

# Using satellite imagery to determine crop residue cover for improving erosion estimates on agricultural lands

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AWRA Wisconsin  
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# Acknowledgements

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- ▶ Aaron Ruesch
- ▶ Dave Evans
- ▶ Brian Gelder
- ▶ Laura Ward Good
- ▶ Matt Zoschke
- ▶ Dane Co.



# Overview

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- ▶ EVAAL
- ▶ IDEP
- ▶ NDTI
- ▶ Clark County Data Analysis
- ▶ Pleasant Valley EVAAL Analysis

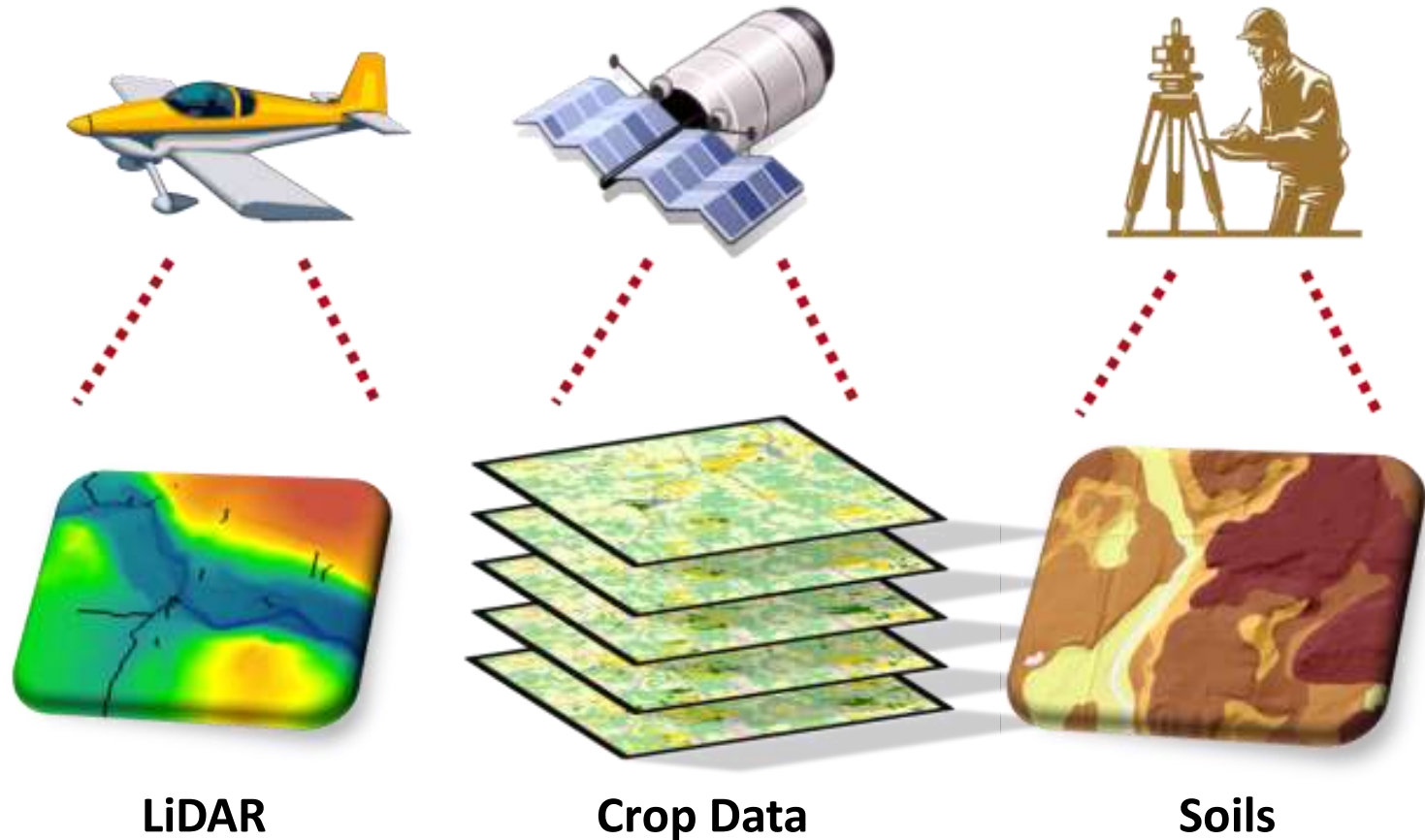
# EVAAL

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- ▶ **Erosion Vulnerability Assessment for Agricultural Lands**
- ▶ GIS-based model
- ▶ Vulnerability to erosion and nutrient export
- ▶ Deprioritizes internally draining areas

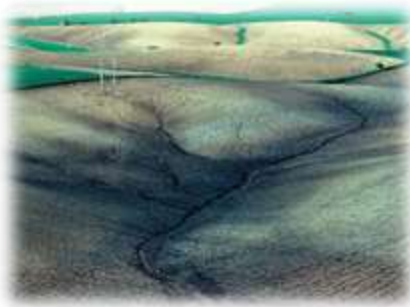


# Available Datasets



# Erosion Vulnerability Analysis

**USLE + SPI - IDA**



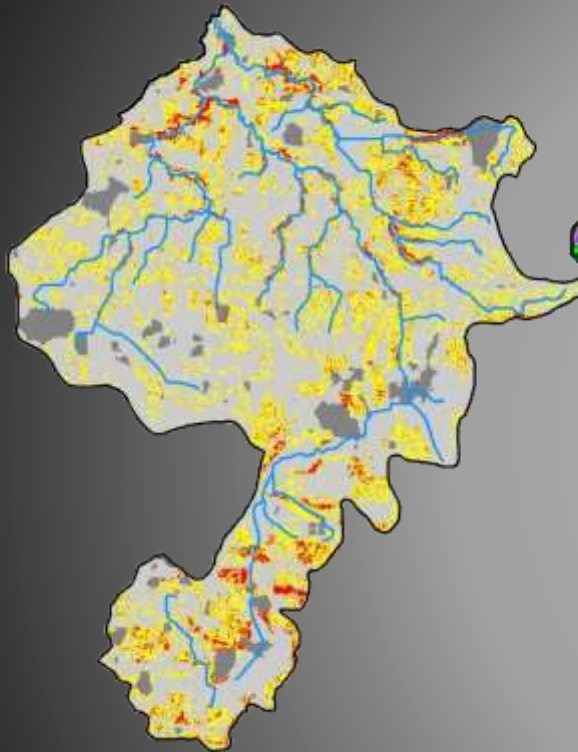
**= E  AAL**

**Erosion Vulnerability Assessment  
for Agricultural Lands**

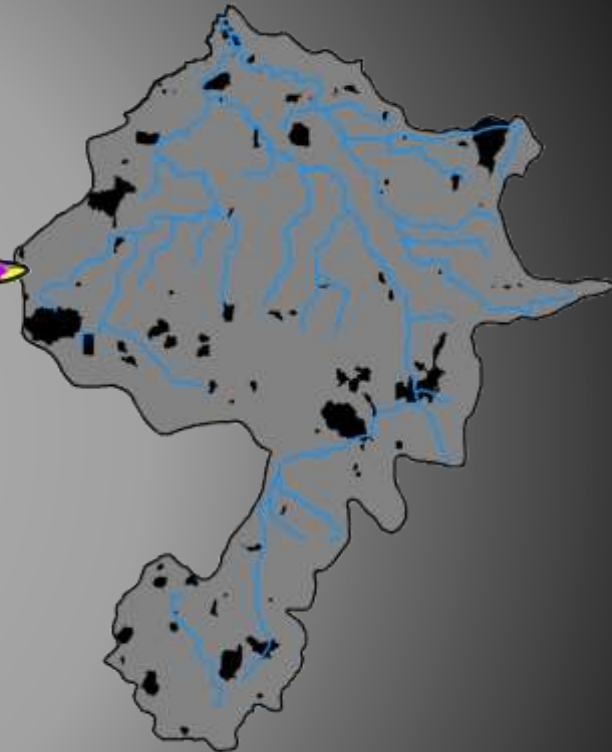


# Results

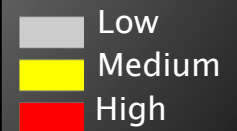
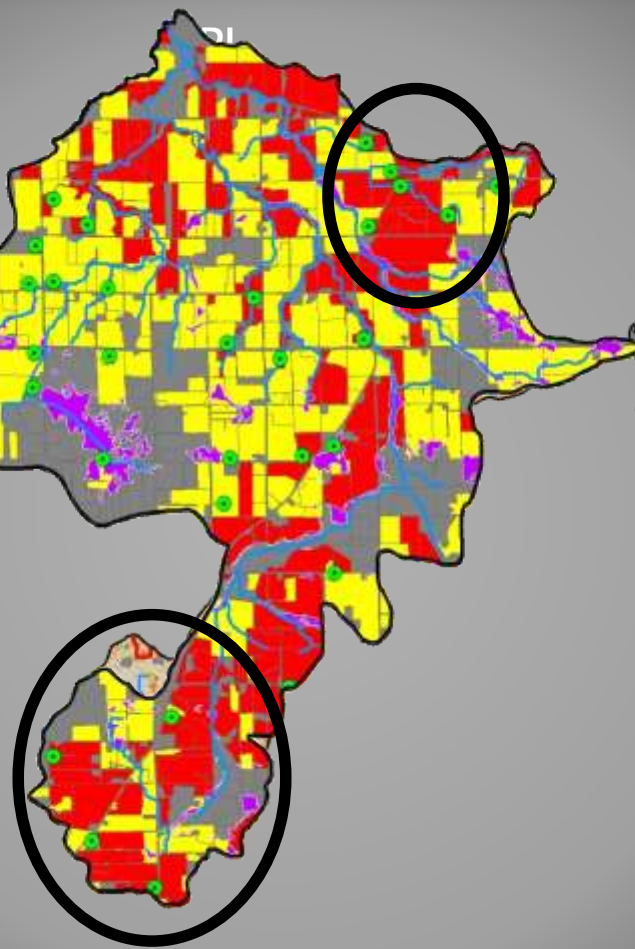
USLE



NC Areas

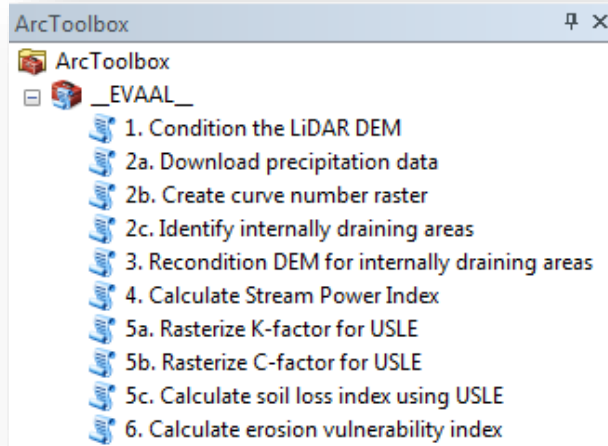


Positional tolerability



# EVAAL Website

- ▶ Documents
- ▶ Tutorial Data
- ▶ ArcToolbox



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## Agricultural NPS pollution

### Erosion Vulnerability Assessment for Agricultural Lands (EVAAL)

The Wisconsin Department of Natural Resources (WDNR) Bureau of Water Quality has developed the Erosion Vulnerability Assessment for Agricultural Lands (EVAAL) toolset to assist watershed managers in prioritizing areas within a watershed which may be vulnerable to water erosion (and thus increased nutrient export) and thus may contribute to downstream surface water quality problems. It evaluates locations of relative vulnerability to sheet, rill and gully erosion using information about topography, soils, rainfall and land cover. This tool enables watershed managers to prioritize and focus field-scale data collection efforts, thus saving time and money while increasing the probability of locating fields with high sediment and nutrient export for implementation of best management practices (BMPs).

**Erosion Vulnerability Index**

EVAAL was designed to quickly identify areas vulnerable to erosion, and thus more likely to export nutrients like phosphorus, using readily available data and a user-friendly interface. This tool estimates vulnerability by separately assessing the risk for sheet and rill erosion (using the Universal Soil Loss Equation, USLE), and gully erosion (using the Stream Power index, SPI), while deprioritizing those areas that are not hydrologically connected to surface waters (also known as internally drained areas, IDA). These three pieces are combined to produce an erosion vulnerability index value that can be assessed at the grid scale or aggregated to areas, such as field boundaries.

**EVAAL, Version 1.0 (August 2014)**

- [Fact Sheet \(pdf\)](#)
- [Tutorial \(ppt\)](#)
- [Methods Documentation \(pdf\)](#)
- [EVAAL Model Files \(zip\)](#)
- [EVAAL Tutorial Data \(PDF, xls, ZIP file format\)](#)

**Contact information**

For questions or information about this model, please contact:

[Theresa M. Possley Nelson, P.E.](#)  
TMDL modeling engineer  
Project manager

Last revised: Friday September 26 2014

**Nonpoint source pollution**

**Agricultural nonpoint source pollution**  
Learn more about agricultural nonpoint source pollution

**Urban nonpoint source pollution**  
Learn more about urban nonpoint source pollution

**What you can do**  
Learn more about controlling nonpoint source pollution in your area

**TMDL implementation**  
Learn more about what the DNR is doing to control nonpoint source pollution

**Related links**

- [Environmental impacts](#)
- [Wisconsin Runoff Rules: What Farmers Need to Know \(PDF\)](#)
- [NR 151 implementation strategy](#)
- [Agricultural technical standards & assistance](#)
- [Financial assistance](#)
- [Discharges, complaints & assistance](#)
- [Notices of discharge](#)
- [Nonpoint program contacts](#)

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





# Limitations

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



# USLE – Tillage Assumptions

$$A = RK(LS)CP$$

Cropland data layer

Crop Rotations

SNAP-Plus (RUSLE2) -> Rotational C Factor

Poor

Good

# USLE



USLE w/ Low C Factor



USLE w/ High C Factor

# Iowa Daily Erosion Project

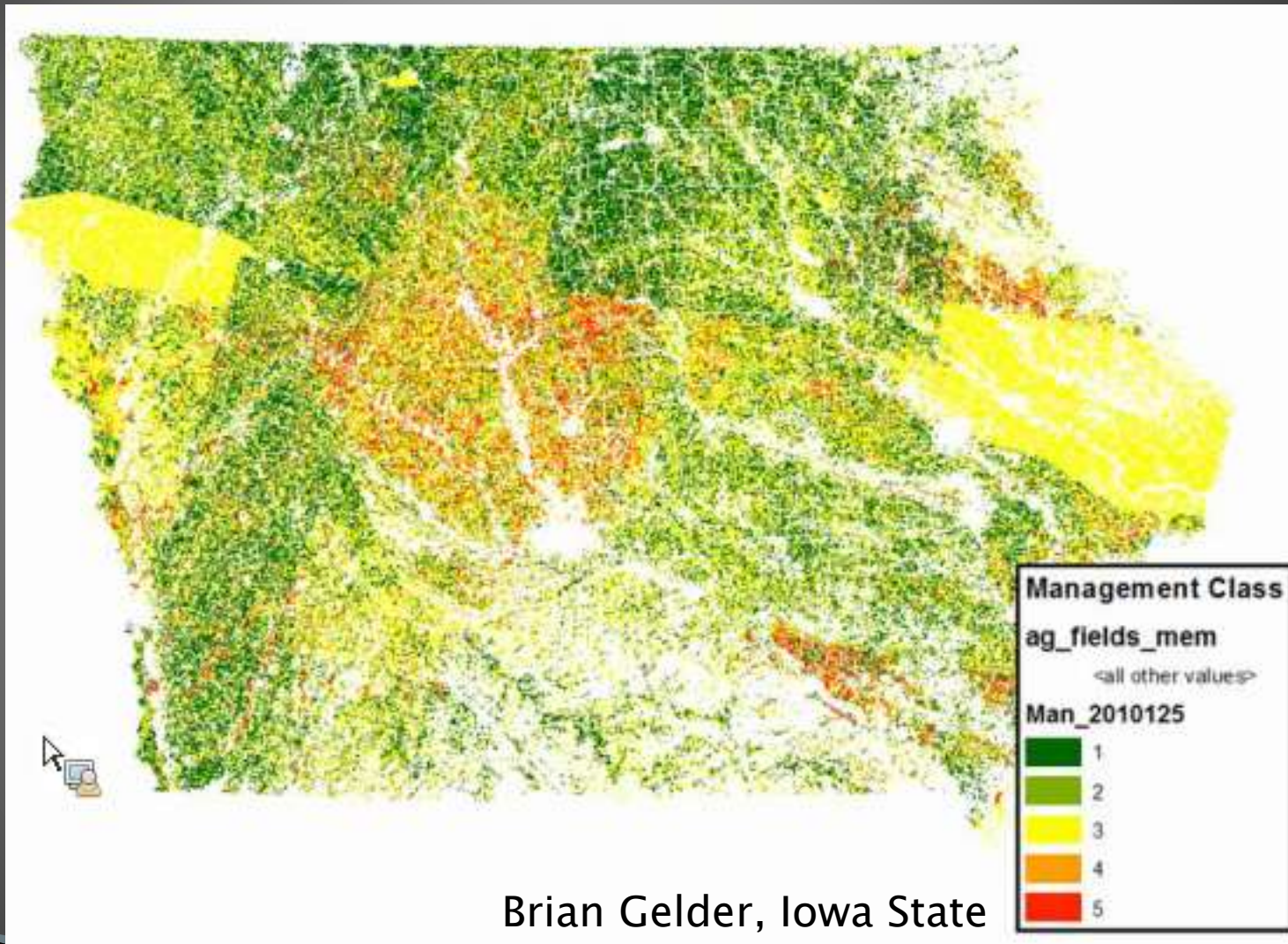
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- ▶ Daily estimates of rainfall, runoff, and soil erosion for the state of Iowa
- ▶ Collaboration:
  - Iowa State University, National Soil Erosion Research Lab, National Laboratory for Agriculture and the Environment, and The University of Iowa
- ▶ Updating to use remotely sensed information:
  - Crop rotations
  - Tillage
  - Topography





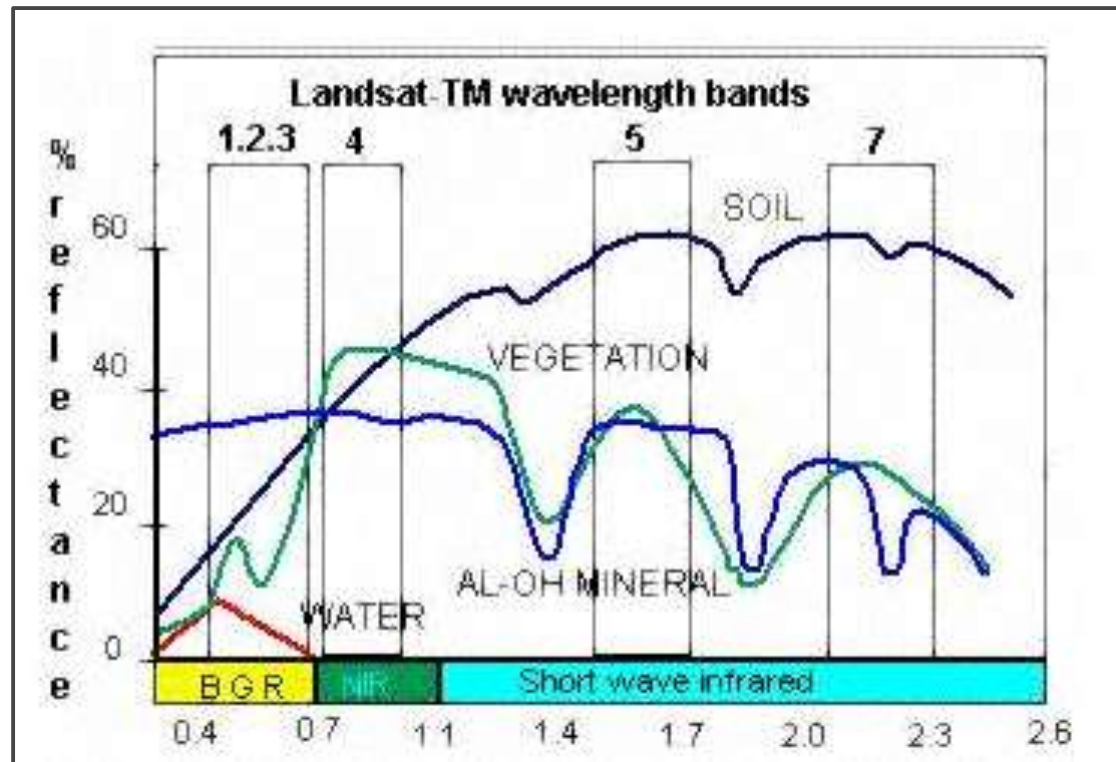
# IDEP Example





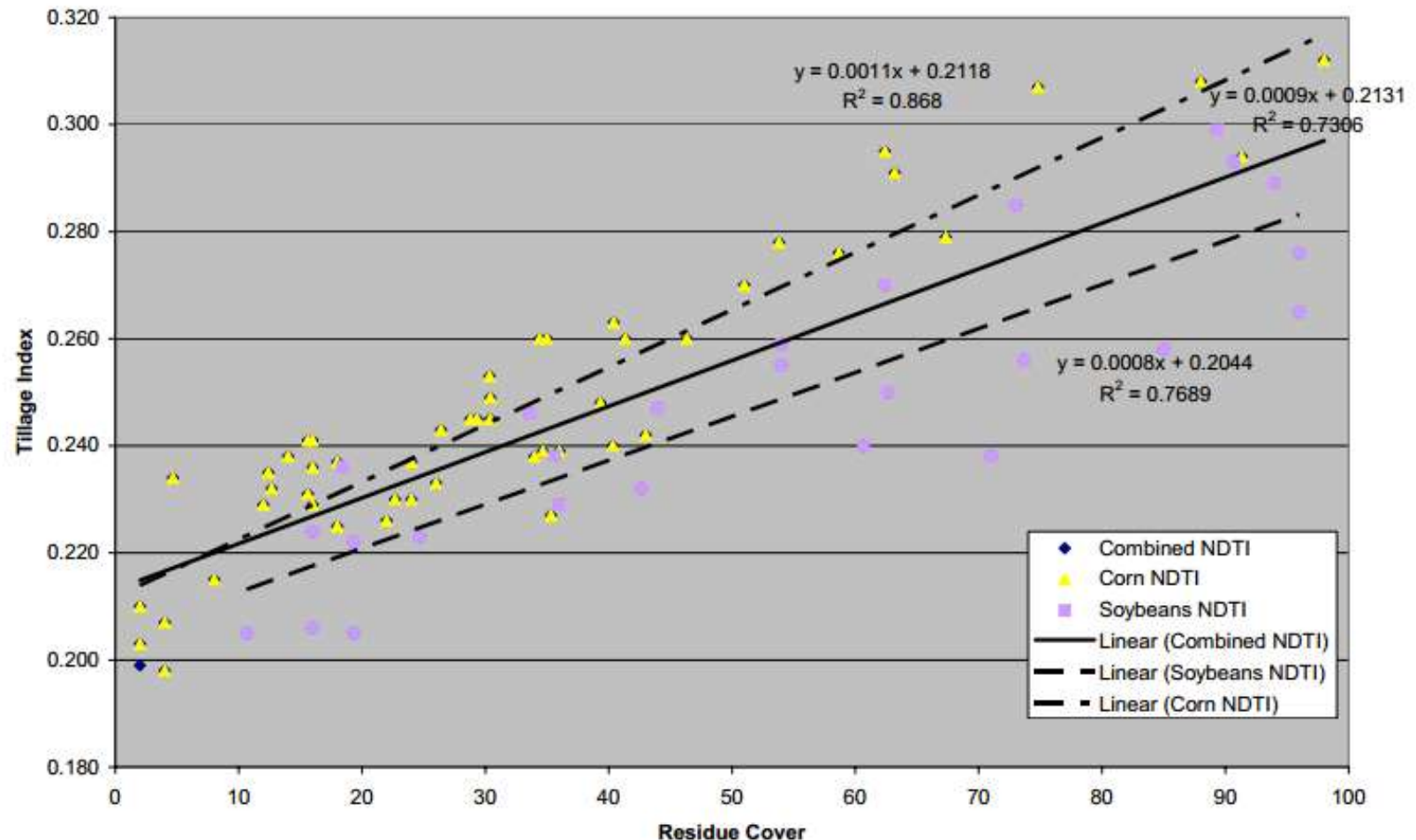
# Satellite Imagery Analysis

- ▶ Landsat 7 ETM+
- ▶ Normalized Difference Tillage Index
- ▶  $NDTI = (band5 - band7) / (band5 + band7)$



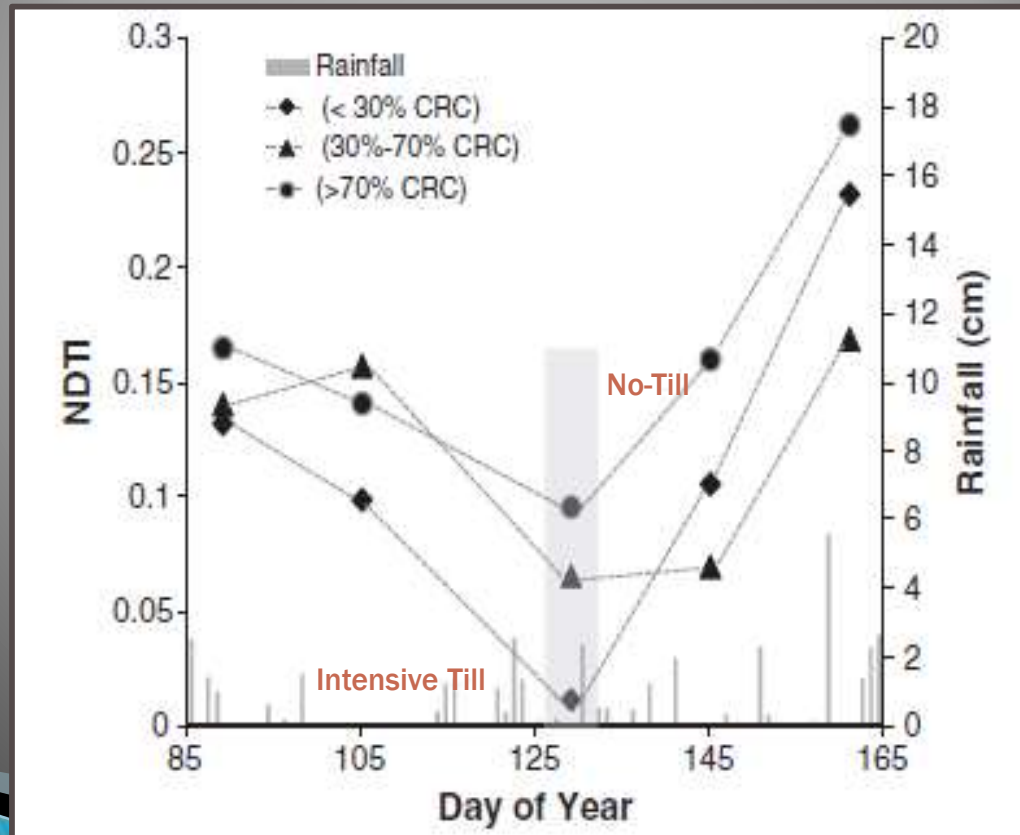
# NDTI and Crop Residue Cover

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



# minNDTI

- ▶ Tillage timing can vary greatly
- ▶ Field will have lowest NDTI value right after tillage/planting and before plant emergence



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



# Clark County Transect Data

- ▶ Annual data collection
- ▶ Includes
  - Crop type
  - Tillage type
  - Percent residue



# NDTI – CRC Analysis

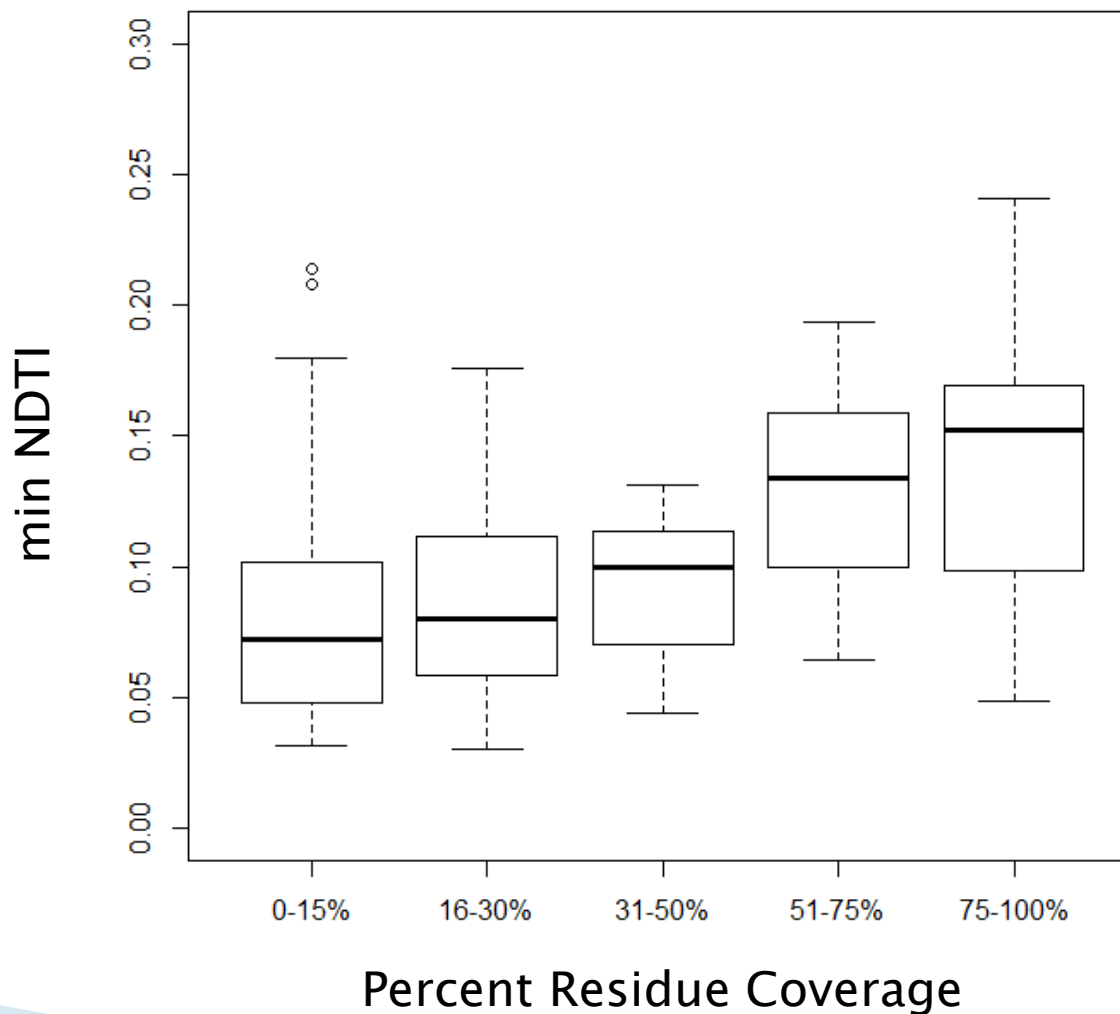
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- ▶ Landsat 7 ETM+ (surface reflectance)
- ▶ Scenes from 2011
  - March–August
- ▶ minNDTI
  - May 16
  - June 1
  - June 17
  - July 3
- ▶ Averaged for each transect field

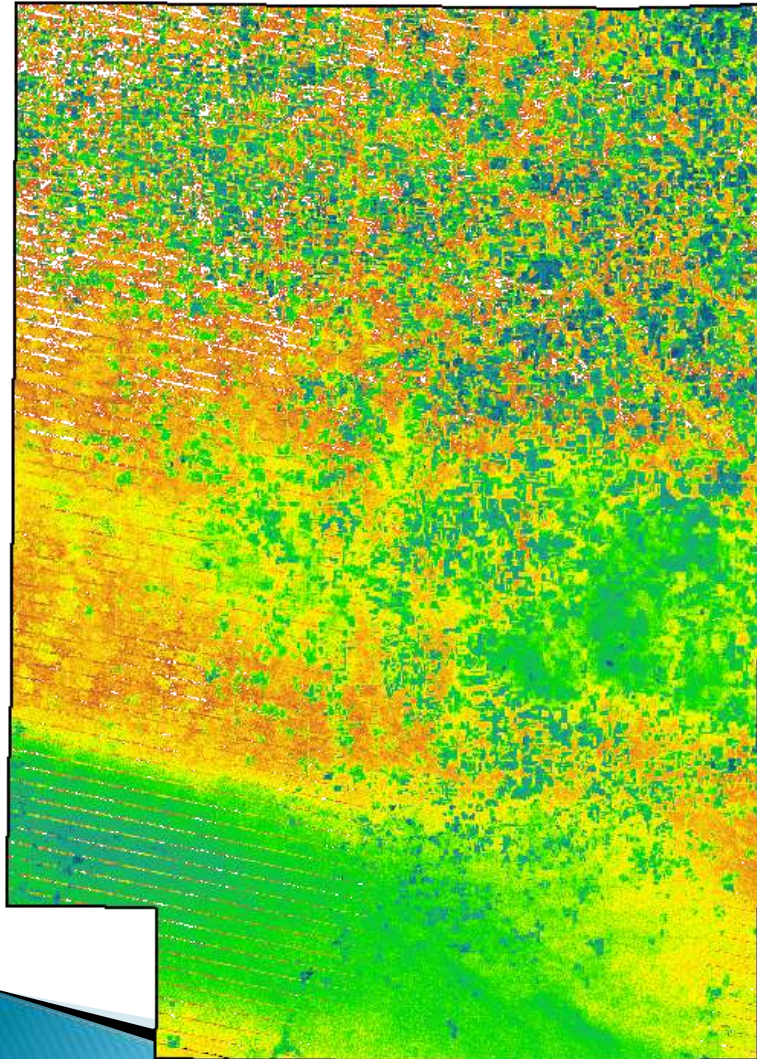




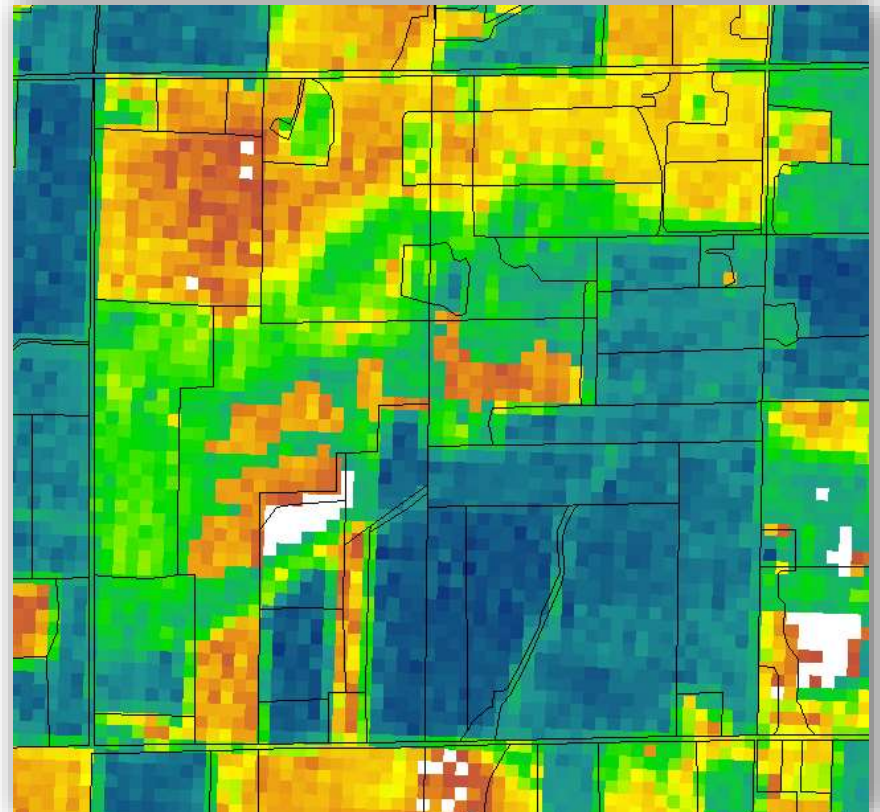
# Clark County minNDTI



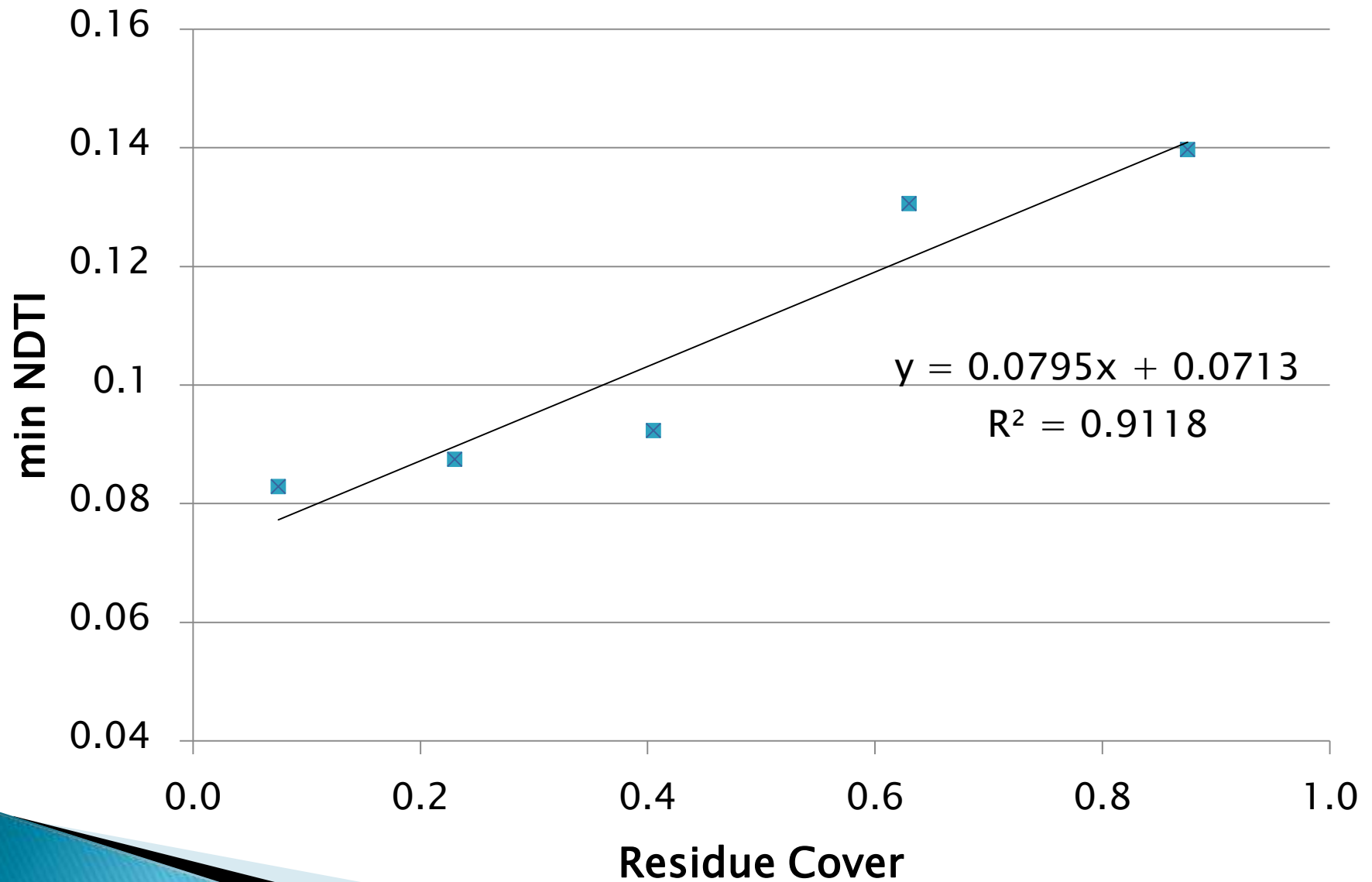
# minNDTI



minNDTI



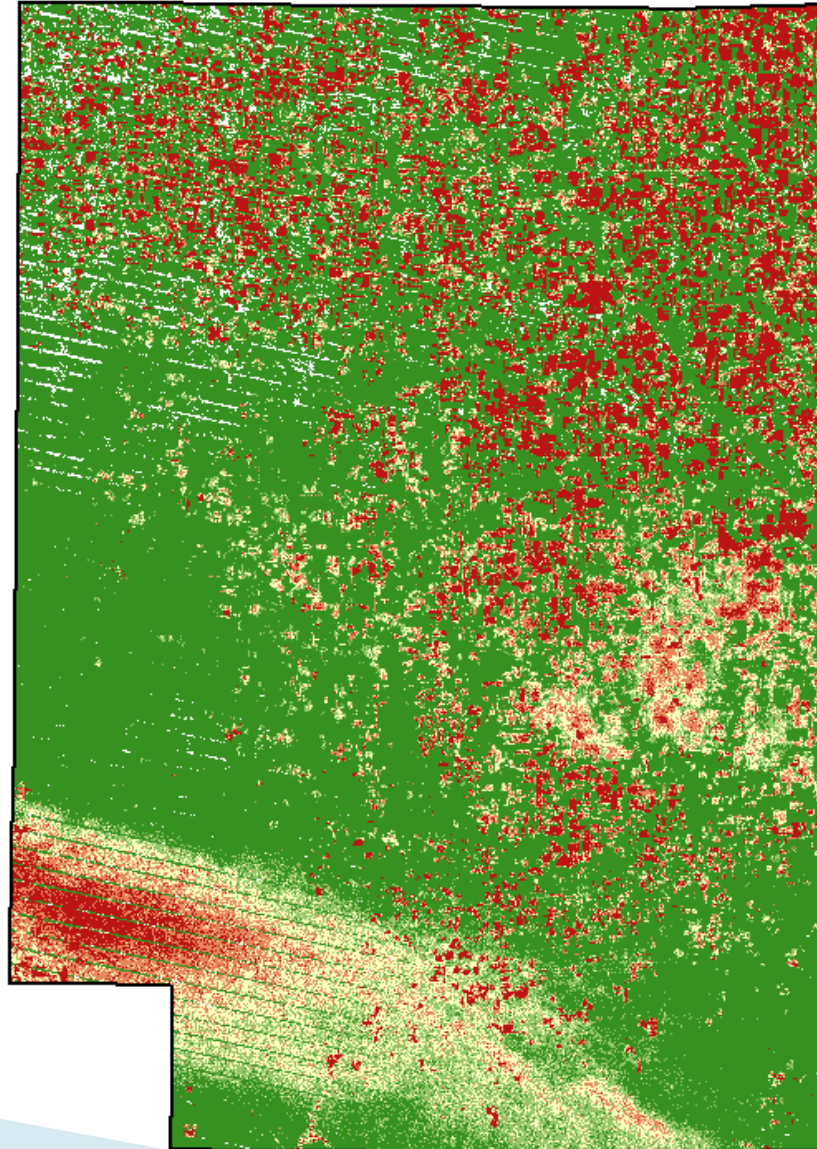
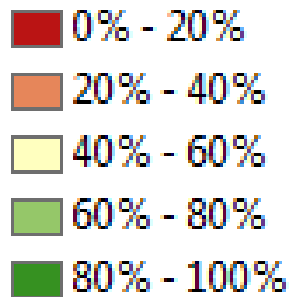
# Clark County minNDTI





# Crop Residue Cover

## Crop Residue Cover %

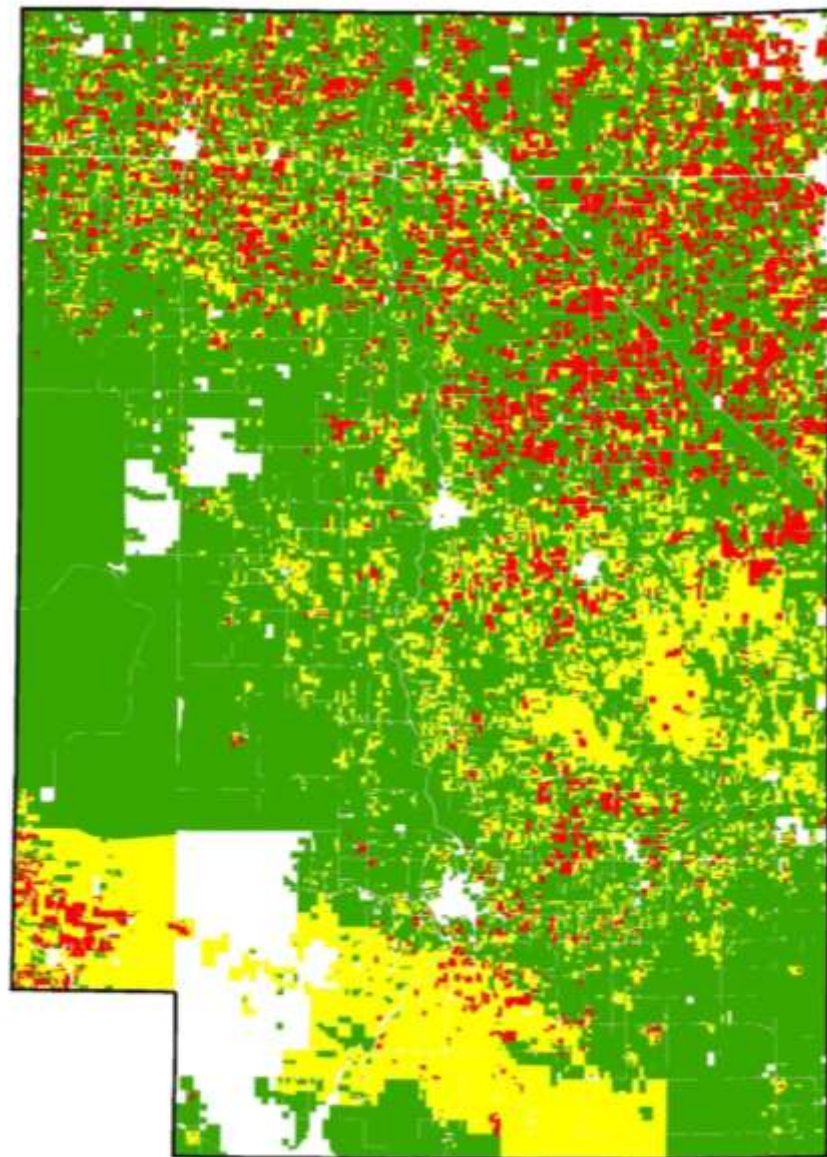


# Relate to Tillage Types



NDTI

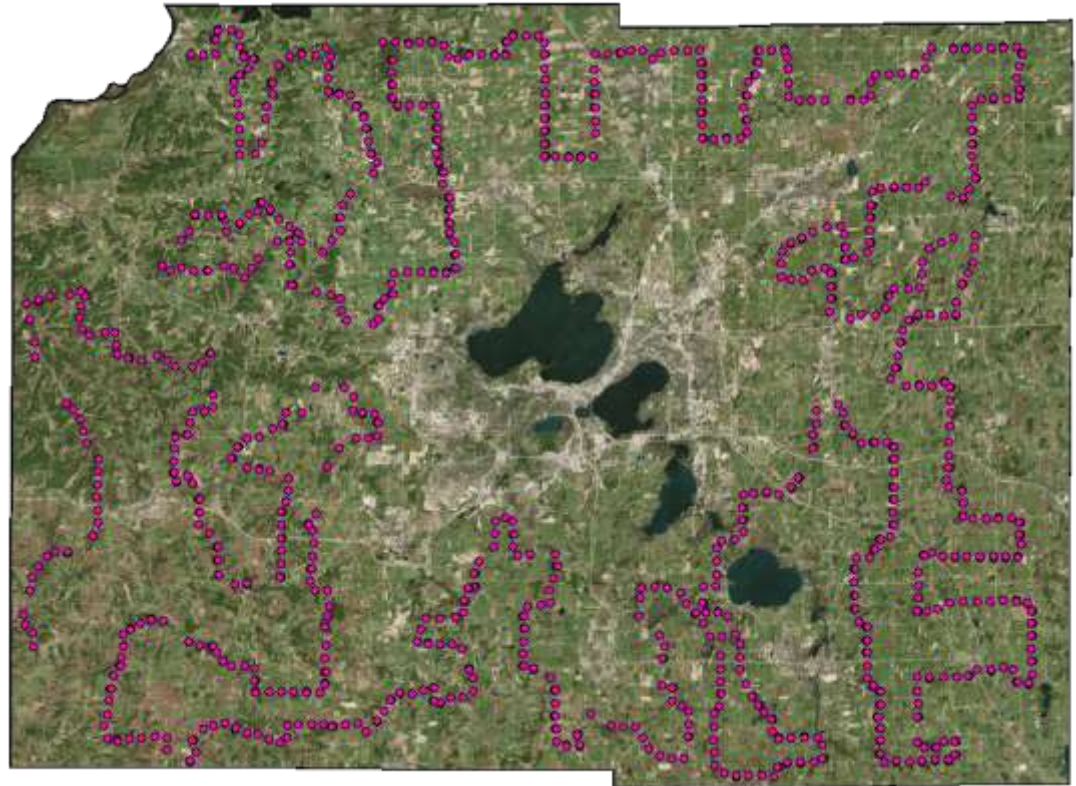
Moldboard (0%–15%)	0.024337 - 0.083000
(15%–75%)	0.083001 - 0.131000
No Till (75%–100%)	0.131001 - 0.300000





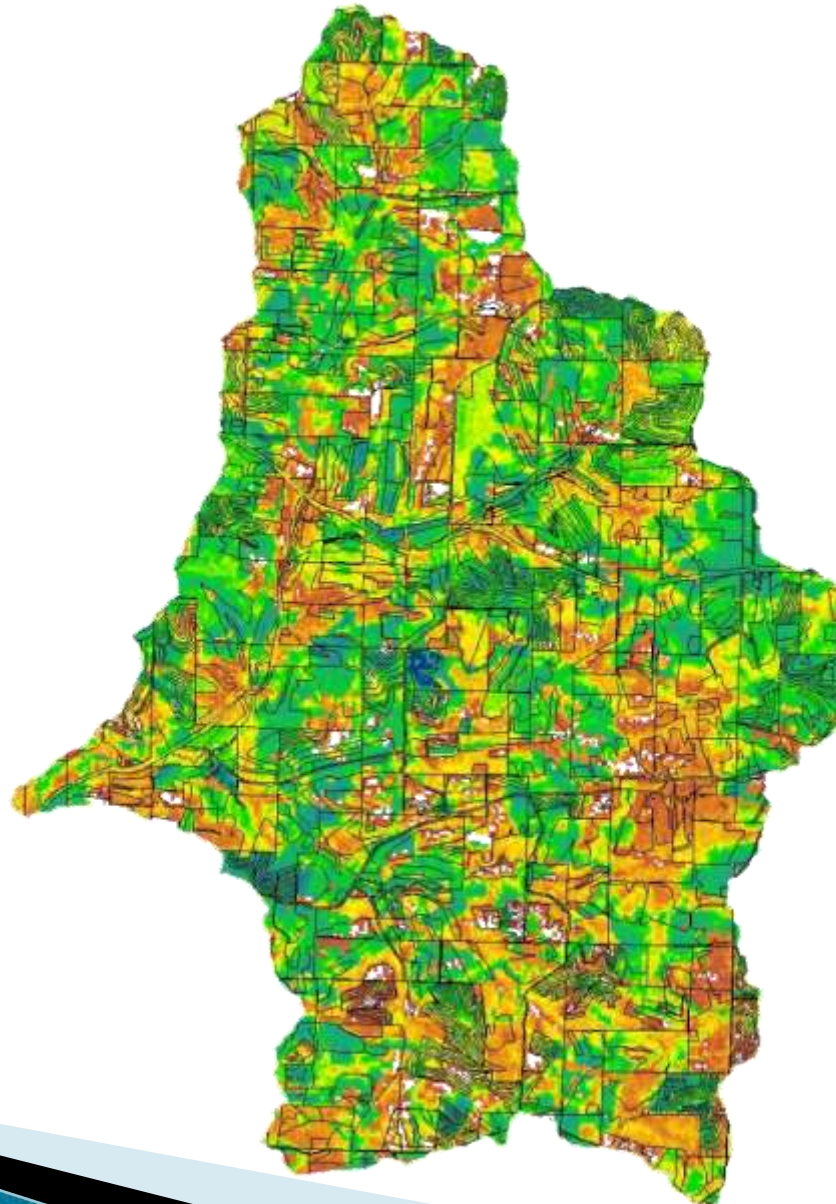
# Pleasant Valley EVAAL

- ▶ Dane Co. transect data
  - Just tillage type – no % residue cover
- ▶ Analysis for Spring 2010






# Pleasant Valley minNDTI

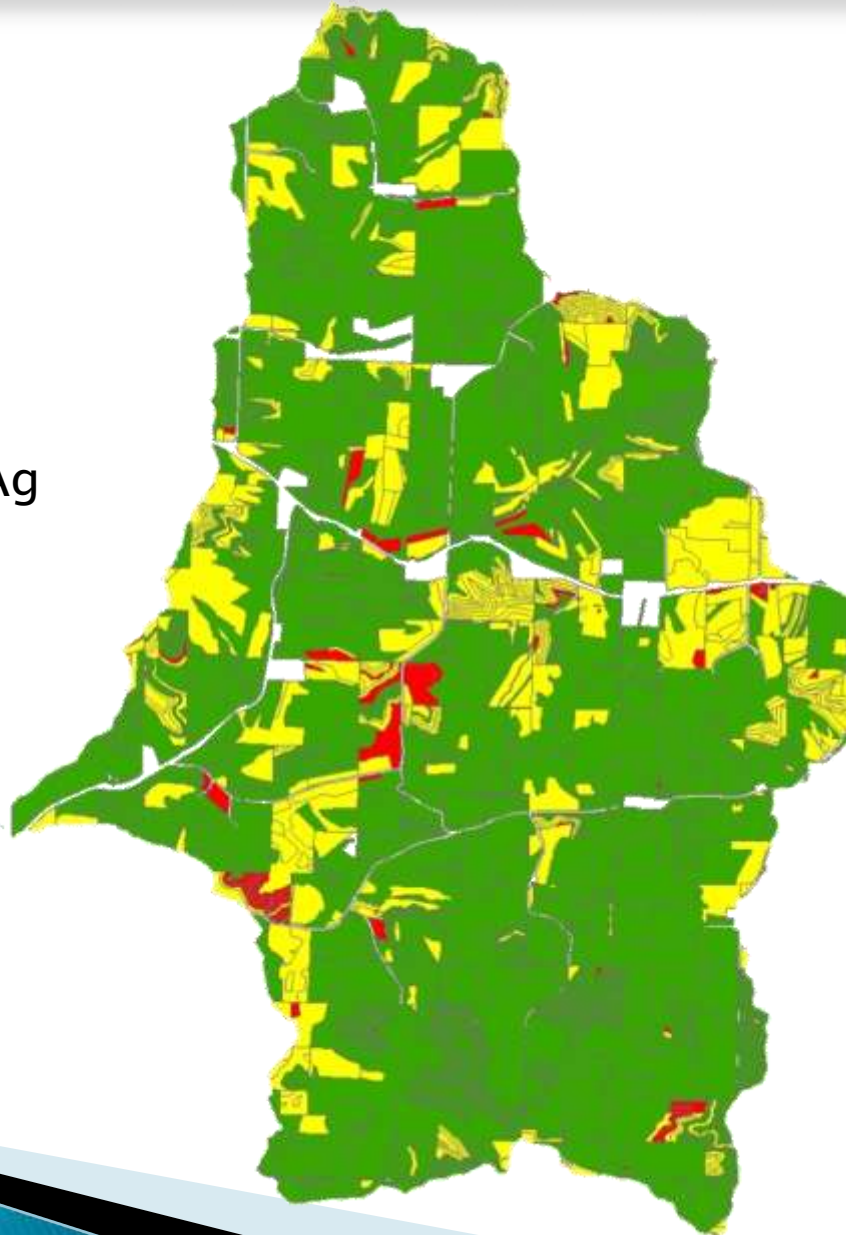
minNDTI



# Pleasant Valley Tillage

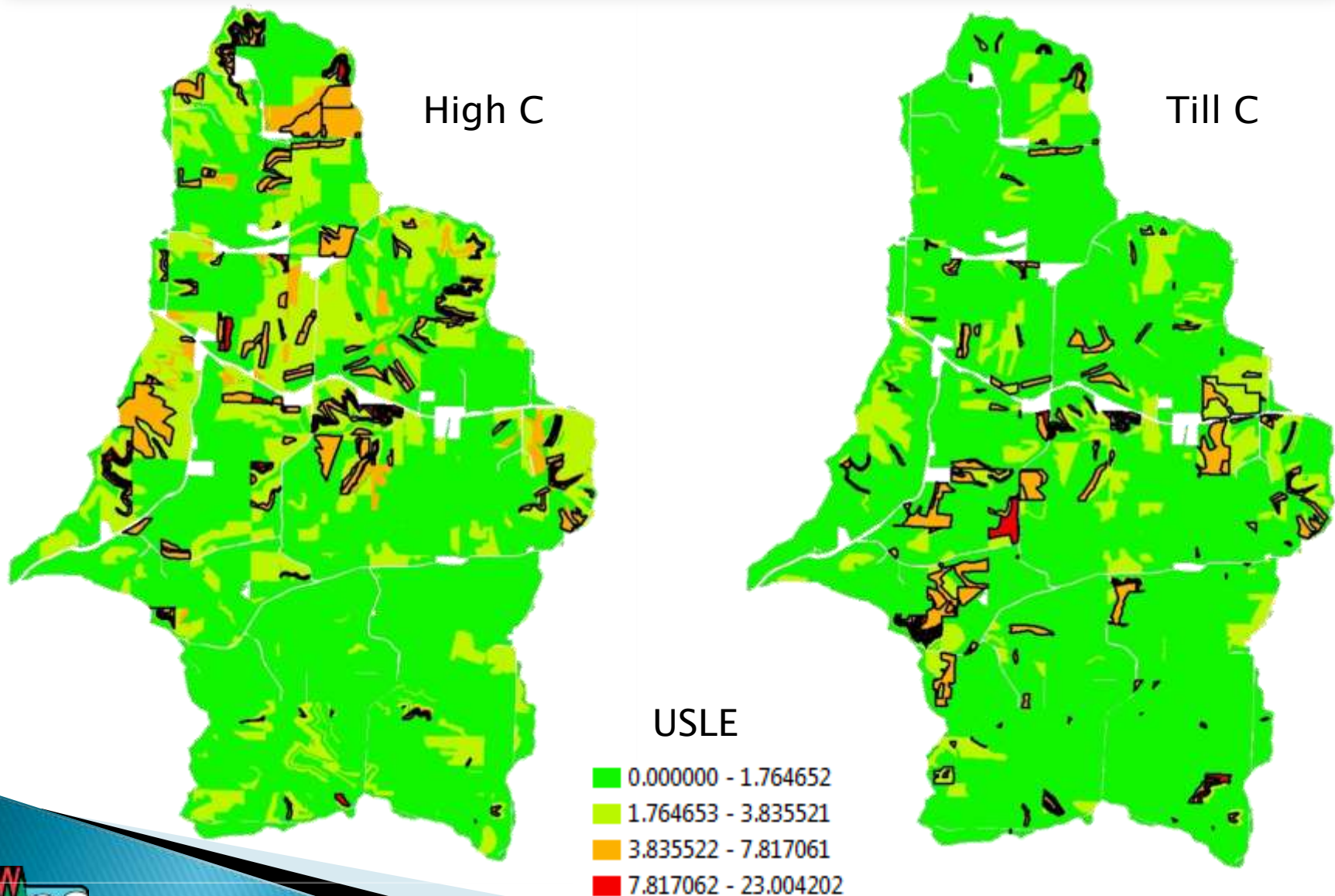
## Tillage Type

-  Moldboard
-  No-Till/Non-Ag
-  No-Till/Non-Ag





# Pleasant Valley USLE



# Challenges

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- ▶ Landsat
  - Data gaps
  - Clouds
  - Timing/availability
- ▶ Validation data
- ▶ Computing time/power





# Next Steps

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- ▶ Evaluate automating process
- ▶ Determine tillage for multiple years
- ▶ Incorporate into EVAAL
- ▶ Potentially coordinate with Iowa State



# Conclusions

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- ▶ EVAAL 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





# Questions

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