

Assessing Linkages between Drinking Water Quality Violations and Social Vulnerability in the United States



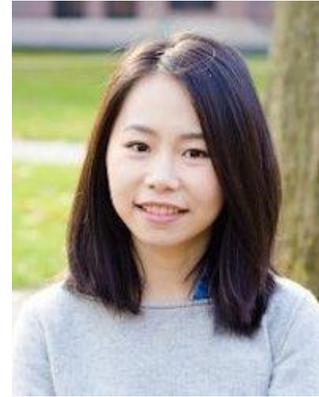
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Bureau of Economic Geology
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The University of Texas at Austin

Outline

- Background
- Results
 - Linkage between drinking water (DW) quality violations and social vulnerability
 - Causes of DW quality violations
 - Spatial and temporal variations in DW quality violations
 - Persistence of violations linked to social vulnerability
- Opportunity
 - Texas spatial variability, climate extremes, DAC definition
- Summary

REPORT CARD FOR AMERICA'S INFRASTRUCTURE United States

2021

Drinking Water



1/3rd of Americans drink tap water
1/3rd filter their tap water
1/3rd drink bottled water
waterpolls.org

The FDA Knew the Bottled Water Was Contaminated. The Public Didn't.

FDA inspectors have found some companies failed quality standards for bottled water, but the agency didn't take significant action

By Ryan Felton
November 21, 2019



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Texas Report Card



DRINKING WATER

Texas' drinking water sector has improved in the conservation, planning, management, and increases in State funding and financing support.



Plastic Water Bottle Pollution: Where Do All The Bottles End Up?

EPA: Environmental Justice Screening and Mapping Tool

How does this apply to drinking water?

Medium	Indicator	Year
Air	PM 2.5	2018
Air	Ozone	2018
Air	Diesel PM	2017
Air	Air toxics cancer risk	2017
Air	Air toxics hazardous risk	2017
Air/other	Traffic proximity/volume	2019
Dust/lead/paint	Lead paint	2016-2020
Waste/air/ water	Proximity to superfund site	2022
Waste/air/ water	Risk Manag. Plan facility proximity	2022
Waste/air/ water	Hazardous Waste proximity	2022
Waste/air/ water	Undergrd. Storage tanks	2022
Water	Wastewater discharge	2019

Missing non-point sources of water contamination (e.g., geogenic contamination and regional nitrate).

Infrastructure Investment and Jobs Act (IIJA): Drinking Water and Wastewater Infrastructure

Updated January 4, 2022

- Funding over 5 years
- Clean Water State Revolving Funds (CWSRF): ~\$12 billion
- **Drinking Water State Revolving Funds (DWSRF): ~ \$12 billion**
- **DWSRF Lead lines: \$15 billion**
- **Emerging contaminants (PFAS) DWSRF \$4B; CWSRF: \$1B**
- **Small and disadvantaged communities: \$5 billion (Safe Drinking Water Act)**
- **Water recycling/reuse & Western water projects: \$8 billion (Bureau of Reclamation)**

- **49% of funding to Disadvantaged Communities (DACs)**

Texas Allotments

Category	Amounts
Drinking Water SRF	\$140,697,000
DWSRF Lead Service Line Replacement	\$221,567,000
DWSRF Emerging Contaminants	\$59,085,000
Clean Water SRF	\$82,018,000
CWSRF Emerging Contaminants	\$4,305,000

1st year total allotment for Texas is ~\$508,000,000;

2023: DWSRF total: \$342,000,000; CWSRF total: \$408,000,000

DWSRF and CWSRF Base programs require 49% of funds as additional subsidy to disadvantaged communities.

State Definitions of DACs

Type of Indicator	Indicators	No. States + Indicator
Socioeconomic	Median Household Income	49
	Unemployment Rate	10
	Poverty Rate	8
	% of Population with Government Assistance	1
	Labor Force Participation Rate	1
Demographic	Population Trends	7
	Age Composition	2
Financial	Water Rates	27
	Water System Size	16
	Water System Debt	7
	Municipal Bond Rating	2
	Proposed Loan Amount	1
	Property Value	3
Public Health	Human Health-related Factors	2
Env. Justice	EJ Community or Similar Designation	2
Defined Categories	Specifically defined and identified (e.g. colonias)	3

Basic Questions:

1. How do Safe Drinking Water Act (SDWA) violations vary spatially and temporally in the U.S.?
2. Do socially vulnerable populations have higher risk of SDWA violations?

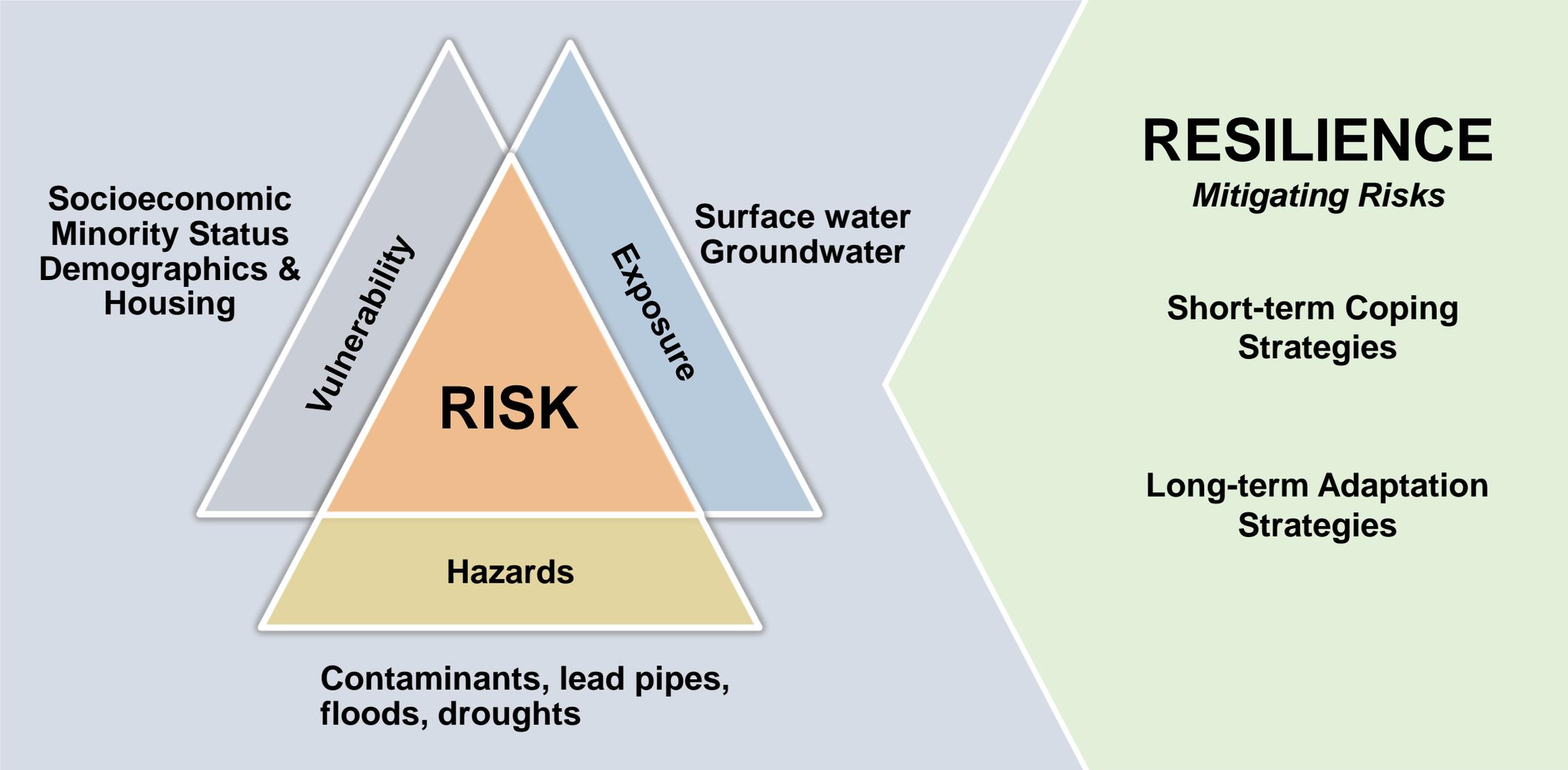
Baseline Information

1. How many people are impacted by drinking water quality violations?
 - a. 1 in 10; b. 3 in 10; c. 5 in 10
2. What are the **dominant sources of drinking water quality violations** in community water systems?
 - a. naturally occurring contaminants (e.g., arsenic, radionuclides, fluoride)
 - b. anthropogenic (nitrates)
 - c. organics (e.g., pesticides, herbicides)
 - d. pathogens (total coliform, E. coli, cryptosporidium etc)
 - e. disinfectants and disinfection byproducts
 - f. a, b, and e
3. Which state has the highest number of community water systems with any health-based violations?
 - a. Texas b. California c. Florida d. Louisiana e. Pennsylvania f. Washington g. New Jersey
4. Which community water systems are most vulnerable to contamination?
 - a. surface water systems b. groundwater systems c. large systems d. small systems
 - e. rural systems f. (b+d) g. (b+d+e)

Risk and Resilience Framework for Managing Water Quality in Community Water Systems



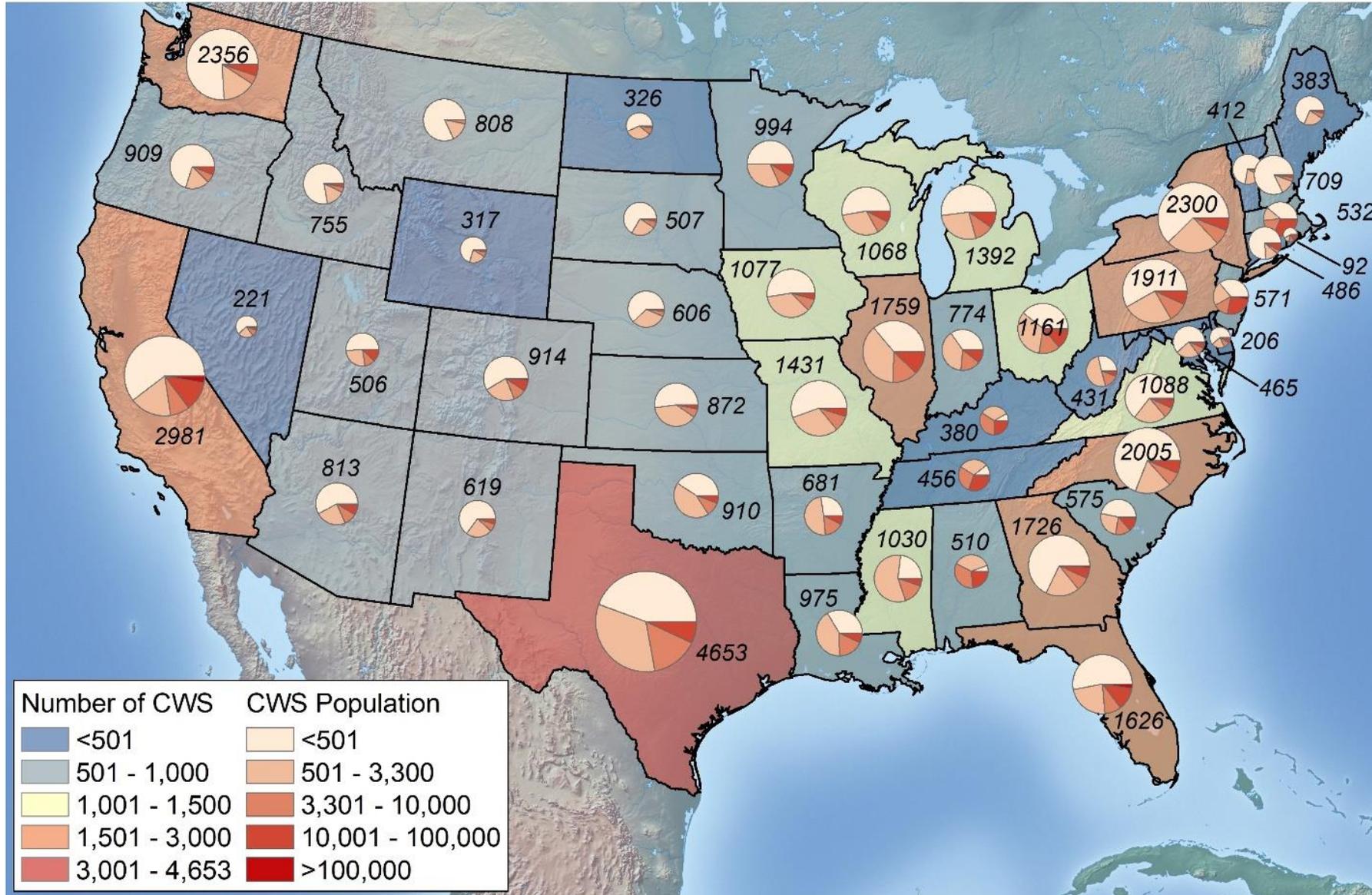
Risk and Resilience Framework for Managing Water Quality in Community Water Systems



Outline

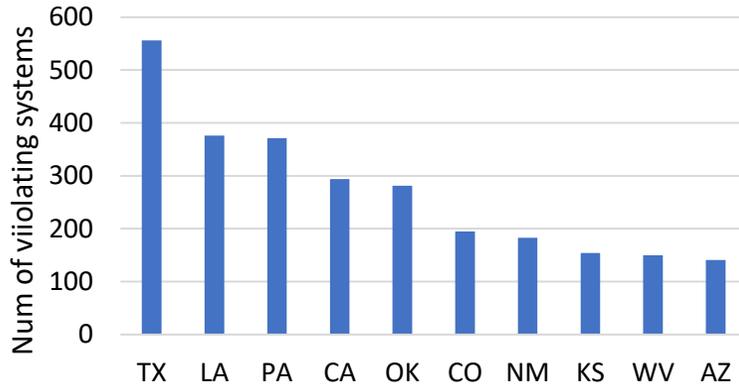
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Number and Size of Community Water Systems

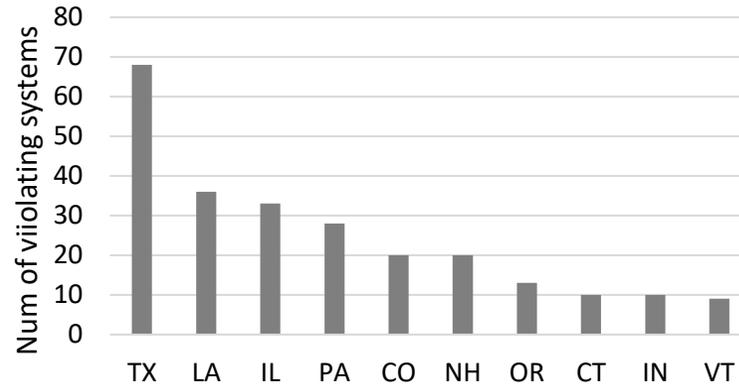


State Ranking of Number of Community Water Systems with Health Based Violations

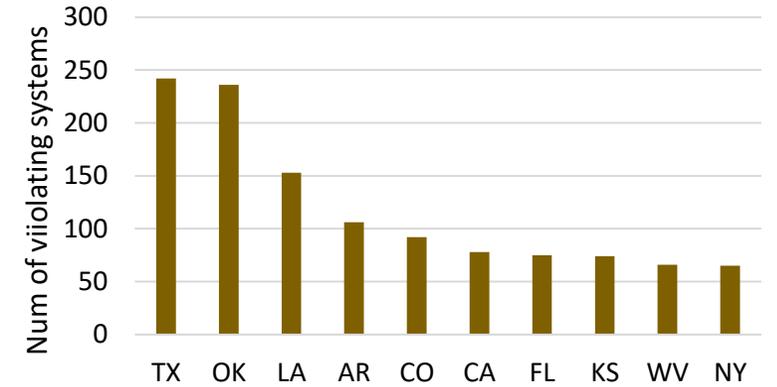
Any Health Based



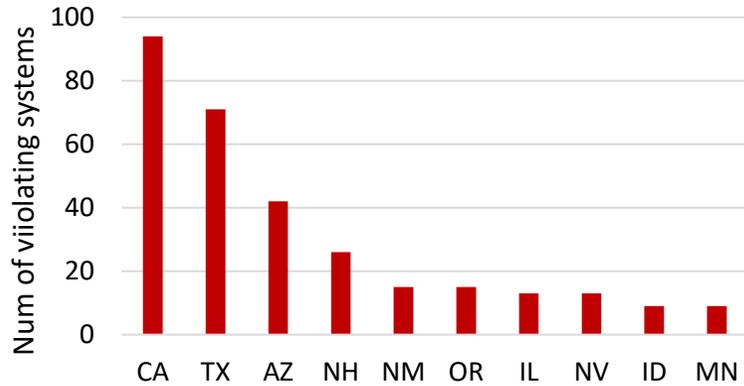
Lead & Copper Rule



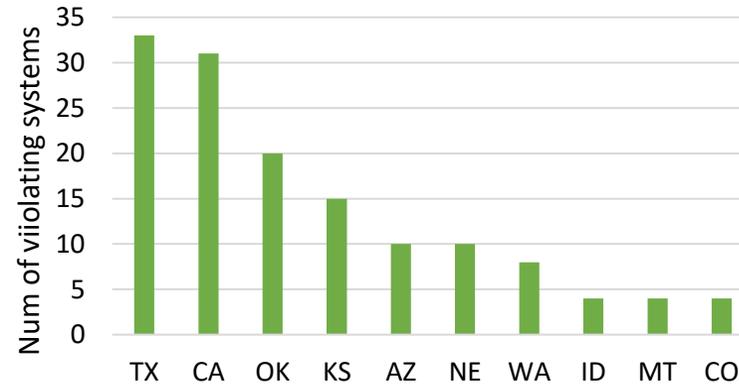
Any DBP Rule



Arsenic Rule



Nitrates Rule

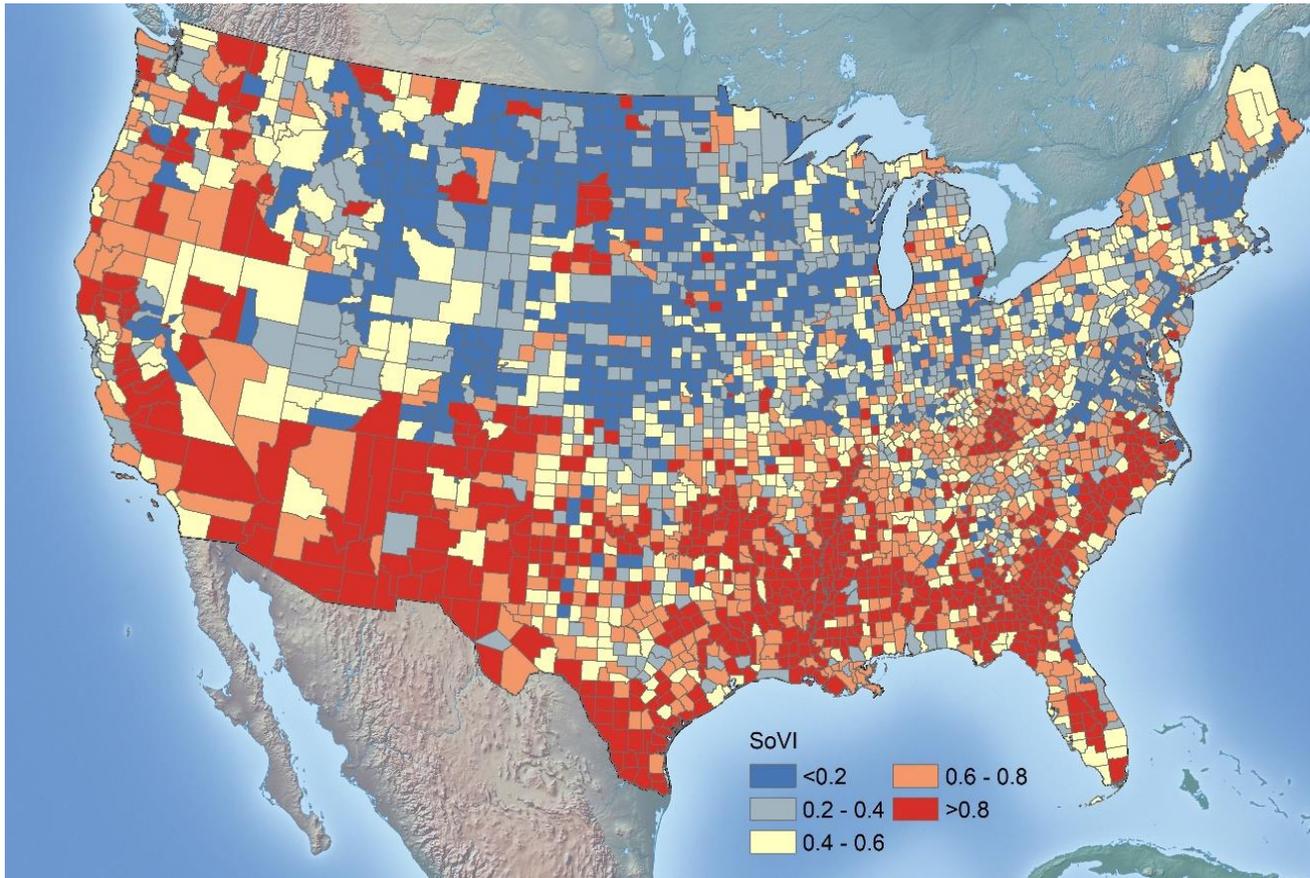


Revised Total Coliform Rule



Social Vulnerability Index (SVI, CDC, 2018)

Social vulnerability refers to potential negative effects on communities caused by external stresses on human health; Natural or human caused disasters or disease outbreaks



SoVI – Overall Vulnerability

Theme 1
Socioeconomic
Status

Below Poverty

Unemployed

Income

No High School Diploma

Theme 2
Household
Composition &
Disability

Aged 65 or Older

Aged 17 or Younger

Civilian with a Disability

Single-Parent Households

Theme 3
Minority Status
& Language

Minority

Speak English “Less than Well”

Theme 4
Housing &
Transportation

Multi-Unit Structures

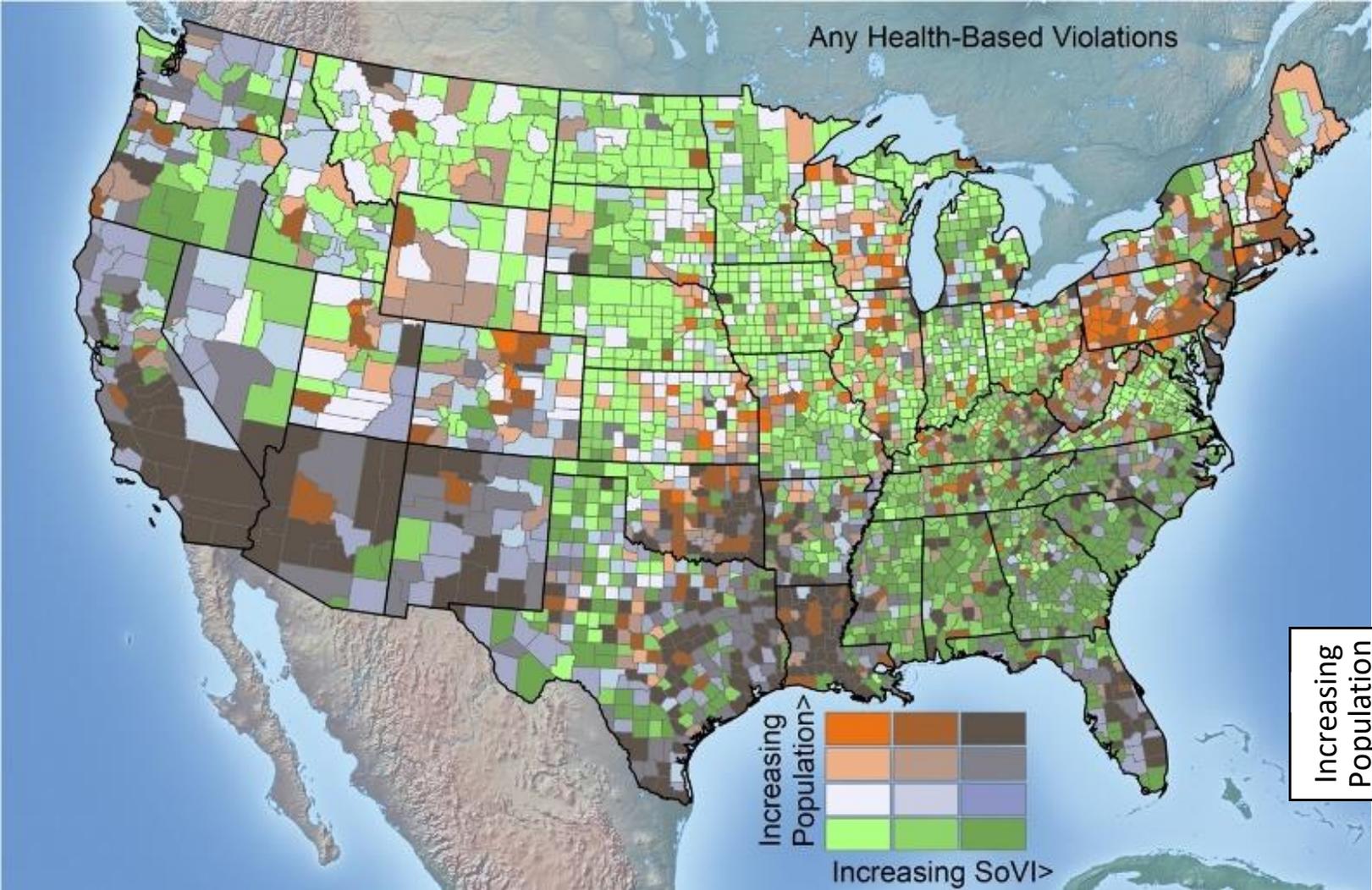
Mobile Homes

Crowding

No Vehicle

Group Quarters

Population served by Community Water Systems with any health-based violation (2018 – 2020)



DW Violations

high

low

	Southwest Southcentral
Midwest	

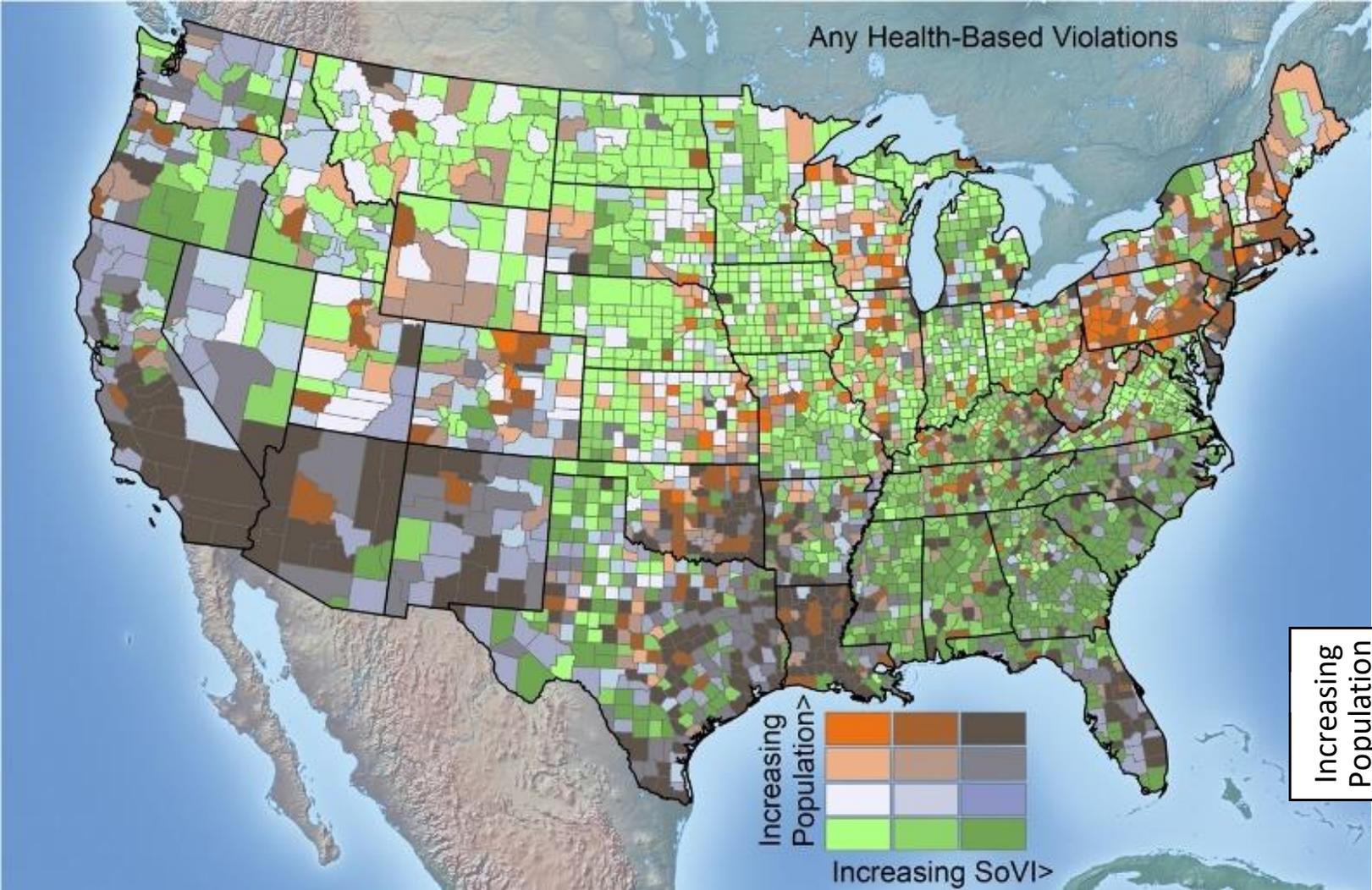
low

SoVI

high

Increasing Population ↑	3,168,302	6,093,369	15,909,384
	421,814	468,233	542,774
	63,527	68,072	45,404
	*27,415,585	*85,627,754	*164,764,283
	Increasing SoVI →		

Population served by Community Water Systems with any health-based violation (2018 – 2020)



DW Violations

high

low

Northeast	Southwest Southcentral
Midwest	Southeast

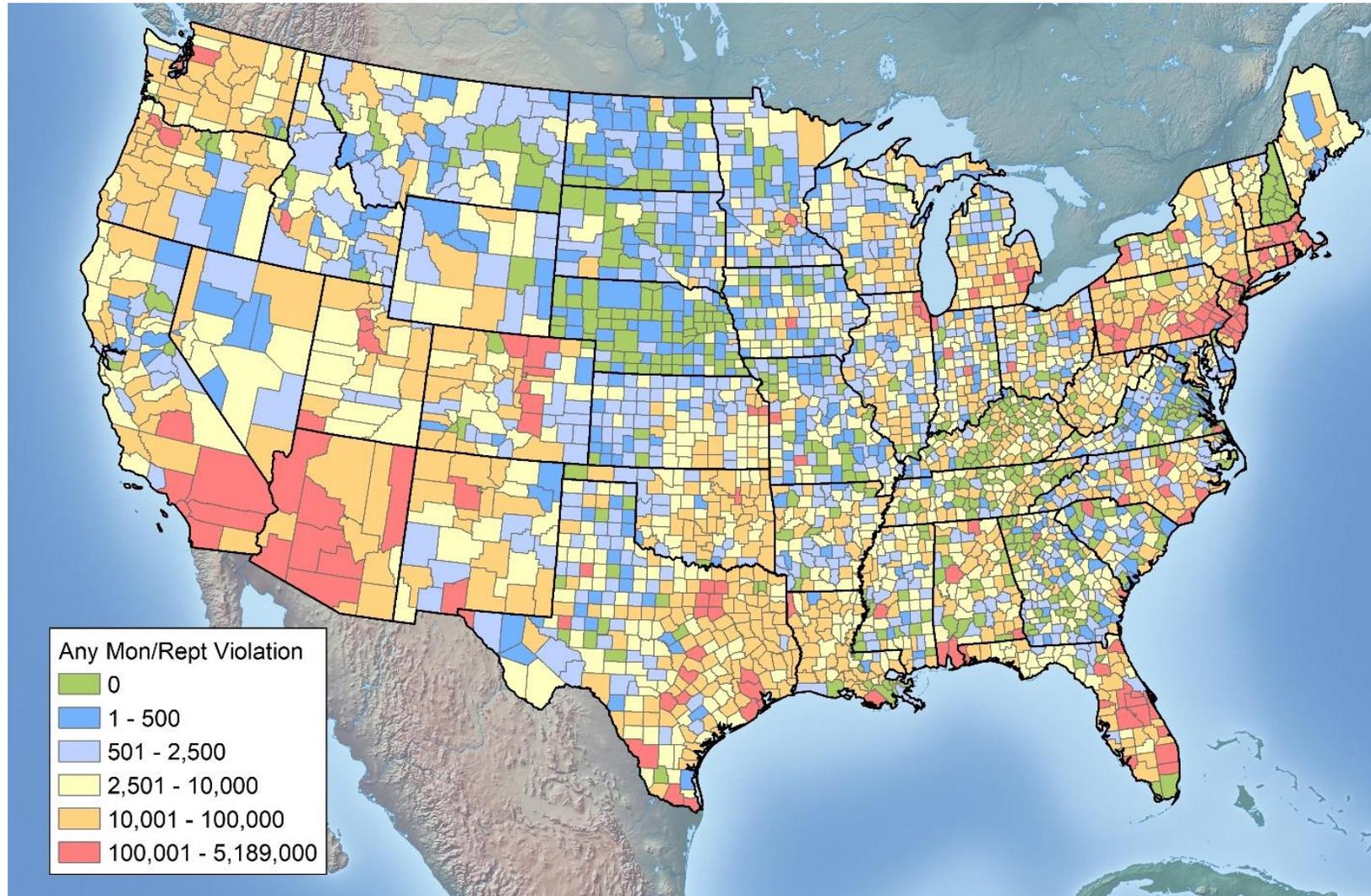
low

SoVI

high

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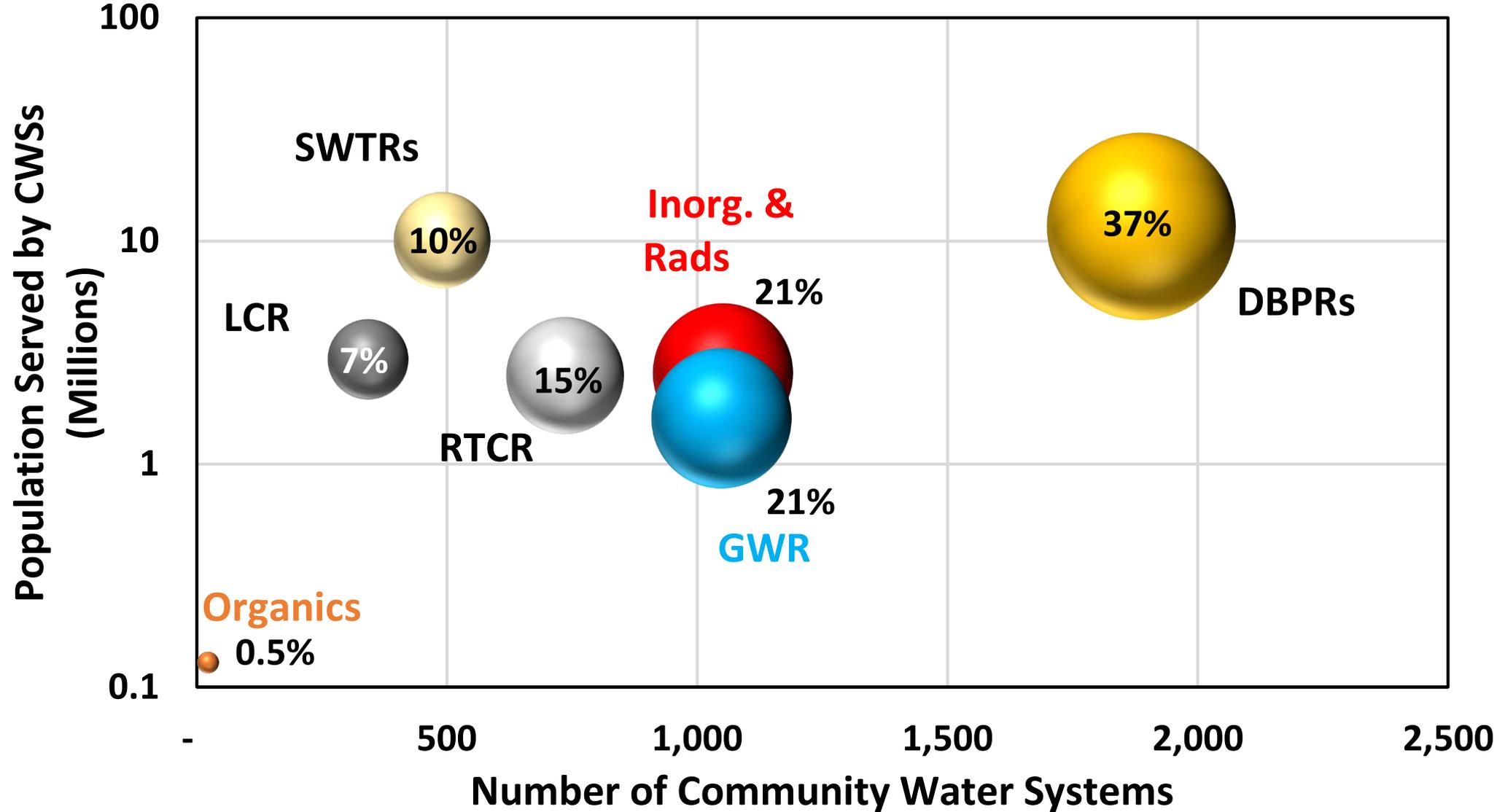
Is the Distribution of Health Based Violations an Artifact of Monitoring and Reporting Violations?



Outline

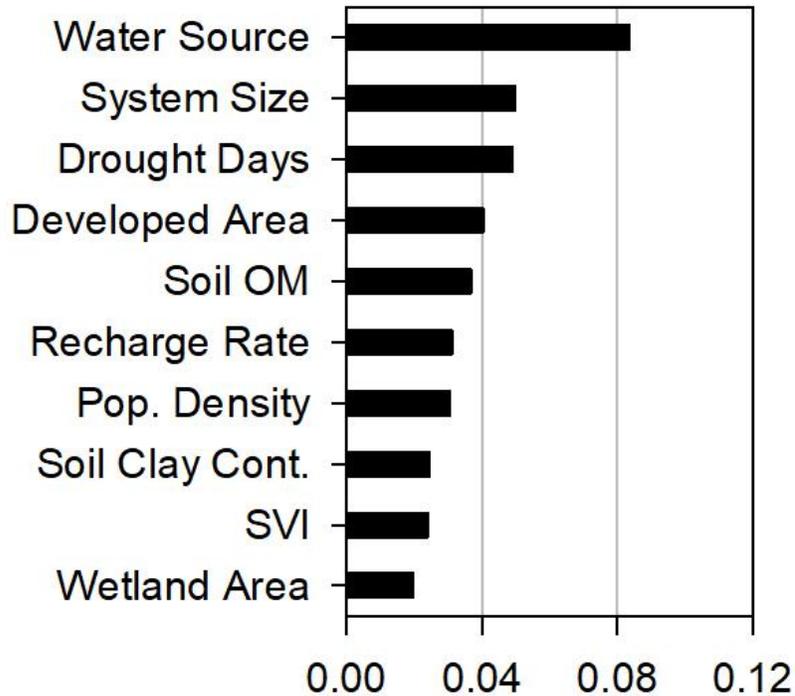
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Relationship between Violations and Populations Served

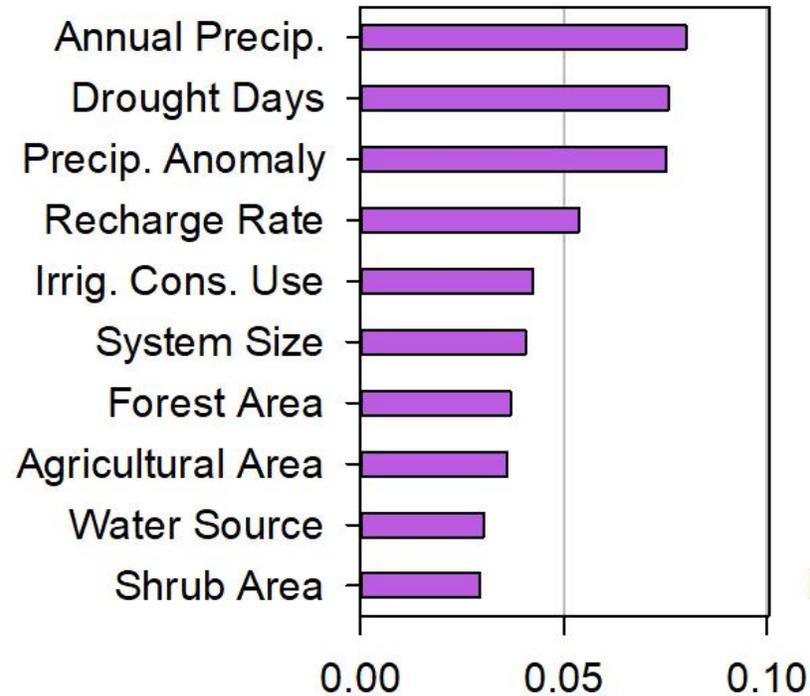


Environmental Causes of Violations based on Data Analytics

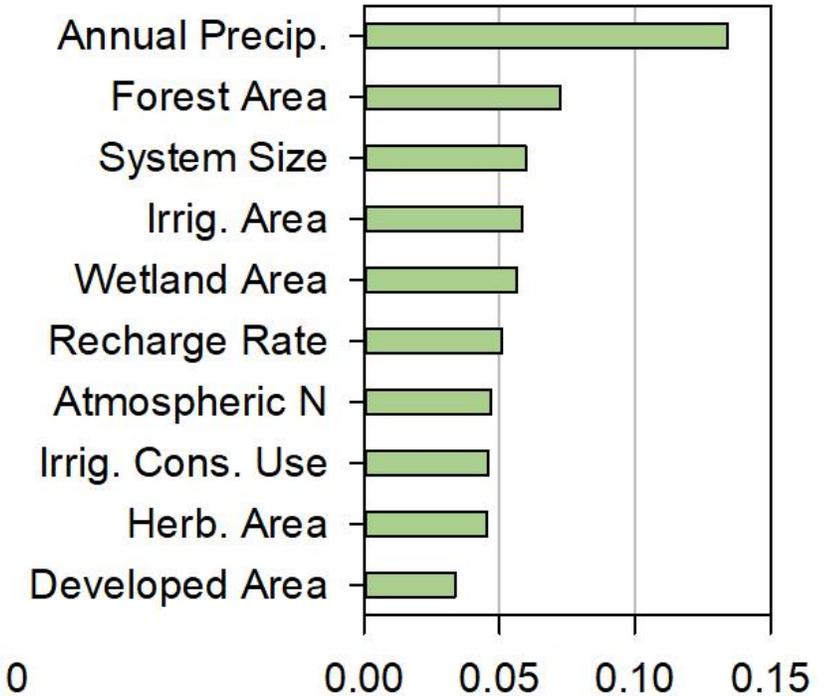
Any HB Violation



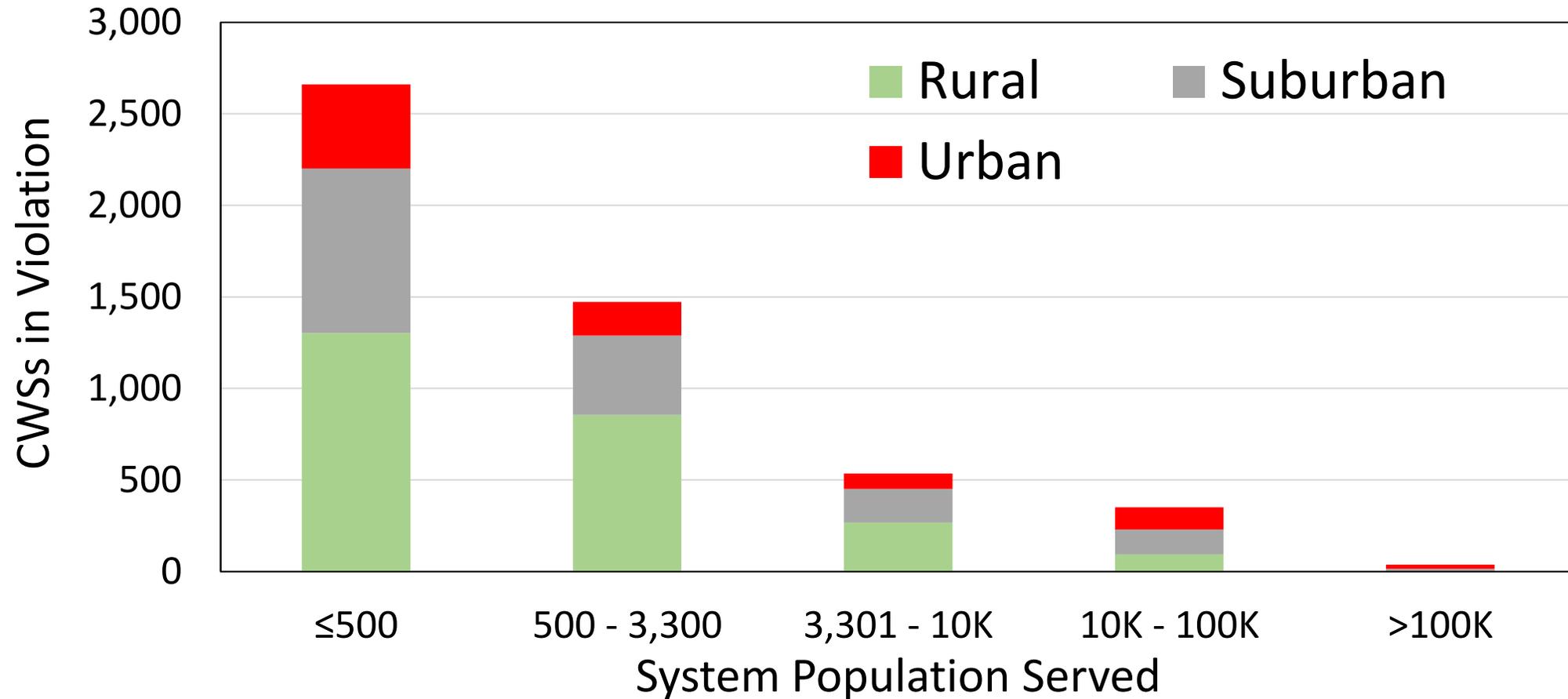
Arsenic



Nitrates



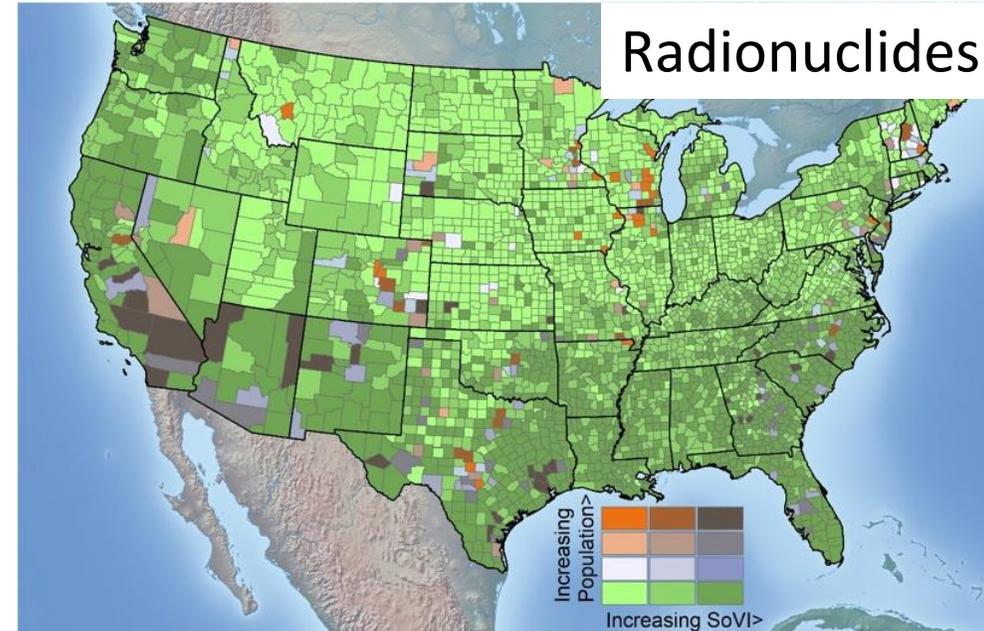
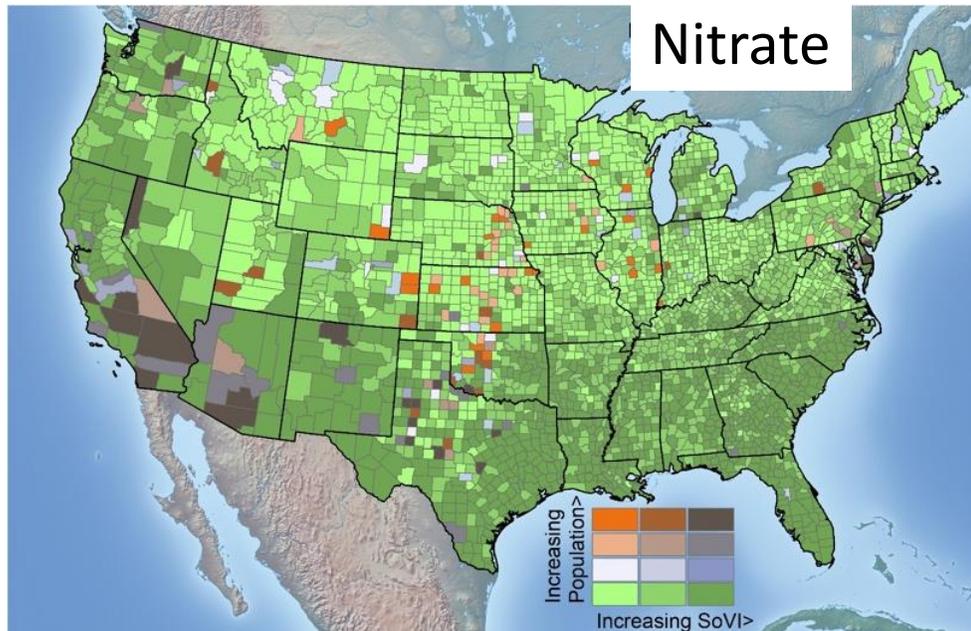
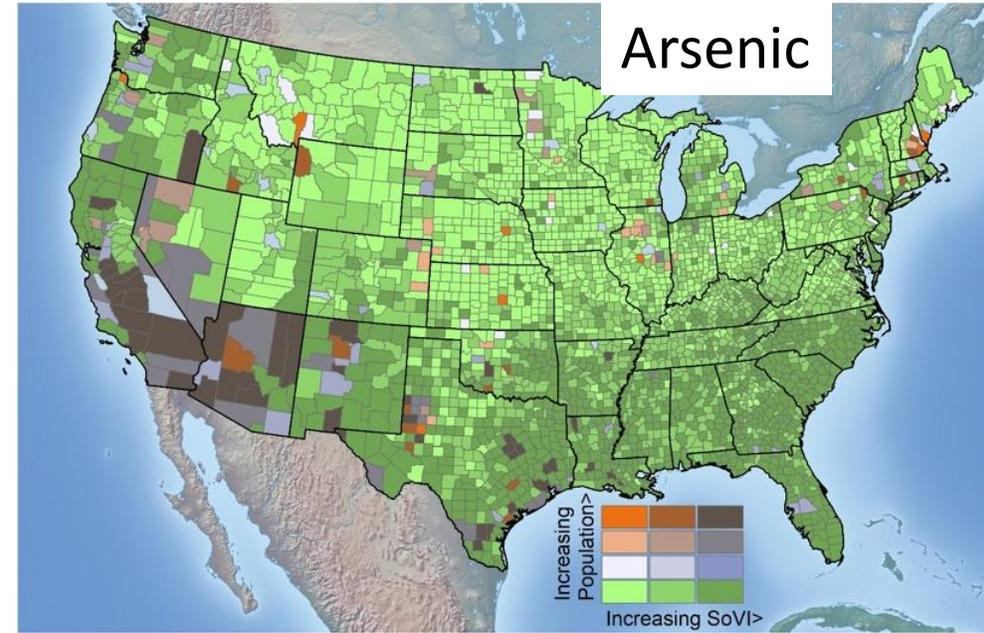
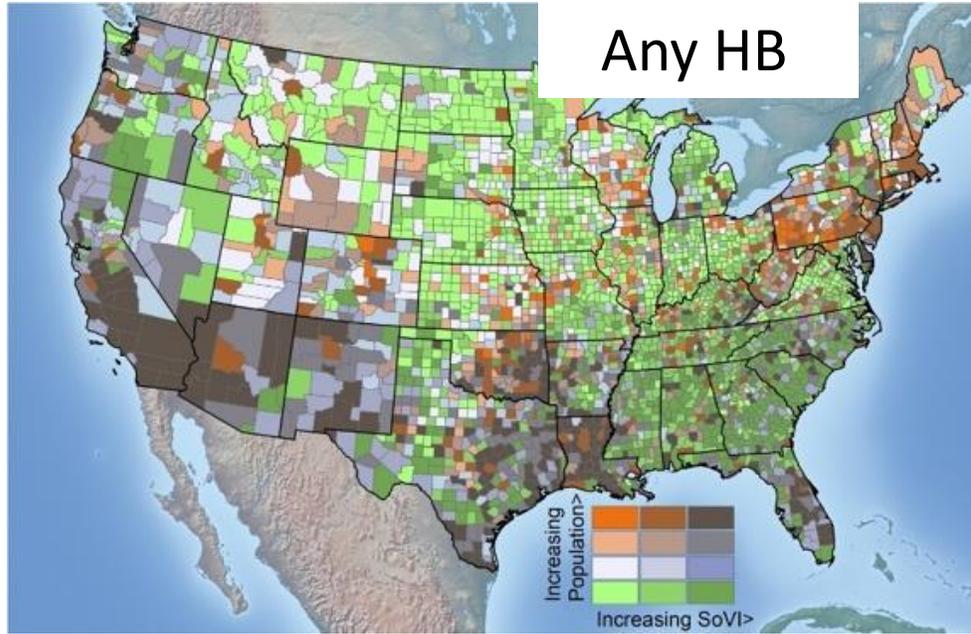
Health-based violations mostly in very small to small systems in rural and suburban settings



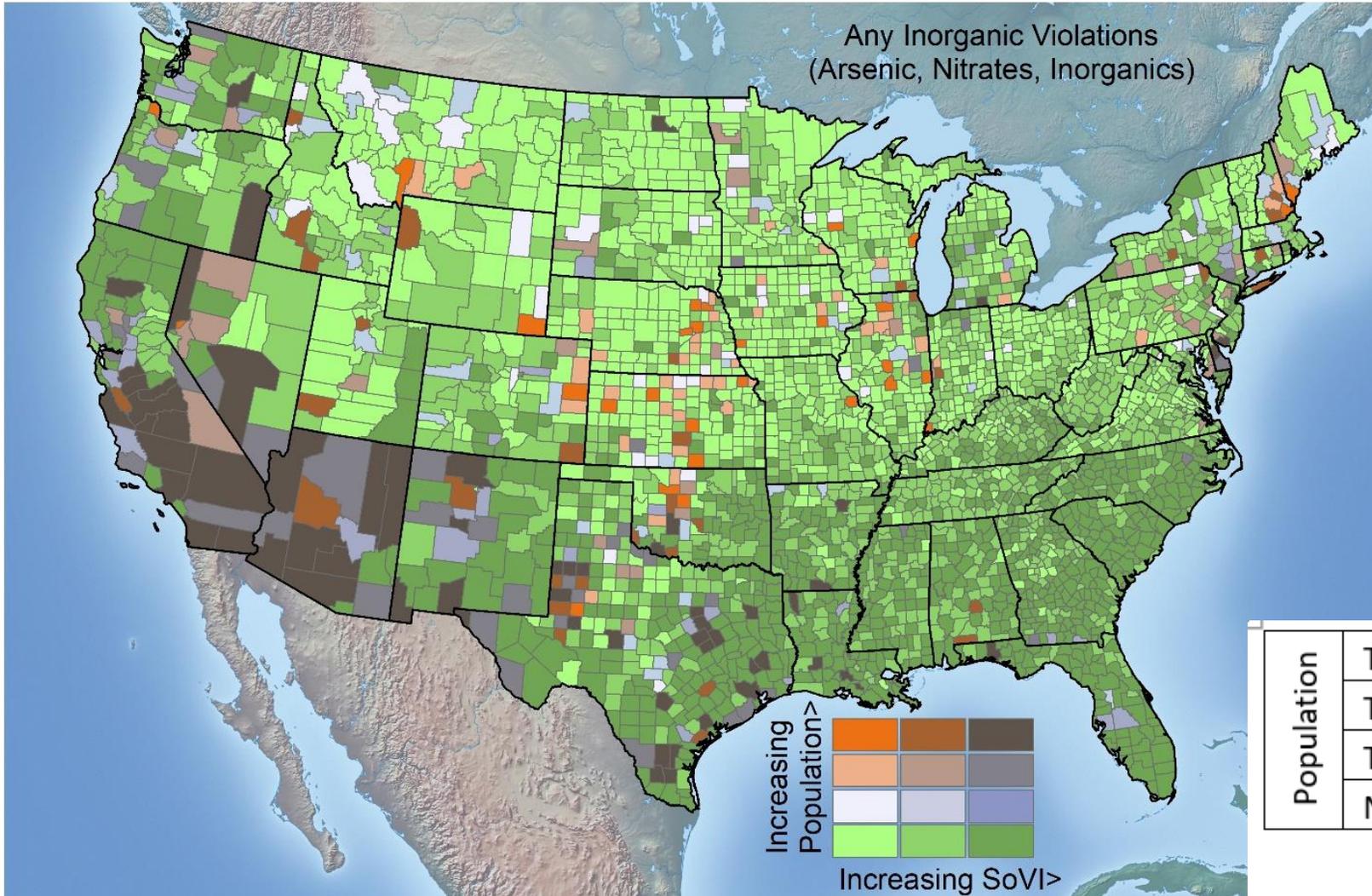
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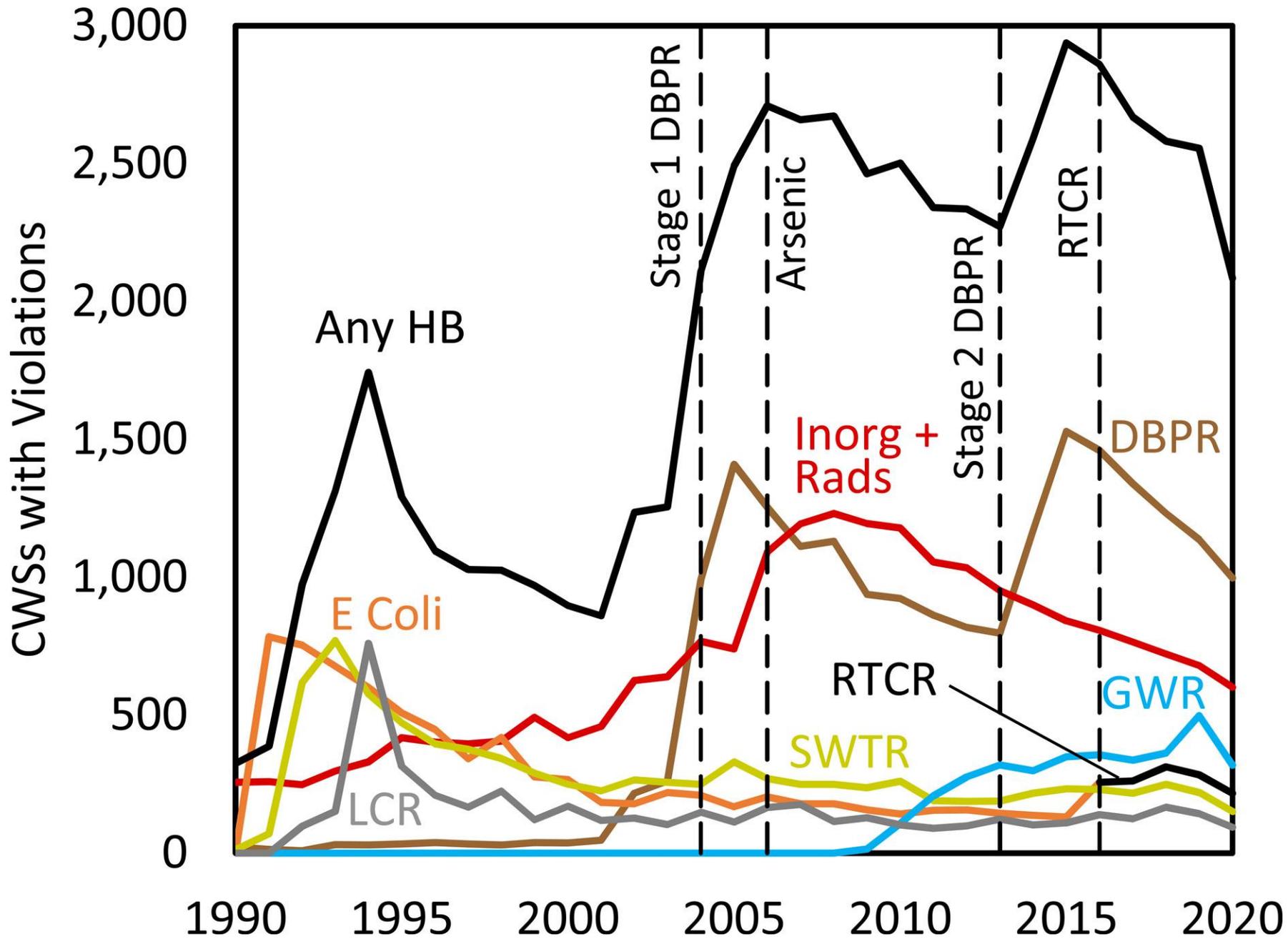
Health Based and Inorganic Violations



Any Inorganic Violation (2018 – 2020)

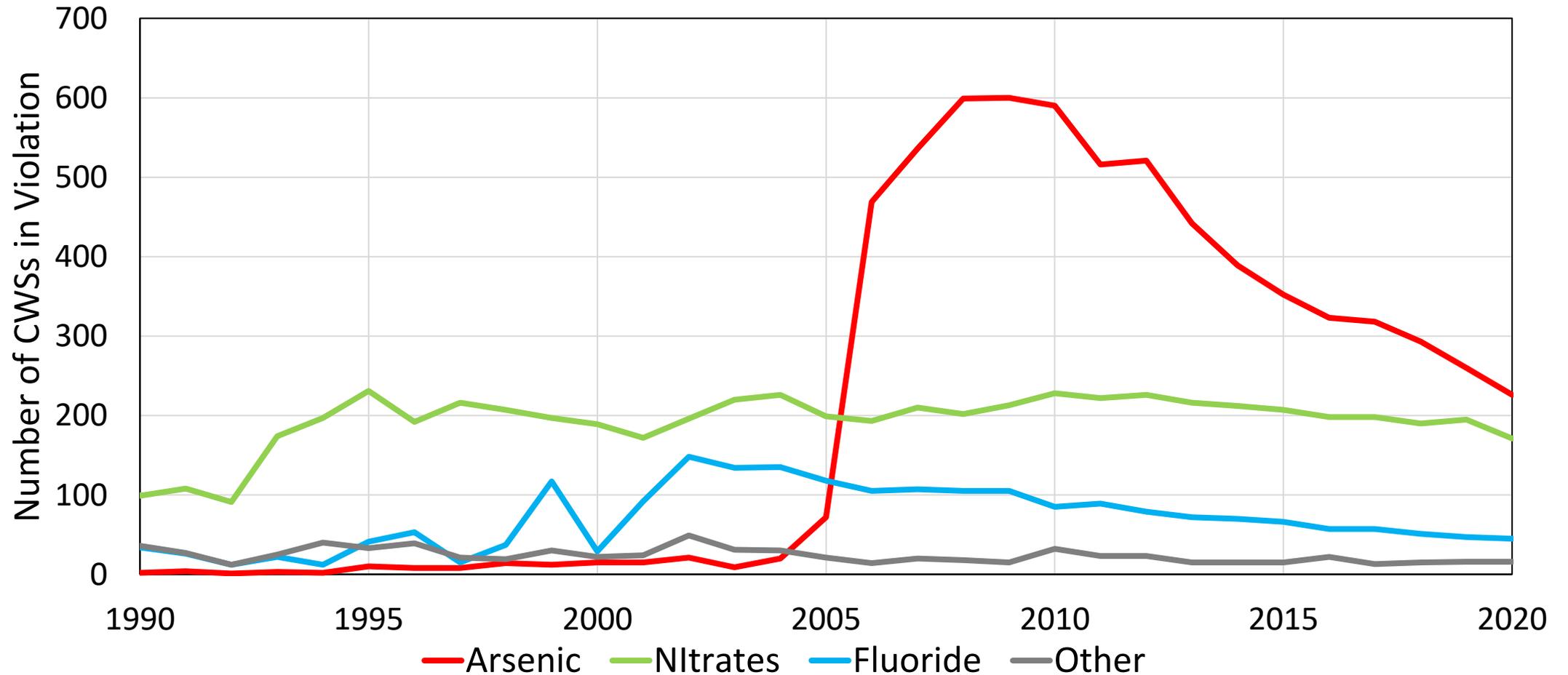


Population	Tercile 3	97,775	1,408,968	444,216
	Tercile 2	22,496	17,415	20,150
	Tercile 1	4,739	3,910	2,779
	No Viol*	30,944,218	90,827,135	180,794,700
	Tercile 1	Tercile 2		
	<u>SoVI</u>			



Temporal Variations in DW Violations

Increasing Arsenic Violation in Response to Rule Change



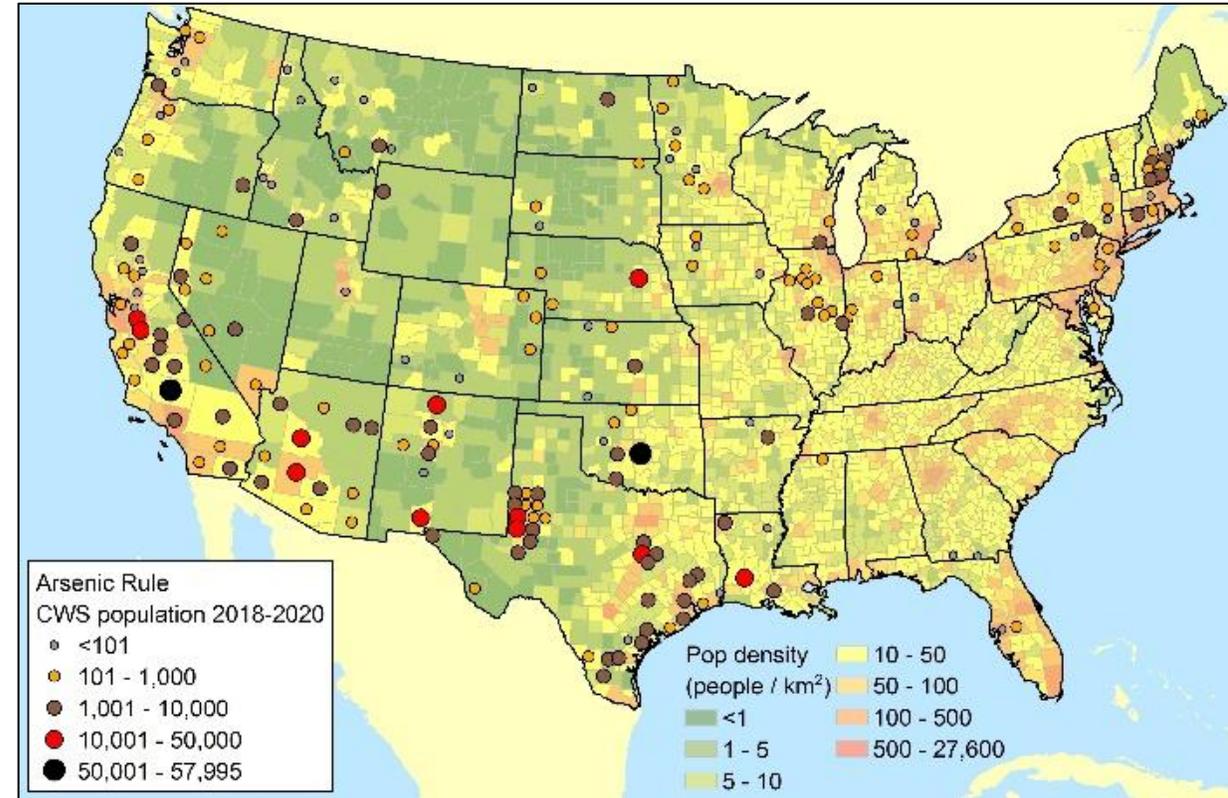
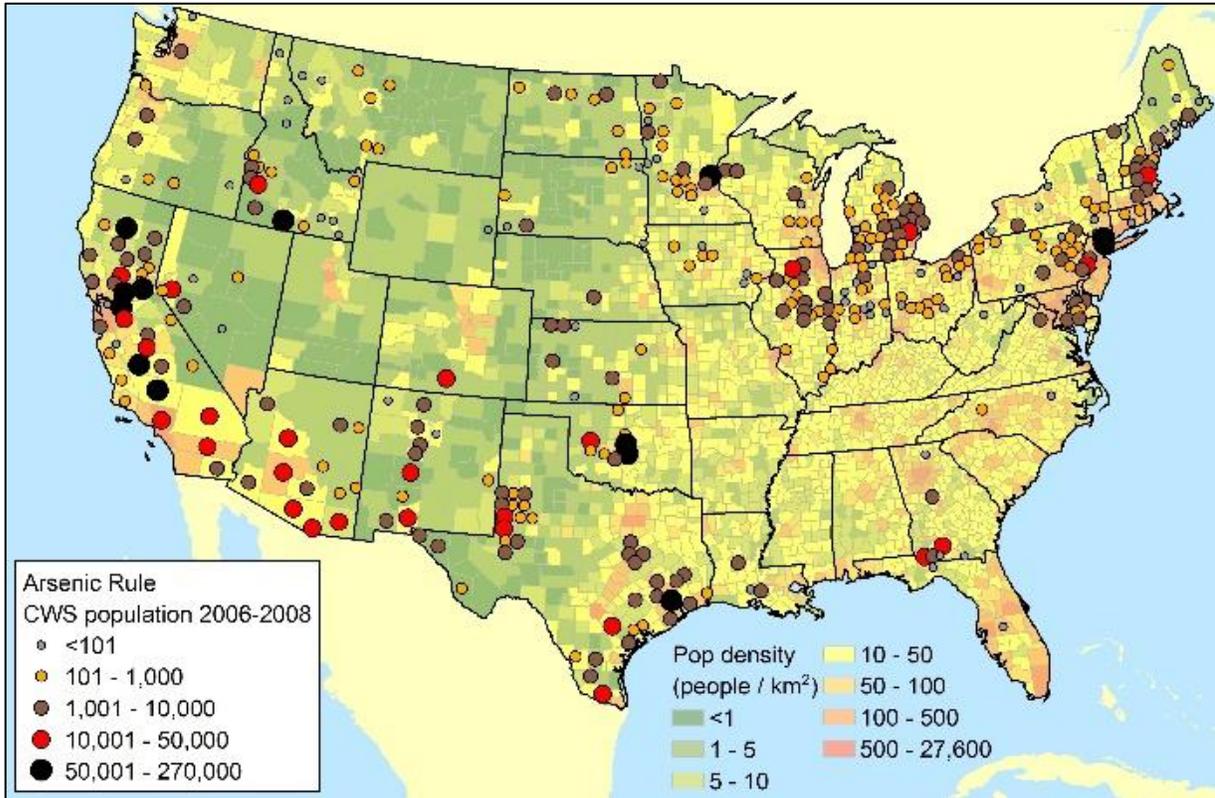
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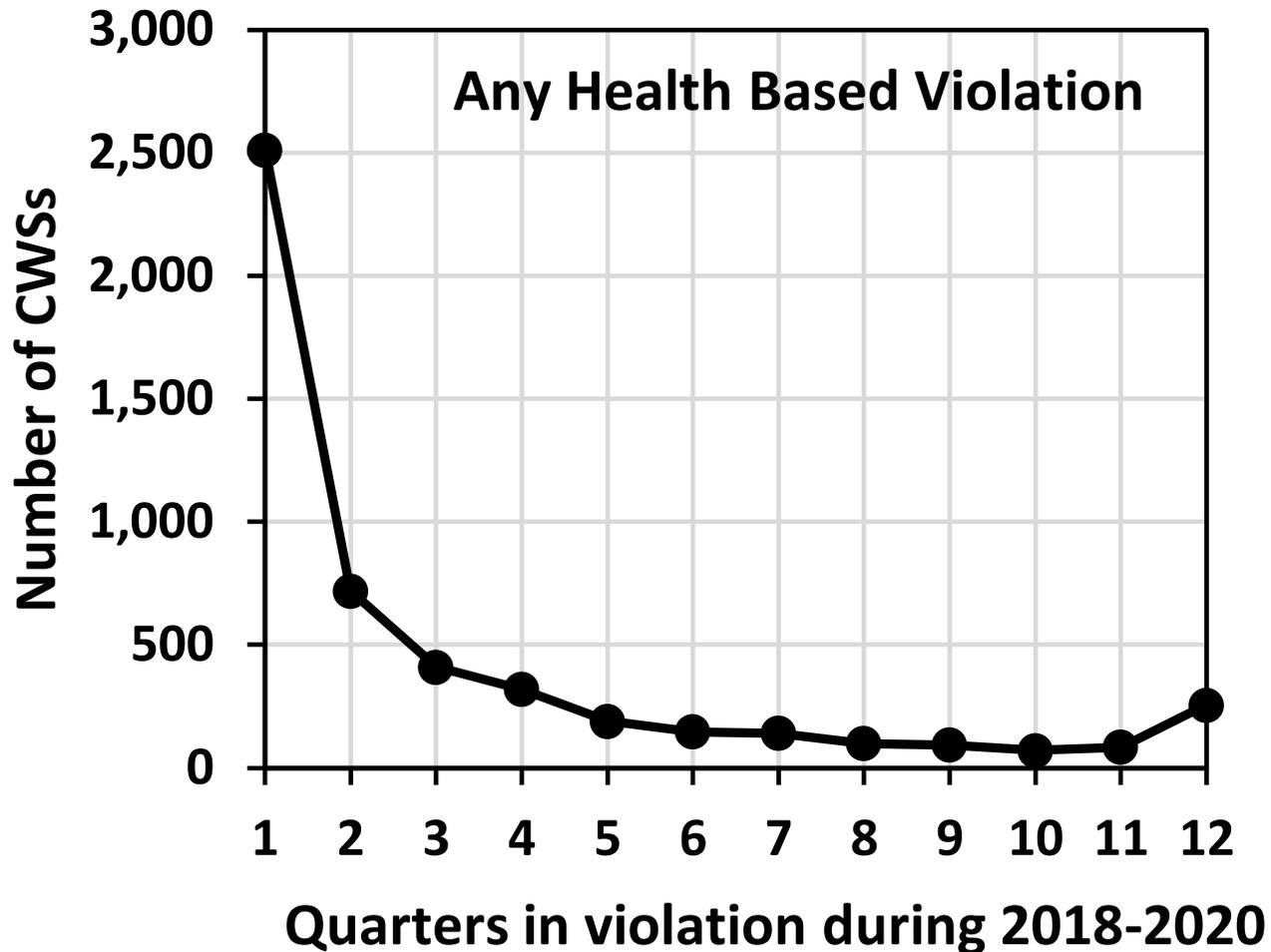
Persistence of Arsenic Violations in SW and SC and not in NE US, related to Social Vulnerability

2006 - 2008

2018 - 2020

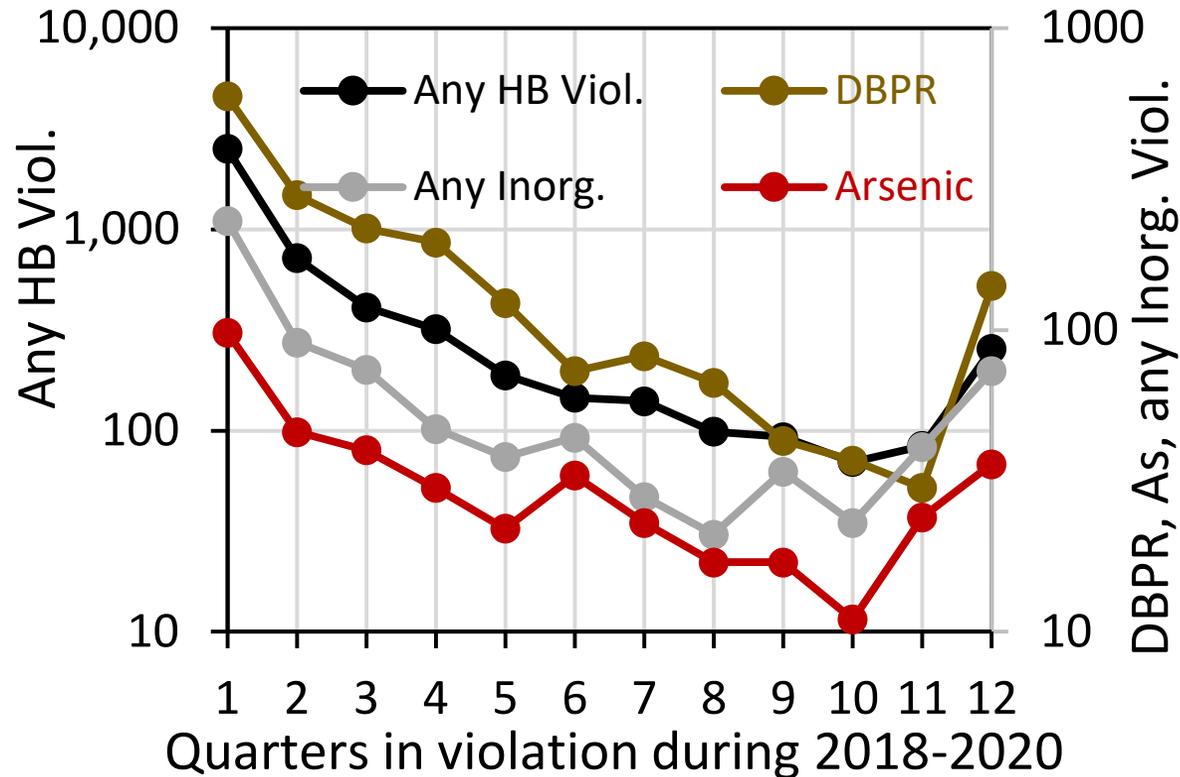


Persistence of Any Health-Based Violations Correlated with Social Vulnerability Index



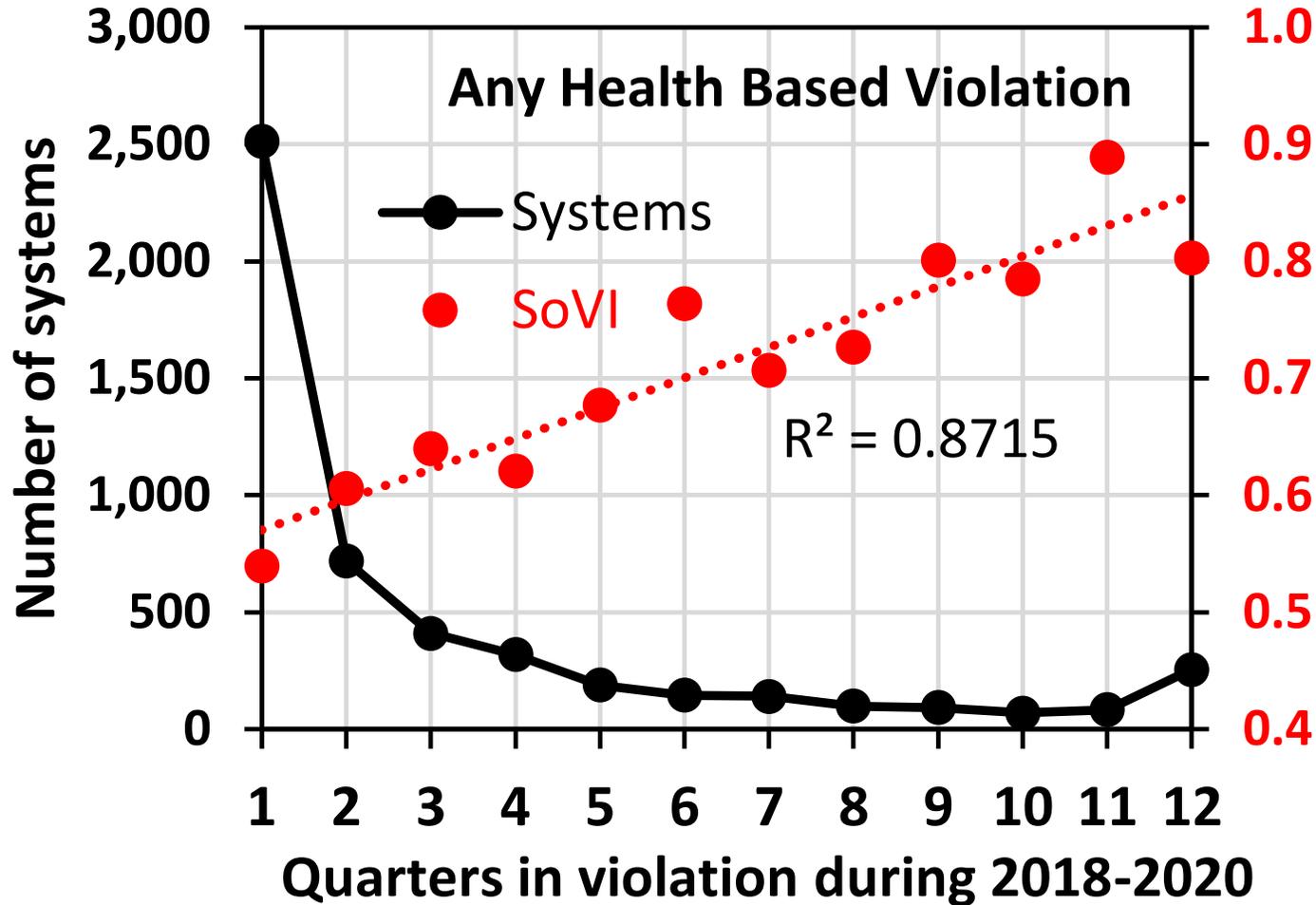
- Any HB violations are persistent

Persistence of Any Health-Based Violations Correlated with Social Vulnerability Index



- Violations of any HB, DBPR, inorganics, and arsenic are persistent
- Violations of SWTR, GWR, and LCR are not persistent

Persistence of Any Health-Based Violations Correlated with Social Vulnerability Index

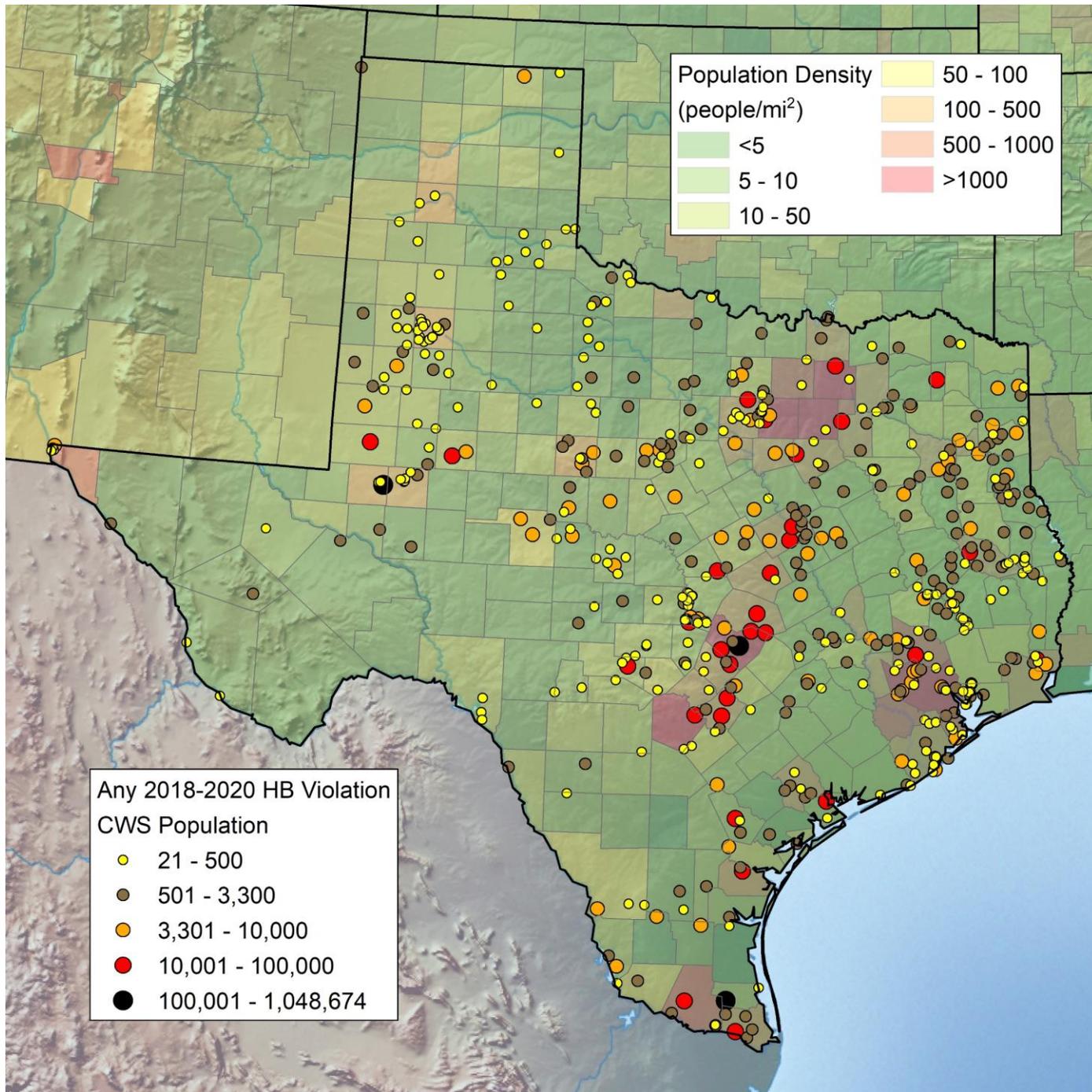


Persistence of any health-based violation strongly linked to increasing SoVI (R^2 0.87)

- Persistence of DBPR, arsenic, and any inorganic are also strongly linked to increasing SoVI (R^2 0.63 – 0.82)

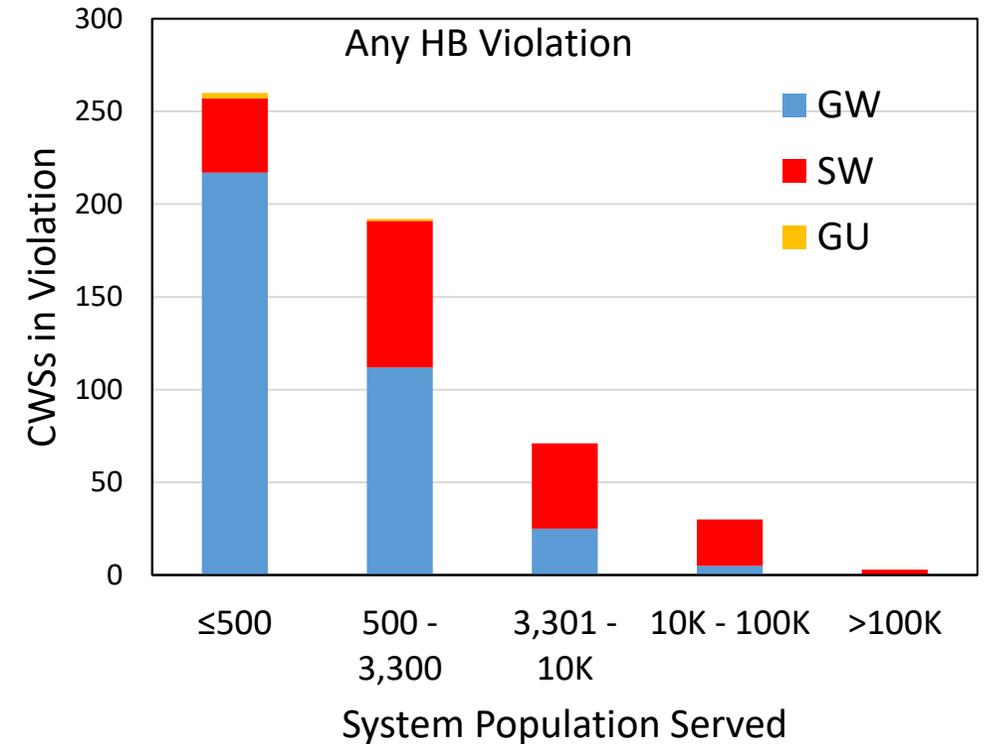
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Any Health-Based Violations

No alternative water source or backup
 Need to evaluate temporal variations
 Persistence
 Linkage to social vulnerability *at census tract level*



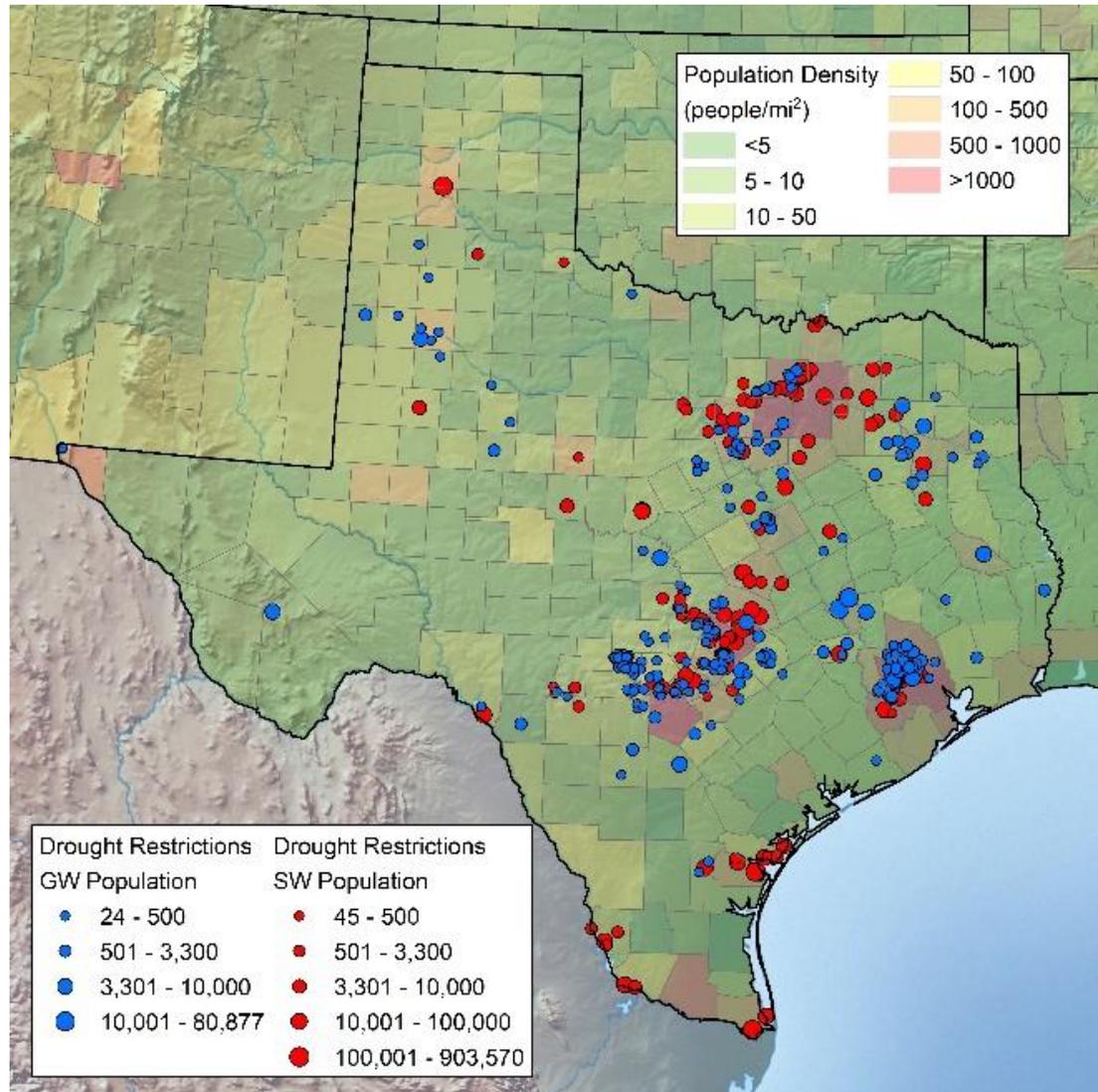
Disadvantaged Community (DAC) Definition

- Texas definition of a DAC:
 - Service area with annual median household income (AMHI) \leq 75% of state AMHI; and;
 - Household cost factor $>$ 1% (water or sewer only) or $>$ 2% (water and sewer)

$$\textit{Household Cost Factor} = \left(\frac{(K + V + Y)}{AMHI} \right) + Z + AA$$

K average annual water bill; V average annual sewer bill; Y annual amortized project cost per household; Z unemployment rate adjustment; AA population adjustment.

System Resilience to Climate Extremes



- Drought may drive increasing GW depth
- Wells may fail
 - Operationally (“go dry”)
 - Become unaffordable
- New well performance tools quantify
 - Pumping cost (affordability) changes
 - Operational performance changes
- Applications:
 - Evaluate CWS drought risk
 - Provide early warning of well failure
 - Assess projected affordability

Summary

- Current EJ tool not suitable for DW quality
- Risk to DW quality violations requires: (1) hazard (contaminants), (2) exposure (SW or GW), and (3) vulnerability
- Spatial variability: high levels of DW quality violations in SW and SC US (DBPRs and inorganic and rad violations)
- Temporal variability related to regulations
- Persistence of violations linked to social vulnerability
- Violations predominantly in very small to small CWSs in rural and suburban settings
- Detailed analysis of Texas

Agencies involved in Community Water Systems

Texas Water Development Board
State Revolving Funds



CADMUS



EPA Env. Finance Centers



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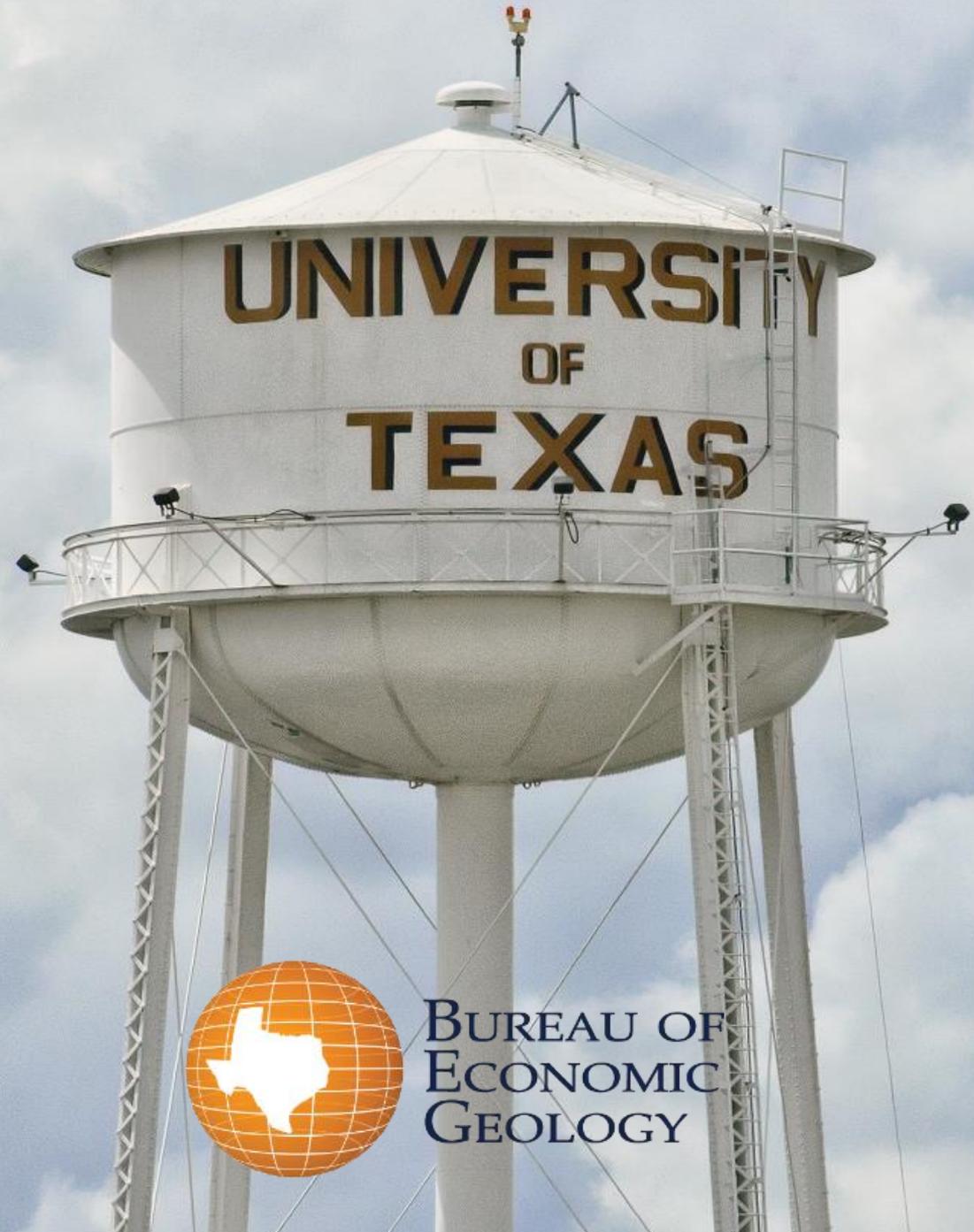
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