

Drinking Water Quality and Social Vulnerability at the System Level in the United States

Bridget R. Scanlon, Robert C. Reedy, Sarah Fakhreddine, and Gregory Pierce

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Study Summary

Growing recognition of water quality concerns, particularly in socially vulnerable communities in the United States, has prompted recent policies and investments to improve drinking water system performance. Current environmental justice tools limit measurement of drinking water quality issues to proximity to point-source contamination, such as superfund sites and social vulnerability to county level or zip code level data.

The **objectives** of this study were to address the following questions:

- (1) Do drinking water quality violations disproportionately impact socially vulnerable populations?
- (2) Which social vulnerability parameters have the greatest impact on the probability of violations?
- (3) Is recurrence of violations linked to a customized measure of local social vulnerability?

We examined relationships between health-based (HB) drinking water quality violations (2018 – 2020) and social vulnerability using a new database of community water system (CWS) service areas and a modified social vulnerability index (SVI), which we specifically designed for drinking water quality.

Results show that drinking water quality violations disproportionately impact socially vulnerable populations, with ~ 70% of the population with any HB violation ranking in the highest modified SVI tercile. Increased risks of drinking water quality violations in high socially vulnerable communities are attributed in part to violations related to pervasive, naturally occurring contaminants (e.g., arsenic, radionuclides) and non-point source contaminants (e.g., nitrate) requiring treatment and difficulties for small systems to implement and maintain treatment systems. Many different social parameters, beyond socioeconomic metrics, are linked to different drinking water quality violations; however, current federal environmental justice tools and existing **disadvantaged community (DAC)** definitions focus on **socioeconomic factors**, neglecting key social vulnerability parameters, such as **race, language, demographics, and housing** related to equitable access to safe drinking water. The modified SVI is strongly linked to recurrence of select drinking water quality violations (i.e., the ability of systems to recover from violations over time), including any HB, arsenic, and disinfection byproduct violations. For example, recurrence of any HB violation is strongly correlated to modified SVI ($R=0.73$).

Why is this research important and why do the results matter?

- New federal drinking water infrastructure laws require states to allocate $\geq 49\%$ of the infrastructure funding (\$50 billion) to DACs. A total of 49 out of 51 states emphasize median household income (MHI) in their DAC definitions. Results of this analysis show that MHI alone identifies a significantly smaller percentage (~30%) of the most vulnerable affected CWS population as compared to the modified SVI, suggesting a broader definition of DACs should be used, beyond MHI.
- One solution proposed to address water quality violations is to prevent source water contamination. However, this study shows that many of the violations are caused by naturally occurring geogenic contaminants and nonpoint source nitrate contamination. Understanding the causes of drinking water quality violations is essential to developing effective solutions.

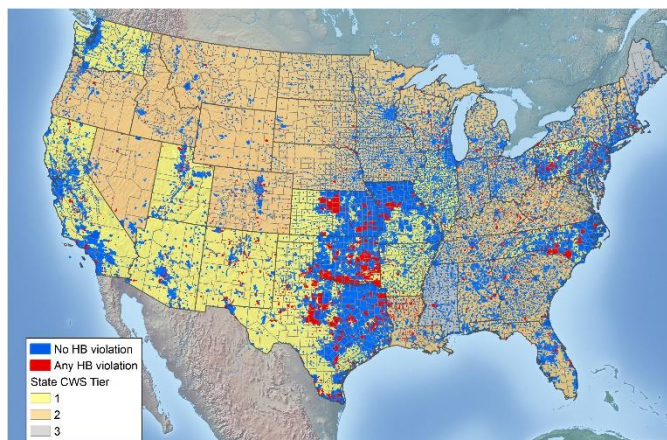


Figure 1. CWSs with no HB violations (blue) and with HB violations (red) for EPIC classified Tier 1 (15 states with published CWS service areas) and Tier 2 states (estimated CWS service areas).