



IOWA AGRICULTURE & FOOD SECURITY

Assessing Drought-Induced
Vegetation Stress and its Impact on
Crop Production Across Iowa

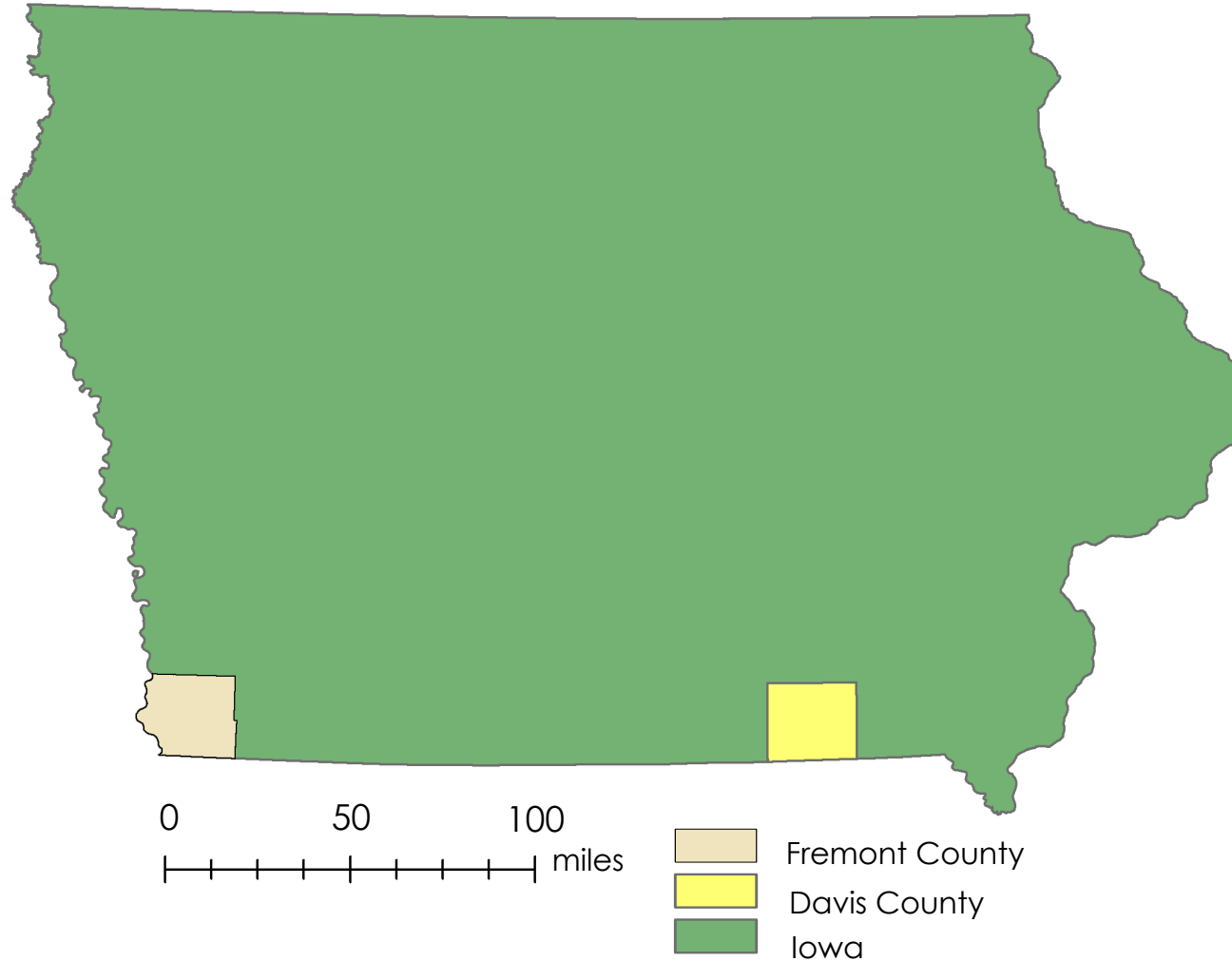
Brittany Greene

Audrieauna Beatty

Abigail Whiteside



Project Overview



Study Area:
Iowa

Case Studies:
Davis and Fremont Counties

Study Period:
July – September 2018

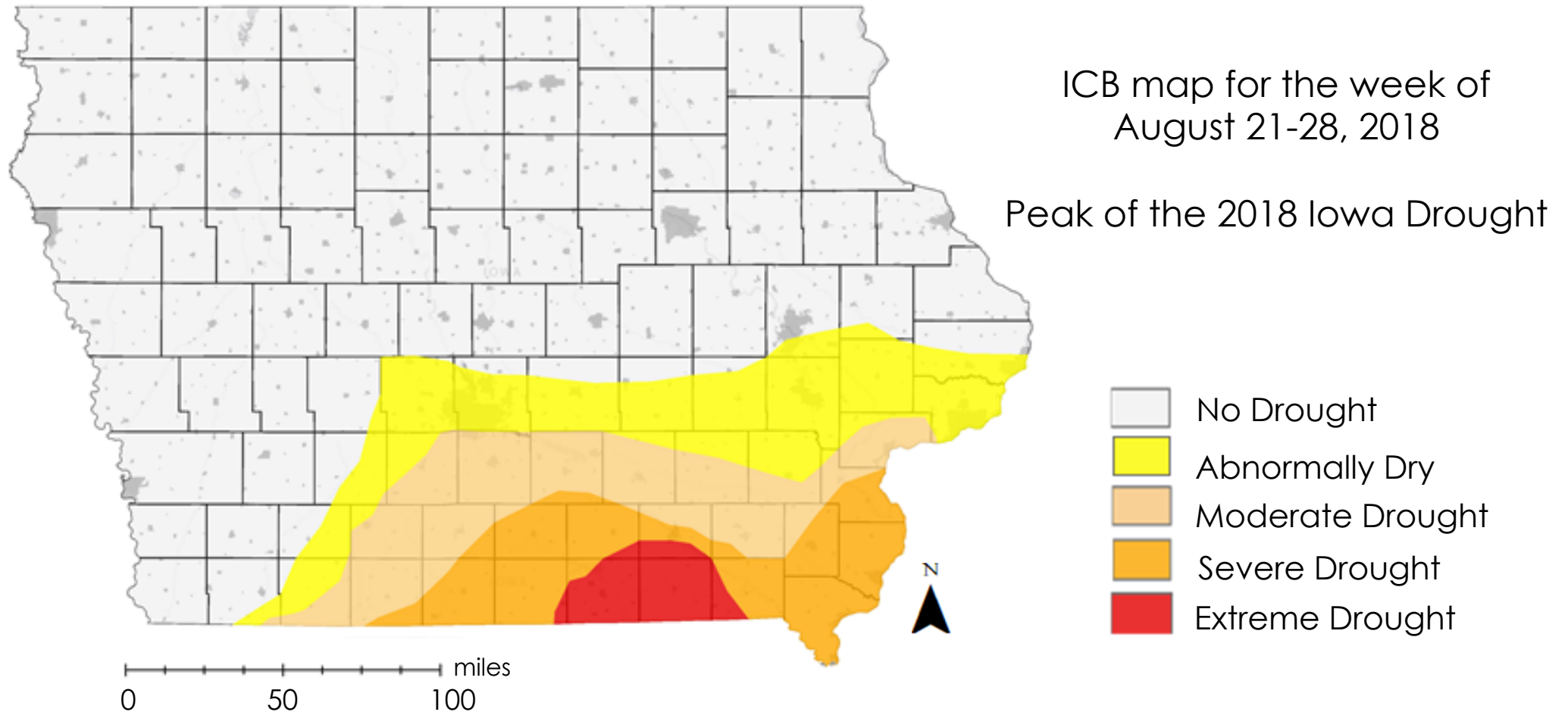
Community Concerns

- ▶ 92% of land in Iowa is dedicated to agriculture, and **27% of Iowa's economy is dependent on agriculture**
- ▶ Drought costs an average of **\$9.4 billion per drought** event
- ▶ Corn yield per acre **decreased 20% from 2011 to 2012** from drought-induced vegetative stress
- ▶ **Increasing dependence on the state's aquifers** for irrigation



Project Partner

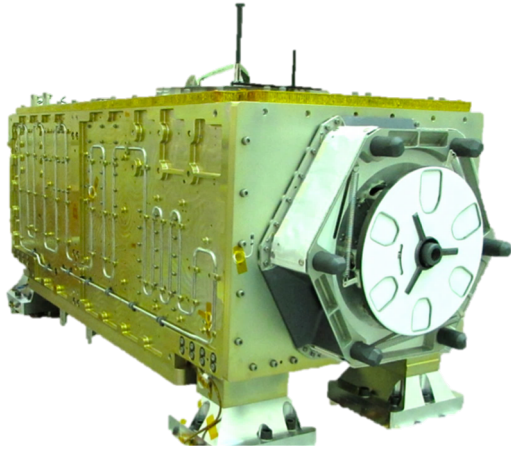
Iowa Climatology Bureau (ICB)
Iowa Department of Agriculture and Land Stewardship



Project Objectives

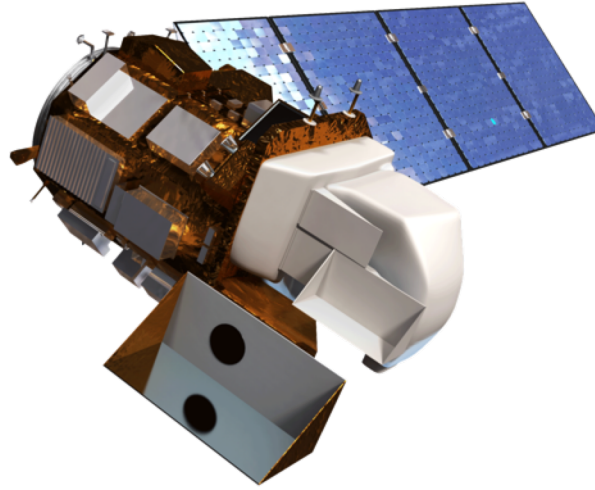
- ▶ **Compare** current drought monitoring methods with new techniques using International Space Station ECOsystem Space-borne Thermal Radiometer Experiment on Space Station Evaporative Stress Index (ISS ECOSTRESS ESI) and Atmosphere-Land EXchange Inverse (ALEXI) ESI
- ▶ **Analyze** the differences between ISS ECOSTRESS ESI and ALEXI ESI to determine the added value to using an ESI product in drought monitoring methods

Earth Observations



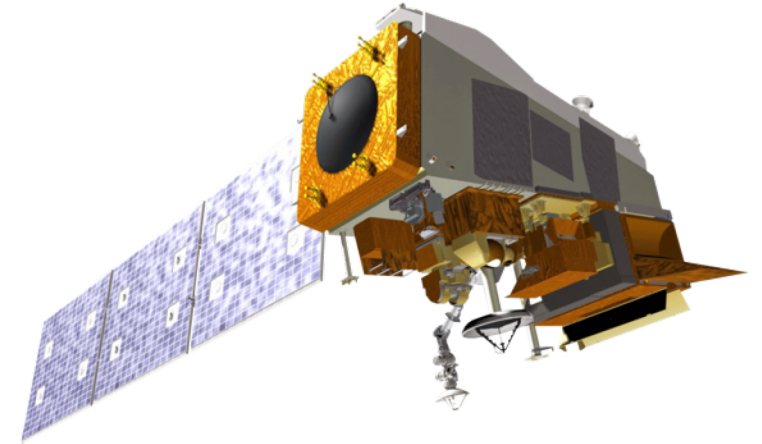
ISS ECOSTRESS ESI

- ▶ Evaporative Stress Index
- ▶ Spatial Resolution:
38 x 68 m
- ▶ Repeat Cycle: 3 days



Landsat 8 TIRS

- ▶ Land Surface Temperature
- ▶ Spatial Resolution:
100 m
- ▶ Repeat cycle: 16 days

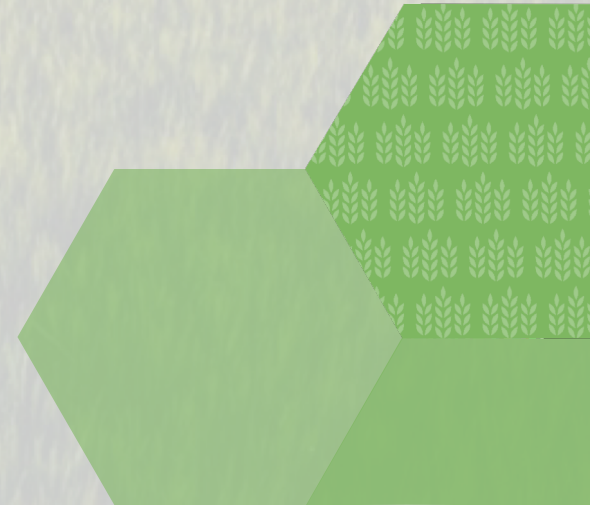


Suomi NPP VIIRS

- ▶ Land Surface Temperature
- ▶ Spatial Resolution:
750 m
- ▶ Repeat Cycle: 16 days

Ancillary Datasets

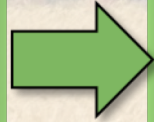
- ▶ **ALEXI ESI** – to conduct statewide analysis of drought
- ▶ **Multi-Radar/Multi-Sensor System (MRMS)** – to provide precipitation measurements for the statewide drought analysis
- ▶ **Land Information System (LIS) Soil Moisture 0-10cm** – to supply soil moisture measurements for statewide drought analysis
- ▶ **ICB maps** – to compare current methods with ESI products



Methodology

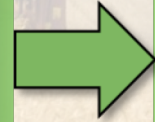
Data Acquisition

- ▶ Landsat 8 TIRS
- ▶ Suomi NPP VIIRS
- ▶ ALEXI ESI
- ▶ ISS ECOSTRESS ESI
- ▶ MRMS Precipitation
- ▶ NASA LIS Soil Moisture



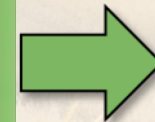
Data Processing

- ▶ Calculate Land Surface Temperature
- ▶ Calculate average precipitation and soil moisture values
- ▶ Clip and project data over Iowa



Data Analysis

- ▶ Fuzzy Logic
- ▶ Percent Difference

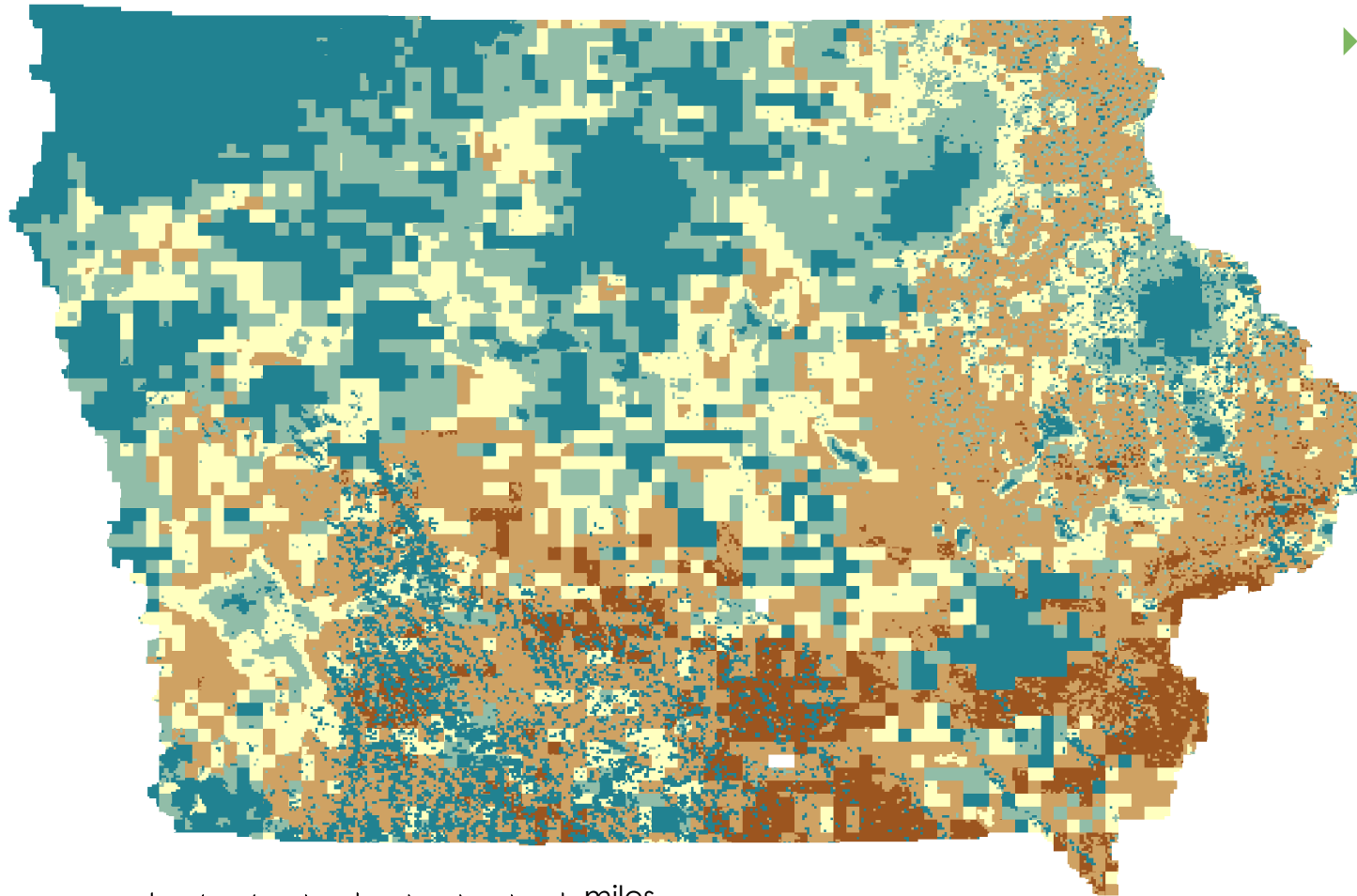


End Products

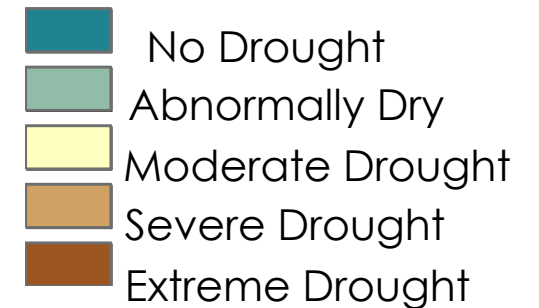
- ▶ ALEXI ESI Drought Assessment
- ▶ ISS ECOSTRESS ESI Drought Assessment
- ▶ Comparative Drought Assessment

ALEXI ESI Statewide Drought Analysis:

One Week Before Peak Drought, August 12-18, 2018



► 14% of Iowa was under Extreme Drought

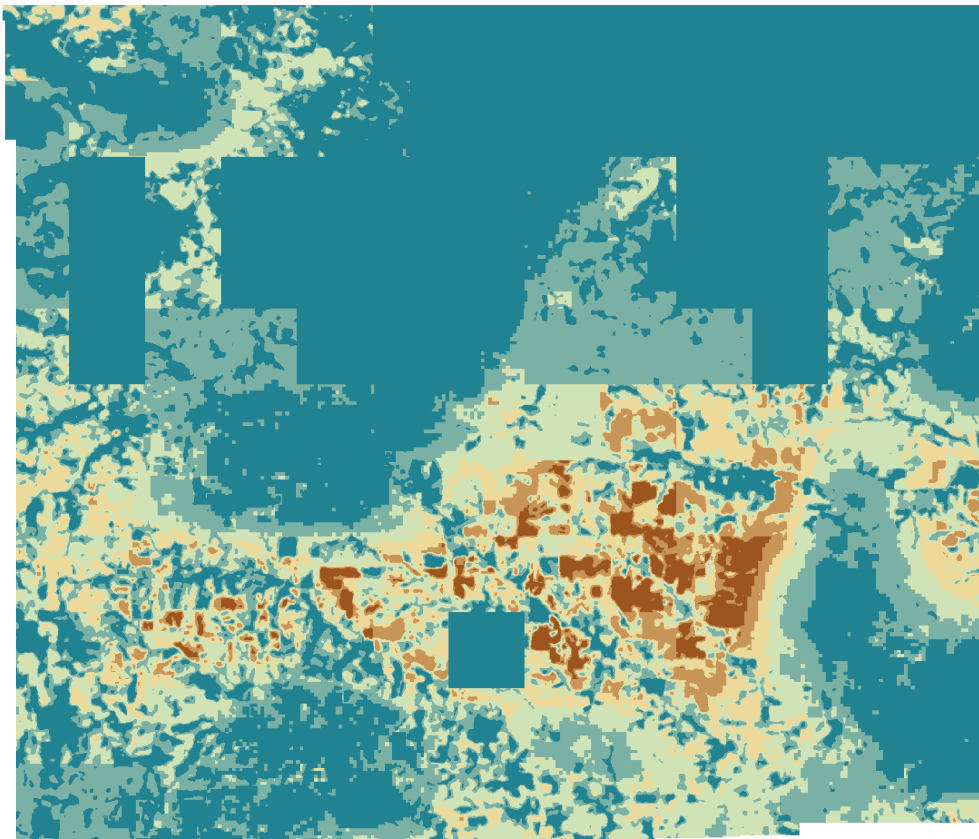


0 50 100 miles

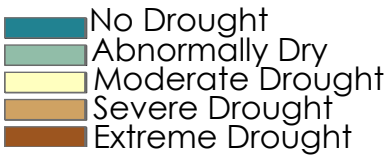
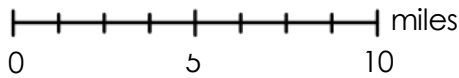
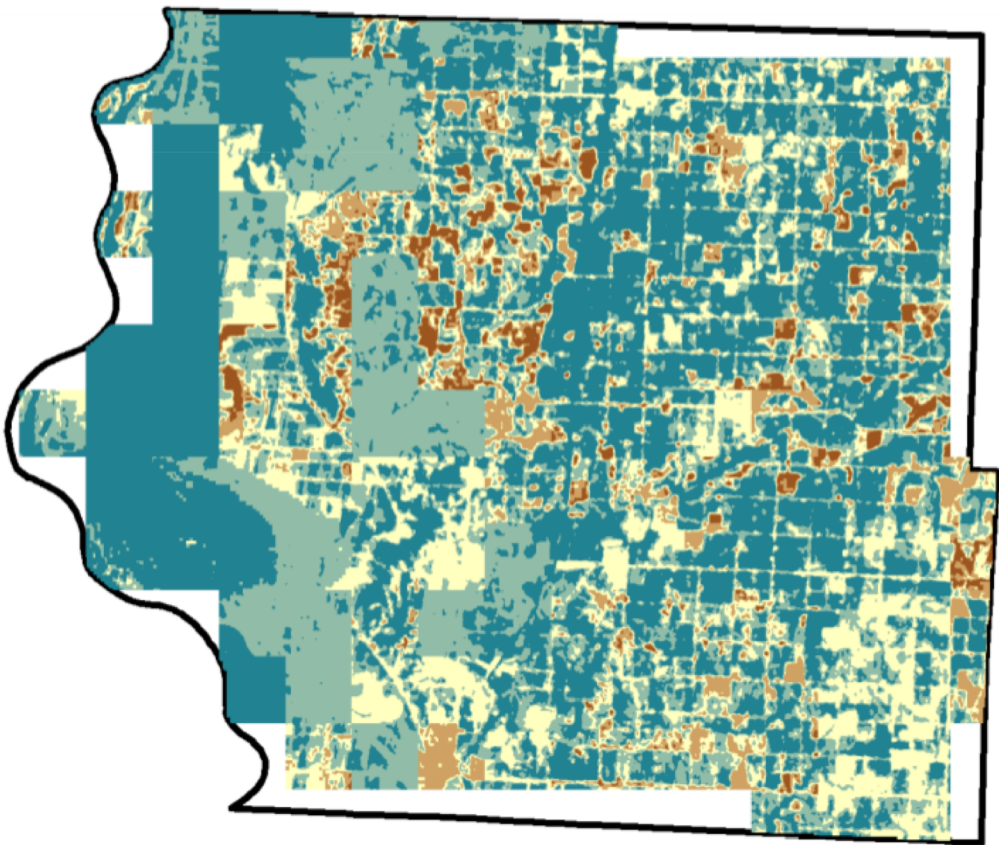
ECOSTRESS ESI County Drought Analysis

One Week Before Peak Drought, August 12-18, 2018

Davis County



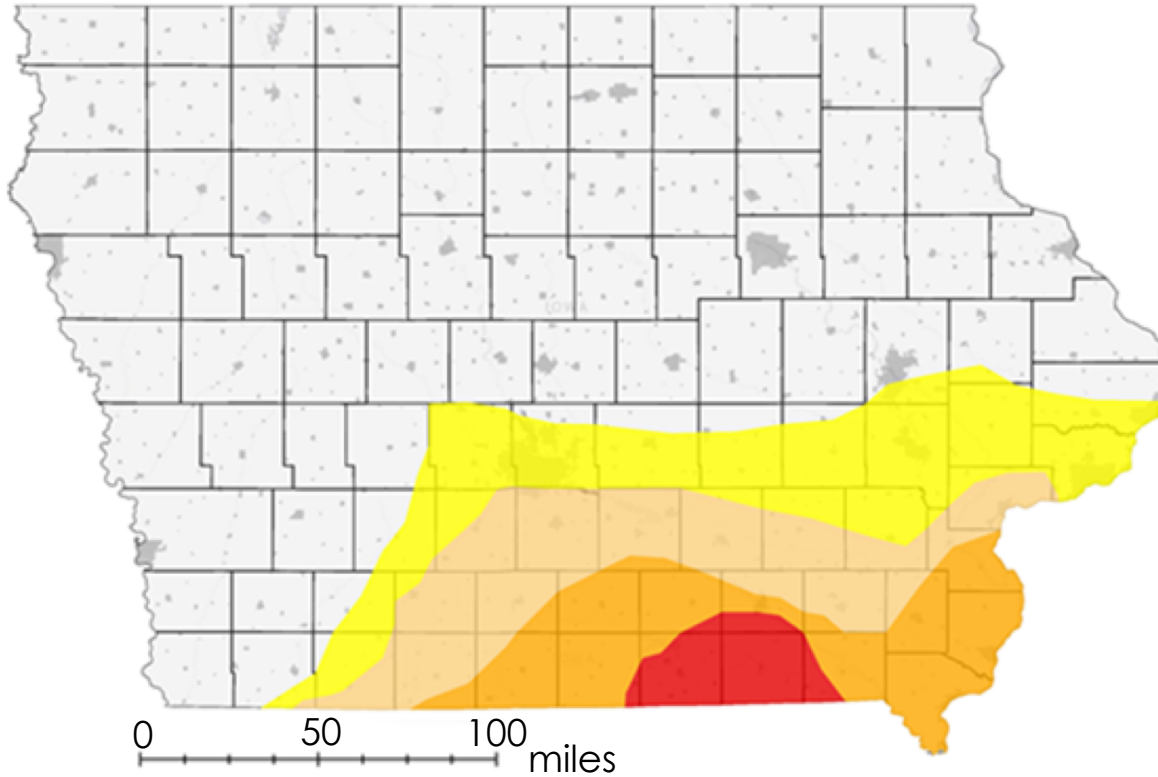
Fremont County



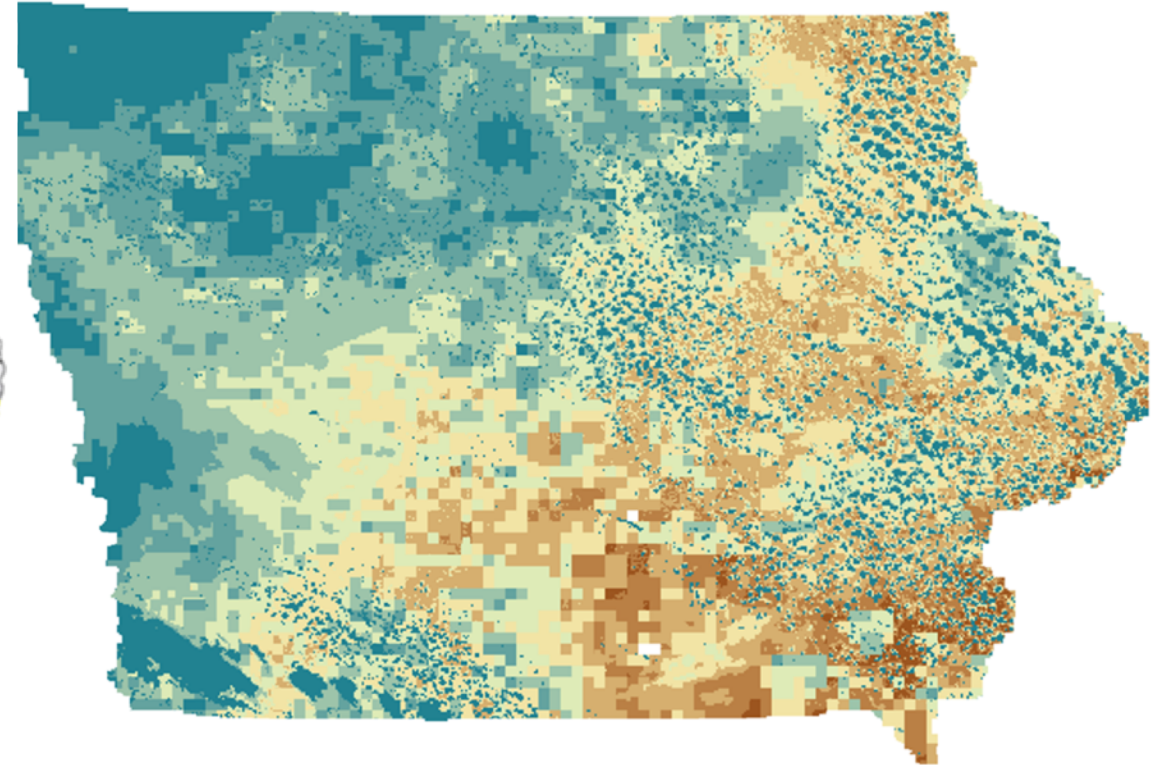
Results: ICB vs ALEXI ESI Comparison

Week of Peak Drought, August 19-25, 2018

ICB Map

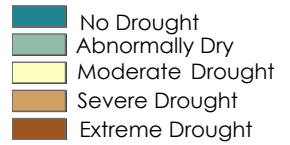
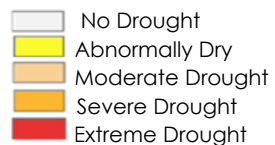


ALEXI ESI Map



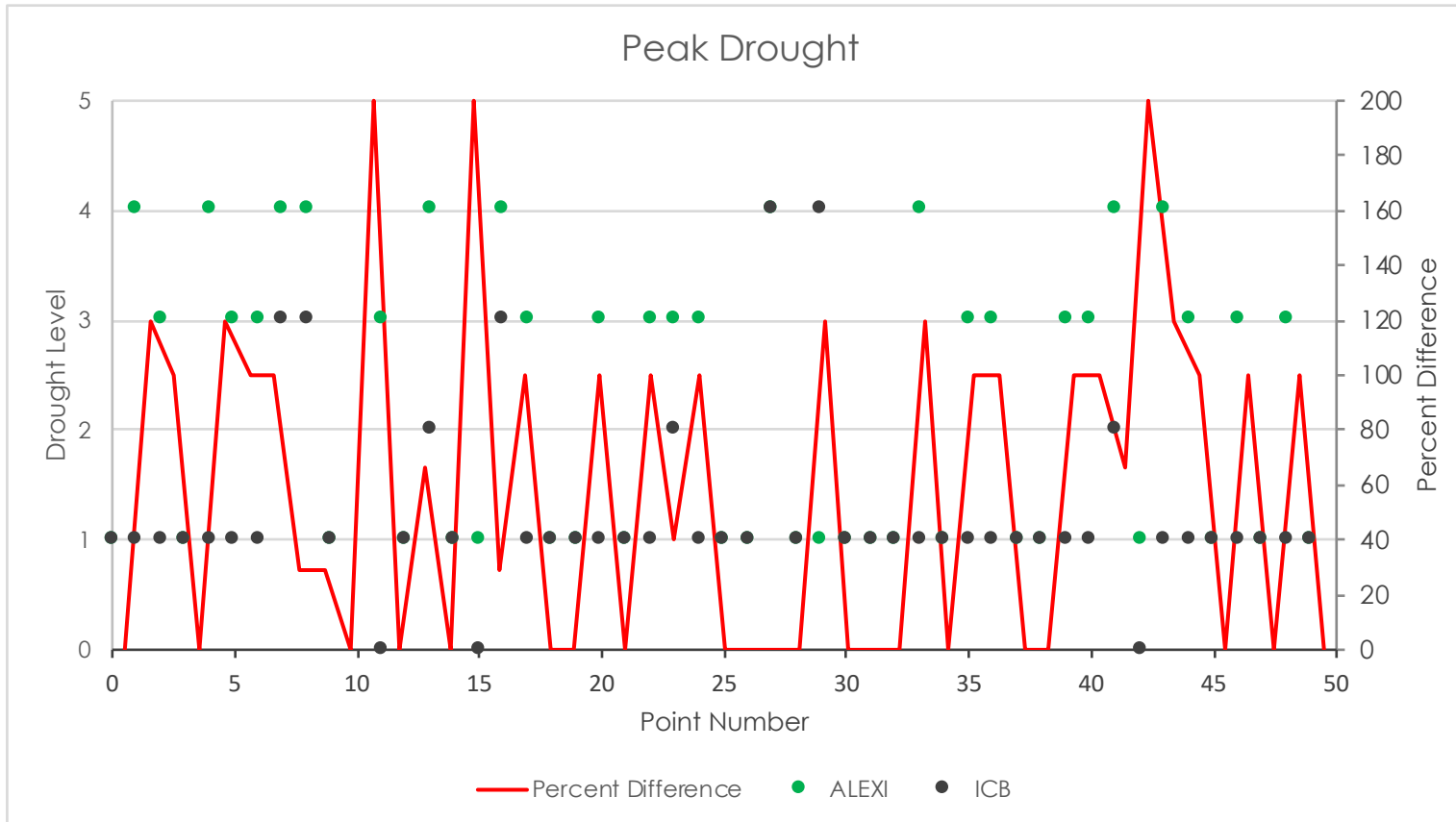
► <25% under Moderate to Extreme Drought

► 50-75% under Moderate to Extreme Drought

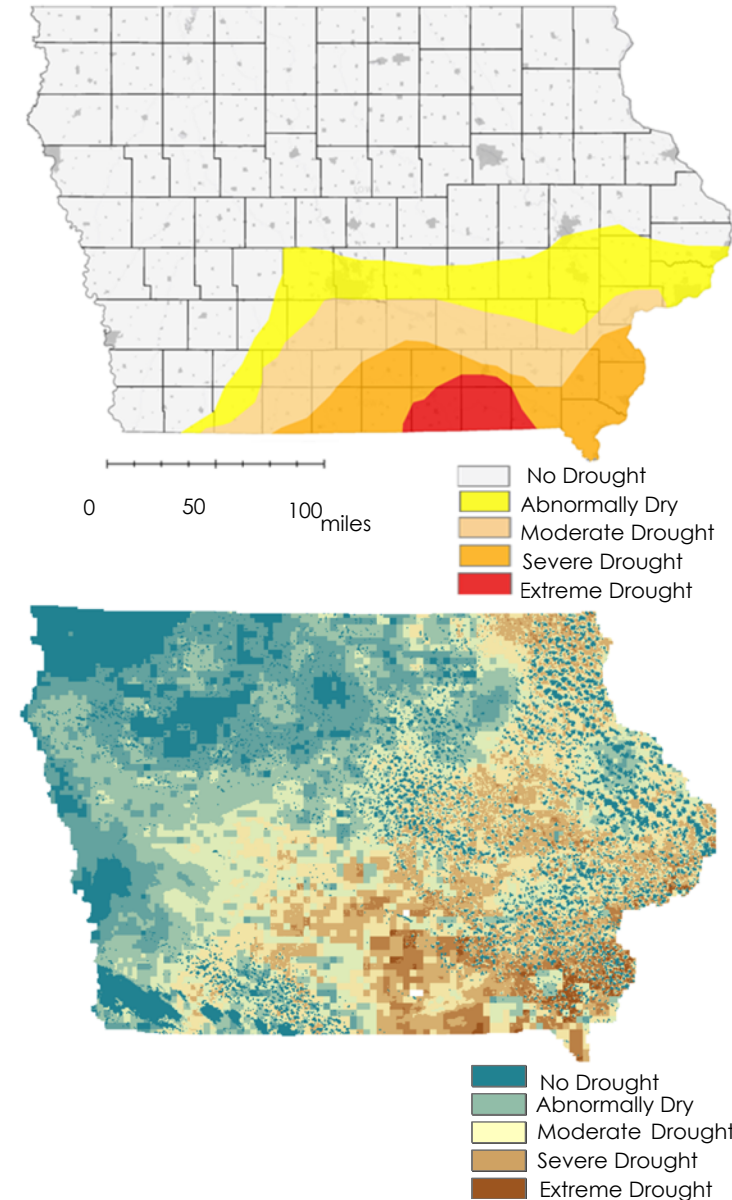


RESULTS: ICB vs ALEXI ESI Comparison

Week of Peak Drought, August 19-25, 2018



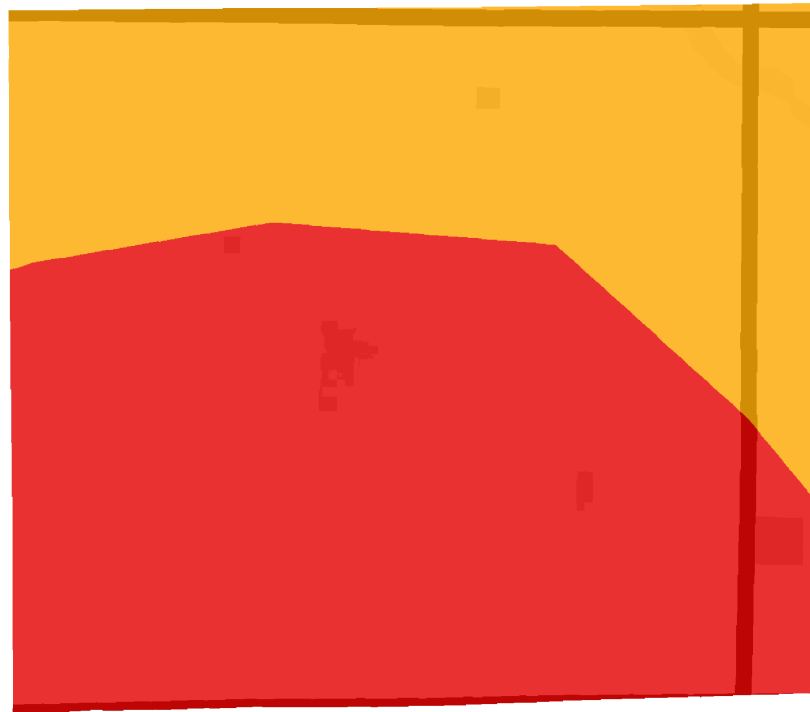
► Average Percent Difference: 58.35%



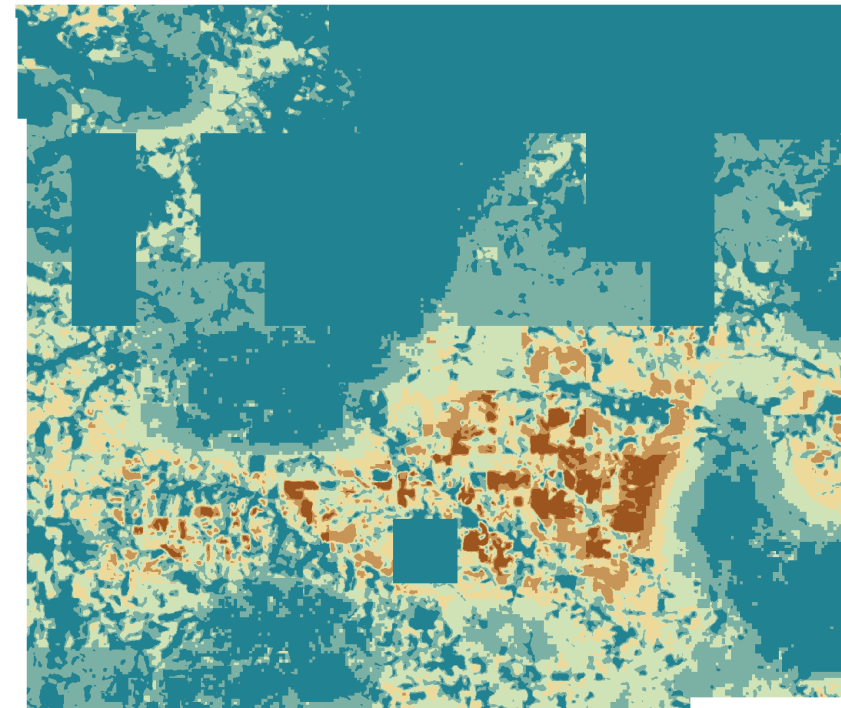
Results: ICB vs ECOSTRESS Comparison

One Week Before Peak Drought, August 12-18, 2018

Davis County



ICB Map



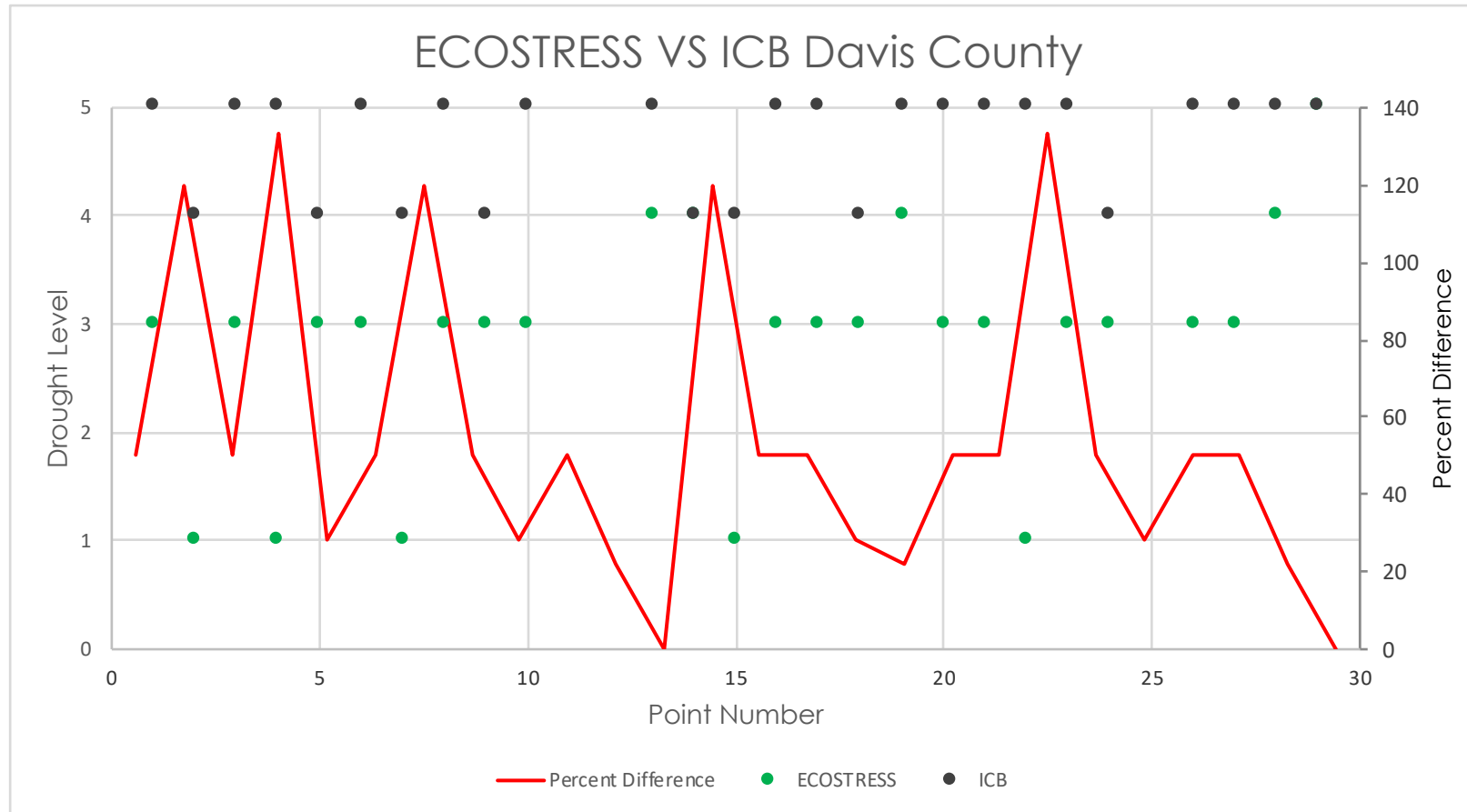
0 5 10 miles

ECOSTRESS Map

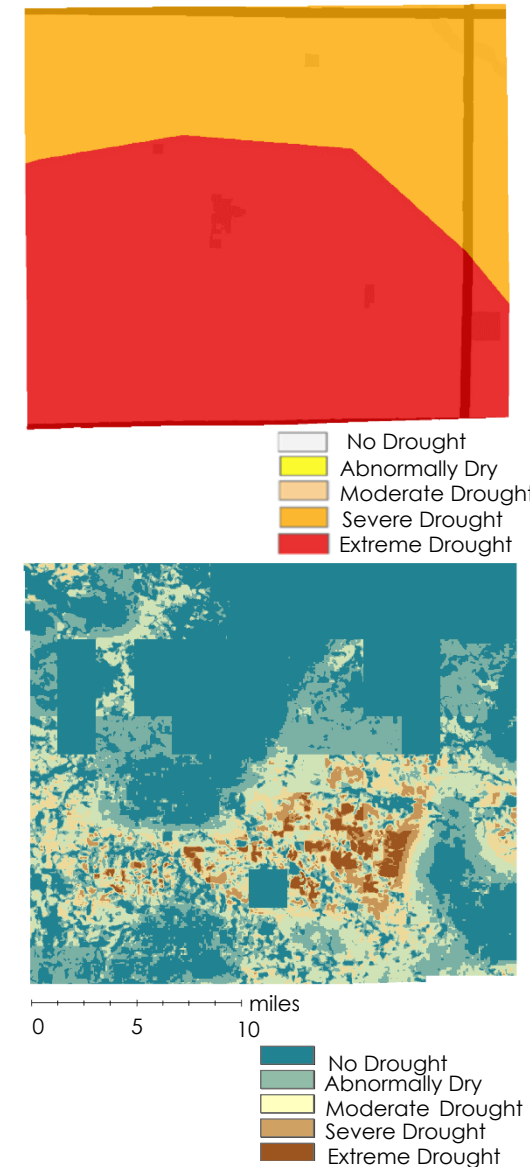


Results: ICB vs ECOSTRESS Comparison

One Week Before Peak Drought, August 12-18, 2018



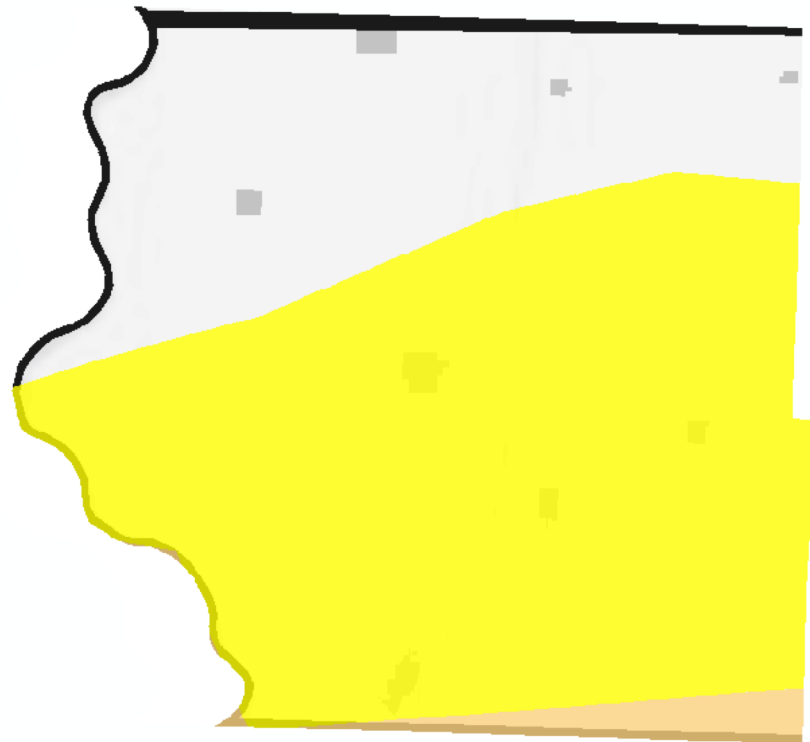
► Average Percent Difference: 54.14%



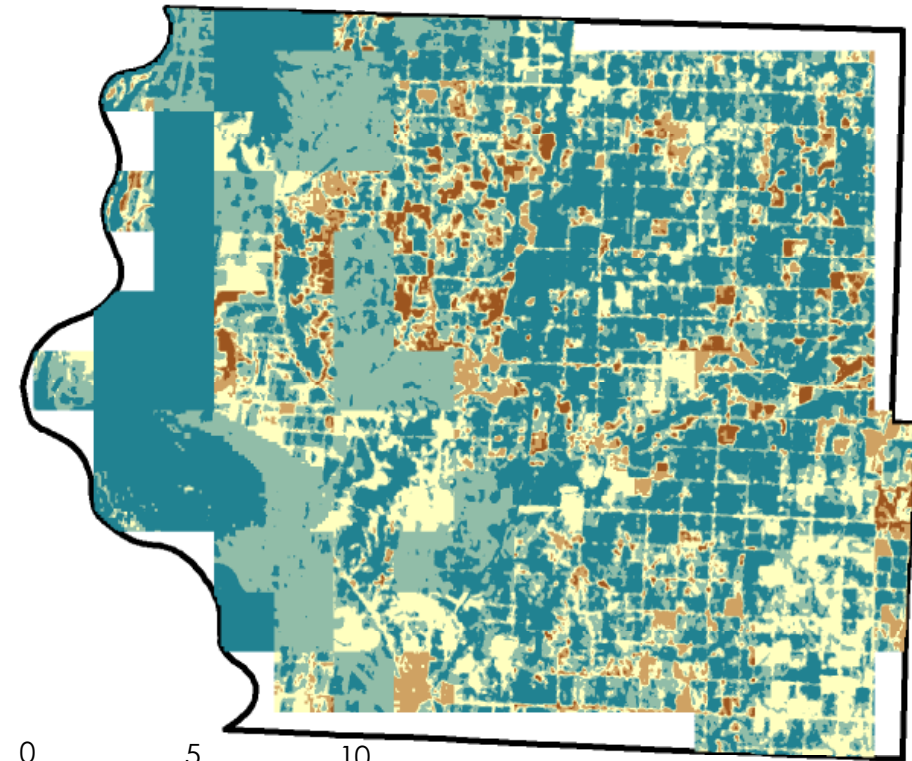
Results: ICB vs ECOSTRESS Comparison

One Week Before Peak Drought, August 12-18, 2018

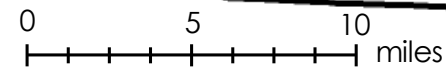
Fremont County



ICB Map

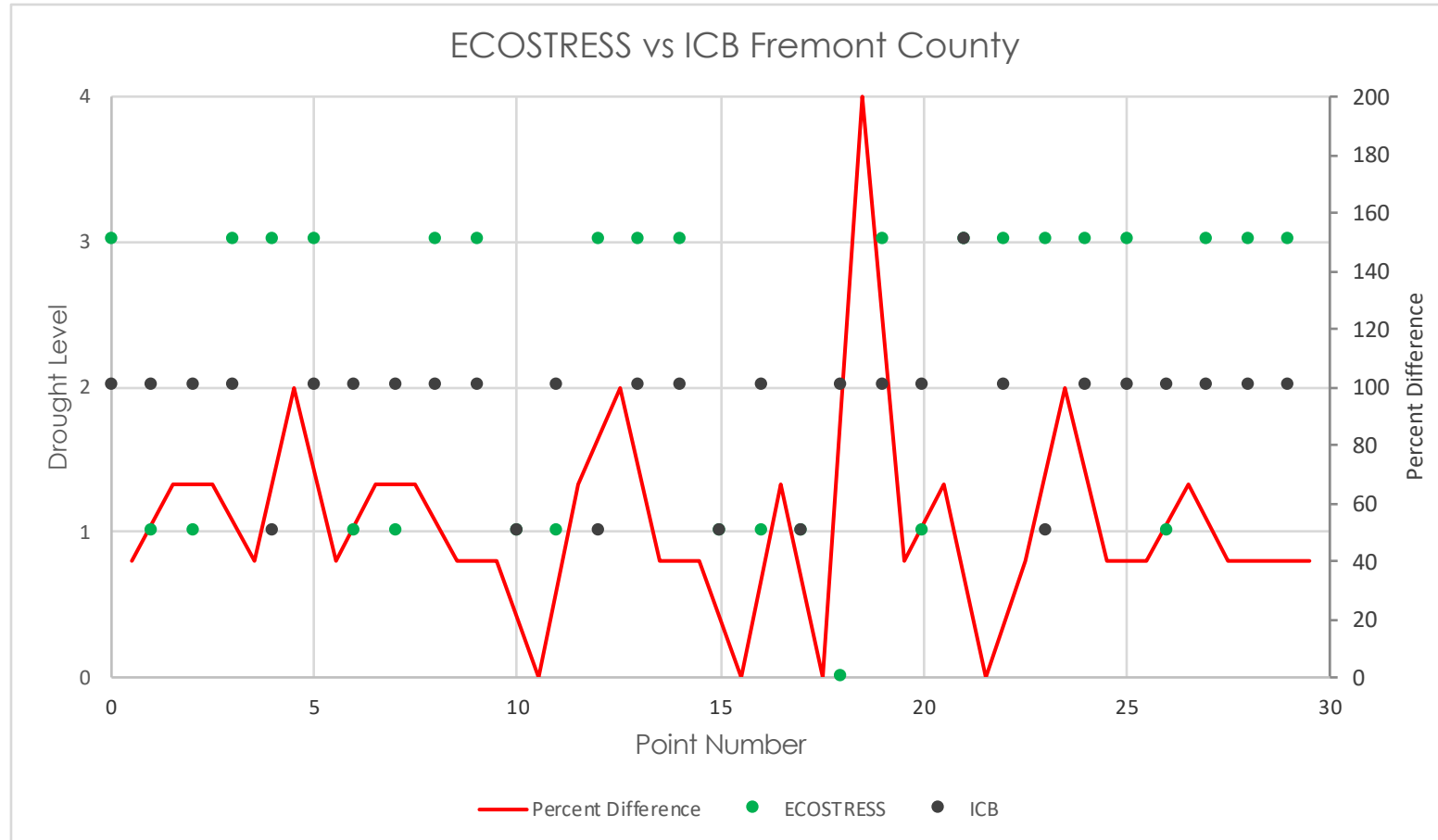


ECOSTRESS Map

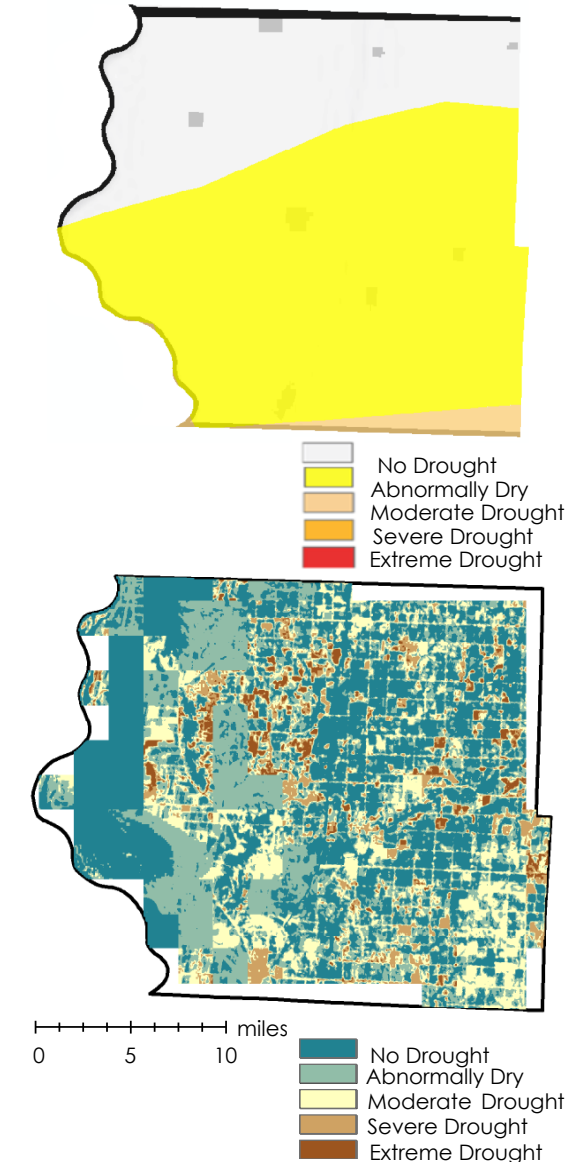


Results: ICB vs ECOSTRESS Comparison

One Week Before Peak Drought, August 12-18, 2018



► Average Percent Difference: 53.11%




Conclusions

- ▶ ALEXI ESI detected more drought conditions over the state of Iowa compared to current ICB maps.
- ▶ ISS ECOSTRESS ESI could provide higher spatial and temporal resolution of drought conditions compared to current ICB maps.
- ▶ Current ICB methods can be supplemented with finer resolution ESI products to offer a field by field view of drought conditions.



Current Limitations

- ▶ ECOSTRESS data is unavailable during critical growth periods.
 - ▶ ECOSTRESS is currently in an Early Adopter stage.
 - ▶ Different dates pulled for Land Surface Temperatures for county maps.
 - ▶ Fuzzy Overlay can distort data (cloud cover, extent).
 - ▶ There is a slight deviation of coordinates between ICB and our maps.
 - ▶ Data resampling is limited by the original spatial resolution.
- 

Future Work

- ▶ ECOSTRESS has the potential to be involved in large-scale studies which can provide higher resolution thermal imagery in locations where cloud cover is not an issue.
- ▶ Future studies would observe crop drought vulnerability at the beginning of the growing season, the most critical phase of plant development.
- ▶ Continuous coverage from April to November would increase understanding of the water requirements of corn and soybeans throughout the entire growing season.
- ▶ A Crop Vulnerability Assessment would help farmers decide if they should plant corn or soybean in a given area based on tendency towards drought.

Image Credit: Pixabay

ACKNOWLEDGEMENTS

DEVELOP

Partner:

- ▶ Dr. Justin Glisan (Iowa Department of Agriculture and Land Stewardship, Climatology Bureau)

Advisors & Mentors:

- ▶ Dr. Jeffrey Luvall (NASA Marshall Space Flight Center)
- ▶ Dr. Robert Griffin (University of Alabama in Huntsville)
- ▶ Madison Murphy (NASA DEVELOP National Program, Alabama – Marshall Node)
- ▶ Kathrene Garcia (NASA DEVELOP National Program, Alabama – Marshall Node)
- ▶ Maggi Klug (University of Alabama in Huntsville)
- ▶ Leigh Sinclair (University of Alabama in Huntsville, Information Technology & Systems Center)
- ▶ Helen Baldwin (University of Alabama in Huntsville)
- ▶ Dr. Chris Schultz (NASA Short-term Prediction Research and Transition Center)
- ▶ Dr. Chris Hain (NASA Short-term Prediction Research and Transition Center)

Questions?



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