Modeling Water Quality Benefits of Conservation Practices

Yongping Yuan, Ph.D
Hydrologist
USEPA-Office of Research and Development
Environmental Science Division
Landscape Ecology Branch
Las Vegas, NV

July 20, 2010

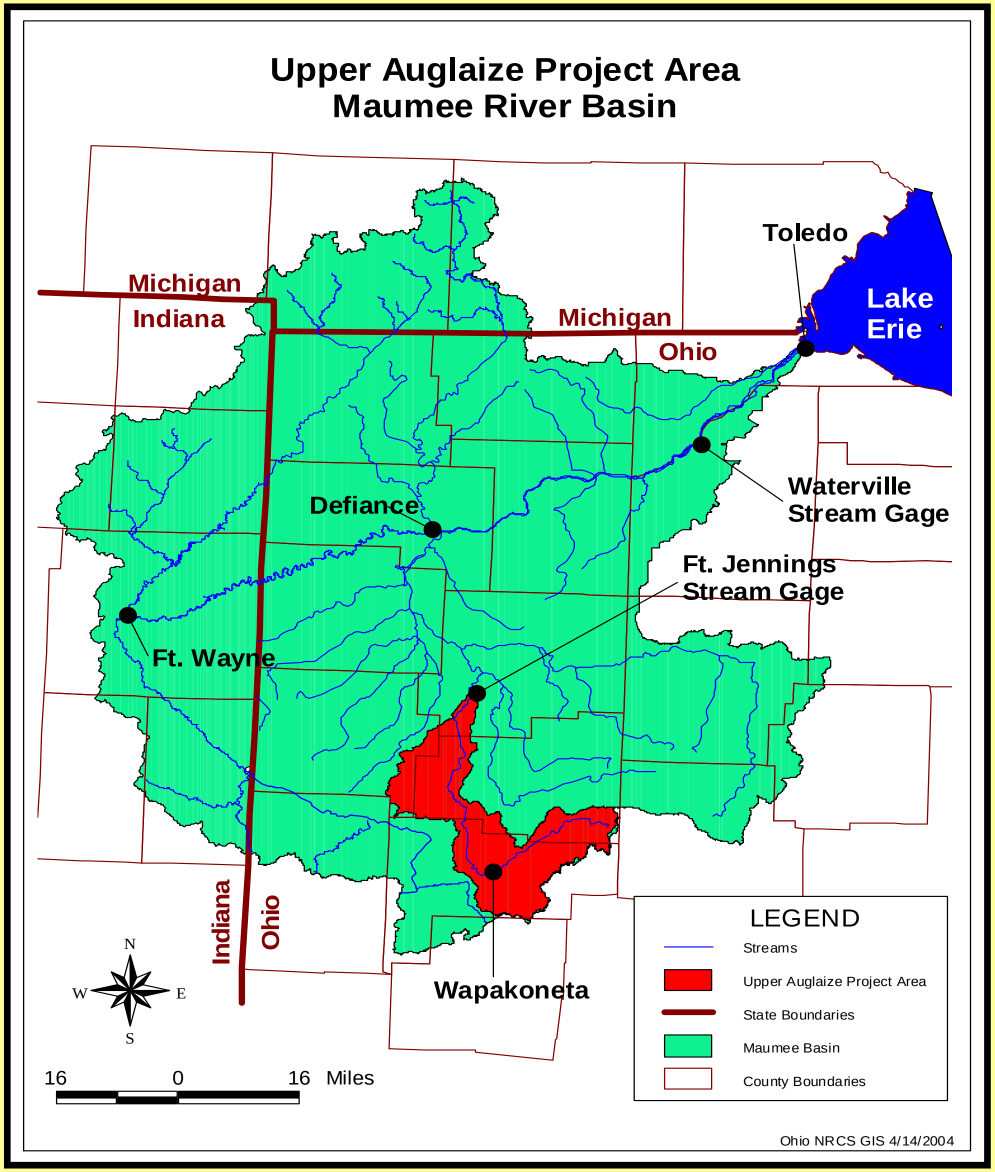
Ecosystem Services Research Projects

- **Estimating Ecosystem Services (ES).**
- **Understanding potential ES changes due to land-use and climate changes.**
- **Studying potential strategies to minimize degradation of ES.**
- **Conservation practices are important strategies recommended by the USDA-NRCS for environmental and water quality improvement.**

How conservation practices are evaluated?

- Monitoring programs.
- Long-term monitoring are needed because it better reflects multi-year climatic variability and helps assure that a range of events conditions are covered.
- Monitoring with complimentary simulation modeling are alternative ways.

Modeling Water Quality Benefits of Conservation Practices for the Upper Auglaize Watershed, OH

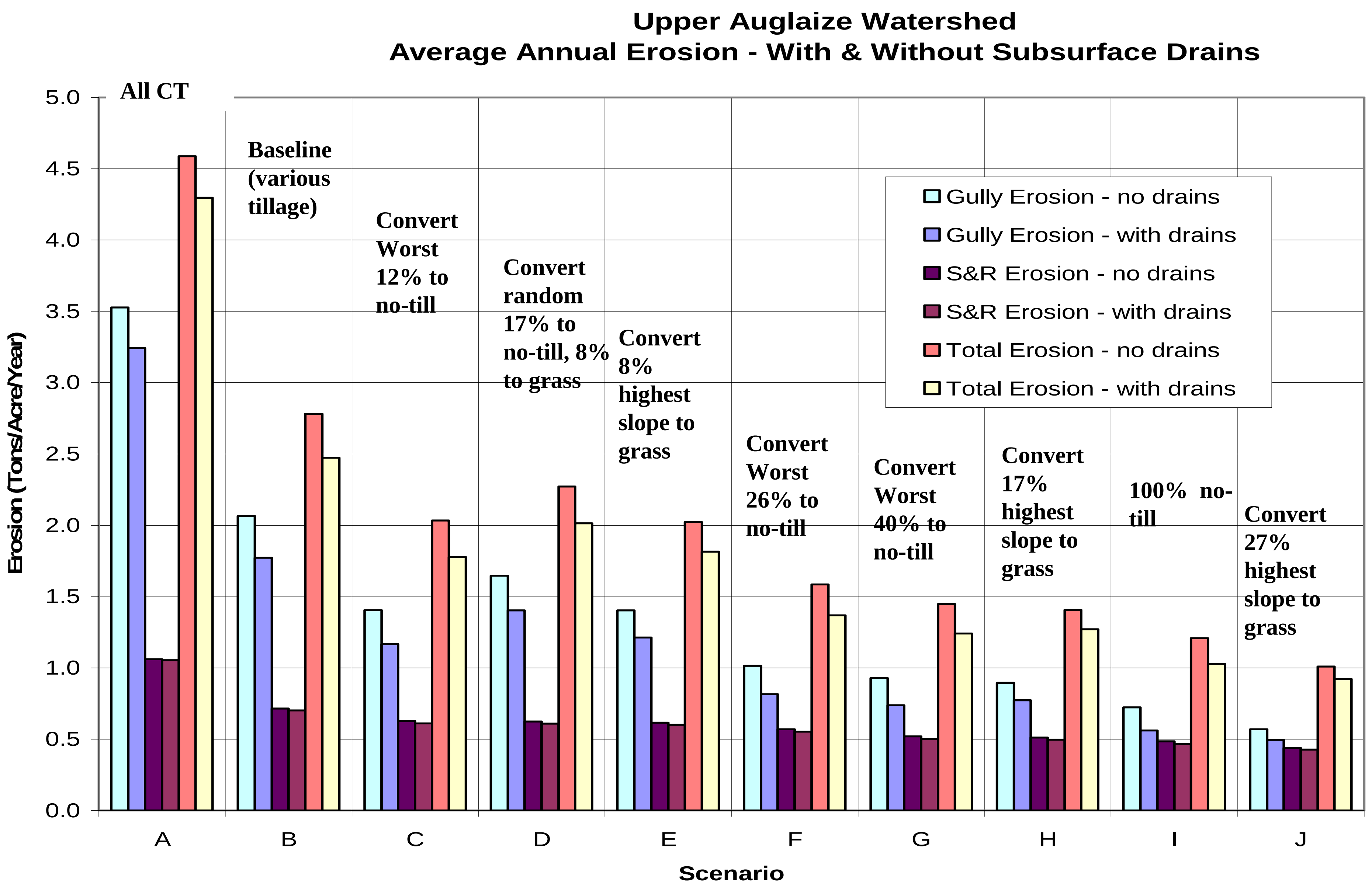


The Upper Auglaize (UA) watershed is located in the southern portion of the Maumee River Basin.

The watershed encompasses 85,812 ha upstream of the Fort Jennings USGS gaging station at the outlet.

Land use is predominately agricultural with 74% cropland (83% of which are corn and soybean), 11% grassland, 6% woodland, and 9% urban and other land uses.

Upper Auglaize Watershed, OH

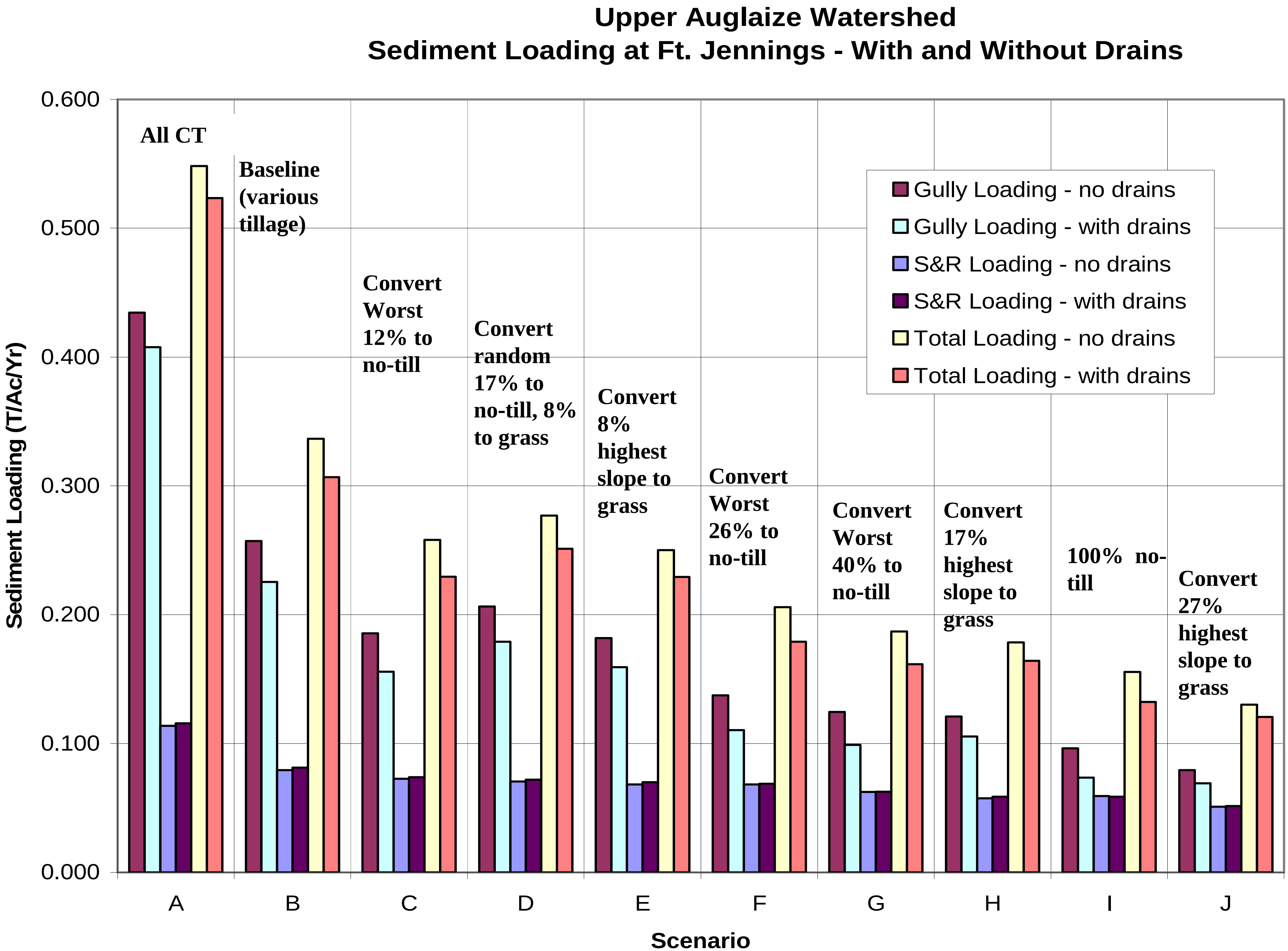


Remove existing conservation practices = 74% increase in soil erosion

Convert the worst 12% to no-till =28% decrease in soil erosion

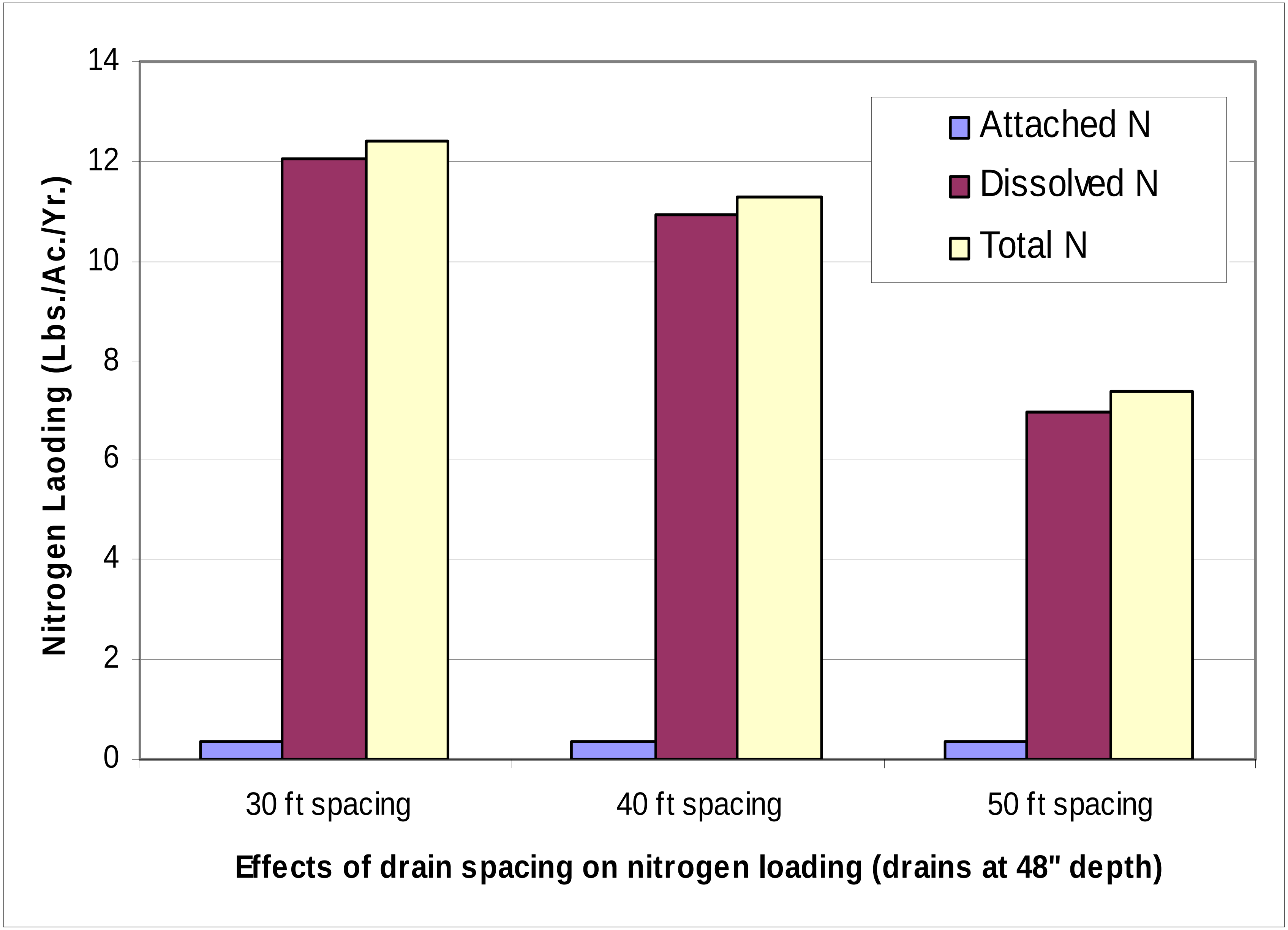
Convert random 17% to no-till =19% decrease in soil erosion

Convert the highest slope 8% to grass =27% decrease in soil erosion

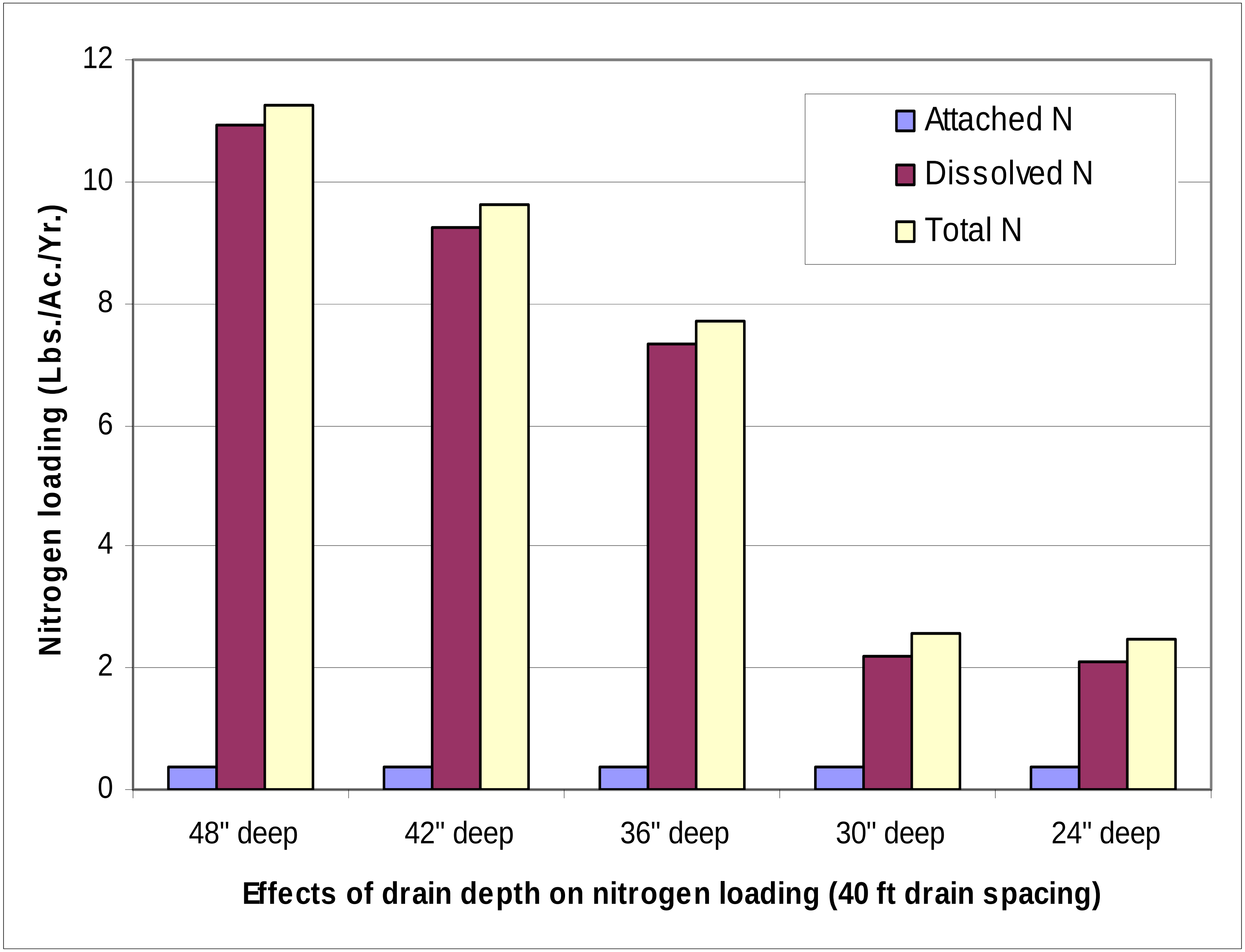

Upper Auglaize Watershed
Sediment Loading at Ft. Jennings - With and Without Drains
Sediment Loading (T/Ac/Yr)
0.600
0.500
0.400
0.300
0.200
0.100
0.000
All CT
Baseline (various tillage)
Convert Worst 12% to no-till
Convert random 17% to no-till, 8% to grass
Convert 8% highest slope to grass
Convert Worst 26% to no-till
Convert Worst 40% to no-till
Convert 17% highest slope to grass
100% no-till
Convert 27% highest slope to grass
Gully Loading - no drains
Gully Loading - with drains
S&R Loading - no drains
S&R Loading - with drains
Total Loading - no drains
Total Loading - with drains
A
B
C
D
E
F
G
H
I
J
Scenario

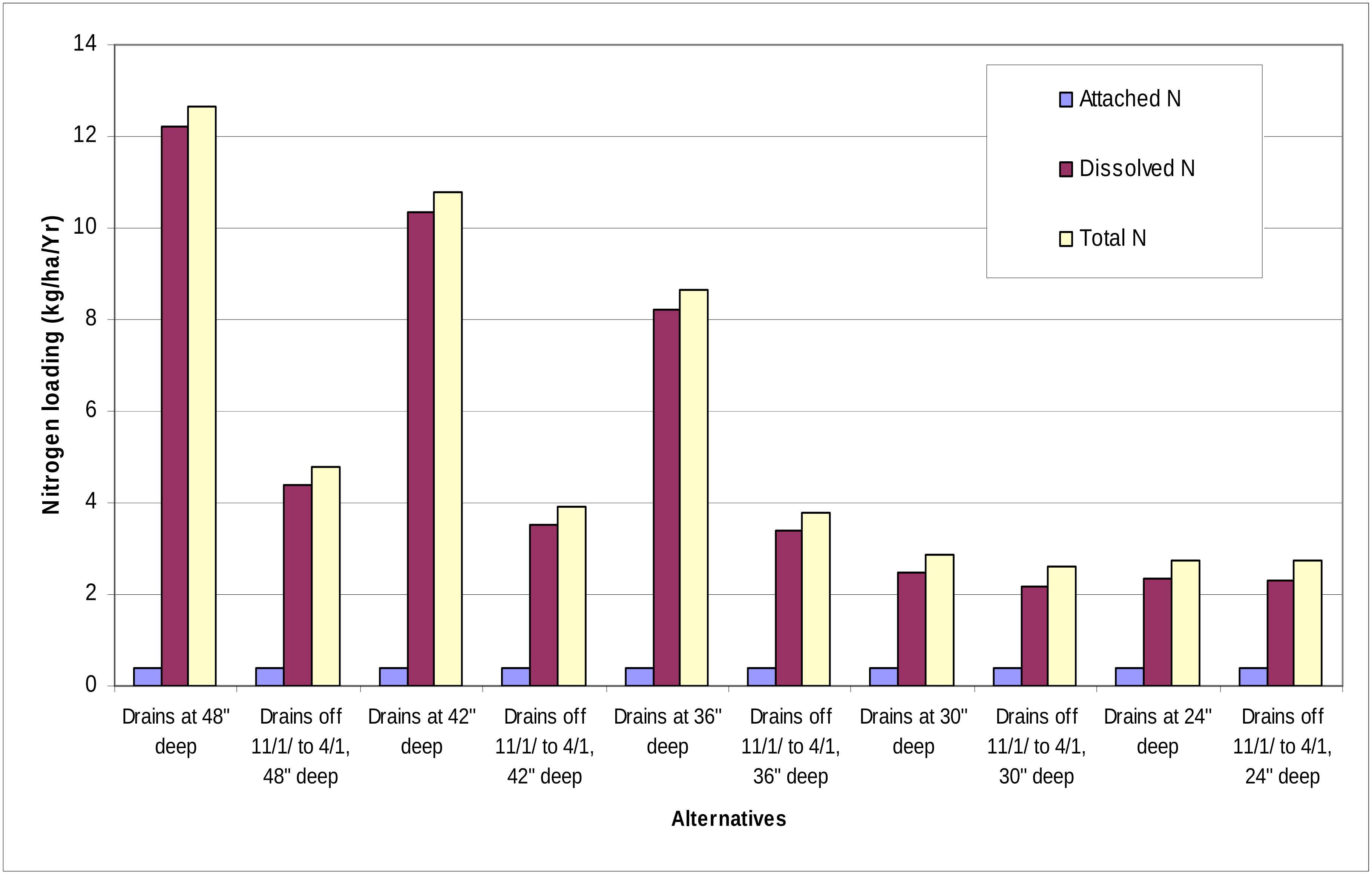
Subsurface drainage management to reduce nitrogen loadings

Upper Auglaize Watershed, OH



Upper Auglaize Watershed, OH



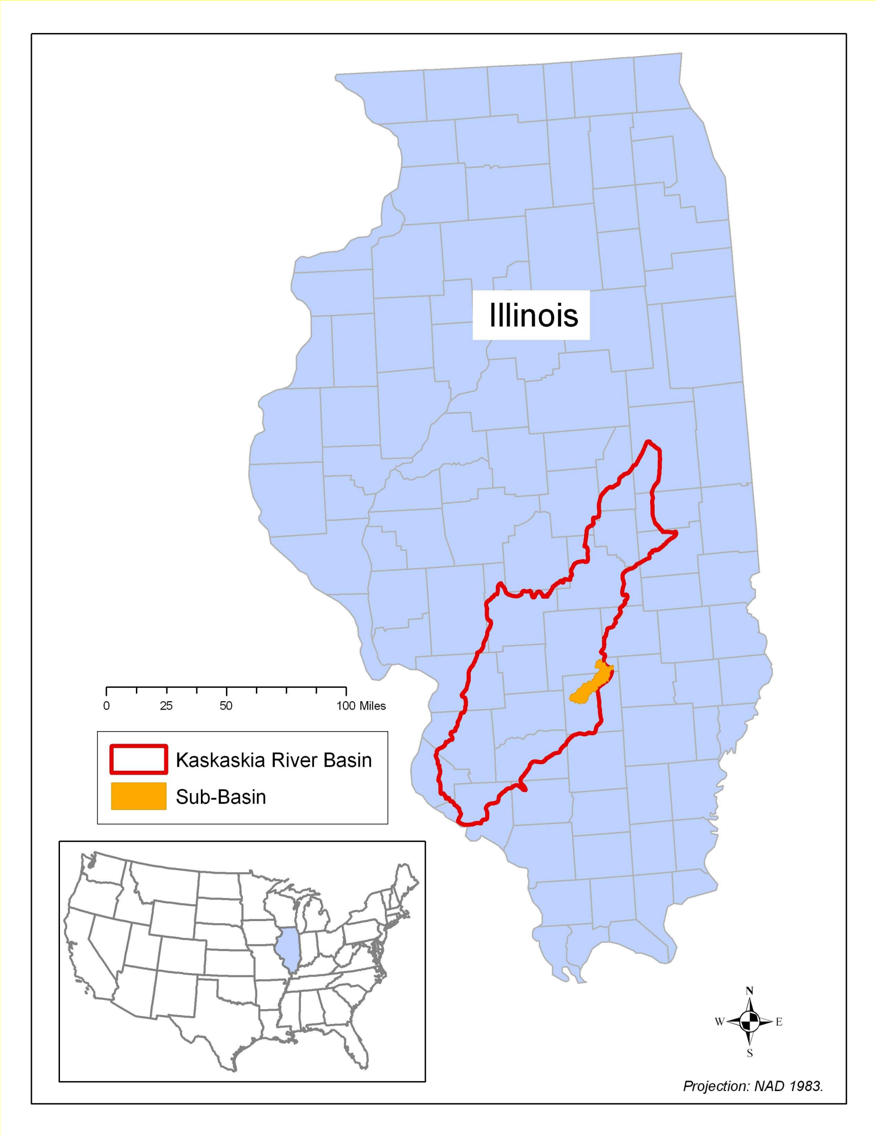


Effects of turning drains off during dormant season (Nov. 1 to Apr. 1) on N loading

Conclusions

- **Wider drain spacing and shallow depth to drain can reduce N loadings.**
- **N loading could be significantly reduced by controlling subsurface drains from November 1 to April 1 of each year.**
- **If turning off subsurface drains from November 1 to April 1 of each year is not an acceptable option, controlling subsurface drains at a shallow depth (2 feet) would achieve the same benefit.**

Modeling Water Quality Benefits of Conservation Practices for the Kaskaskia River Basin



Kaskaskia River Basin is 14,950 km^2 which is approximately 10.2% of the state of the Illinois.

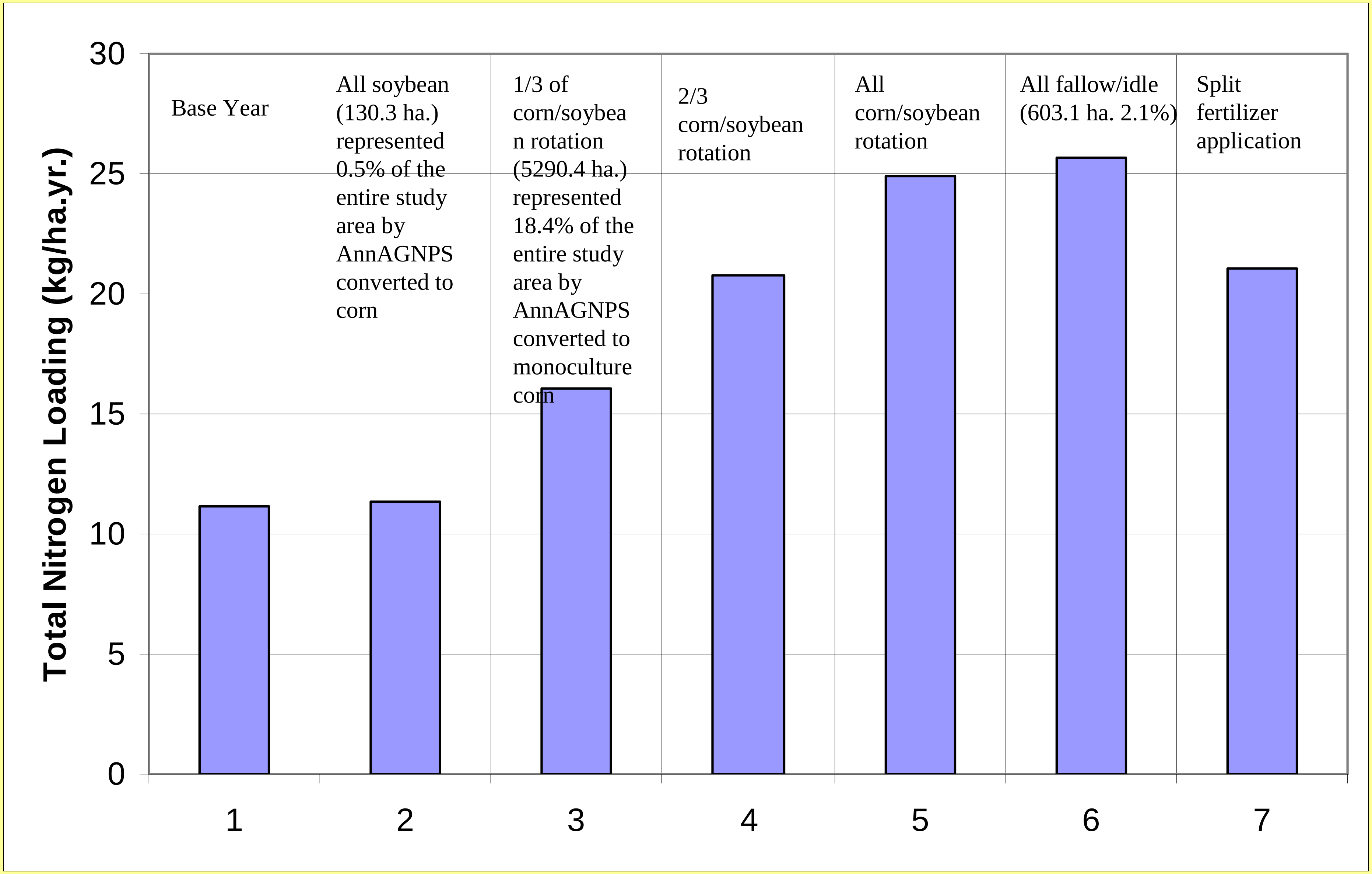
The USGS stream gauge station 05592900 East Fork Kaskaskia River is located in Marion County, Illinois, and drainage area is 289.3 km^2.

The dominant landuse is agriculture (61%), and major crops are corn/soybeans. The other landuse include forest (26%), urban (9%), wetland (3%) and barren (1%).

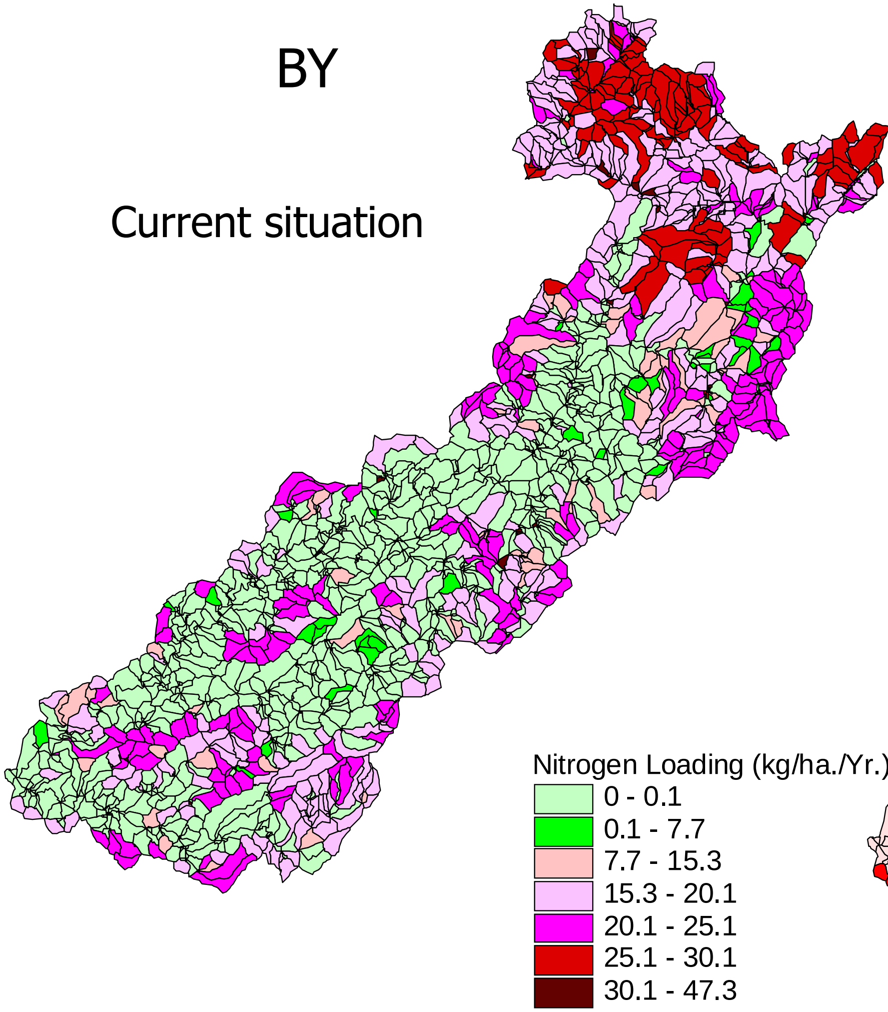
Simulation of Future Alternatives

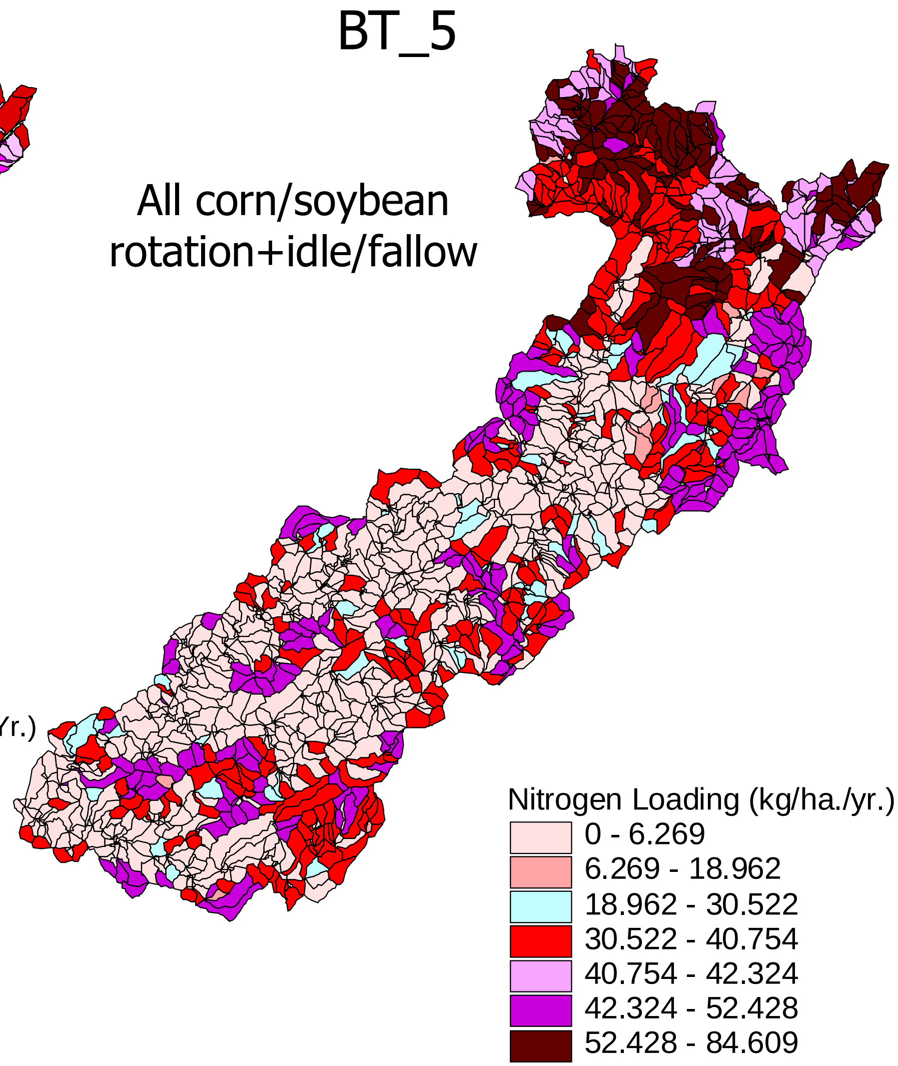
ID	Description
BY	Base Year
BT_1	All soybean (130.3 ha.) represented 0.5% of the entire study area by AnnAGNPS converted to corn
BT_2	1/3 of corn/soybean rotation (5290.4 ha.) represented 18.4% of the entire study area by AnnAGNPS converted to monoculture corn
BT_3	2/3 of corn/soybean rotation (10580.8 ha.) represented 36.8% of the entire study area by AnnAGNPS converted to monoculture corn
BT_4	All corn/soybean rotation (15871.2 ha.) represented 55.3% of the entire study area by AnnAGNPS converted to monoculture corn
BT_5	All fallow/idle (603.1 ha.) represented 2.1% of the entire study area by AnnAGNPS converted to corn
MS_1	Split fertilizer application

Simulations of the Future Alternatives of the East Fork Kaskaskia River Watershed



Nitrogen loading distribution based on AnnAGNPS model simulation



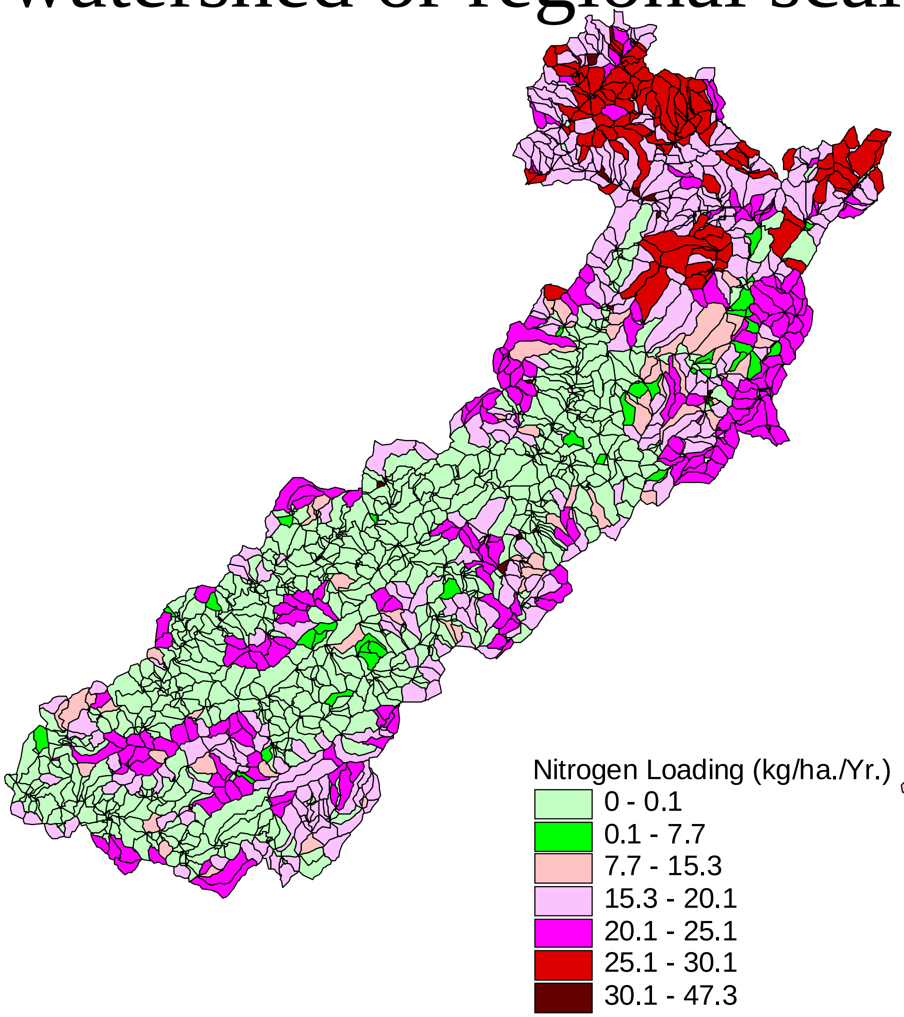


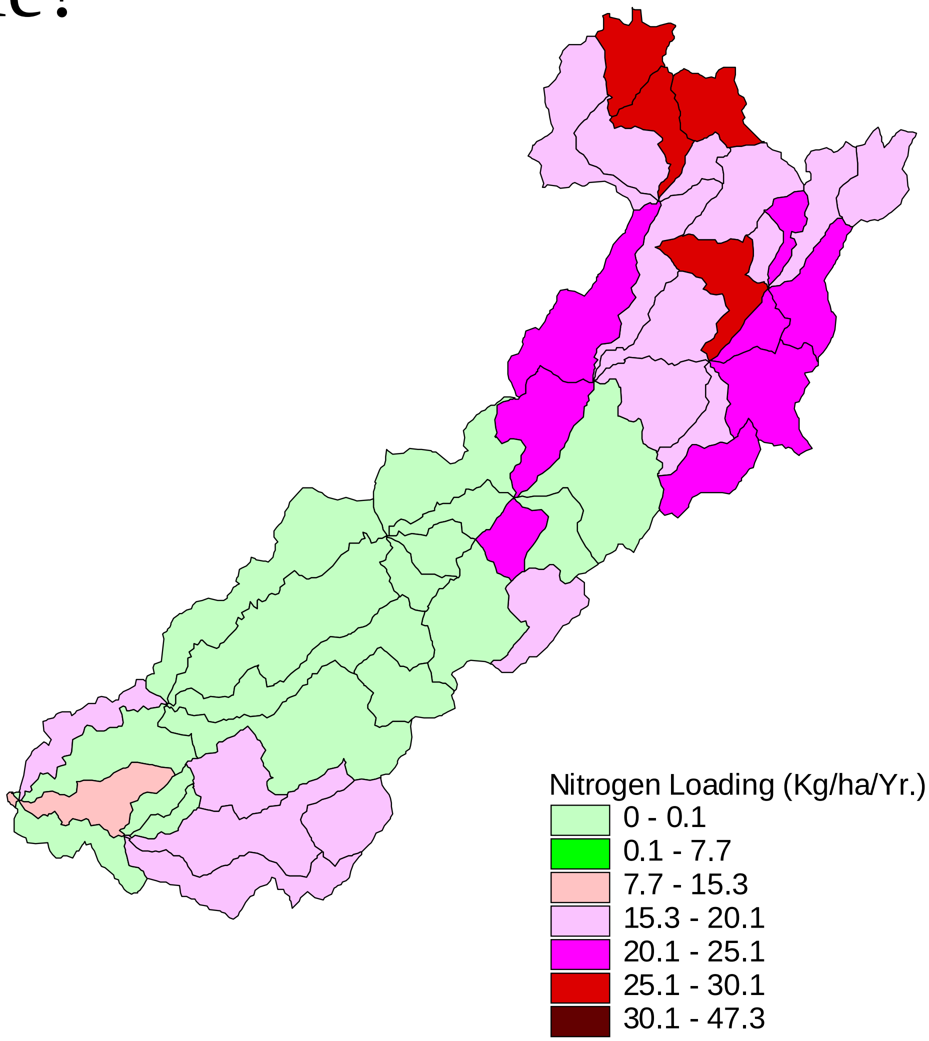
Convert the highest 10% to grass =23% decrease in Nitrogen loading

Convert additional 19% the second highest to grass =56% decrease in Nitrogen loading

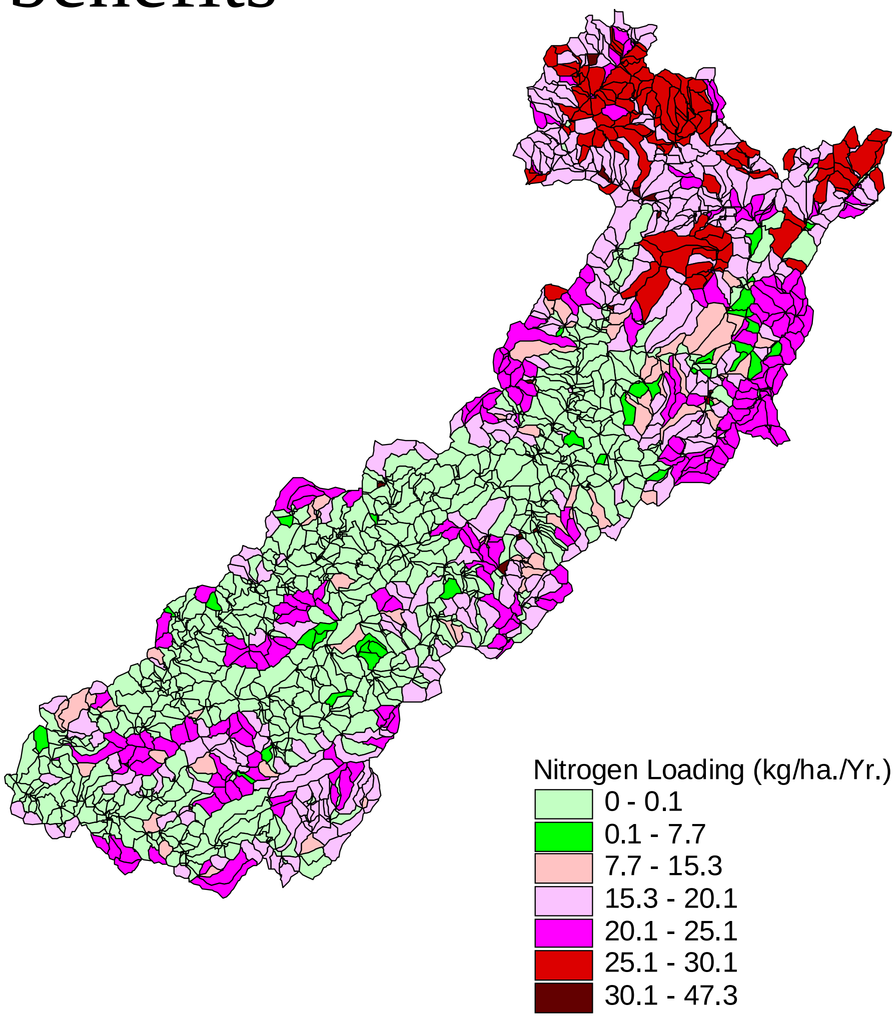
Additional reductions might be achieved through wetland construction/riparian buffer implementation

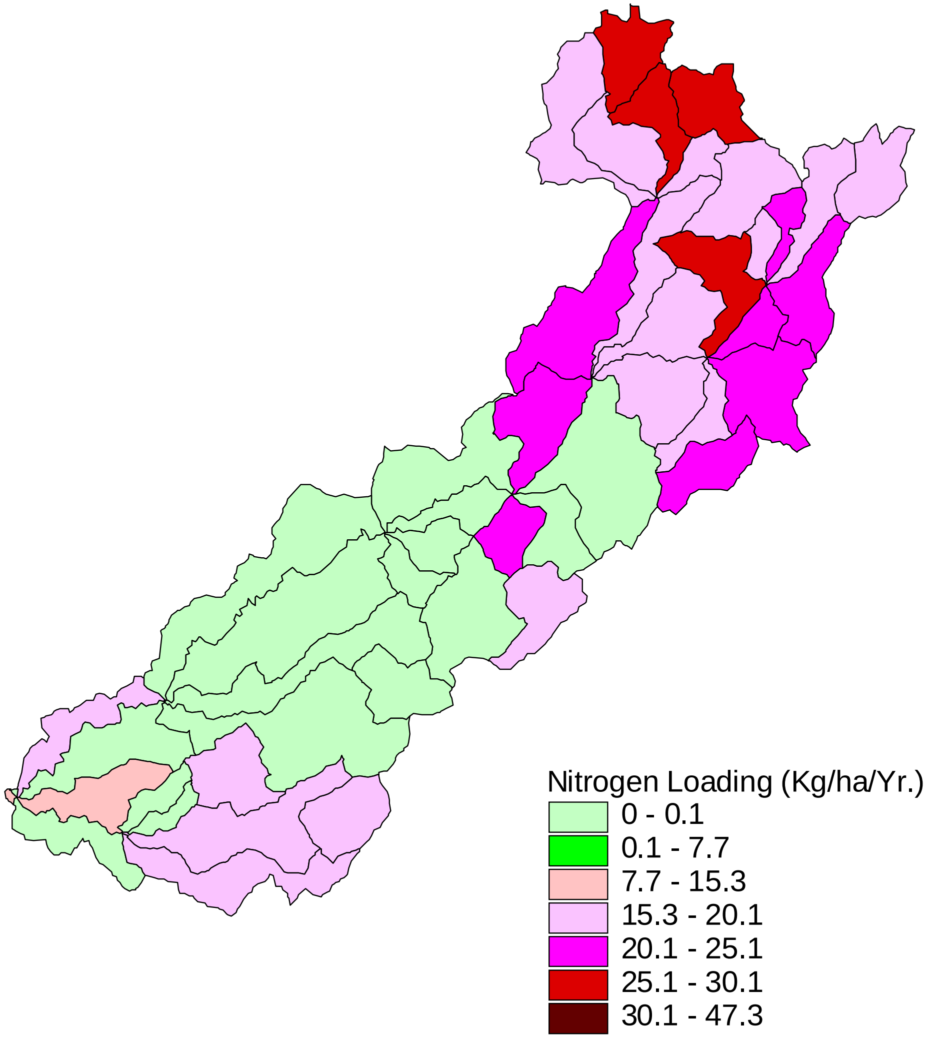
Challenging issues 1: How well a model can capture or simulate conservation practices at a watershed or regional scale?





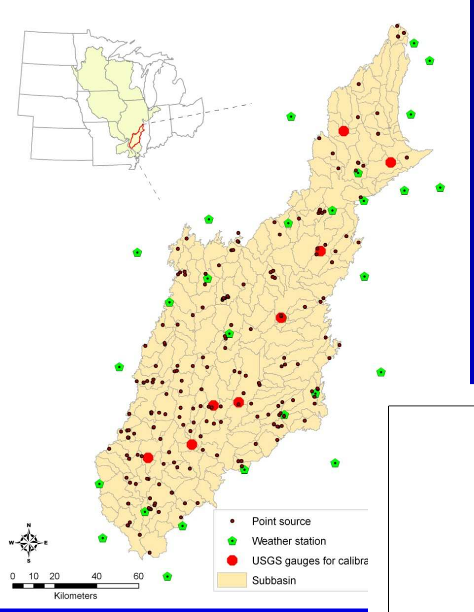
Challenging issues 2: Conservation Practices Targeting to achieve maximum environmental benefits

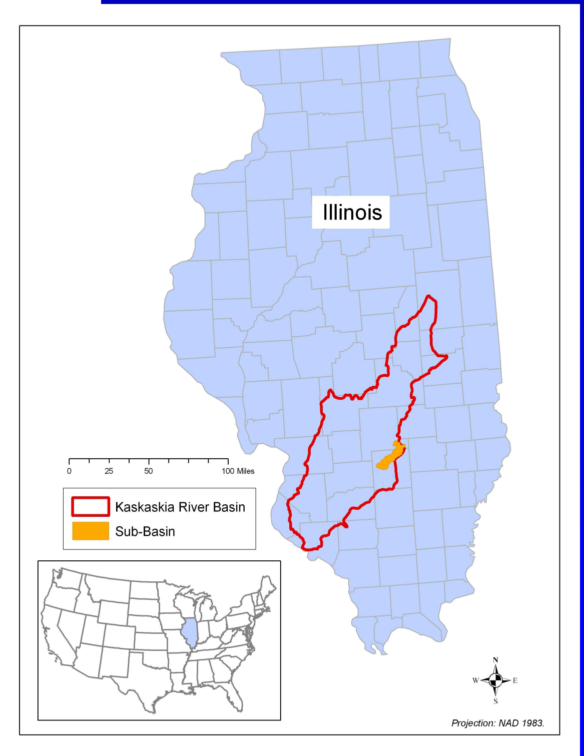




Challenging issues 3: Water quality benefits of conservation practices at regional scales

- **Studies on evaluating water quality benefits of conservation practices are usually performed on a field or small watershed scale.**
- **How to evaluate the impact of conservation practices on a watershed scale and regional scale?**
- **Where is the best location to establish conservation practices to achieve maximum maximum environmental benefits?**





Questions?