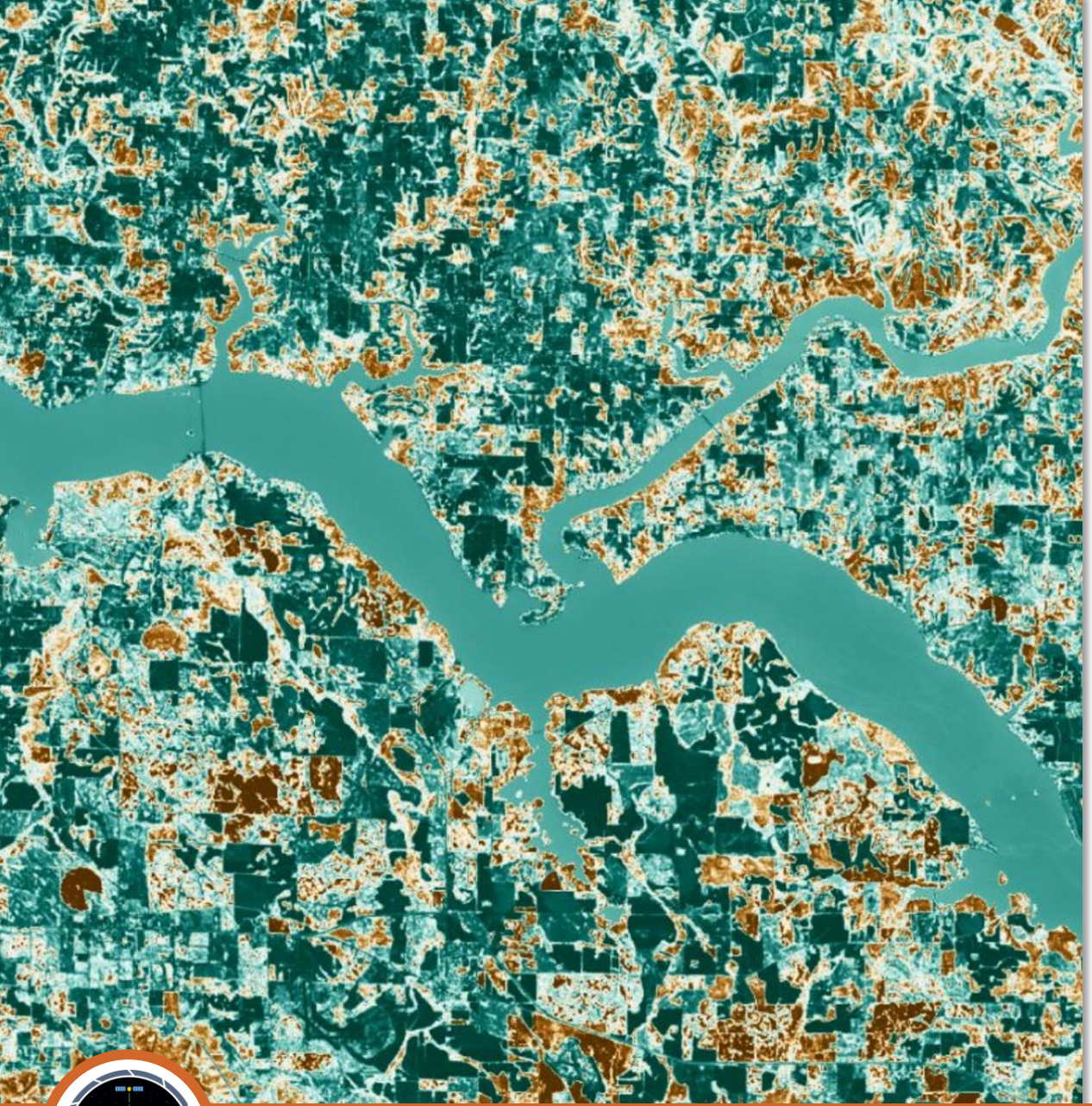


National Aeronautics and Space Administration

Alabama Agriculture

Using NASA Earth Observations to Assess the Feasibility of Monitoring Water Retention in Cover and Winter Crops

Isaac Goldings

Hannah Sundararajan

Mikki Arimitsu

Isabel Tate

DEVELOP

Alabama – Marshall | Fall 2024

Community Concerns

2024: **driest August since 1895** in Alabama

Negatively impacts **agricultural commodities**

Producers **fall behind** on growing and harvesting

Lower yields and quality of crops

Image Credits: Bruce Dupree, Alabama Extension

Cover and Winter Crops

Growing Season
April – October

Winter Season
November – March

Growing Season
April – October

Image Credits: Margaret Barse & Kate Nichols, Alabama Extension

Project Partner

Alabama Drought Reach (ADR)

Partnership between **Auburn University Water Resources Center** and the **Office of the State Climatologist**

Image Credit: Adam Newby

Image Credit: Liz Junod

Mission: monitor agricultural impact of drought and improve drought communications with the agricultural community

Project Objectives

1. Classify and map cover and winter crop implementation
2. Quantify soil water retention
3. Compare soil water retention across soil groups and land cover types to estimate the impact of cover and winter crops

Study Period

Alabama Percent Area in U.S. Drought Monitor Categories

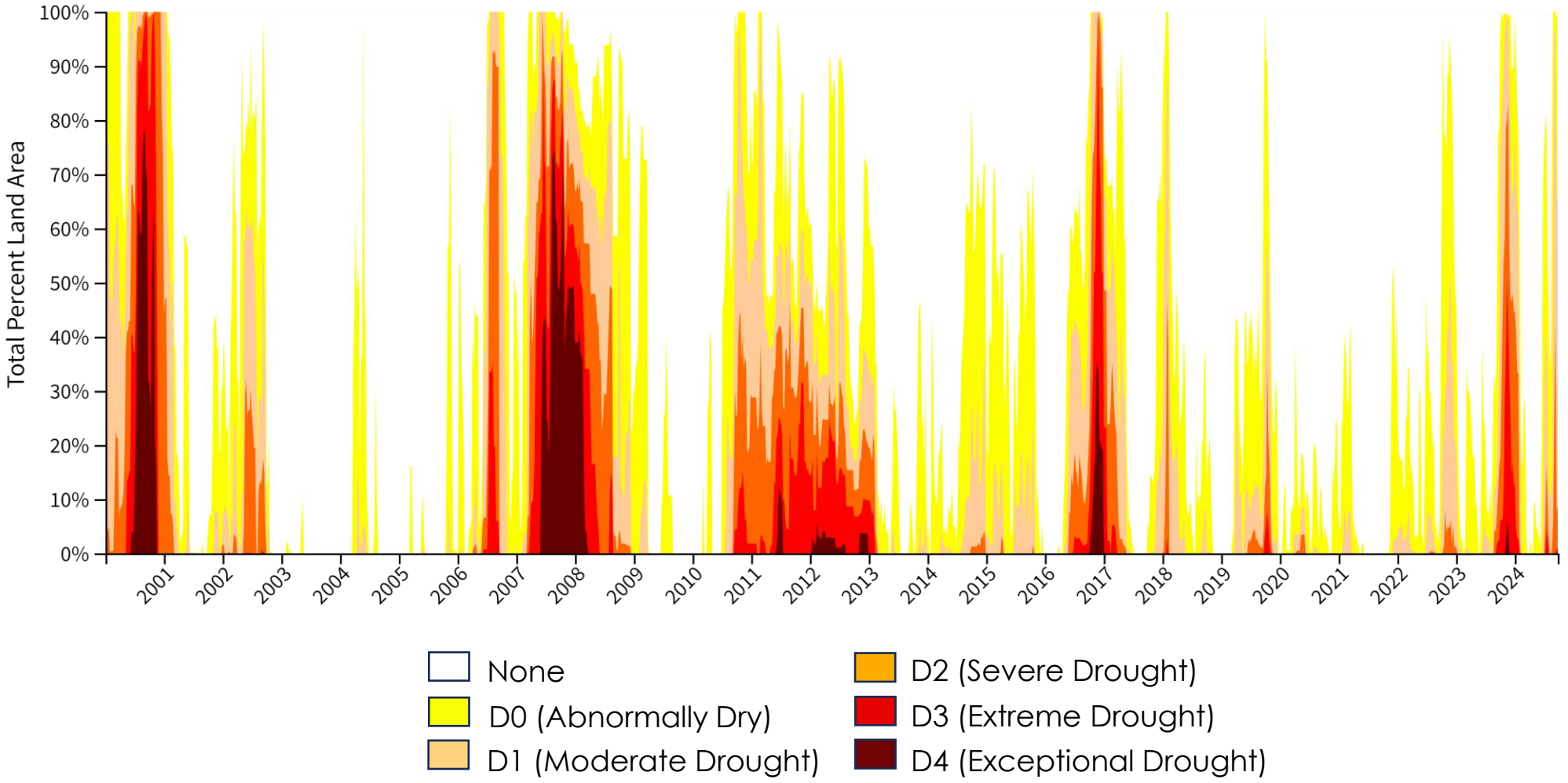


Image Credit: U.S. Drought Monitor

Study Period

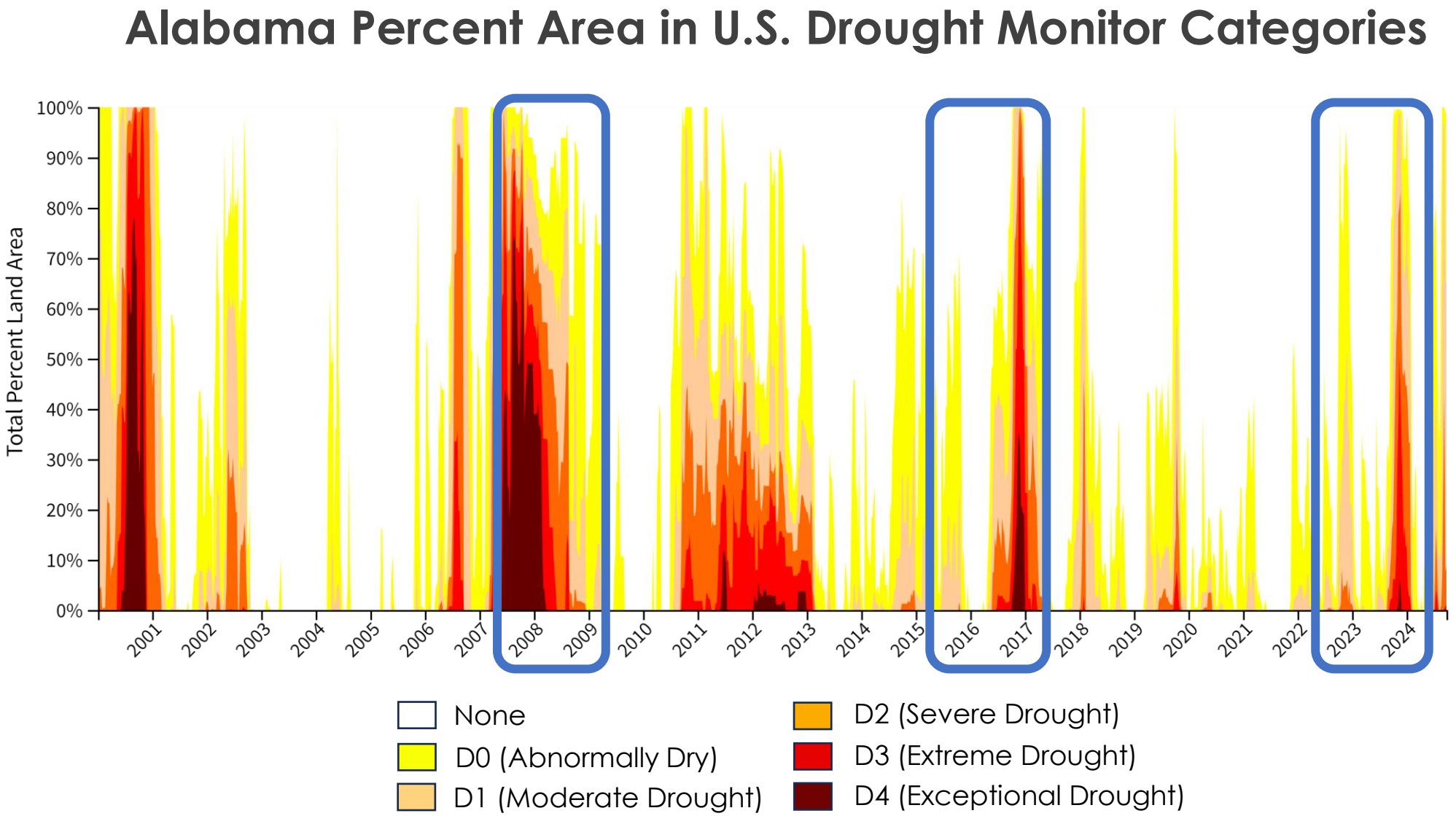
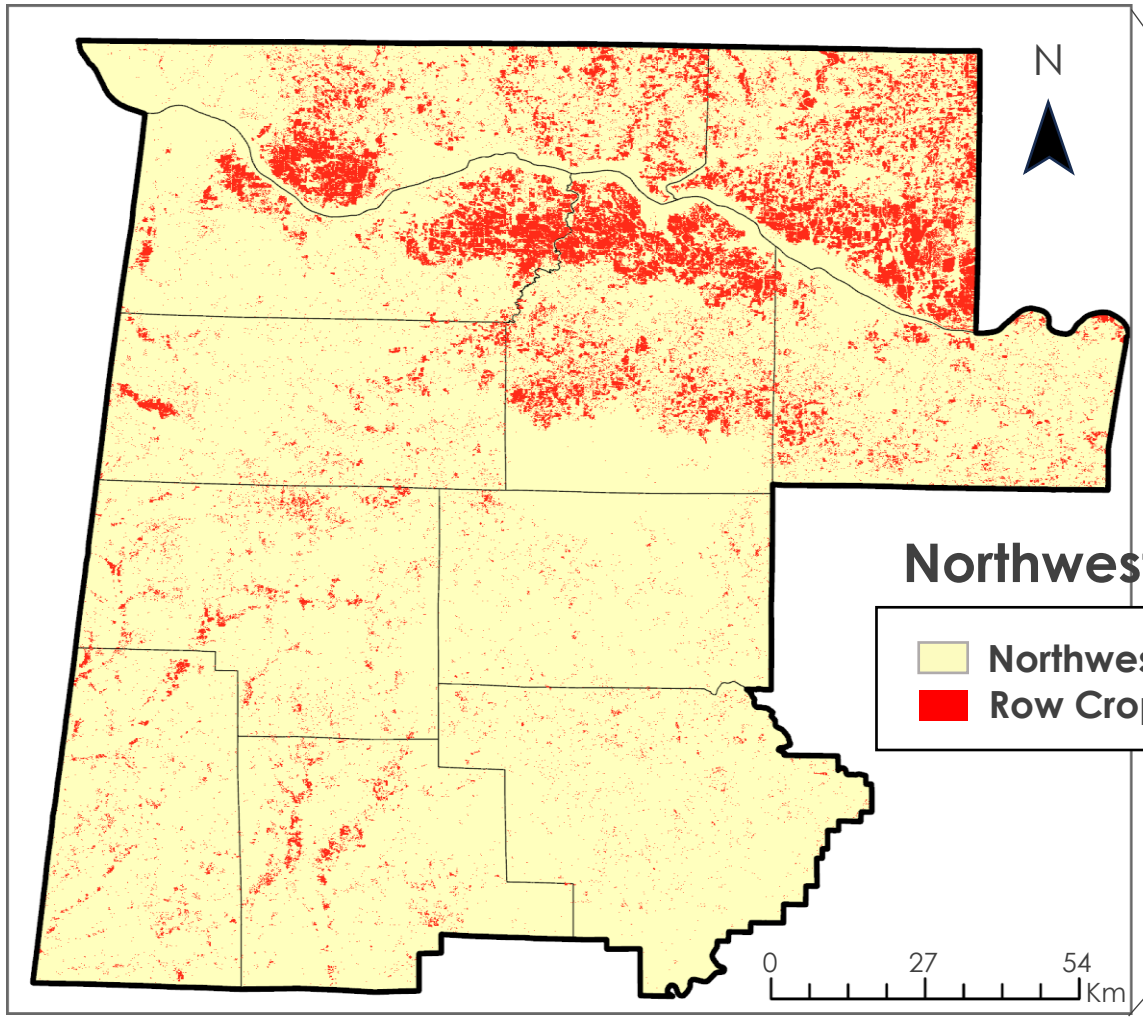


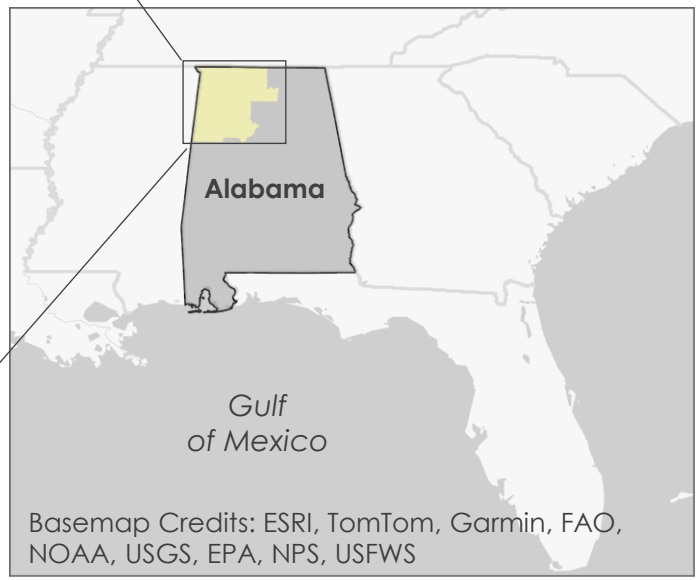
Image Credit: U.S. Drought Monitor

Study Area

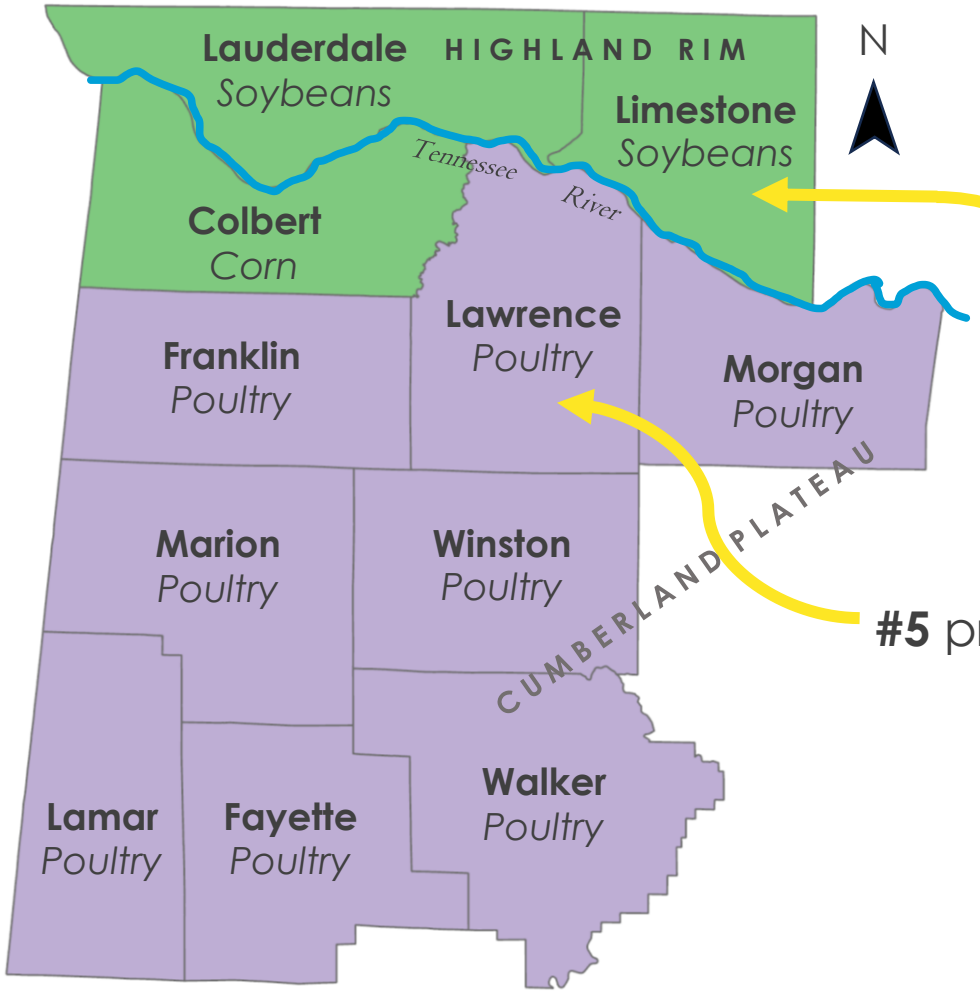


Northwest Strategic Extension Team (SET)
Alabama, USA

11 counties



Study Area



Northwest SET

Top Agricultural Commodities in Sales by County

Census of Agriculture (2022)

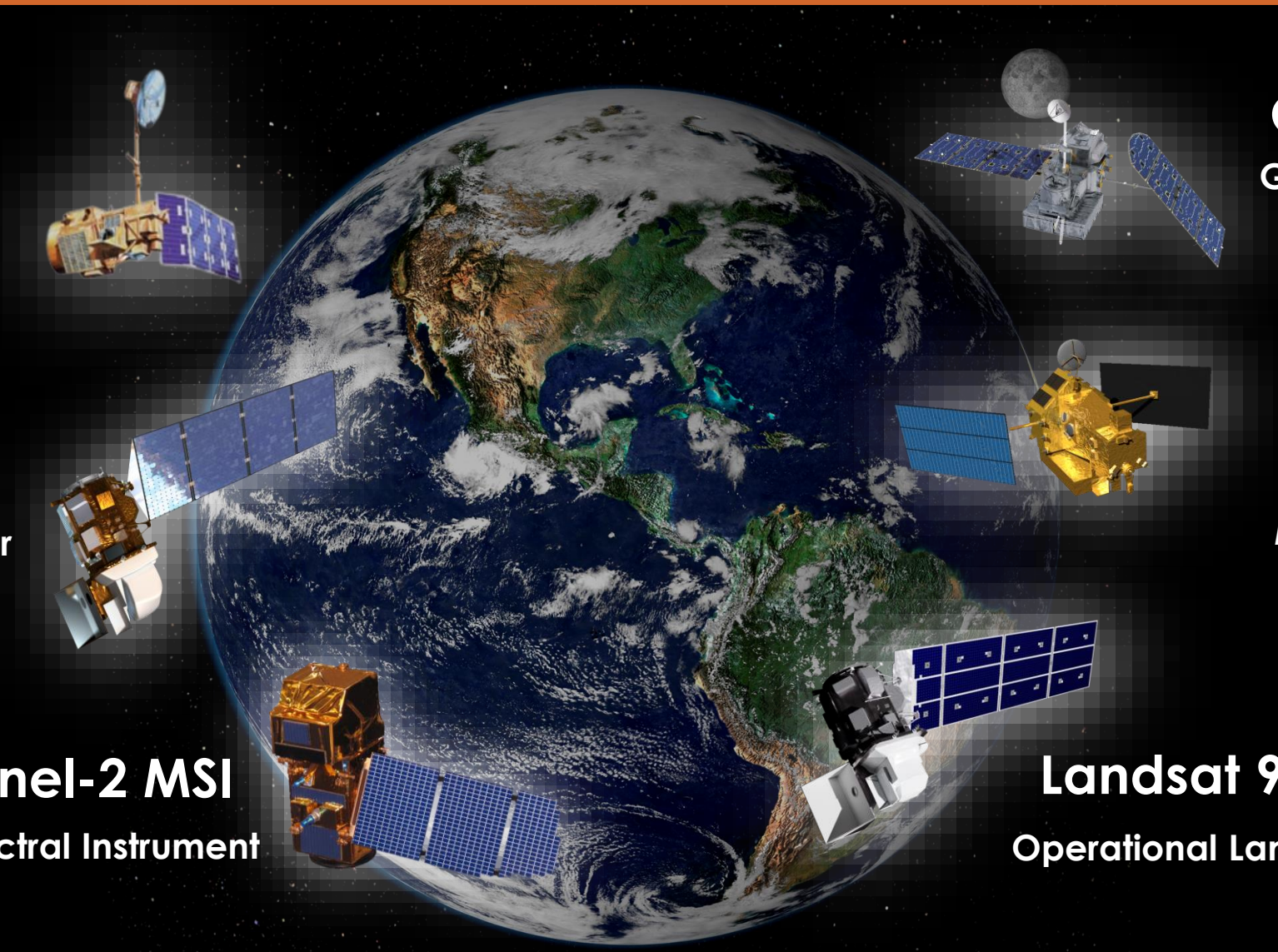
#1 producer of oilseeds, dry beans, dry peas
#3 producer of cotton in AL

#5 producer of all crops in AL

Majority Share of Sales

- Row crops
- Livestock, poultry and products

Earth Observations



Landsat 5 TM
Thematic Mapper

GPM-IMERG
Global Precipitation Measurement

Landsat 8 OLI
Operational Land Imager

TRMM
Tropical Rainfall Measuring System

Sentinel-2 MSI
MultiSpectral Instrument

Landsat 9 OLI-2
Operational Land Imager-2

Image Credits: NASA Landsat Science Outreach Team, NASA GSFC, Rama, Reto Stöckli, Nazmi El Saleous, Marit Jentoft-Nilsen

Methods Overview

Winter & Cover Crop Mask

Utilizing Harmonized Landsat Sentinel-2 & Landsat 5 TM

ArcGIS Pro

Extract Crop Mask

Jupyter Hub

Normalized Difference Vegetation Index (NDVI)

ArcGIS Pro

Apply NDVI Threshold

Winter & Cover Crops

Water Retention Package

Utilizing GPM-IMERG

ArcGIS Pro

Land Cover Curve Numbers

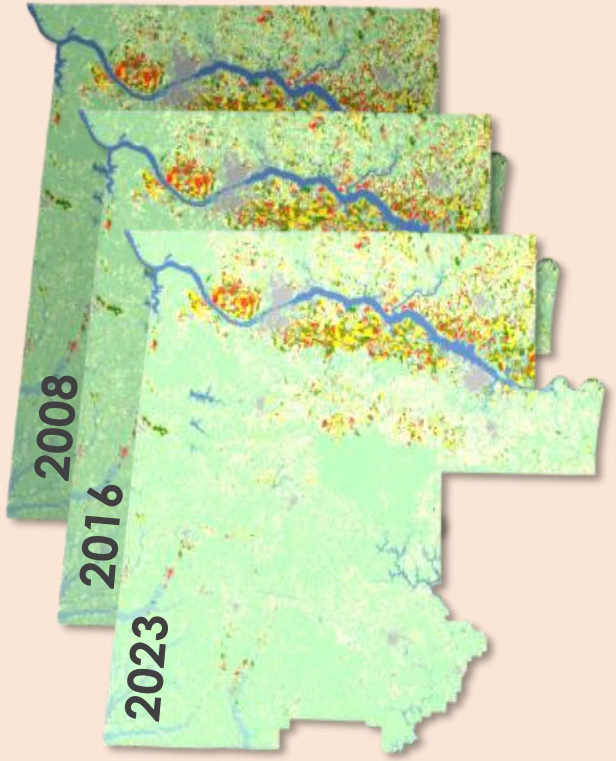
ArcGIS Pro

Precipitation

Water Retention Calculation

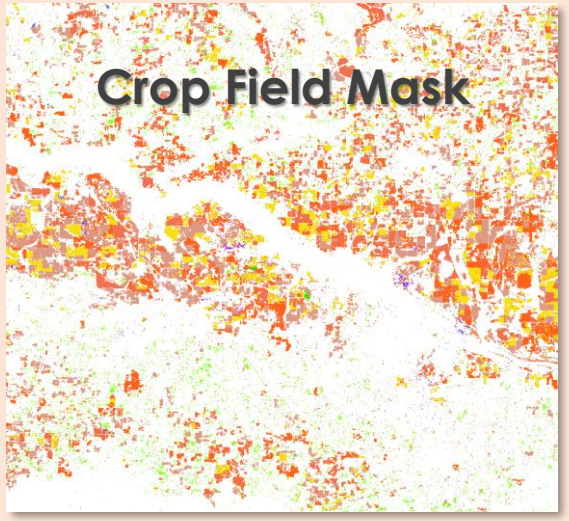
Methods: Winter & Cover Crop Map

USDA Cropland Data Layer

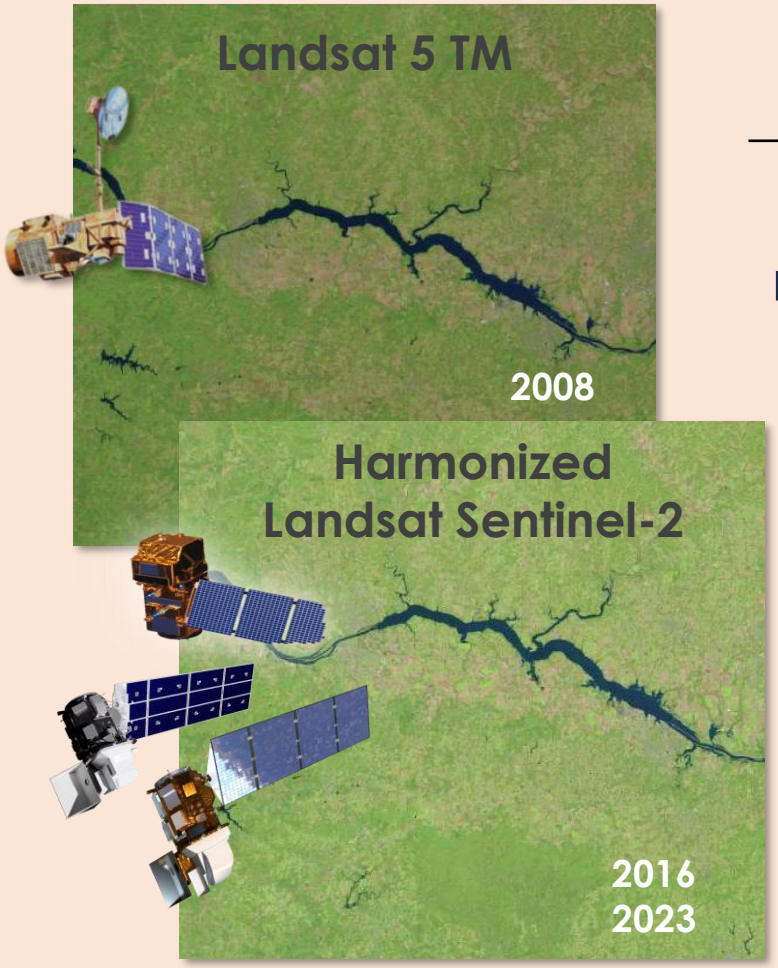


Code	Crop
62	Pasture / Grass
63	Forest
64	Shrubland
65	Barren
68	Apples
71	Other Tree Crops
72	Citrus
77	Pears
83	Water
92	Aquaculture

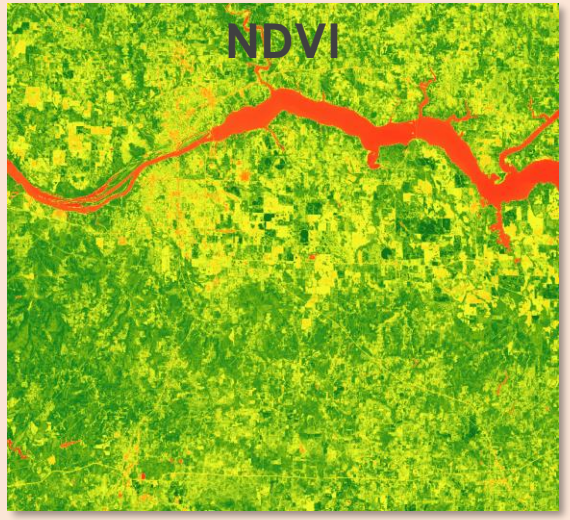
*Crop Field **Exclusion** Sample*



Methods: Winter & Cover Crop Map



$$\frac{NIR - Red}{NIR + Red}$$



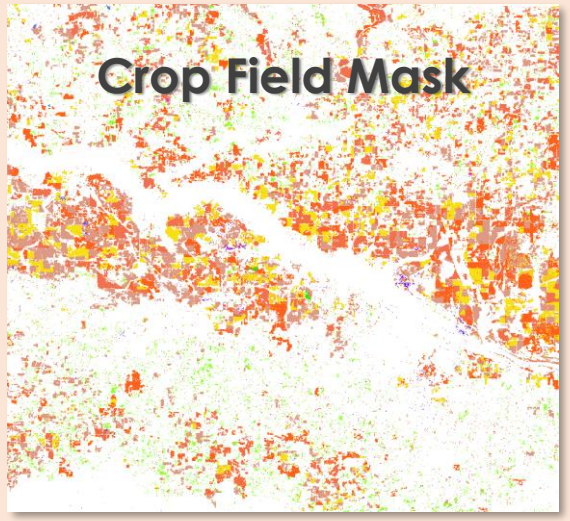
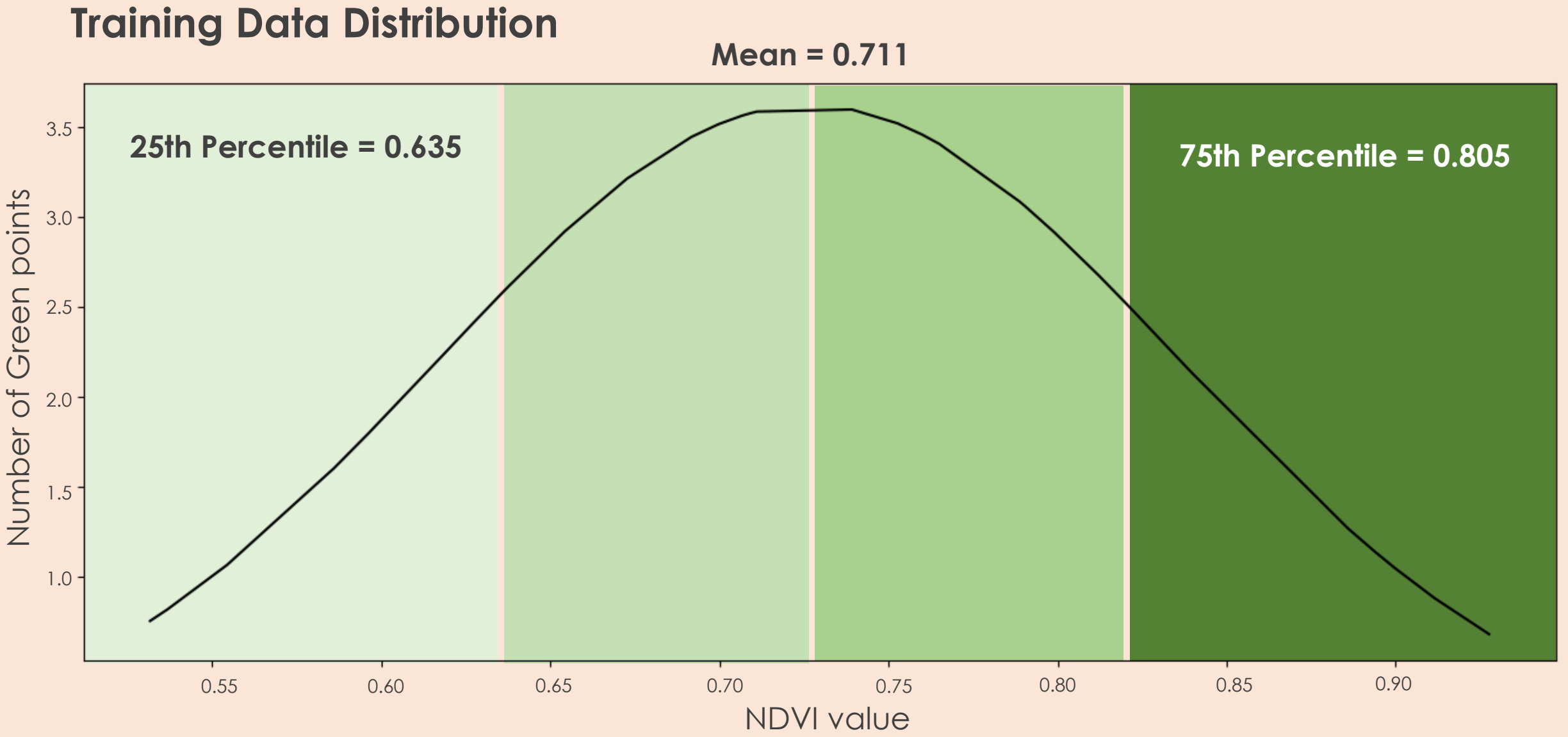


Image Credit: NASA, ESA

Methods: Calculating NDVI Threshold

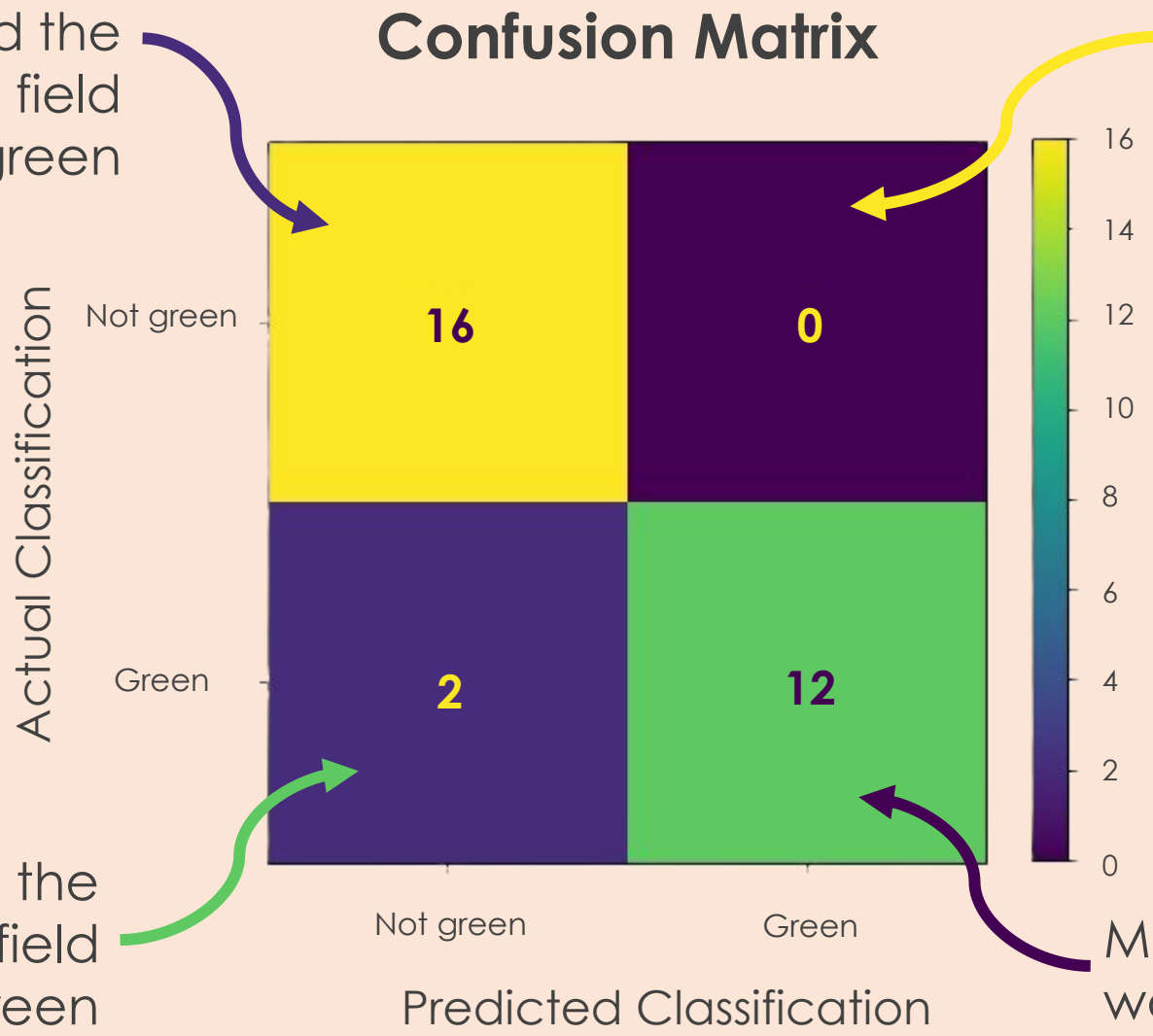


Methods: Testing Our NDVI Threshold

Model predicted the field was not green, field **was not** green

Model predicted the field was green, field **was not** green

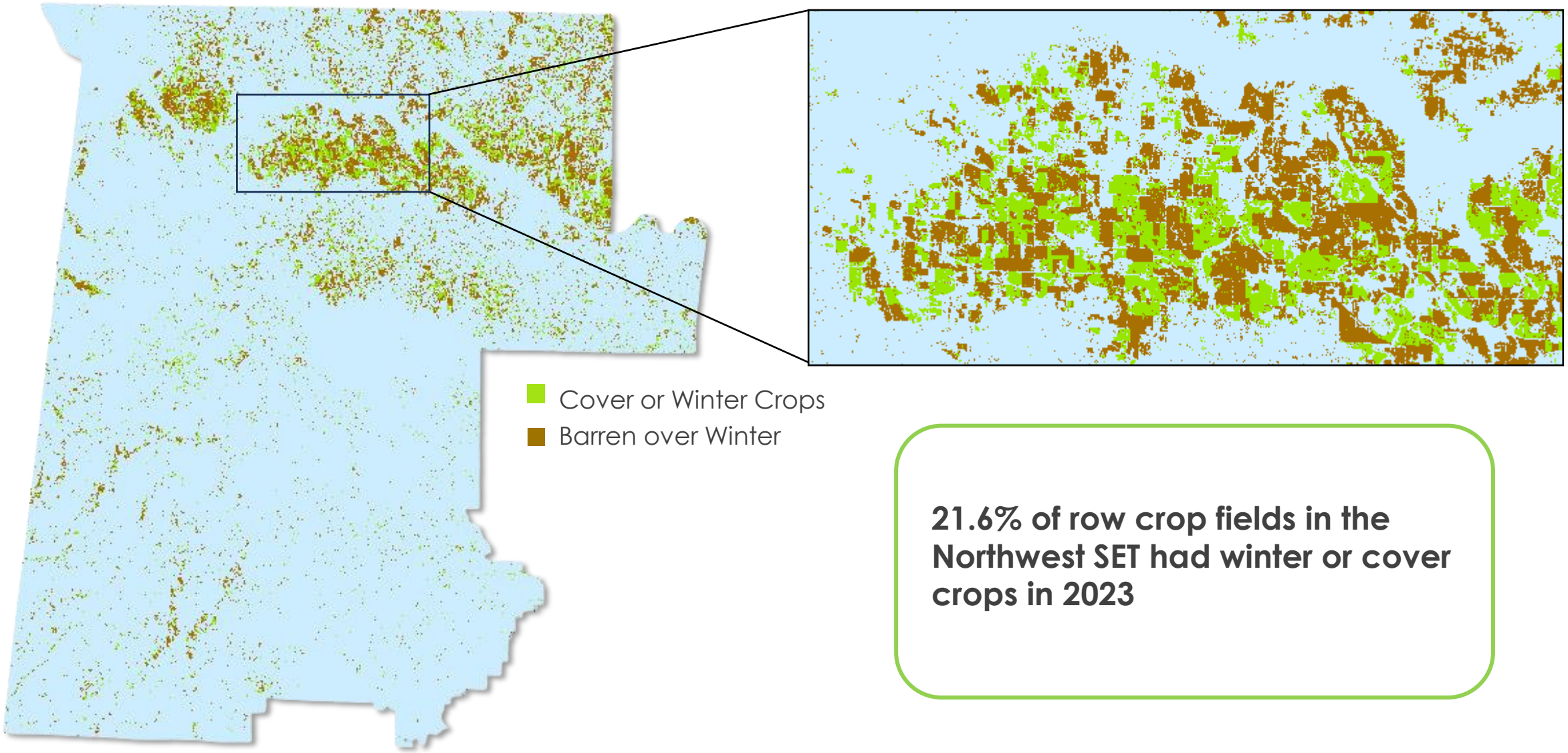
93% accuracy
(28/30)



Model predicted the field was not green, field **was** green

Model predicted the field was green, field **was** green

Results: Winter and Cover Crop Map



21.6% of row crop fields in the Northwest SET had winter or cover crops in 2023

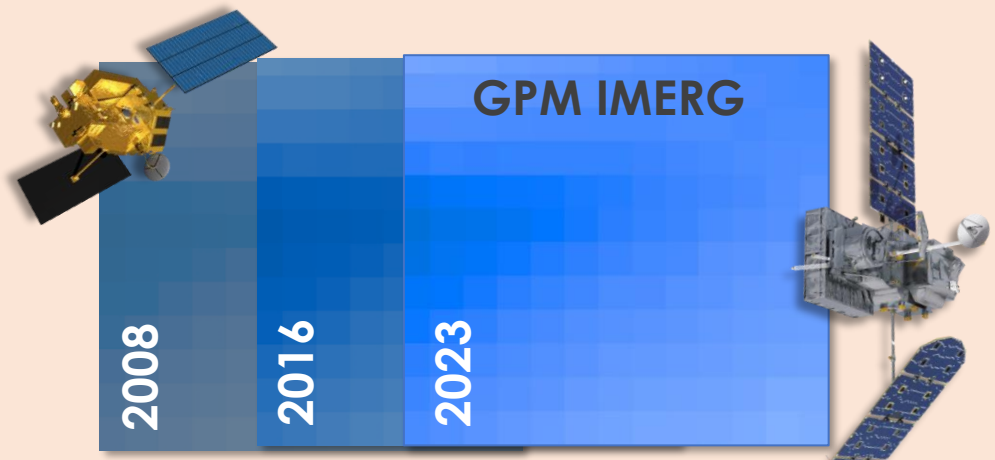
Methods: Water Retention Analysis

Cover Crop
Cover
No Cover

Soil Group
A
B
C
D

Curve Number (CN)				
NLCD 2019	Hydrologic Soil Group			
Land Use Description	**A**	**B**	**C**	**D**
Barren Land (Rock/Sand/Clay)	78	86	91	93
Grassland/Herbaceous	50	69	79	84

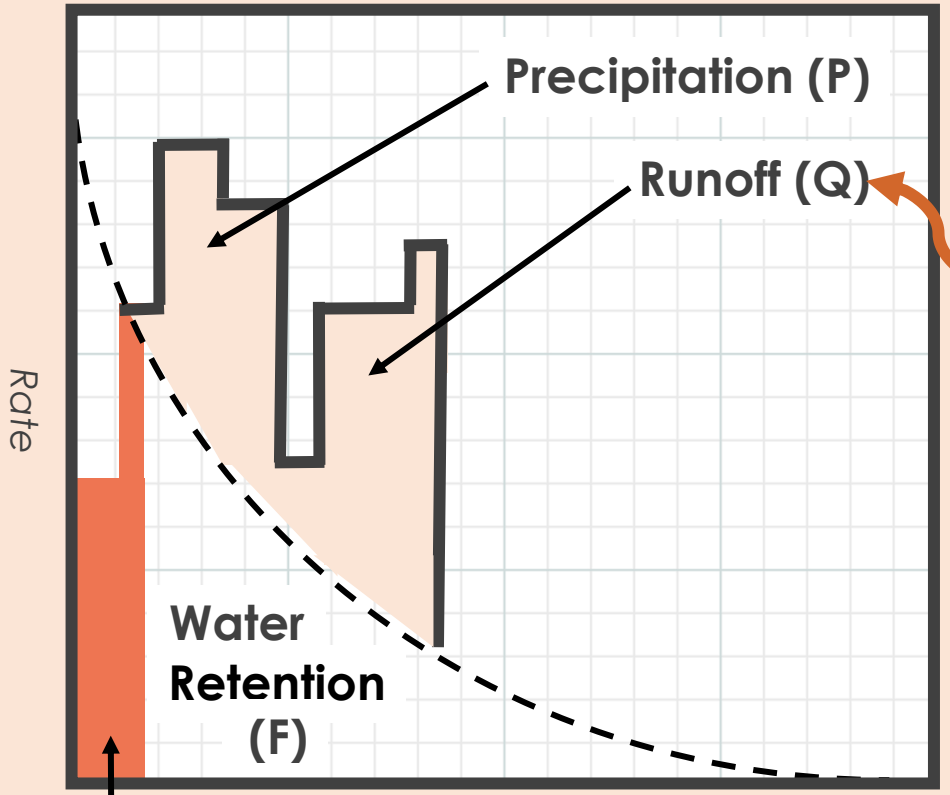
Methods: Water Retention Analysis



Precipitation (P)

Curve Number (CN)

Soil Conservation Service Curve Number Method



Takes the **Curve Number** as an input

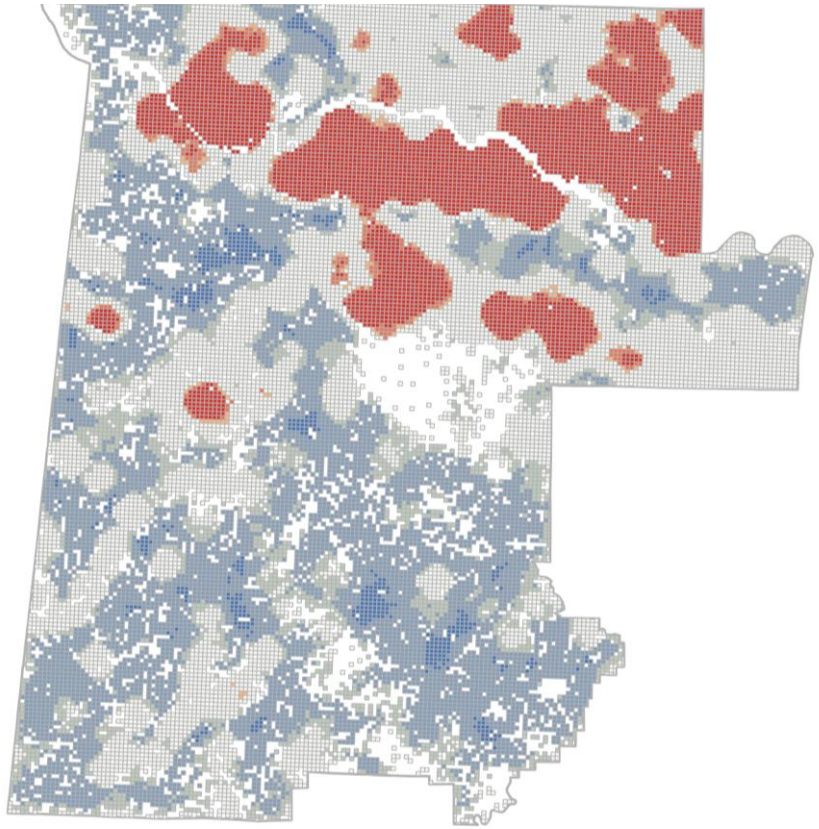
Initial Abstraction (Ia)

Takes the **Curve Number** as an input

Image Credit: NASA

Results: Hot Spot Analysis (2023)

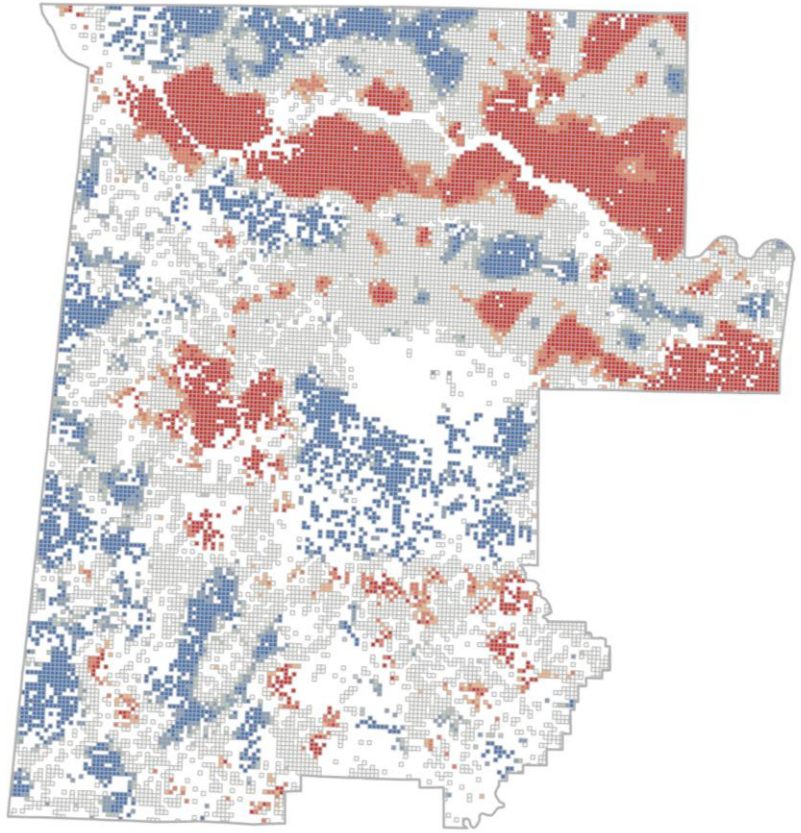
Cover & Winter Crop Hot Spots
(Area, m)



Hot Spot with 99% Confidence
Hot Spot with 95% Confidence
Hot Spot with 90% Confidence
Not Significant
Cold Spot with 90% Confidence
Cold Spot with 95% Confidence
Cold Spot with 99% Confidence

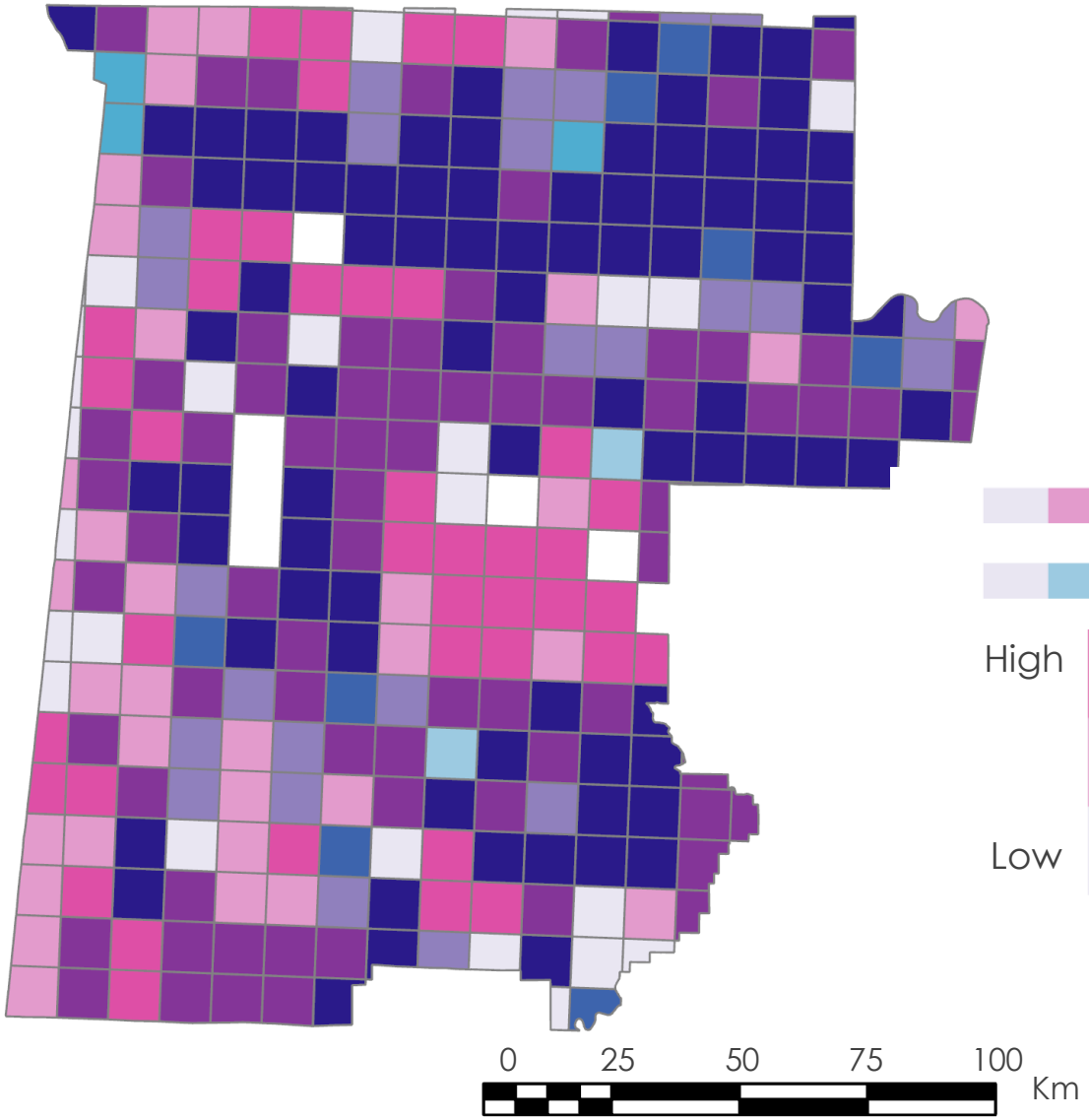
Km
0 25 50 75 100

Water Retention Hot Spots
(Avg., mm/day)

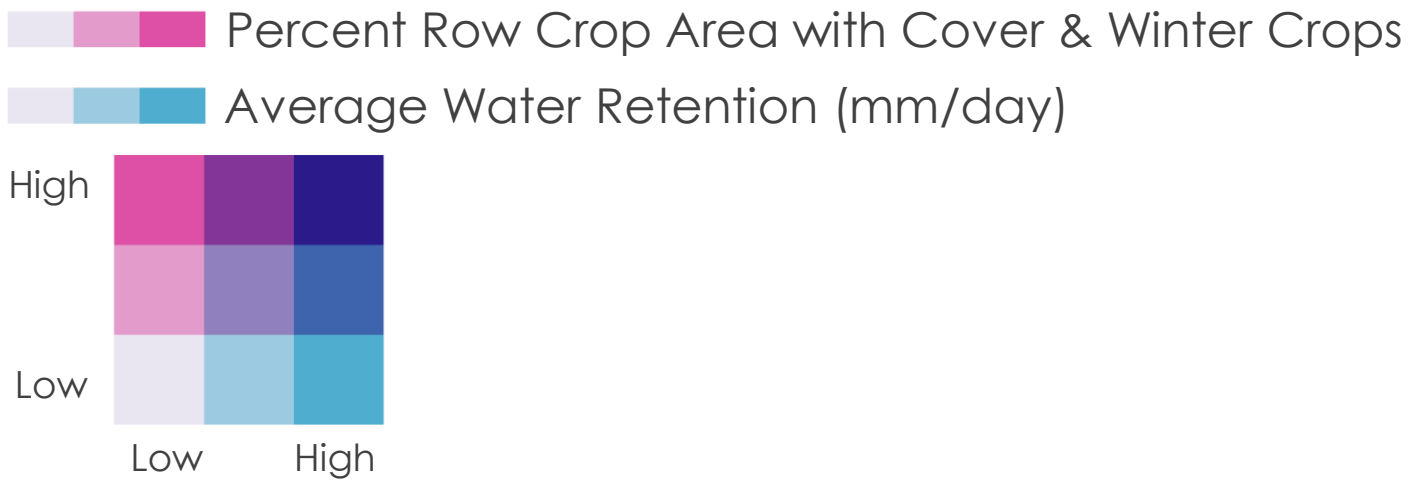


Km
0 25 50 75 100

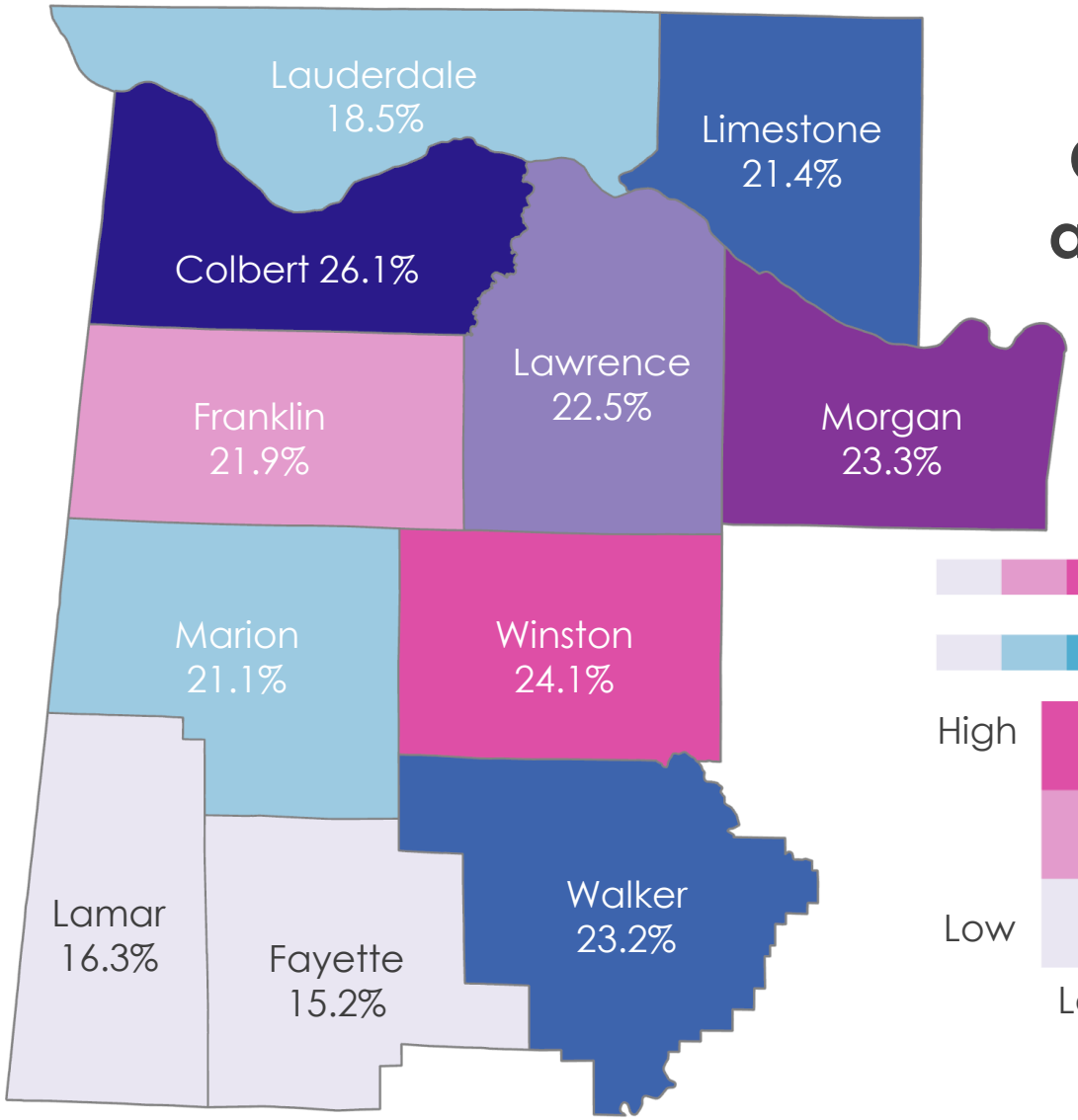
Results: 10km-level Analysis (2023)



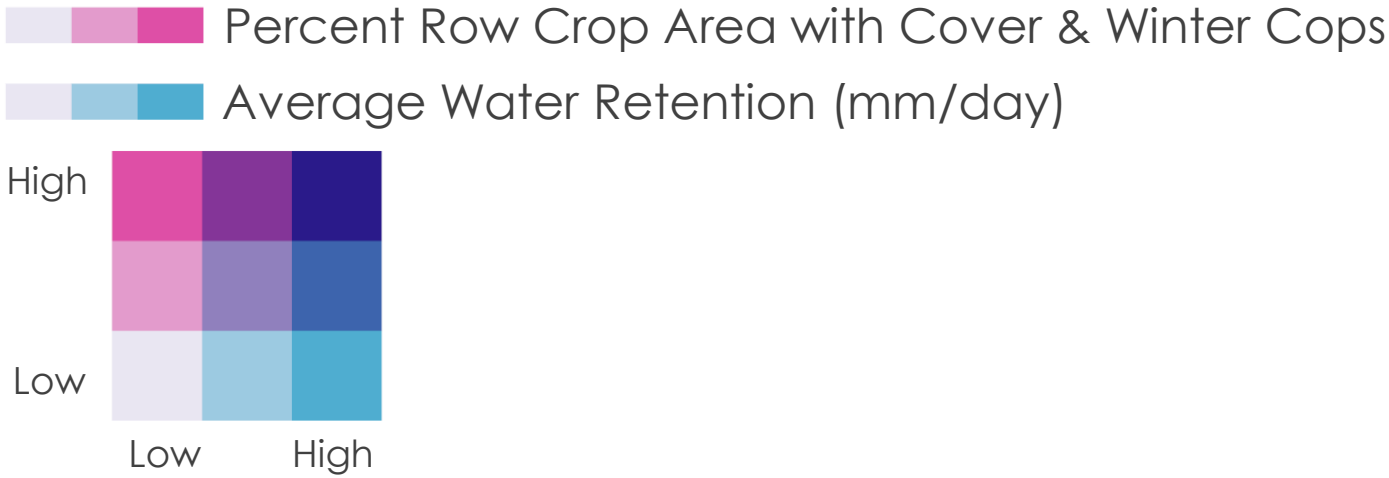
Cover & Winter Crop Adoption Rate (%) and Average Water Retention (mm/day)



Results: County-level Analysis (2023)

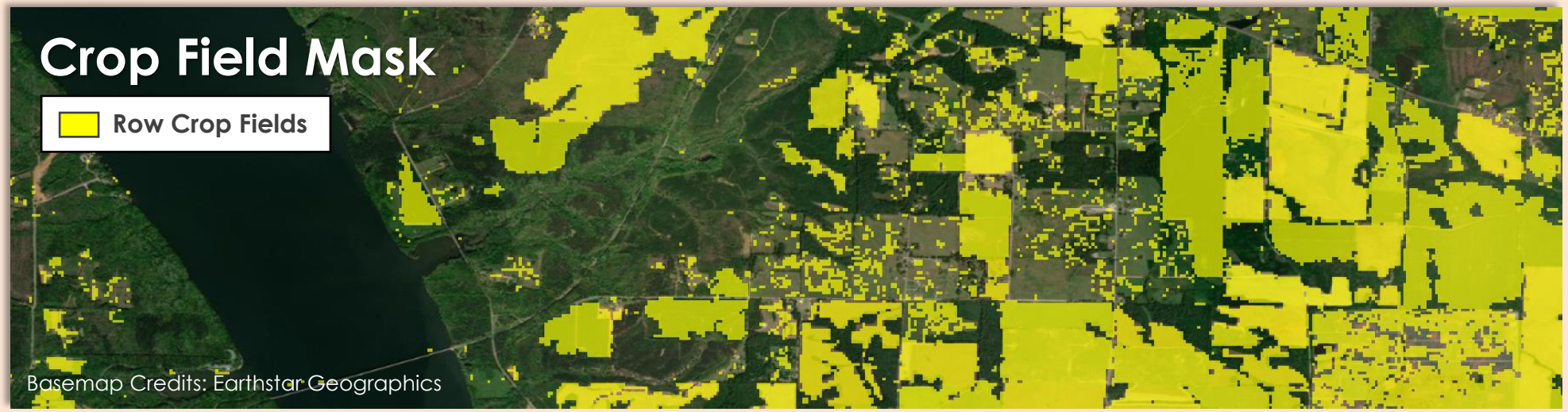


Cover & Winter Crop Adoption Rate (%) and Average Water Retention (mm/day) by County



Errors and Uncertainties

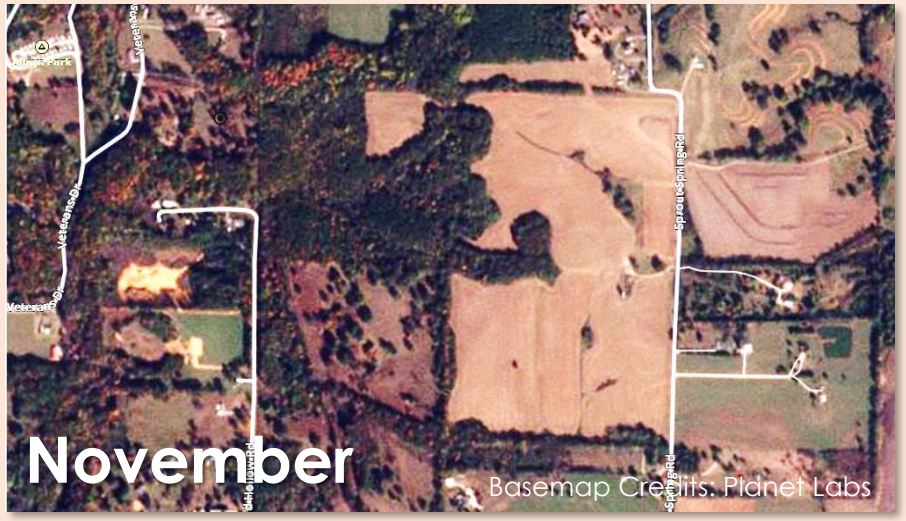
CDL Accuracy (80%)



False Positives: Weeds

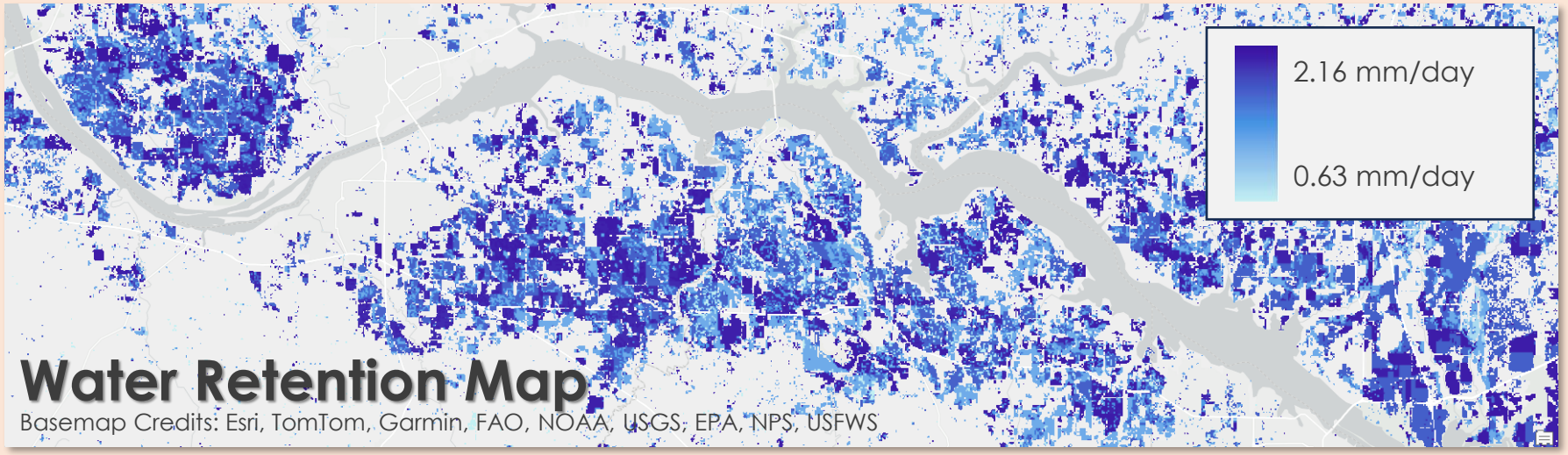
Image Credits: Margaret Barse & Bruce Dupree, Alabama Extension

Errors and Uncertainties



Human Error: Visual Identification

Curve Number Inefficiencies

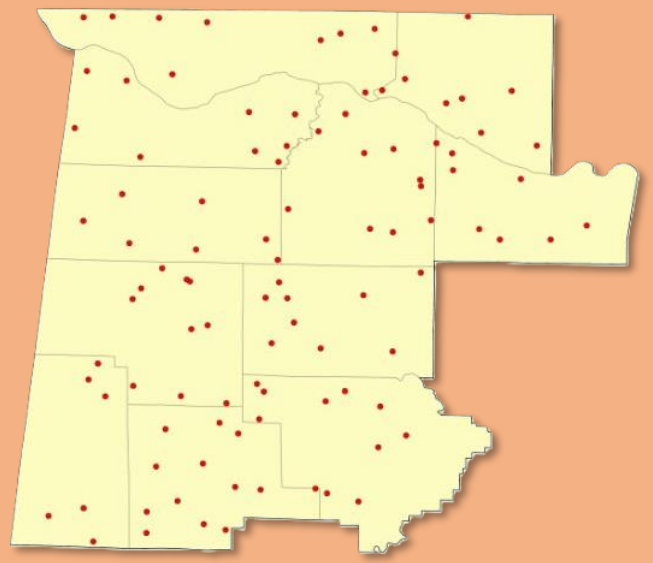


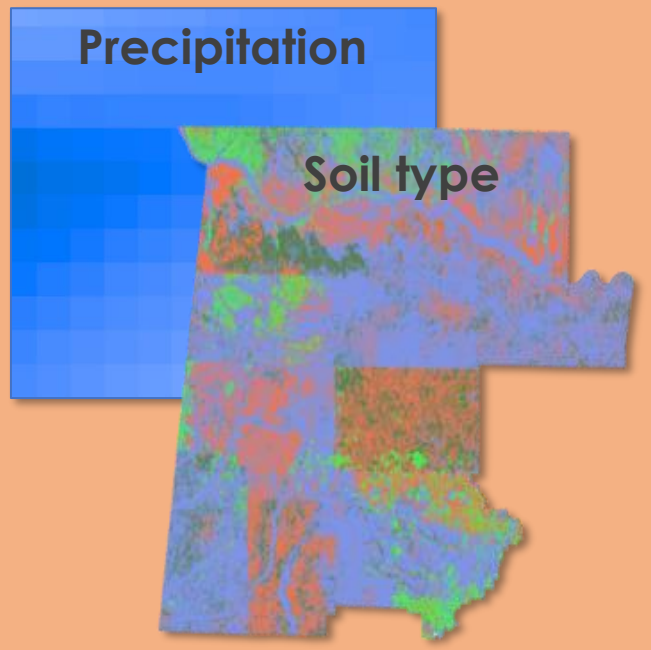
Limitations

Basemap Credits: Planet Labs

Ground-truth data for validation

Spatial extent





Water retention calculation parameters

Future Considerations

Future work should focus on

- Investigating other SET regions in Alabama
- Attaining ground-truth points
- Assessing the impact of increased water retention
- Communicating water retention benefits

Alabama Drought Reach

Further studies should consider

- Time series approach to differentiate between winter and cover crops
- More robust water infiltration equations and parameters
- Machine learning classification

DEVELOP

Conclusions

- Utilizing NASA Earth observation data provided a **feasible and scalable** approach for monitoring cover and winter crop **implementation and effectiveness**
- Cover and winter crops were **significantly adopted** across row crop fields in our study area, with some counties showing **higher adoption rates** such as **Colbert County**
- Fields with cover and winter crops showed **improved water retention**
- Soil health and water retention can be enhanced by cover and winter crops, providing a **strategy for drought mitigation**

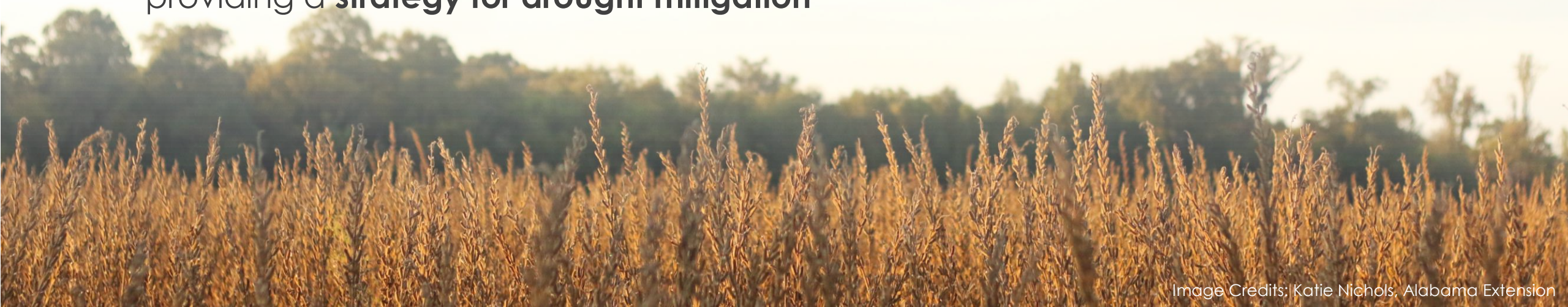


Image Credits: Katie Nichols, Alabama Extension

Acknowledgments

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Marisa Smedsrud (Maryland – Goddard)

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