress  
Residue – Cover and  
Nutrients

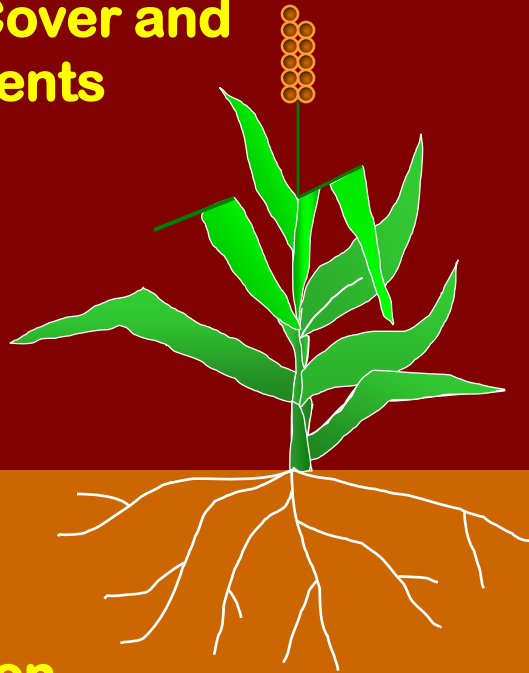
## Optimum Growth

Radiation Interception LAI  
Radiation Use Efficiency

## Constraints

Water, Temperature, Nitrogen,  
Phosphorus

Residue – Cover and Nutrients



↑  
↑  
Water, Nitrogen  
and  
Phosphorus Uptake

Root Growth

**Radiation Use Efficiency  
Adjusted for CO<sub>2</sub>**

**ET – Penman-Monteith  
Canopy Resistance  
Adjusted for CO<sub>2</sub>  
Impact on Leaf  
Conductance**



**CGM Estimates of Precip, Temperature,  
Humidity, Solar Radiation,  
Wind Speed**

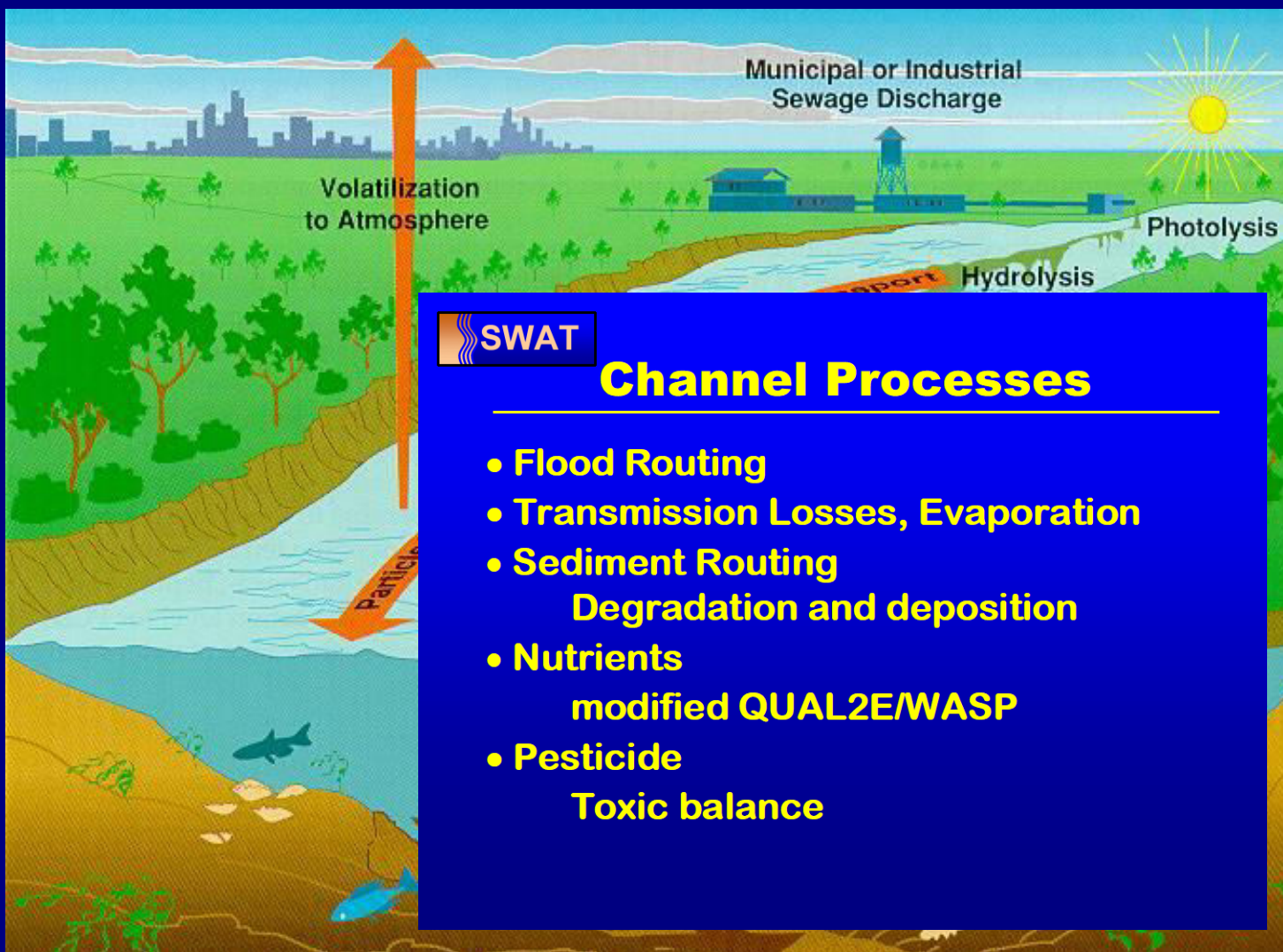




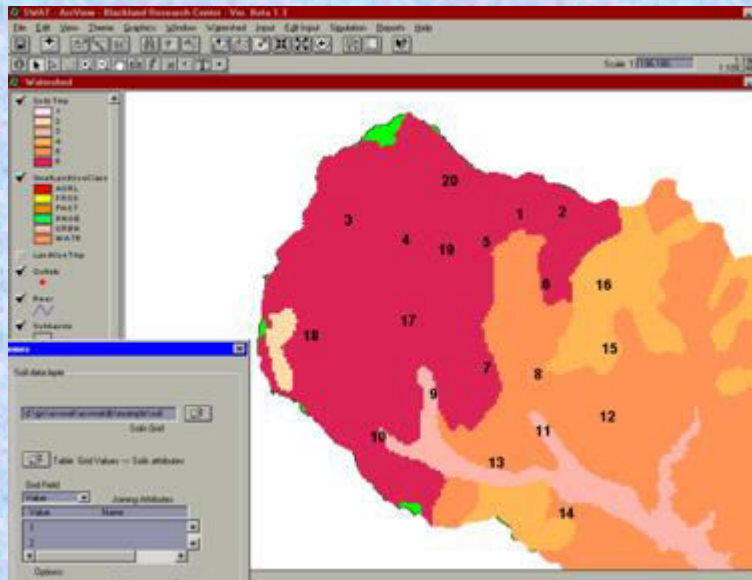
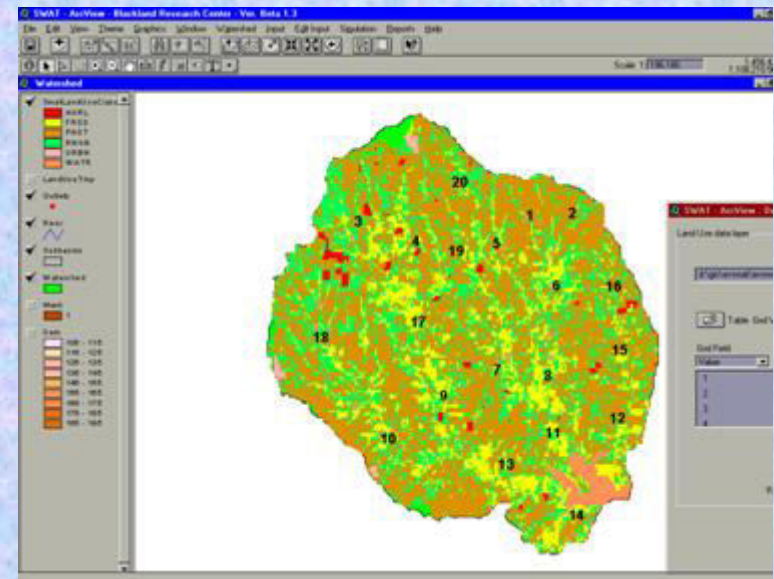
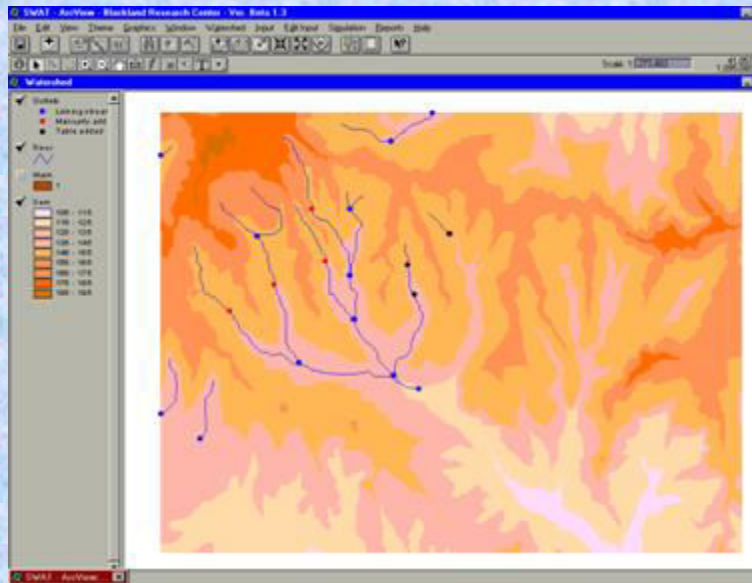
# **Management**

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- **Crop Rotations**
- **Removal of Biomass as Harvest/  
Conversion of Biomass to Residue**
- **Tillage / Biomixing of Soil**
- **Fertilizer and Manure Applications**
- **Edge-of-Field Buffers**
- **Pesticide Applications**
- **Irrigation**
- **Water Impoundment (Wetlands, Rice)**



# ArcView GIS Interface



## Weather

- Daily Precip and Max/Min Temp
- Monthly Radiation, Windspeed, Humidity



# **Need for Models in the U.S.**

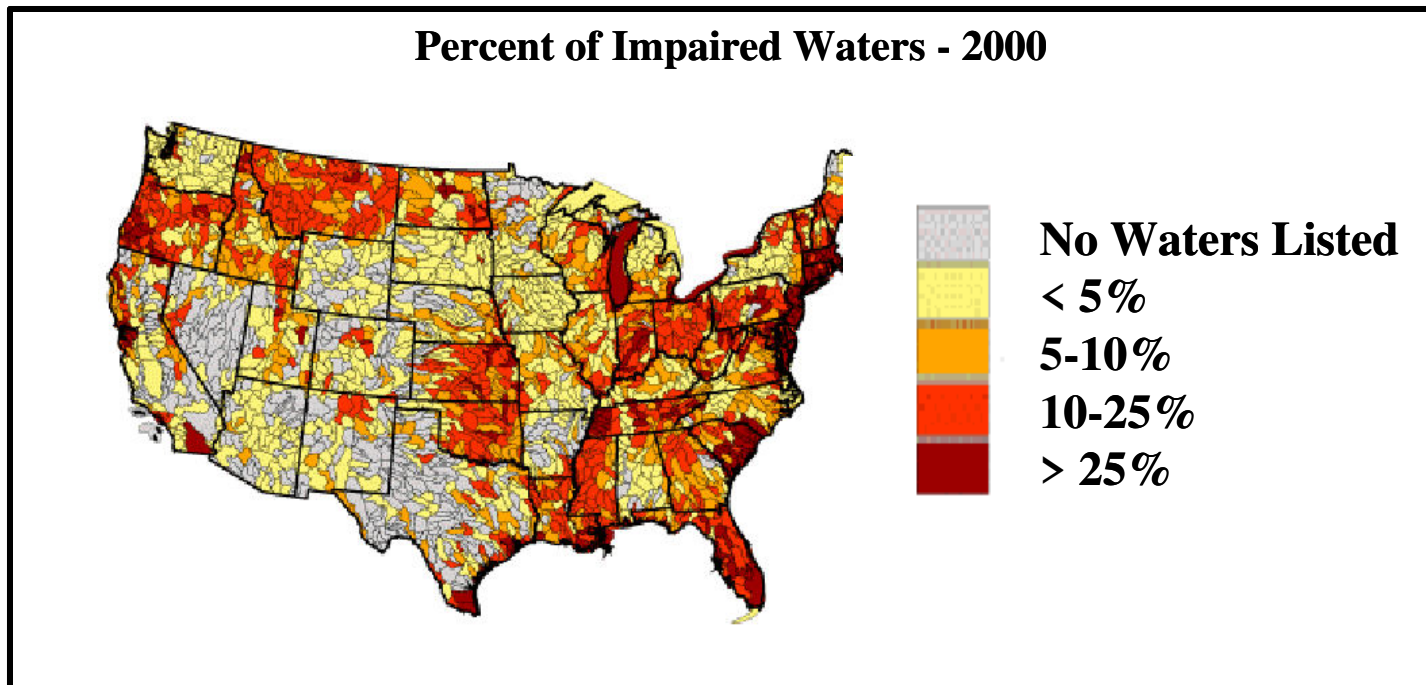
- **US EPA – Watershed Assessments**
- **NRCS – National Conservation Assessments**

**Climate Change**

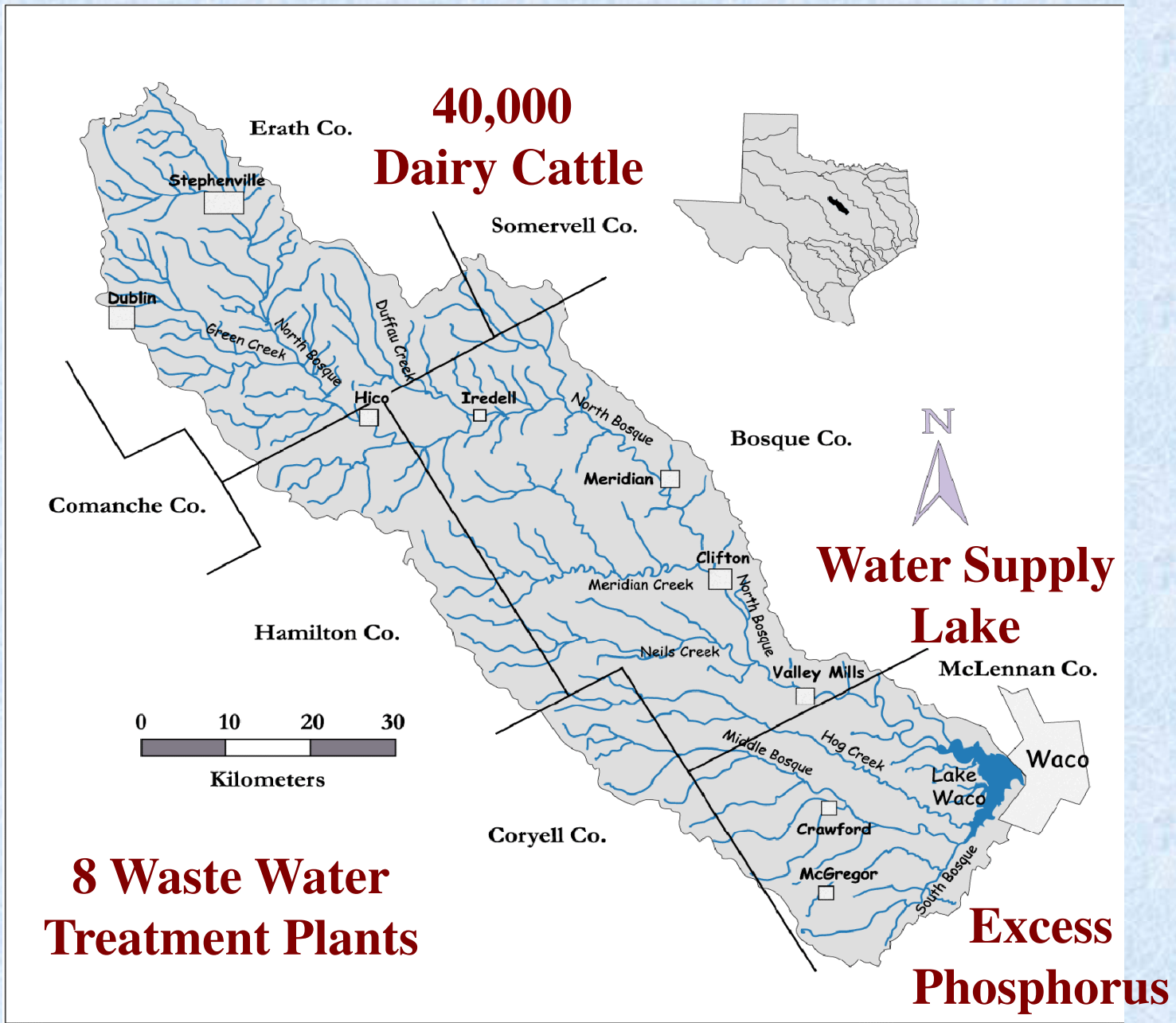
**Water Supply – Irrigation Management**

# U.S. Environmental Protection Agency

- 15,000 Water Bodies Identified as Impaired
- Plan to Restore Water Quality Standards
- Models/GIS Tools for Evaluating Management Strategies



# Bosque River Watershed, Texas





# **P Control Measures/Management Scenarios**

- **Dairy Management Scenarios:** Haul Off, manure application at crop P requirement (P rate), reduction of dairy diet P to 0.4% (reduction in manure P content by 29%)
- **WWTP Management Scenarios:** Concentrations of total P in WWTP effluents were varied to 0.5, 1 and 2 mg/l
- **Combined Management Scenarios:** Combinations of dairy and WWTP scenarios to achieve reductions in loadings and concentrations

# **Dairy and WWTP Scenarios**

- **Dairy Scenarios: Concentrations showed reductions of 1 to 12%; Loadings showed reductions of 7 to 60% along the river**
- **WWTP Scenarios: Concentrations showed reductions of 21 to 78%; Loadings showed reductions of 4 to 50% along the river**
- **Benefits of dairy scenarios are better at reducing sol P loadings than concentration; WWTP scenarios showed greater benefits in reducing the concentration as opposed to total loadings**



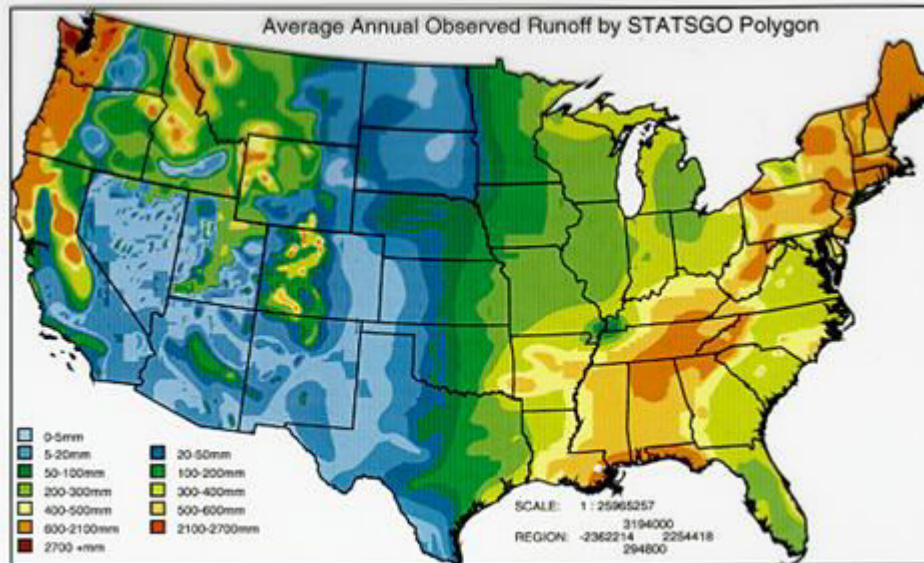
# National Assessment of Conservation Programs

- Conservation Tillage Systems
- Buffers and Grass Waterways
- Manure and Fertilizer Management



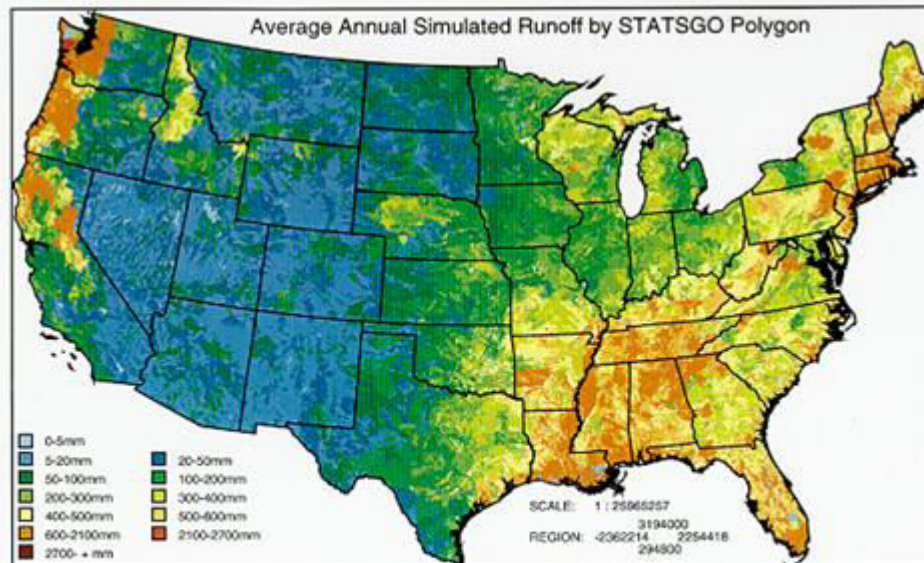


**Observed  
(USGS)**



**Validation  
of  
Flow  
and  
Sediment**

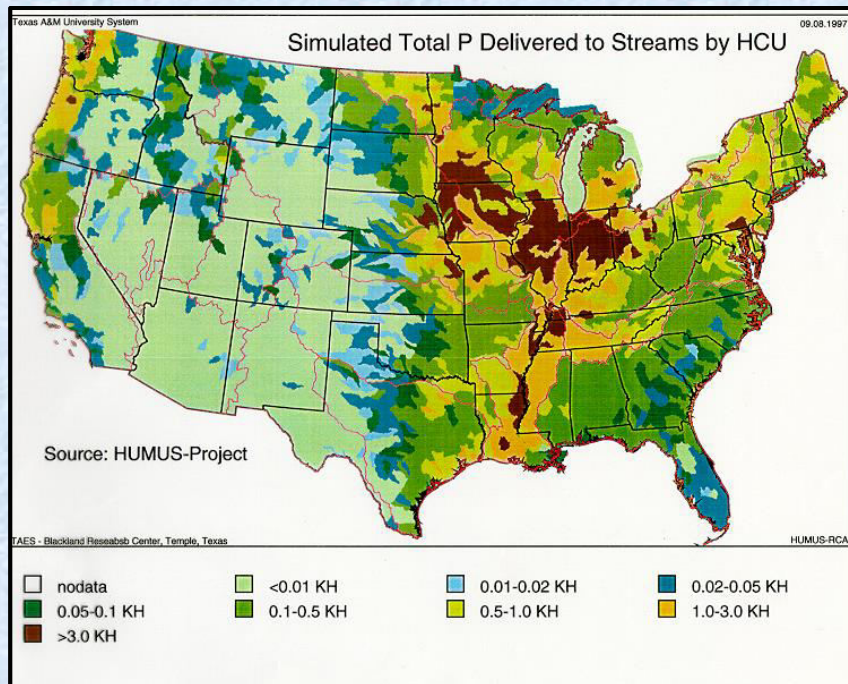
**SWAT  
Simulated**



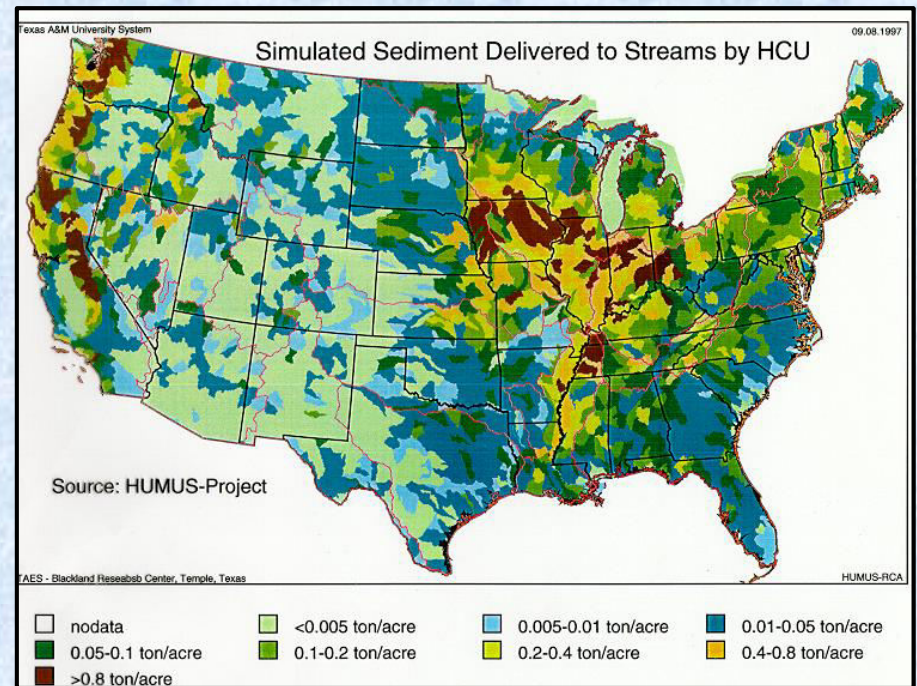


# HUMUS Results

## Point and Non Point Sources

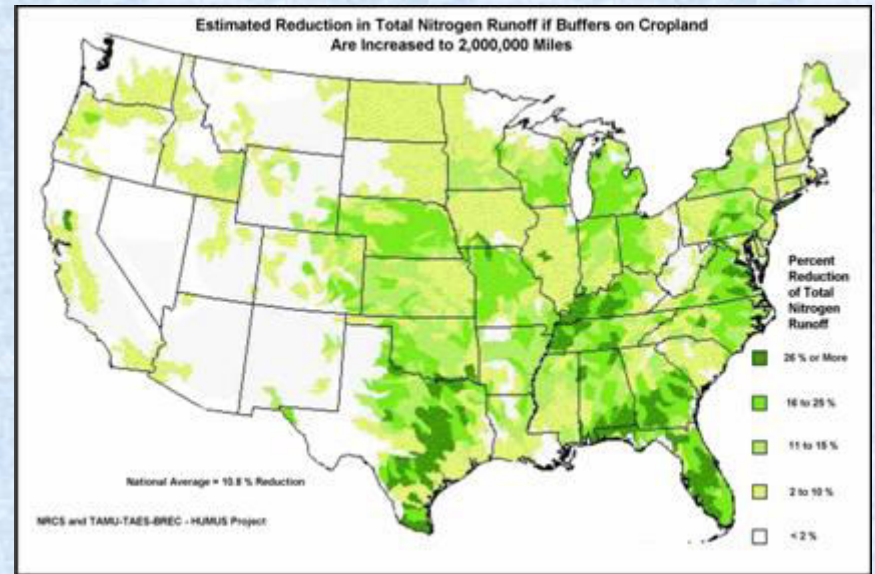


**Simulated Total P Delivered  
to Streams by HCU**

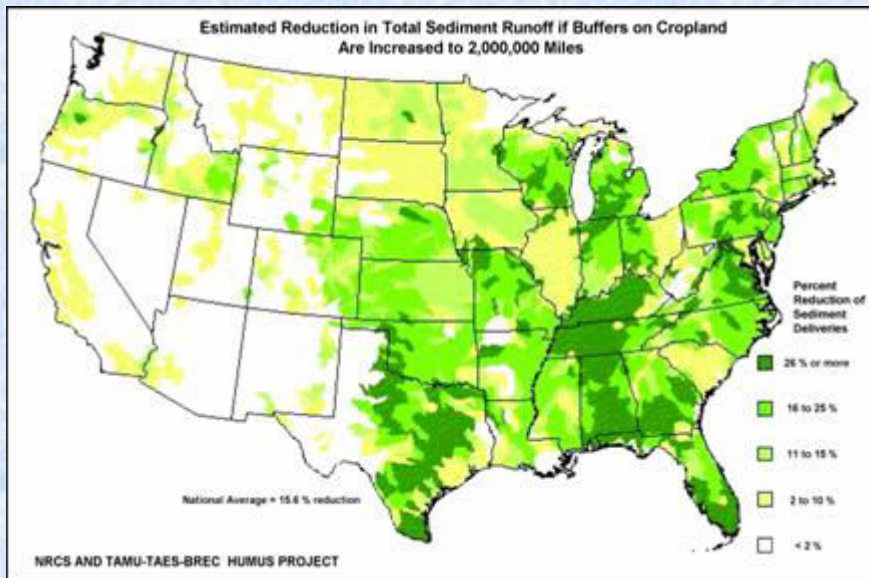


**Simulated Sediment Delivered  
to Streams by HCU**

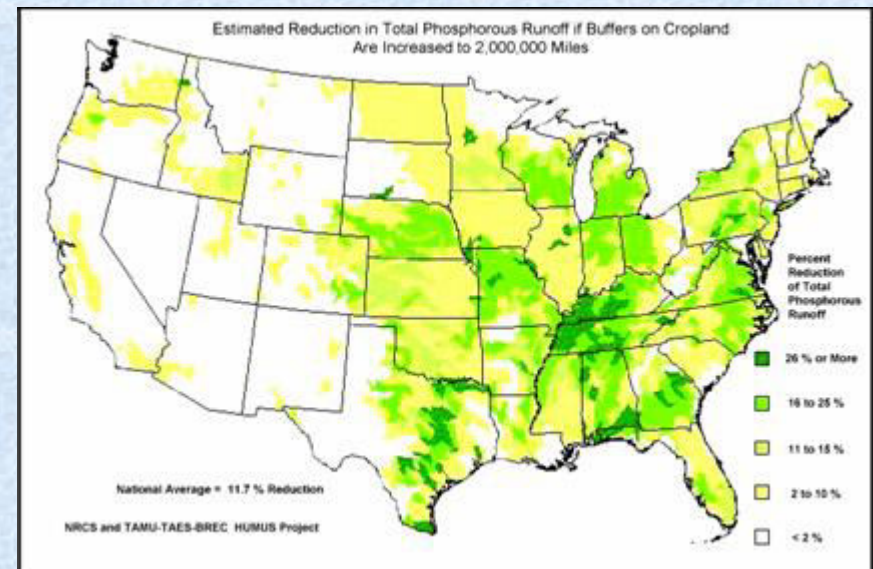
# HUMUS Scenario Reduction due to 2 million miles of buffers



## Sediment Reduction



## Nitrogen Reduction



## Phosphorus Reduction



# **Data Availability in the U.S.**

**Inputs for SWAT – Downloaded from Web**  
**<http://www.epa.gov/OST/BASINS/gisdata.html>**

**1:250,000 Scale**

**Digital Elevation Model**

**STATSGO Soils Data**

**Land Use/Land Cover**

**Daily Precipitation and**

**Max/Min Temperatures**

# *The National Elevation Dataset*

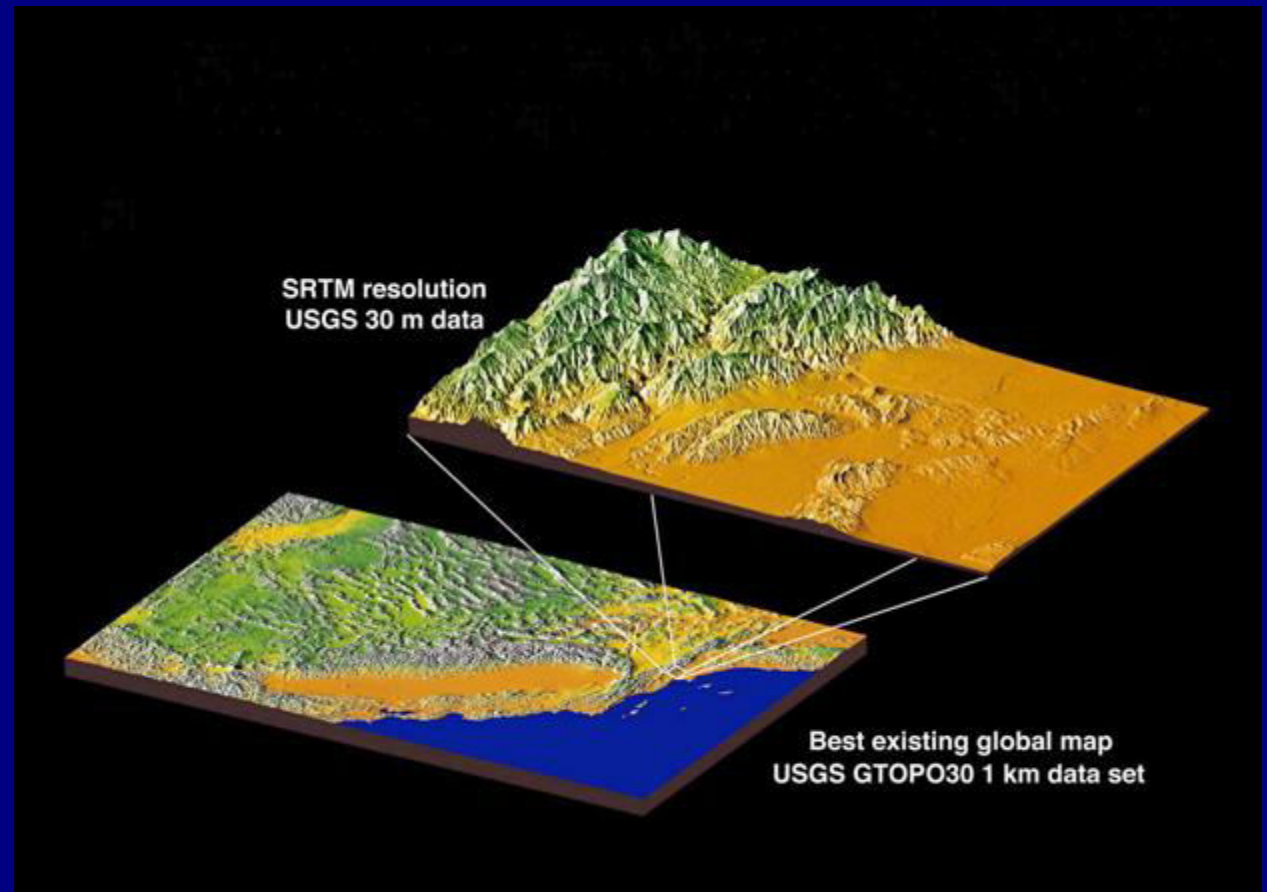




## Shuttle Radar Topography Mission

The Shuttle Radar Topography Mission (SRTM) used radar instruments to collect data for the most detailed, near global topographic map of the Earth ever made

- 1 arc-second elevation data for the United States
- 3 arc-second data for the globe



## **Shuttle Radar Topography Mission**

1-arc second (30 meter) SRTM data postings of the continental United States can now be obtained in two ways via the USGS EDC Seamless Distribution System:

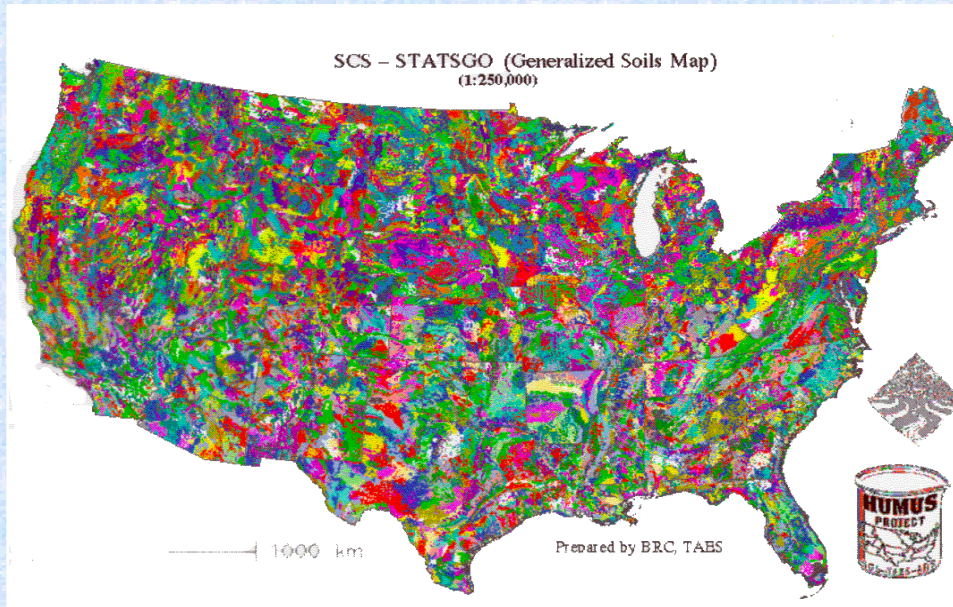
<http://seamless.usgs.gov/>

- Electronic Download
- Media (CD)

Updated 21 May 2003

USGS is now distributing elevation data from SRTM for South America and North America - 90m resolution

# Soil Data - USDA-NRCS

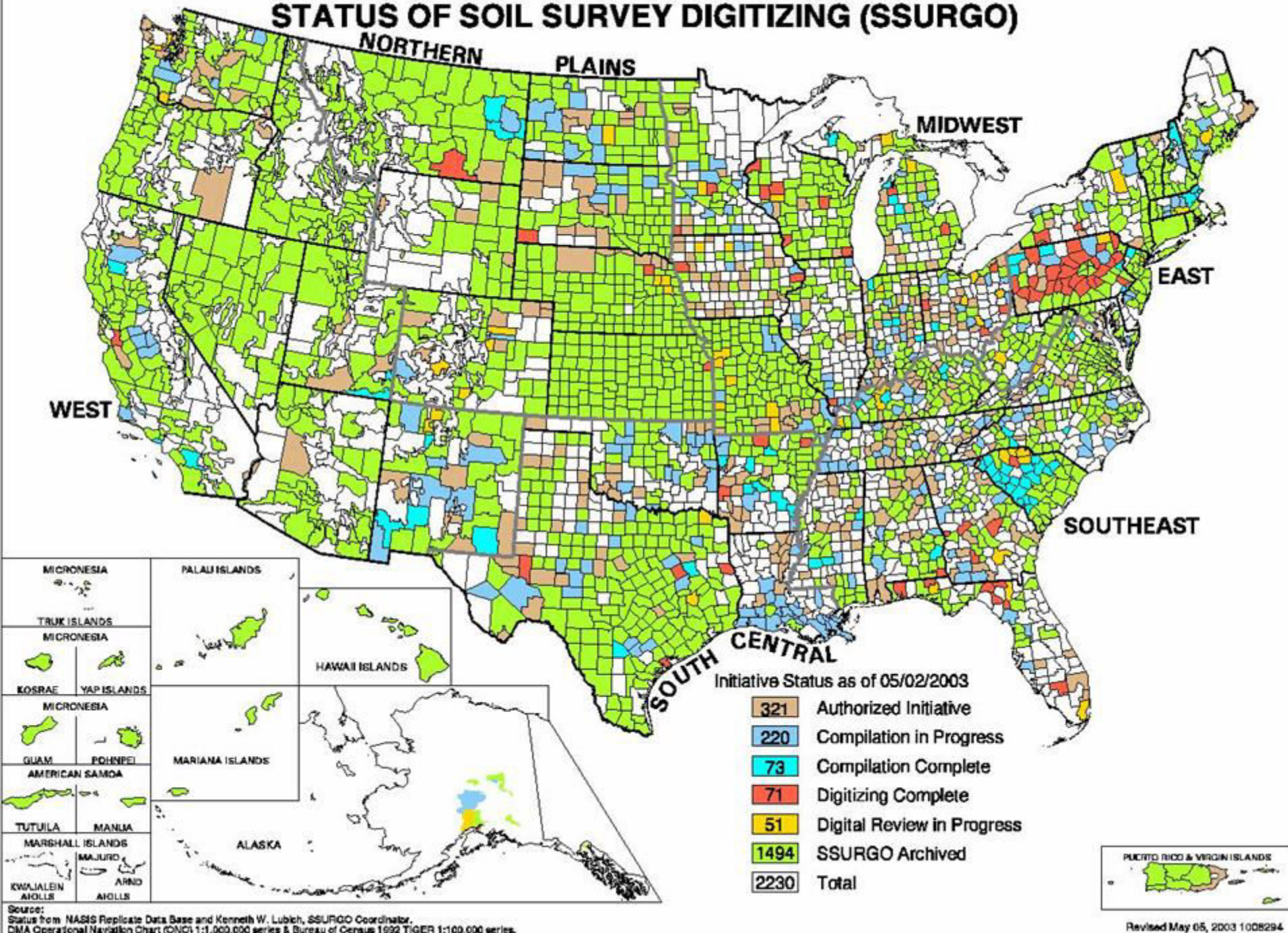


## **STATSGO Soils**

STATSGO: Produced at 1:250,000 scale for entire US. Minimum mapping unit is 625 hectares.



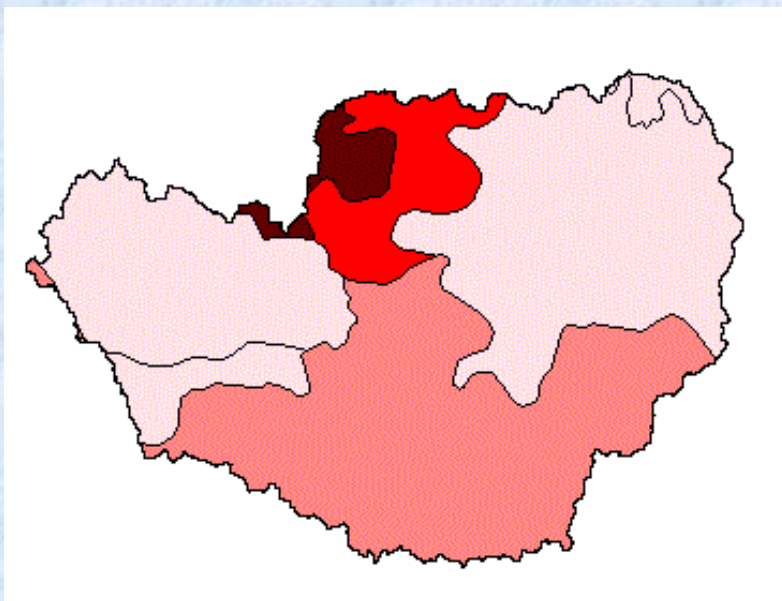
# STATUS OF SOIL SURVEY DIGITIZING (SSURGO)



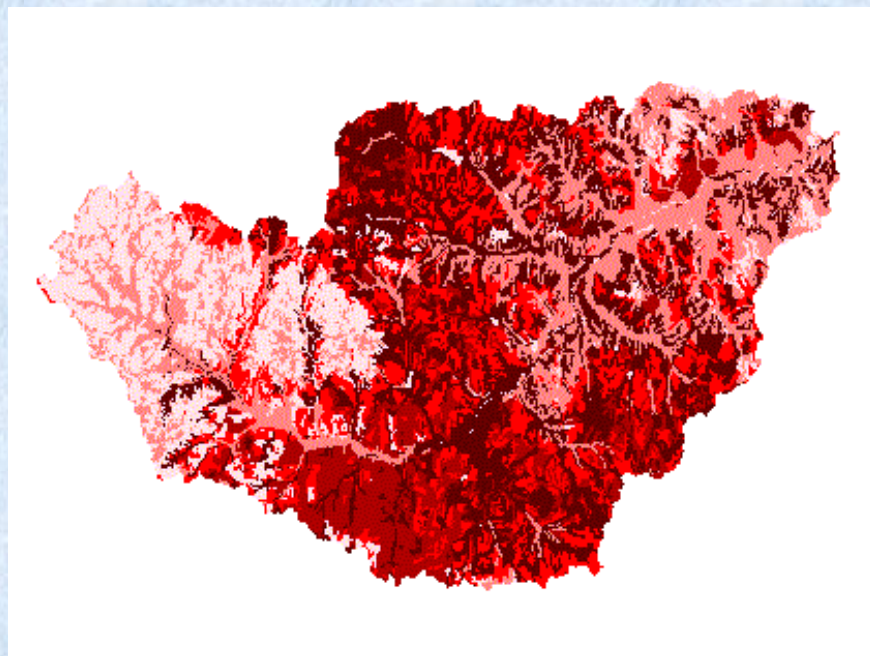


# ARS – Little Washita Experimental Watershed – 522 km<sup>2</sup>

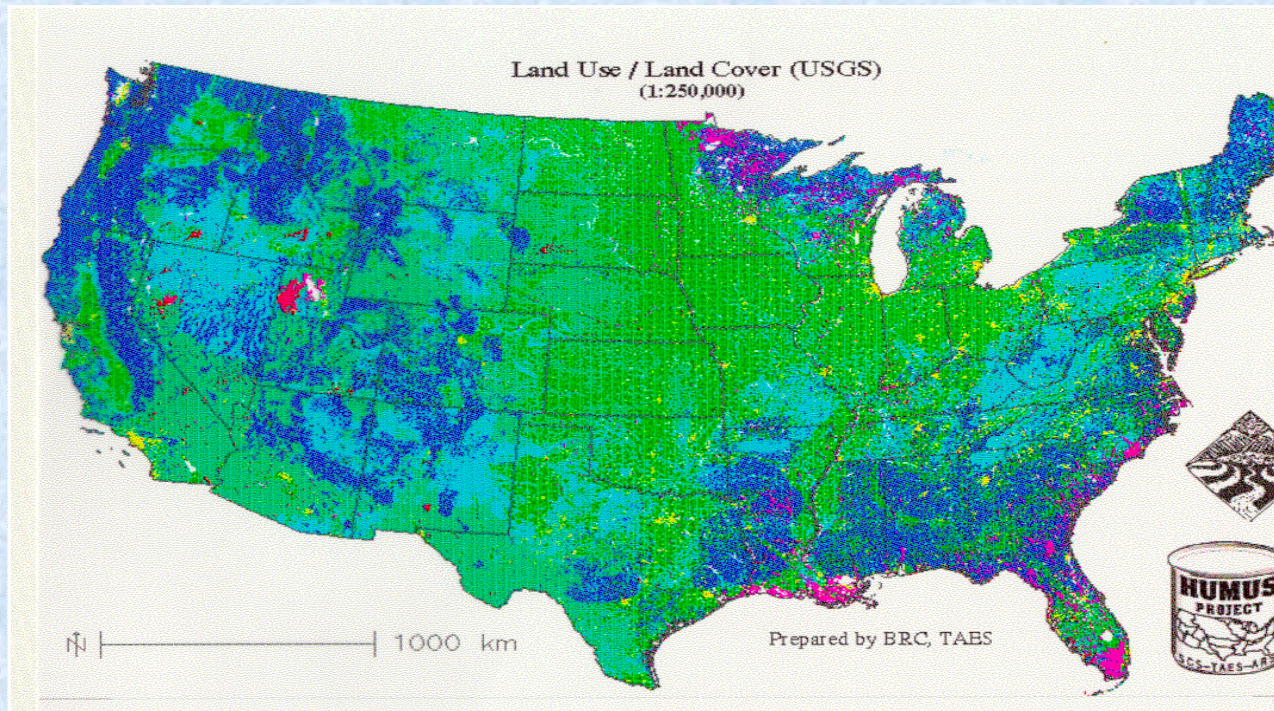
STATSGO



SSURGO



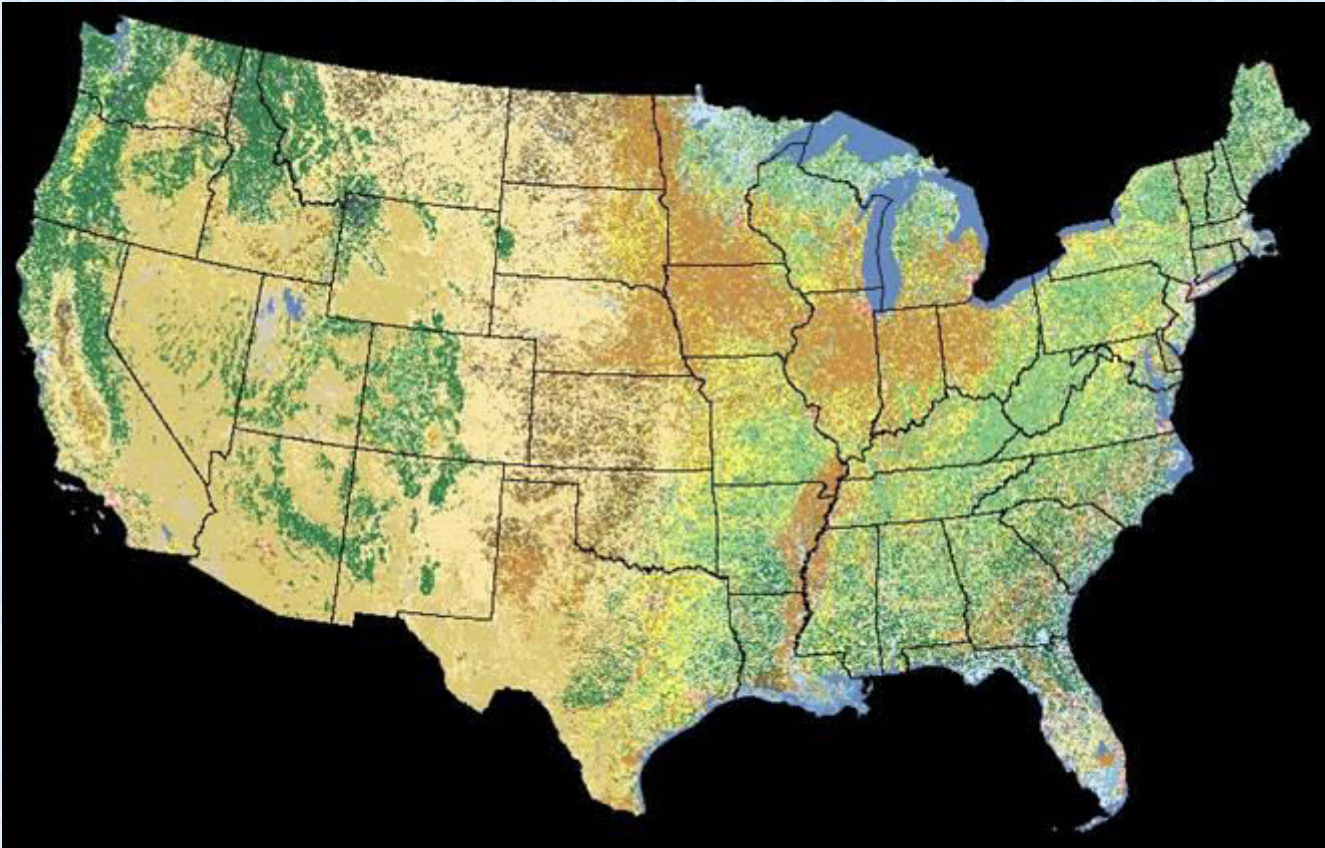
# Land Use / Land Cover



USGS LUDA data:  
Produced at 1:250,000 from  
aerial photography of early  
1980s.



# National Land Cover Dataset

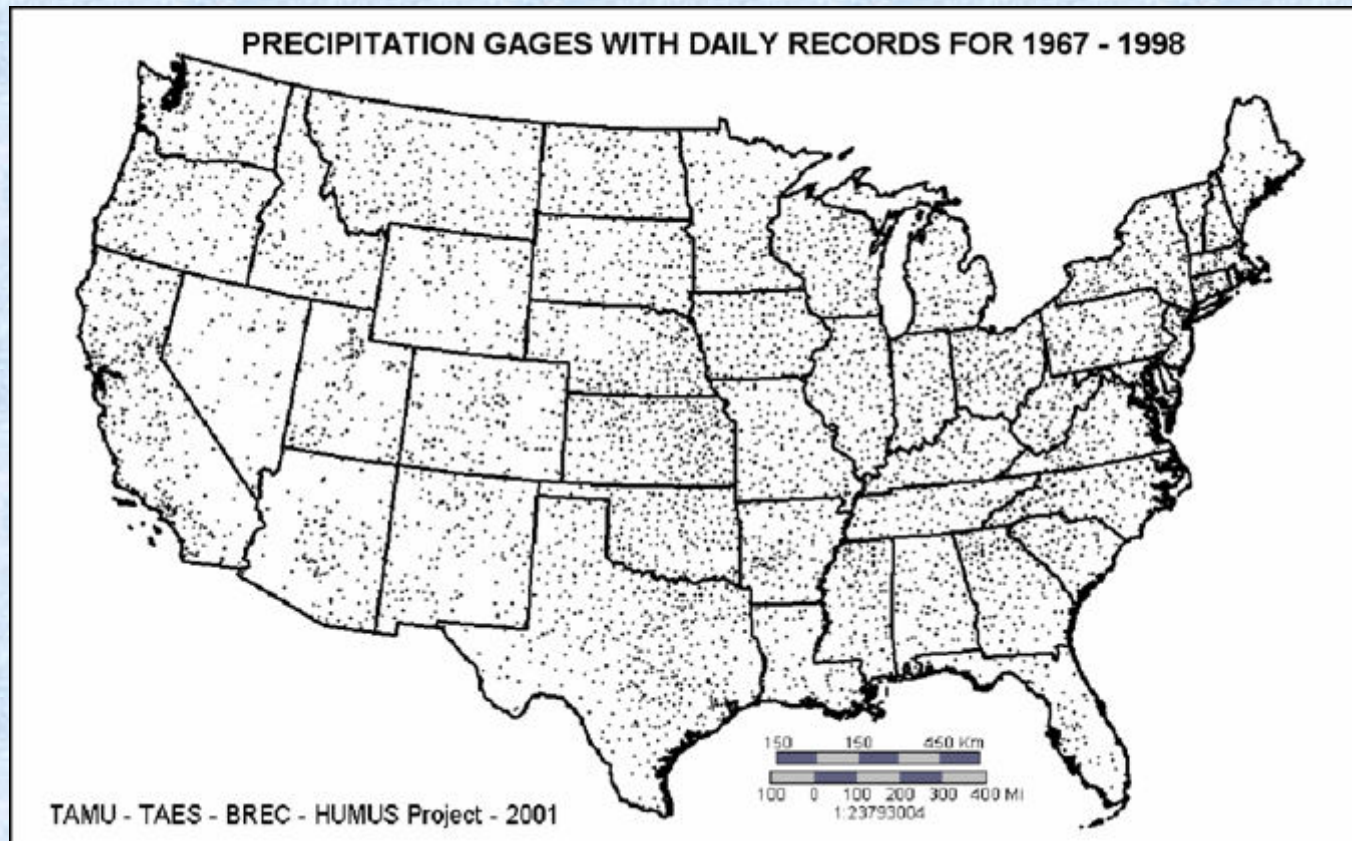


Mid-1990s Landsat Thematic Mapper satellite data

21-class land cover classification scheme

30 meter spatial resolution

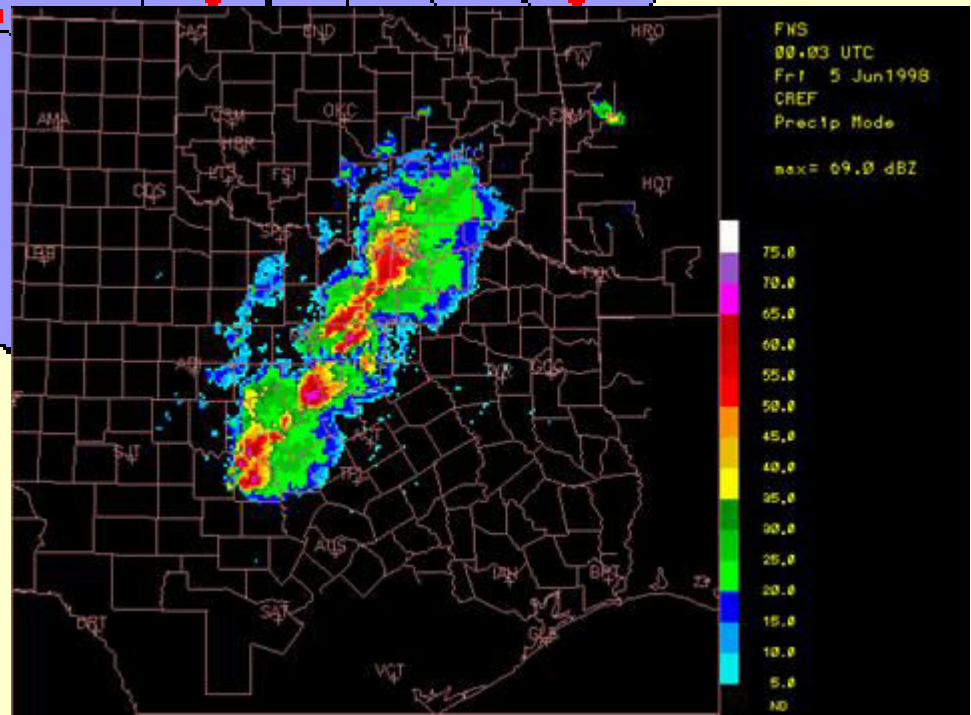
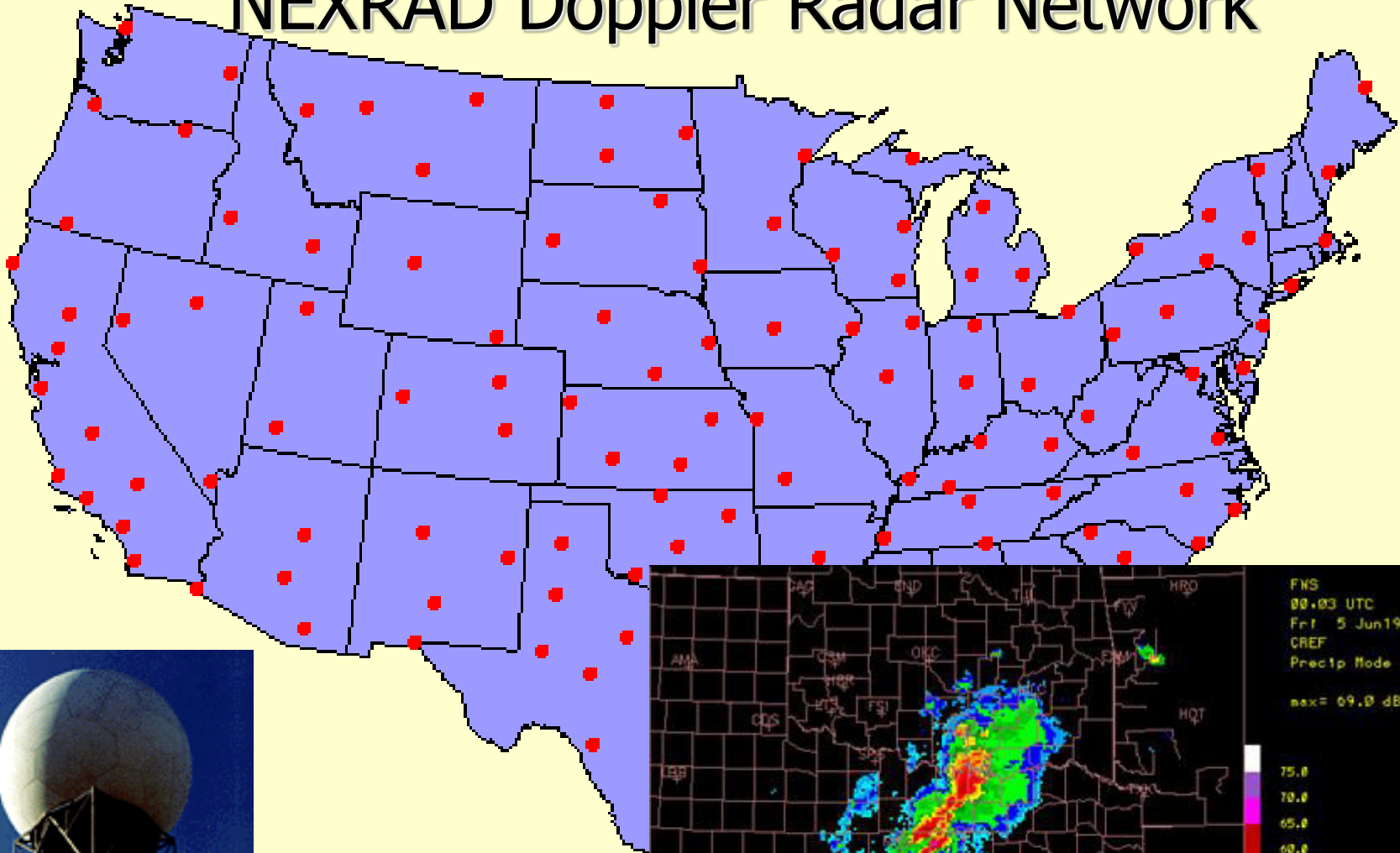
# Daily Precipitation and Temperature



6,000 Stations – 30+ Years



# NEXRAD Doppler Radar Network





Scale 1: 536,366

1,987.14  
1,285,431.78

## Watershed

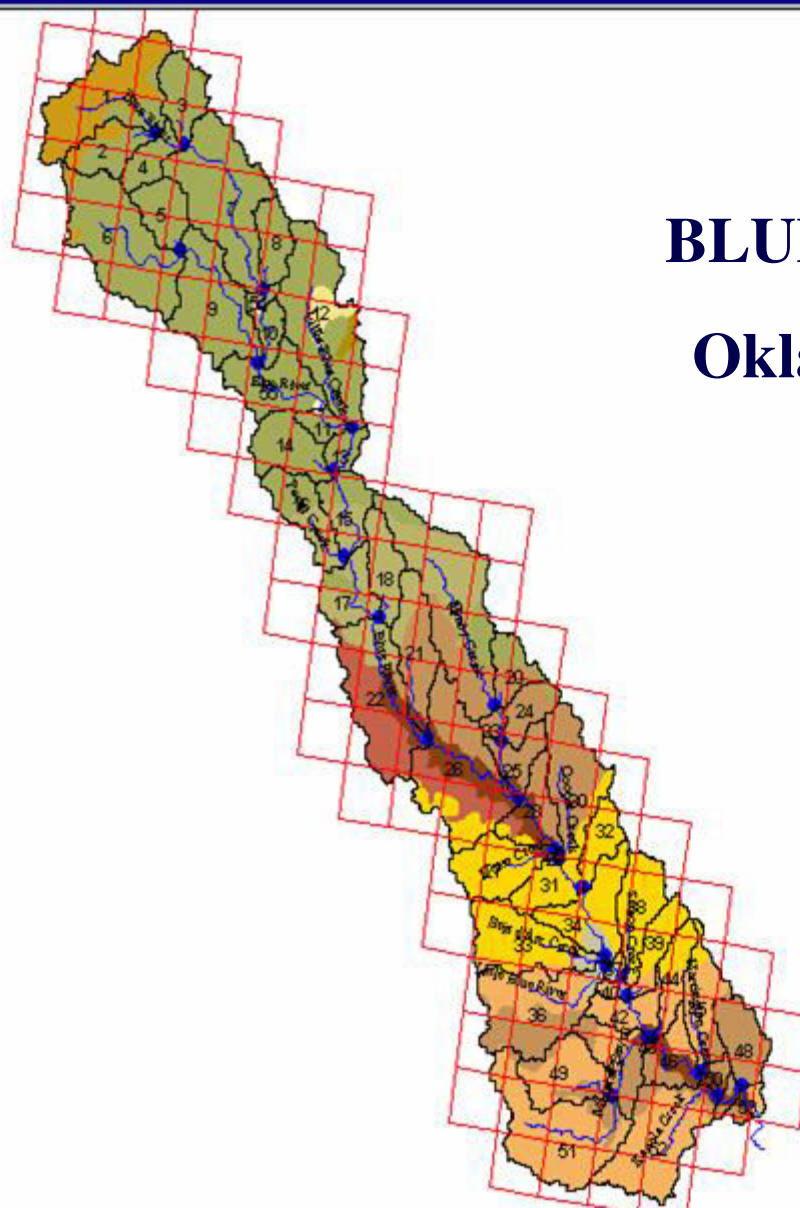
- ☒ Hrad
- ☒ Subbasins
- ☒ Streams
- ☒ Outlets
  - Linking stream added Outlet
  - Table added Outlet

- ☒ SoilClass
  - DK154
  - DK157
  - DK158
  - DK161
  - DK162
  - DK163
  - DK164
  - DK166
  - DK200
  - DK206
  - DK214

- ☒ SwatLandUseClass
  - AGRC
  - AGRR
  - FRSD
  - FRSE
  - FRST
  - PAST
  - RNGB
  - RNGE
  - UCOM
  - URHD
  - URLD
  - WATR
  - WETL

- ☐ Outlets
  - Linking stream added Outlet
  - Table added Outlet

- ☒ Streams



# BLUE River

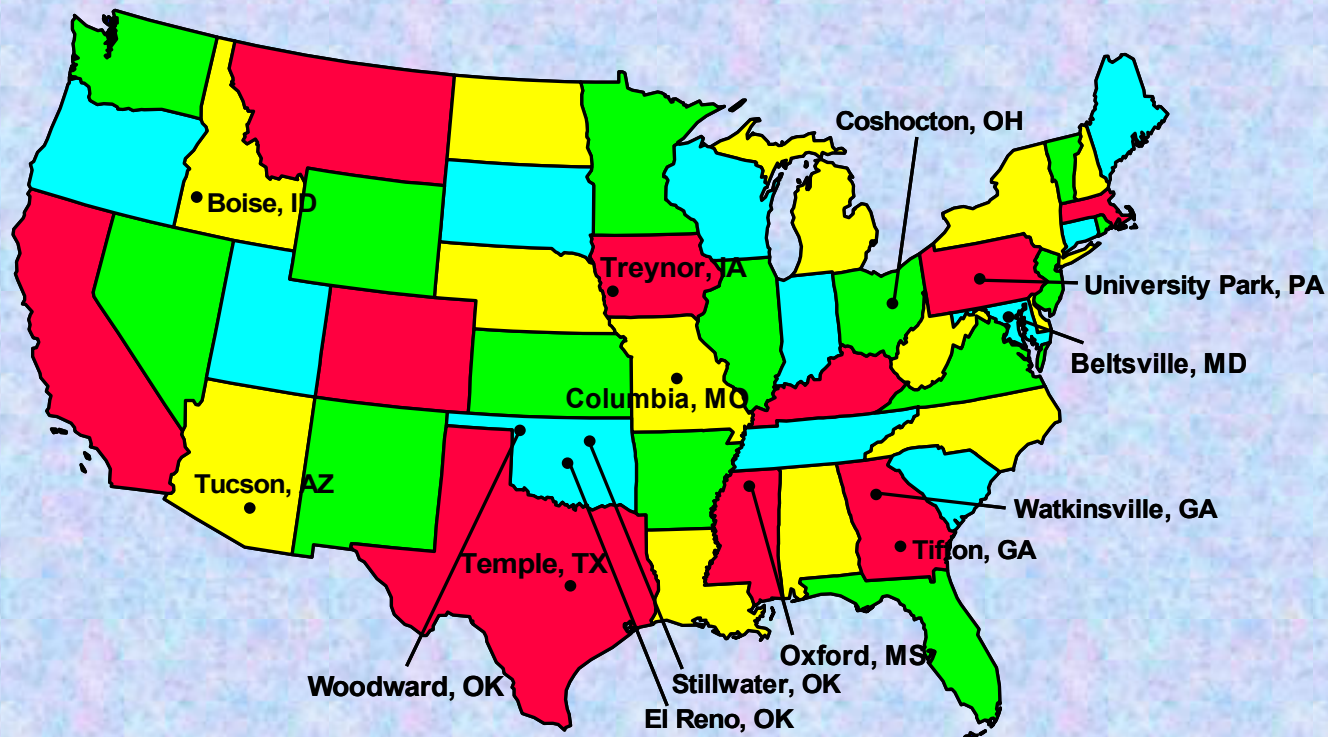
## Oklahoma

# Model Validation

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- Limited Validation at Application Watersheds
- Need Research Watersheds for Comprehensive Validation across Ecosystems
- Continuous Flow and Sediment Data – 30-60 Yrs

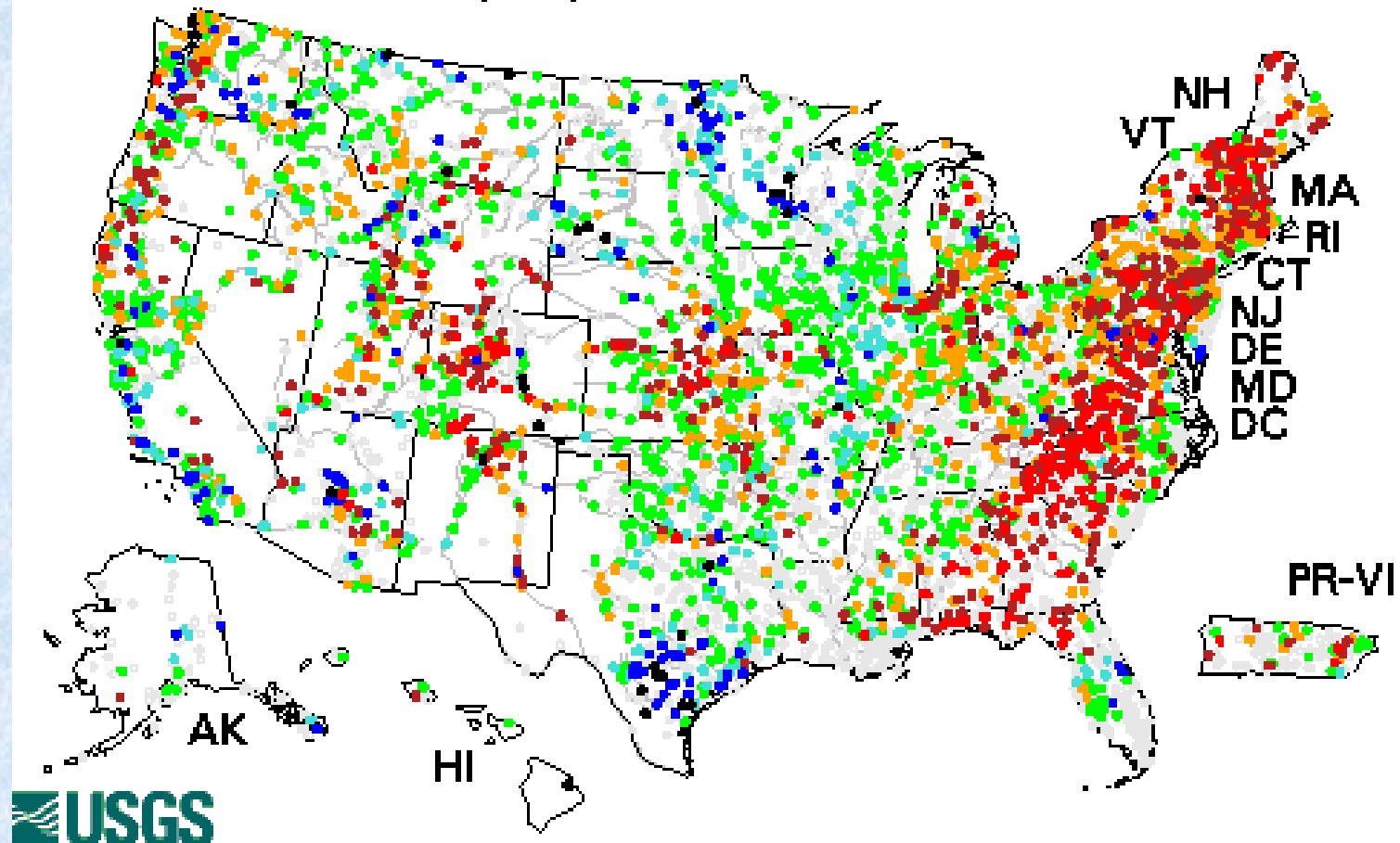
## ARS Watershed Locations





# USGS Water Watch

Tuesday, September 10, 2002 11:20ET



Web access to USGS water resources data in real time

# USGS National Water Information System

- Real-time and Historic Data
  - Streamflow and stage
  - Groundwater levels
  - Water Quality
  - Site information
- Tabular or Graphical Format

agency_cd	site_no	dv_dt	dv_va	dv_cd
5s	15s	10d	12n	3s
USGS	08158000	1999-01-24	152	
USGS	08158000	1999-01-25	333	
USGS	08158000	1999-01-26	1180	
USGS	08158000	1999-01-27	1160	
USGS	08158000	1999-01-28	1030	
USGS	08158000	1999-01-29	184	
USGS	08158000	1999-01-30	151	
USGS	08158000	1999-01-31	158	
USGS	08158000	1999-02-01	150	
USGS	08158000	1999-02-02	152	
USGS	08158000	1999-02-03	154	
USGS	08158000	1999-02-04	155	



**SWAT**  
**2005**  
3rd  
international  
conference

**1<sup>st</sup> Announcement**

**Sponsors:**



**EAWAG**

Swiss Federal Institute for Environmental  
Science and Technology

**SWAT Team**

USDA-ARS Research Lab, Temple, Texas  
Texas Agricultural Experiment Station, Temple, Texas  
Texas A&M University in College Station



**July 11-15, 2005**  
**Zurich, Switzerland**

**Home**

**Theme**

**Schedule**

**Costs**

**Conference Location  
and Accommodation**

**Transportation**

**Program**

**Scientific Committee**

**Registration Form**

**Abstract and  
paper format**

**Contact**