Impact of unconventional energy development using hydraulic fracturing on water resources availability in LA

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Background

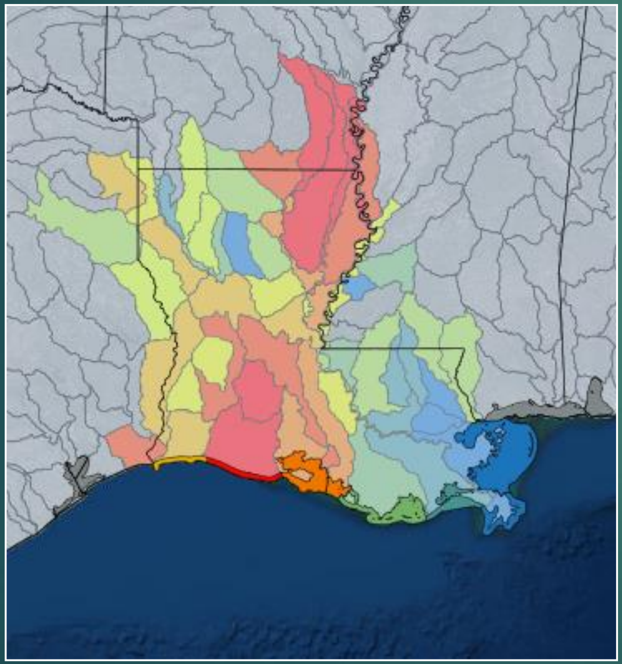
We think Louisiana has a lot of water. But…

- Water withdrawals (2005) were between 10 to 20 thousand of mgal/day. Just below Texas and California (20 to 46 thousand mgal/day).
- 52% Louisiana water withdrawals come from the thermoelectric sector.
- 82% of the withdrawals come from surface water.

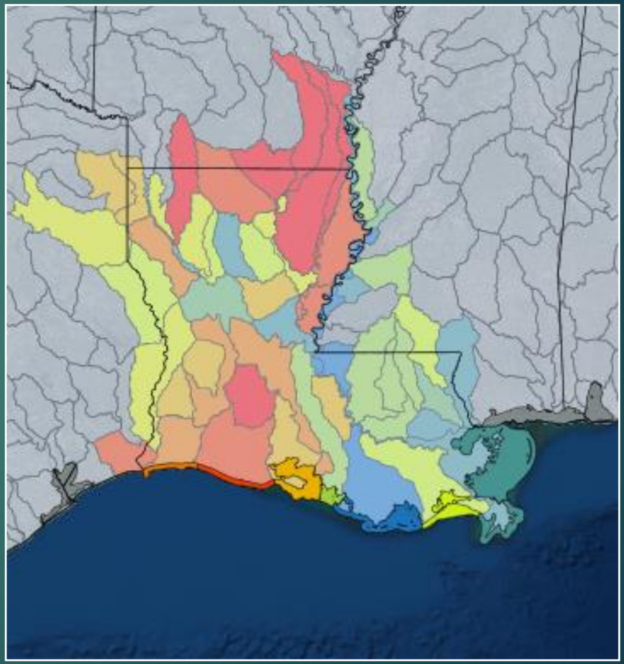
Background

High withdrawals means low water availability?

Not necessary. A water stress metric is required to assess the availability.



Withdrawals (Agriculture).



Stress ratio (Agriculture).

Images extracted from Hydroviz.org

How to estimate water stress?

A breakdown of the *Water Supply Stress Index (WaSSI)*

$$WaSSI = \frac{Total\ water\ withdrawals}{Total\ water\ supply}$$

$$Surface\ WaSSI = \frac{Surface\ water withdrawals}{(1 - ENV)(Surface\ water\ supply)}$$

Agriculture
Industrial
Power generation
Public supply

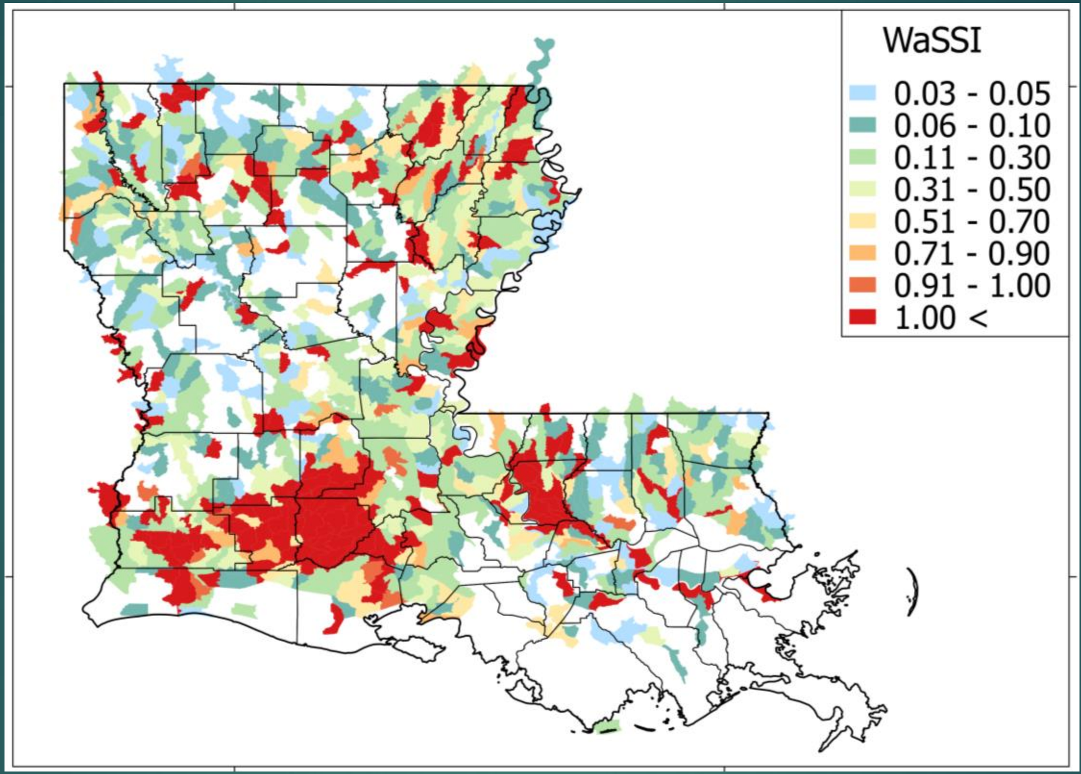
$$Groundwater WaSSI = \frac{Groundwater\ water\ withdrawals}{Groundwater\ supply}$$

Agriculture
Industrial
Power generation
Public supply
Livestock
Rural domestic

Louisiana water sectors obtained from Sargent, 2011

Background

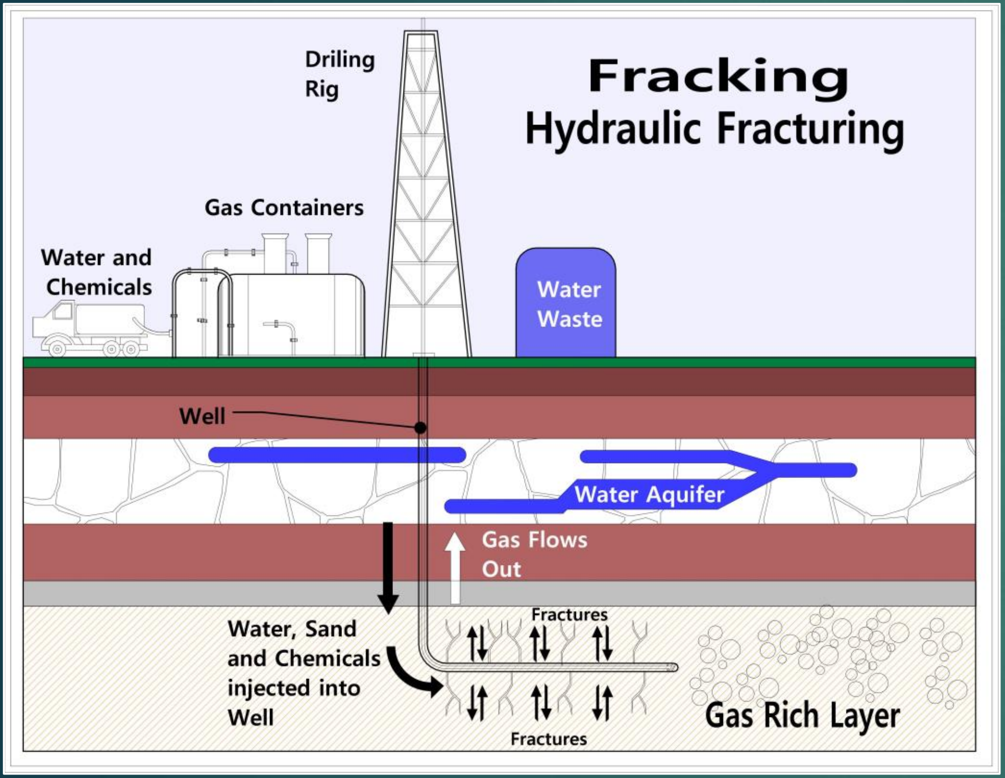
Louisiana Groundwater stress (2010)



White areas indicates WaSSI < 0.03

- For water stress matrices Mining has not been accounted in Louisiana.
- For unconventional fossil fuels extraction a hydraulic fracturing is required.

Unconventional energy development



- Hydraulic fracturing (HF) also known as fracking.
- The injected fluid is composed by **water (98%)**, proppant and chemicals (2%).
- Vertical or Horizontal wells can be hydraulic fractured.

Image adapted from epa.gov

Unconventional fossil fuels extraction is accounted under *Mining* category water use

Prospective shale play

Most productive shale gas play

Recent tight oil shale play

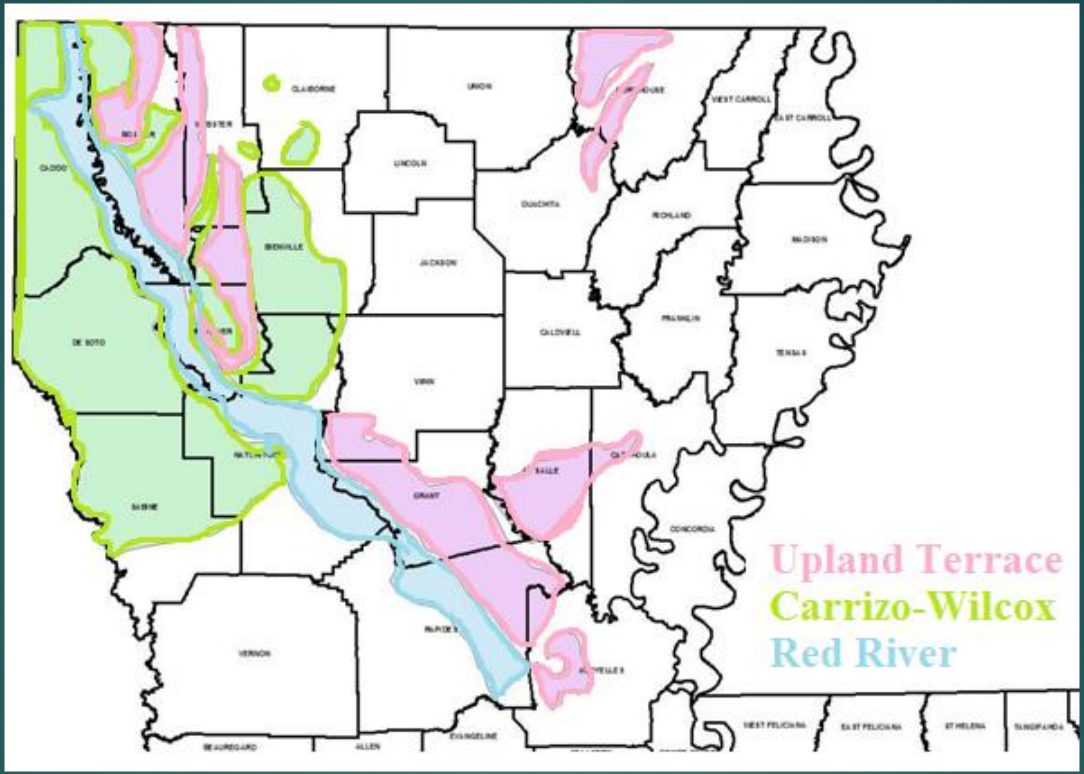
Image adapted from Welsh, DNR, 2017

Background

Concerns about fracking

- Requires huge amount of water. From 3.31 up to 8.83 Million of gallons (or more) per job.
- Groundwater pollution.
- Flow back and produced water treatment.
- Air pollution. (Methane leakage and benzene).
- Depletion of water resources.
- Fracking induced earthquakes.

Why digging into HF is important?



Northwest Louisiana Aquifers

- No study has account the impact of HF in a small spatial frame.
- South Caddo Parish groundwater emergency in 2011.
- Most of Louisiana power plants use Natural gas as a fuel.

Image adapted from USGS/LA Water Science Center

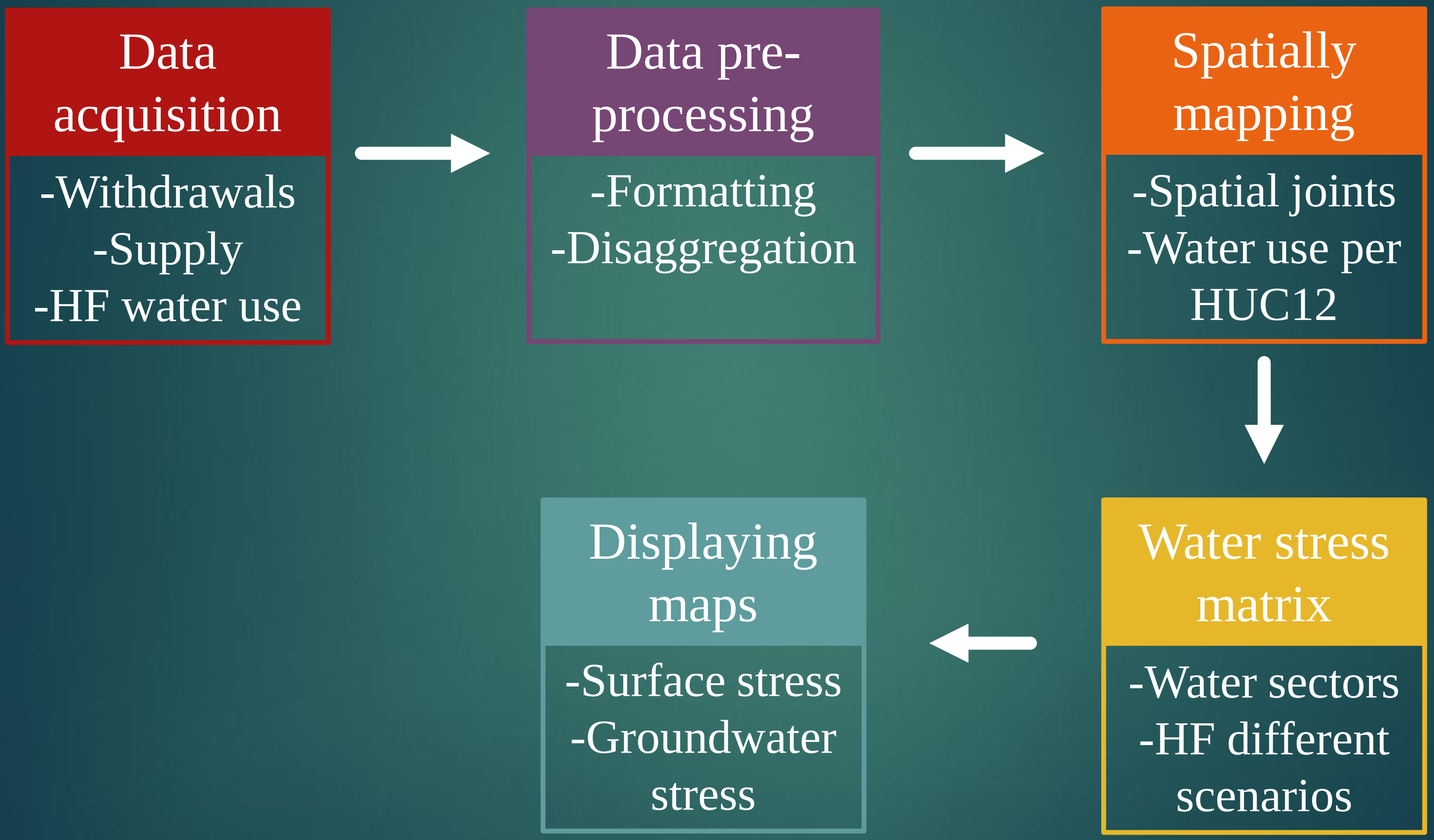
Research Questions

- Based on a small spatial scale and a short time period, what is the impact of hydraulic fracturing activities on Louisiana's current surface and groundwater resources?

- How different scenarios of future projected hydraulic fracturing activities can impact the sustainability of Louisiana water resources?

Methodology

Methods scheme

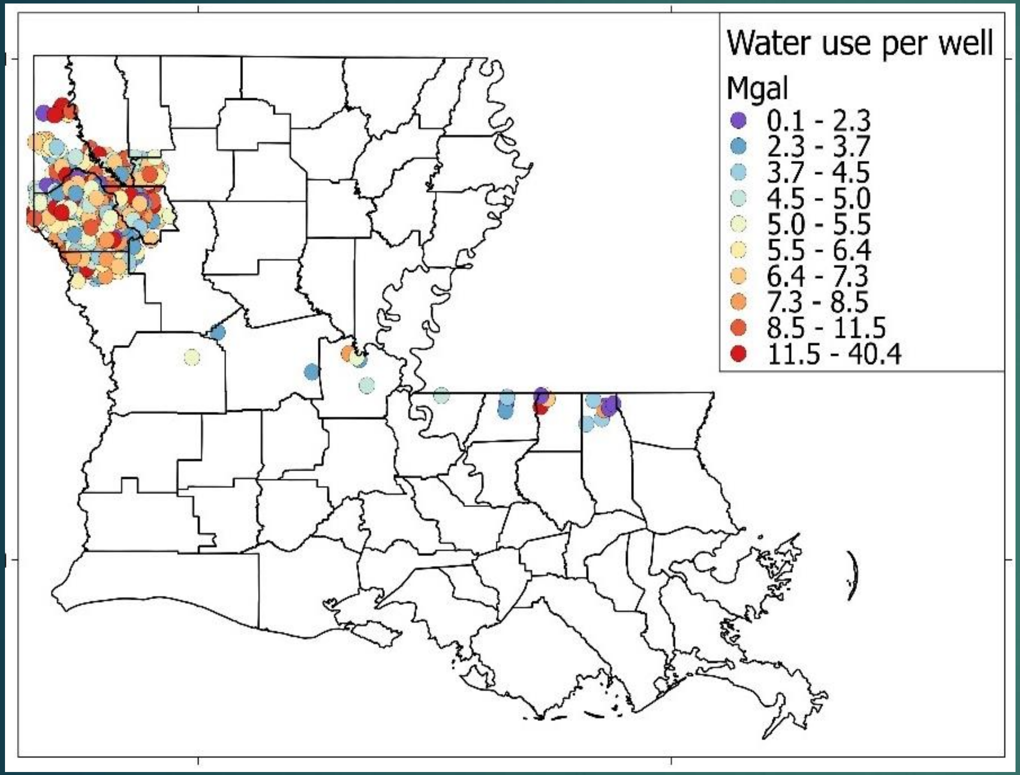


Methodology

Datasets

Source	Variable	Spatial Scale	Temporal Scale
NHDPlus	Surface water supply	Stream lines	Annual average (1971-2000)
USGS	Groundwater recharge	1 x 1 km2	Annual average (1951-1980)
Fracfocus.org	Oil and gas wells water use	Location	One-time event from 2011-2016
USGS	Surface water withdrawals	Parish	Annual average (2010)
USGS	Groundwater withdrawals	Parish	Annual average (2010)

Drilled wells



Information available regarding to number of wells

Description	Number of wells
Total wells spatially located	2,865
Total wells with water use for HF reported	1,364
Severe year 2011	567

Figure: Wells with HF water use reported on year 2011

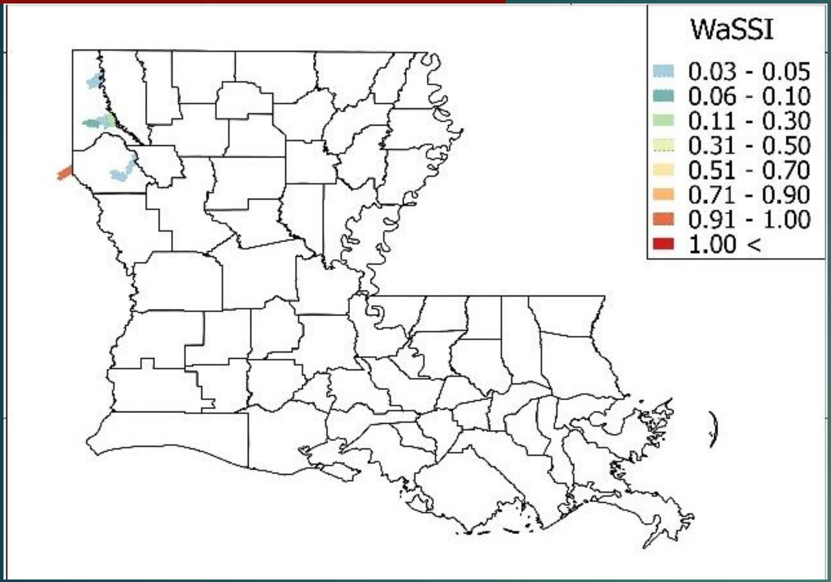
Methodology

Testing scenarios

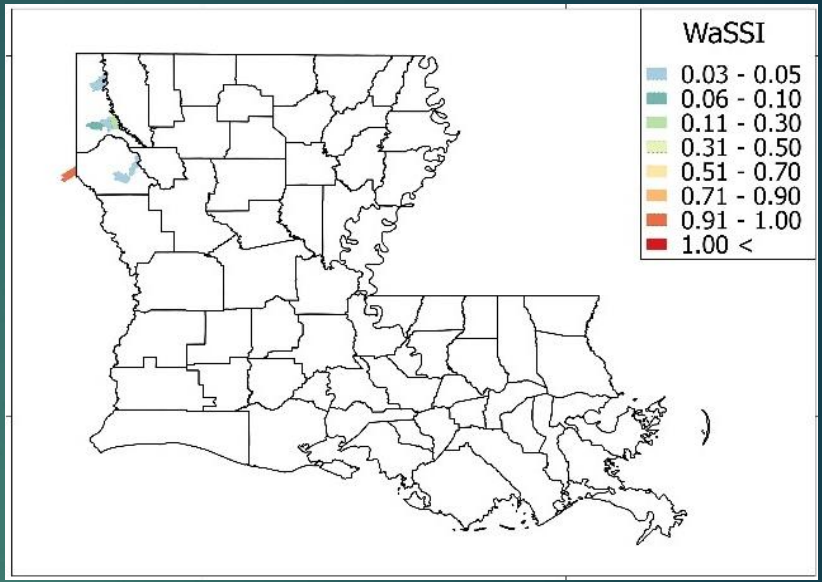
Water stress scenario	Haynesville (# wells)	Tuscaloosa (# wells)	Haynesville (# HUCs)	Tuscaloosa (# HUCs)
Base case (No fracking)	0	0	94	19
HF water use of **2011**	544	23	94	19
HF water use of all **existing wells**	2,832	33	94	19
HF water use required for shale play **total extraction**	10,000	6,312	167	330

Results

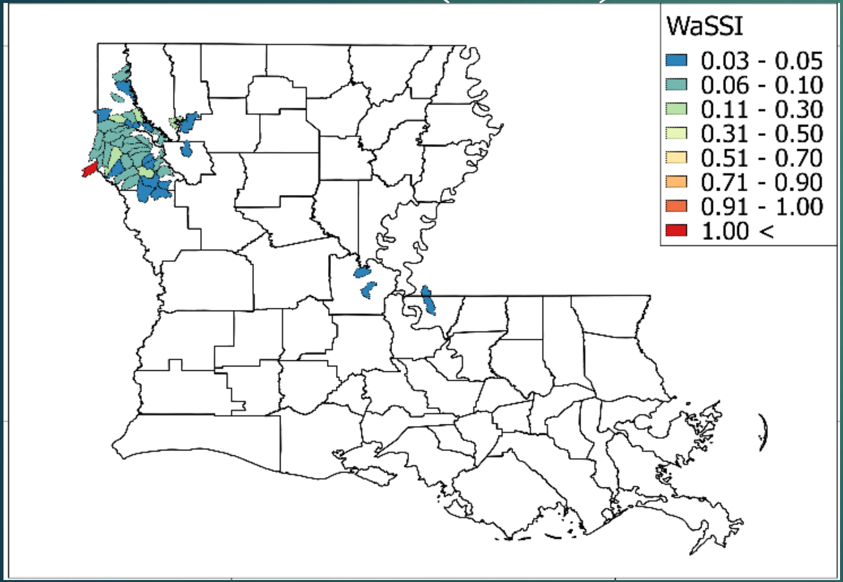
Surface WaSSI



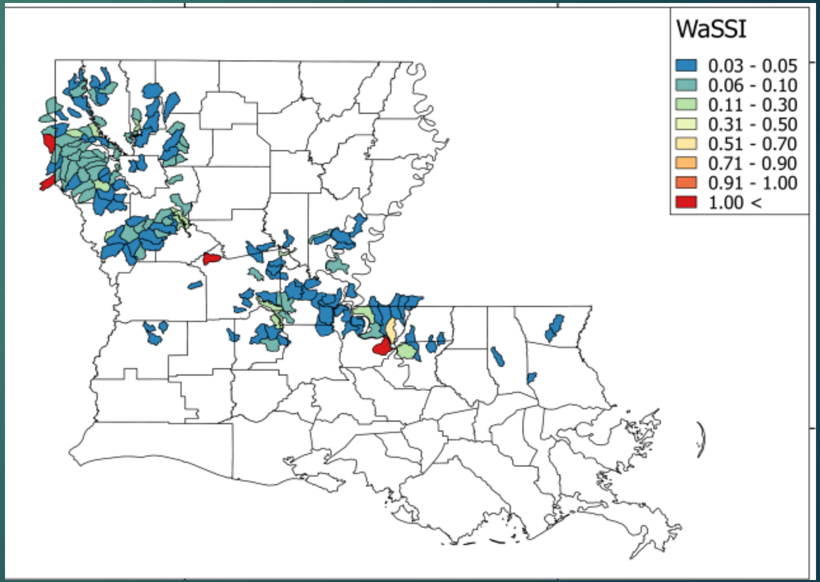
Base Case (No HF)



HF 2011



Existing wells

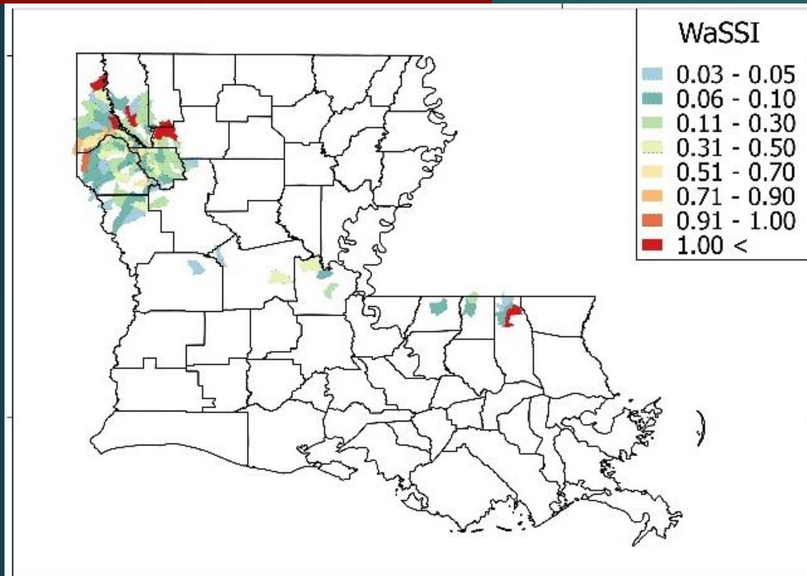


Total extraction

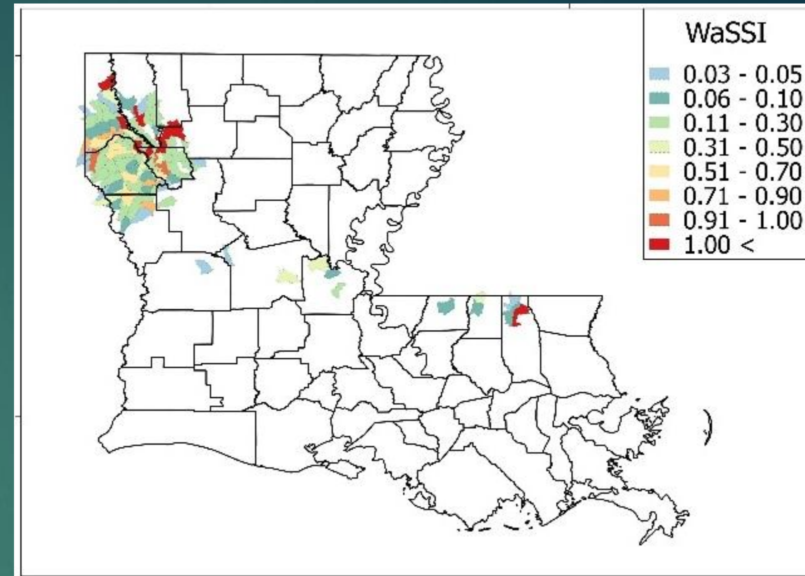
(White color in the figure indicates WaSSI values below 0.03)

Results

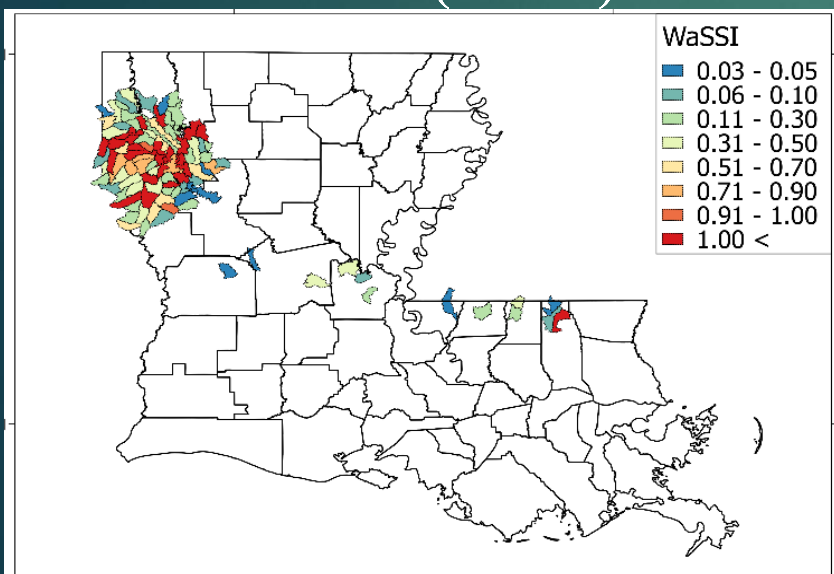
Groundwater WaSSI



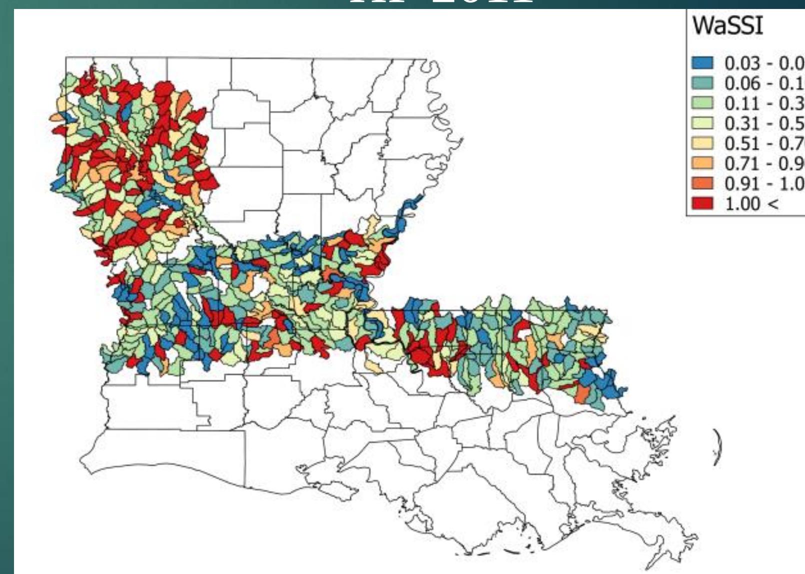
Base Case (No HF)



HF 2011



Existing wells



Total extraction

(White color in the figure indicates WaSSI values below 0.03)

Results

Haynesville shale play

Stressed HUC units count

Stress on System	Number of HUC-12 Units (%) per scenario and source							
	Base case		2011 year		Existing wells		Full extraction	
	SW	GW	SW	GW	SW	GW	SW	GW
High > 1	1(1)	5(5)	1(1)	7(7)	1(1)	23(24)	2(0)	53(32)
Medium 0.50-1.00	0(0)	7(7)	0(0)	13(14)	0(0)	16(17)	0(0)	35(21)
Low < 0.50	93(99)	82(88)	93(99)	74(79)	93(99)	55(59)	165(100)	79(47)

Results

Tuscaloosa shale play

Stressed HUC units count

Stress on System	Number of HUC-12 Units (%) per scenario and source							
	Base case		2011 year		Existing wells		Full extraction	
	SW	GW	SW	GW	SW	GW	SW	GW
High > 1	0(0)	1(5)	0(0)	1(5)	0(0)	1(5)	2(0)	43(13)
Medium 0.50-1.00	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0)	27(8)
Low < 0.50	19(100)	18(95)	19(100)	18(95)	19(100)	18(95)	327(100)	260(79)

Summary results

Water stress scenario	Haynesville: # HUCs migrating to high stress category (%)	Tuscaloosa: #HUCs migrating to high stress category(%)
HF water use of **2011**	8 (8%)	0 (0%)
HF water use of all **existing wells**	27 (29%)	0(0%)
HF water use considering all the wells required for shale plays **total extraction**	65(45%)	18 (7%)

Conclusions

- Surface water in Louisiana shale play areas seems to be sufficient to cover water demands for HF.
- Groundwater resources are sensitive to HF activities. especially for the Haynesville shale play, HF water can impose significant stress on the groundwater resources.
- The water source selection used for unconventional extraction activities is critical for LA water stress sensitive areas.
- Relevance of reporting HF water use is significant for proper water management at small scale regions.

Future work

- Similar work can be conducted in different states with more hydraulic fracturing activity.
- Recycled flow back and produced water opportunities to help alleviate the impact in high stressed areas.
- Surface water available may be enough but not cost-feasible. A cost analysis can be performed to assess the feasibility of using alternative resources.
- Future studies may consider the quality aspects of hydraulic fracturing.

Questions

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Thank You for Attending Today's Presentation

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