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Louisiana Department of Natural Resources, Office of Conservation, 11/30/2023

Ongoing Research on Louisiana's Aquifer Systems, Groundwater and Beyond – from the La. Water Resources Research Institute (LWRRI)

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LWRRI

LOVE PURPLE
LIVE GOLD

Louisiana Water Resources Research Institute (LWRRI)

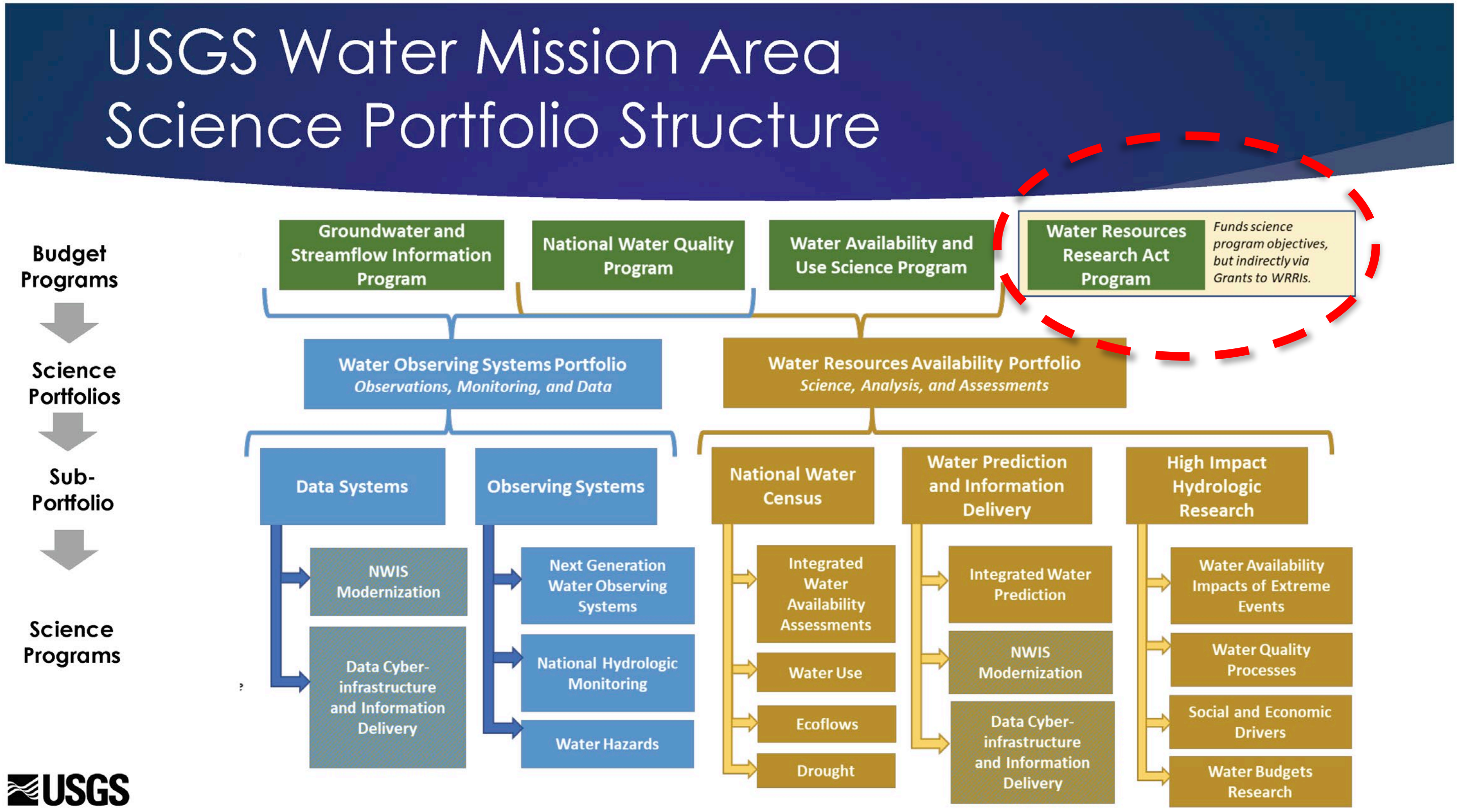
Water Resources Research Act Program

The Water Resources Research Act Program, authorized by section 104 of the Water Resources Research Act of 1984, is a Federal-State partnership which:

- Plans, facilitates, and conducts research to aid in the resolution of State and regional water problems
- Promotes technology transfer and the dissemination and application of research results
- Provides for the training of scientists and engineers through their participation in research
- Provides for competitive grants to be awarded under the Water Resources Research Act

The Institutes

There are 54 Water Resources Research Institutes or Centers, one in each of the 50 states as well as the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam.



https://water.usgs.gov/wrri/

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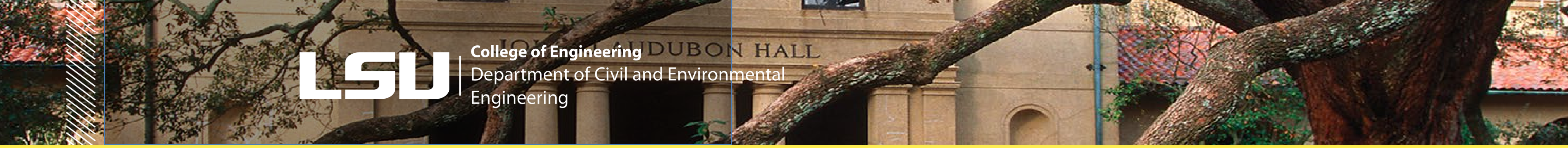
Outline

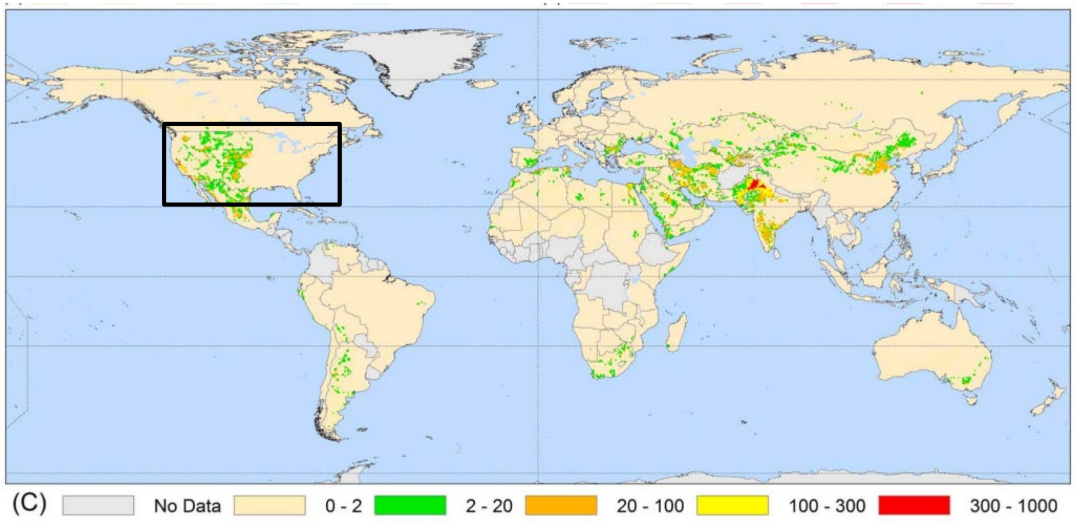
- Motivations
- Regional scale data collection
- Geological and groundwater modeling for LA and beyond
- Concluding remarks



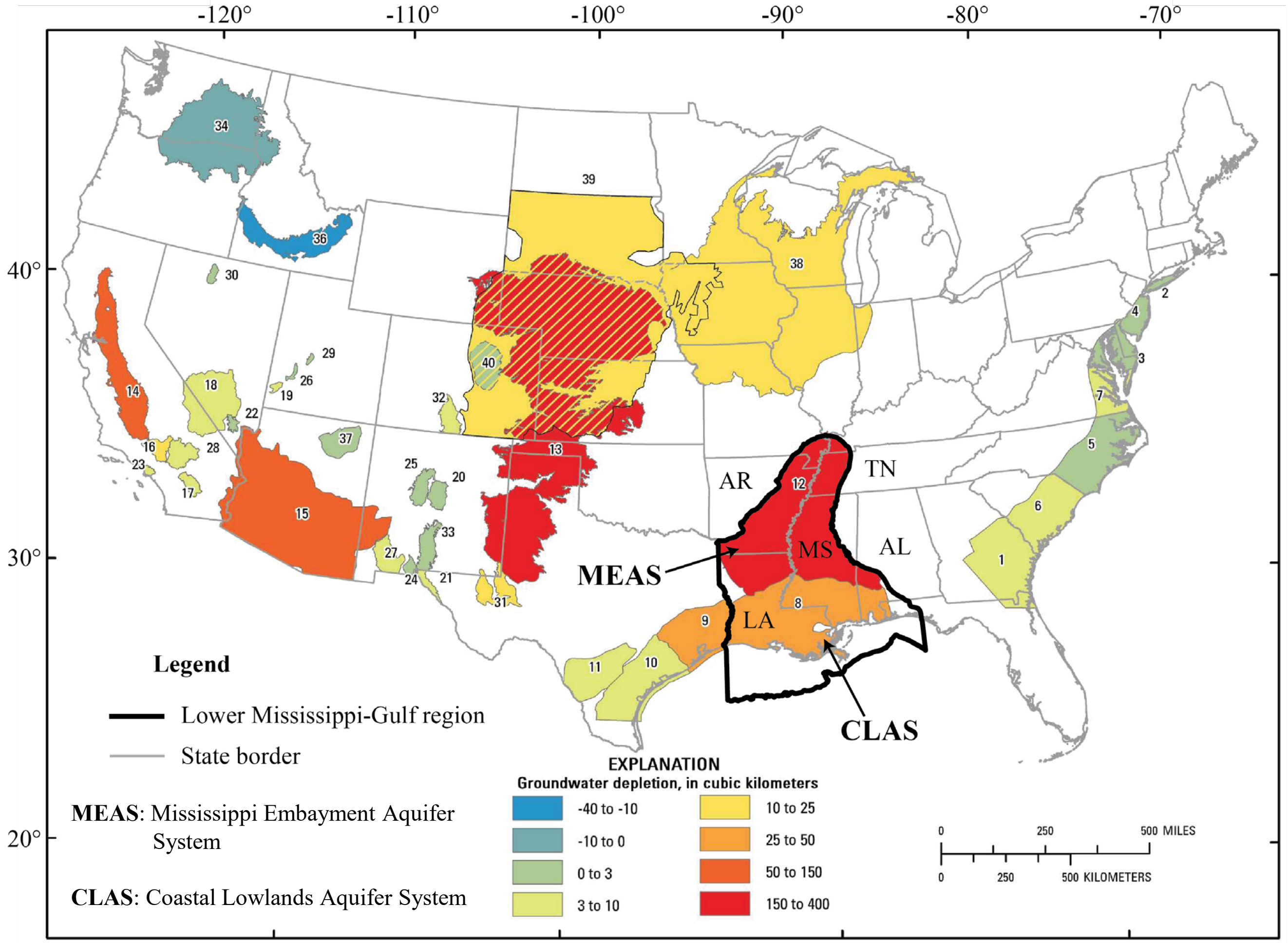
Motivations

- **Groundwater depletion: A global concern**

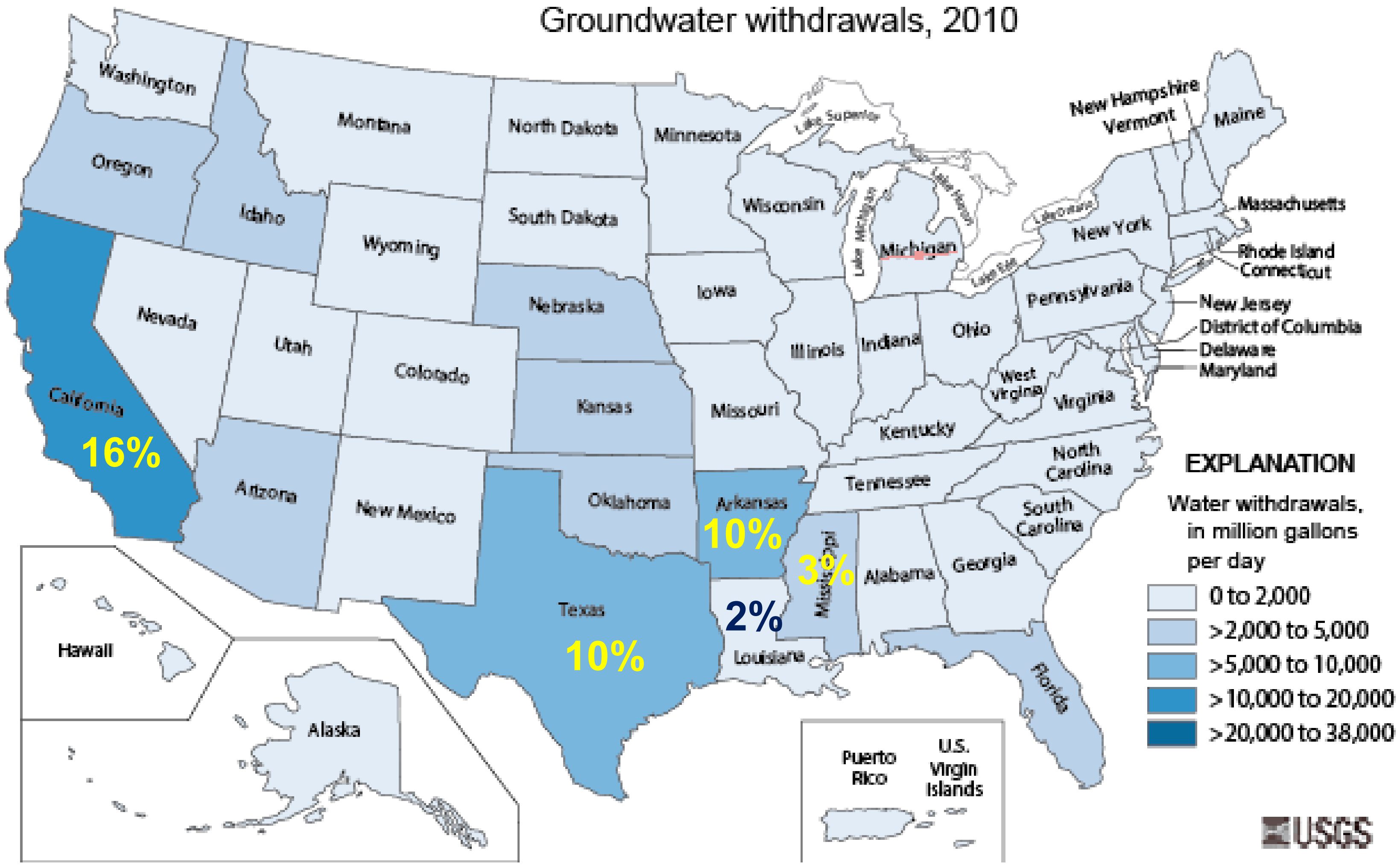
- Overexploitation of groundwater has resulted in global groundwater depletion (Wada et al., 2010);
- Depletion from 1900 to 2008 was estimated about 1,000 km^3 in the US (Konikow, 2011);
- Considerable depletion in the Lower Mississippi-Gulf region.



Global groundwater depletion (mm/year) (Wada et al., 2010).



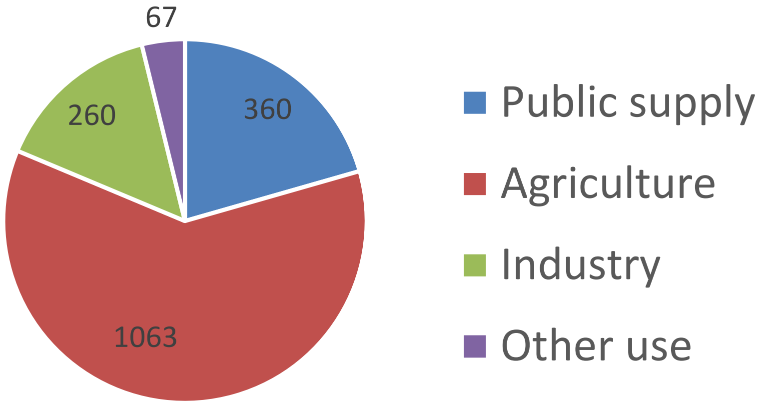
Groundwater depletion from 1900 to 2008 in the US (Konikow, 2013).



Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014, Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p.

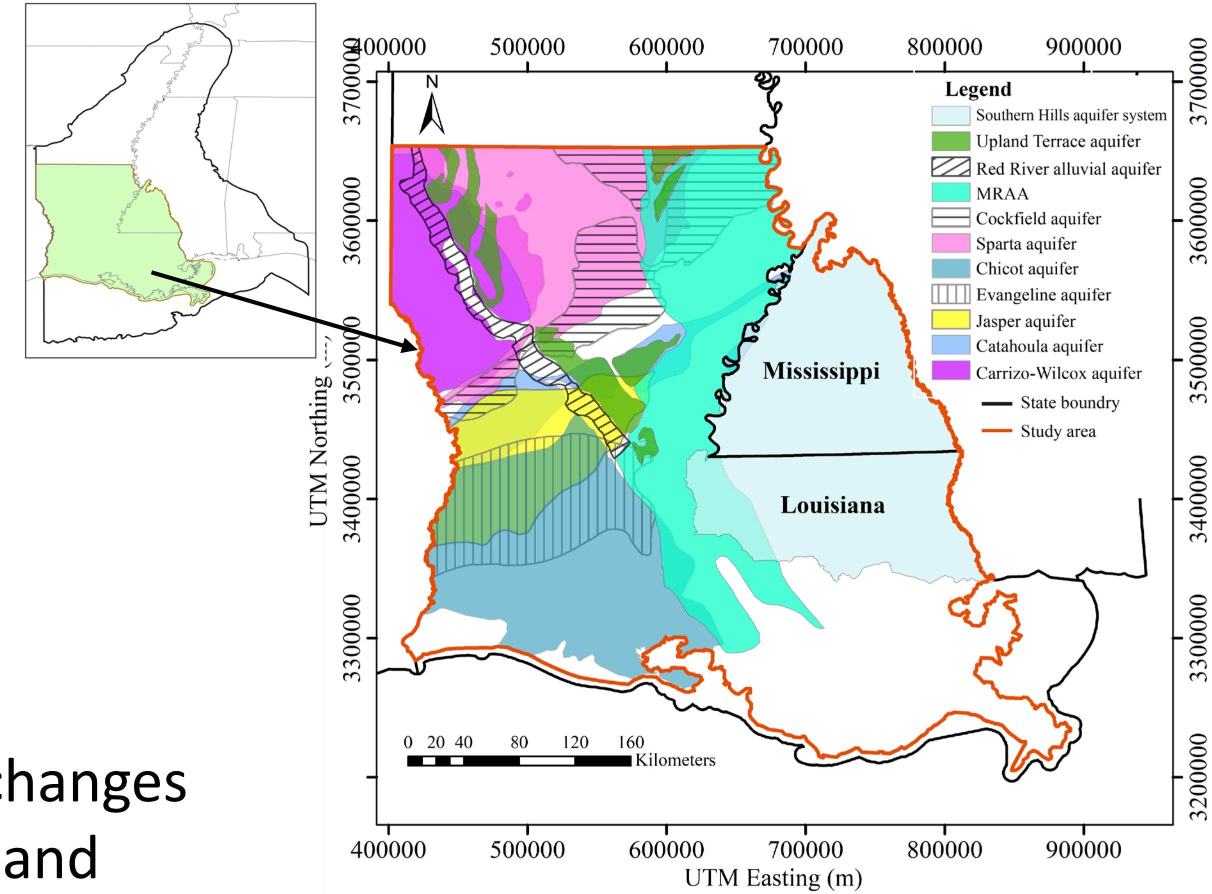
Motivations

- **Significance of groundwater use in Louisiana**



Groundwater use 1750 MGD in Louisiana in 2015 (USGS 2018)

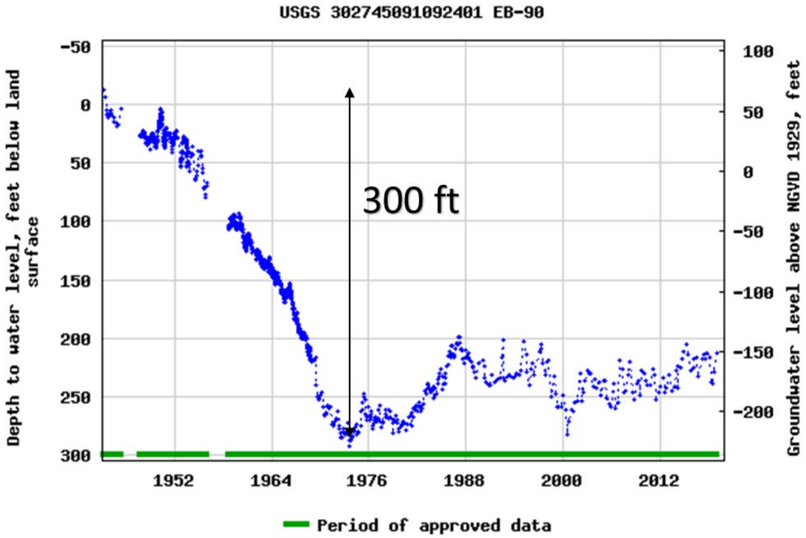
- **Goal:** Assess aquifer conditions and storage changes under long-term effects of natural processes and anthropogenic activities.

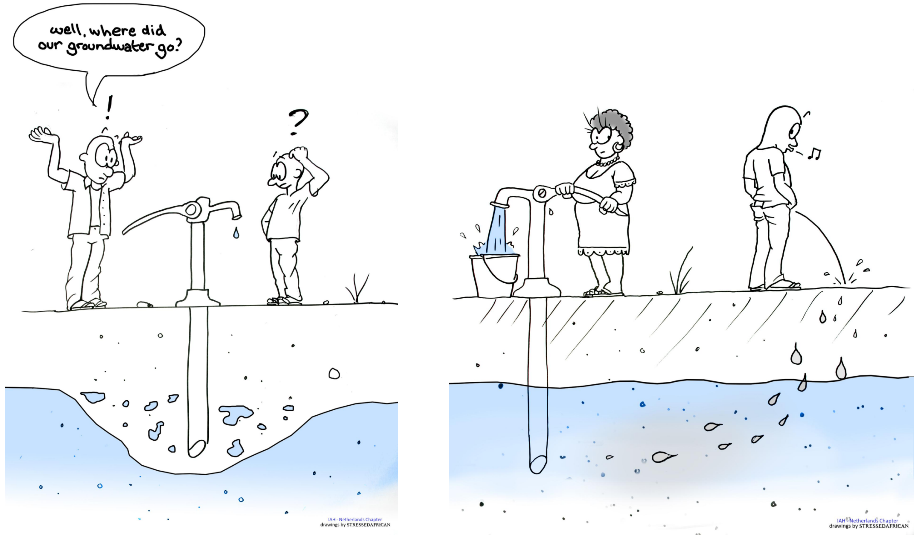


Aquifers or aquifer systems in Louisiana

Critical issues relating to groundwater withdrawal

- Significant groundwater level decline
- Saltwater intrusion
  - ✓ Southern Hills aquifer system (Southeast)
  - ✓ Mississippi River alluvial aquifer (Northeast)
  - ✓ Chicot aquifer system (Southwest)
  - ✓ Sparta aquifer (North)
- Land subsidence
  - ✓ Baton Rouge
  - ✓ New Orleans
  - ✓ Southwest Louisiana
- Transboundary issues
  - ✓ South Arkansas
  - ✓ East Texas
- Dry well issues
  - ✓ Northwest Louisiana



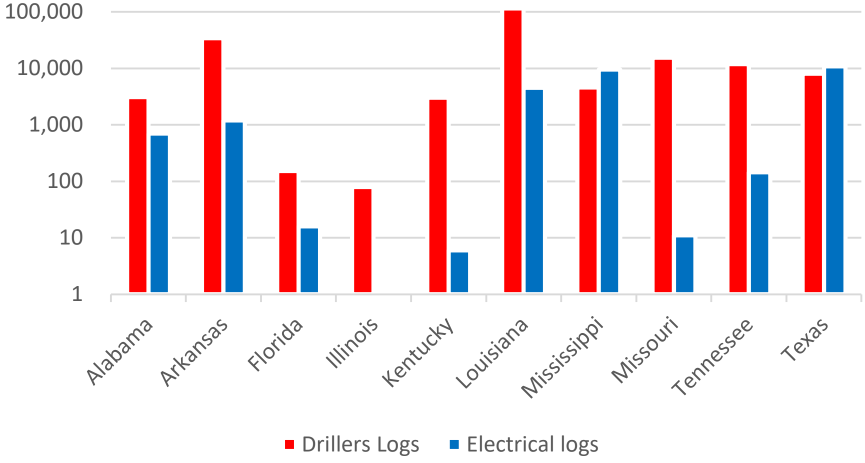


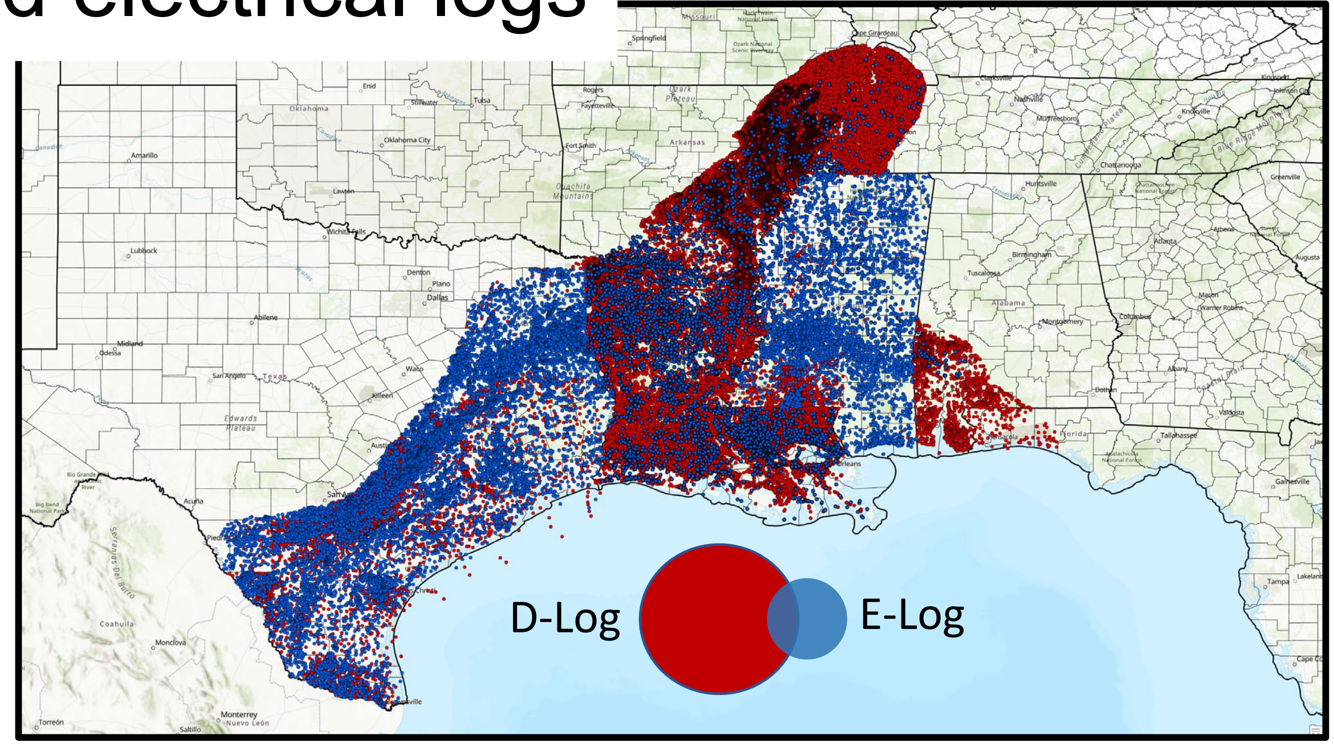
California Department of Water Resources,
Texas Water Development Board, ...
There is no groundwater study plan in Louisiana.

Compilation of drillers logs and electrical logs

State	Drillers Logs	Electrical logs	Total
Alabama	3,106	702	3,808
Arkansas	34,278	1,191	35,469
Florida	152	16	168
Illinois	79	1	80
Kentucky	3,028	6	3,034
Louisiana	114,472	4,556	119,028
Mississippi	4,561	9,584	14,145
Missouri	15,368	11	15,379
Tennessee	11,933	145	12,078
Texas	8,071	10,804	18,875
Total	**195,048**	**27,016**	**222,064**

Number of well logs





Data Share
https://storymaps.arcgis.com/stories/f8bcf151e444416c96c3f19e7bc41dc9)

USGS science for a changing world
Geological Survey of Alabama Founded 1848
Mississippi Department of Environmental Quality
Missouri Department of Natural Resources
Texas Water Development Board
Louisiana Department of Natural Resources
Louisiana Geological Survey Earth Science Serving Louisiana 1934
State Oil and Gas Board of Alabama Founded 1945
Florida Geological Survey Est. 1907
Illinois Illinois State Geological Survey Prairie Research Institute
TN Department of Environment & Conservation
Kentucky Geological Survey

Compilation of groundwater use data

State	Data Source	Data collection frequency	Year
Louisiana (statewide)	USGS (LA), CAGCD, LSU AgCenter	Monthly	1999-2020
Arkansas (statewide)	USGS (AR)	Monthly	1999-2020
Mississippi (MEAS, CLAS)	MDEQ	Yearly (non-ag) Monthly (ag)	1990-2021 2014-2020
Tennessee (MEAS)	TDEC	Monthly (public) Yearly (private)	2001-2020 2006-2020
Alabama (CLAS) Florida (CLAS) Texas (CLAS)	USGS (TX)	Yearly	1925-2018

USGS science for a changing world

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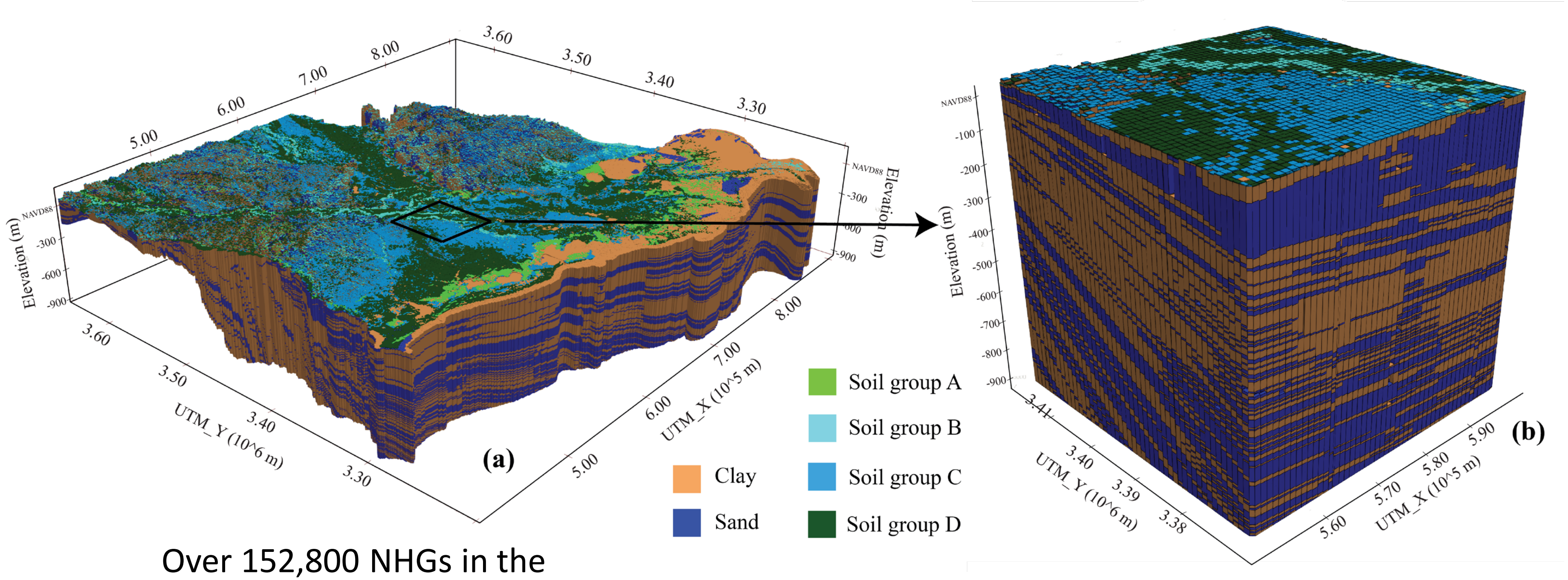
TN Department of Environment & Conservation

High-fidelity statewide groundwater model construction

➢ Model structure

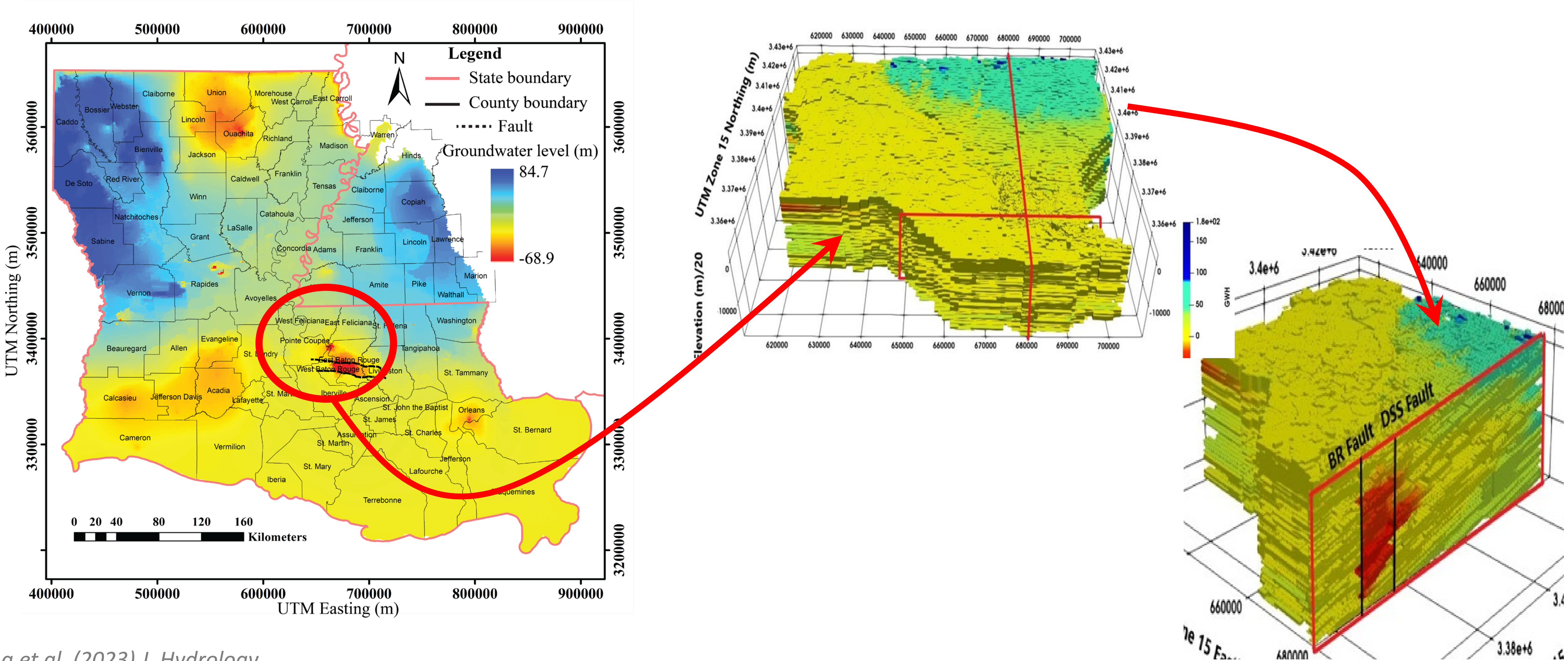
- The 3D groundwater model covers Louisiana and Southwest Mississippi was built using MODFLOW6 (Langevin et al., 2022);
- The model structure honored sedimentary heterogeneity of the lithofacies model;
- Hydrologic soils were included at the model top;
- Nearly 4.4 million computation cells.



Over 152,800 NHGs in the model domain.

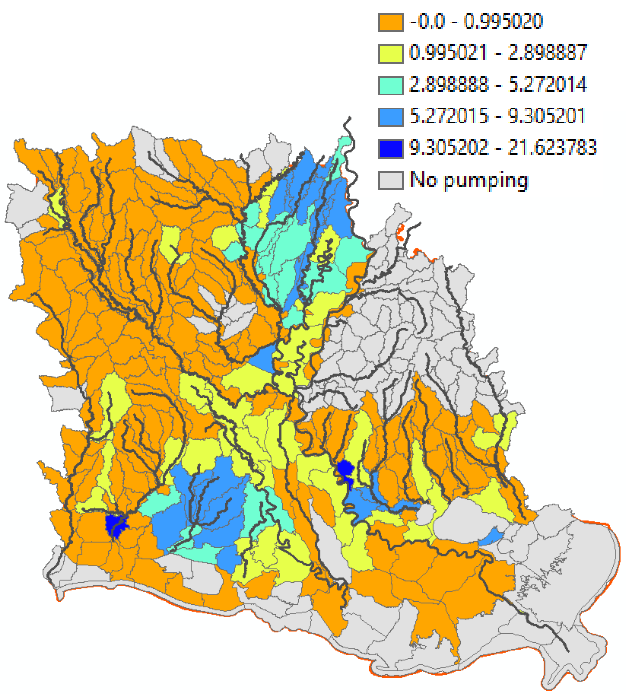
Yang et al. (2023) Hydrogeology J.

High-fidelity groundwater modeling using MODFLOW 6

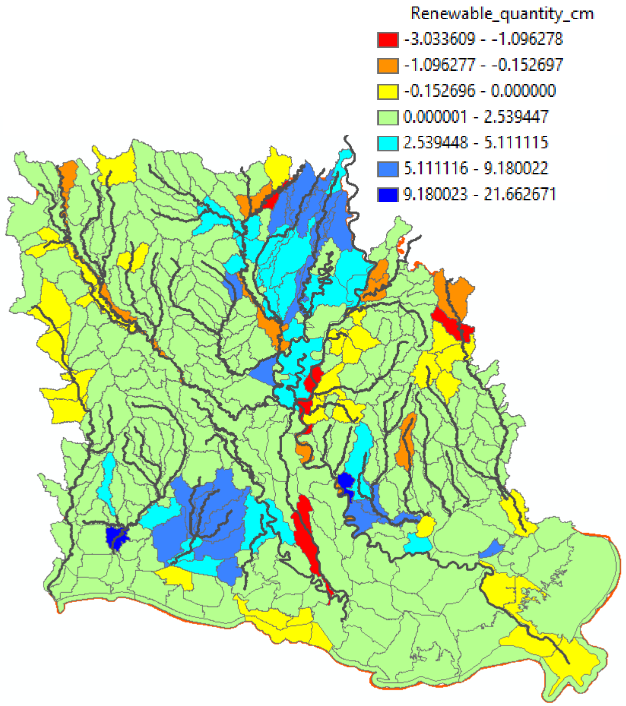


Yang et al. (2023) J. Hydrology

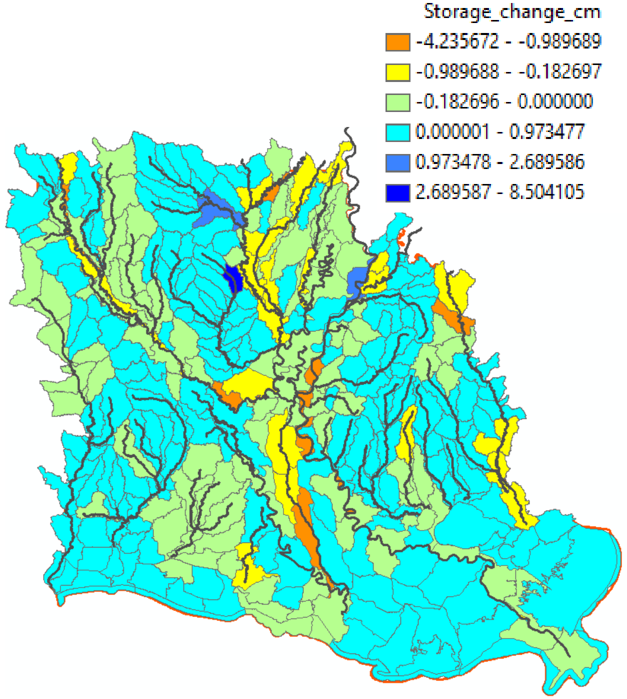
Assessing Louisiana groundwater condition from 2004 to 2021 on HUC10 watersheds



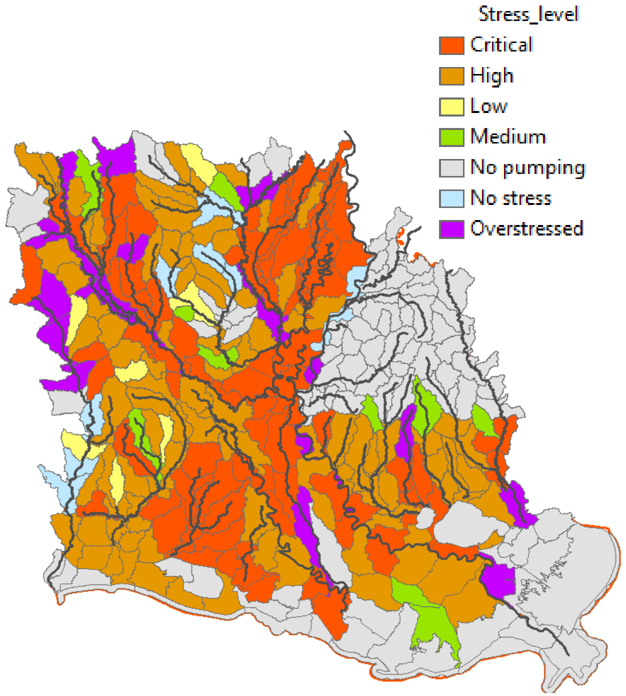
Pumping rate (cm/year)



Renewable flux (cm/year)
Groundwater availability



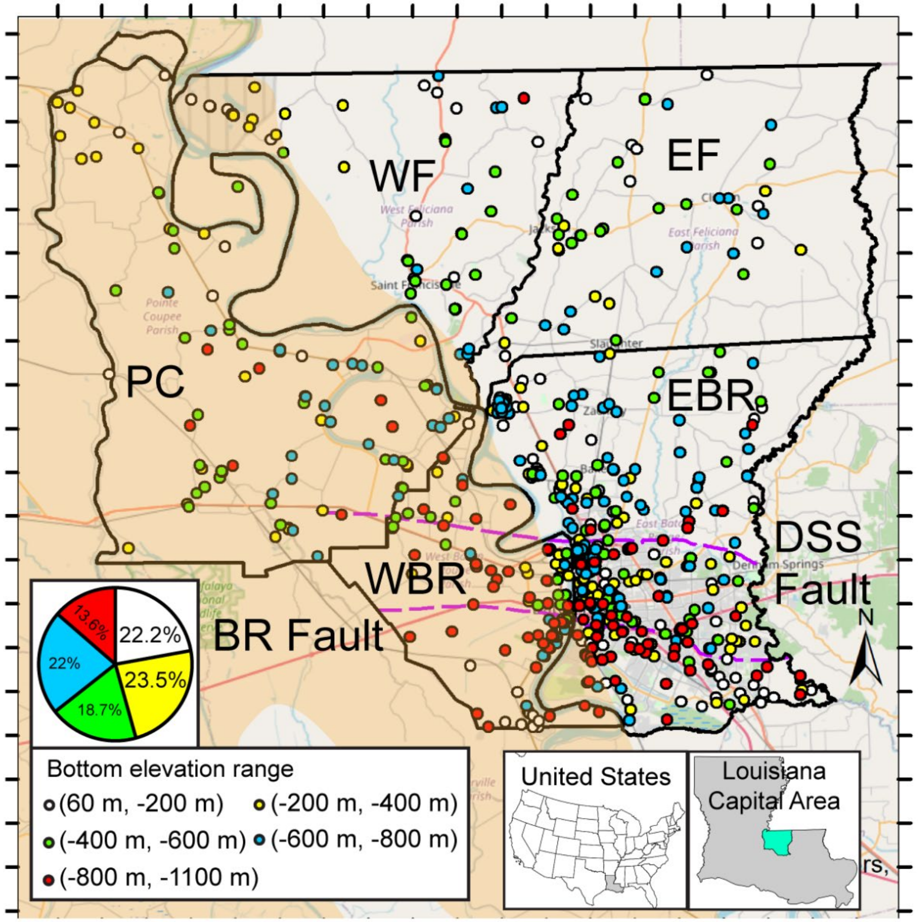
Storage change (cm/year)

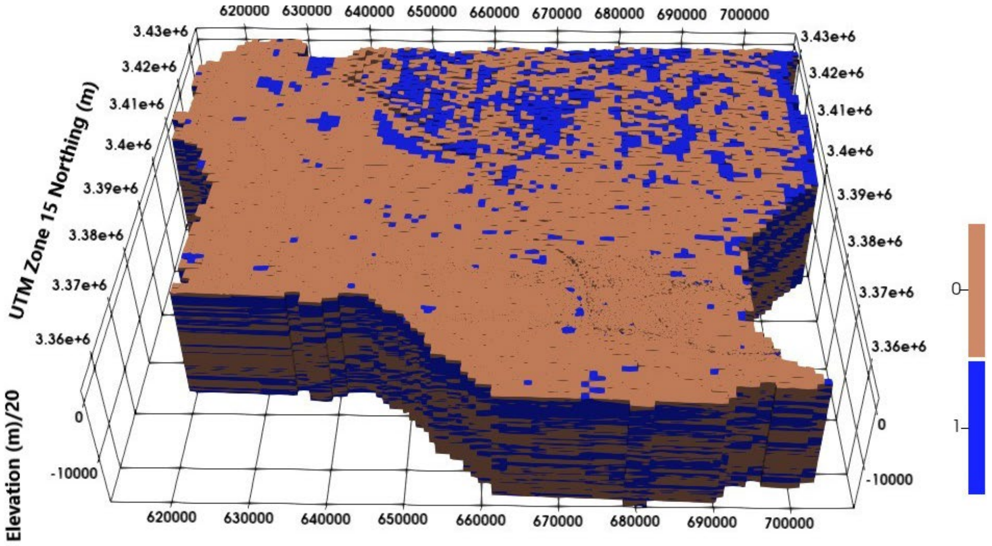


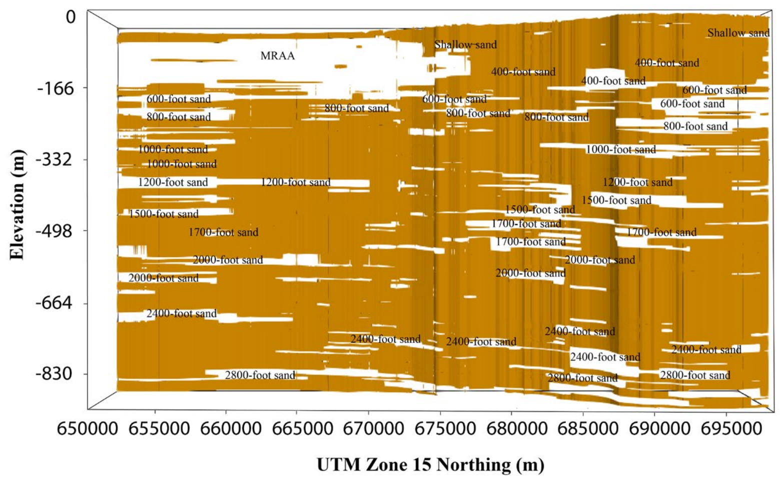
Renewable groundwater stress (RGS)

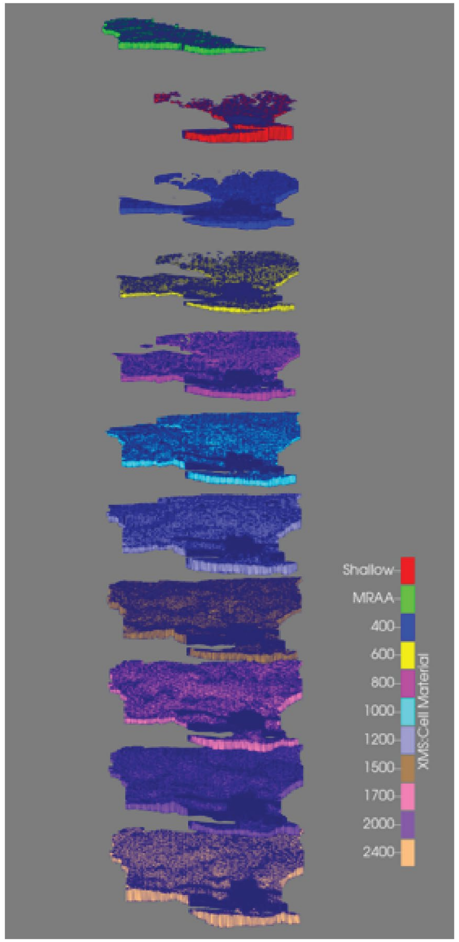
Yang et al. (2023) (under review)

Capital Area Groundwater Availability Model (GAM)



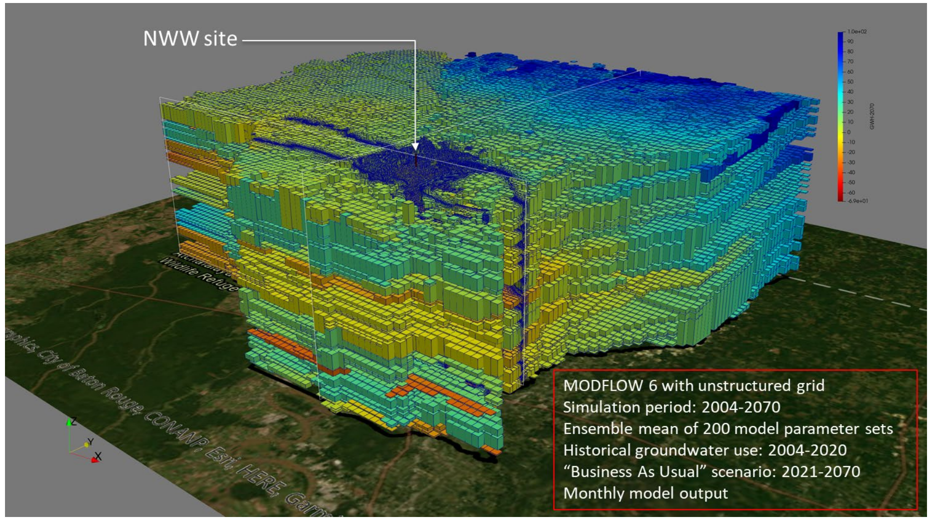


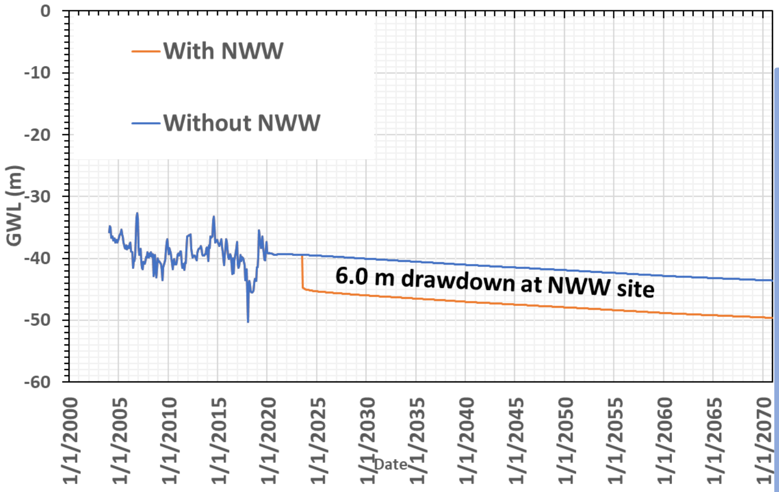


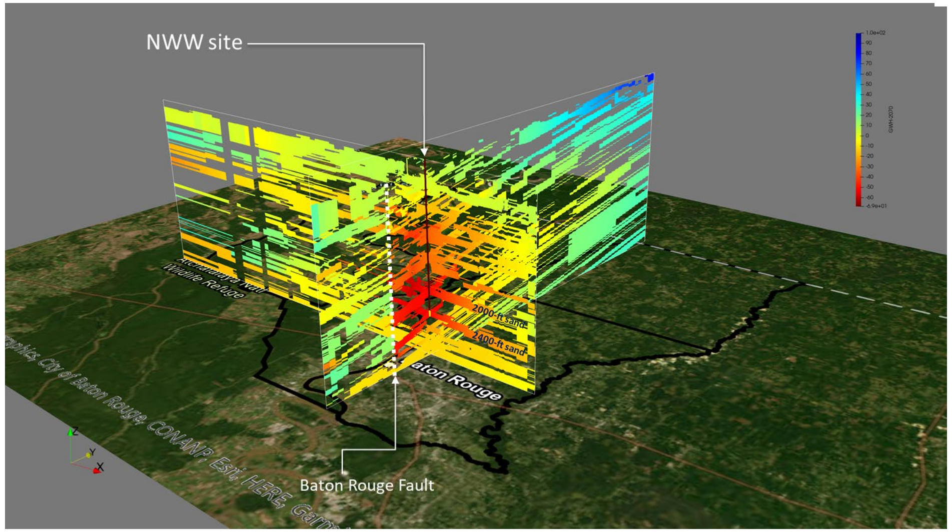


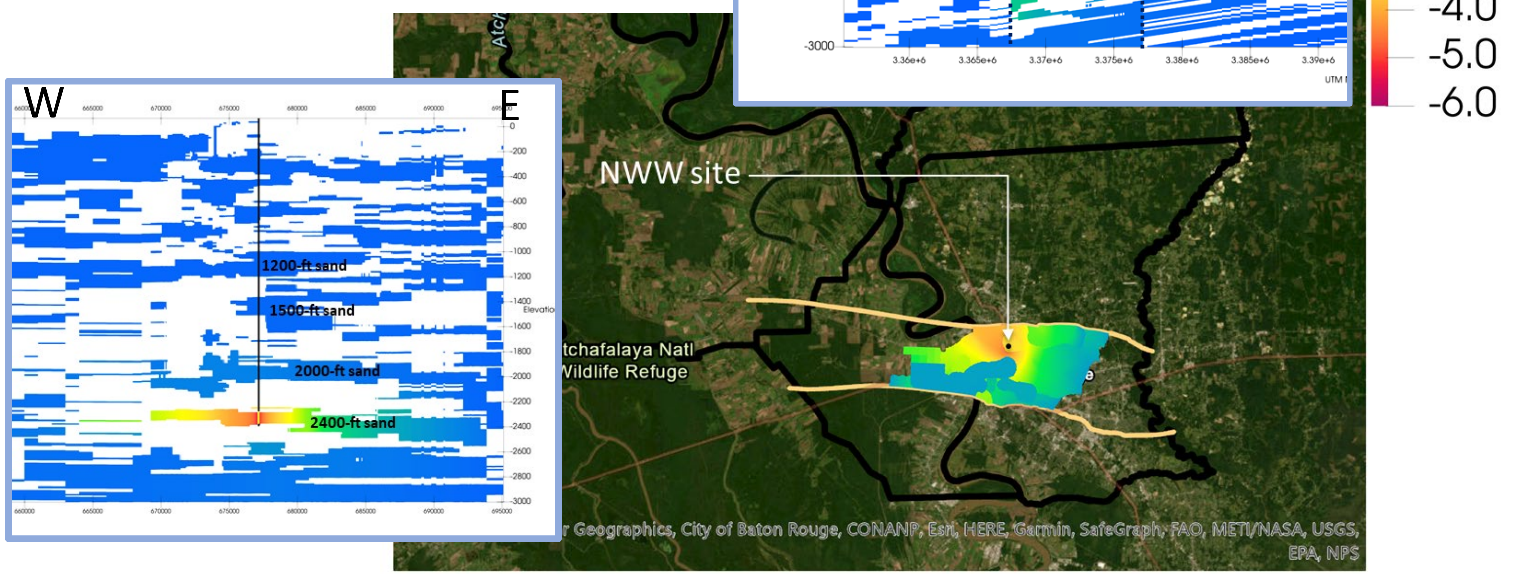
Chen et al. (2023) J. Hydrology, Regional Studies
Mohamed et al. (2023) AGU Fall Meeting

Assessment for Application for a Permit to Drill a New Water Well









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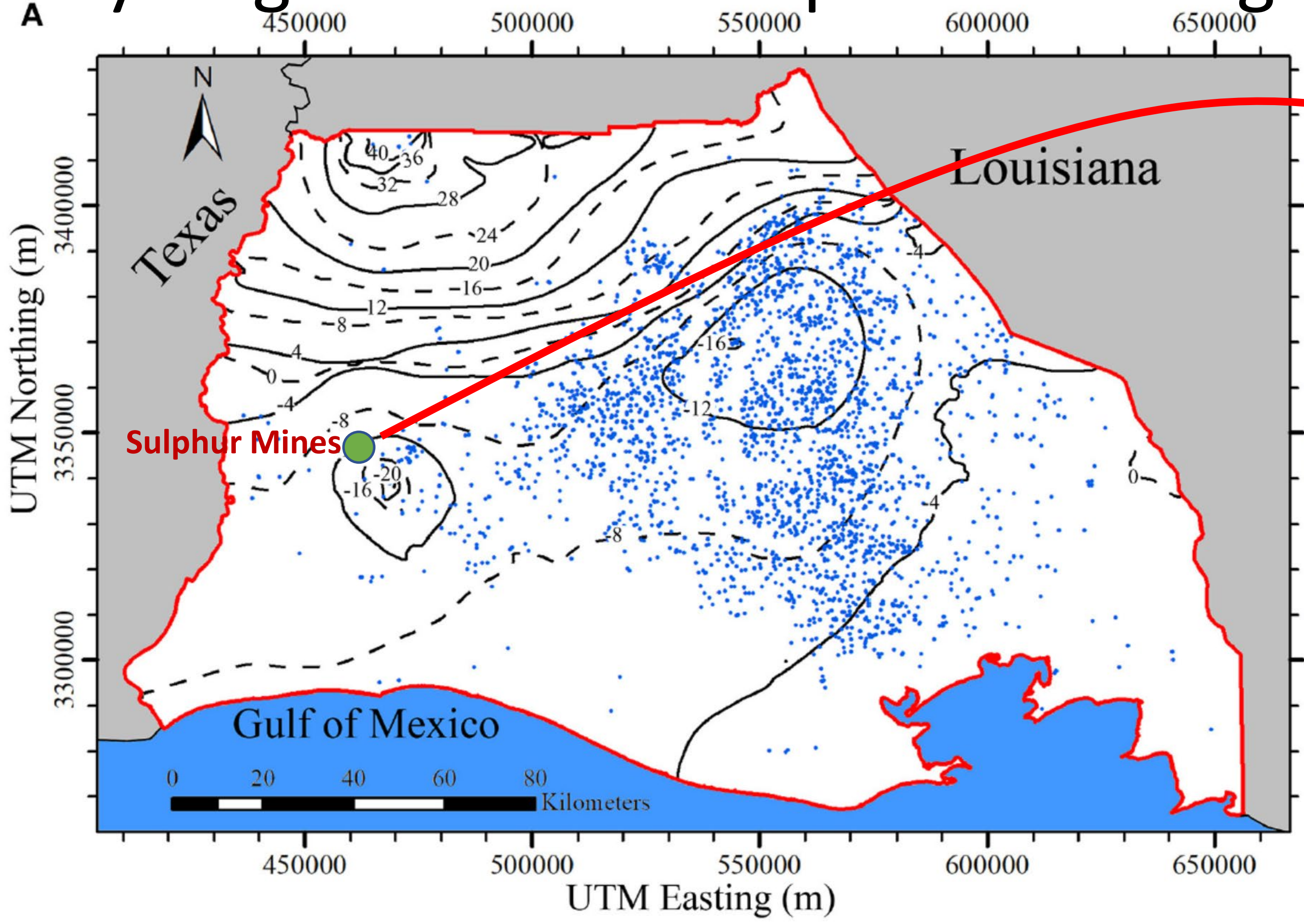
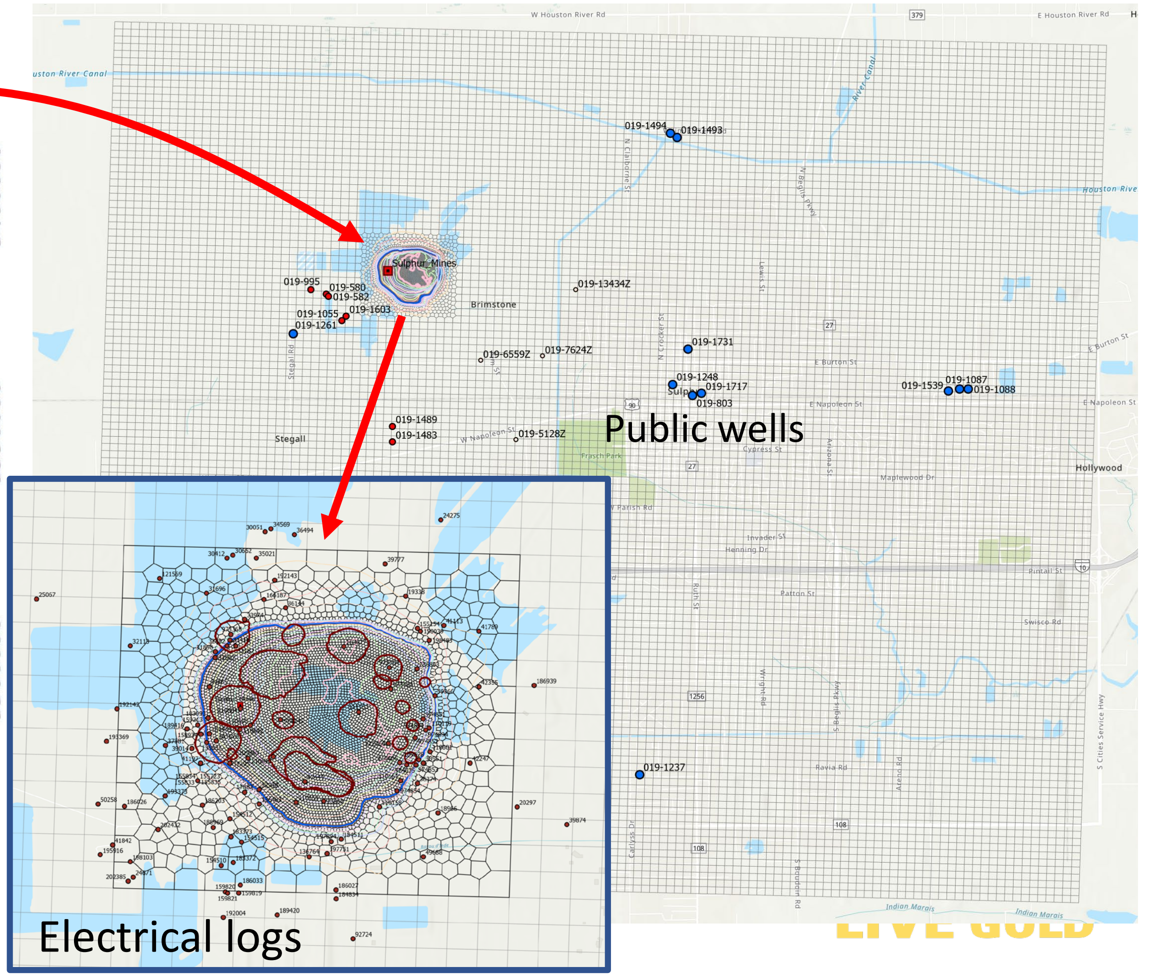
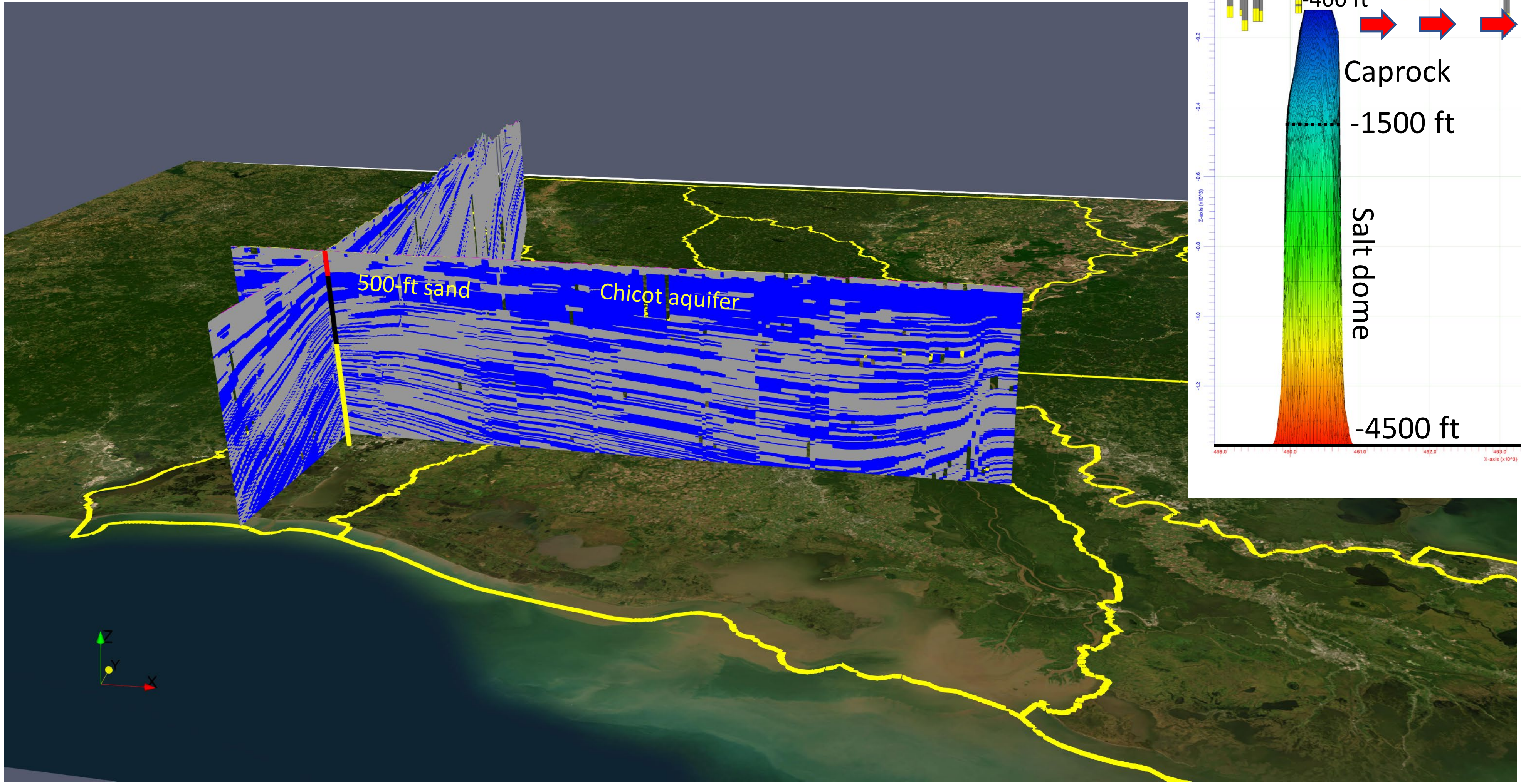
Sulphur Mines salt dome investigation: groundwater, chloride, and hydrogen sulfide transport modeling to public supply wells

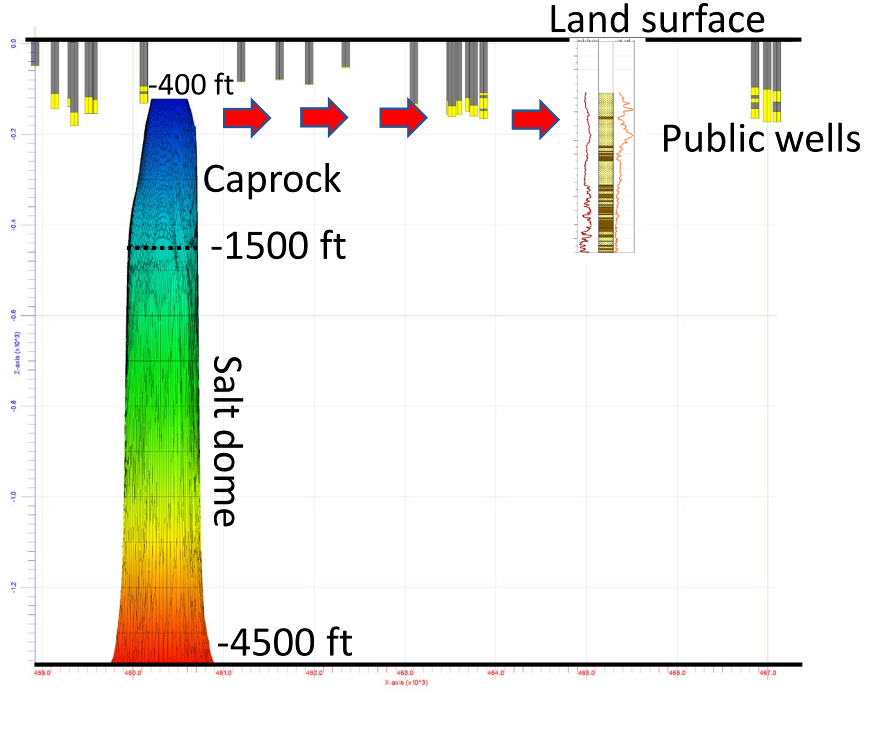


Vahdat-Aboueshagh et al. (2021) Frontiers in Water



Sulphur Mines salt dome investigation





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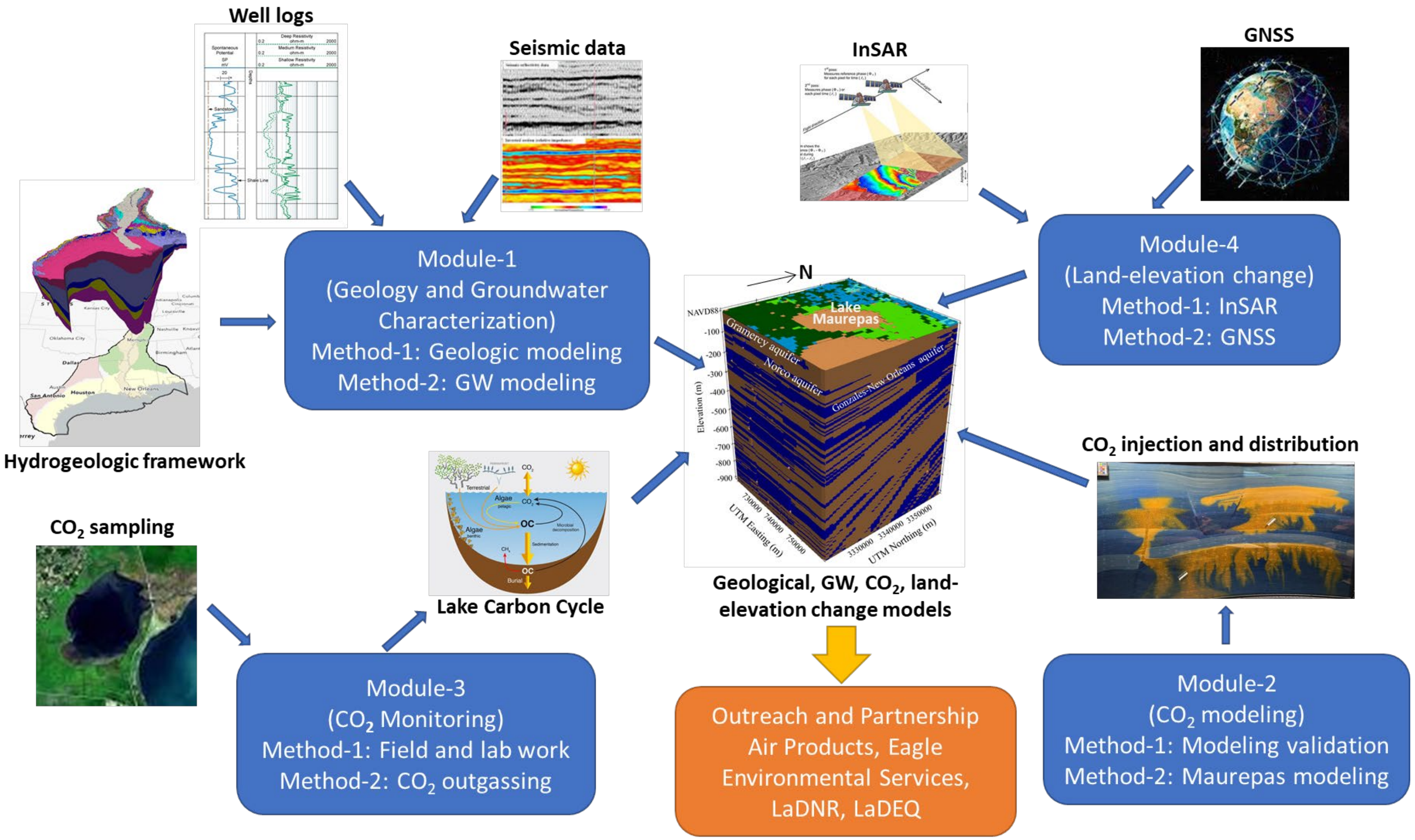
CCS: Assessing CO_2 Geological Storage Impacts on Louisiana's Water Resources and Environment



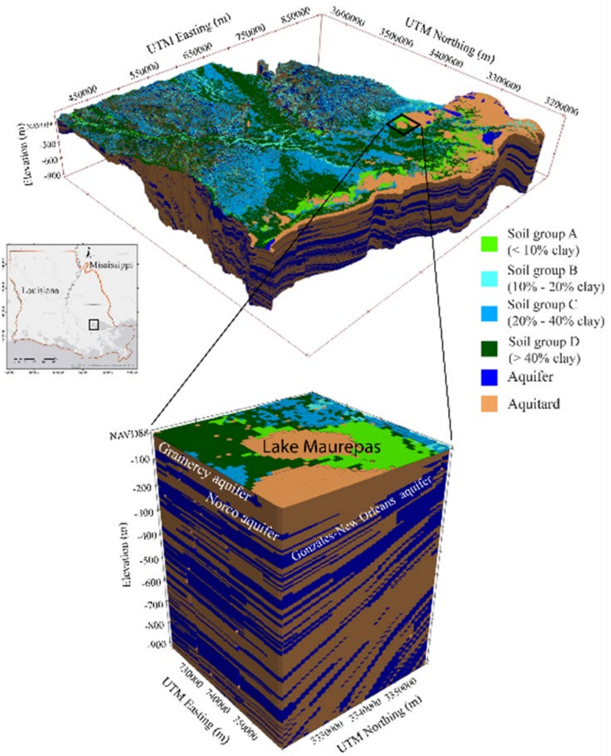
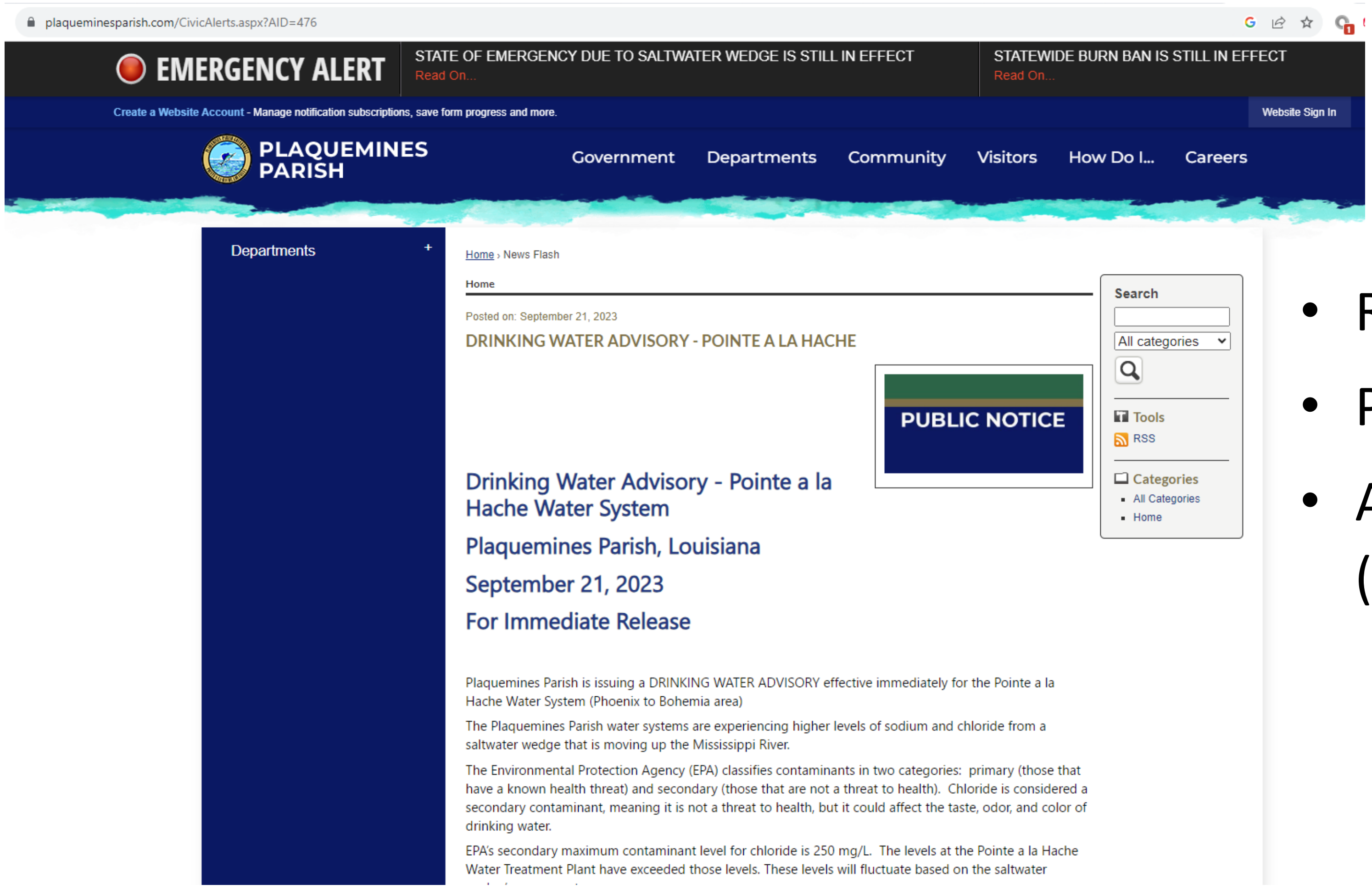


Figure. A preliminary Louisiana geologic model and stratigraphy beneath Lake Maurepas.

Love Purple
Live Gold

Saltwater intrusion to Mississippi River – Solutions to Plaquemines Parish


plaqueminesparish.com/CivicAlerts.aspx?AID=476

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Posted on: September 21, 2023

DRINKING WATER ADVISORY - POINTE A LA HACHE

PUBLIC NOTICE

Drinking Water Advisory - Pointe a la Hache Water System

Plaquemines Parish, Louisiana

September 21, 2023

For Immediate Release

Plaquemines Parish is issuing a DRINKING WATER ADVISORY effective immediately for the Pointe a la Hache Water System (Phoenix to Bohemia area)

The Plaquemines Parish water systems are experiencing higher levels of sodium and chloride from a saltwater wedge that is moving up the Mississippi River.

The Environmental Protection Agency (EPA) classifies contaminants in two categories: primary (those that have a known health threat) and secondary (those that are not a threat to health). Chloride is considered a secondary contaminant, meaning it is not a threat to health, but it could affect the taste, odor, and color of drinking water.

EPA's secondary maximum contaminant level for chloride is 250 mg/L. The levels at the Pointe a la Hache Water Treatment Plant have exceeded those levels. These levels will fluctuate based on the saltwater

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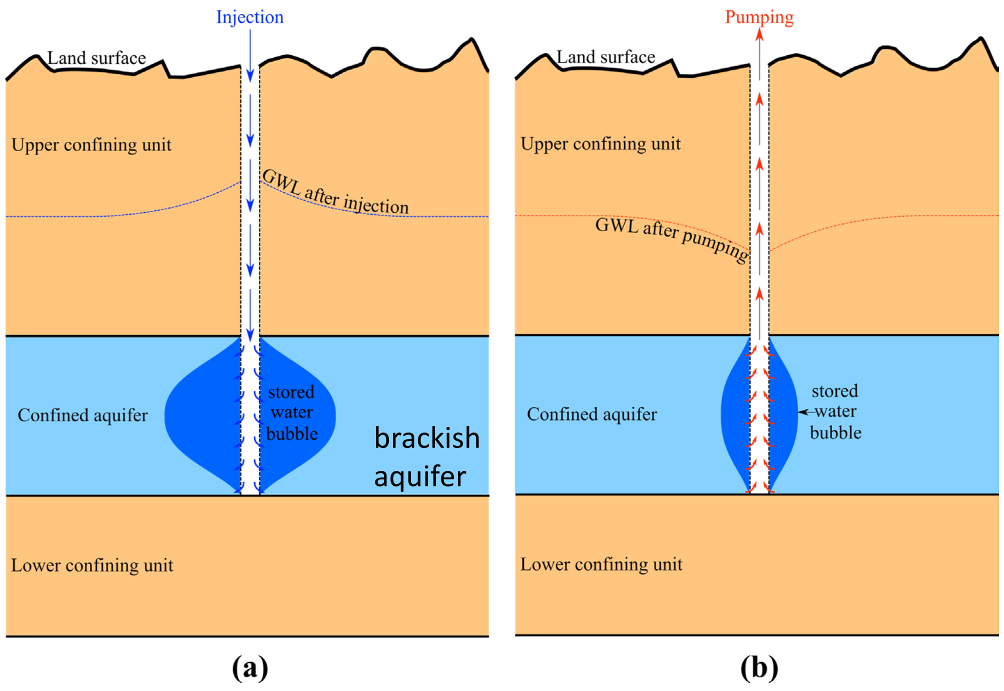
- Aquifer storage and recover (ASR)

Aquifer Storage and Recovery (ASR)



- Store surplus surface water in the aquifer
- Extract groundwater during low river
- A natural-based solution
- Low cost

TABLE 1. Summary of Aquifer Storage and Recovery (ASR) site suitability criteria, their category grouping, and sources of data.

Category	ASR criteria	Abbreviation	Data source	Source scale
Aquifer characteristics	Depth to the thickest sand layer	DS	MODFLOW model	Annual/monthly average (2004–2014)
	Hydraulic gradient	HG		1×1 km^2
	Storage zone thickness	ZT		
	Transmissivity	TM		
Water availability	Excess surface water[1]	SW	National Hydrography Dataset (NHD)Plus	Annual-average (1971–2000) Streamlines
	Groundwater availability/deficit	GW	United States Geological Survey (USGS)	Annual-average (1951–1980) 1×1 km^2
	Average stream size weighted by stream order	SO	Shuttle Radar Topography Mission (SRTM)	30 m
Water quality	Chlorides in groundwater	GQ	USGS- National Water Information System (NWIS)	Discrete samples (1940–2016)
	Total dissolved solids in surface water	SQ		Well measurements
Land cover	% Developed land cover	DL	NLCD 2011	2011
	% Cultivated crop cover	CC		30 m
	Well density per km^2	WD		

[1]Data sources listed are for surface water and groundwater supply, respectively. See the methodology section for data source of water usage.

Vahdat-Aboueshagh et al. (2022) J. of Hydrology
LaHaye et al. (2021). JAWRA

Aquifer Storage and Recovery (ASR)

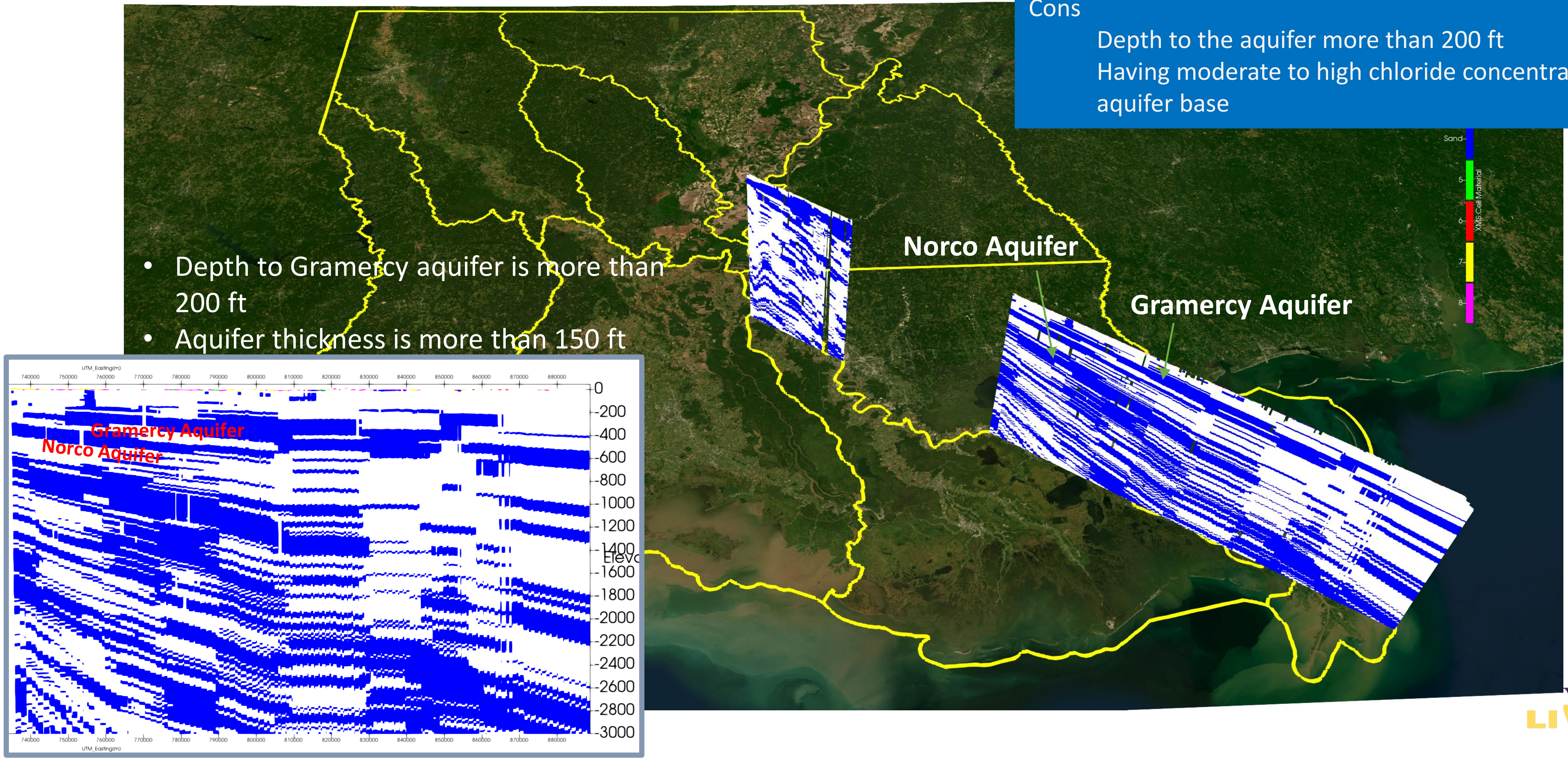
Pros

- Gramercy aquifer thickness more than 150 ft.
- Gentle hydraulic gradient as the aquifer is near the Gulf.
- Plenty of surface water from Mississippi River
- No groundwater deficit

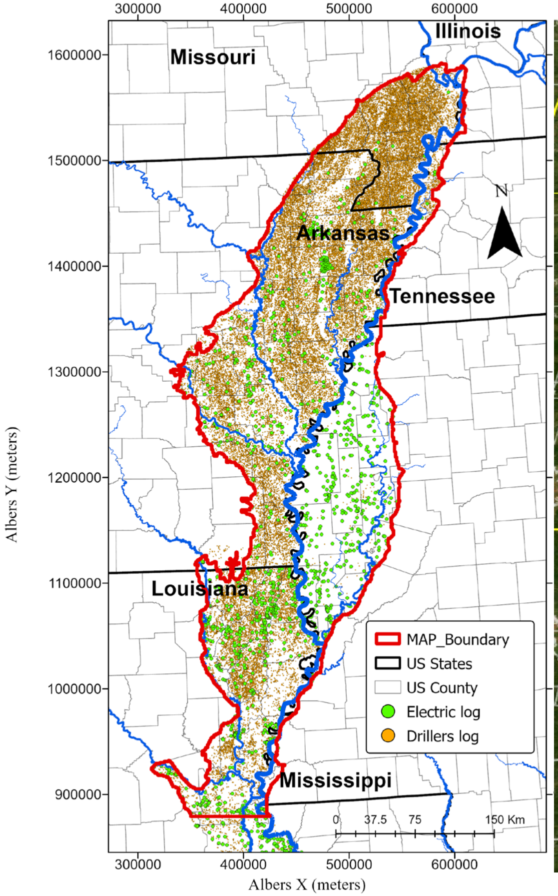
Cons

- Depth to the aquifer more than 200 ft
- Having moderate to high chloride concentration near aquifer base

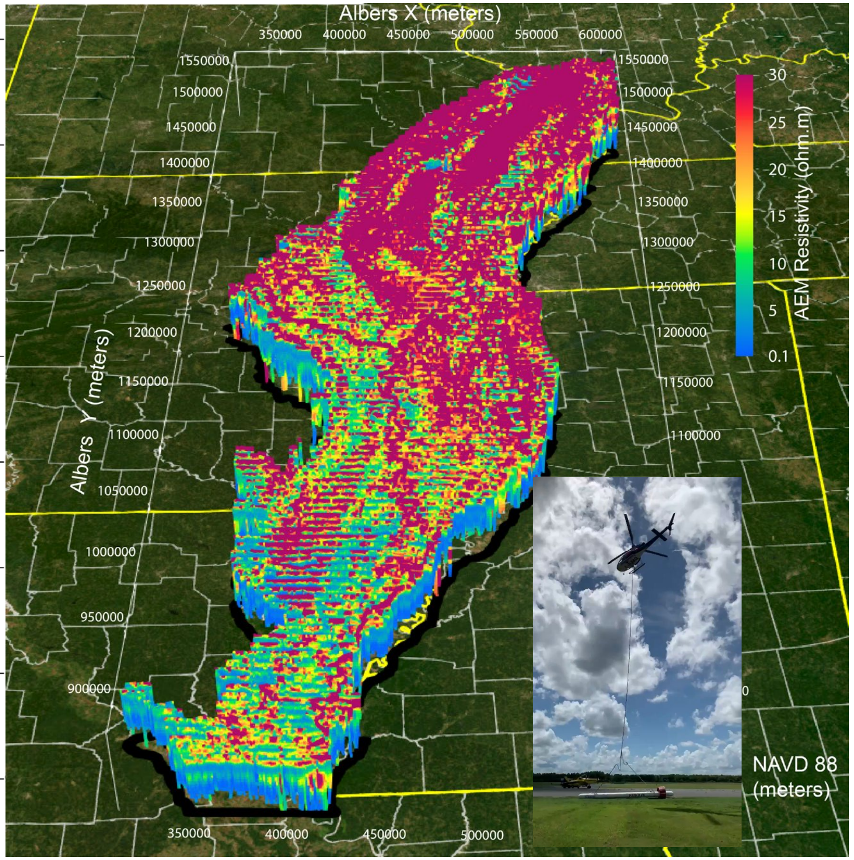
- Depth to Gramercy aquifer is more than 200 ft
- Aquifer thickness is more than 150 ft



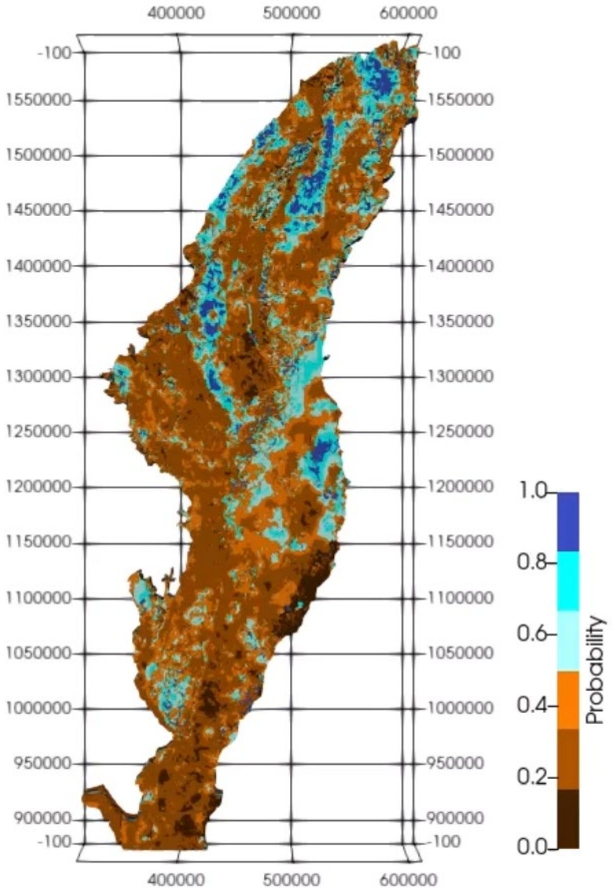
Mississippi Alluvial Plain Study –Airborne electromagnetic (AEM) data and borehole data fusion: MRVA Characterization



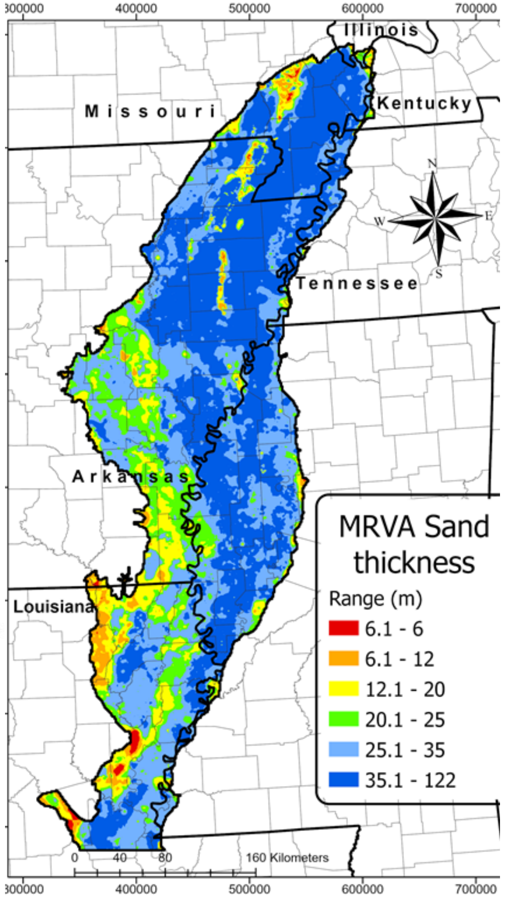
Borehole data



AEM data (USGS)



Sand probability map



Isopach map

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MAP Holocene-Pleistocene (H-P) Interface – Coastal Implications

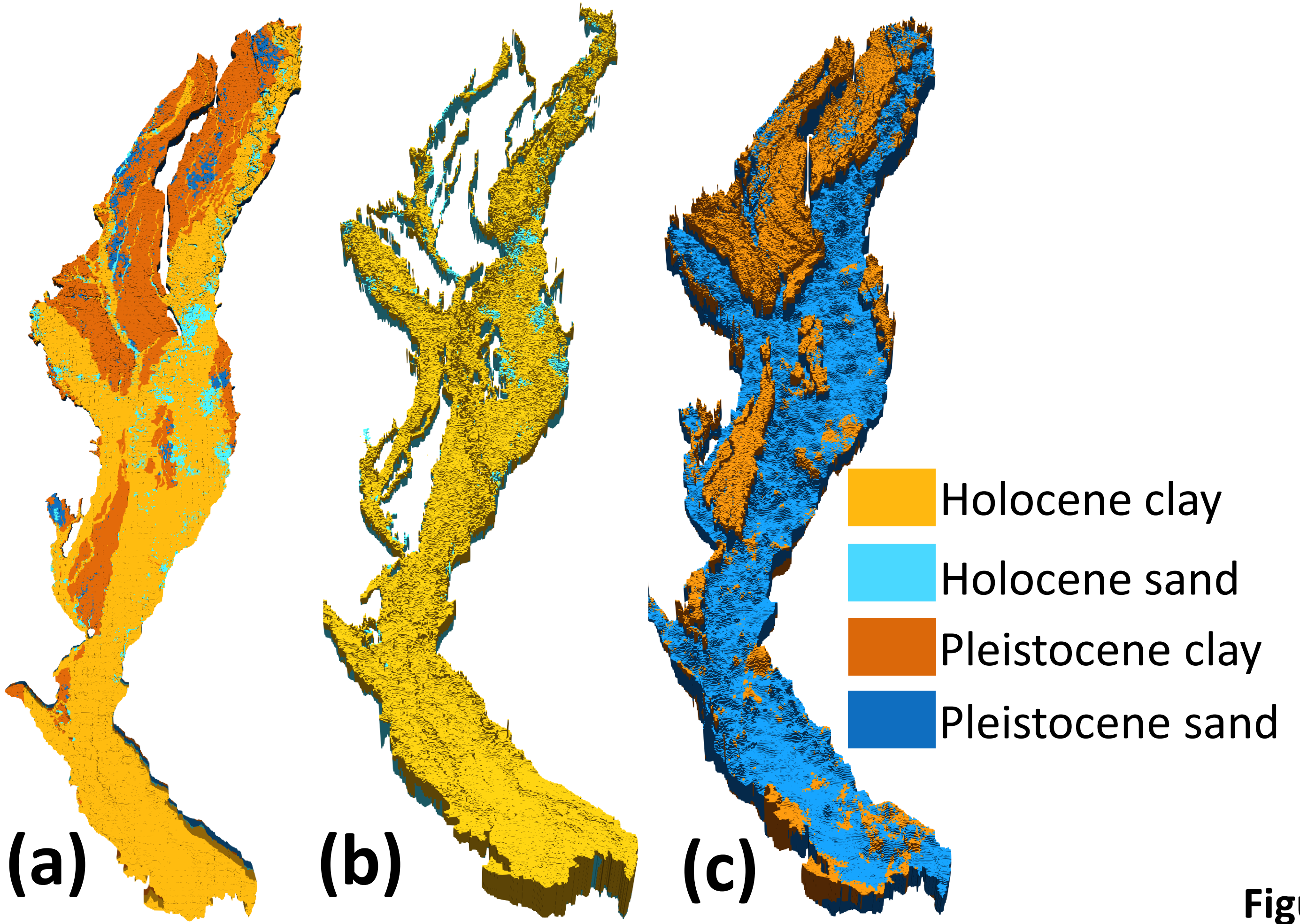


Figure. The H-P lithologic model (a) Map view of the model. (b) Holocene deposits. (c) Pleistocene deposits.

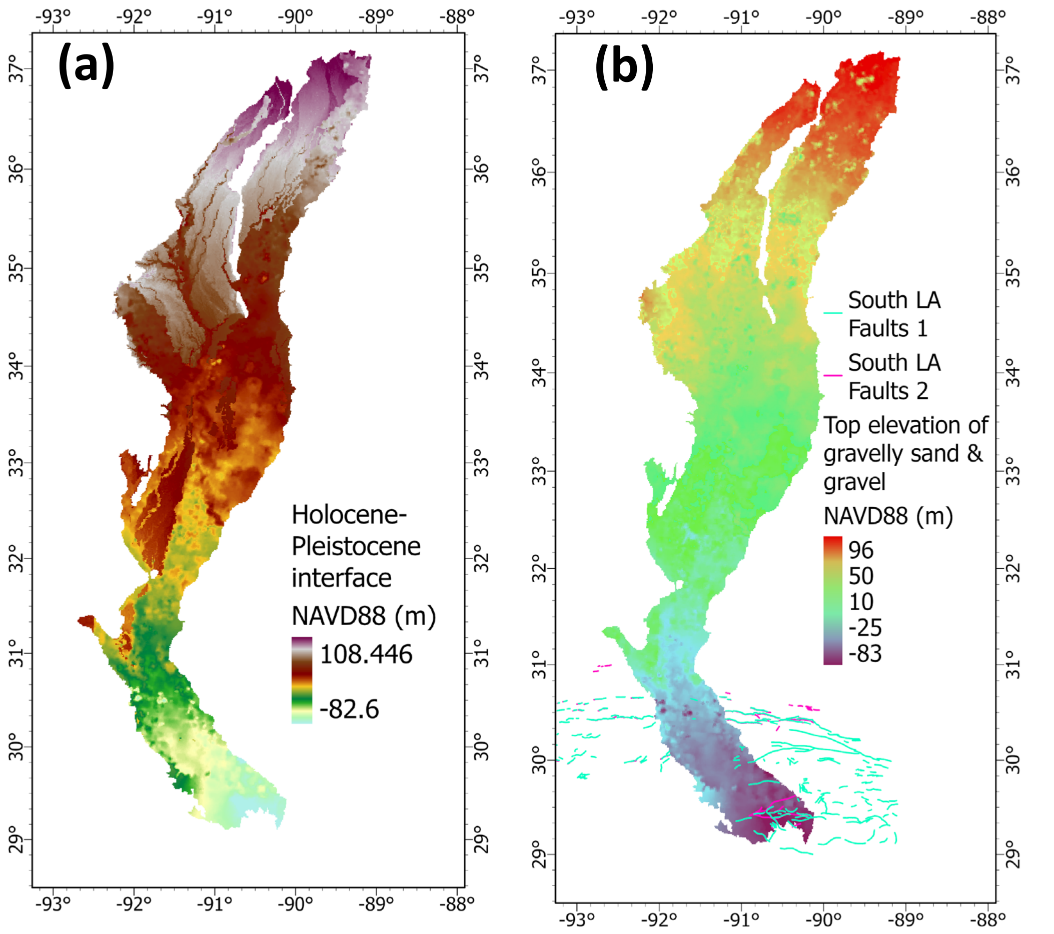
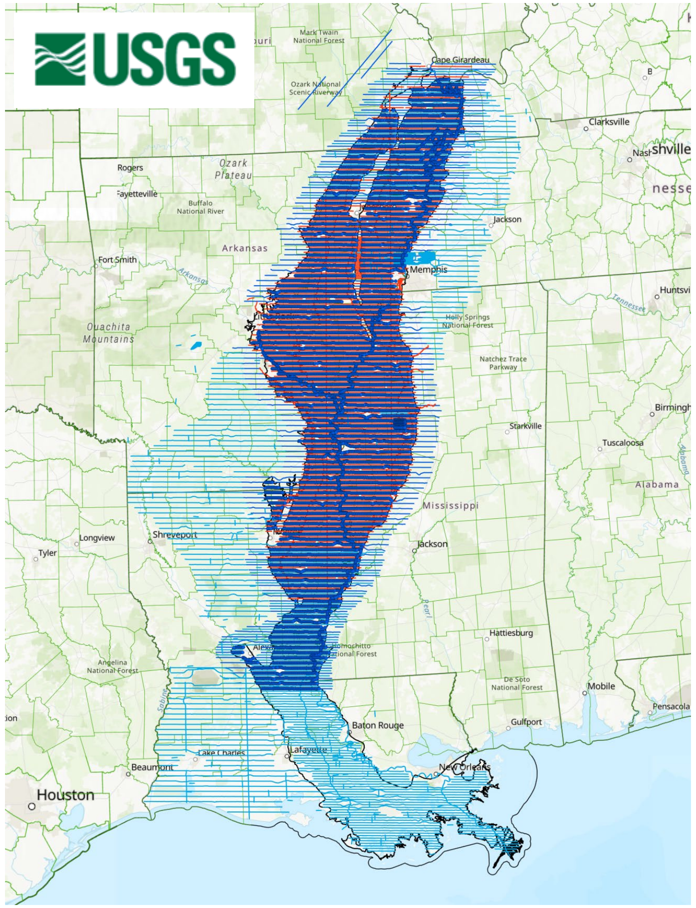


Figure (a) H-P interface for the MRVA. (b) The top altitude map for gravelly sand and gravel

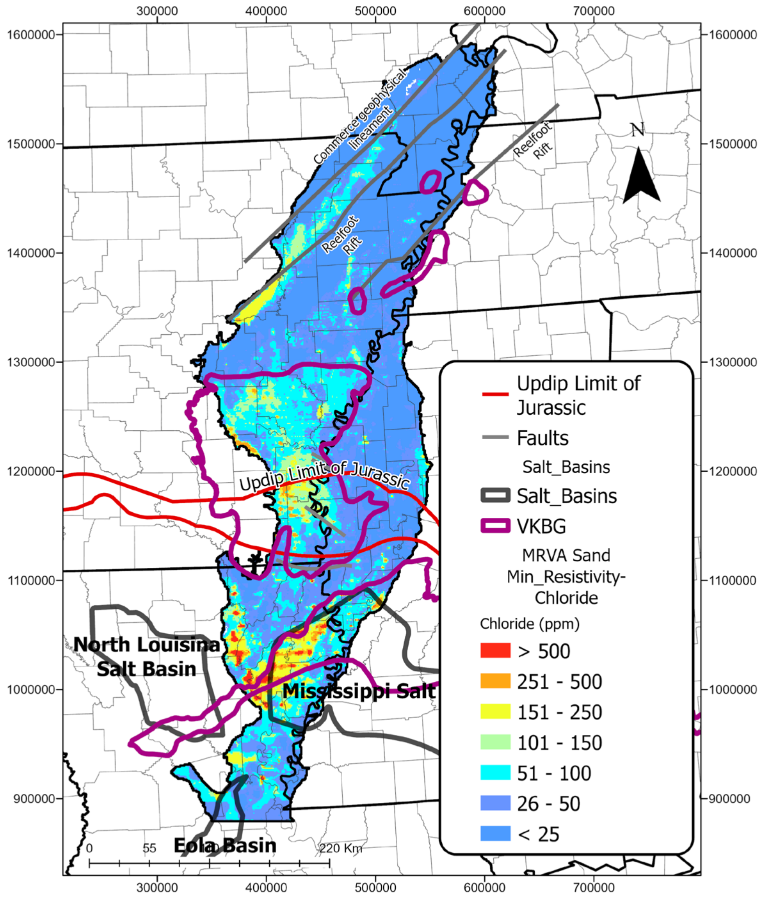
Song and Tsai (2023) AGU Fall Meeting

AEM data and borehole data for saltwater delineation



AEM data (USGS) 2023

MRVA base



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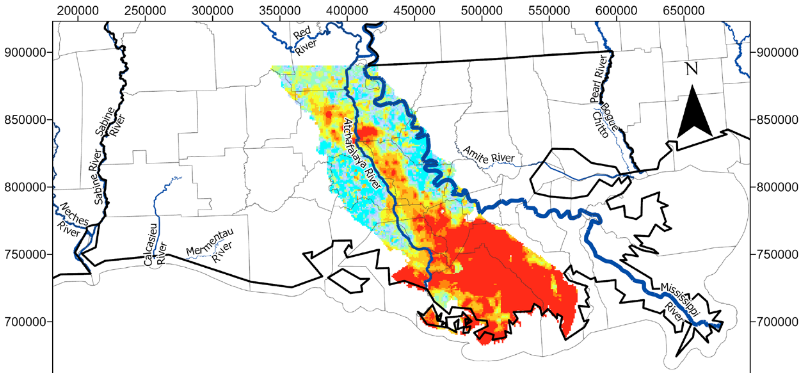
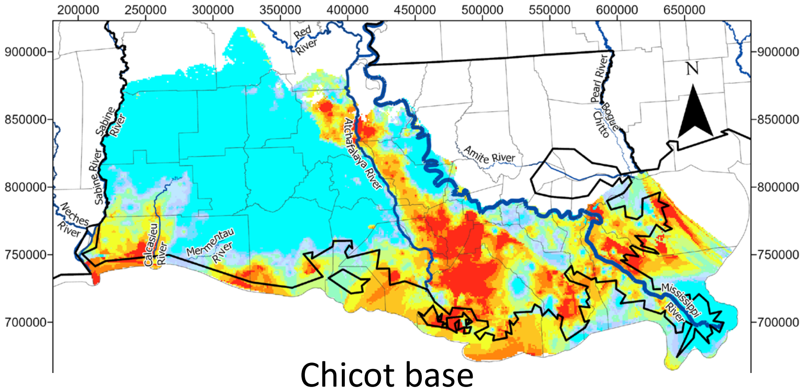
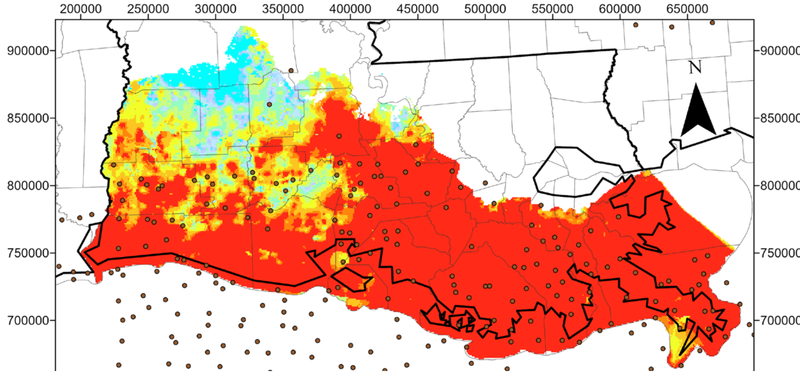
MRAA base



Chicot top



Chicot base



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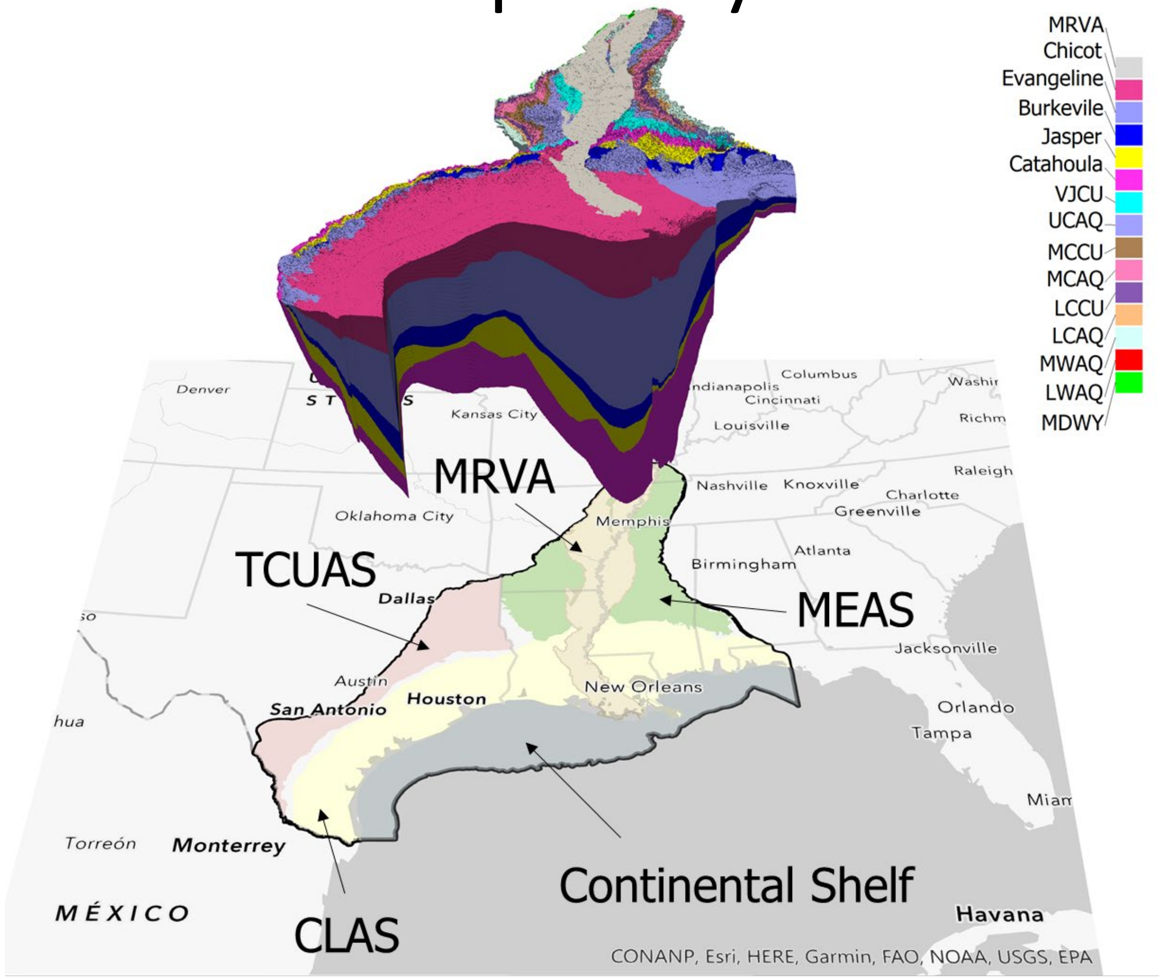
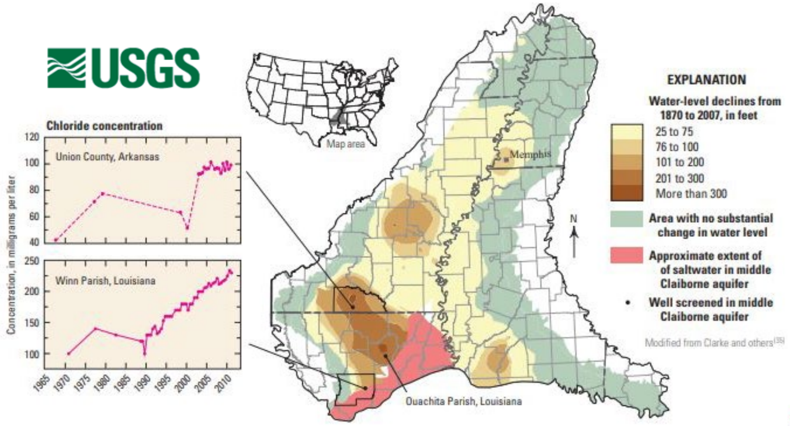
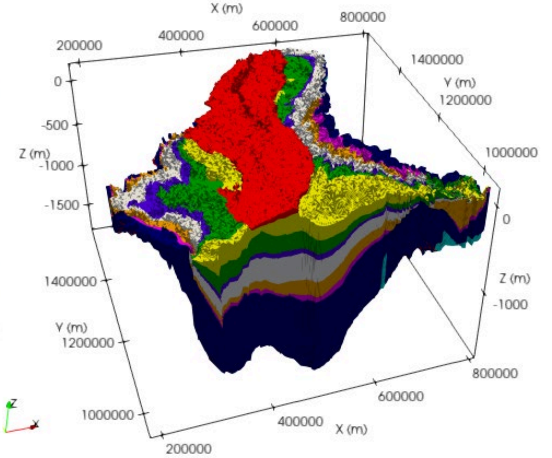
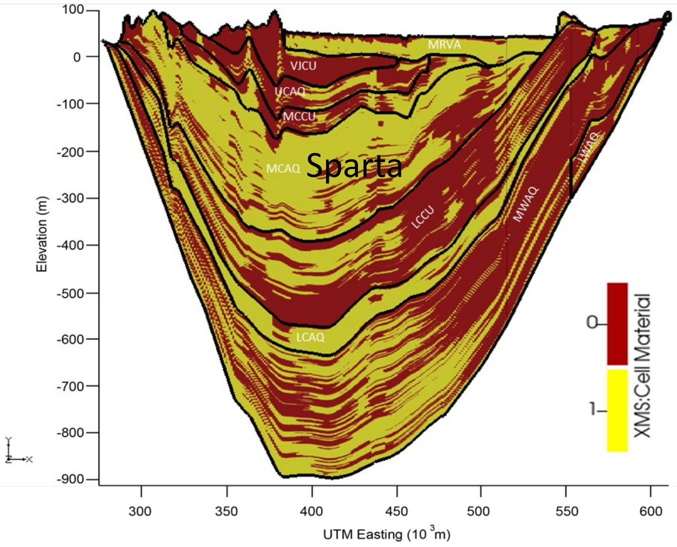
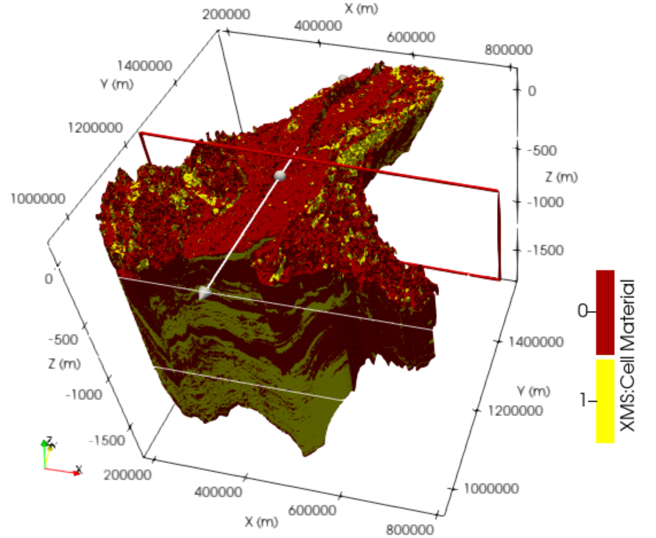
Groundwater studies for Mississippi Embayment and Coastal Lowlands aquifer systems











Concluding remarks

- Louisiana is the first state in the US to have a high-fidelity statewide groundwater model for groundwater availability studies.
- Have ability to conduct intrastate and interstate groundwater studies.
- Groundwater use data is critical for groundwater studies.
- It is imperative to continue to expand digital well log database.
- Recommend AEM survey on Florida Parishes

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