ANALYSIS OF IMPACT OF SALINITY ON WATER SUPPLY STRESS: IMPLICATIONS AND POTENTIAL SOLUTIONS FOR LOUISIANA FRESHWATER AND COASTAL SYSTEMS

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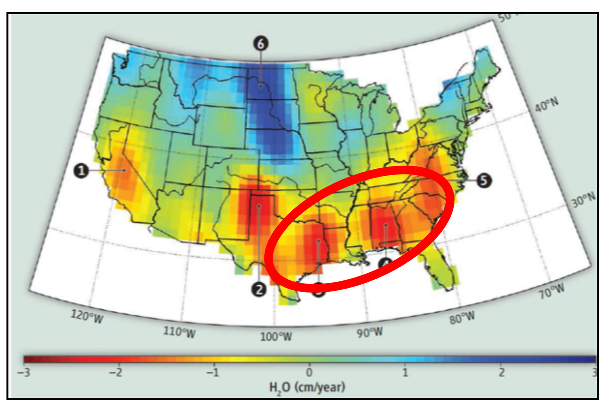
Problem

Despite relatively abundant rainfall and surface water, **groundwater is being overused** across the Southeastern US.

This can lead to **subsidence, salt water intrusion**, coastal **land loss,** and **loss of available freshwater** for coastal communities.

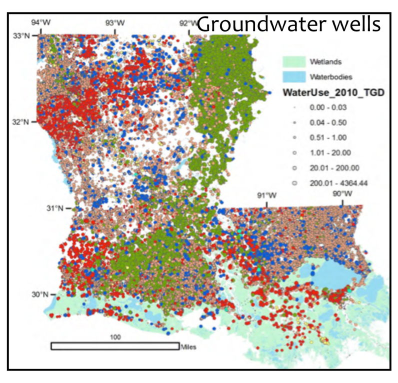


GRACE satellite estimates of changes in terrestrial water storage over the last decade. (Famiglietti and Rodell, 2013, Science).

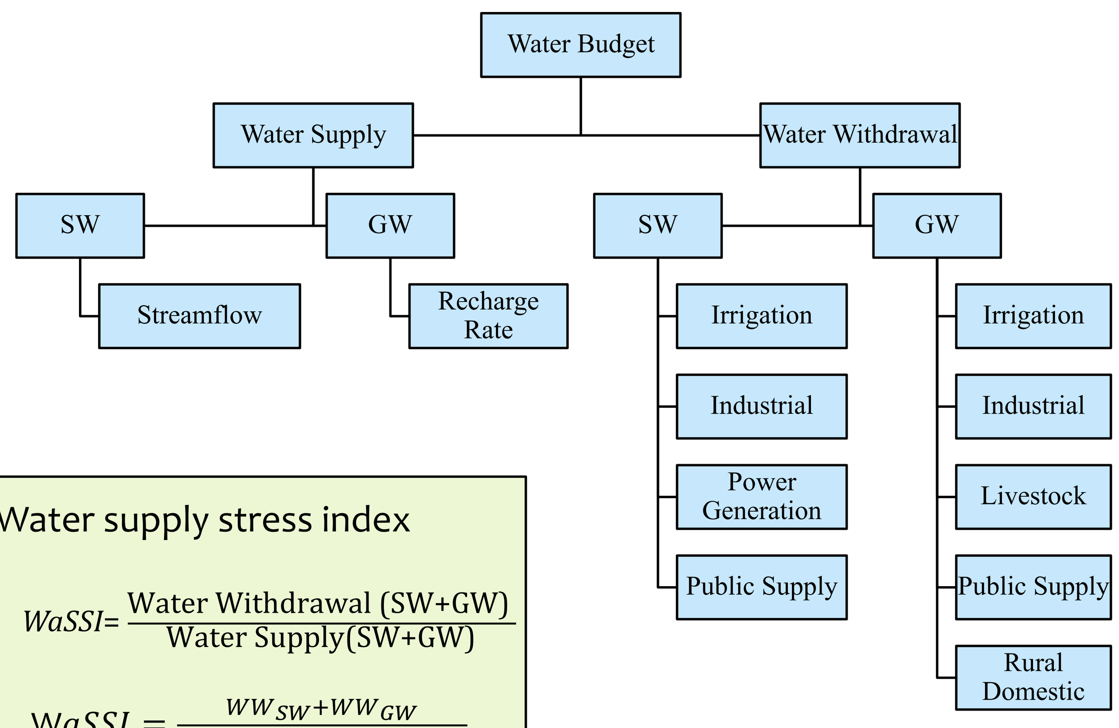
Research Questions

What are the **natural drivers and social dynamics** that control water usage decisions that lead to overuse of groundwater in coastal regions such as south LA?

Can we identify opportunities for implementing **new sustainable water management strategies**



Approach: Water Stress Framework

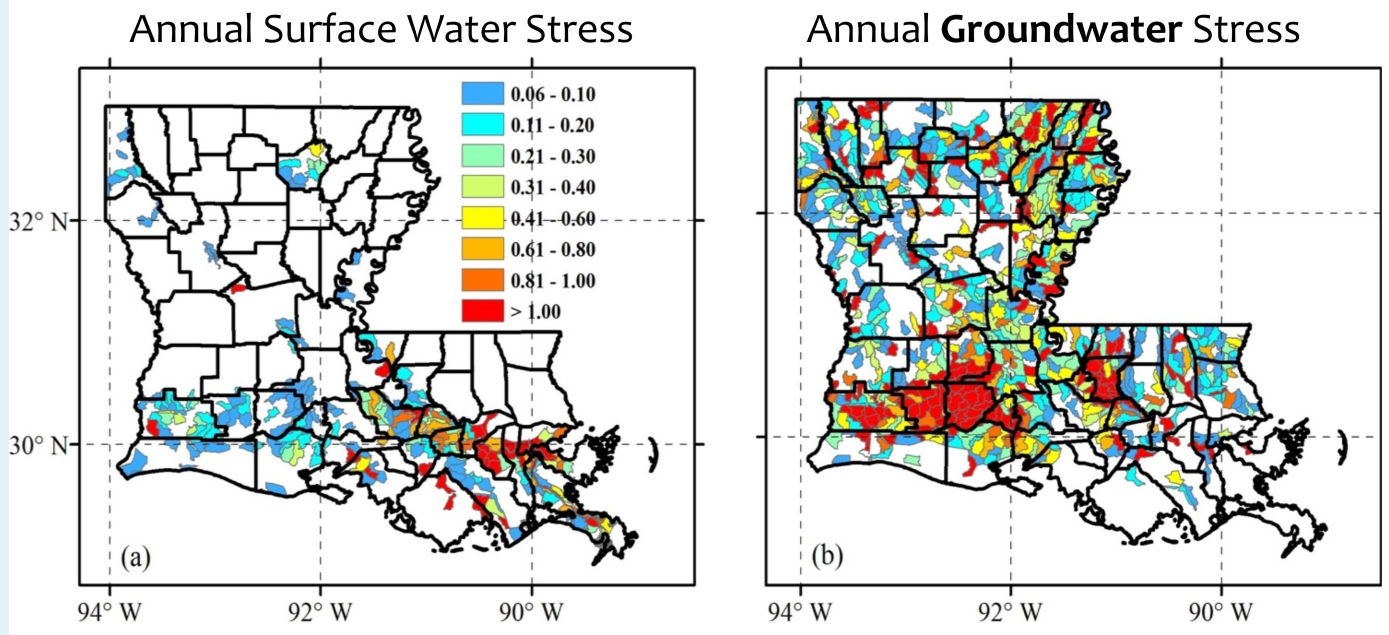


Water supply stress index

$$WaSSI = \frac{\text{Water Withdrawal (SW+GW)}}{\text{Water Supply(SW+GW)}}$$

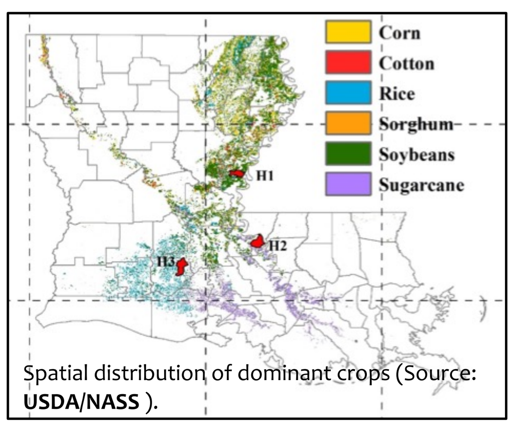
$$WaSSI = \frac{WW_{SW}+WW_{GW}}{(1-ENV)*WS_{SW}+WS_{GW}}$$

Water Stress Results



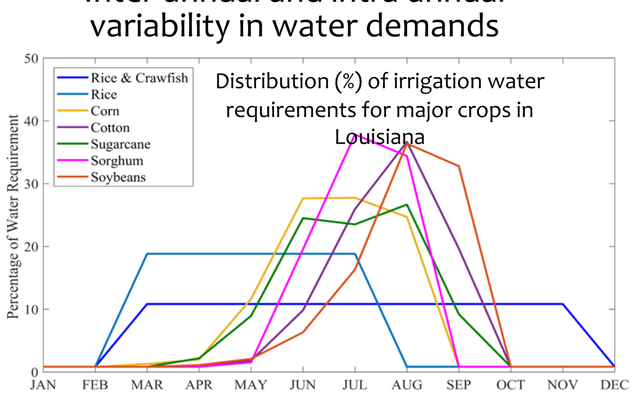
Areas in red indicate water deficits. For groundwater that implies water is being mined faster than it is replaced through natural recharge processes.

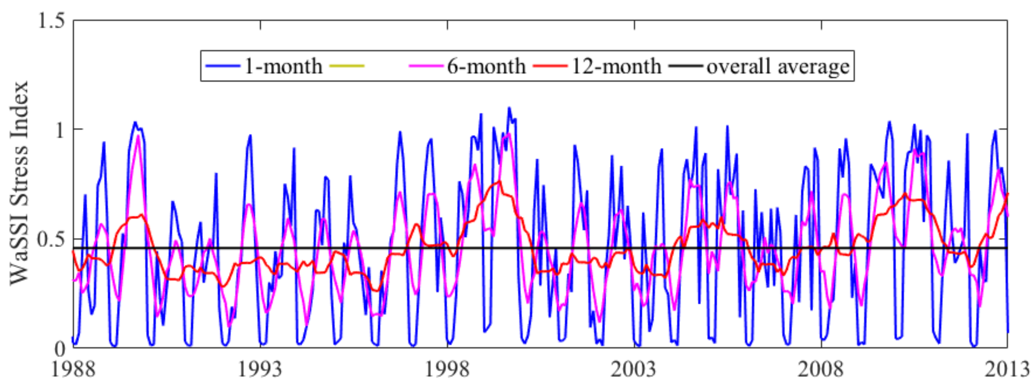
Impact of Climate Variability



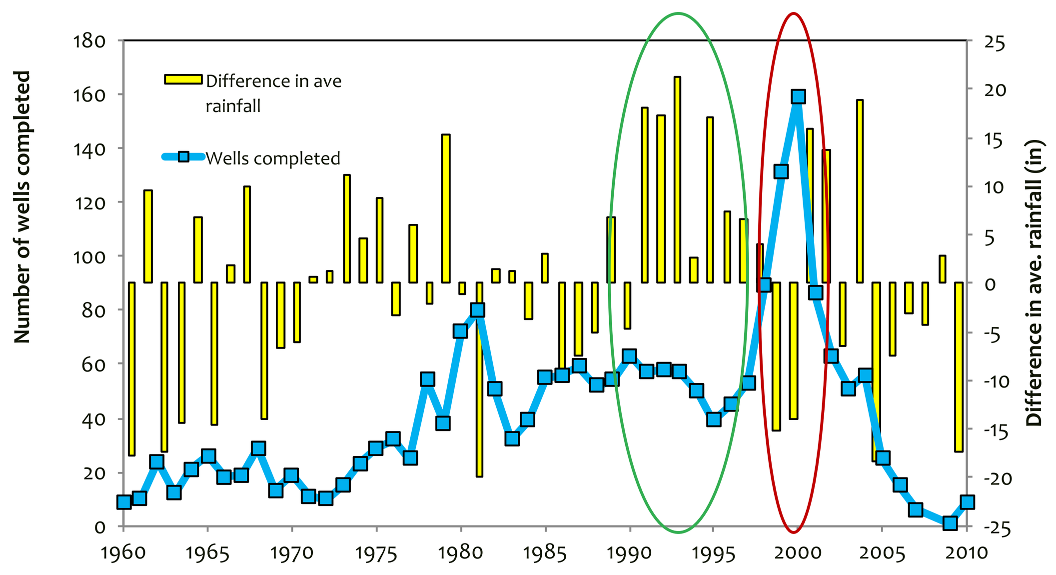
Spatial distribution of dominant crops (Source: USDA/NASS).

Inter-annual and intra-annual variability in water demands





Farmers adapt to climate variability by drilling more wells!



Farmers invested in groundwater wells instead of surface water infrastructure in response to seasonal deficits and drought.

Integrating water quality into the water stress analysis

Focus on one water use sector (agriculture):

Sector-specific Stress: $SWaSSI = \frac{WWi_{sw}+WWi_{gw}}{WSi_{sw}+WSi_{gw}}$

Use existing chemical data to quantify fraction of useable water in a given HUC12:

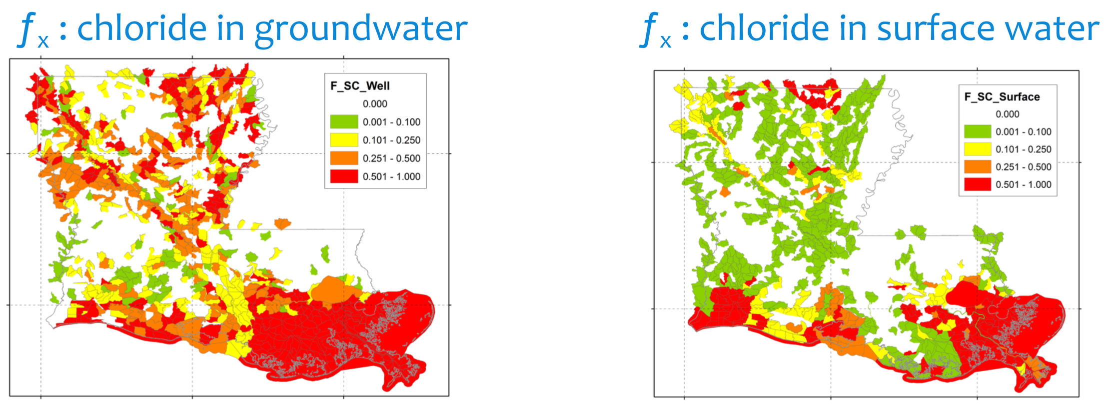
water quality parameter (e.g., salinity) — threshold of acceptable salinity for agriculture sector

$$f_X = \frac{(\Sigma \text{ number of measurements of X > threshold value})}{(\Sigma \text{ number of all measurements of X})}$$

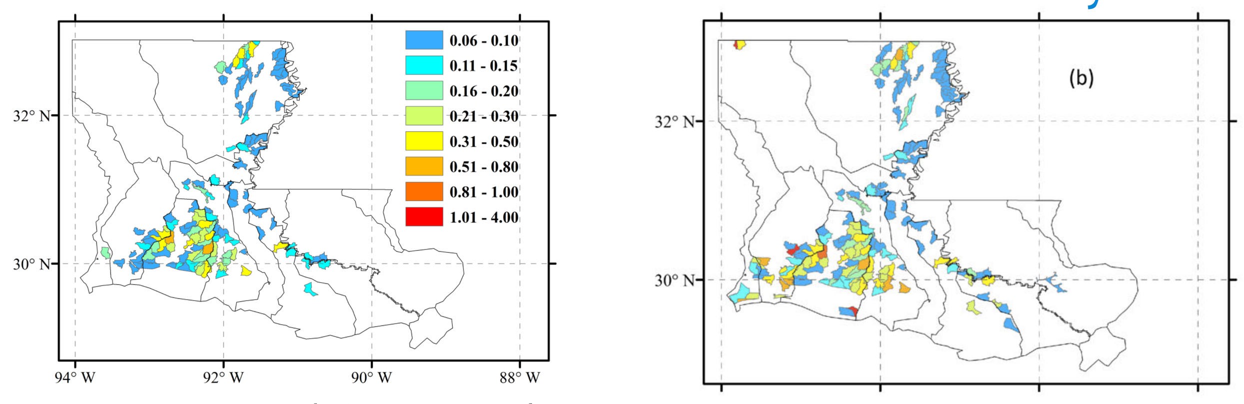
Incorporate into SWaSSI:

$$SWaSSI = \frac{WWi_{sw}+WWi_{gw}}{(1-f_{x\_sw})*WSi_{SW}+(1-f_{x\_gw})*WSi_{GW}}$$

Irrigation and water quality sampling at a rice farm in southwest Louisiana



Water stress attributable to elevated salinity



SWaSSI prior to considering Water quality — SWaSSI after considering Water quality

Most of the increased stress occurred in the Calcasieu, and Vermilion-Teche watersheds.

Social Dynamics: what drives the decision making?

How our results were corroborated by field interviews?

Community stakeholder involvement

- Farmers who owned majority of acreage they farmed and who had experienced extended or repeated drought had multiple deep-water wells.
- Less than 20% of farmers stored surface water for future use. Those who did store surface water had a naturally occurring pond area, or had identified areas in their property that were not viable for farming.
- Loan qualification is easier when farmers have wells on property

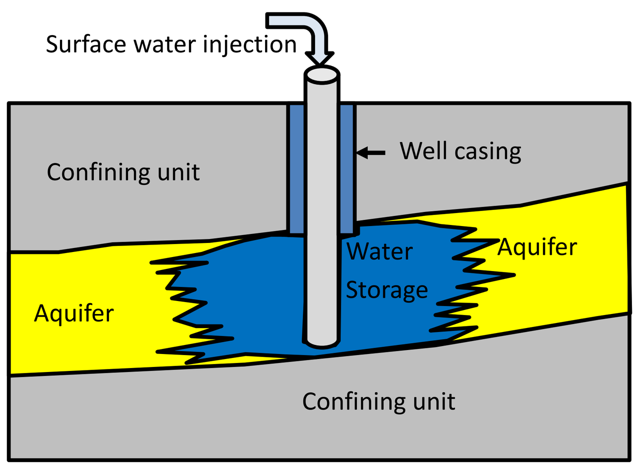
Key Insights & Implications for Water Management

- There is a **delicate balance** between freshwater and saltwater in coastal zones -- this can be disrupted by unplanned changes in water management in both systems.
- There is abundance of surface water on an average annual scale that can offset groundwater demand, but there is substantial **seasonal and inter-annual variability** that is hidden by annual averages.
- Hence, **"reliability"** appears to be a primary factor why farmers choose groundwater over surface water.
- Water quality plays an important role in affecting water management decisions
- Our water stress framework can be used to evaluate a wide variety of **scenarios**: climate, crop patterns, additions of power plant, water policy, water prioritization

Future Work: Integrated water management solutions

Developing storage capacity

Can we identify opportunities for building surface water storage capacity to benefit farmers during irrigation season but also mitigate flooding during emergencies?



More information available in these publications

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