Using observed subfield soil moisture patterns to bracket near-surface water retention functions and inform smart-sensor-placement algorithms

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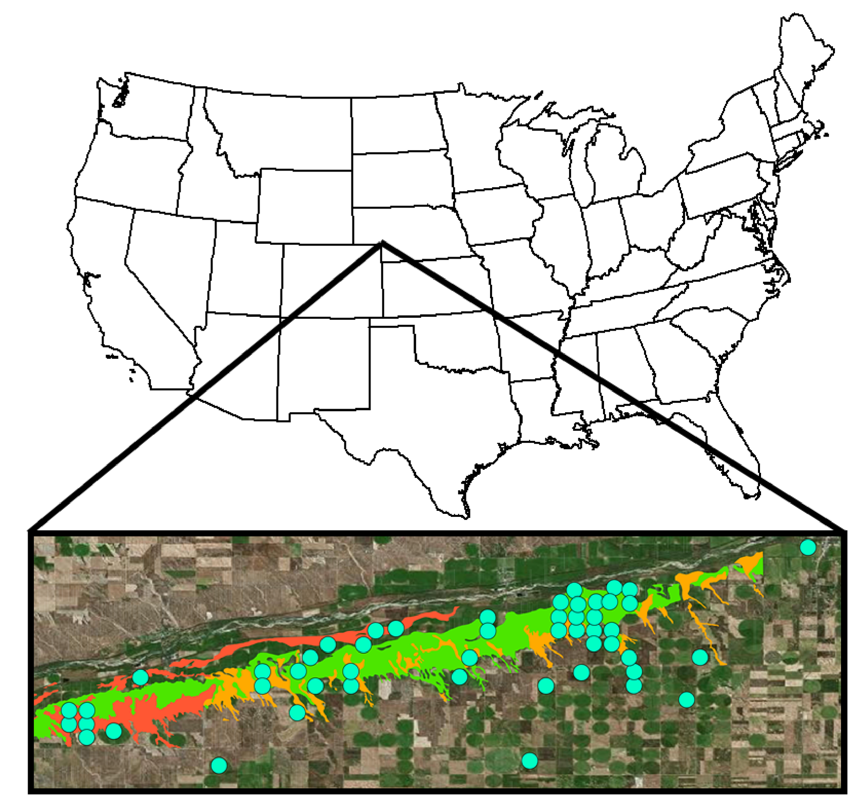
1. Introduction

- The long-term sustainability of irrigated agriculture depends on the societal agreed upon rate of aquifer decline. This rate is dependent on complex interactions in coupled social ecological systems and is defined in both terms of **water quantity** and **quality**. Additionally, the rate of groundwater pumping, water table decline, leaching, and recharge is **often poorly characterized** at both the **field** and **watershed scale**, thus limiting stakeholders' ability to make informed decisions.
- Monitoring soil moisture through the use of soil moisture sensors, and incorporating their status into irrigation scheduling can be effective in **reducing** both **pumping volumes** and the loss of applied agricultural additives (e.g. **nitrogen**). The challenge exists when selecting the number of sensors and their location to best represent the variability of a field.

2. Study Site

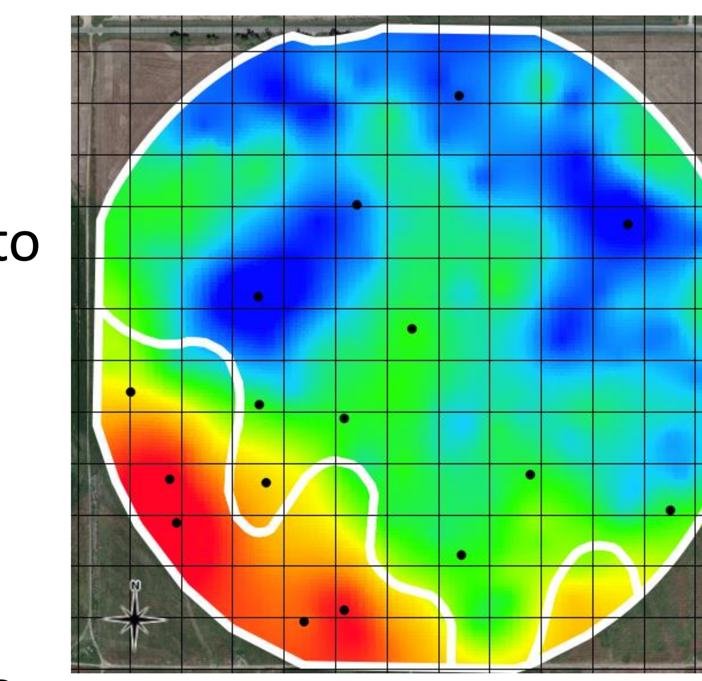
Site Research Objectives

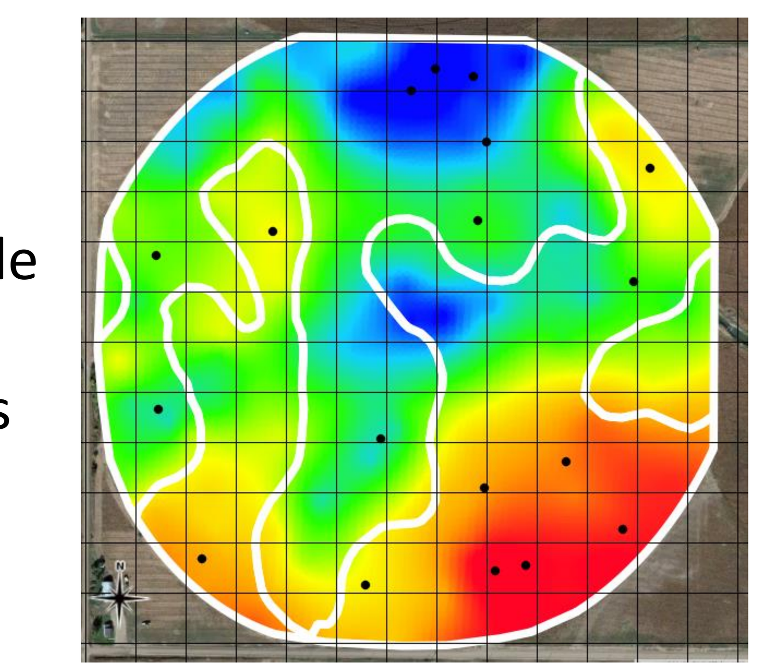
1. Identify **spatial patterns** in **soil moisture** on the subfield scale.
2. Determine the **key factors** (soil properties, topography, etc.) **driving soil moisture patterns** in 3-4 study sites.
3. Build a locally calibrated **statistical model** to describe the relationship between soil moisture patterns and important covariates.
4. **Predict soil moisture patterns in unmeasured fields** using the **data-driven statistical model**, then determine the ideal **location** and **number** of **sensors** to bracket soil moisture variability.



3. Observed Patterns in Soil Moisture

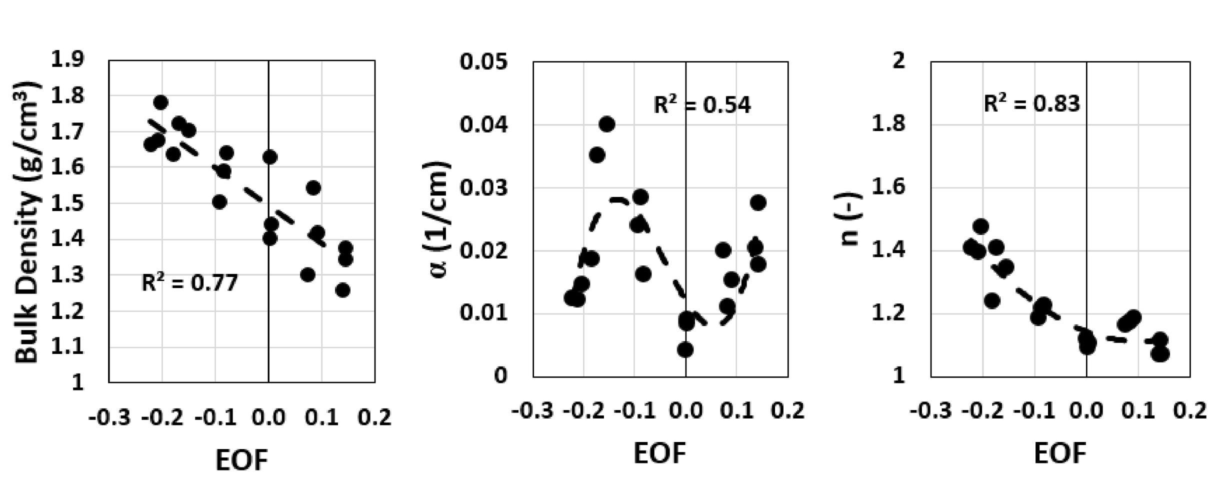
- Utilizing a non-contact and non-destructive method to measure soil moisture over an entire field, we are able to observe patterns of soil moisture that persist from wet to dry conditions. We propose a method to determine **soil-moisture-derived management zones** (SMDZ) that can be used to inform **smart-sensor-placement algorithms**.
- This method utilizes multiple measurement dates and a statistical analysis known as an empirical orthogonal function.





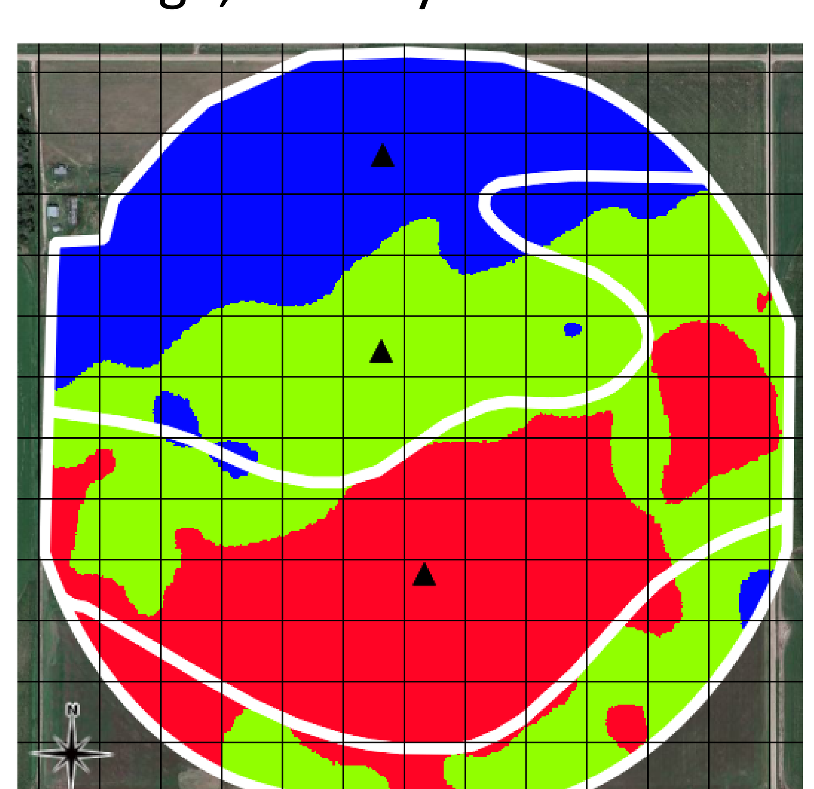
4. Soil Properties within Zones

- Preliminary results indicate that key soil properties correlate well within the SMDZs.
- Most fields can be represented with **3-5 zones** that bracket the range of observed moisture conditions.



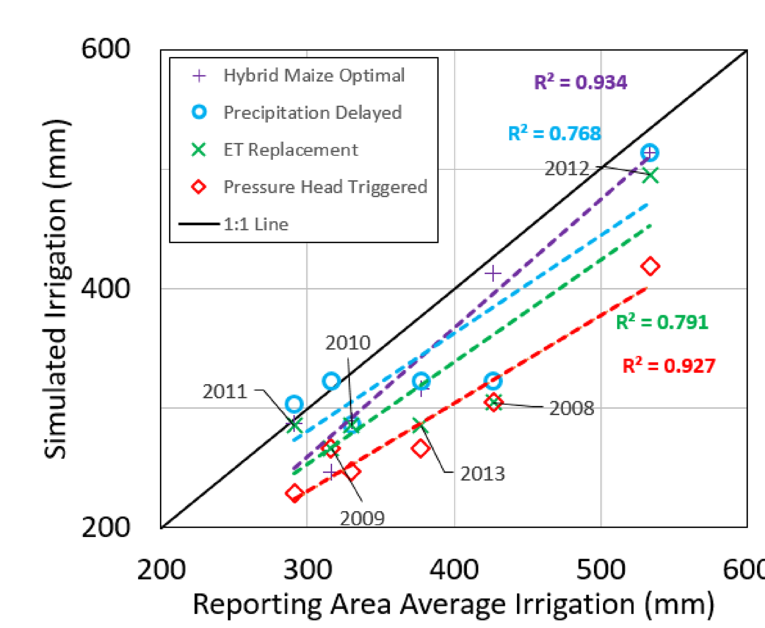
5. Smart Sensor Placement

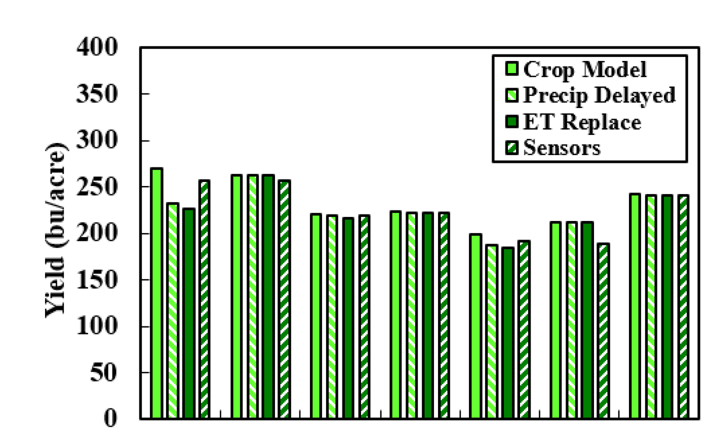
- After our calibration sites have been characterized, we can then leverage data layers such as Lidar elevation and SSURGO soil properties to partition unmeasured fields into wet, average, and dry zones.



6. Reduced Pumping

- Based off previous work in the study area (Gibson et al., 2017), we believe a reduction of pumping of up to 30% of irrigation water can be achieved through the use of soil moisture sensors placed in SMDZs with minimal impact on yield.





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Summary and Conclusions

- We observe subfield soil moisture patterns that persist from wet to dry conditions (SMDZs).
- Preliminary work shows soil properties tend to be consistent within a SMDZ.
- Using SMDZs, the soil moisture variability throughout a field can be bracketed with a small number of observations (soil moisture sensors).

Future Work

- We will be extracting soil cores in fall of 2017 to estimate recharge and N leaching within SMDZs.

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