Prioritizing Water Quality Improvement Efforts on Agricultural Lands Using Readily Available GIS Data

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Overview

- Water quality in Wisconsin
- EVAAL
- Tillage estimations

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Water Quality in Wisconsin

- TMDL = Total Maximum Daily Load
- Established under the Clean Water Act
- The maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards

Impaired Waters

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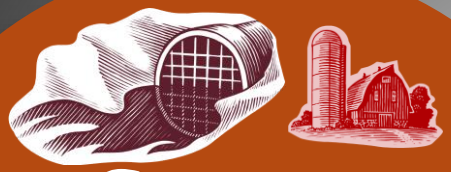
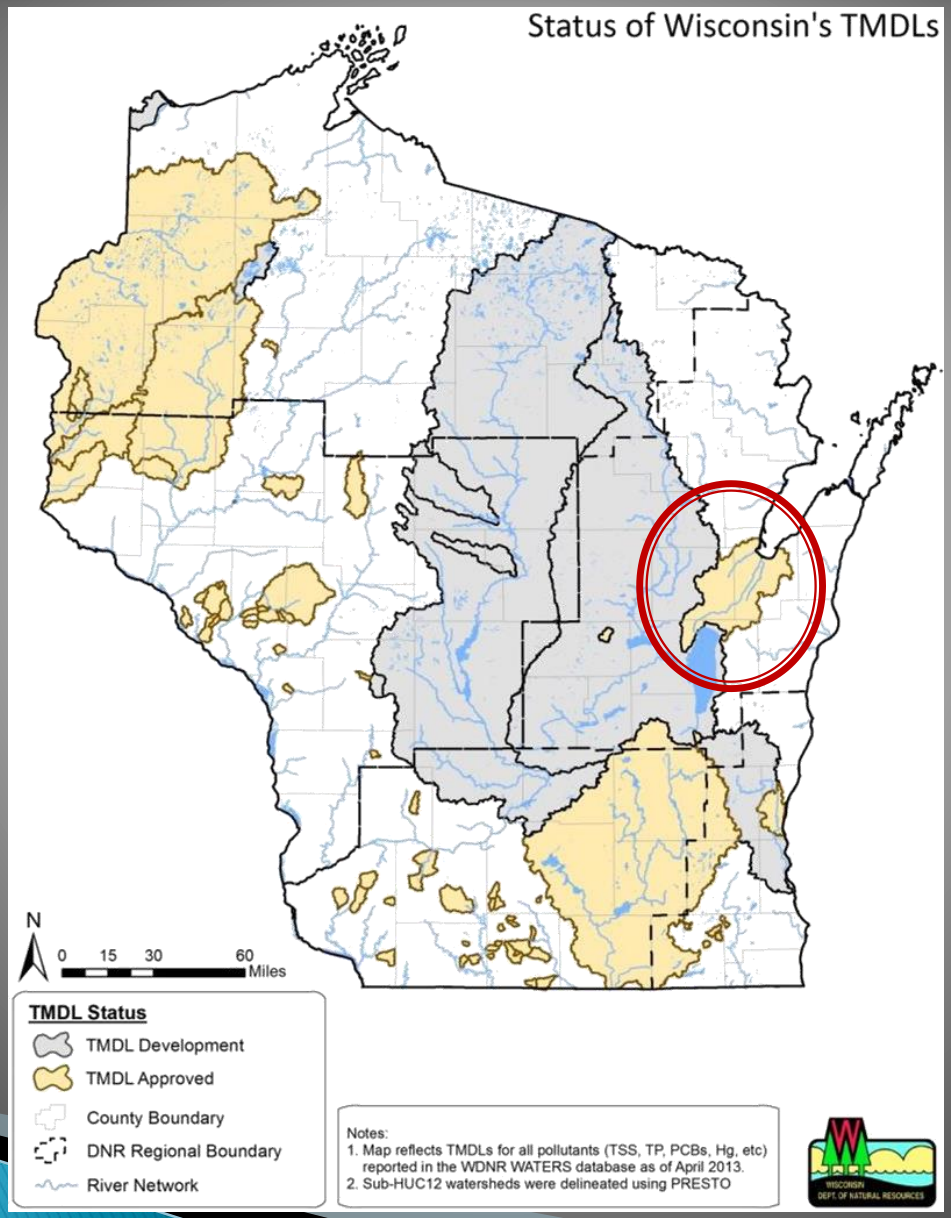
TMDL Purpose



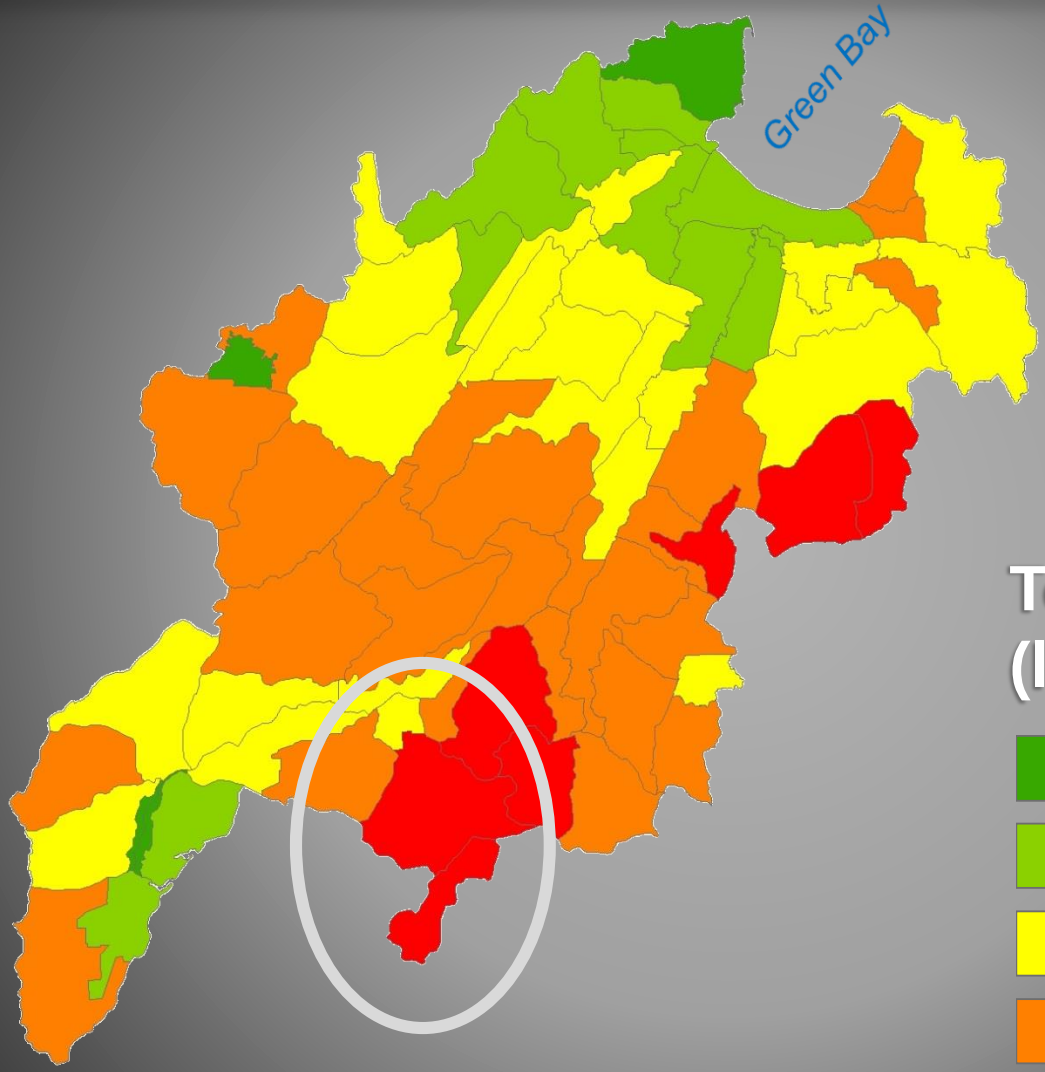
Current Pollutant Load

Meets water quality standards

TMDLs Statewide



TMDL Results



Total Phosphorus (lbs/acre/year)

- 0.0-0.3
- 0.3-0.6
- 0.6-0.8
- 0.8-1.1
- 1.1-1.6

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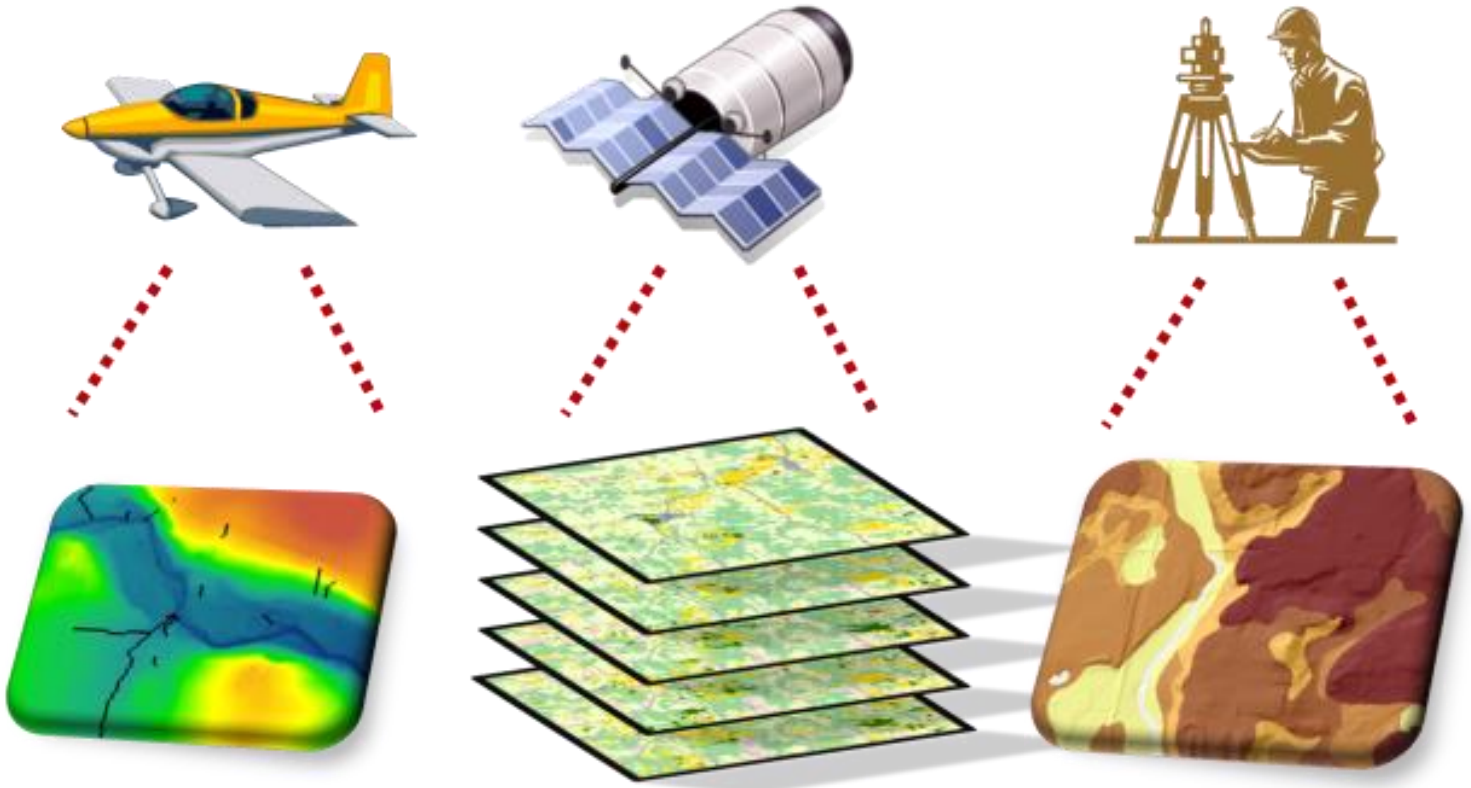
Kankapot Creek Watershed

- 23 square miles
- 187 farms
- 1,129 fields

Available Datasets



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

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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

EVAAL
Erosion Vulnerability Assessment for Agricultural Lands

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Erosion Vulnerability Analysis

USLE + SPI – IDA

= EVAAL

Erosion Vulnerability Assessment for Agricultural Lands

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Universal Soil Loss Equation

- Sheet and rill erosion

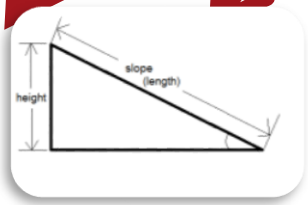
$$A = RK(LS)CP$$

- Rainfall erosivity
- Soil erodibility
- Slope/Slope-Length
- Cover factor
- Practice Factor

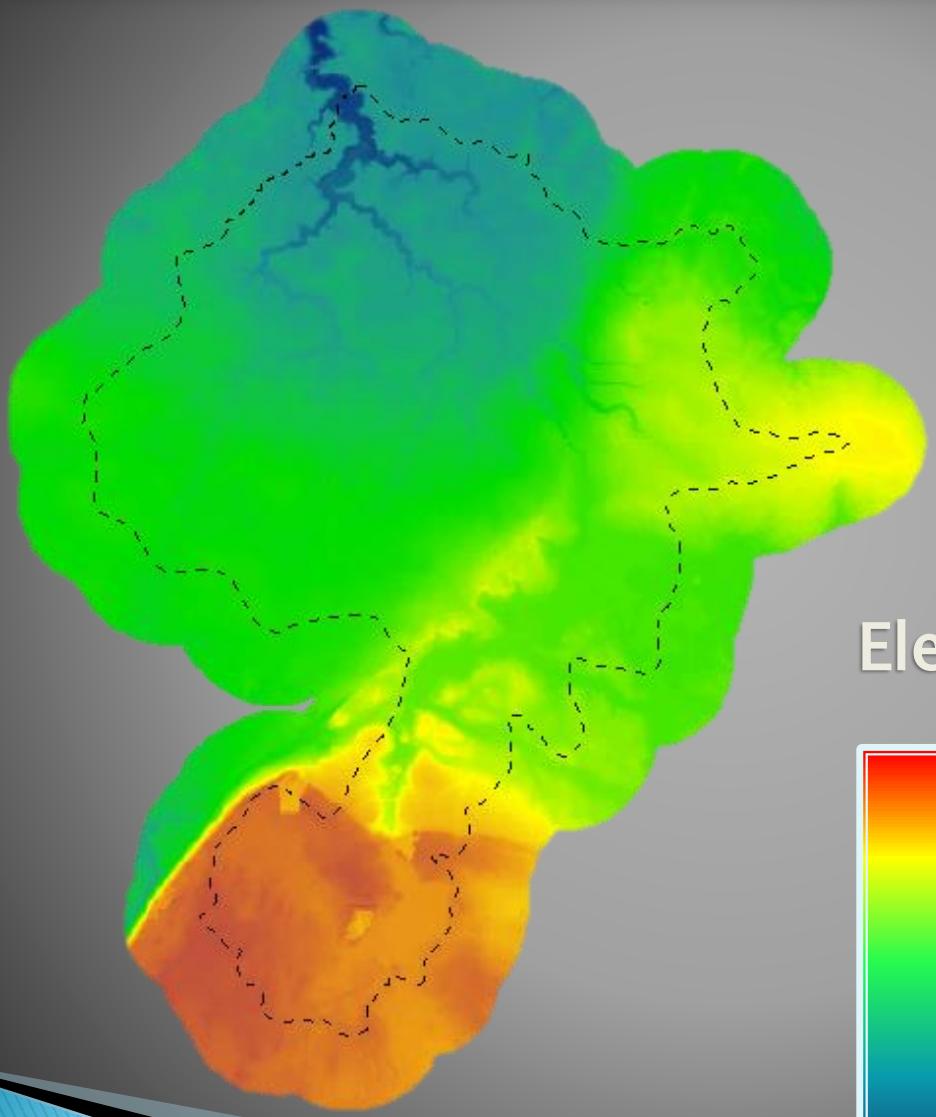
Constant

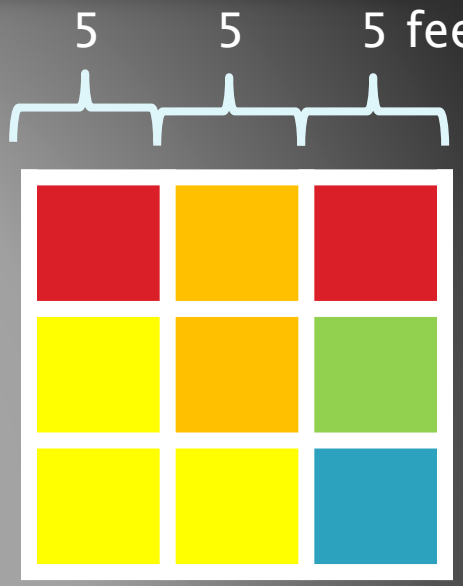
Constant

$$A = K(LS)C$$



LiDAR Data





Elevation (feet)

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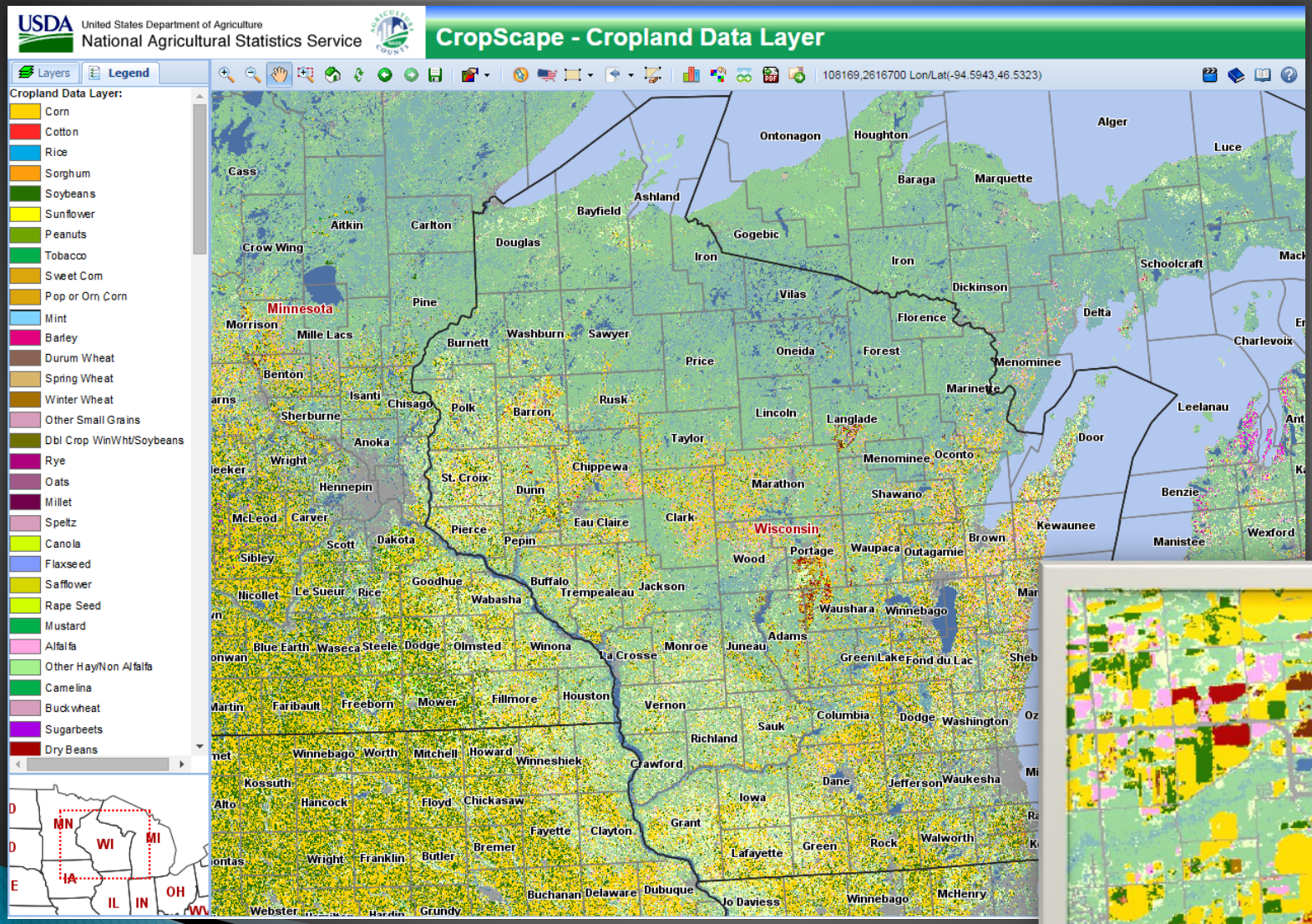
Crop Data



http://nassgeodata.gmu.edu/CropScape/

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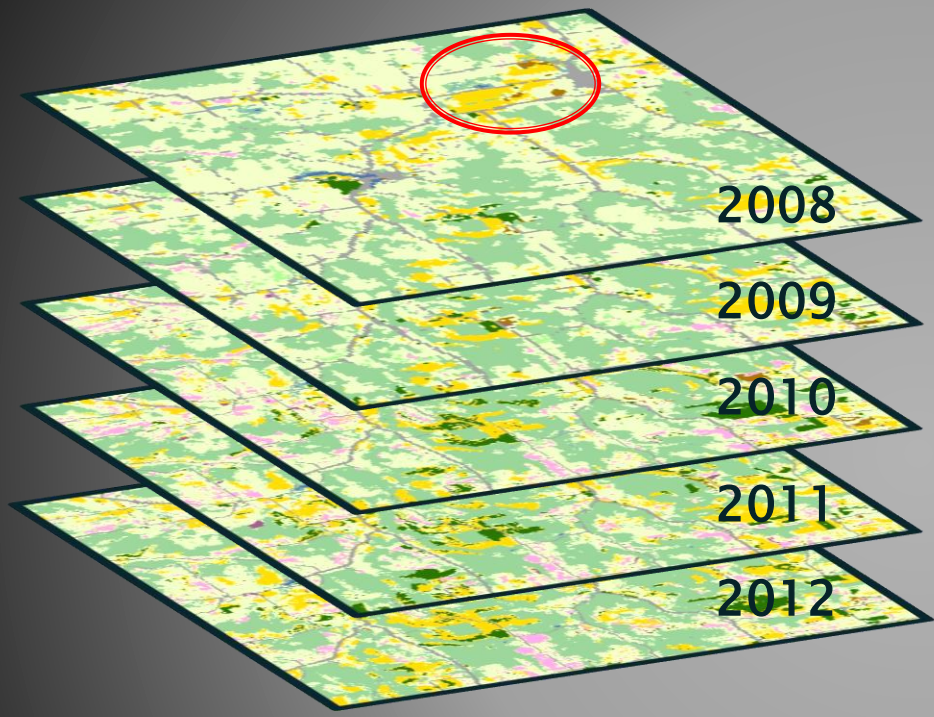
Crop Rotations



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**

RUSLE2 -> Rotational C Factor

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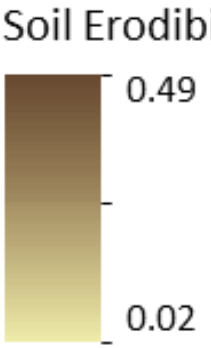
Soils – gSSURGO



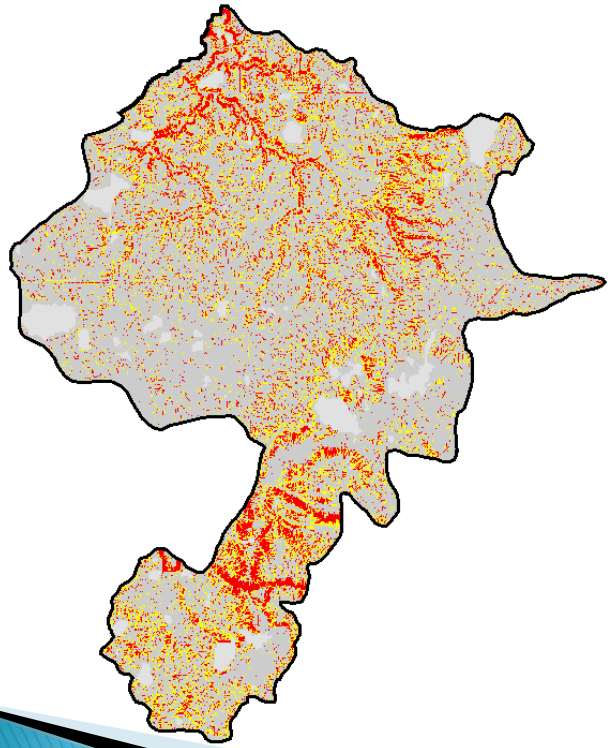
10 meter resolution

http://datagateway.nrcs.usda.gov/

Stream Power Index

- Potential for gully erosion

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



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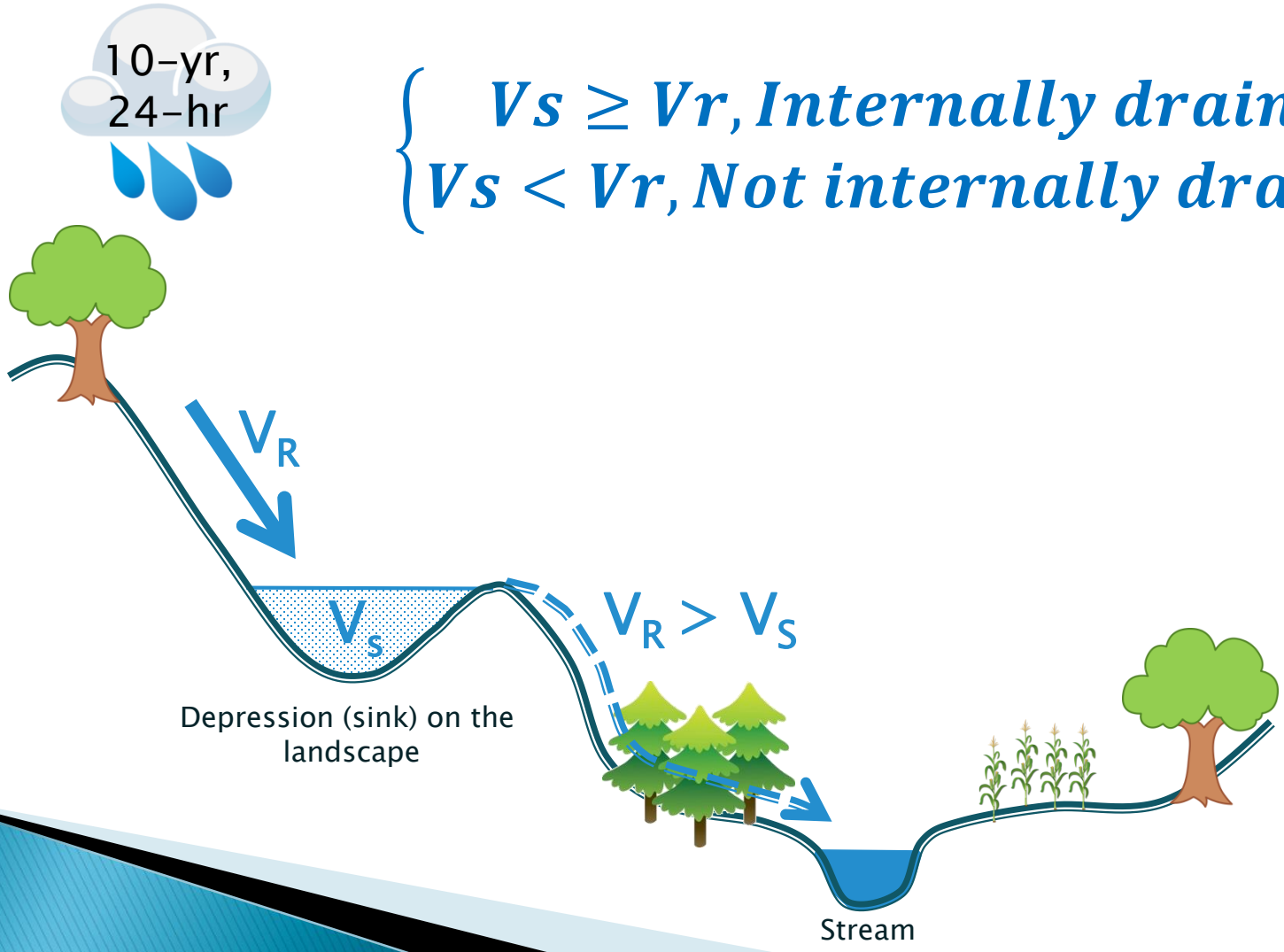
Internally Draining Areas

- Areas that do not contribute to surface waters



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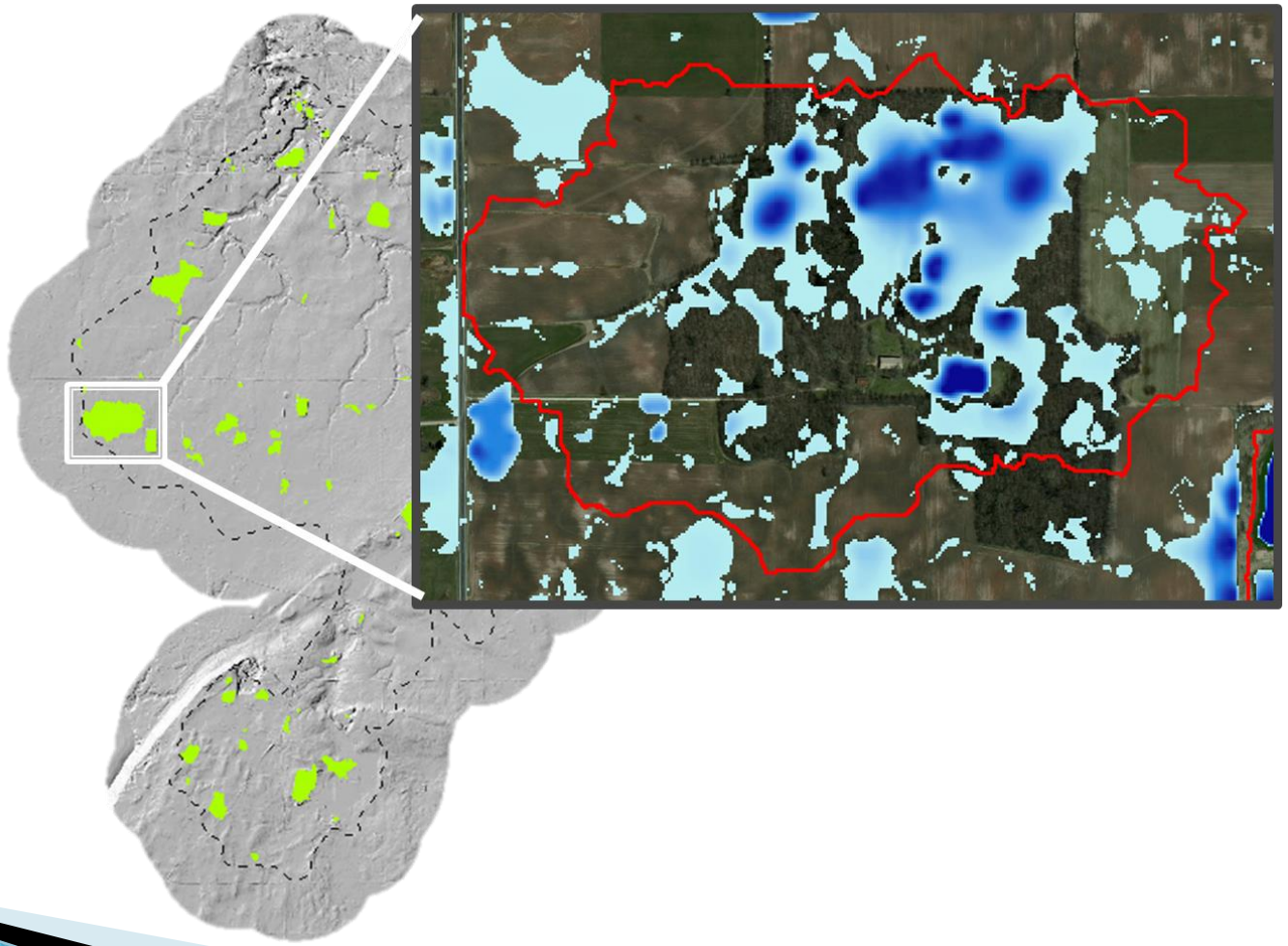

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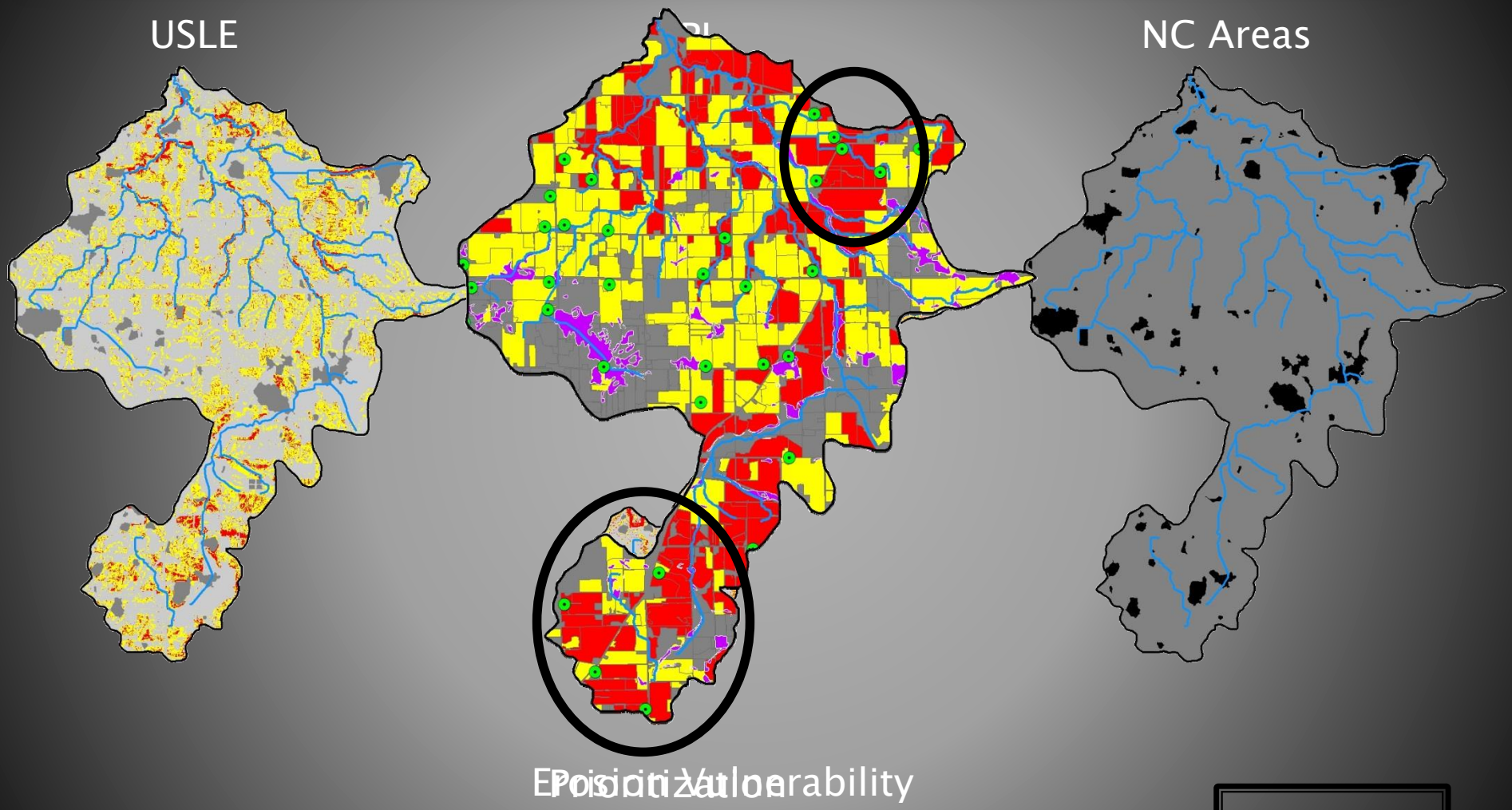
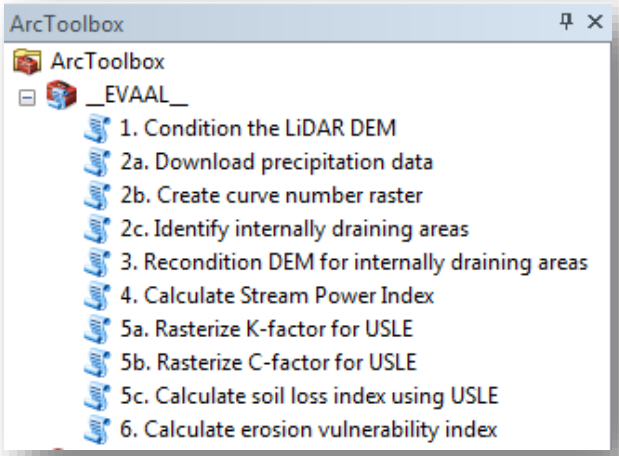
Results



EVAAL Website

- Documents
- Tutorial Data
- ArcToolbox



http://dnr.wi.gov/topic/nonpoint/evaal.html

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EVAAL Applications

- Counties, consultants, NGOs for watershed planning
  - > 15 counties
    - 9 key element & TMDL implementation plans
    - Land and water resource management plans
    - Lake management planning
    - Adaptive management/water quality trading

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Limitations

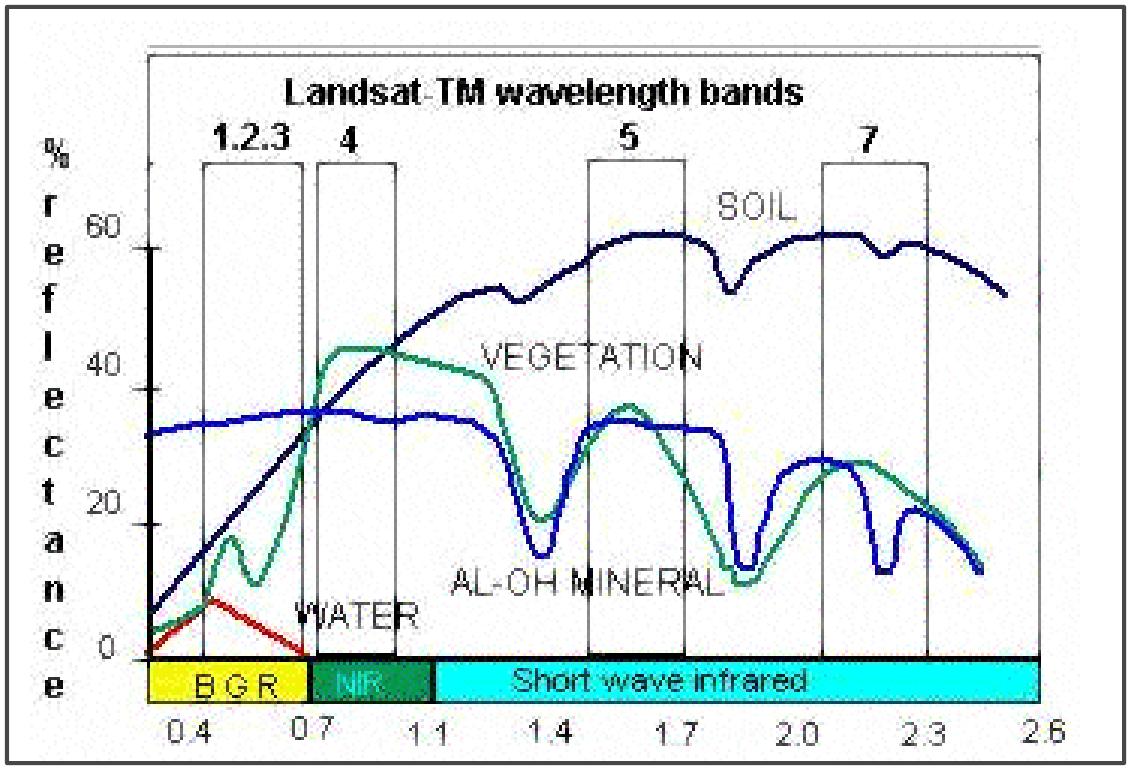
- We can't model what we don't know
  - Tillage
  - Manure application
  - Soil P
  - BMPs
- Erosion must be driving factor
- Does not account for delivery factors or tile drainage
- Cannot "target", rather "prioritize"

Tillage – Overview

- Currently assuming high or low C factor
- Use Landsat satellite imagery
- Calculate Normalized Difference Tillage Index (NDTI) values and correlate to residue cover and associated tillage type

Satellite Imagery Analysis

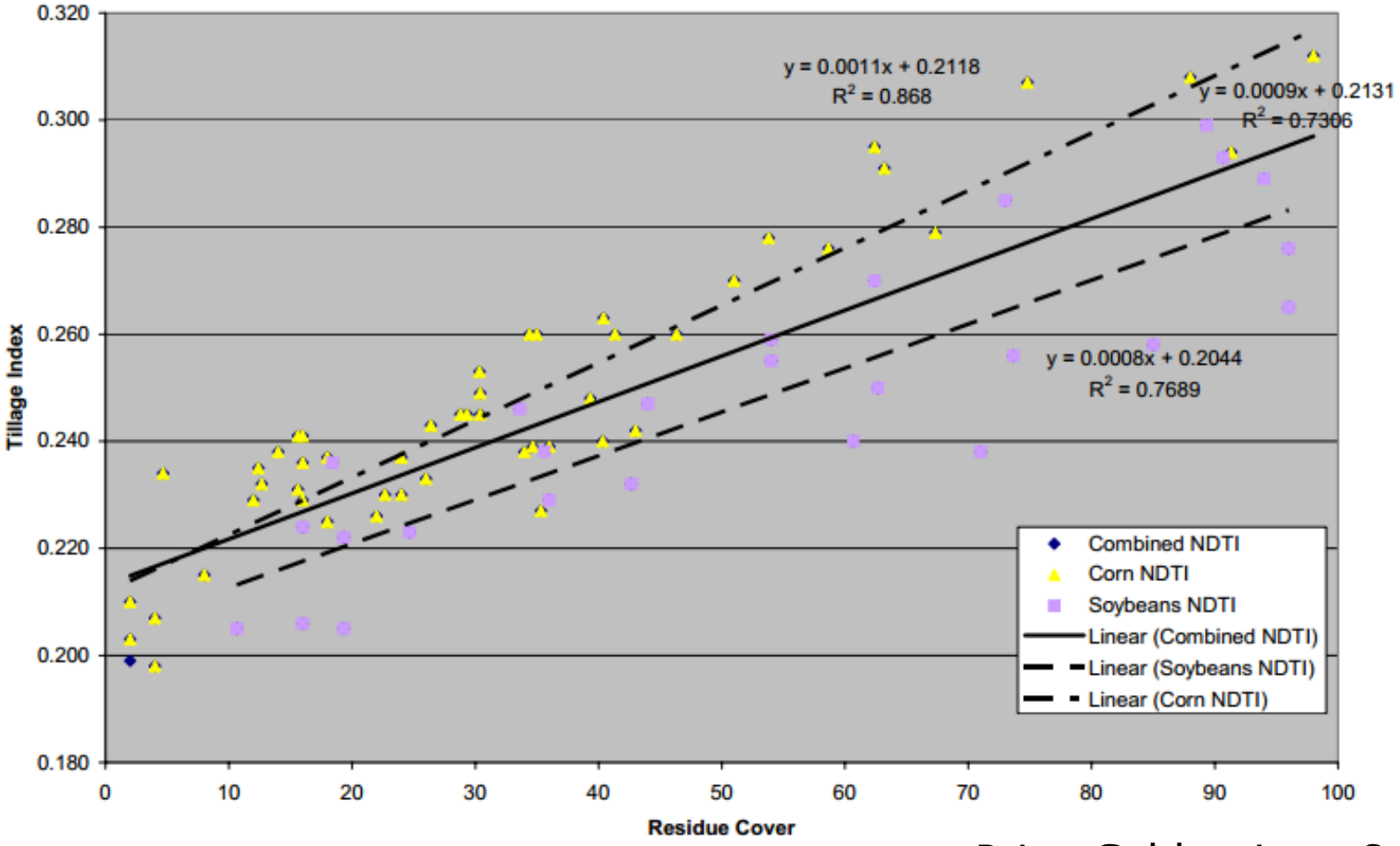
- Landsat 7 & 8
- Normalized Difference Tillage Index
- NDTI = (band5 – band7) / (band5 + band7)



"Remote Sensing Of Crop Residue Cover Using Multi-temporal Landsat Imagery"
B. Zheng – 2012

NDTI and Crop Residue Cover

- NDTI is positively correlated with crop residue cover and green vegetation



Brian Gelder, Iowa State

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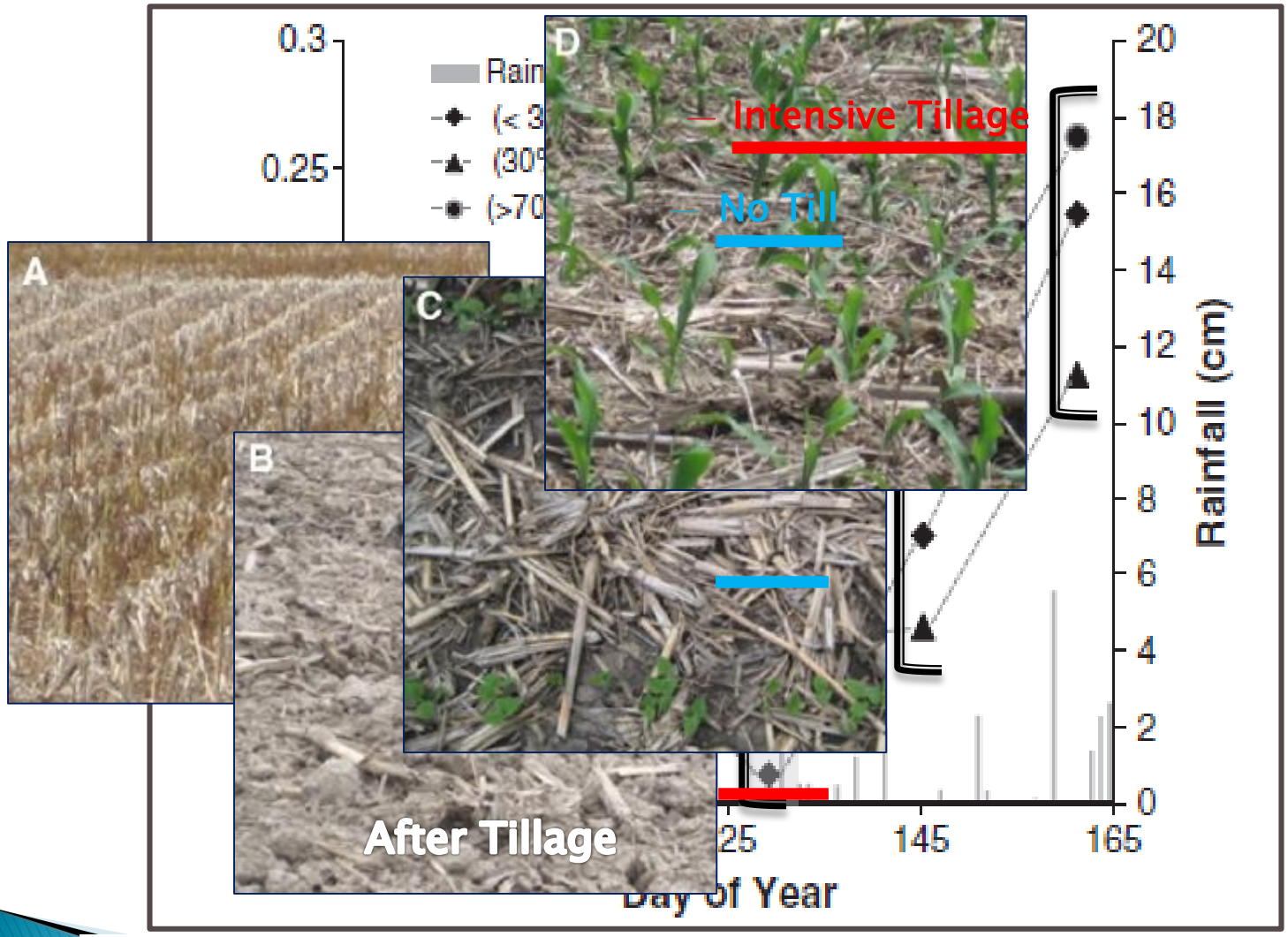
NDTI Changes with Time



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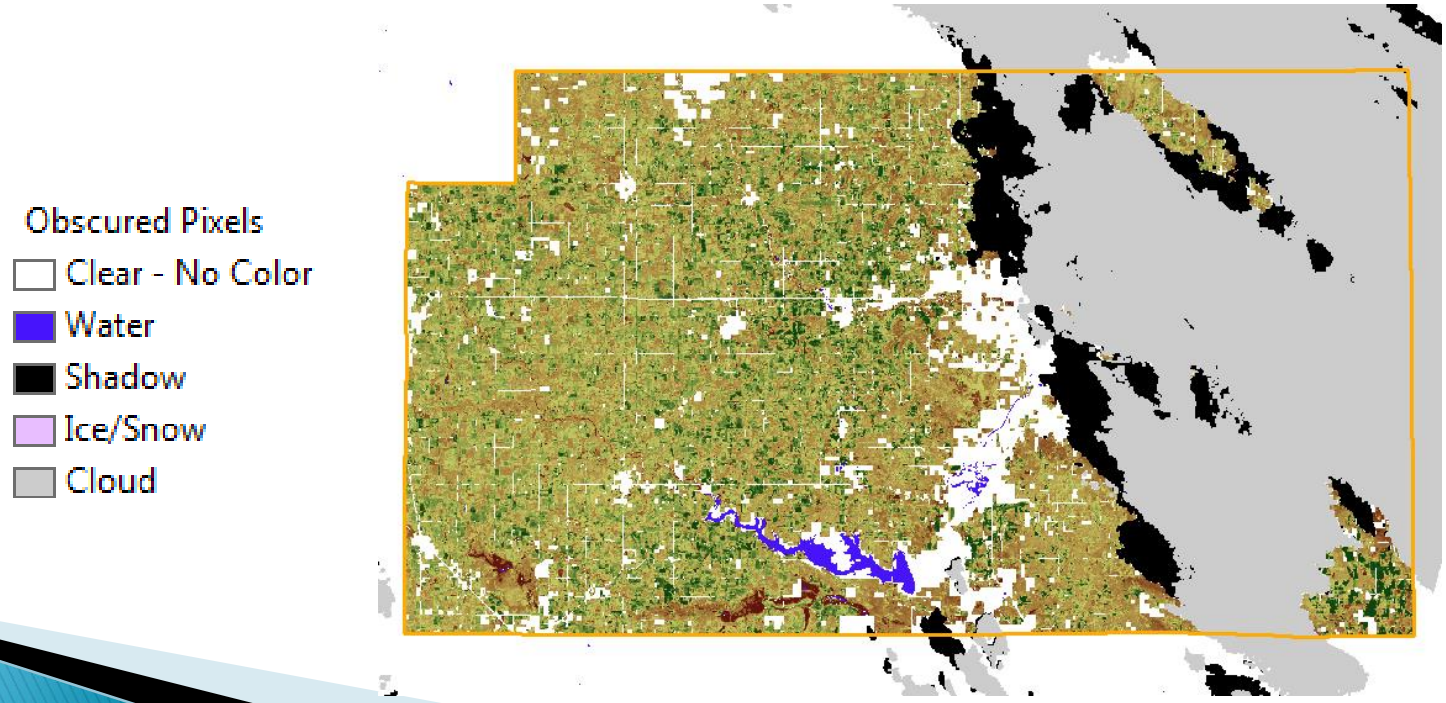
Methods

- Obtain imagery throughout spring planting season
- Preprocessing: remove obscured pixels
- Calcualte minNDTI



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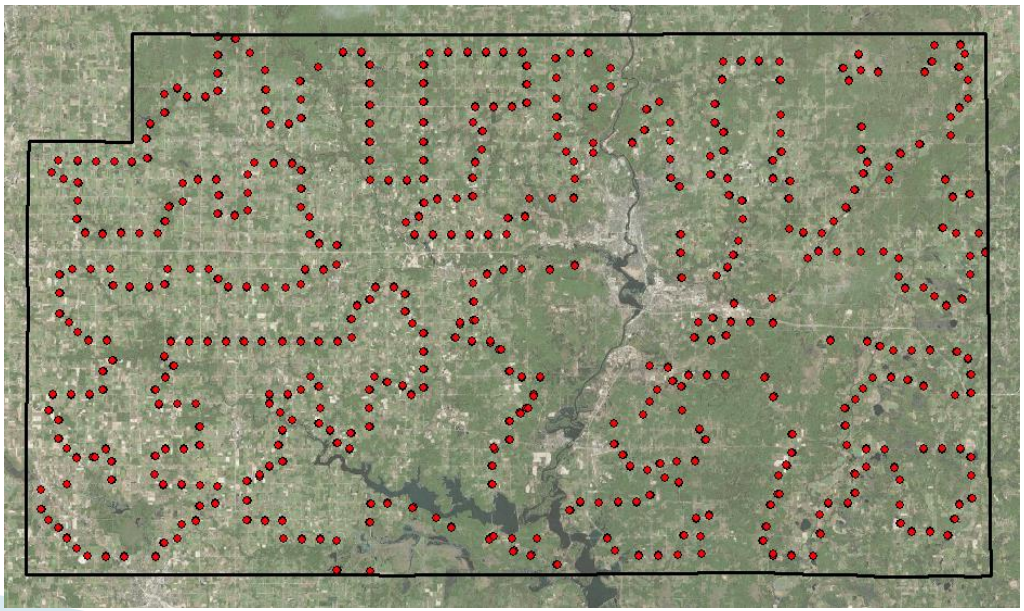
Transect Data

- Link known tillage practices and crop residue percentages to spectral signatures
- Annual data collection
- Includes
  - Crop type
  - Tillage type
  - Percent residue

Transect_Stops



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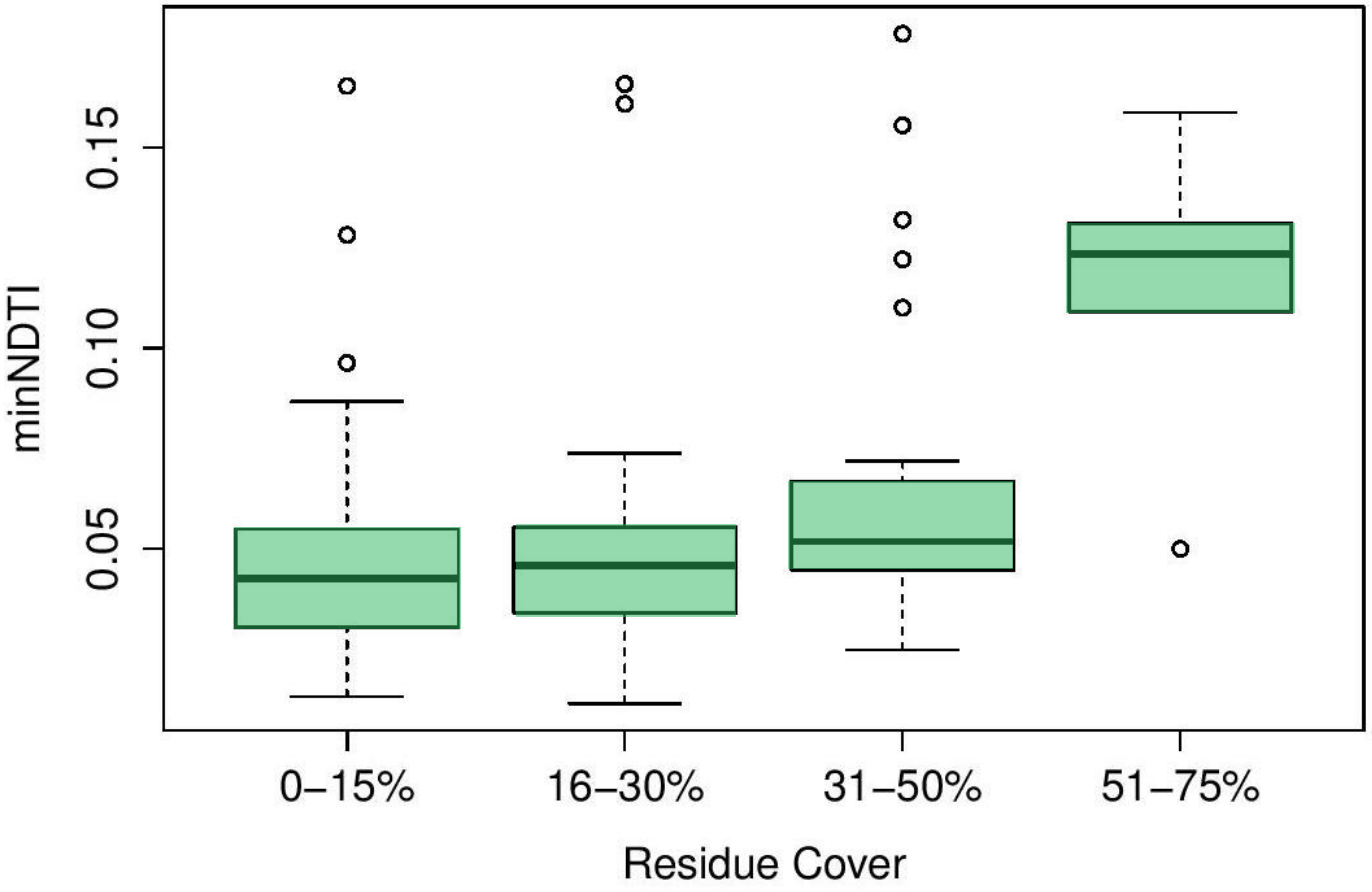
Reported Residue Cover and minNDTI

2012



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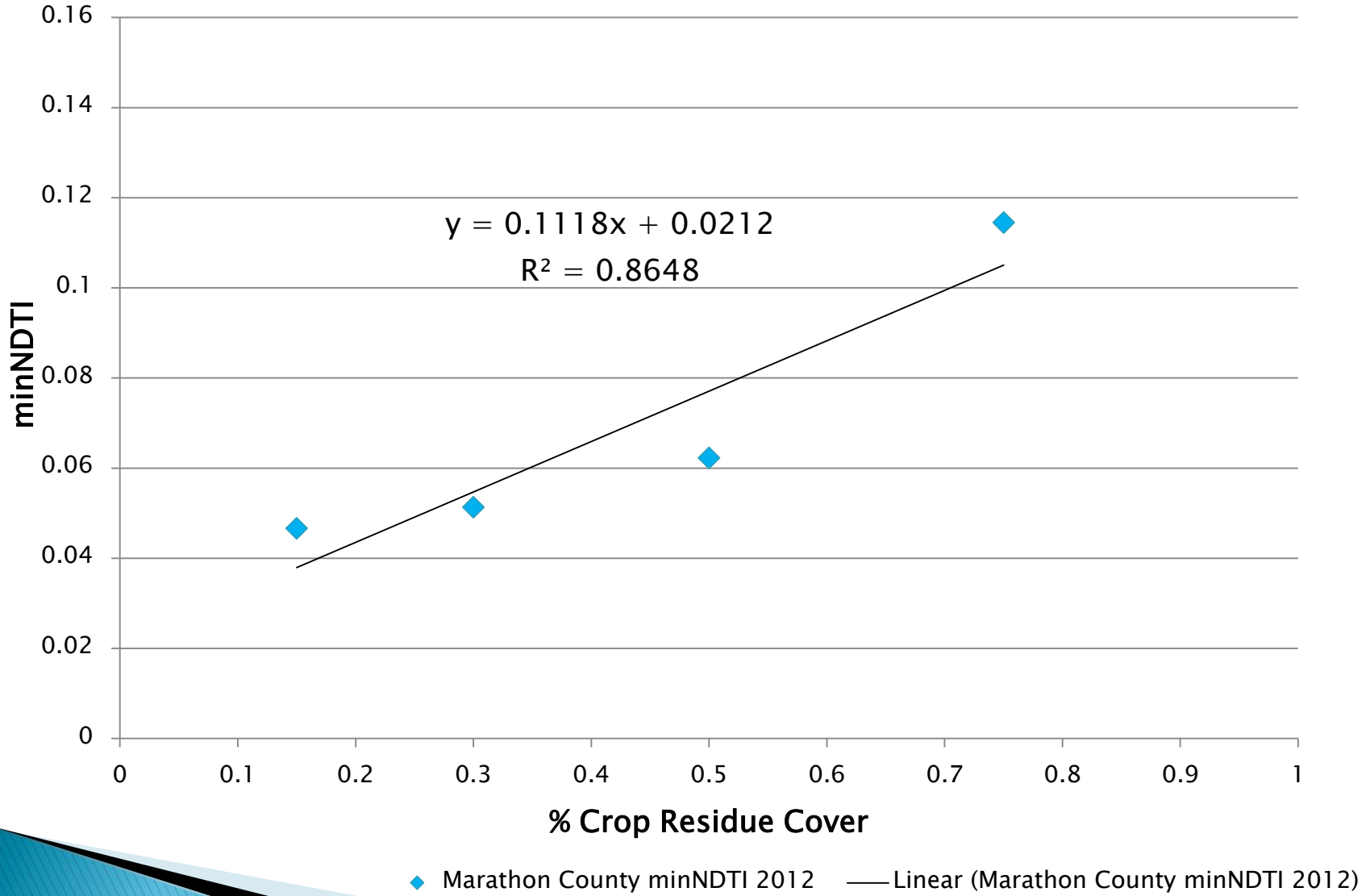
Relating Residue Cover and minNDTI



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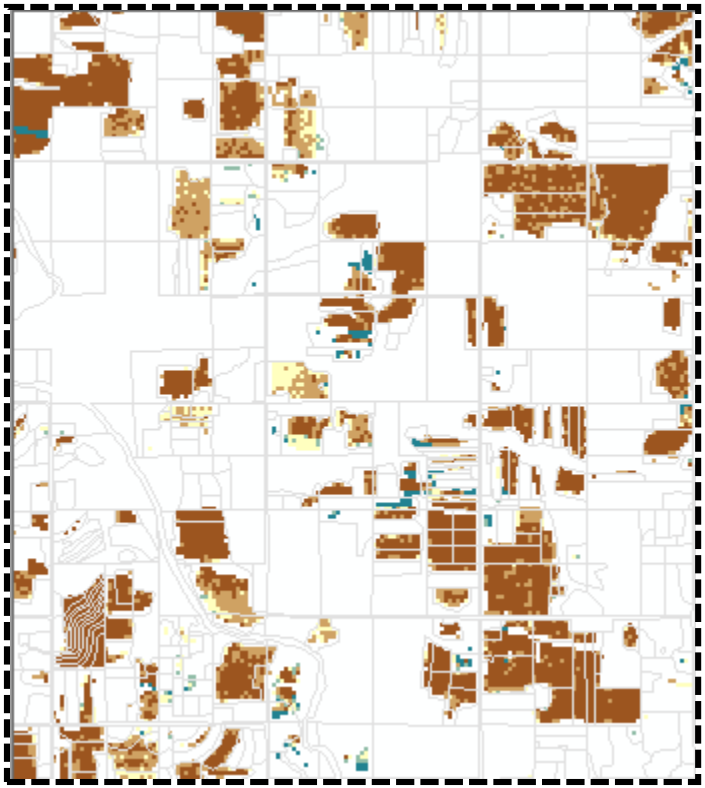
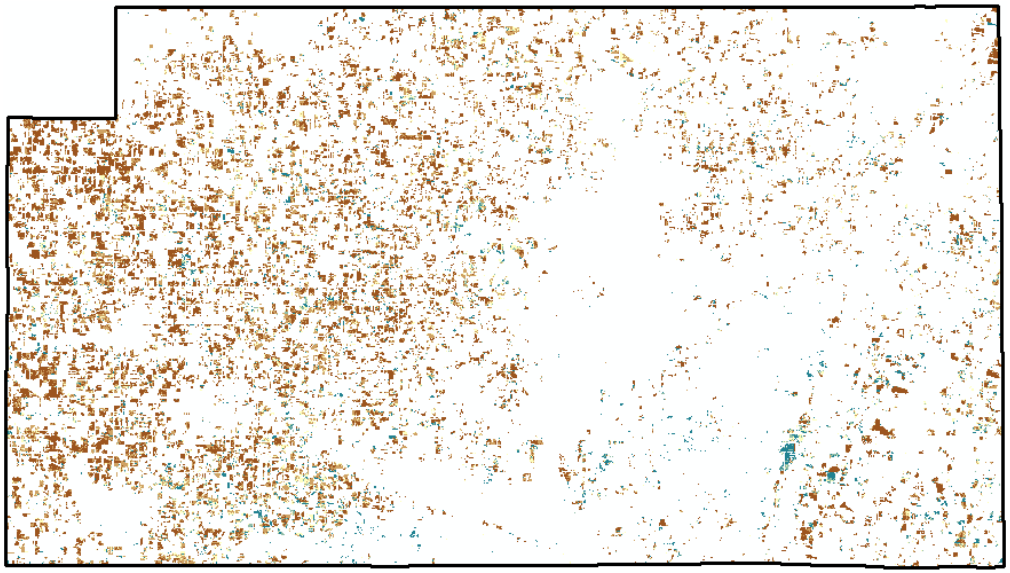
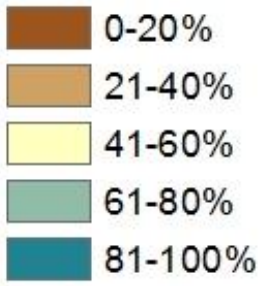
Marathon County Crop Residue Cover







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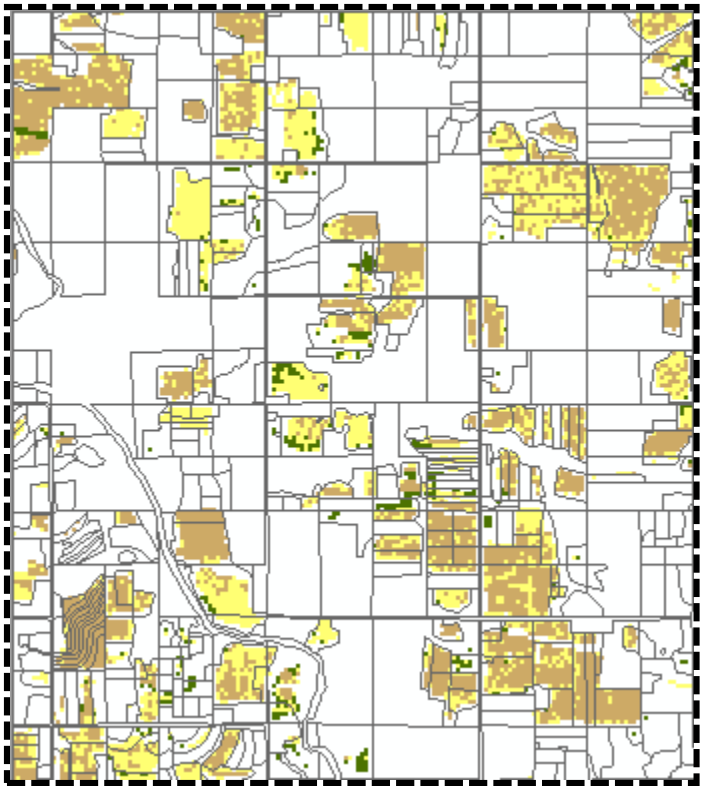
Relating minNDTI to Tillage Type



Tillage Type (%CRC)		2012 minNDTI
Moldboard (0-15%)		0.0001 – 0.0380
(16-75%)		0.0380 – 0.0771
No Till (76-100%)		0.0771 – 0.2999

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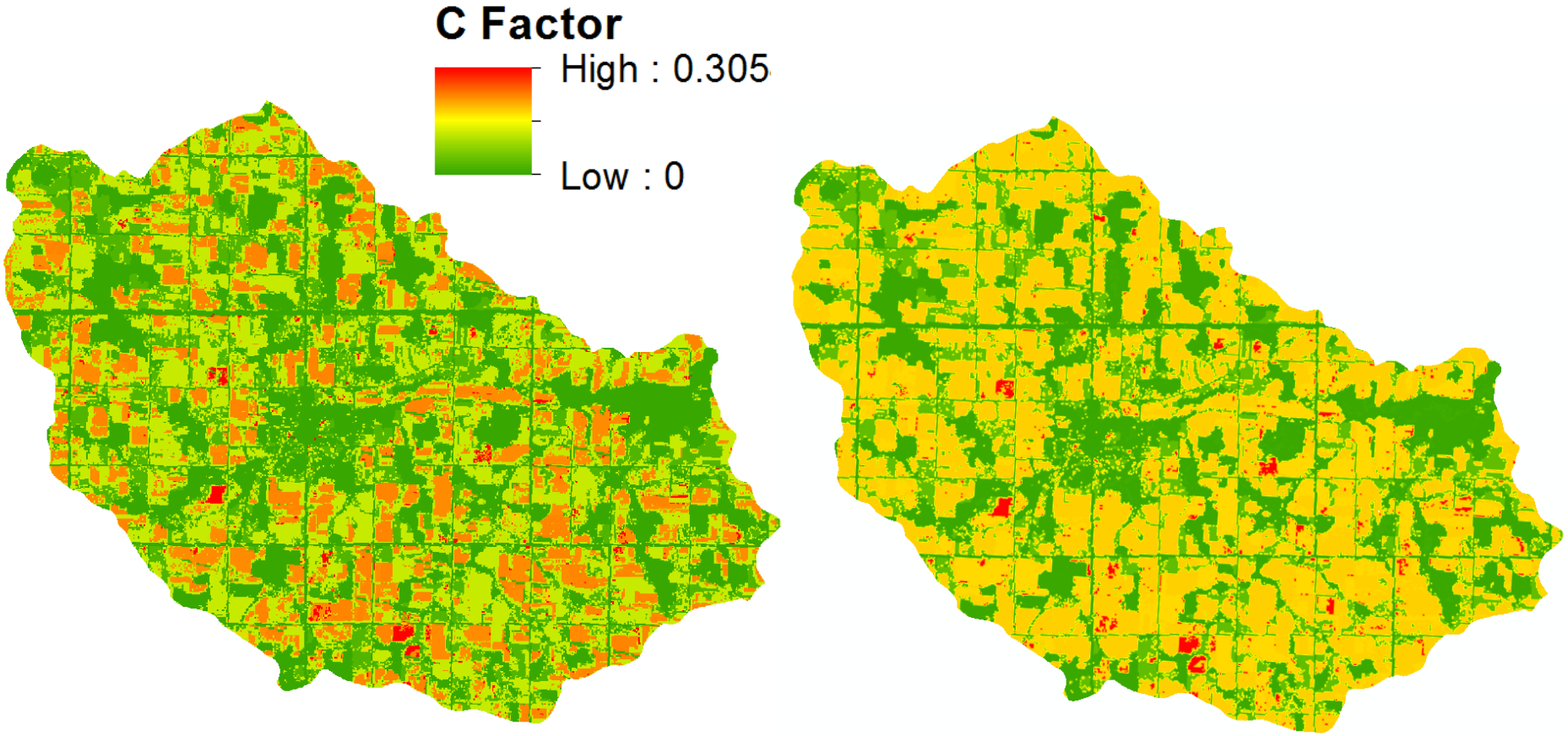
USLE C Factor



NDTI C factor

High C factor

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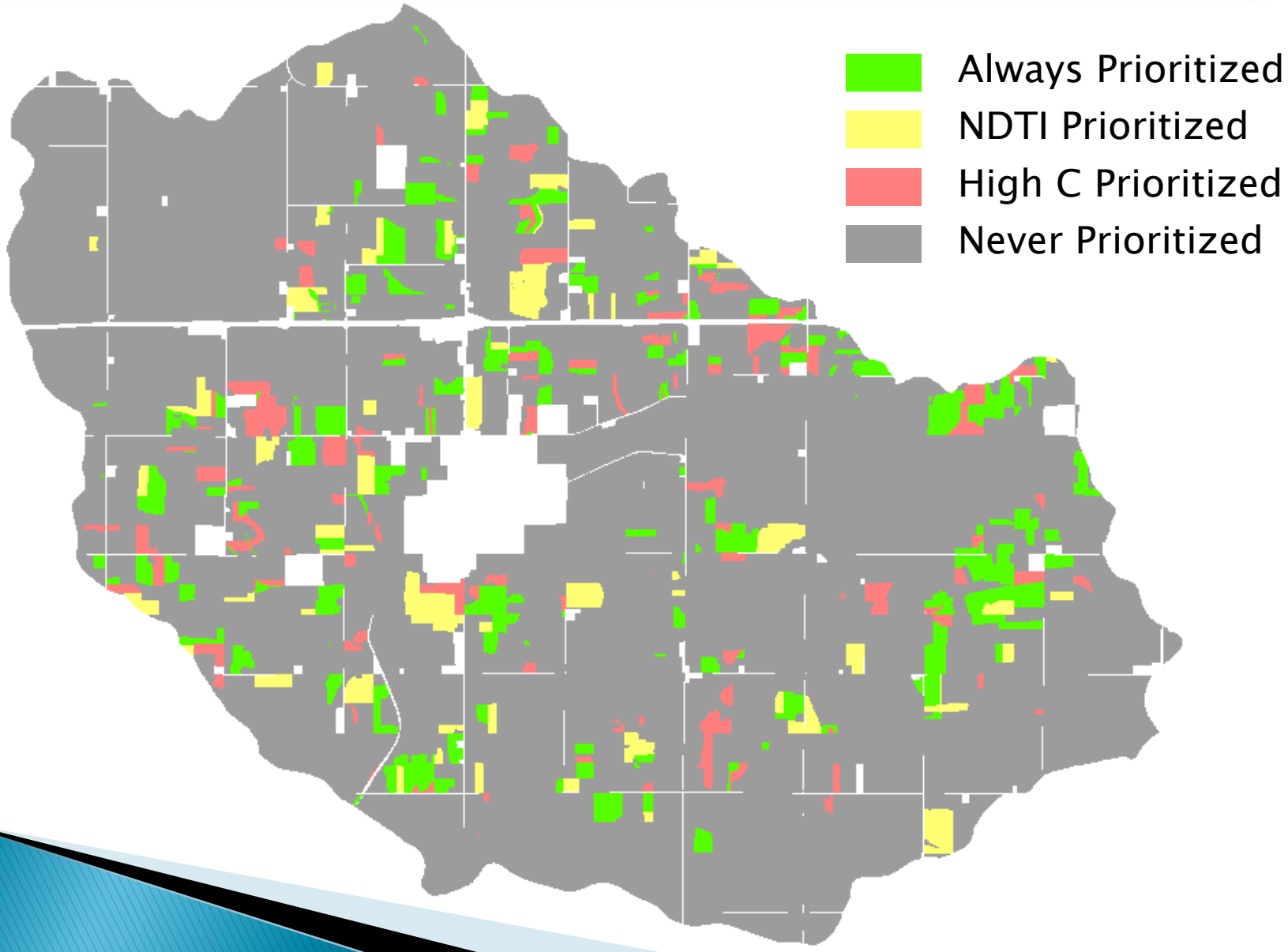
Change in USLE top 10% prioritization



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Challenges

- Landsat
  - Data gaps
  - Clouds
  - Timing/availability
  - Soil moisture impacts
- Validation data
- Computing time/power

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Conclusions

- EVAAL uses readily available data to assess erosion vulnerability; can be used to prioritize watershed efforts
- NDTI is positively correlated to crop residue coverage; can be used to infer tillage
- EVAAL results can be improved using satellite derived tillage information

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Questions

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