Irrigation in Nebraska

2017 AIPA Water Conference

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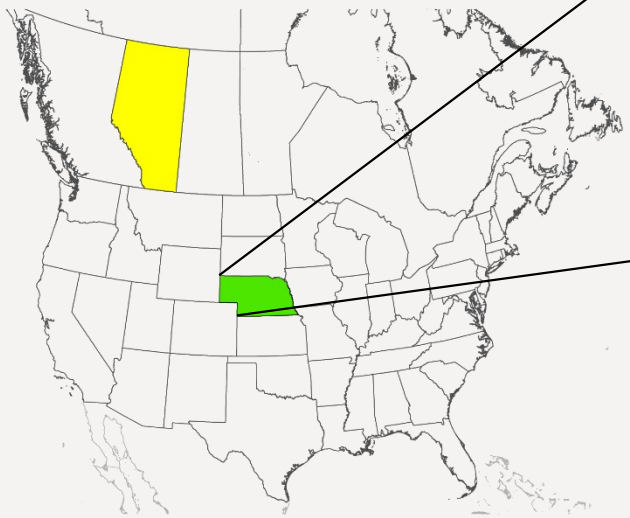
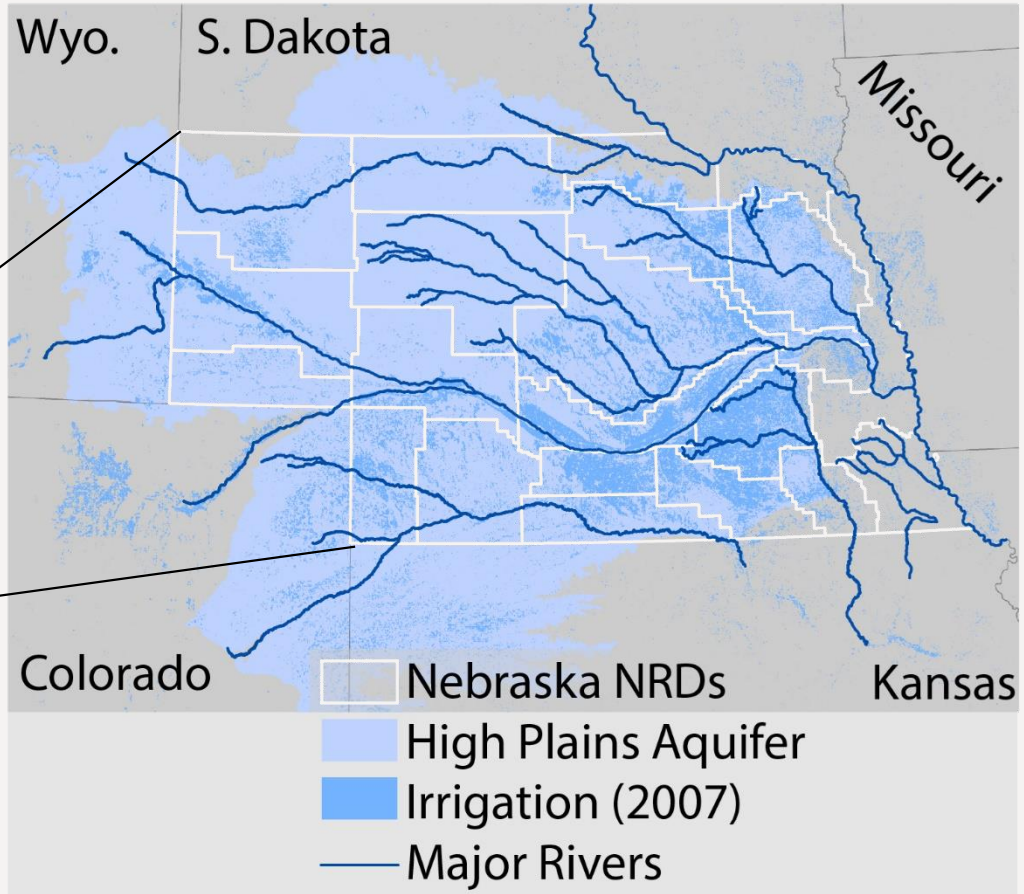
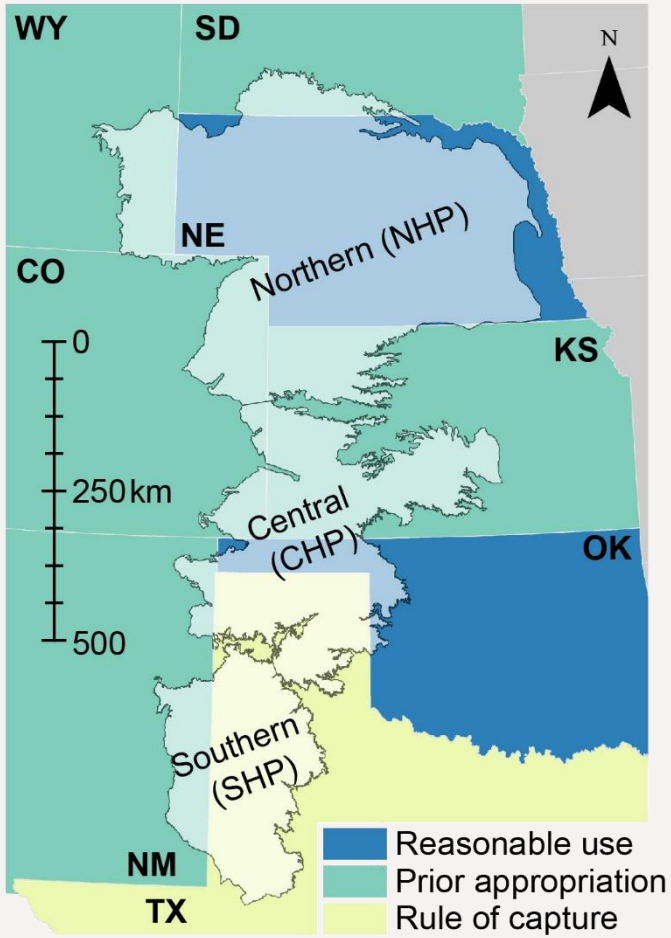
NEBRASKA

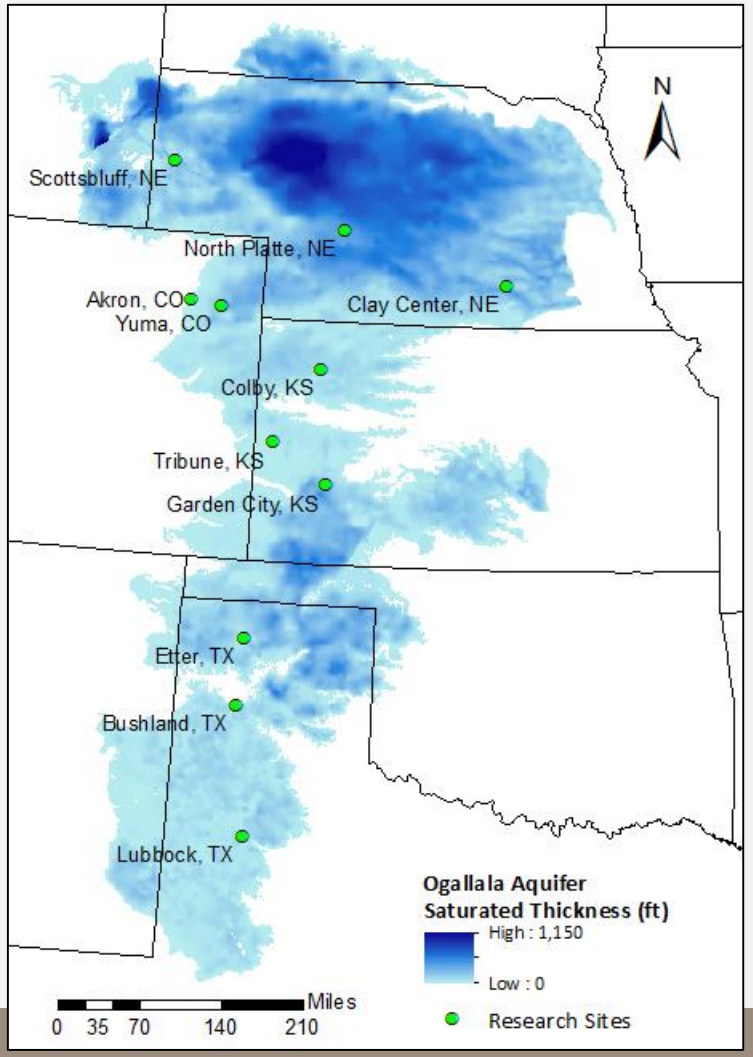
- Rivers flow West->East
- Holds ~75% of the High Plains Aquifer (volume)
- Divided into Natural Resource Districts





The High Plains Aquifer





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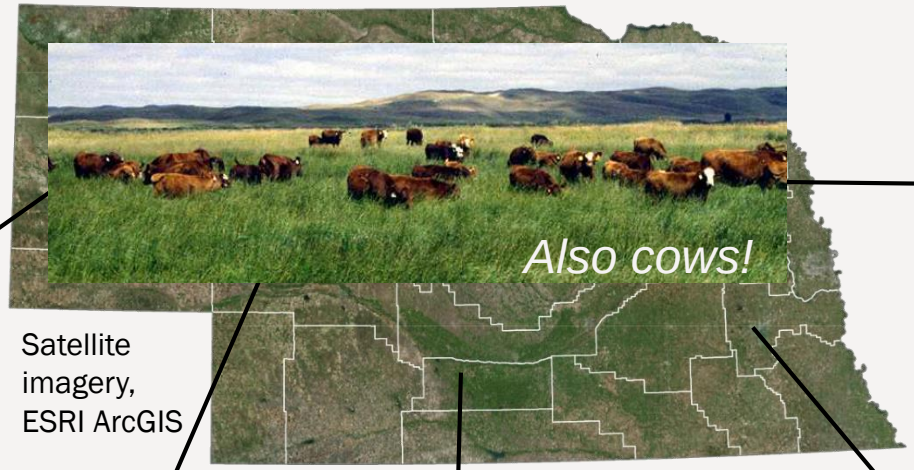
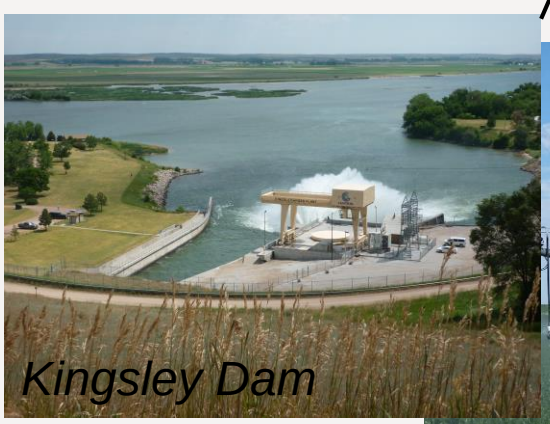
The Cornhusker State



Satellite imagery, ESRI ArcGIS



University of Nebraska

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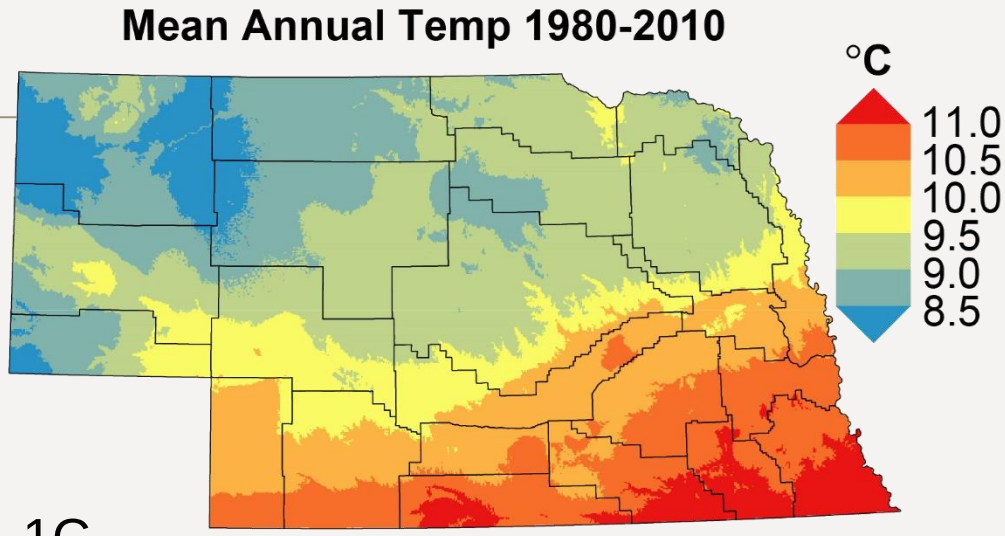
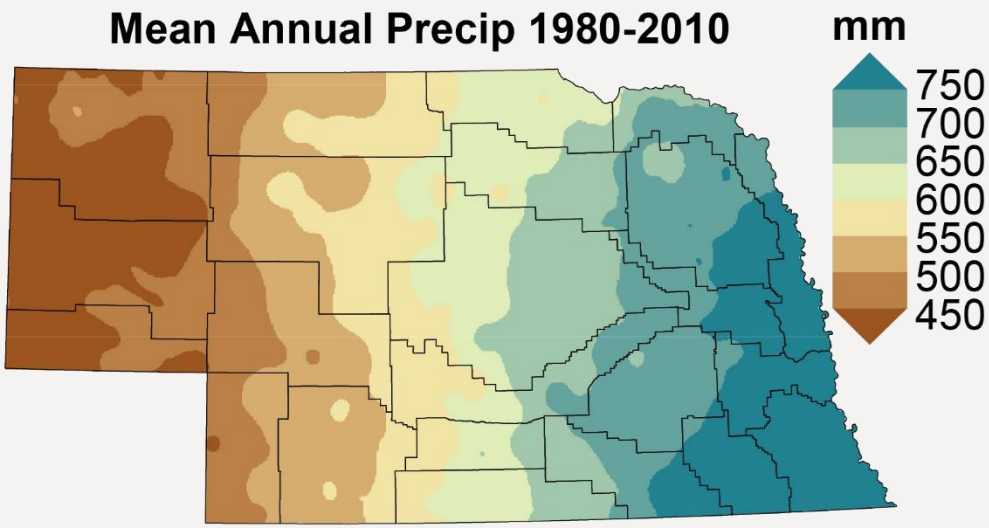
Photos: Wikipedia, Michael Forsberg (crane), Erin Haacker, Daran Rudnick, UNL

CLIMATE

- Temp gradient from N to S
- Precip gradient from W to E
- Avg annual temp:
  - Nebraska: High 17C/Low 4.5C
  - Lethbridge, AB: High 13C/Low -1C
- Avg annual precip:
  - Nebraska: 600 mm
  - Lethbridge, AB: 380 mm





0 100 200 km

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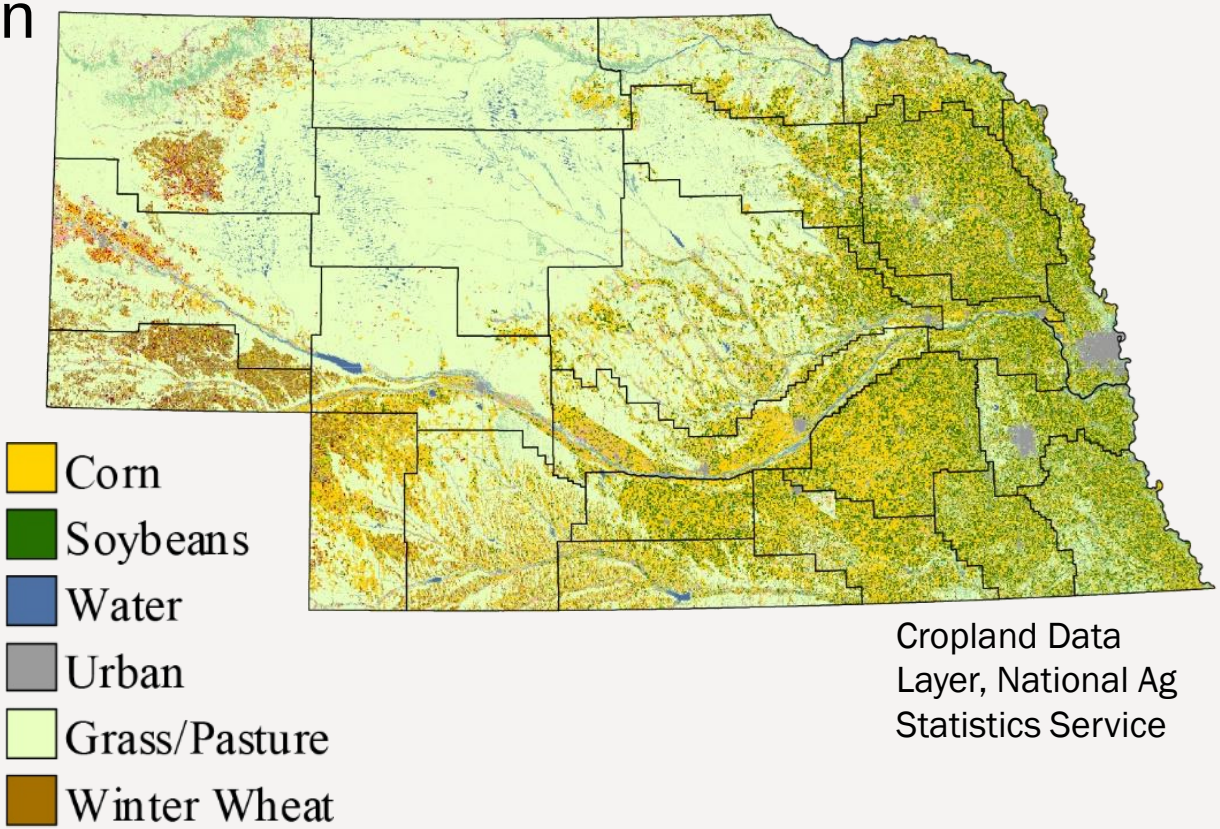
Crops and Geography

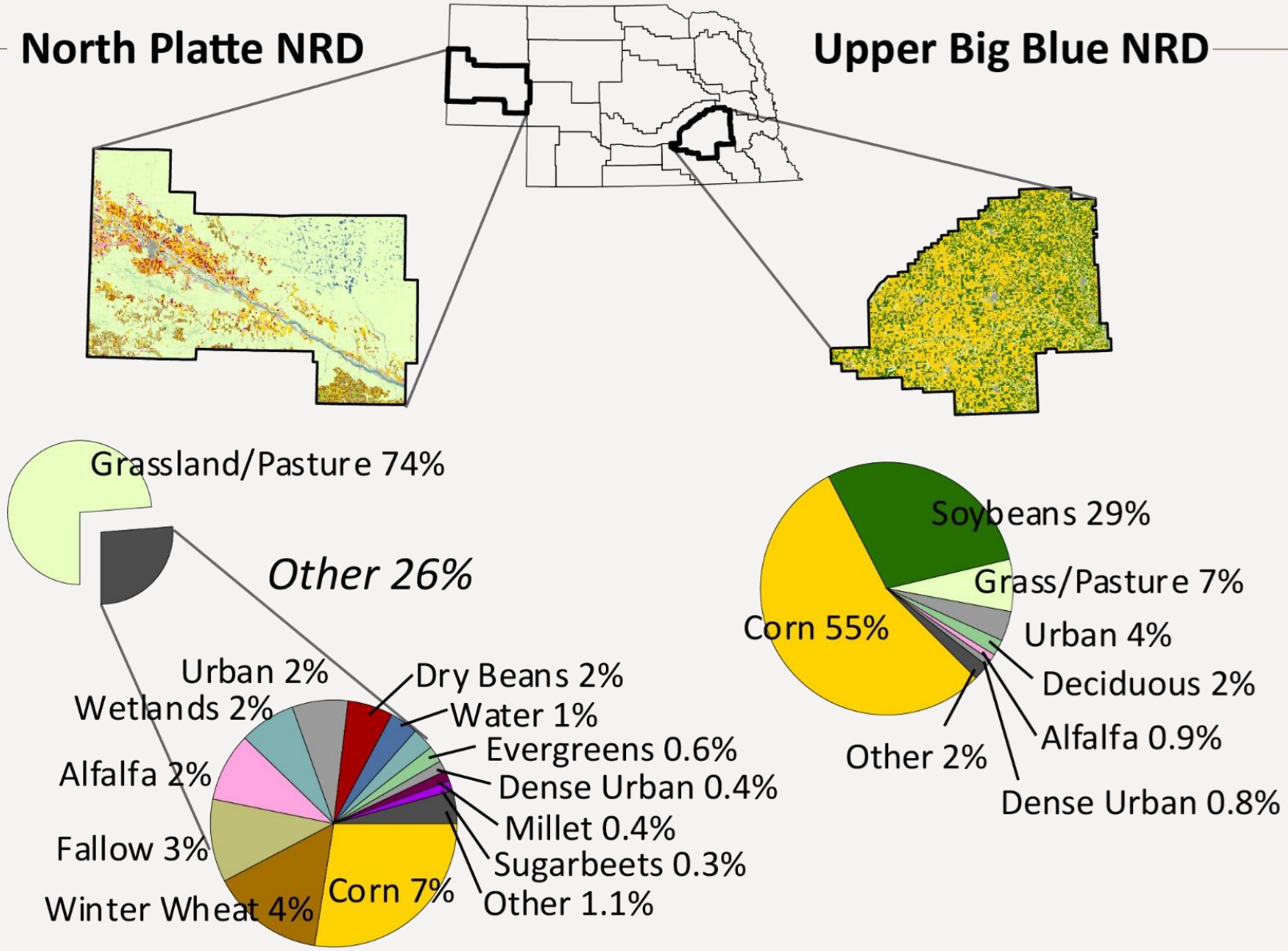
- Eastern NE
  - Corn-soy rotation
- Western NE
  - Pasture
  - Corn
  - Winter wheat
  - Dry beans
  - Alfalfa
  - Other locally important crops

Land Cover 2016



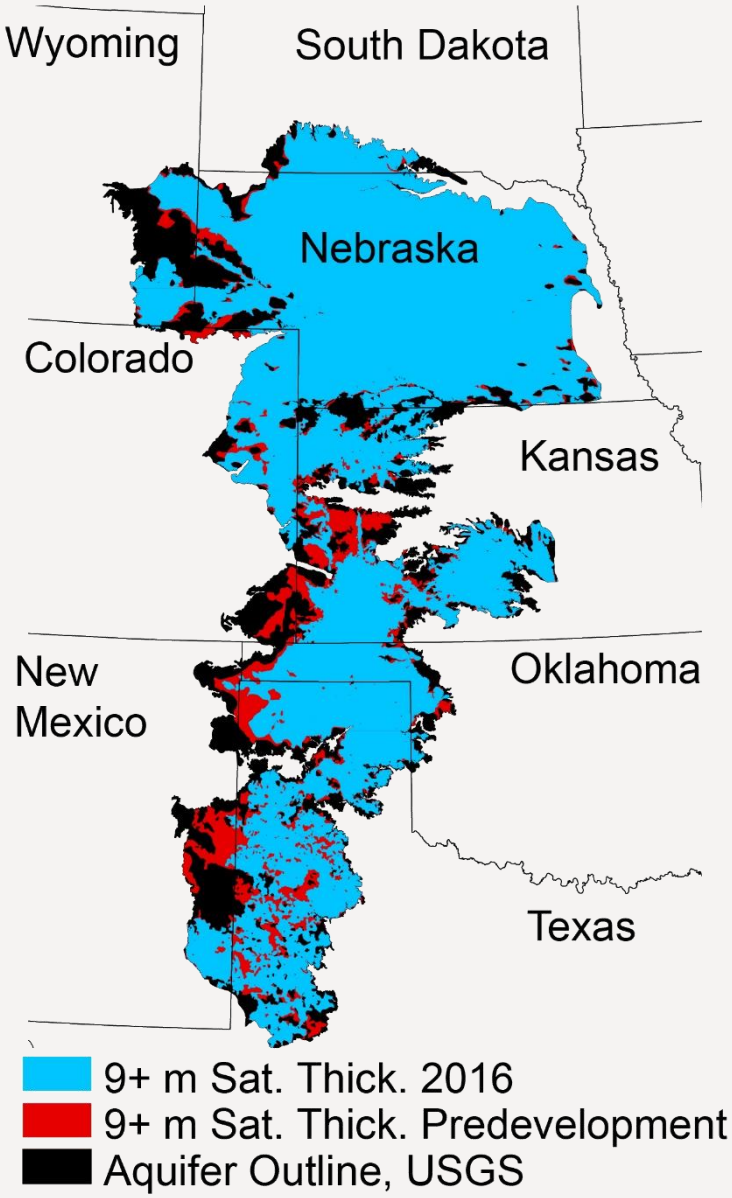
Cropland Data Layer, National Ag Statistics Service

Land Use 2016



High Plains Aquifer

- Greatest saturated thickness in Nebraska
- Most reliance in Texas
- Large declines in Texas, Oklahoma, Colorado, Kansas



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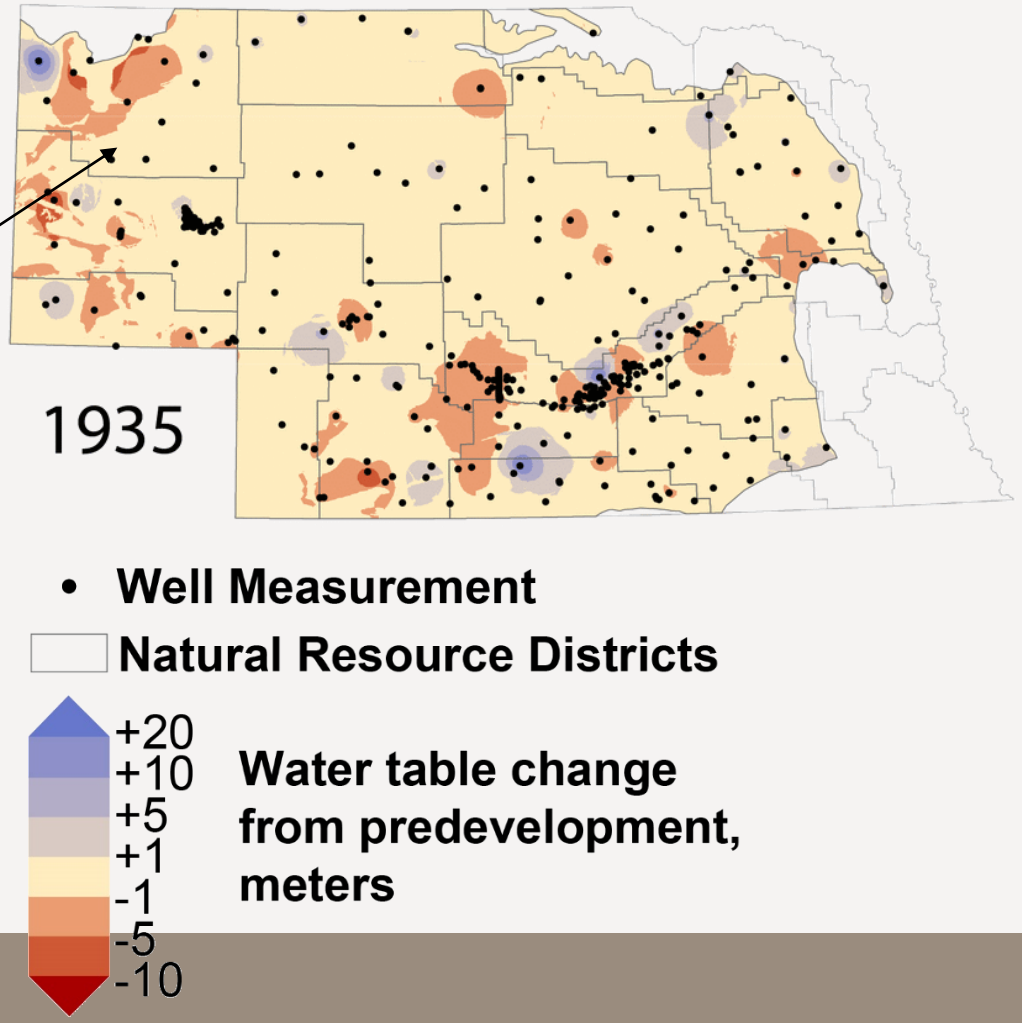
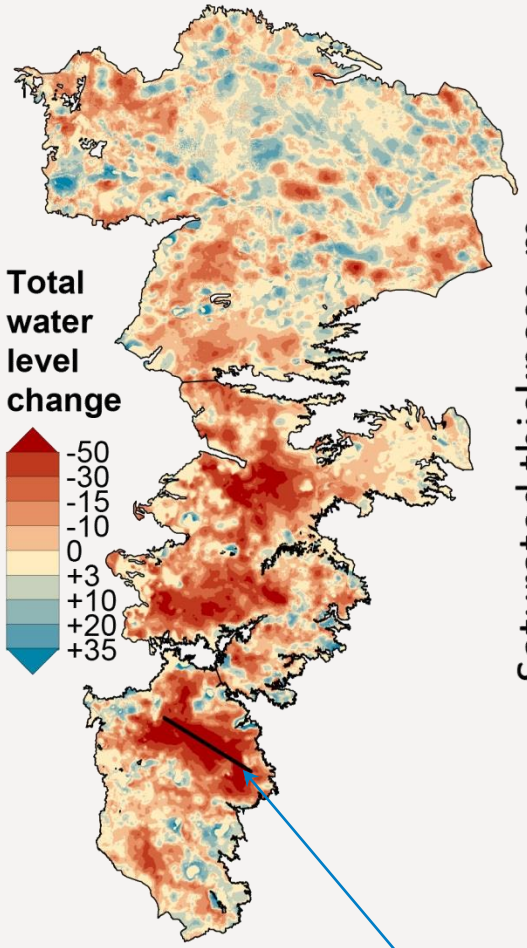
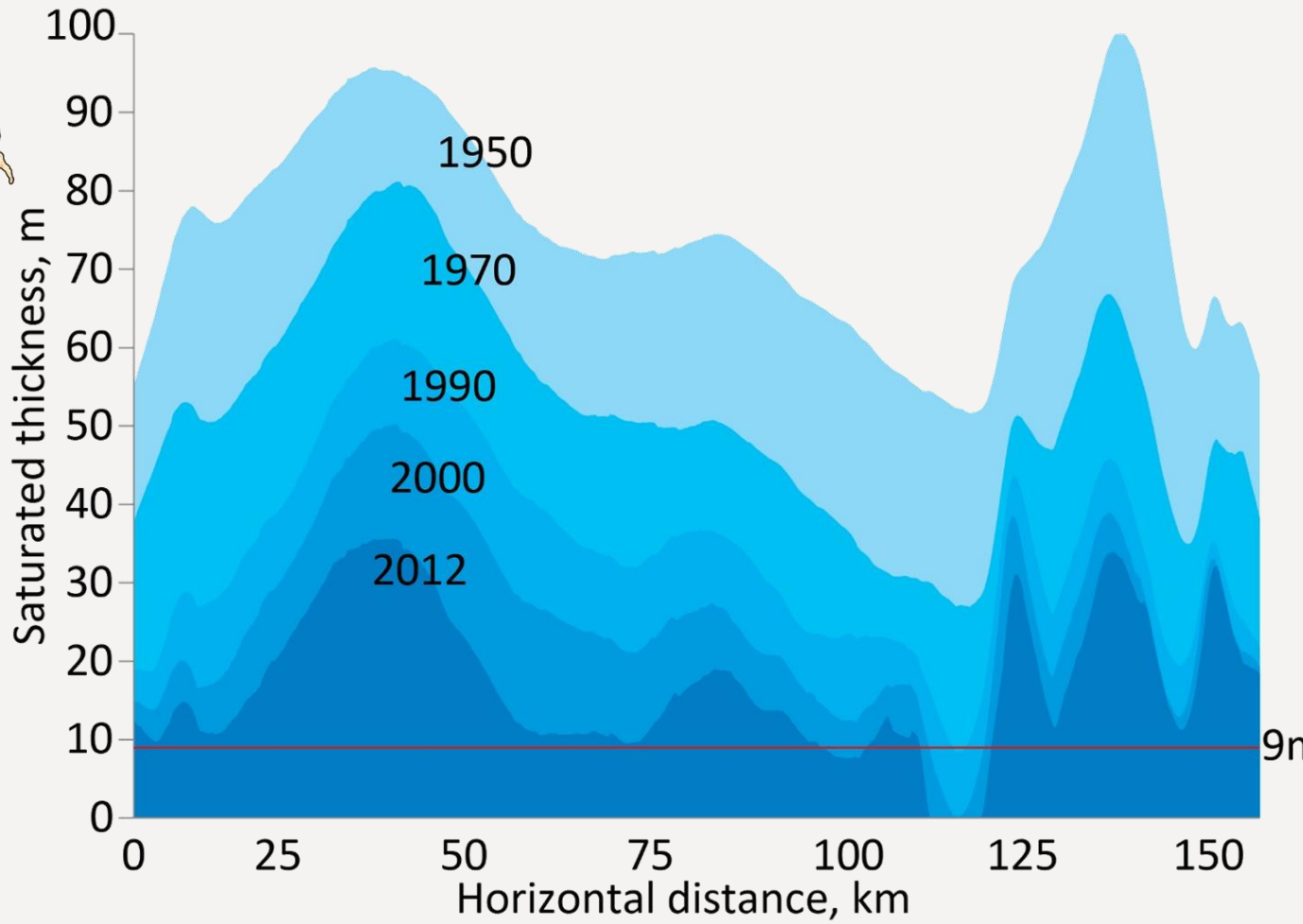
History of Well Development

- Water table increases in much of Nebraska
- Local decreases
- Most early wells drilled along rivers
- Dams contributed to water level increase



Water level declines in Texas





Cross section line, map view

Haacker et al. 2015

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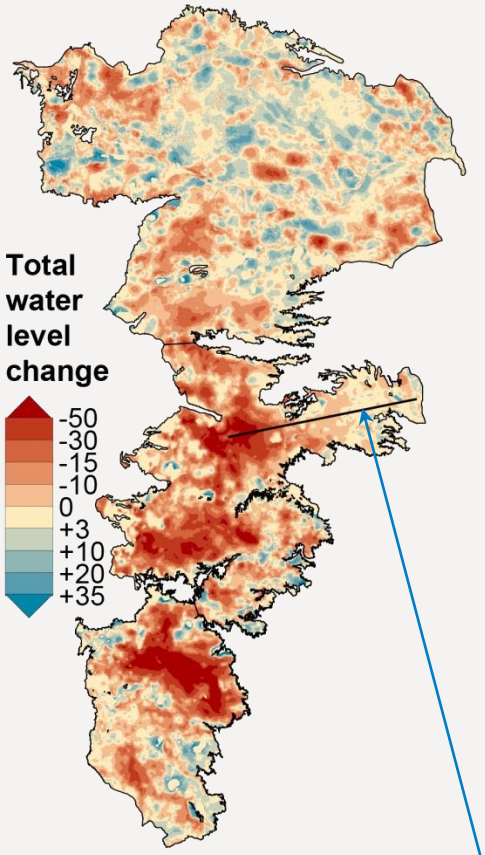
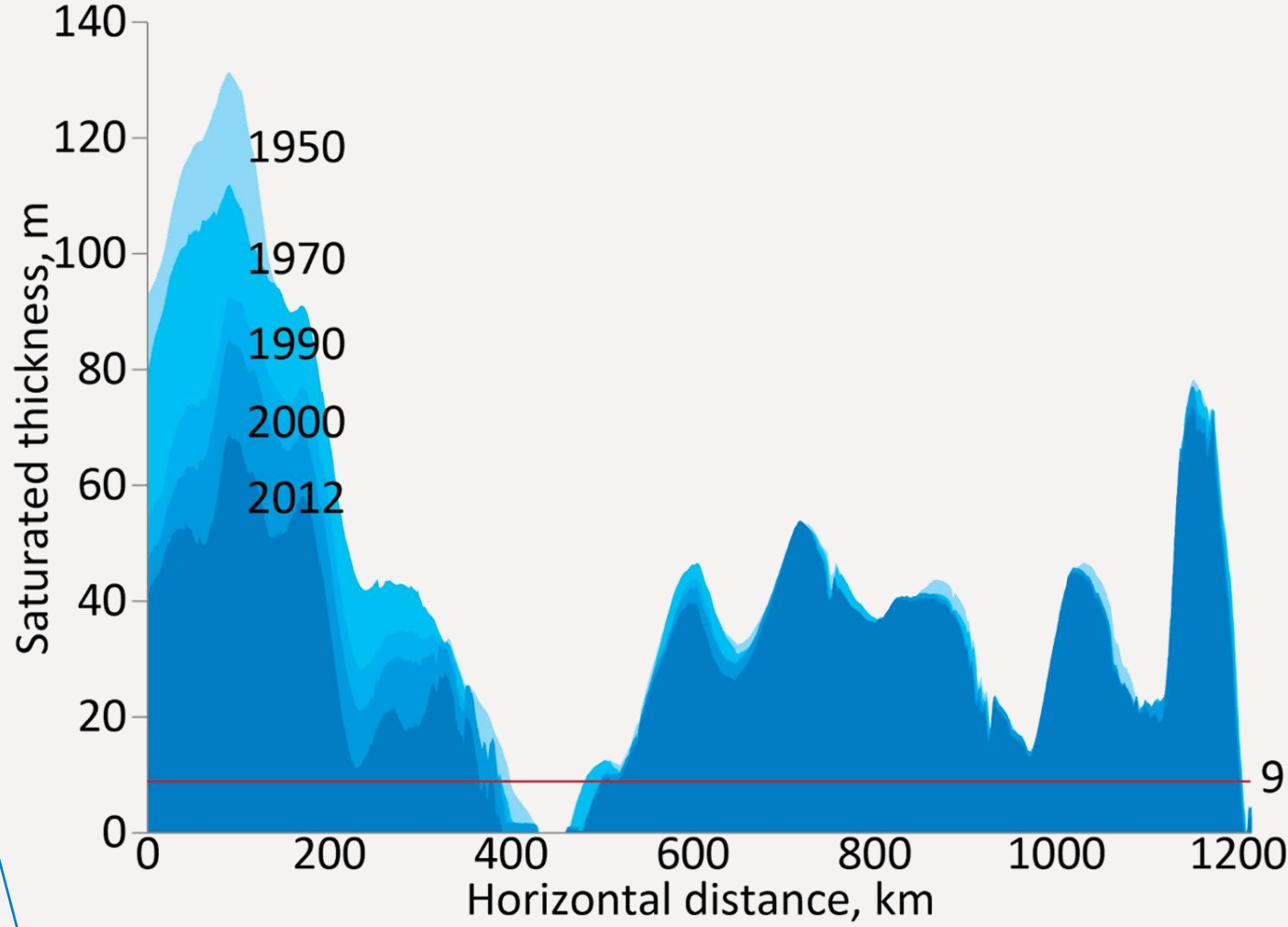
Water level declines in Kansas





Cross section line, map view

Haacker et al. 2015

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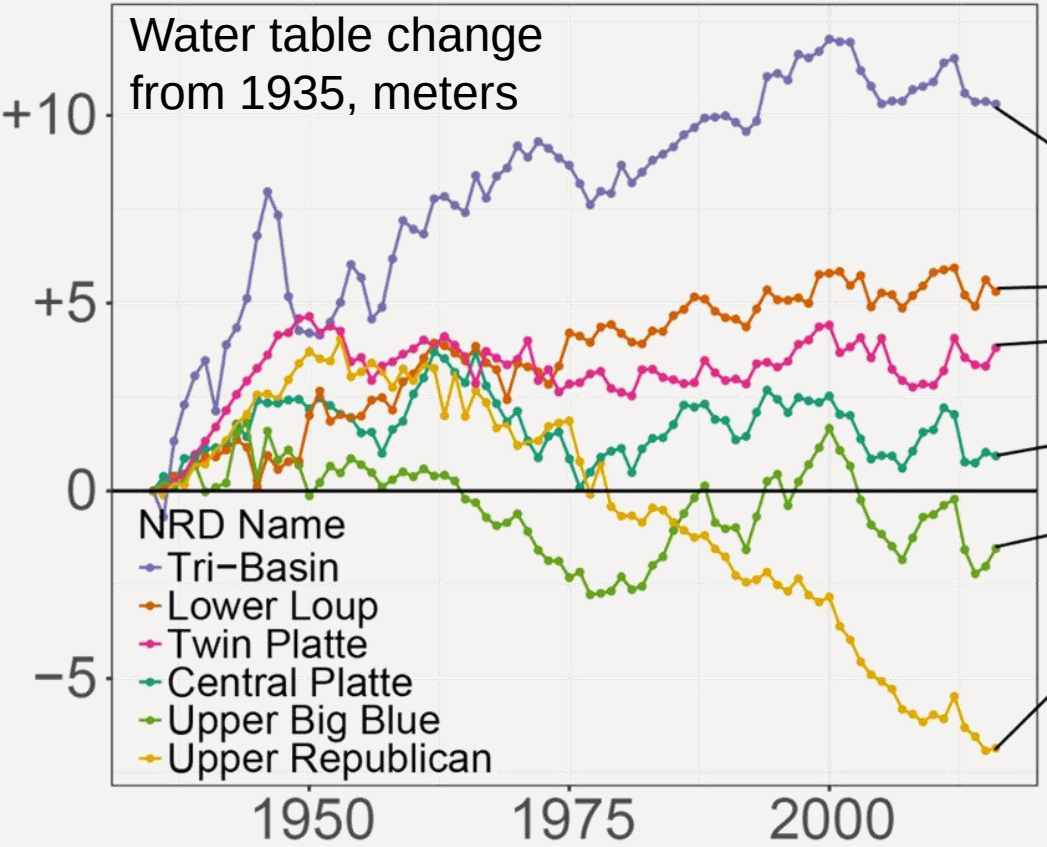
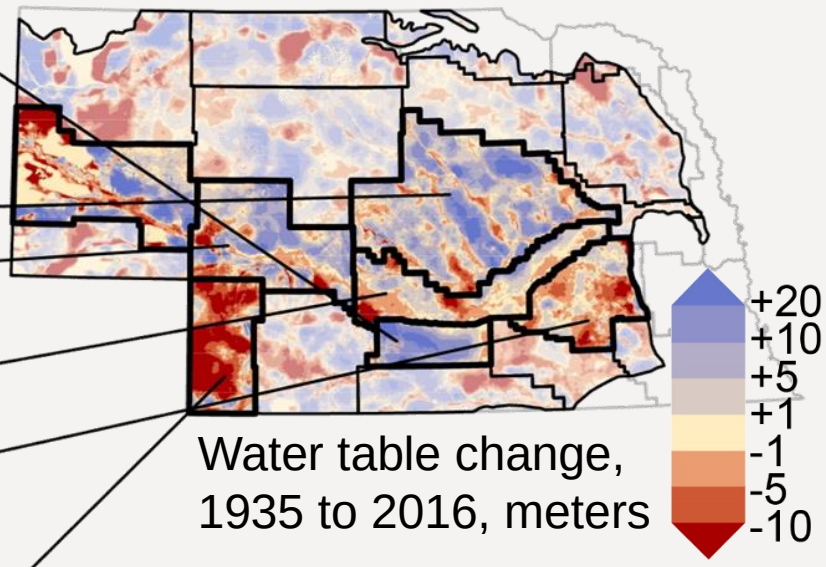
Water Tables over Time

- Water table changes vary within and between NRDs, over time
- Surface water use affects the water table

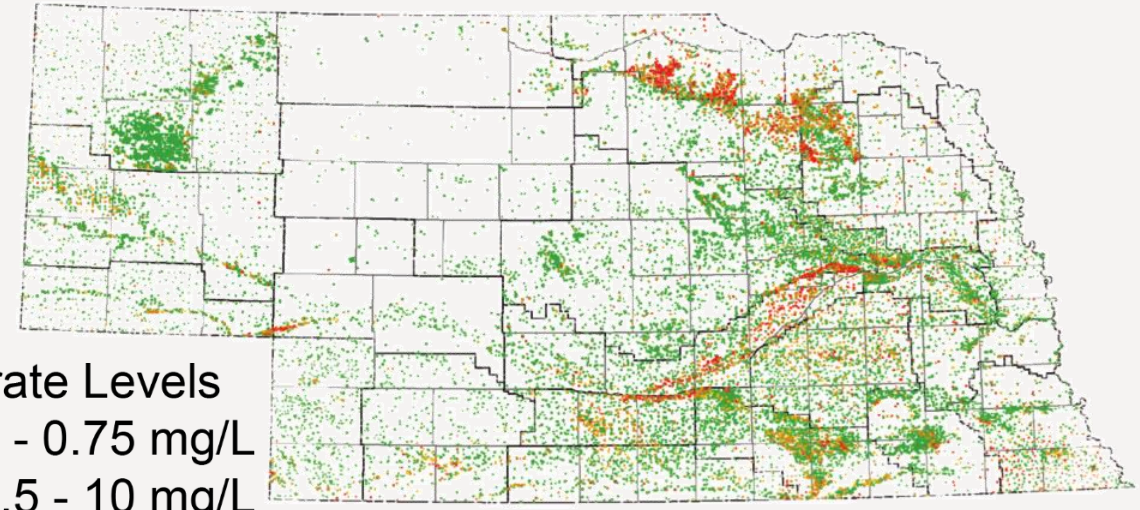




- NRDs created in 1972

Nitrate Contamination

- Over-application of fertilizer
- Worse in areas with sandy soil
- Worse in shallow wells

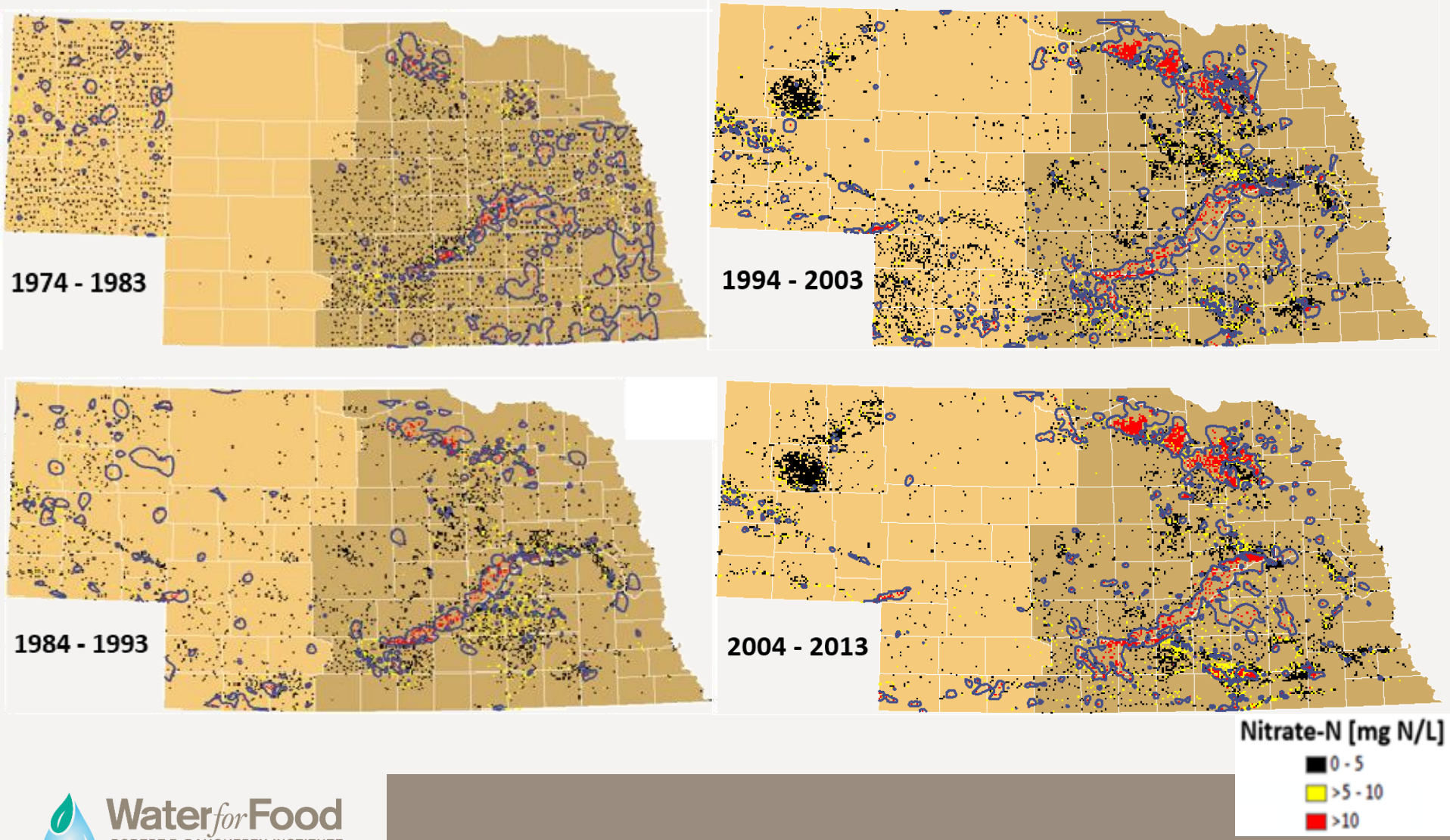


Nitrate Levels
- 0 - 0.75 mg/L
- 7.5 - 10 mg/L
- 10 - 20 mg/L
- 20+ mg/L

}Legal limit: 10 mg/L

- Affects individuals and nearby municipalities
- Cost of mitigation can be prohibitive

Groundwater Nitrate Distribution



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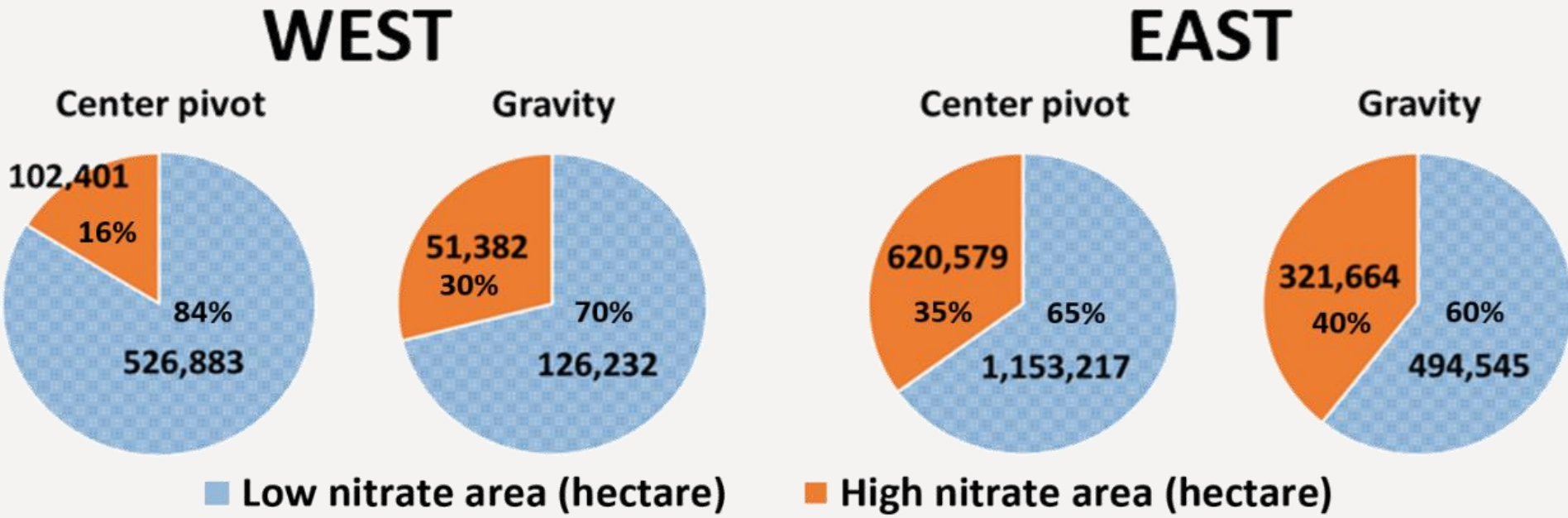
Data: NDEQ (NE Dept. of Env. Quality)

High and Low Nitrate by Irrigation Type, NE



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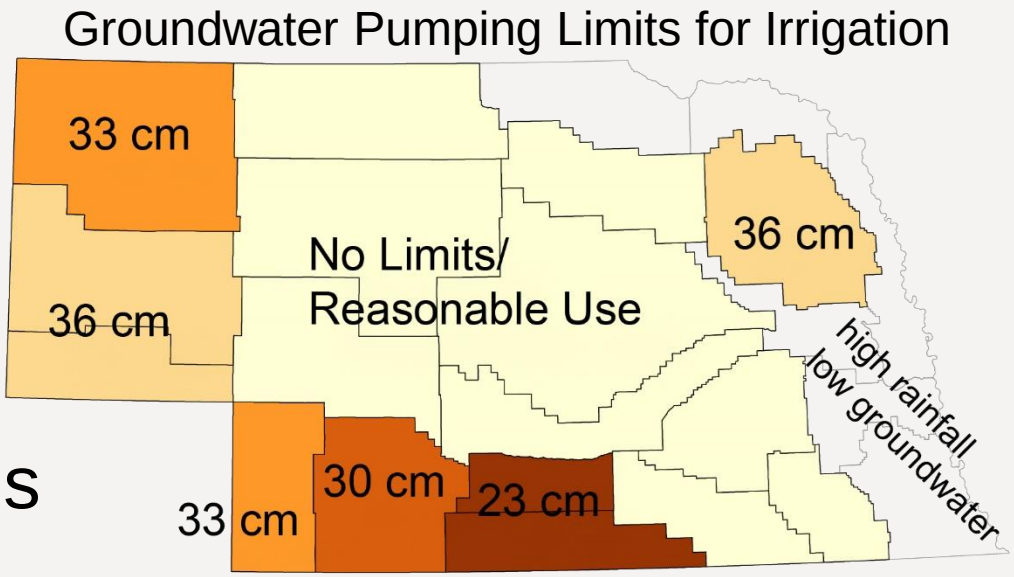
Data sources: School of Natural Resources (2015), Water GIS data, Irrigation Systems, UNL (2010), 2005 Land use mapping

Natural Resource Districts

- Enacted at the state level in 1972
- Responsible for groundwater, surface water, soil health, etc.
- Some water restrictions
  - Usually average over 5 years, e.g. 33 cm limit = 165 cm in 5 years



Private Sector Technology Development

Irrigation Technology

- Nebraskans pioneered center pivot technology
- Many options now available to farmers
- Tech adoption depends on upfront costs, expected $ benefits

Modern mobile drip irrigation

Irrigation Technology

- Sub-surface Drip
- Variable Rate Pivot

SDI Lateral Lines

SDI Manifold:

- RTU Unit, Valve, Flow Meter, Pressure Regulator, and Injection Port

Modern Water Management

- Integrated Management Plans
- Streamflow Augmentation
- Best Management Practices

Full Irrigation

Deficit Irrigation

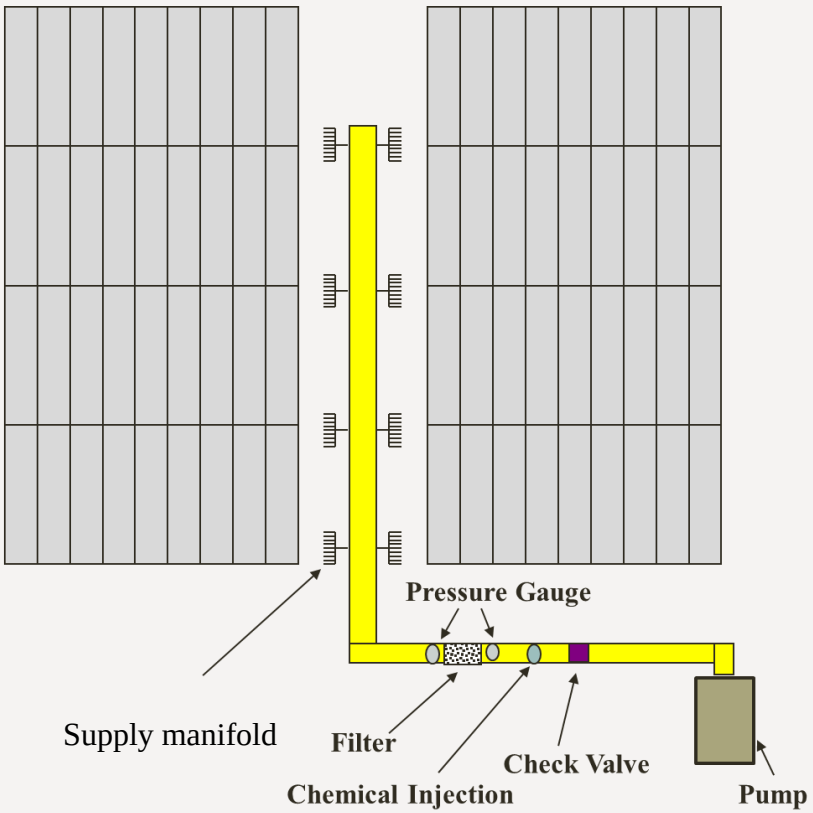
Rainfed

North Platte, NE

Crop: Corn
Years: 2005-2006
Irrigation: 6 inch Allocation

Results:

- Grain yield had the highest positive response to irrigation in July
- Grain yield had a negative response to irrigation in September
- Yield was strongly correlated to water stress during the milk and dough growth stages
- Evenly distributing the 6 inch allocation among July, August, and September was a good strategy but was susceptible to year to year variability
- Applying a large portion of the allocation in July was a good strategy across years



Subsurface Drip Irrigation System at West Central Research and Extension Center

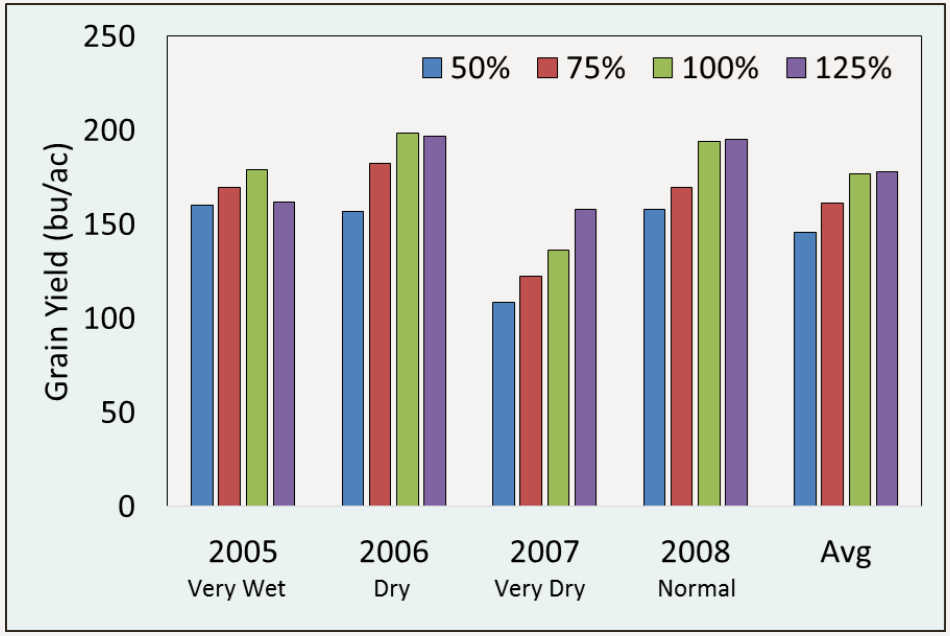
Source: Payero et al. (2009)

SCOTTSBLUFF, NE

Results:

- Yield response to irrigation (not including 125% treatment) was 4.2 bushel per acre-inch
- IWUE decreased with an increase in irrigation and ranged from 7.2 bu/ac-in (125% trt) to 12.6 bu/ac-in (50% trt)
- Maximum yield occurred with 11.8 inches of irrigation in a wet year (rainfall ~ 10.8 in) and 14.8 inches in a dry year (rainfall ~ 5.7 in)
- Concluded: Timing of irrigation in relationship to plant growth stage may be more critical than simply greater amounts of irrigation

Crop: Corn & Dry Beans
Years: 2005-2008
Irrigation: 100% (FIT), 125%, 75%, & 50%
Tillage: Disked prior to planting



Corn grain yield response for different irrigation treatments in contrasting growing seasons.

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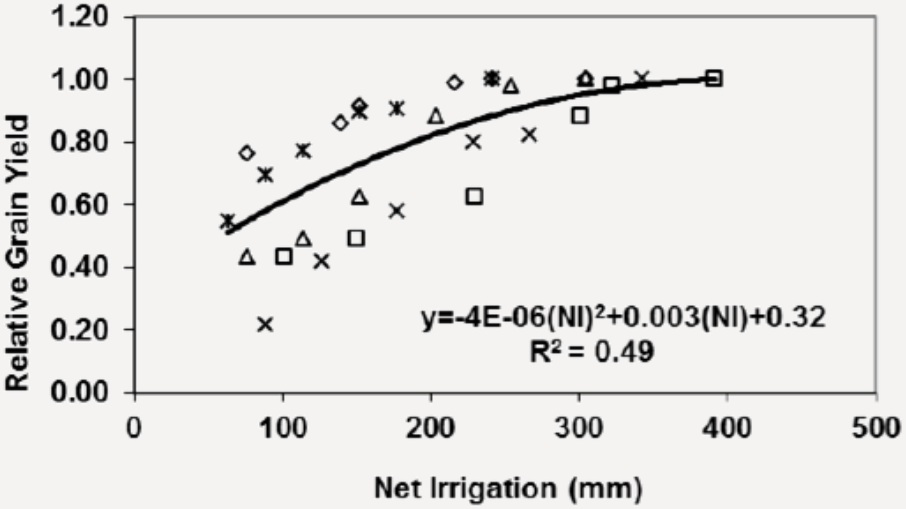
Source: Spurgeon and Yonts (2013)

GARDEN CITY, KS

Results:

- CWUE was not significantly different between 100%, 80%, and 70% (CWUE = 7.65 to 7.89 bu/ac-in), but decreased significantly from 50% to 25%
- Yield and ET decreased with a reduction in irrigation
- Deficit treatments utilized more non-growing season rainfall and extracted more soil water during the growing season as compared to FIT
- Variability in yields increased as irrigation decreased, illustrating a greater income risk with less irrigation

Crop: Corn
Years: 2005-2009
Irrigation: 100% (FIT), 80%, 70%, 50%, 40%, & 25%
Tillage: No-Till



Relative Grain Yield response to net irrigation (NI)

Source: Klocke et al. (2011)

THANK YOU

Photo: Jose Payero