SWAT+ Watershed Simulation of Wetlands and Pesticide Fate and Transport

SWAT Modeling Team

SWAT+
SOIL & WATER ASSESSMENT TOOL

New, completely restructured version (Bieger et al., 2017)

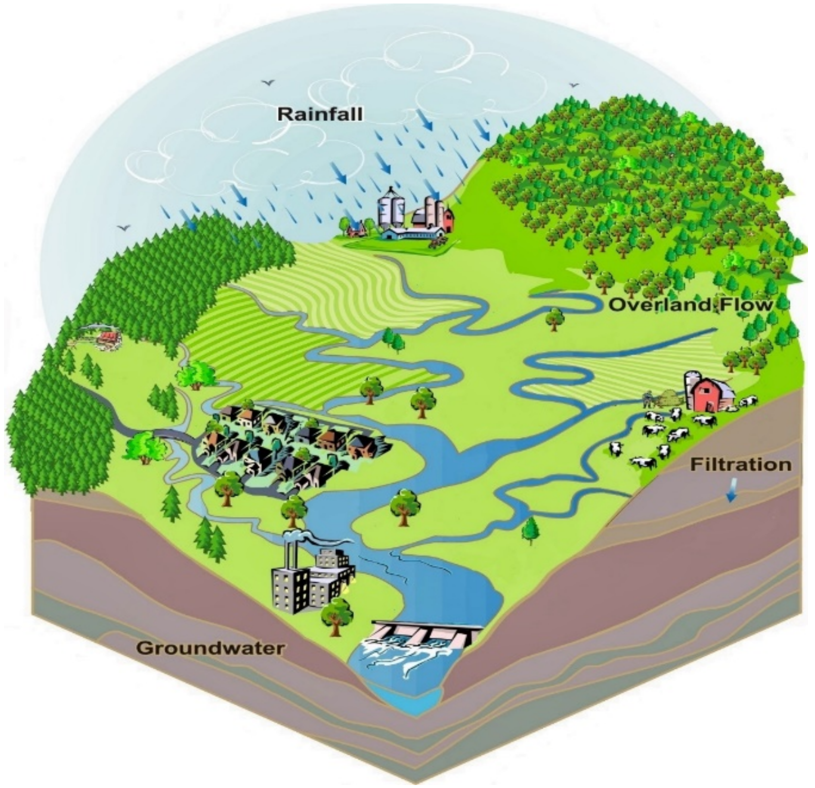
MODULAR – Extensive use of data structures and modules. Easier to maintain, link to other models, and add process subroutines.

RECODING - Spatial objects with new input/output data structure is complete. Continue recoding process subroutines and modules.

VERSION CONTROL – Bit Bucket, archive code and data

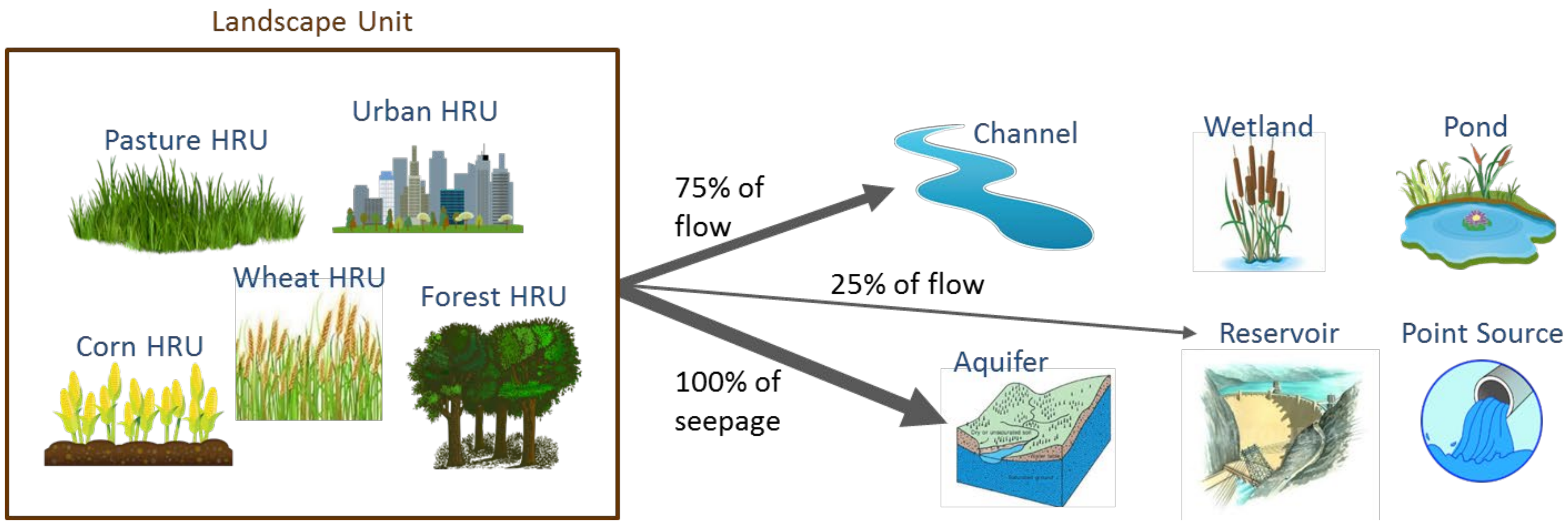
FACILITATE- maintenance of code and input files, linkage of SWAT and other models, addition of new process subroutines

SWAT+
SOIL & WATER ASSESSMENT TOOL

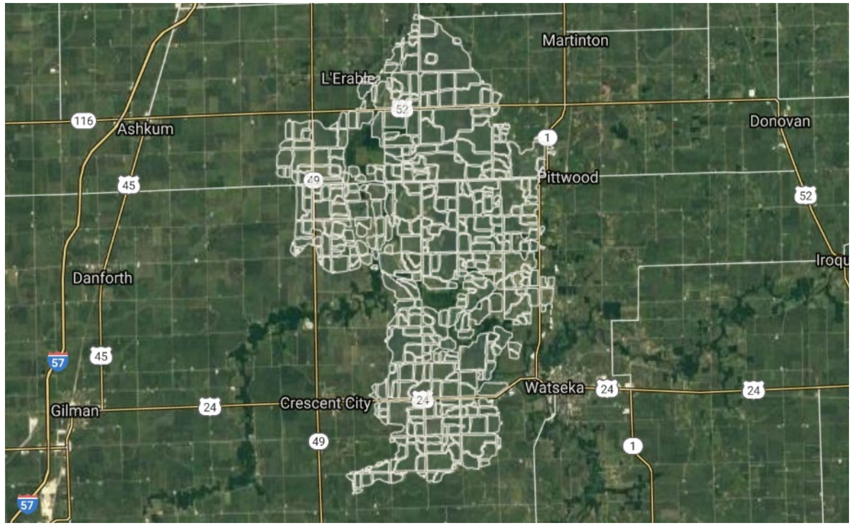


- New, completely restructured version
- Far fewer input files
- Improved simulation of small-scale processes
- Improved
  - Water cycle
  - Nutrient cycle
  - Plant growth
  - River/stream processes
- Flexible spatial representation of connectivity within a watershed using "connect" files

Connectivity
Spatial objects and connections in SWAT+



- ➢ Flexible spatial representation of connectivity within a watershed using "connect" files for each spatial object



Connectivity

Flexible spatial representation allows:

- ➢ Field and Grid Based
- ➢ First Order Steams
- ➢ Flood Plains
- ➢ Water Allocation
- ➢ New spatial objects: pumps, canals, water rights, animal herds

Relational Input File Structure

Relational input file structure allows:

- Reduces the number of input files
- Data files can be maintained as databases
- Crowd sourcing – SWAT community can add and support data files
- Interface → Connecting objects
- Decision Tables – precise, compact way to model complex rule sets and corresponding actions – Land management, reservoir release, land use change, scenario analysis

Land Processes and Management

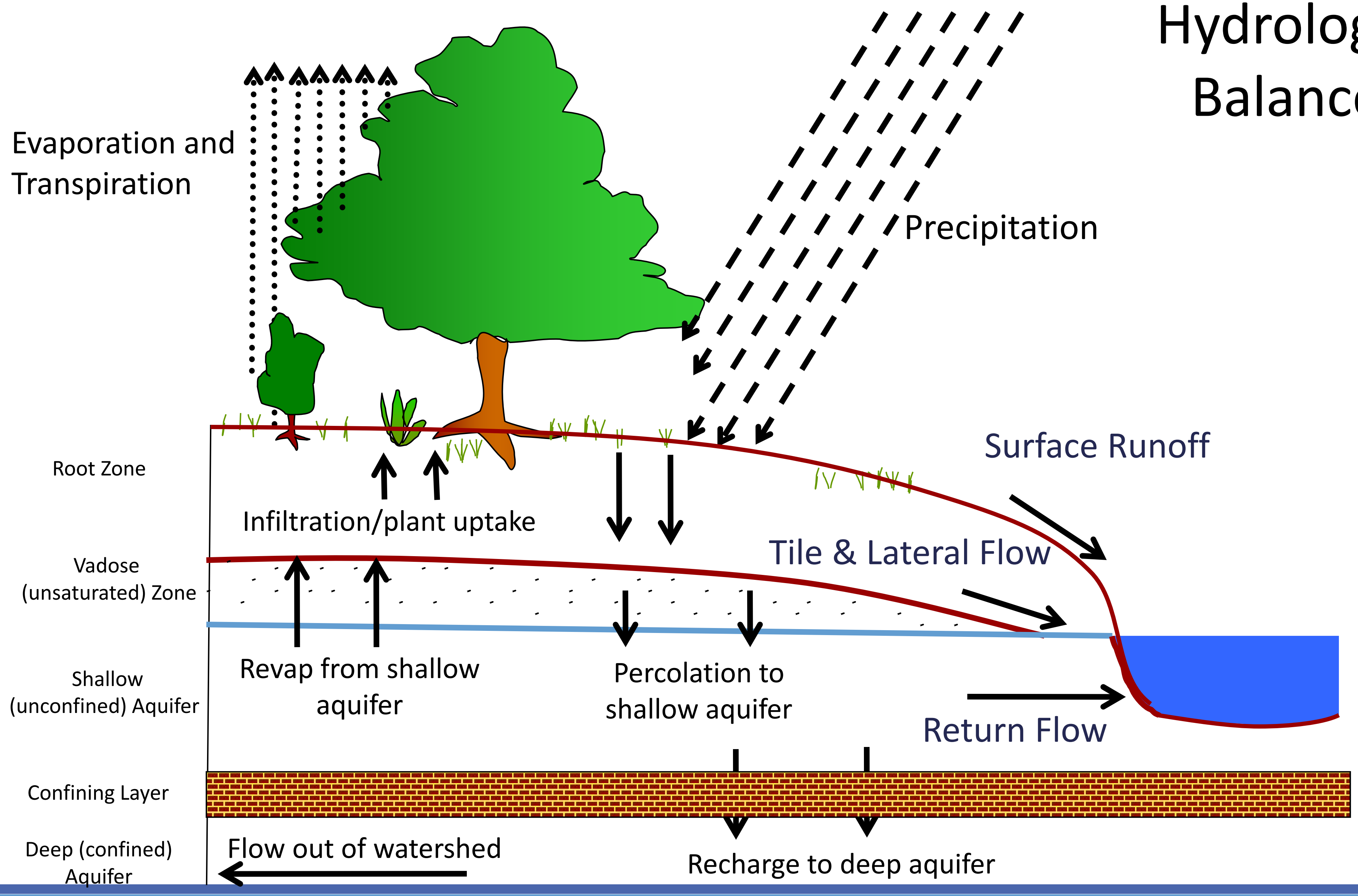
Upland Processes

- Weather
- Hydrology
- Sedimentation
- Plant growth
- Nutrient cycling
- Pesticide dynamics
- Carbon dynamics
- Pathogen fate

Management

- Crop rotations
- Removal of biomass as harvest conversion of biomass to residue
- Tillage/biomixing of soil
- Fertilizer applications
- Grazing
- Pesticide applications
- Irrigation
- Subsurface (tile) drainage
- Water impoundment (e.g., rice)
- Urban BMP's – water retention, green roof, water garden

Hydrologic Balance



Plant Growth

<u>Yield Prediction</u>

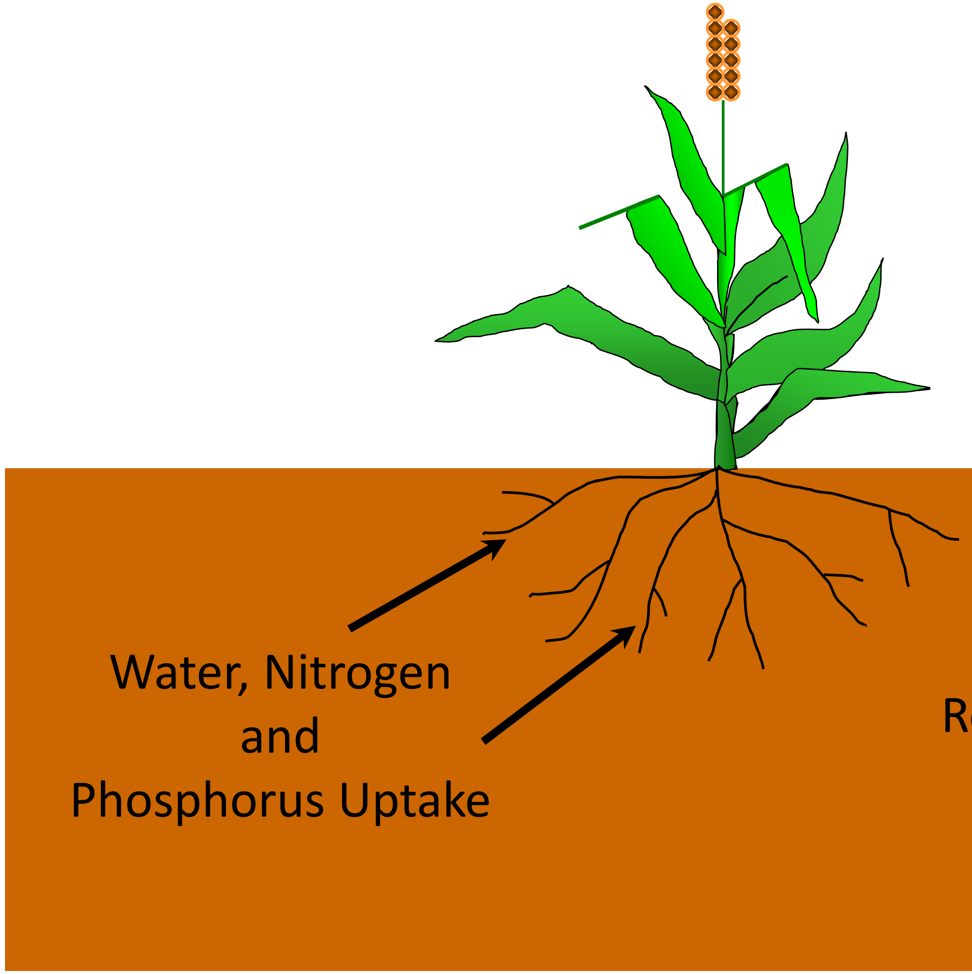
- Harvest Index – Water Stress
- Residue – Cover and Nutrients

<u>Optimum Growth</u>

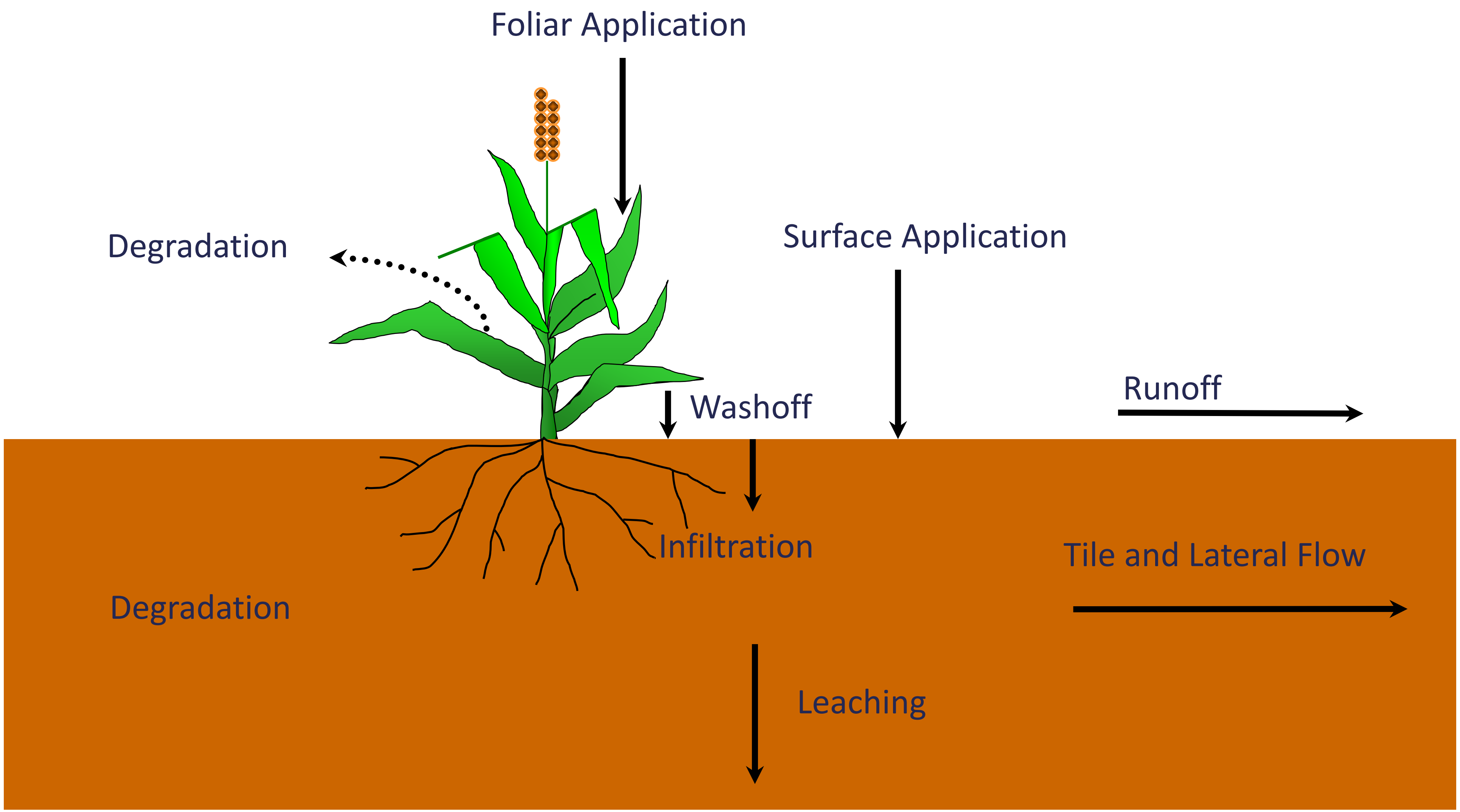
Radiation Interception – LAI,
Radiation Use Efficiency

<u>Constraints</u>

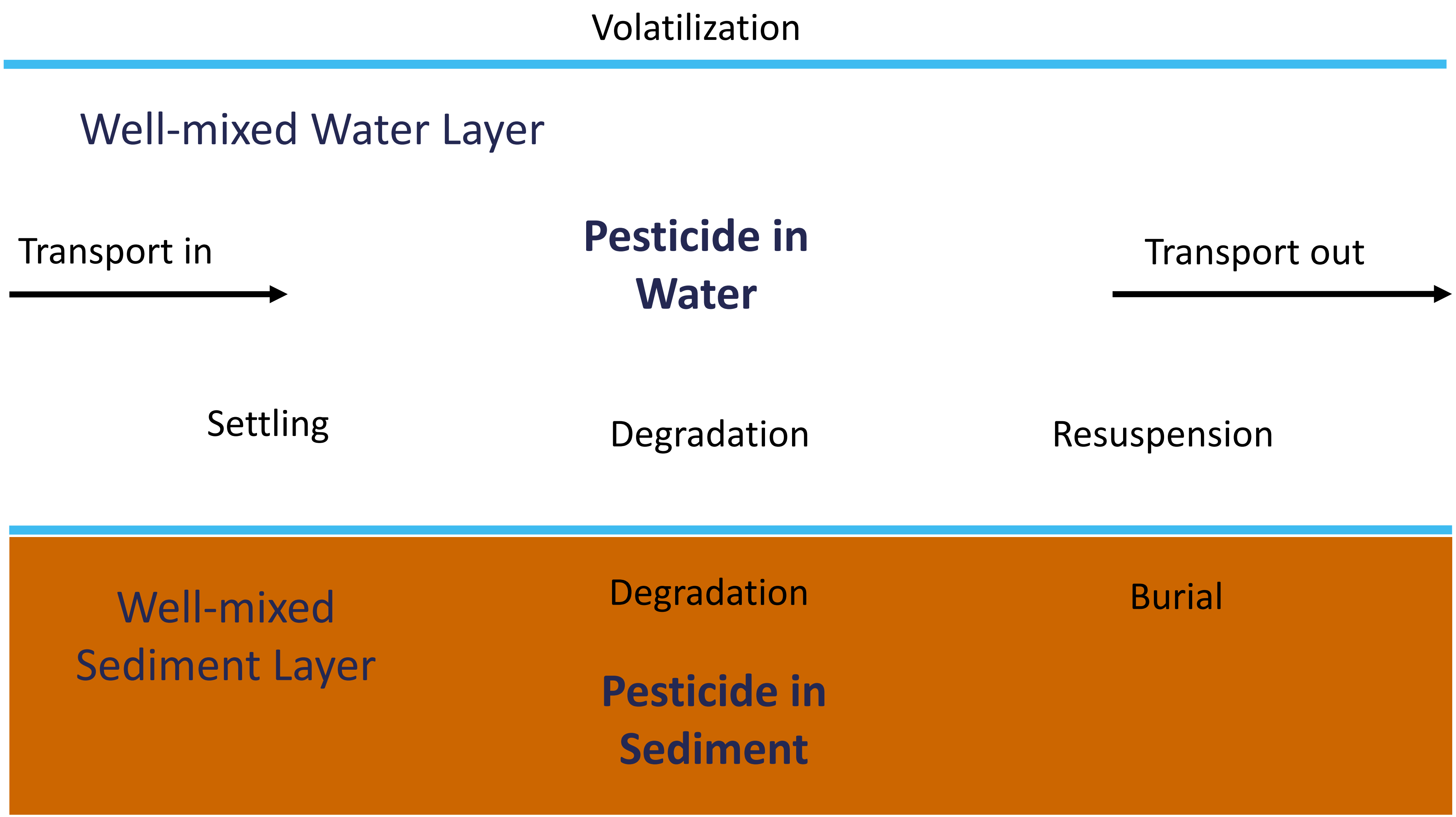
Water, Aeration, Temperature, Nitrogen,
Phosphorus



Pesticide Processes



In-stream Pesticide Processes



Sediment Transport

- MUSLE – sediment leaving fields

  $sed\_yld = 11.8(Qq_p)^{0.56}\ KCSLP$

- Channel erosion – (shear – $shear_{cr}$)

  Widening – bank material and vegetation

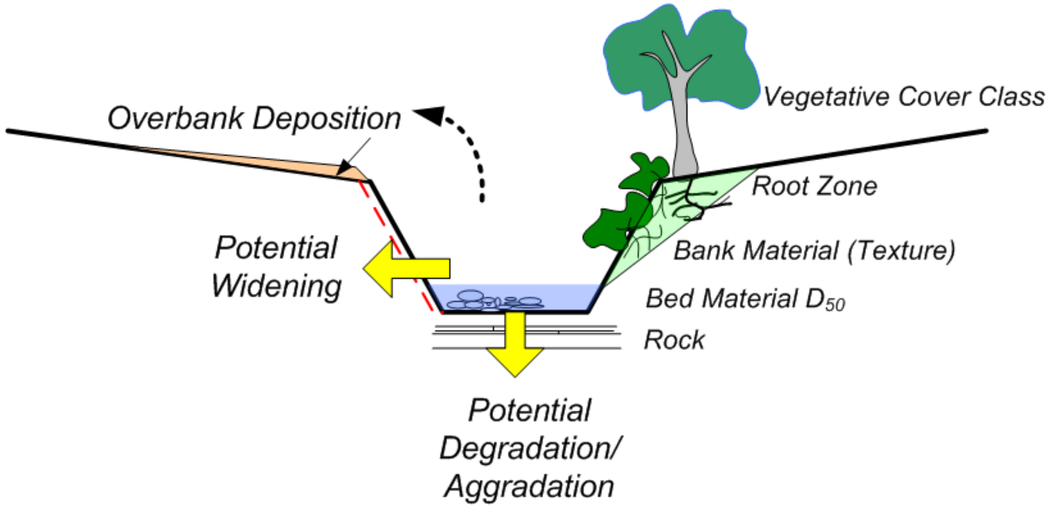
  Downcutting – bed material – D_{50}

- Wetland Deposition

  dep = (conc – $conc_{norm}$) * $setl_{vel}$

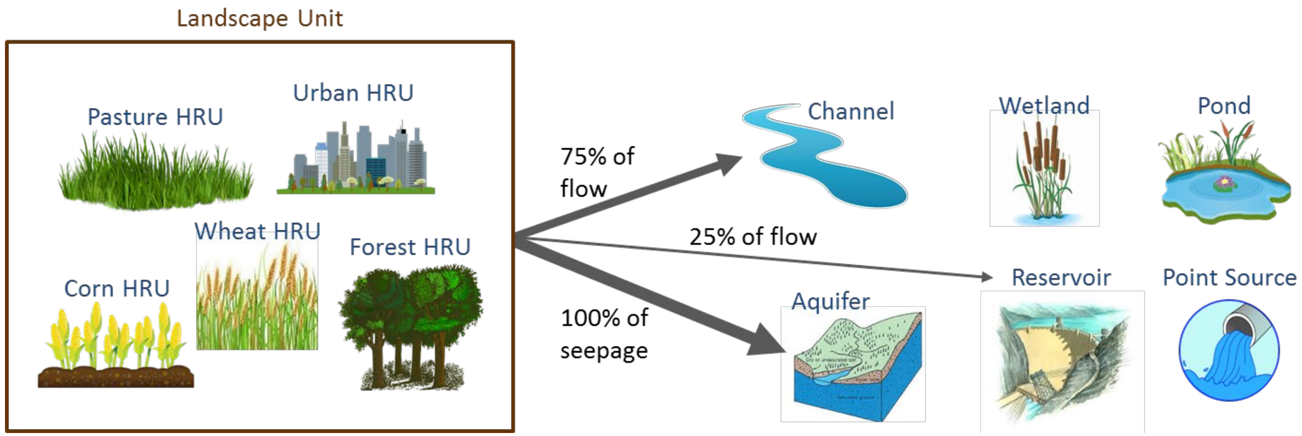
- Flood plain deposition in wetlands

  Overbank sediment is deposited in wetlands

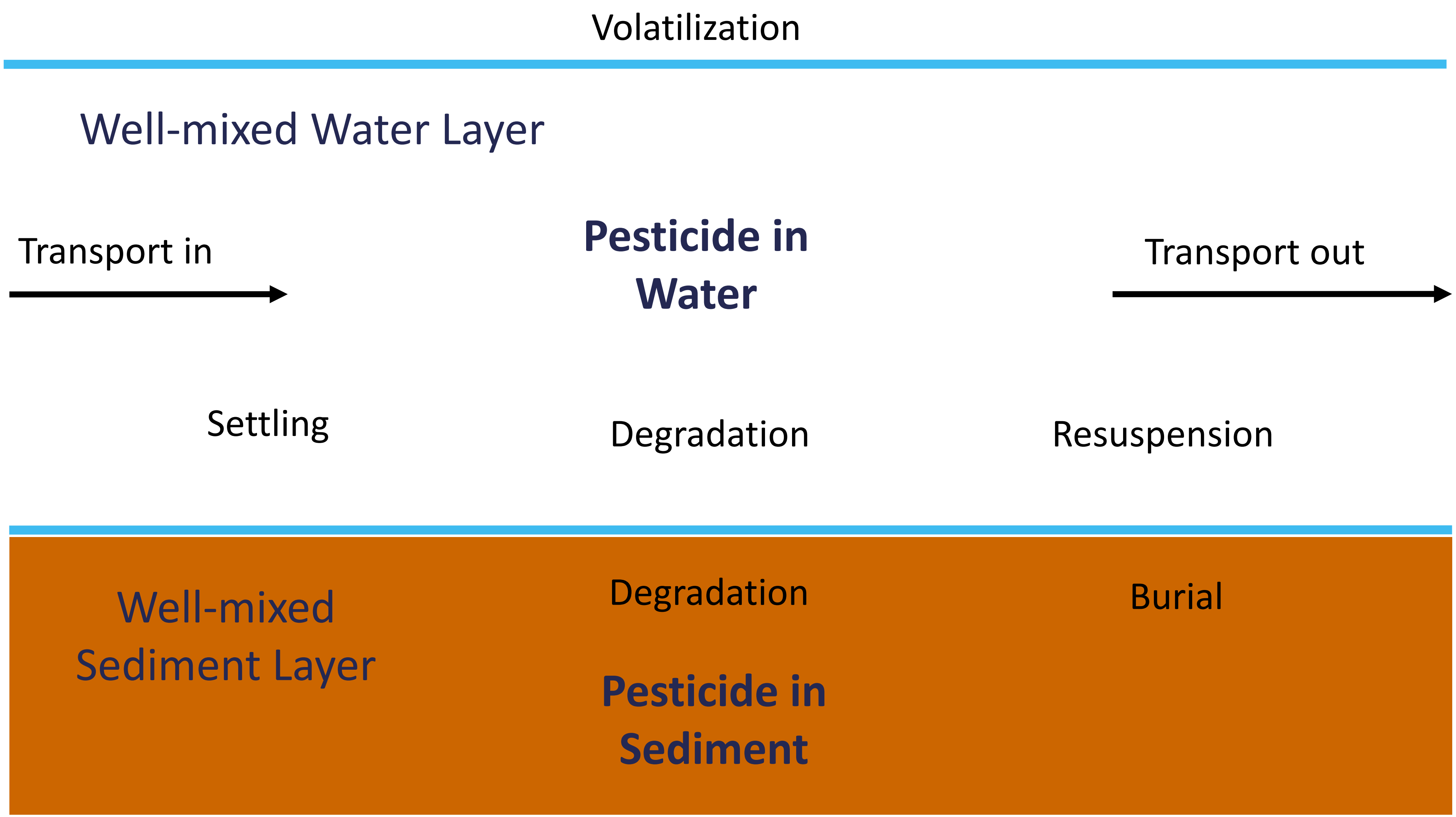


Wetlands

- HRU (soil/plant) that can pond water
- Inflow → connect files – upland/flood plain
- Outflow – decision tables – condition outflow on
  volumes, season, any state variable
- Nutrients
  N and P settling rates – developed at Iowa State



Wetland Pesticide Processes



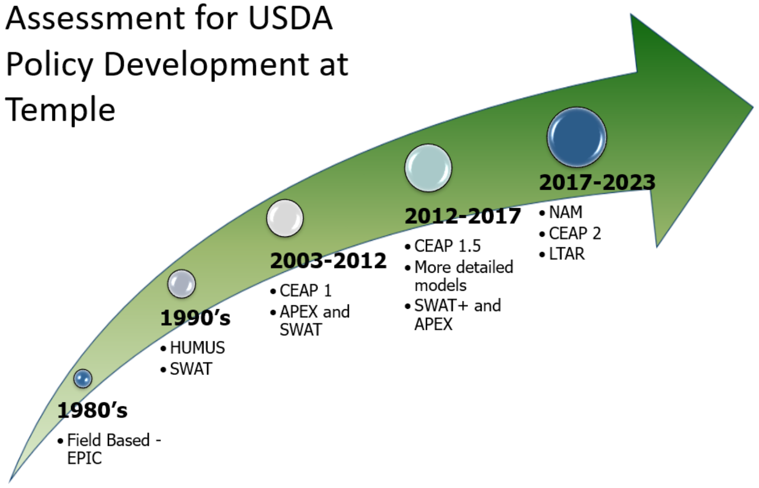
National Agroecosystem Model (NAM)

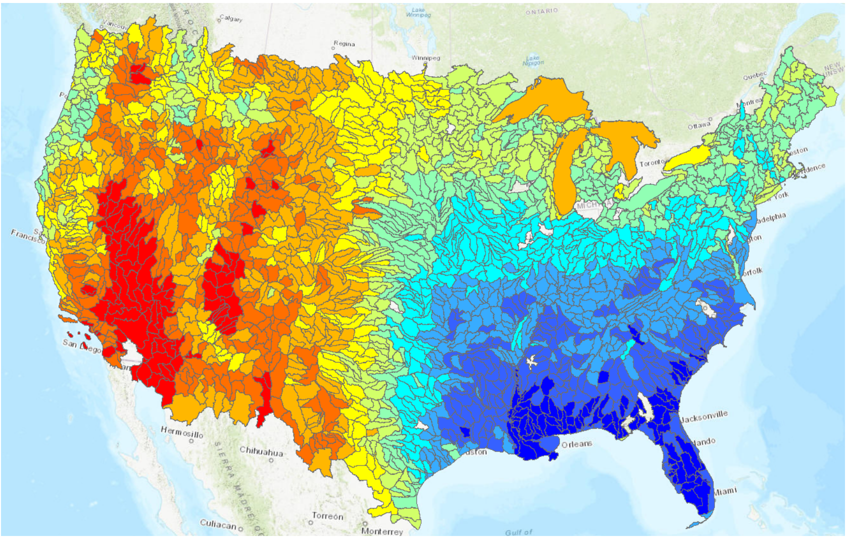
- A highly detailed national modeling framework developed to predict the effects of agriculture on the environment.
- Joint ARS/NRCS/Texas A&M effort
- Scope - Contiguous US

- Conservation Effects Assessment Project (CEAP)
  - 2002 Farm Bill -significant increase in conservation funding
  - CEAP developed to guide and evaluate conservation programs
  - Survey current conservation
  - Estimate the benefits on water quality using models

- Long Term Agroecosystems Research (LTAR)
  - Network developing national strategies for the sustainable intensification of ag production
  - 18 long-term research sites across the U.S.

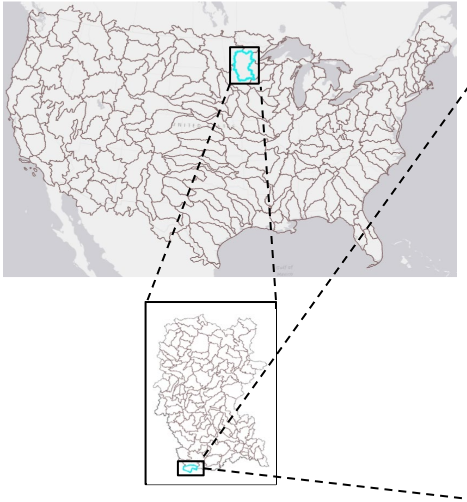
History of Conservation Assessment for USDA Policy Development at Temple



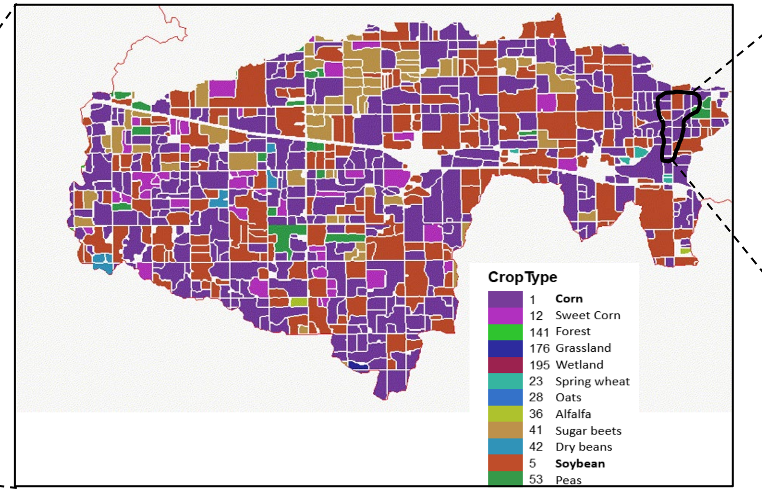


Scope and Scale

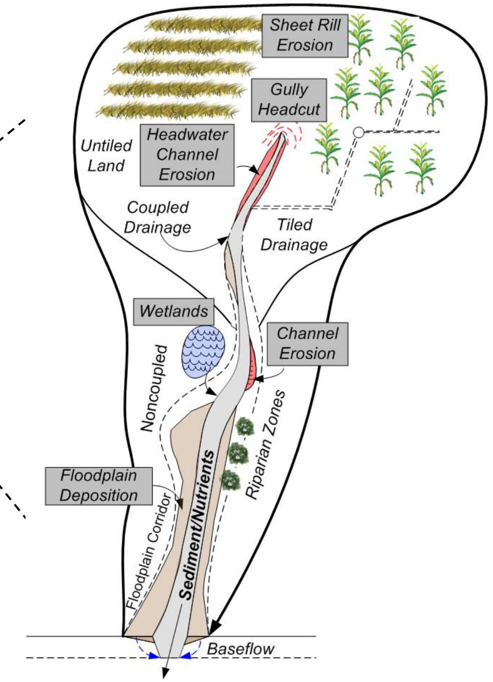
National Extent



Field Based Computational Units



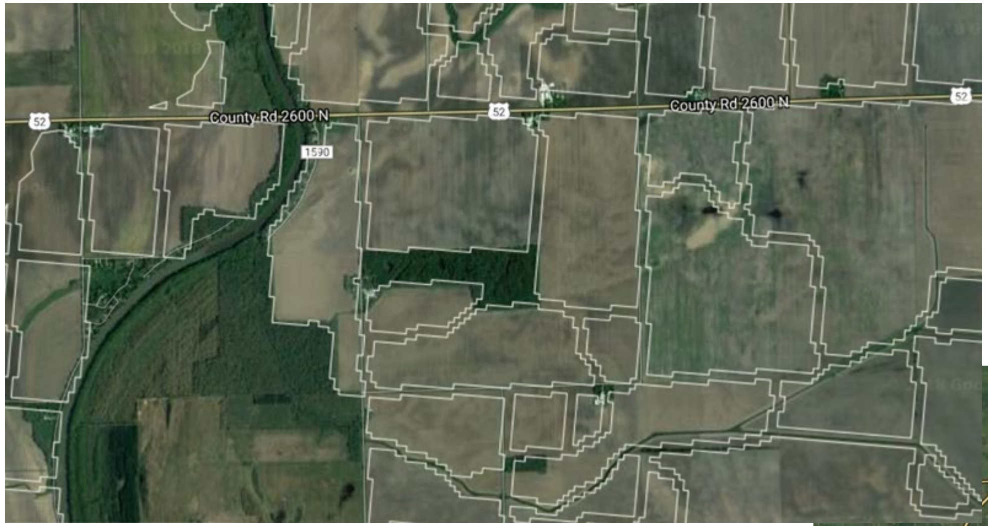
Process Based
SWAT+ Simulation

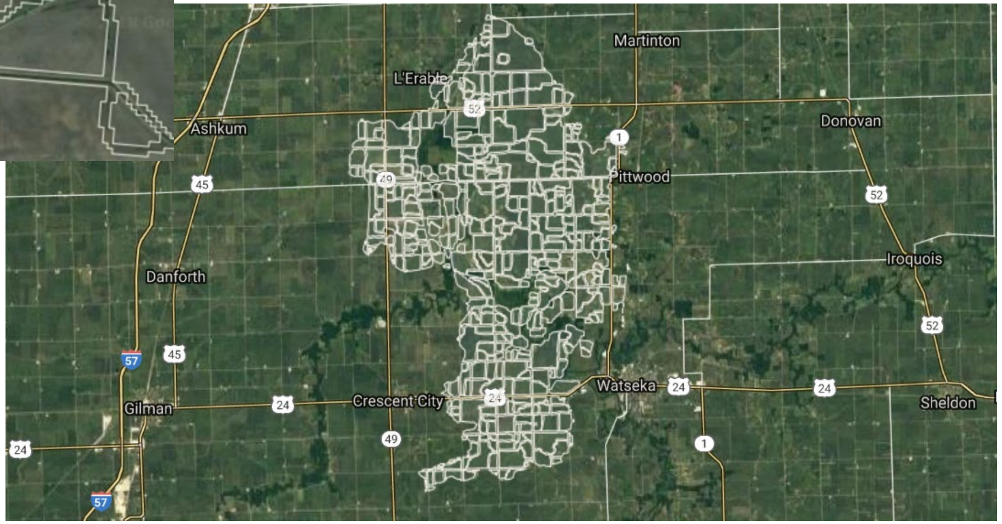


- 2,120 SWAT+ Models
- 86,000 Subbasins
- 7.5 Million HRUs

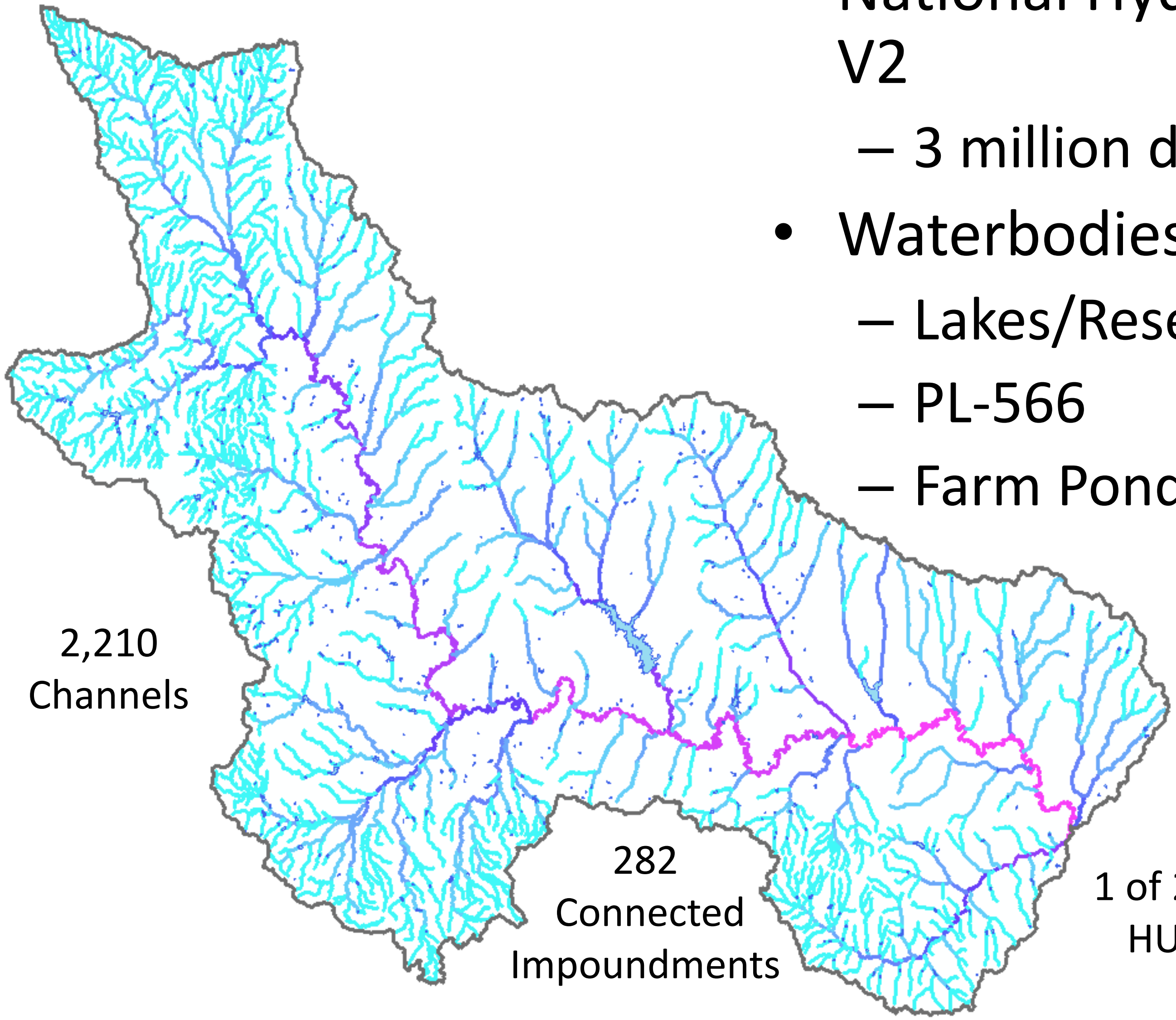
Cropland Field Boundaries

- Field map of U.S. derived from satellite data – 4.2 million fields in U.S. - Average size 20-30 ha
- Derived from Yan and Roy (2016) South Dakota State



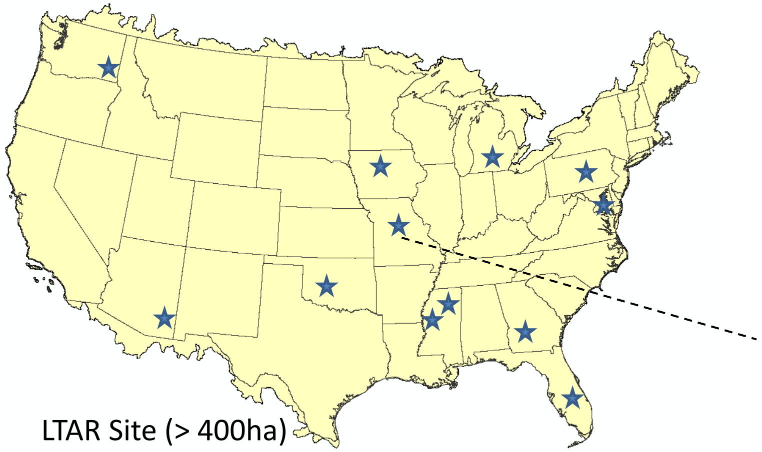


Stream Reaches and Water Bodies

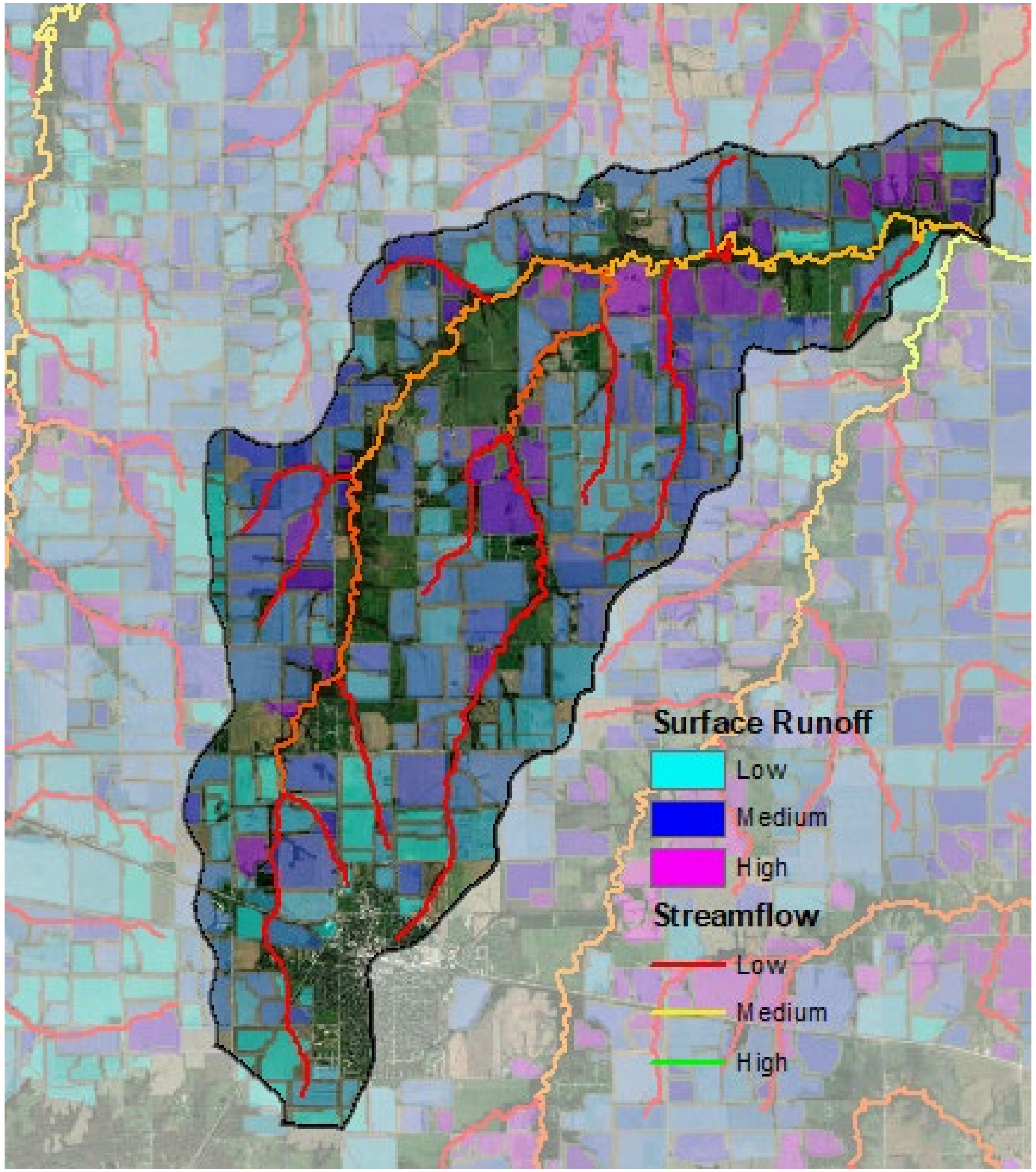


- National Hydrography Dataset V2
  - 3 million digitized reaches
- Waterbodies
  - Lakes/Reservoirs
  - PL-566
  - Farm Ponds

Goodwater Creek

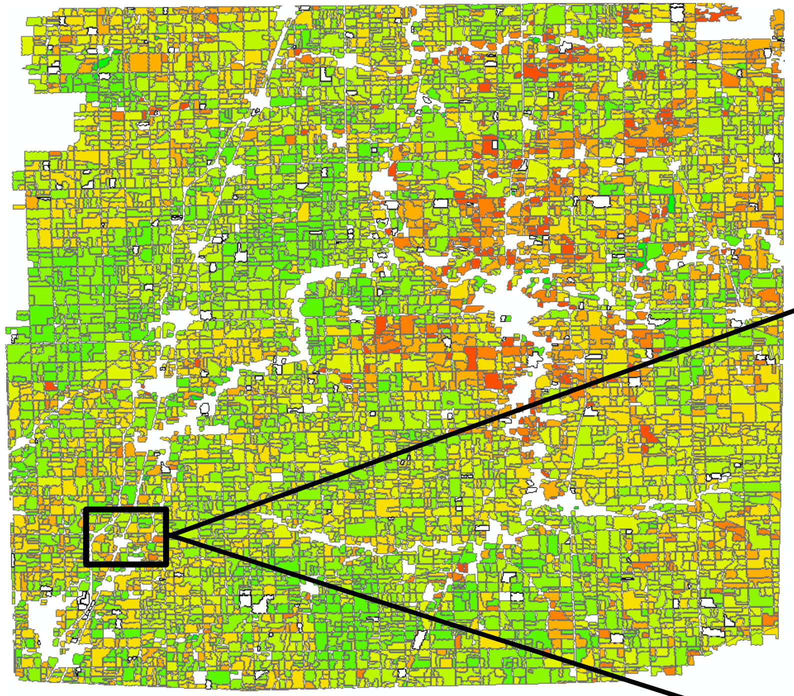


- 1 HUC-12
- Field level
- Convenient Computational Unit
- Reliability unknown
- Relative maybe ok
- Absolute maybe not



Iroquois County, Illinois

Corn Yield **7,918 Fields**

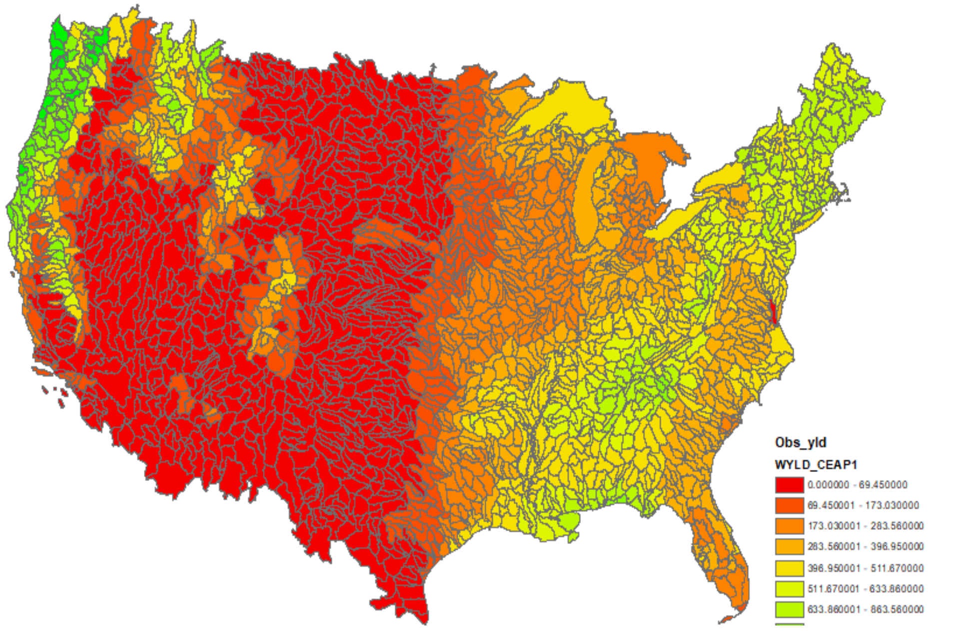


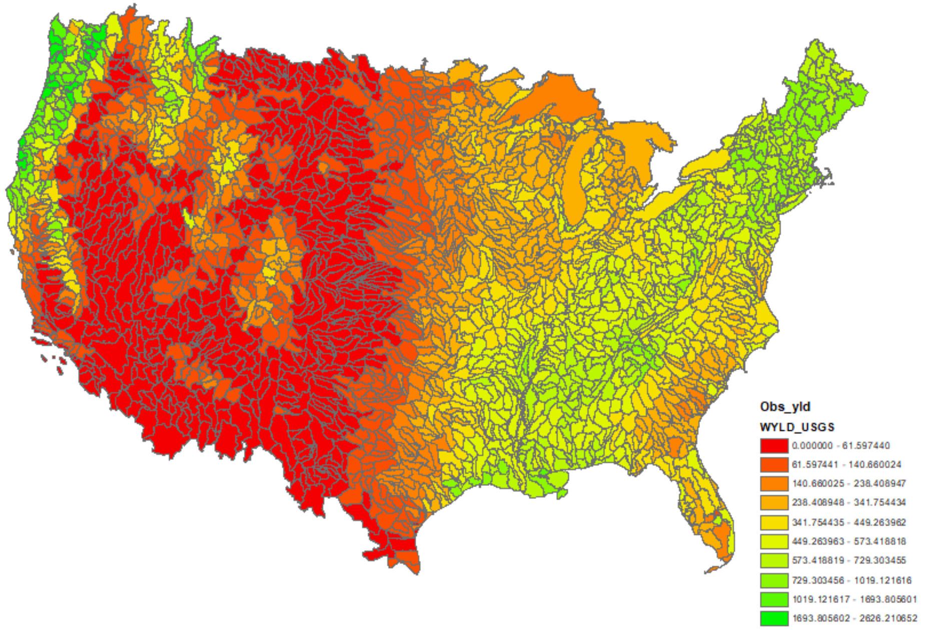
Corn Yield

Soybean Yield

Status of Calibration

- Water budgets
  - Soft calibration of water yield and for 2,100 HUC8's with USGS data
  - Soft calibration of LTAR water budgets at 8 sites
- Crop yields
  - Assembled county yield estimates for major agronomic crops
  - Calibration routine embedded in SWAT+
- Stream flow and channel degradation
  - Flow duration curves at LTAR sites
  - Channel downcutting and widening
- Nutrient budgets
  - Assembling national budget data
  - Assembling LTAR monitored data





Thank you