Historical Use of Irrigation in Response to Regional Drought

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1 Introduction

Irrigation is well-known for overcoming weather variability (e.g., drought) in agricultural systems, but assessment of irrigation as a resiliency strategy has remained incomplete at the nationwide scale due to sparse data records. As a result, much of the research linking irrigation and weather events has relied on predictive models or estimates to forecast future climate change impacts on agricultural systems. Most studies linking irrigation and climate lack a foundation in historical behaviors and observations, so the past cannot robustly inform the future.

Purpose:
This project seeks to evaluate the historical relationship between irrigation and extreme drought events to analyze how growers have changed their irrigation strategies to mitigate environmental risk.

Figure 1. Corn with an overhead irrigation system.
Photo by M Walfred/University of Delaware

2 Methods

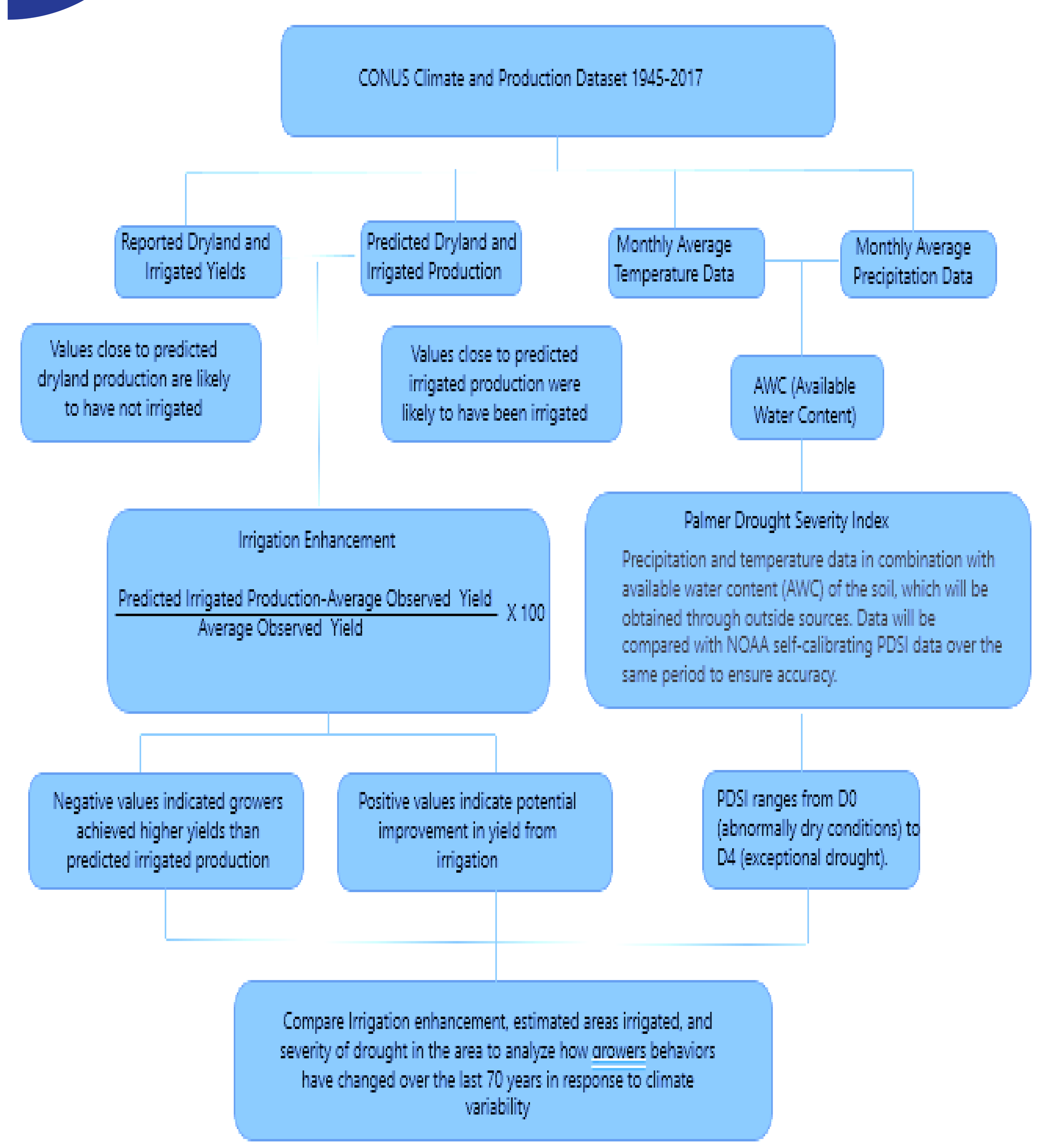

Figure 2. Conceptual flowchart of methods for identifying changing irrigation use relative to drought events.

3 Data

Drought Events

Year	Region	Duration	Intensity
1987	Northern Great Plains/ West Coast/ Northwest	1987-1989	$46.6 billion
2012	West Coast/Great Plains/East Coast/Midwest	2012-2013	$35.7 billion
1980	Central /Eastern U.S.	1980-1981	$34.7 billion
2011	Southern Plains/Southwest	2011-2012	$14.6 billion
2002	Western/Great Plains/Eastern U.S.	2001-2002	$13.7 billion
2013	Western/Great Plains	2013-2014	$12.1 billion
1983	Midwest	1983-1984	$9.0 billion
2008	East Coast/Northwest/Great Plains/Midwest	2008-2009	$9.0 billion
2006	Midwest/Great Plains/ Southeast	2006-2007	$8.2 billion

Fig 3. Recent regional drought events with large economic impacts.

Irrigation Enhancement

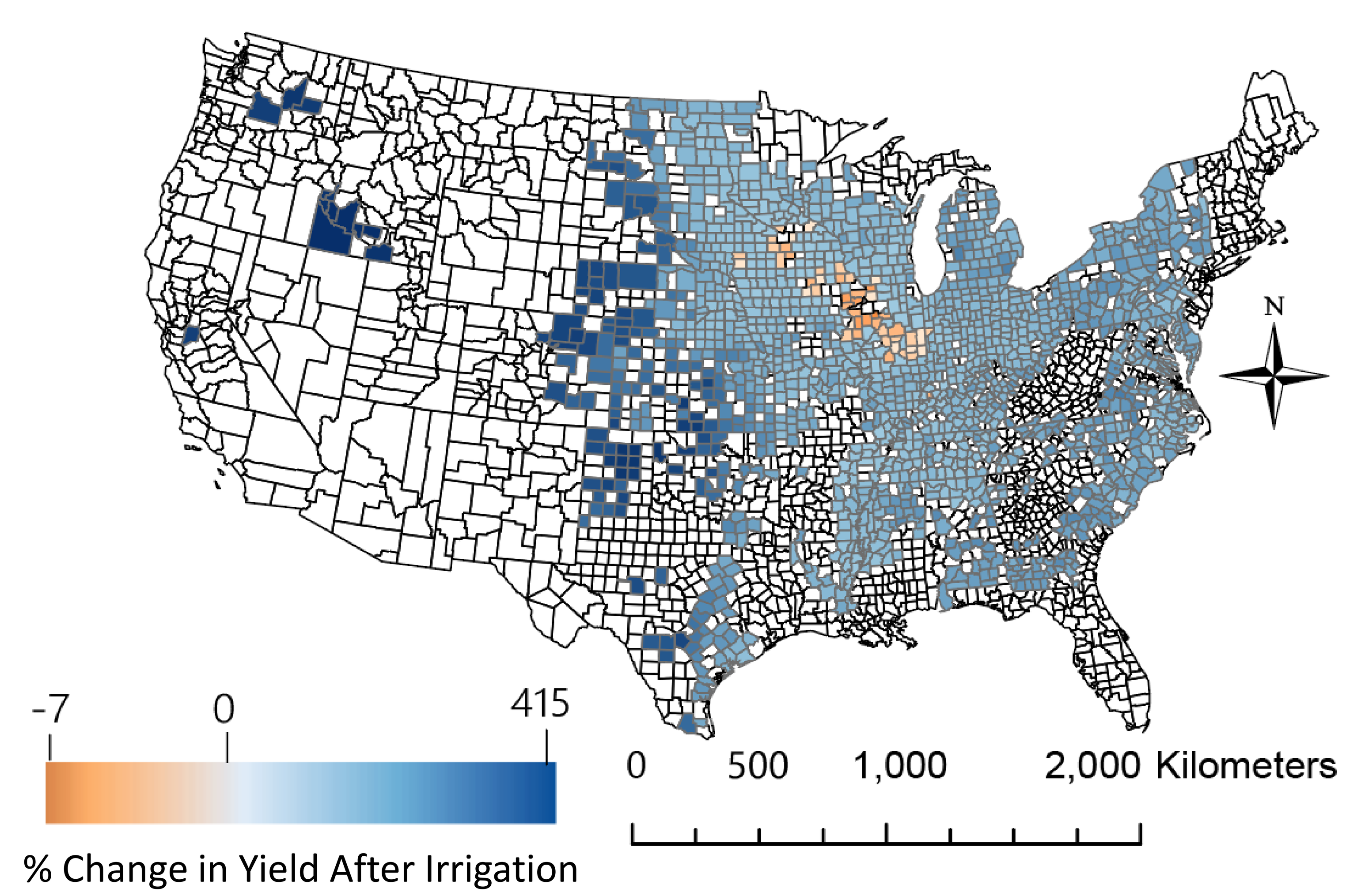

Fig 4. 2012 irrigation enhancement map, measured as percent change between estimated irrigated yield and estimated dryland yield.

4 Products to be Developed

Normal Year

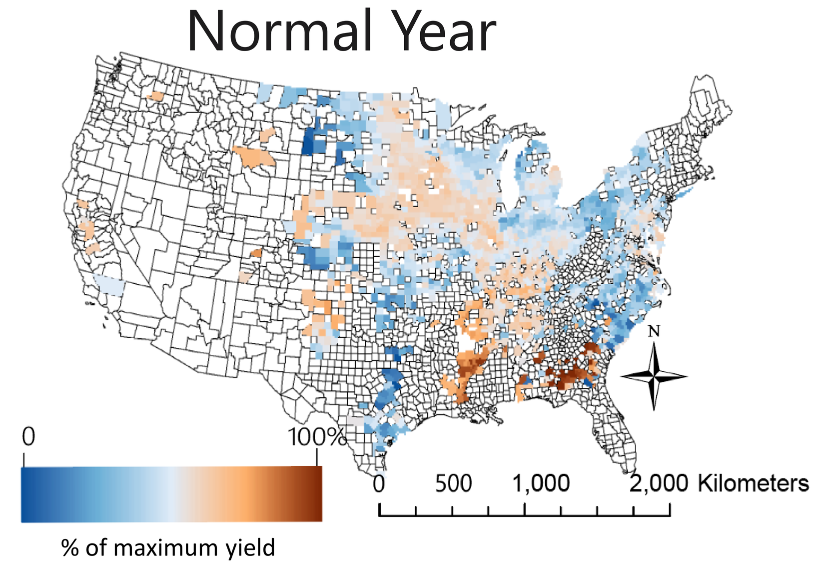

Fig 5. Percent of maximum yield under fully irrigated conditions during 2015 (wet year).

Drought Year

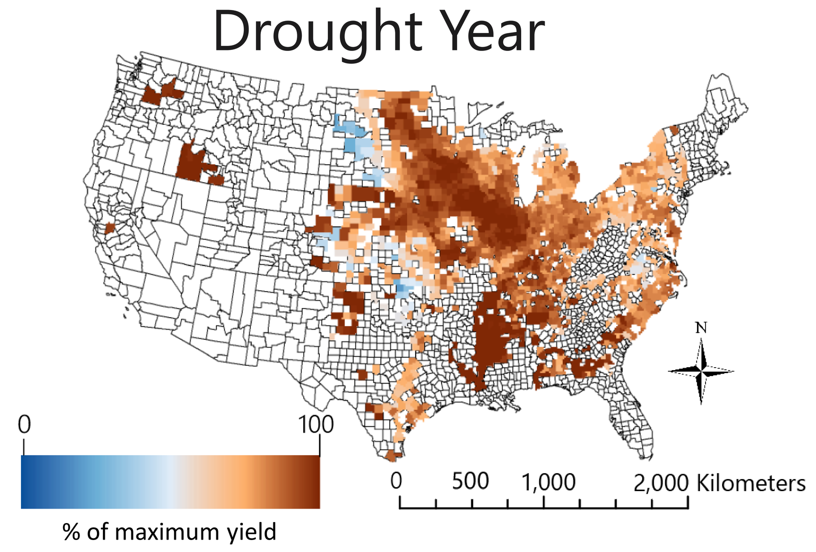

Fig 6. Percent of maximum yield under fully irrigated conditions during 2012 (dry year).

Drought Mitigation

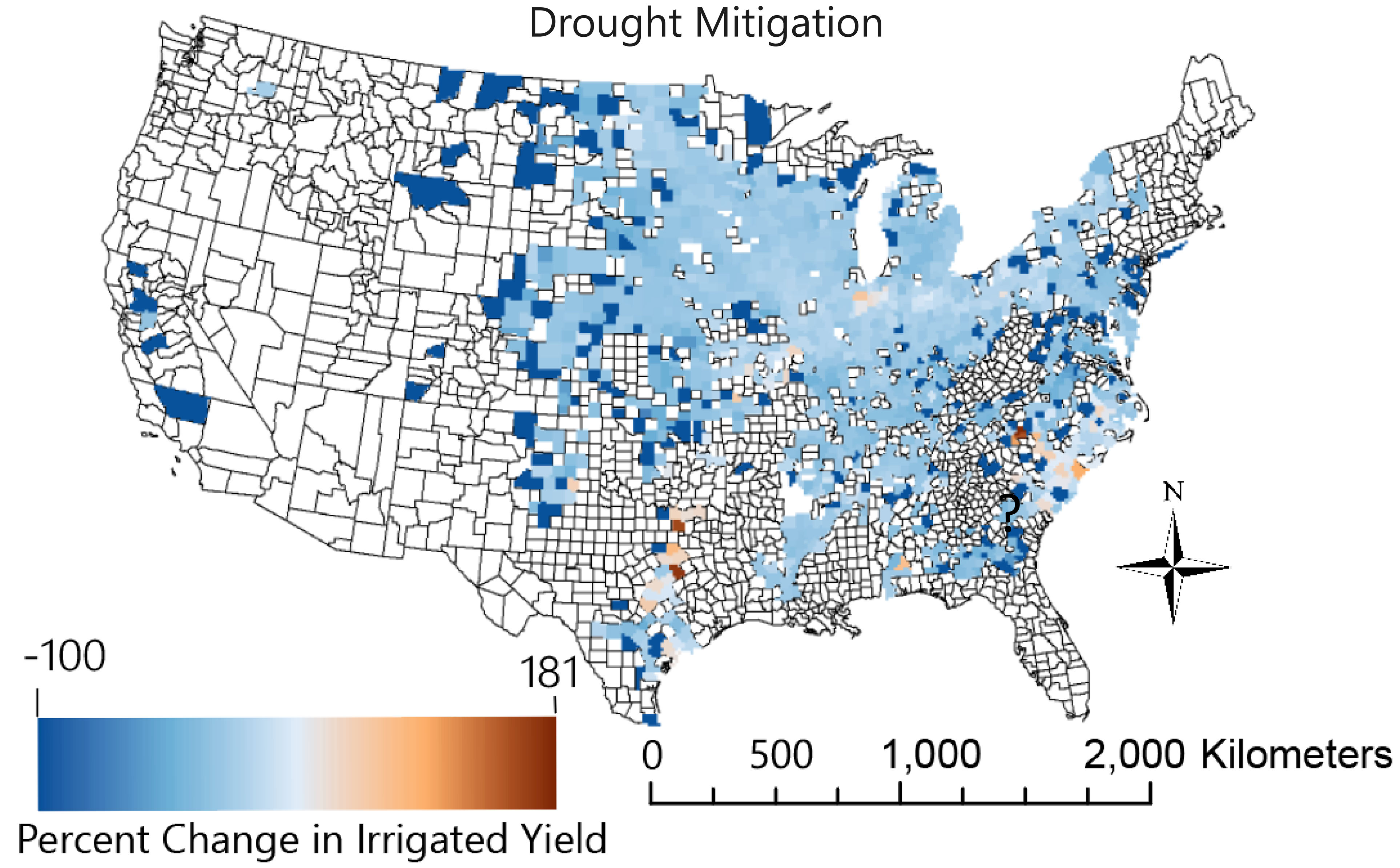

Fig 7. Percent change in yield between Fig. 5 and Fig. 6 to identify regions where irrigation was used intensely to mitigate the negative impacts of drought conditions. Specifically, three regions stand out: (1) Southern High Plains, (2) Great Lakes, and (3) Southeast US.

5 Applications

This study will allow for better informed projections of future water use from irrigation. This is increasingly more important as we face increases in rates of irrigation and overall irrigated land (McDonald & Girvetz, 2013), coupled with the lagging recharge rate of many of the nation's aquifers (Konikow et al., 2013).

These data can also impact the management of watersheds by providing insight from past responses to extreme climate variability. This is especially relevant as drought is expected to become increasingly frequent in future years (Fig. 8). This study can better equip decision-making for water conservation despite variable weather events.

Geospatial data used or produced during this study will also be made available for custom teaching and learning material for K-12 teachers and students through the PI Smidt's data literacy initiative in coordination with the Scientist in Every Florida School Program.

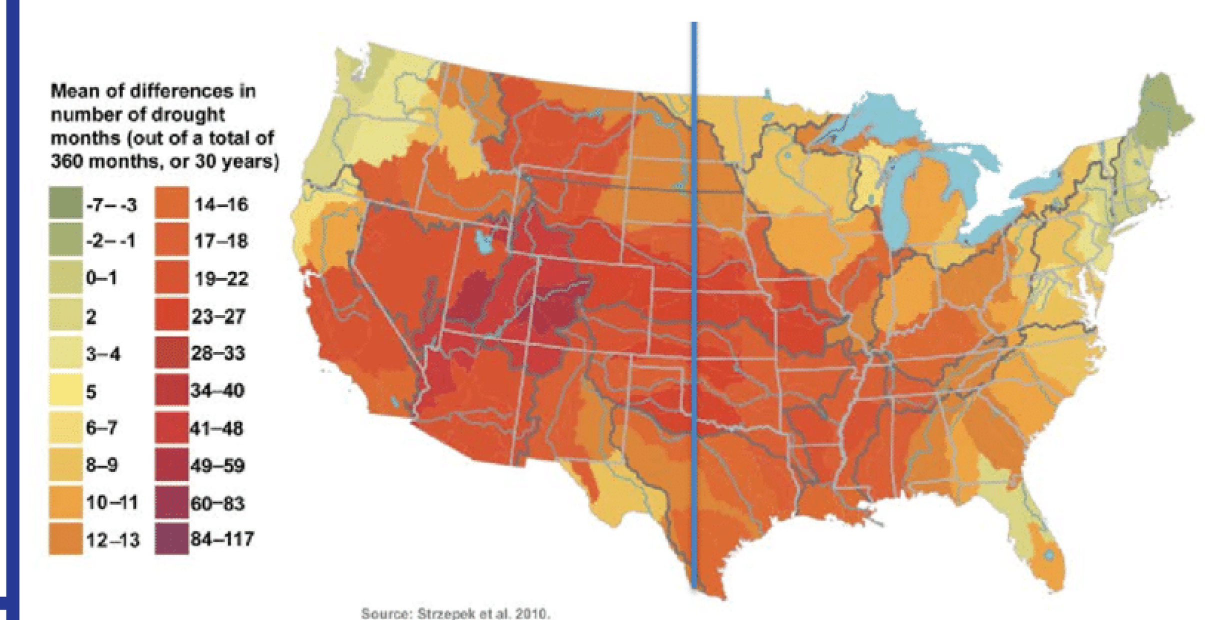

Fig 8. Projections of the mean changes in the extreme Palmer Drought Severity Index (PDSI) for the 30-year period centered on 2050. (Figure is from Averyt et al. 2011 redrawn from Strezepek et al 2010). Approximate boundary of 100 th meridian represented by blue line.

6 Future Work

This work will continue to analyze historical agricultural data to fully identify regional relationships between irrigation use and drought events. Furthermore, this work will seek to identify how these relationships have changed through time.

This project will seek to pave the way for future research applying the historical behaviors of agricultural producers to create better informed projections of future irrigation use.

These data will also factor into other studies analyzing irrigation migration through time. Based on past migration trends and observed relationships between drought and irrigation use, we will seek to identify where irrigation is likely to be the most intense in the future relative to drought projections. We ultimately hope to use these data to more proactively develop successful water conservation strategies that balance agricultural and environmental demands.

References

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