Water Quality Models to Support Watershed Planning

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Wisconsin Department of Natural Resources

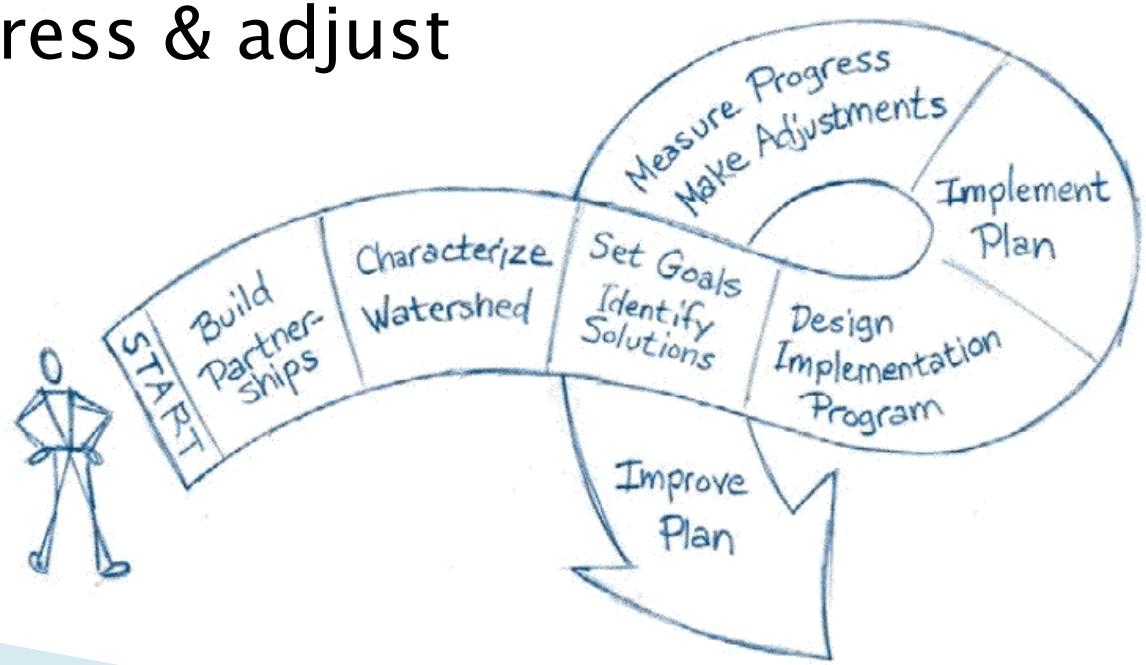
WI Lakes Partnership Convention
April 6, 2017

Overview

- Planning process
- PRESTO
- EVAAL
- STEPL
- More information

Planning Process

1. Build partnerships
2. Characterize watershed
3. Finalize goals & identify solutions
4. Design an implementation program
5. Implement the watershed plan
6. Measure progress & adjust



Planning Process

- Characterize watershed
  - Watershed boundaries
  - Land use
  - Pollutant sources & loads

- Finalize goals & identify solutions
  - Best management practices
  - Load reductions

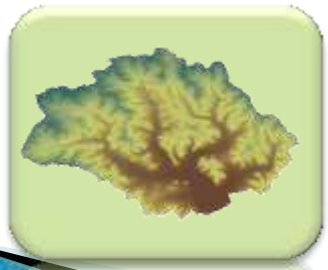
- Design an implementation program
  - Where to work?

PRESTO

- Statewide GIS-based tool that calculates average annual phosphorus loads from point and nonpoint sources

- Combines three concepts:

Watershed Delineation



Effluent Aggregation

Pollutant Runoff

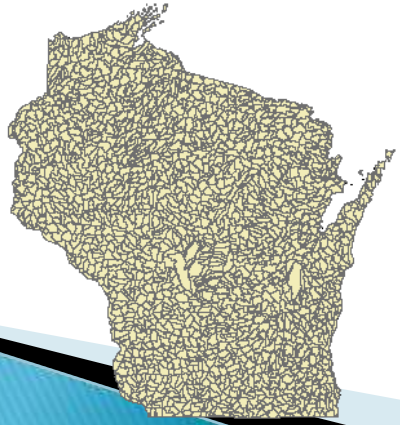
PRESTO – Data

SWAMP Outfall Locations And Effluent Point Loads

Elevation

Hydrography

Point Source : Nonpoint Source Load Ratio

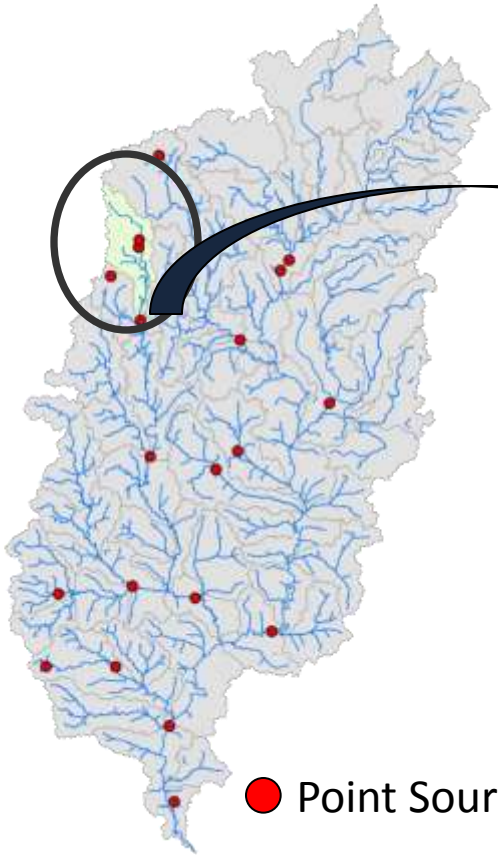


Sub-basin Boundaries

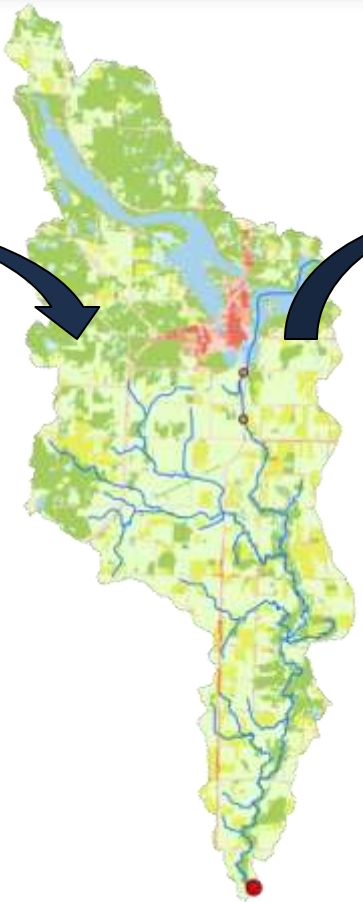
Land cover

Tabular Model Parameters

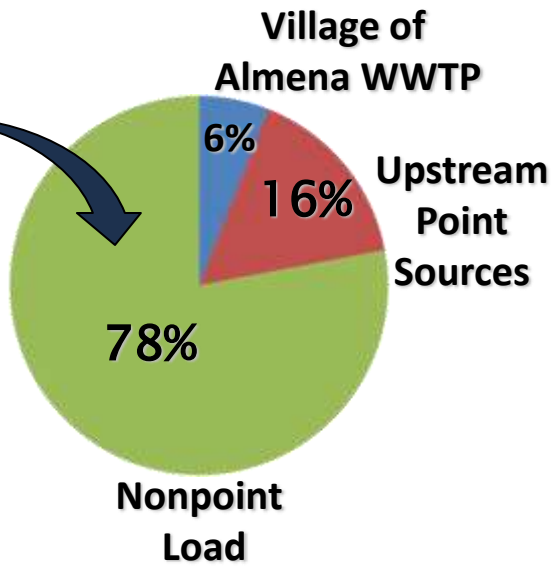
PRESTO – Results



Red Cedar River Watershed
(HUC 08, 1,890 mi^2)



Village of Almena WWTP
Upstream Watershed: 32.9 mi^2



22% : 78%

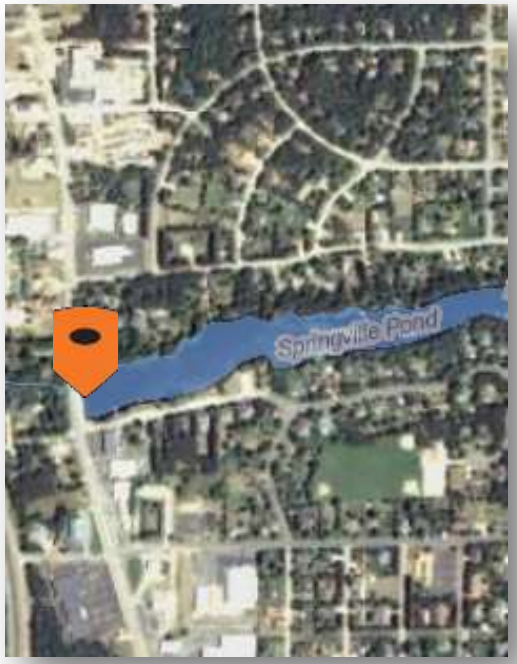
Point to Nonpoint
Phosphorus Load Ratio

PRESTO-Lite

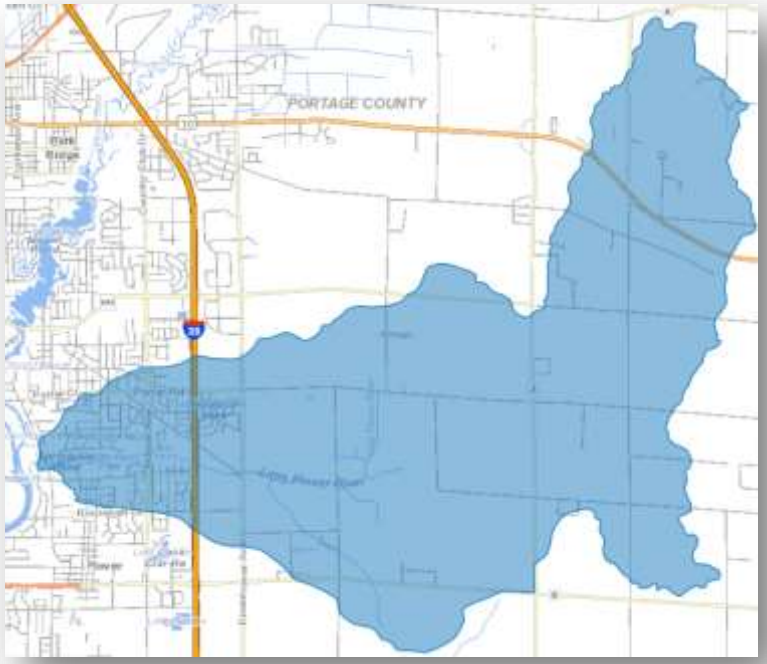
Web-based Application for Watershed Delineation and Characterization

Locate

Click



Delineate

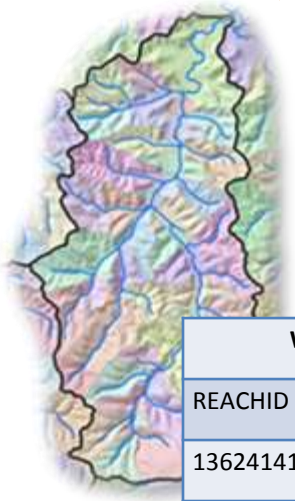


PRESTO-Lite

Web-based Application for Watershed Delineation and Characterization

presto
Pollutant Load Ratio
Estimation Tool

Watershed Delineation + Effluent Aggregation + Pollutant Runoff + Watershed Characteristics + Web Interface



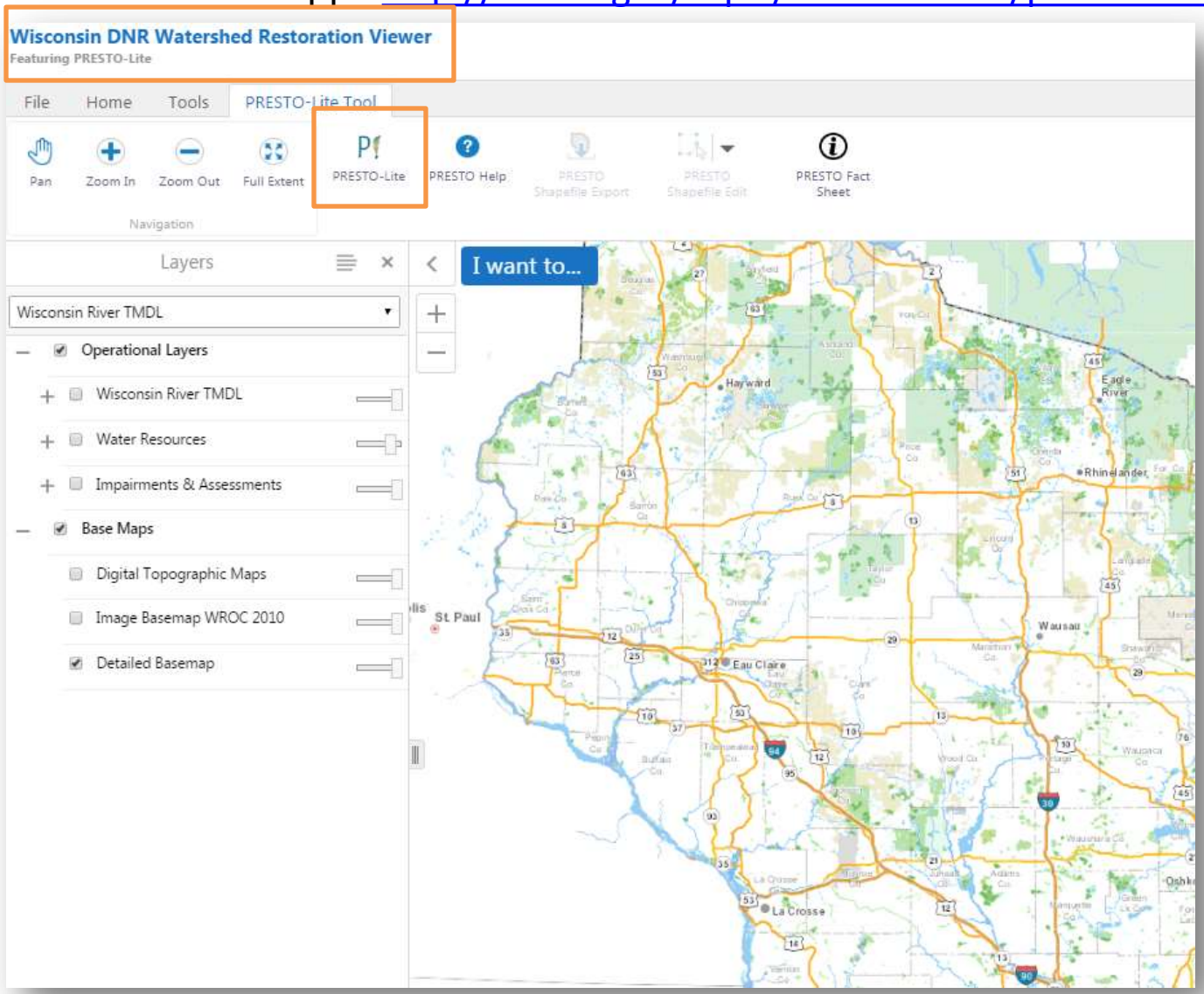
Wisconsin Hydrography Dataset Plus

Watershed		
REACHID	ATTR1	ATTR2
13624141	A	0.1234
13624143	B	5.6789

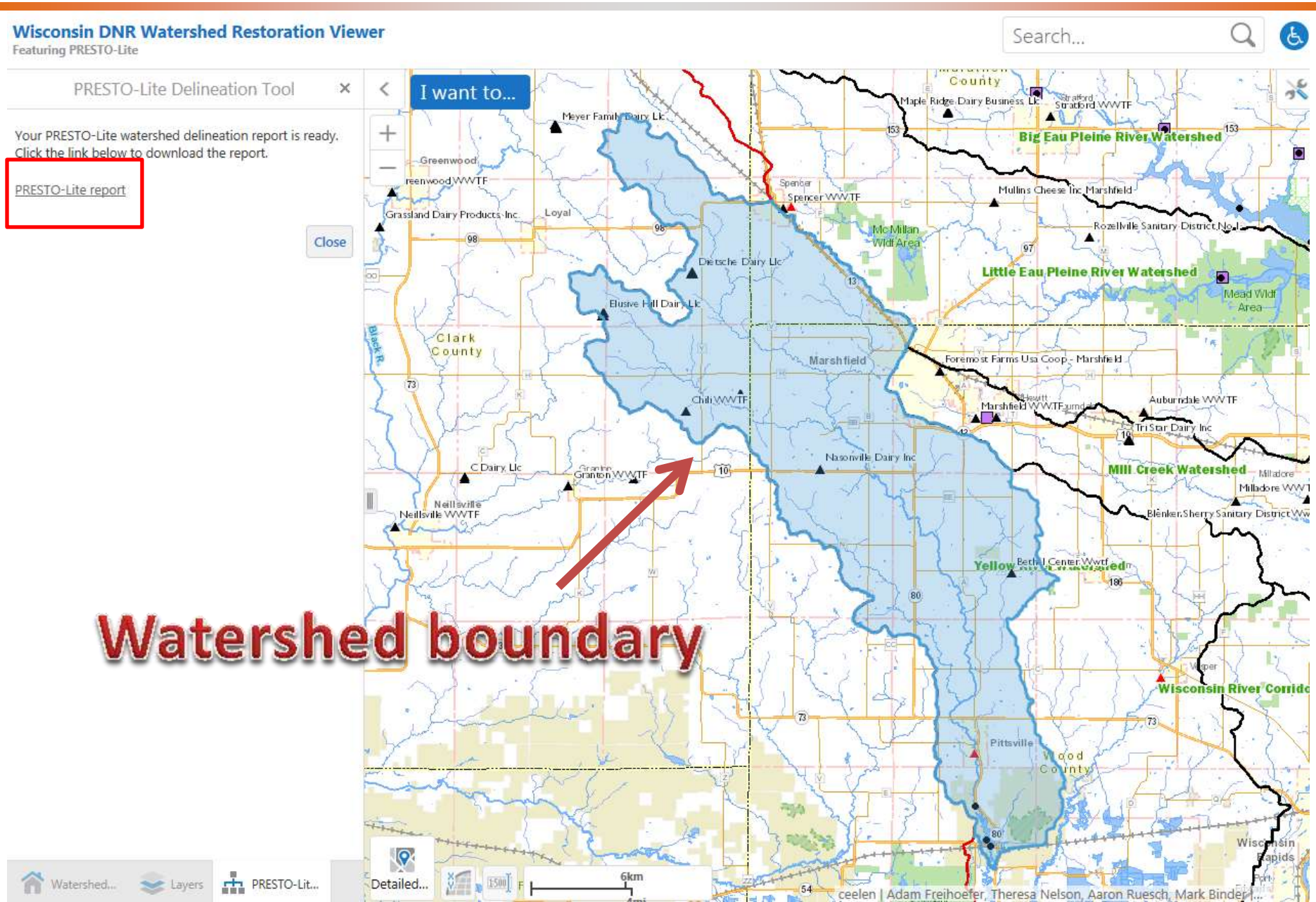
PRESTO-Lite

Web-based Application for Watershed Delineation and Characterization

Visit PRESTO Website to launch app : http://dnr.wi.gov/topic/surfacewater/presto.html



PRESTO-Lite
What's in the Results?

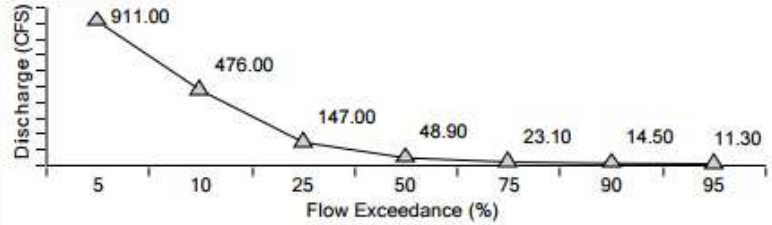


PRESTO-Lite
What's in the Results?

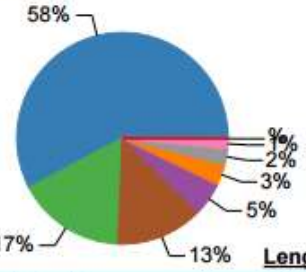
PRESTO-Lite Watershed Delineation Report

Reach ID: 200088244
Watershed Name: Owl Creek-Yellow River
Waterbody Name: Yellow River
HUC08: Castle-Rock
Watershed Area: 215.03 mi²
Average Annual Precipitation: 32.40in

Stream Flow

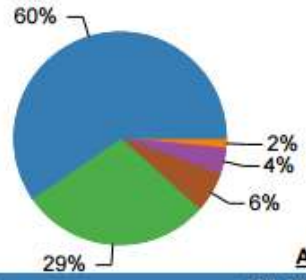


Tributary Stream Type



Type	Length
Macroinvertebrates	394352 ft
Cool-Cold Headwater	113495 ft
Cold Headwater	91835 ft
Warm Mainstem	34481 ft
Coldwater	21707 ft
Cold Mainstem	16633 ft
Warm Headwater	10032 ft
Cool-Cold Mainstem	687 ft
Large River	0 ft

Landcover



Type	Area
Agriculture	126.81 mi²
Forest	61.41 mi²
Urban	13.25 mi²
Wetland	8.36 mi²
Grassland	3.29 mi²
Barren	1.06 mi²

PRESTO Phosphorus Load Estimate

Avg. Annual Nonpoint Phosphorous Load (80% Confidence Interval)	81,301 (40,238 - 164,269) lb
Number of Facilities (Individual Facility Information below)	
Avg. Annual Point-source Phosphorous Load (2010 - 2012 total of all facilities)	1,697lb
Most Likely Point : Nonpoint Phosphorous Ratio	2% : 98

PRESTO-Lite Demo

What's in the Results?

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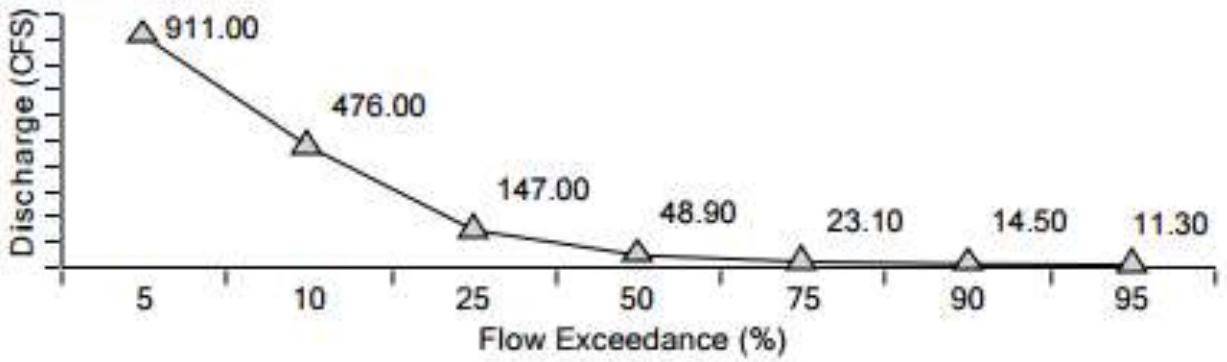

PRESTO-Lite Demo

What's in the Results?

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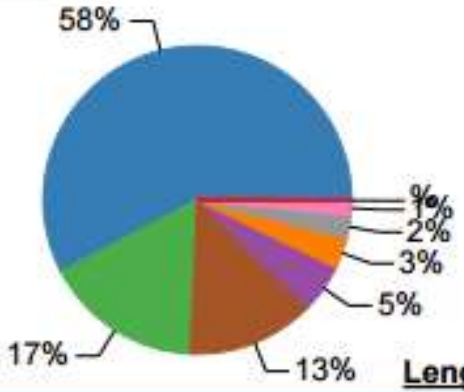

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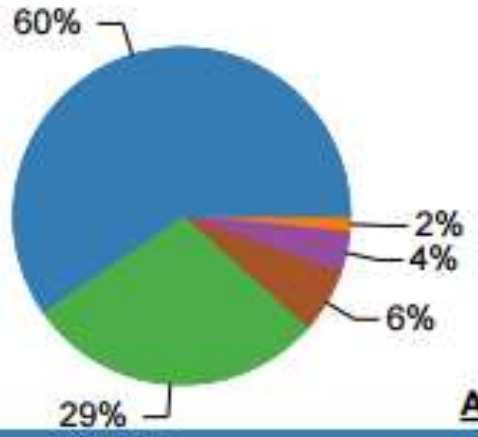

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Landuse

PRESTO-Lite Demo

What's in the Results?

Sources & Loads

PRESTO Phosphorus Load Estimate

Avg. Annual Nonpoint Phosphorous Load (80% Confidence Interval)	81,301 (40,238 - 164,269) lbs
Number of Facilities (Individual Facility Information below)	4
Avg. Annual Point-source Phosphorous Load (2010 - 2012 total of all facilities)	1,697lbs
Most Likely Point : Nonpoint Phosphorous Ratio	2% : 98%
Low Estimate Point : Nonpoint Phosphorous Ratio (Adaptive Management)	1% : 99%

Adaptive Management Results

Facilities Discharging to the Owl Creek-Yellow River Watershed:

Facility Name	Permit #	Outfall #	Waste Type	Receiving Water	Avg. Phosphorus Load (lbs.) (2010 - 2012)
PITTSVILLE WATER AND SEWER DEPT WWTF	0020494	002	Municipal	Yellow River	938
NASONVILLE DAIRY INC	0040312	006	Industrial	Unnamed	294
CHILI WASTEWATER TREATMENT FACILITY	0030961	001	Municipal	Unnamed	281
BETHEL CENTER WWTF	0031313	002	Municipal	Unnamed	184

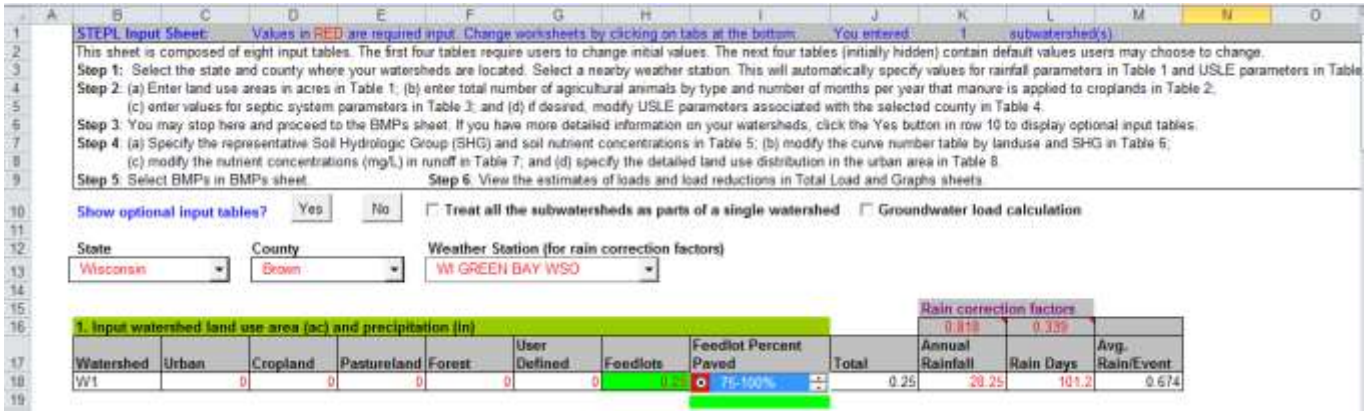
Planning Process

- Characterize watershed
  - Watershed boundaries
  - Land use
  - Pollutant sources & loads

- Finalize goals & identify solutions
  - Best management practices
  - Load reductions

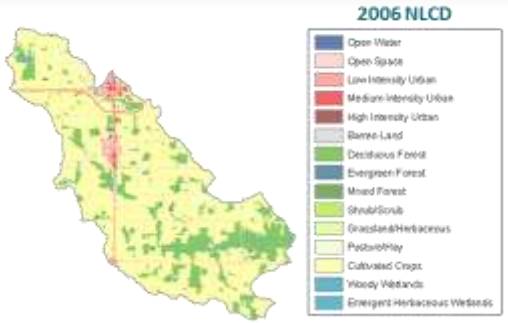
STEPL

- Spreadsheet Tool for Estimating Pollutant Load
- Simple model – MS Excel spreadsheet
- Calculates
  - Pollutant loads by land use type and watershed
  - Load reductions from implementation of BMPs
  - Runoff, nitrogen, phosphorus, BOD, sediment



Input Data

- User defined:
  - Land use distribution
  - Agricultural animal population
  - Septic system information



- These data are derived from user inputs, but can be modified:
  - Soil information (based on county)
  - Curve Numbers (land use/soil group)
  - Urban land use distribution

- Other optional input data
  - BMP type and % area applied
  - Special sediment sources from gullies and eroding streambanks

BMPs Available

BMPs

- Cropland
  - Contour farming
  - Diversion
  - Filter strip
  - Reduced tillage
  - Streambank stabilization
  - Terrace

- Feedlots
  - Diversion
  - Filter strip
  - Runoff management system
  - Solids separation basin
  - Waste storage facility

- Urban
  - Alum treatment
  - Bioretention
  - Dry/wet detention
  - Grass swales
  - Porous pavement
  - Sand filter
  - Settling basin
  - Street sweeping
  - Wetland detention
  - Rain barrel/cistern
  - Infiltration Trench
  - Filter strips
  - Oil/Grid separator

STEPL Output

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	8140.2	1778.8	12165.4	262.5
Total	8140.2	1778.8	12165.4	262.5

Load Reductions

N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)
lb/year	lb/year	lb/year	t/year
7927.4	1696.8	11739.8	129.5
7927.4	1696.8	11739.8	129.5

N Reduction	P Reduction	BOD Reduction	Sediment Reduction
lb/year	lb/year	lb/year	t/year
212.8	81.9	425.6	133.0
212.8	81.9	425.6	133.0

%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
%	%	%	%
2.6	4.6	3.5	50.7
2.6	4.6	3.5	50.7

Planning Process

- Characterize watershed
  - Watershed boundaries
  - Land use
  - Pollutant sources & loads

PRESTO
Pollutant Load Ratio Estimation Tool

- Finalize goals & identify solutions
  - Best management practices
  - Load reductions

Spreadsheet Tool for Estimating Pollutant Load
STEPL

- Design an implementation program
  - Where to work?

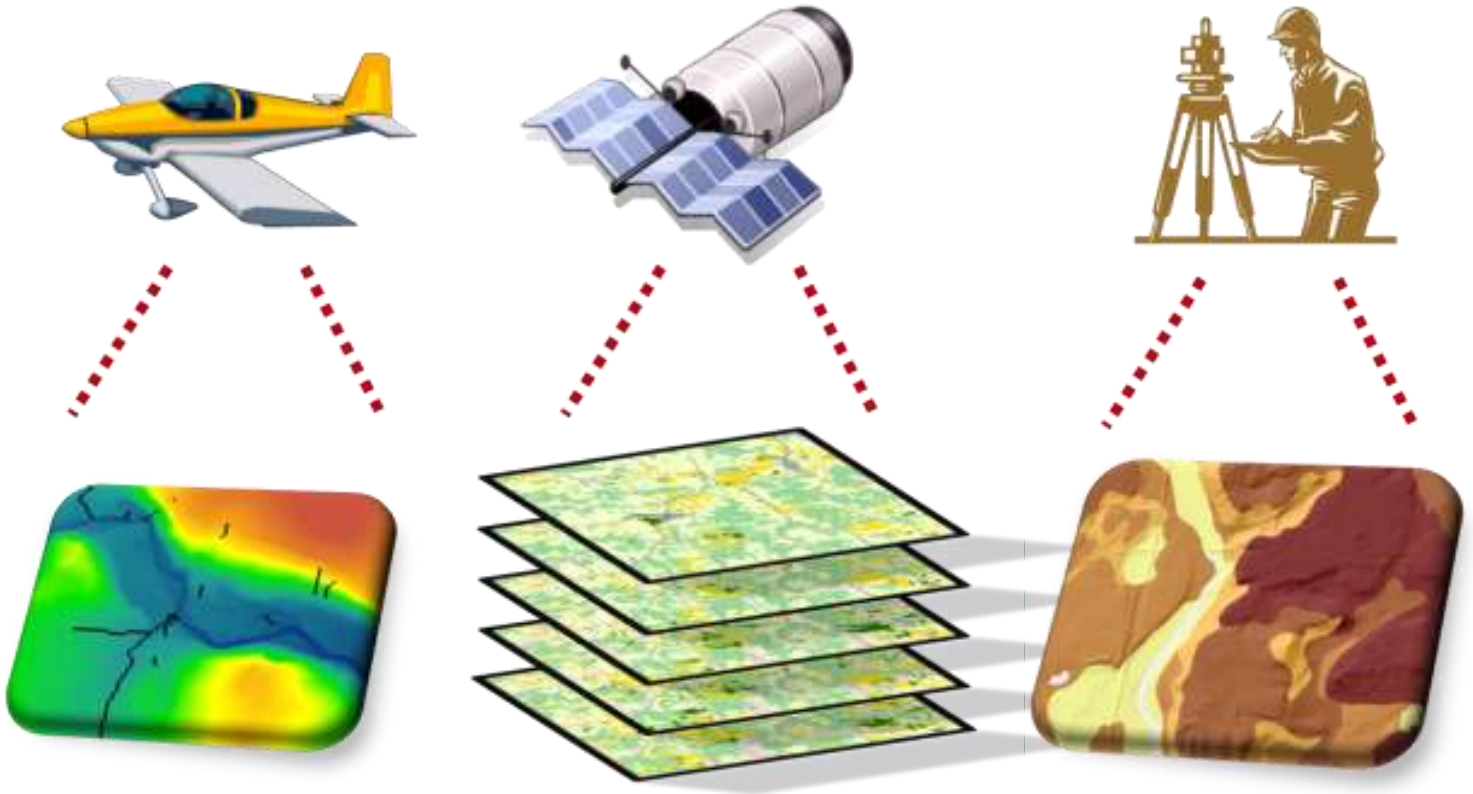
EVAAL
Erosion Vulnerability Assessment for Agricultural Lands

Wisconsin Dept. of Natural Resources

EVAAL

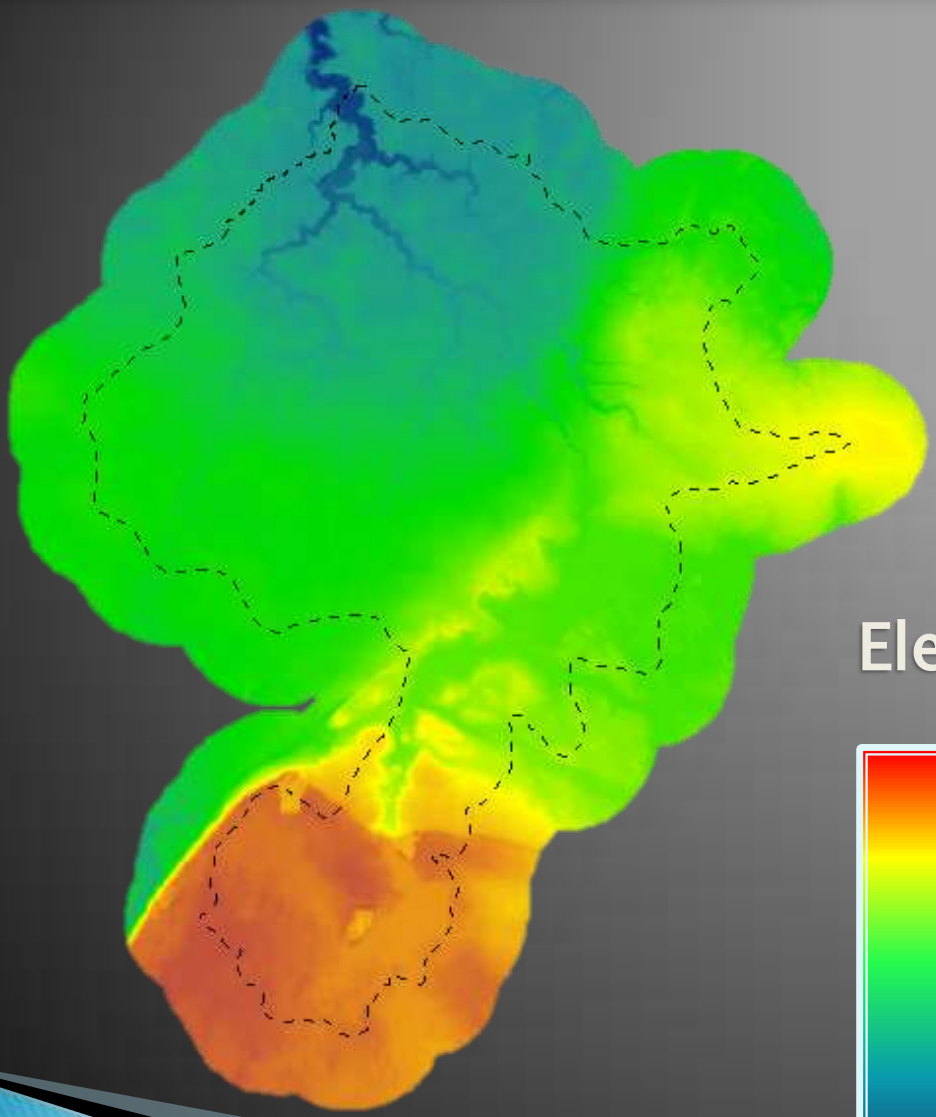
- **E**rosion **V**ulnerability **A**ssessment for **A**gricultural **L**ands
- GIS-based model
- Vulnerability to erosion and nutrient export
- Deprioritizes internally draining areas

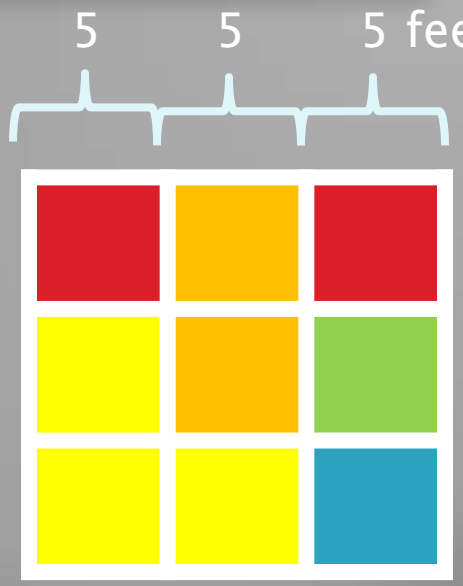
Available Datasets



LiDAR **Crop Data** **Soils**

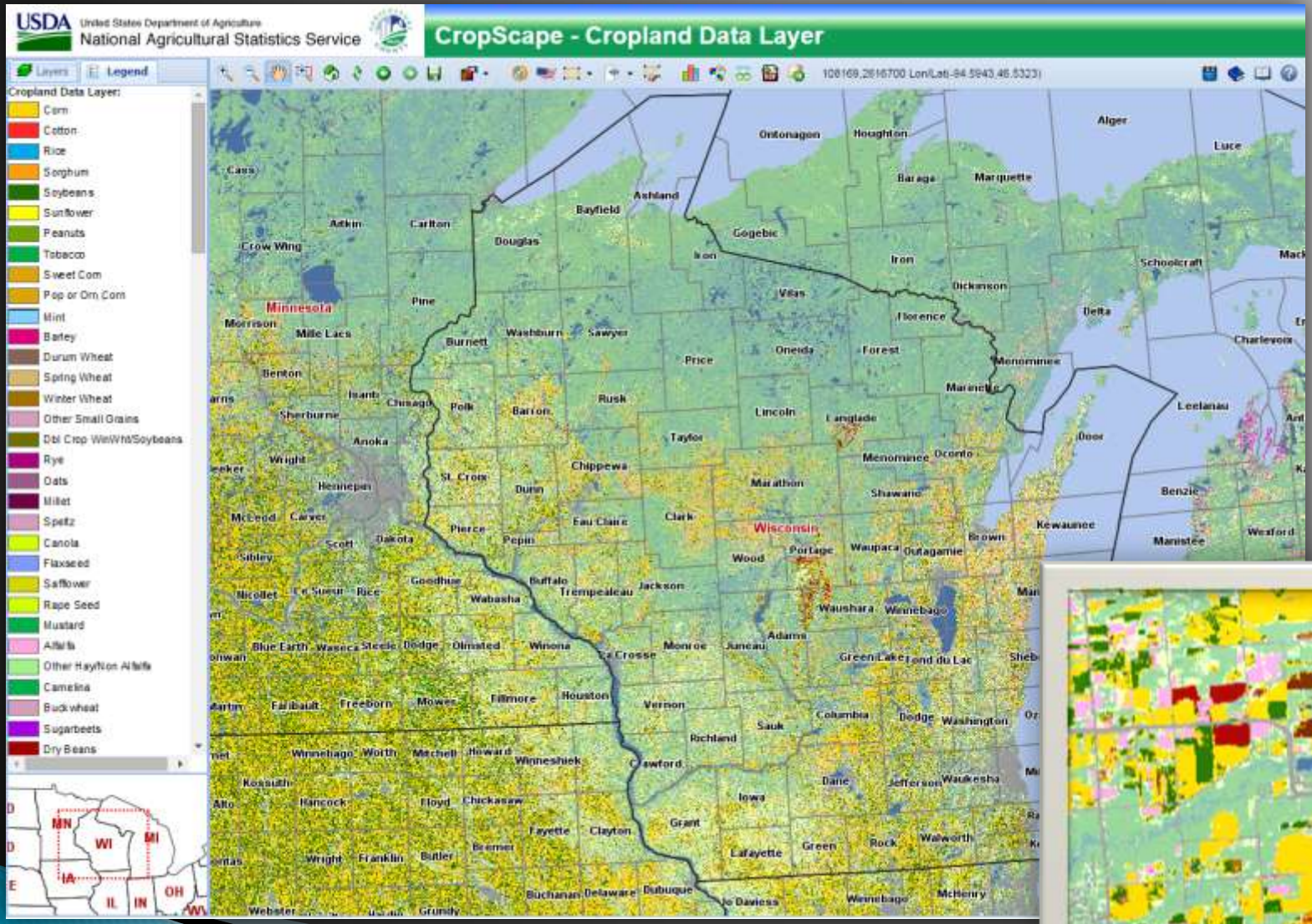
LiDAR Data



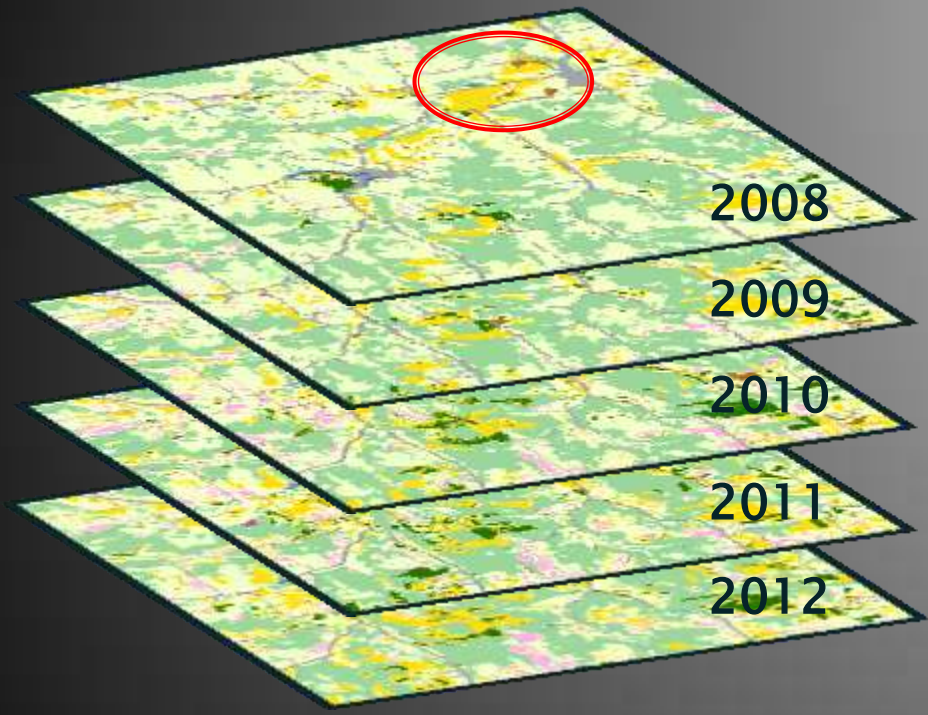


Elevation (feet)

Crop Data


USDA United States Department of Agriculture
National Agricultural Statistics Service
CropScape - Cropland Data Layer
Layers
Legend
Cropland Data Layer:
Corn
Cotton
Rice
Sorghum
Soybeans
Sunflower
Peanuts
Tobacco
Sweet Corn
Pop or Orn Corn
Mint
Barley
Durum Wheat
Spring Wheat
Winter Wheat
Other Small Grains
Dbl Crop WinWht/Soybeans
Rye
Oats
Millet
Speltz
Canola
Flaxseed
Safflower
Rape Seed
Mustard
Alfalfa
Other Hayfton Alfalfa
Camelina
Buckwheat
Sugarbeets
Dry Beans
Minnesota
Wisconsin
Iowa
MN
WI
MI
IA
IL
IN
OH

Crop Rotations



Corn

Soybean

Corn

Corn

Soybean

C–C–S–C–C, C–S–C–S–C, S–C–C–S–C, C–C–C–C–S, S–S–S–S–C
= **Cash Grain Rotation**

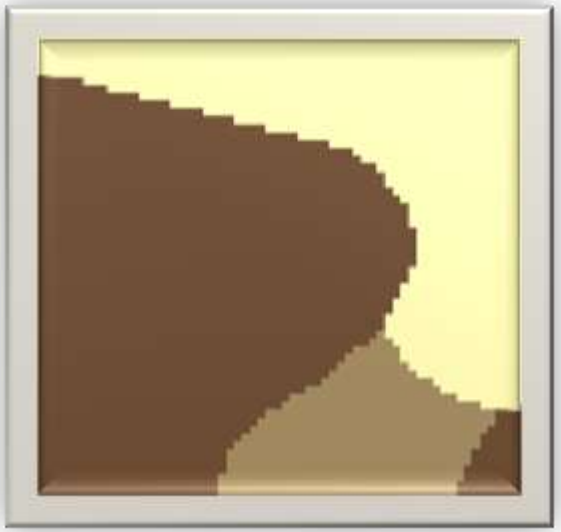
Soils

Soil Erodibility

0.49

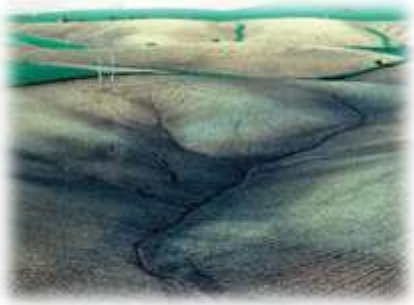
0.02

10 meter resolution



Erosion Vulnerability Analysis

USLE + SPI – IDA

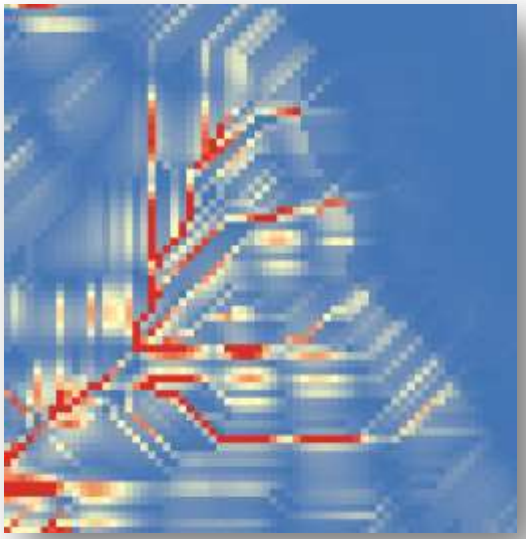


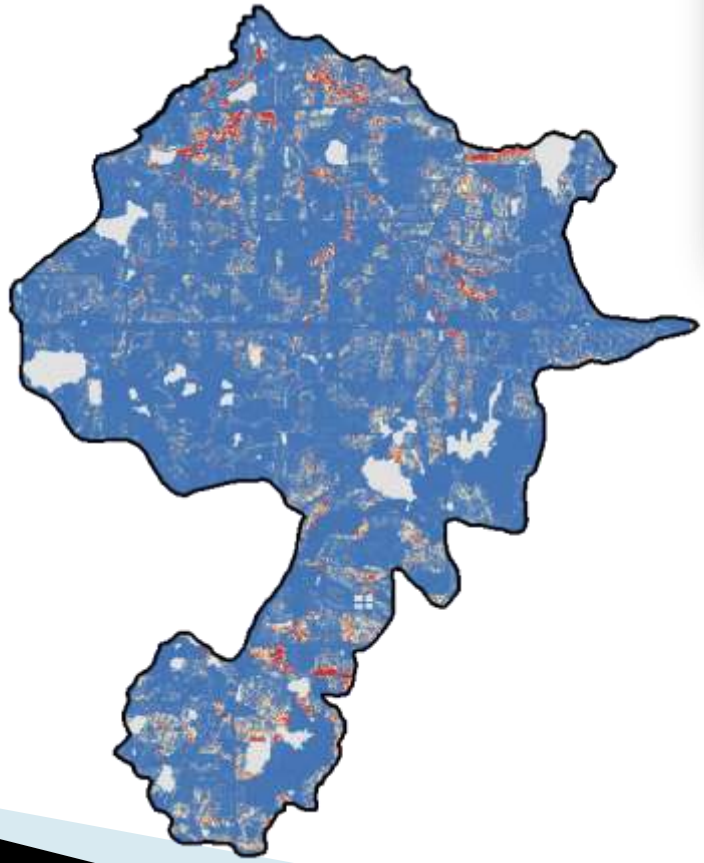
= EVAAL

Erosion Vulnerability Assessment for Agricultural Lands

Universal Soil Loss Equation

- Sheet and rill erosion
  - Soil erodibility
  - Slope/slope length
  - Crop cover

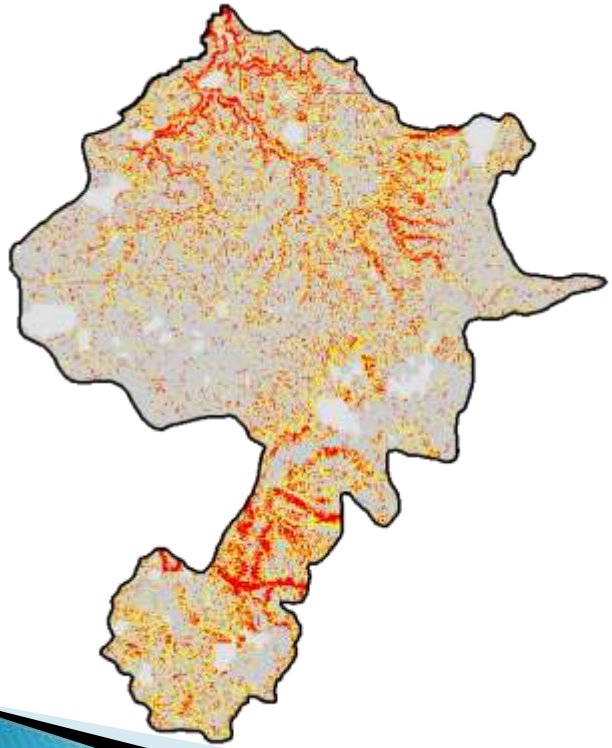




Stream Power Index

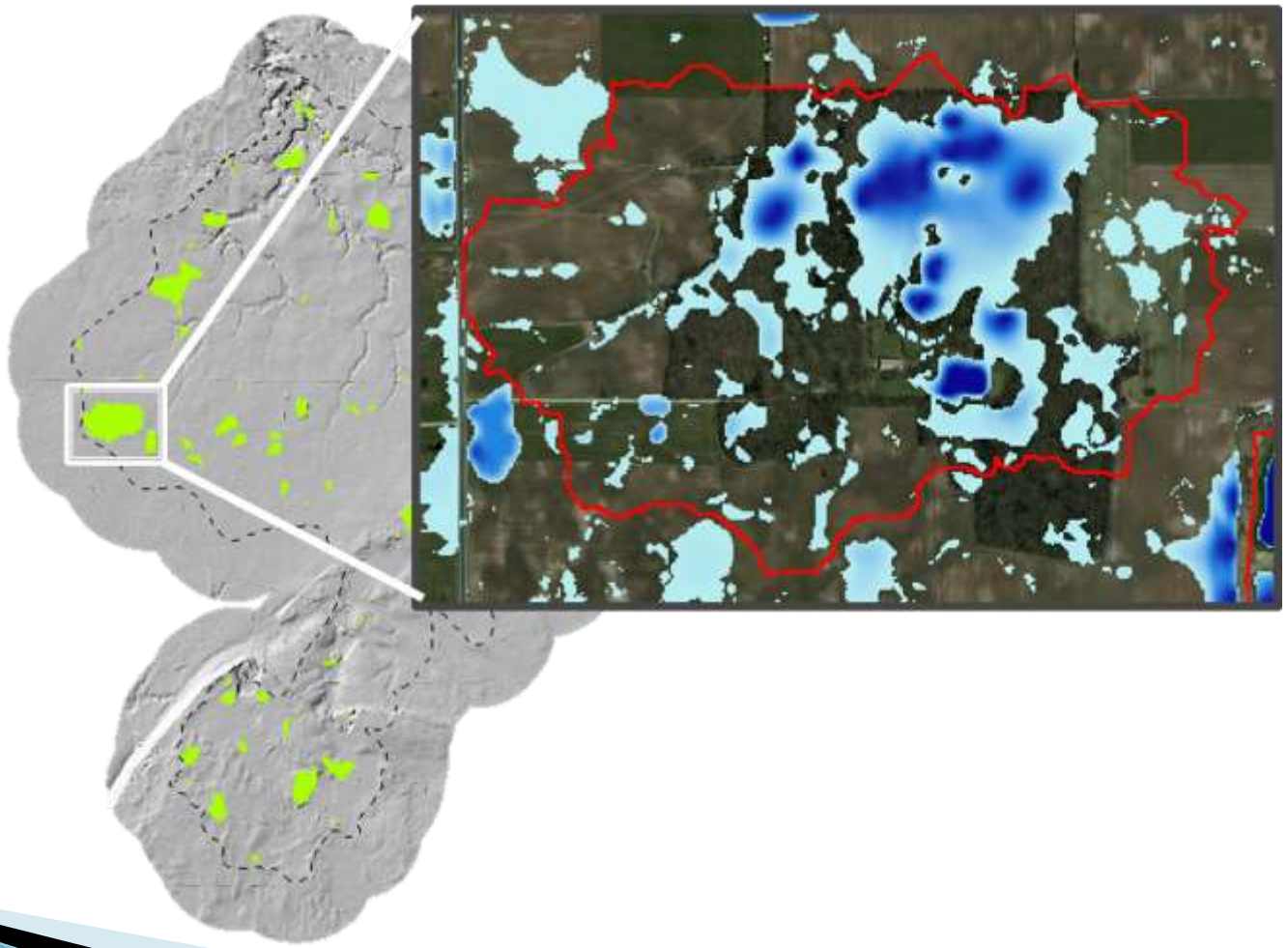
- Potential for gully erosion

$$\mathrm{SPI} = f(\text{slope}, \text{catchment area})$$

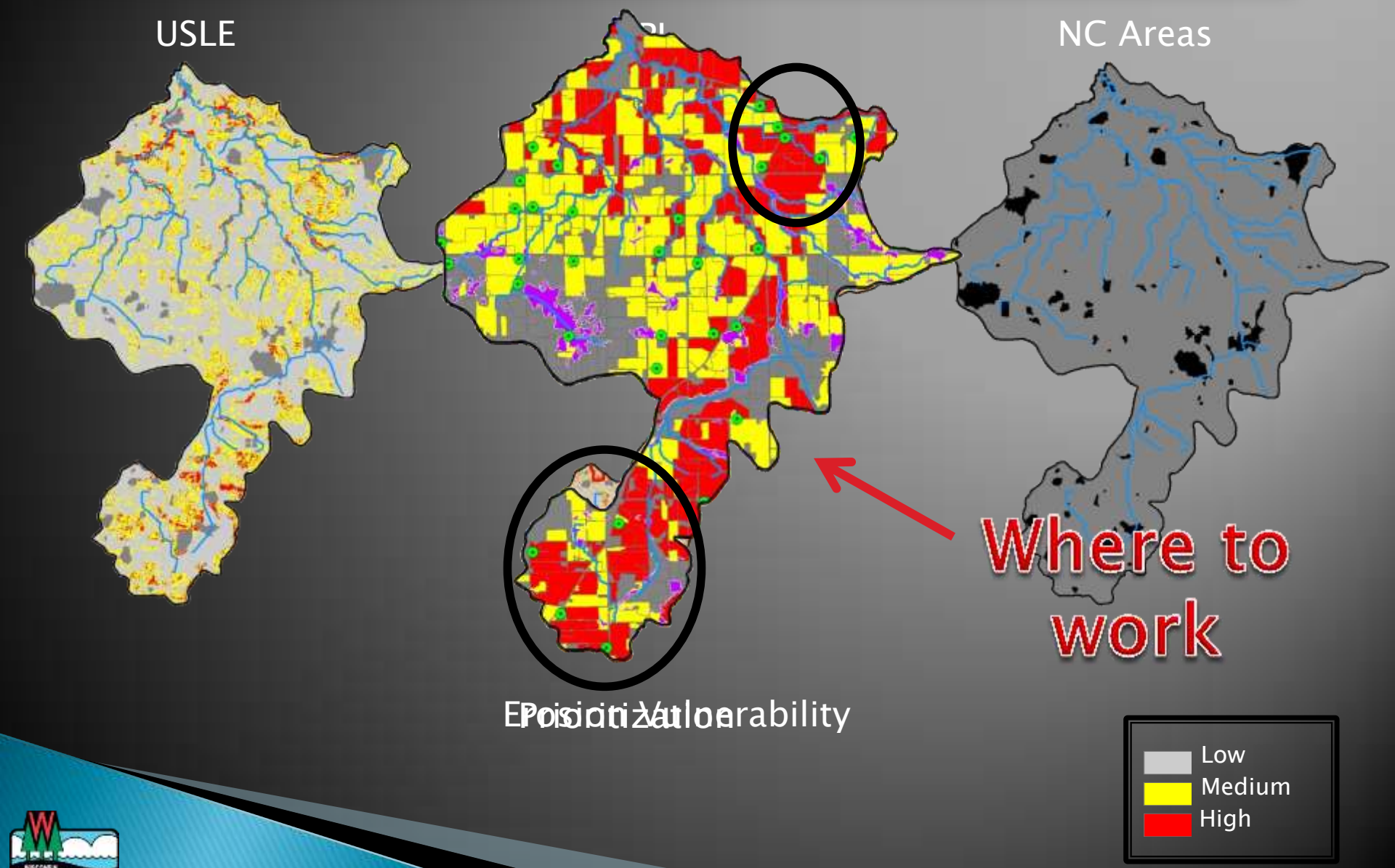


Internally Draining Areas

- Areas that do not contribute to surface waters



Results



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More Information

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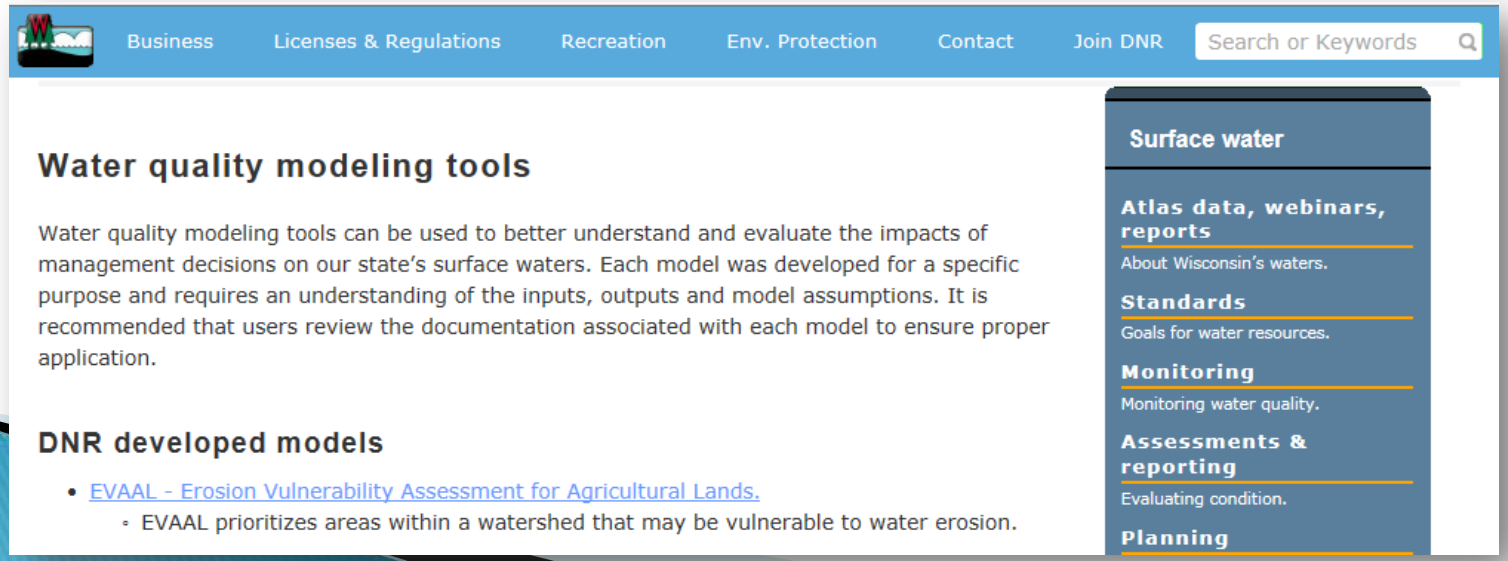
  - http://dnr.wi.gov/topic/surfacewater/models.html

  - DNR models
  - Other water quality models
  - Training
  - Contact Information



Acknowledgements

- Aaron Ruesch
- Adam Freihoefer

Questions?

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