Using the Power of Big Data to Benchmark Irrigation Management & Footprint

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Irrigation is a vital part of agriculture in the western U.S. Corn Belt and Great Plains and a significant use of groundwater resources. With increasing water scarcity and changing climate, it is important to understand how irrigation decisions change across years and fields and how this impact groundwater levels

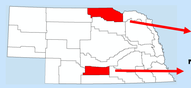
BACKGROUND AND OBJECTIVES

- Gap of knowledge about sources of variation for on-farm irrigation over space and time
- High quality irrigation data are rarely available: previous studies on irrigation impact on groundwater change have made rough estimations about on-farm irrigation
- Indeed, best source of irrigation data has been a single, state average total irrigation value per state reported every five years by USDA-Farm and Ranch Irrigation Survey

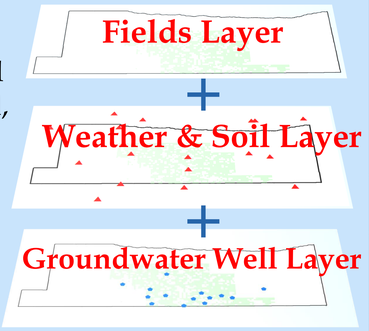
OBJECTIVE: To understand spatial and temporal sources of variation in irrigation and the link between irrigation and groundwater dynamics

METHODS: NRD producer data

- Unique agricultural database with high quality available for Nebraska (USA), with detailed irrigation data not found anywhere else in the world
- Field-scale data collected by 2 NRDs (Tri-Basin, Lower Niobrara) on yield, N fertilizer, and irrigation in corn and soybean fields over 9 crop seasons (2005-2013). *All figures refer to pivot-irrigated maize fields for ease of analysis*
- NRD database complemented with publicly available data on soils (NRCS-SSURGO), weather (HPRCC), and groundwater level (USGS)



Lower Niobrara NRD: 300 reporting fields
Tri-Basin NRD: 1080 reporting fields



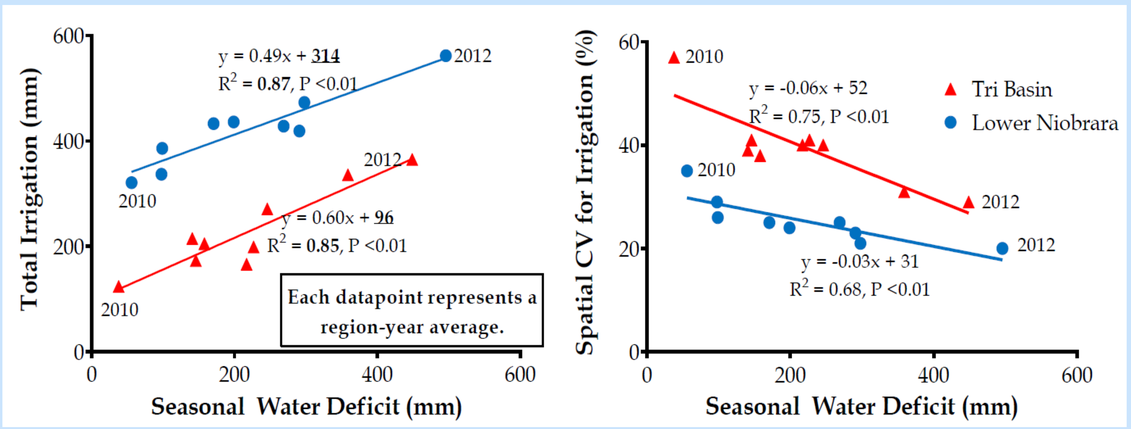
RESULTS

Are irrigation decisions flexible upon site-year specific conditions?

Source of Variation	Significant impact on irrigation?
Precipitation (mm)	YES (P<0.01)
Reference evapotranspiration (ET, mm)	YES (P<0.01)
Crop type (corn or soybean)	YES (P<0.01)
Prior crop (corn or soybean)	NO (P=0.79)
Irrigation system type (pivot or surface)	YES (P<0.01)
Soil available water holding capacity (AWC, 0-1 m soil, in mm)	YES (P<0.01)
Topography index	NO (P=0.24)

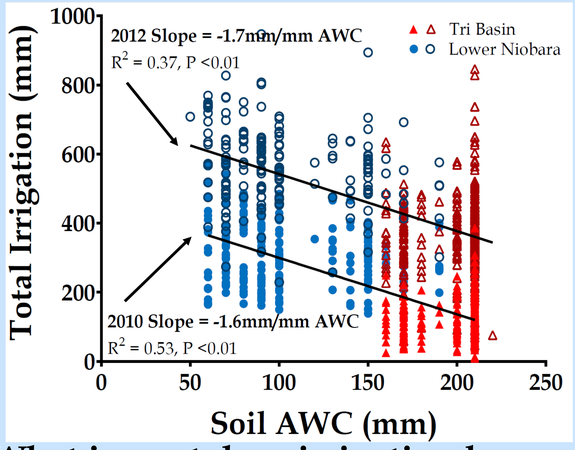
How does irrigation vary across years?

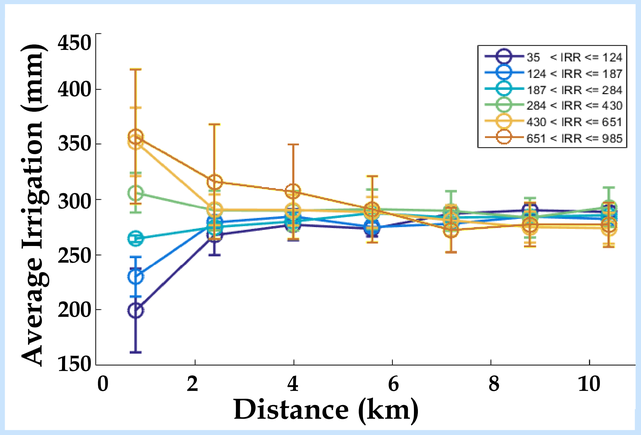
- Year-to-year variation in irrigation was explained by seasonal water deficit (difference between reference ET and precipitation between June 1st and Aug 31st) (LEFT PANEL)
- Irrigation differed by ~200mm between the two regions due to difference in soil (LEFT PANEL)
- Largest field-to-field variation (CV) in irrigation occurred in wet years (RIGHT PANEL)



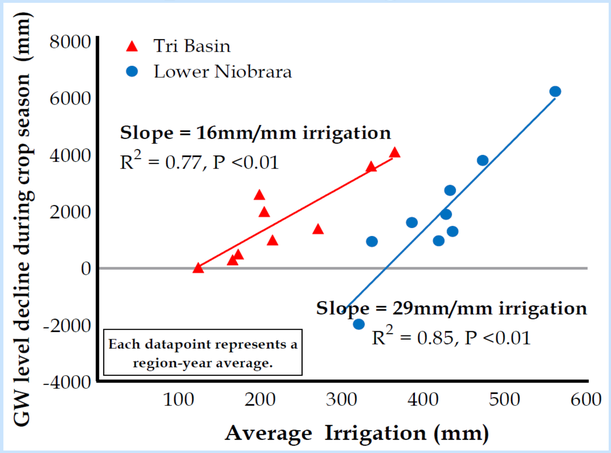
What impact do soil and 'neighbor' have on irrigation decisions?

- Irrigation increased with decreasing soil AWC in both wet (2010) and dry (2012) years; this relationship was NOT proportional, with ca. 1.7mm irrigation increase per unit decrease in AWC (LEFT PANEL)
- Irrigation decisions are influenced by nearby neighbors as can be inferred by the spatial pattern in irrigation amount, which dissipates as distance increases from a given field (RIGHT PANEL)

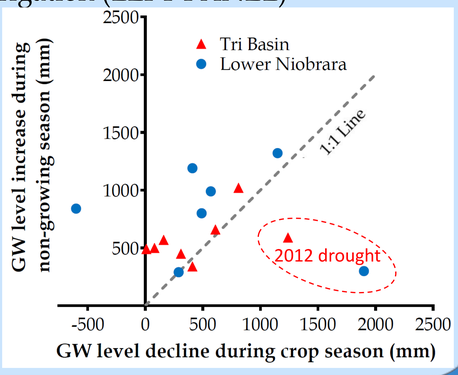




What impact does irrigation have on groundwater (GW) level dynamics?



- Decline in GW level during the crop season (fall *versus* spring GW level) was greatest in region-years with high irrigation (LEFT PANEL)
- GW level increase during the subsequent non-growing season was equal or greater than the decline during the crop season, except for the drought year (RIGHT PANEL)



CONCLUSIONS

- Producer irrigation decisions are variable depending upon field-year weather, crop, and soil conditions
- Decline in groundwater level during the crop season is strongly related to irrigation, however, groundwater level returns to the pre-season level during the subsequent non-growing season in all years but one.
- Next step is to develop a framework to benchmark actual irrigation, relative to crop water requirements and yield

Acknowledgments

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