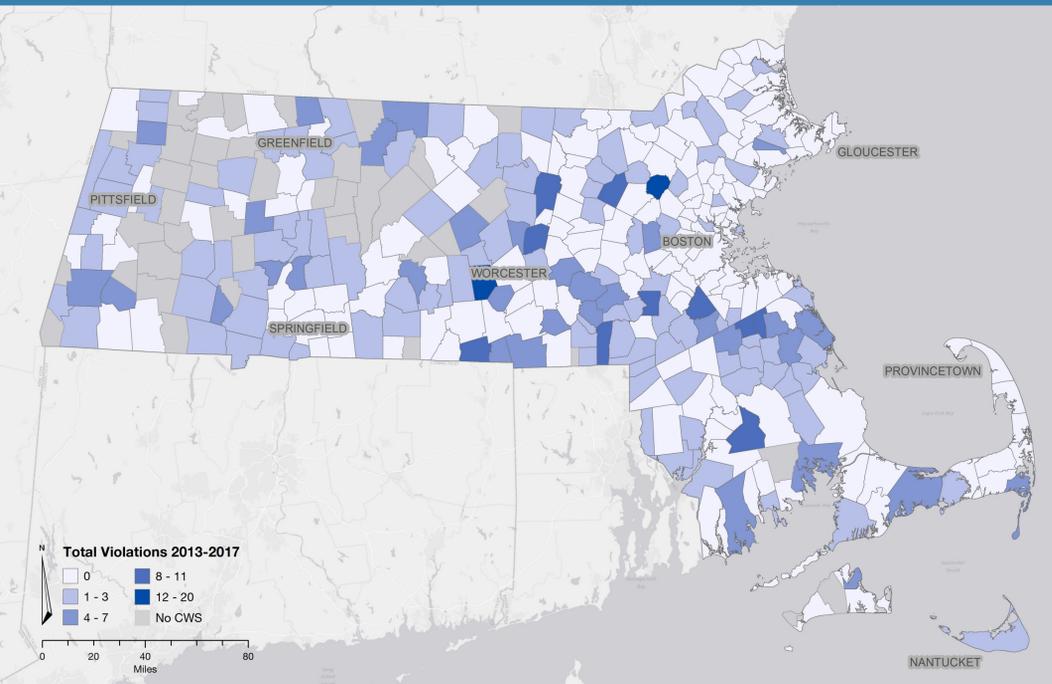


Safe Drinking Water Access in Massachusetts



Maintaining Safe Drinking Water

Drinking water quality in the United States is generally very high. However, harmful contaminants do sometimes enter public water supplies. The Safe Drinking Water Act provides for the protection of public drinking water supplies setting minimum standards for the amount of chemical and microbial contaminants. If a water system exceeds these standards, the utility must notify users and take action to restore the water quality. Maintaining water quality standards requires ongoing investment in treatment and distribution systems. Most water systems in the U.S. are over 50 years old, and many in Massachusetts were established over 100 years ago. At the same time, federal spending on water utilities has decreased by as much as 82%.

Water Quality Violations and Environmental Justice

The water crisis in Flint, Michigan highlighted the possibility for severe health impacts from water quality violations in low-income communities and communities of color. A recent study correlated the number of drinking water quality violations in counties across the U.S. with income and race. This project evaluates potential correlations in Massachusetts towns.

Massachusetts Water Quality

This project focuses on health-based drinking water quality violations in Massachusetts towns between 2013 and 2017. Of the 351 towns in Massachusetts, 311 have a community water system (CWS) that provides water to all town residents year-round. From 2013 through 2017, there were over 800 water quality violations in these systems. The most common violations were for the Total Coliform and Revised Total Coliform Rules, Disinfectant and Disinfection Byproduct Rules, and the Lead and Copper Rule. Other types of violations included treatment rules for both surface and ground water, various chemical contaminant levels, and levels of radionuclides.

Methods

Research Question: Do drinking water quality violations disproportionately impact low-income communities and communities of color in Massachusetts?

This analysis compares spatial clustering of water quality violations with clustering of income, race, and population change in Massachusetts towns to determine if there are any overlapping patterns. Spatial autocorrelation uses information about neighboring locations to identify clusters and outliers. Based on the selected attribute, each location is classified as in a cluster of similar locations, an outlier that is dissimilar from its neighbors, or not significantly correlated with its neighbors.

An initial analysis of all health-based drinking water quality violations did not show any clusters. However, there were spatial clusters for some types of violations when considered as a group. The most common violations in the state are for the Total Coliform Rule, the Disinfectants and Disinfection Byproducts Rules, and the Lead and Copper Rule. Clustering for these types of violations are shown in the maps to the right.

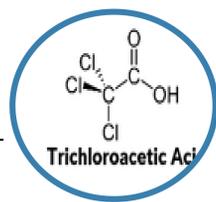
Towns that do not have a Community Water System were not included in the cluster and outlier analysis for violations as there is no town-wide system to monitor for violations.

Clusters and outliers from the analysis of violations were then compared to towns where there were clusters and outliers for non-white population, median household income, and population change.



Total Coliforms

Coliforms are bacteria that are generally not harmful to humans, but there are many other bacteria, parasites, and viruses that can cause human health problems. Coliforms are used as an indicator of these other pathogens in drinking water. Testing for total coliforms helps to determine whether the water is treated adequately and if there are likely to be any pathogens in the distribution system.



Disinfectants & Disinfection Byproducts

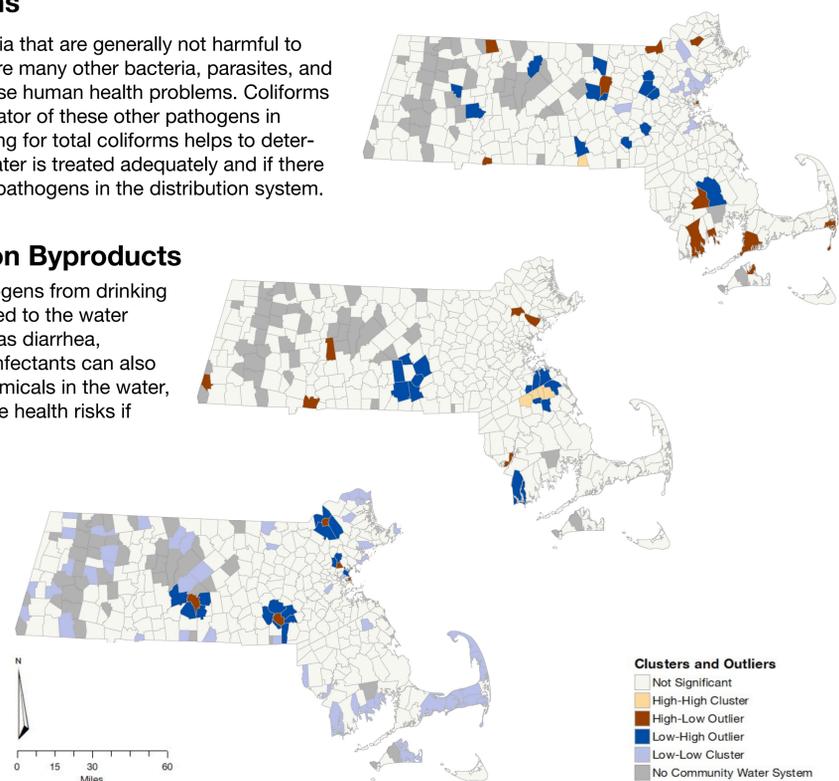
Disinfectants are used to remove pathogens from drinking water. If these pathogens are introduced to the water system, they can cause illnesses such as diarrhea, vomiting, or cramps. However, the disinfectants can also react with other naturally occurring chemicals in the water, resulting in byproducts that could cause health risks if consumed over many years.



Lead and Copper

Exposure to lead and copper in drinking water can cause health problems including damage to the stomach and nervous system or impaired brain development, especially in young children. These metals typically enter drinking water while traveling through pipes or fixtures. Water systems monitor concentrations of the contaminants at the tap and if elevated levels are detected, actions are taken to control corrosion.

Image Credits:
 "Enterobacteria aerogenes on C.L.E.D. Agar" by Nathan Reading
 "Chemical structures of Trihalomethanes" by Hydrovix.com
 "Lead Pipes in Forum Museum" by NH53



Results

While there were no clearly overlapping spatial patterns between the number of water quality violations and the demographic characteristics of towns, there was some individual towns that were in matching clusters or were matching outliers, particularly among clusters with low rates of Lead and Copper Rule violations.

Clustering of demographic characteristics did overlap with several of towns with no community water systems. In these towns, localized or non-permanent treatment systems provide water to local residents or resi-

dents may have private water supplies and be individually responsible for the drinking water quality at their homes.

There may be other factors that are more correlated with water quality violations. Investigation of characteristics of drinking water systems such as the age of the infrastructure or local environmental factors could identify other clusters and outliers that correspond with the spatial patterns of drinking water quality violations identified in this analysis.

Limitations

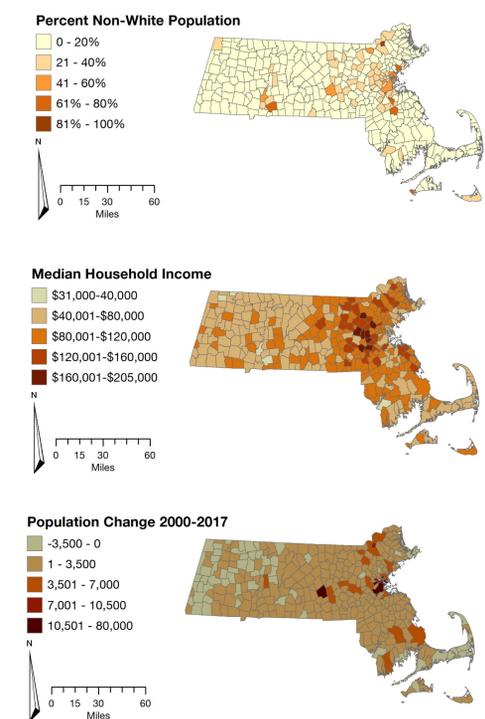
The USEPA acknowledges that the database of water quality violations is incomplete. Unreported violations could change the results of the analysis.

Although each Community Water System included in the analysis serves the associated area, there may be smaller private water systems within the towns that provide water to a subset of the population, changing the demographics of the populations served.

Matching Clusters and Outliers Across Categories

	Total Coliforms			Disinfectants and Disinfectant Byproducts			Lead and Copper			No Community Water System		
	Percent Non-White	Median Household Income	Population Change	Percent Non-White	Median Household Income*	Population Change	Percent Non-White	Median Household Income*	Population Change	Percent Non-White	Median Household Income*	Population Change
HH	0	0	0	0	0	0	0	0	0	0	13	0
HL	0	0	0	0	0	0	0	1	0	0	0	0
LH	0	0	1	0	0	2	0	0	0	0	0	0
LL	0	0	0	0	0	0	12	0	19	19	0	20

Notes:
 Inverse median household income cluster types (i.e. HH=LL) are matched to computed rule violation cluster types to test the hypothesis that areas with low income would have more water quality violations. For towns with no community water system, the totals represent all towns that are either in clusters or are outliers.



Data and Sources

American Community Survey. Race, income, and population data tables, 2017 (5-Year Estimates). Prepared by Social Explorer.
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Projection: NAD 1983 State Plane Massachusetts