LEAD CONTAMINATION IN MASSACHUSETTS PUBLIC SCHOOLS

INTRODUCTION

Today, one of the main sources of lead poisoning is from contaminated drinking water due to outdated lead pipes or pipe fittings. According to the Center for Disease Control and Prevention (CDC), lead poisoning is particularly dangerous to developing children under the age of six. Even low level exposure to children can lead to decreased intelligence, stunted growth, and impaired neurobehavioral development.

In 1988, the Environmental Protection Agency (EPA) passed the Lead Contamination Control Act (LCCA) to reduce lead exposure, specifically in schools including Early Education and Care and K-12. In the past decade, the Office of Energy and Environmental Affairs (EEA) has conducted extensive sampling of lead in schools to identify and mitigate drinking water over the EPA regulation limit (0.015 mg/L).

Environmental Justice (EJ) addresses the disproportionate amount of industrial pollution in marginalized populations and ensures the equal protection, education, and involvement of all with respect to environmental improvement. In 2010, the EEA identified communities throughout the state of Massachusetts that fit EJ criteria. This data can be used to estimate the quality of school systems in marginalized populations.

This study identifies which town in the state of Massachusetts is most in need of government funding for mitigation based on three criteria: 1) the concentration of lead in drinking water, 2) the number of children one to six years old, and 3) the percent of persons with less than a high school diploma. After a town was identified as most in need, a specific school was determined based on similar criteria.

METHODOLOGY

To determine which town, and specifically, which school has the greatest need for drinking water mitigation, the lead data was combined with the EJ and population data.

The lead concentration for each town was calculated by taking the average of all the samples within a school and across all the schools in a town. The results under the EPA regulation were queried out. Next, a shapefile with only the "Percent of persons with less than a high school diploma" attribute from the EJ data was created and joined to a shapefile of Massachusetts towns using a summarize join to find the graduation rate in each town. The "population by age and gender" attribute from 2010 U.S. Census data was joined to the towns shapefile using a summarize join that calculated the sum of male and female children ages one to six years old.

These three shapefiles (lead concentration, graduation rate, and population of children under the age of six) were converted to rasters, which were then reclassified into five classes each. The reclassified rasters were combined using the Weighted Overlay tool. The influences were as defined in the table below. The output ranked the severity of need in each town in five categories: Very Low, Low, Medium, High, and Very High.

This process was repeated at the school-level once the most in need town was determined. The original lead data was joined to 2010 U.S. Census Block Groups. These groups split the town into sections based on population density. The percent of persons with less than a high school diploma and population of children ages of one and six were also joined to the Block Groups. Three rasters of the town were created and reclassified into five sections. Another Weighted Overlay was performed using the same influences as the previous step. The school most in need of mitigation could be determined based on the results of the Weighted Overlay. The schools were ranked in five categories from Very Low to Very High.

Influence %	Raster
70	Lead Concentration
10	Graduation Rate
20	Children Population

Cartographer: Camden Myles
CEE 187: Introduction to GIS
May 3, 2019

Projection: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
Data Sources: MassGIS, MassEEA, ESRI & 2010 U.S. Census

RESULTS

Town-Level Analysis

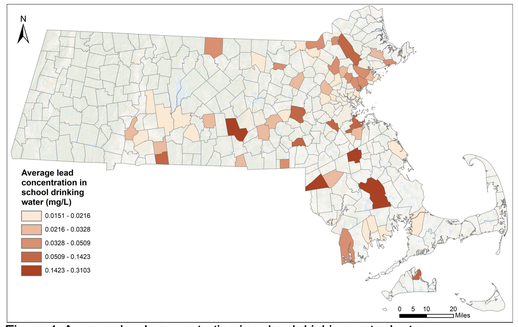


Figure 1. Average lead concentration in school drinking water by town

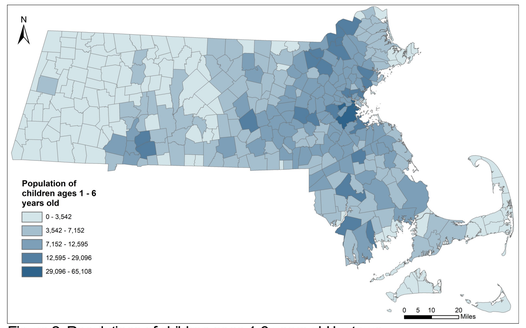


Figure 2. Populations of children ages 1-6 years old by town

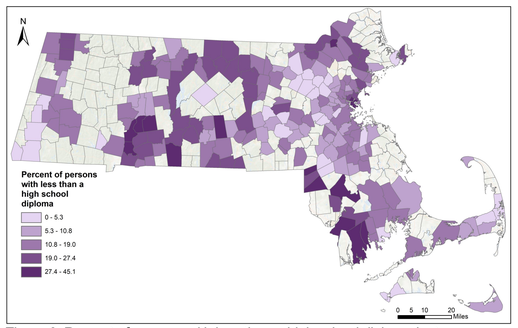


Figure 3. Percent of persons with less than a high school diploma by town

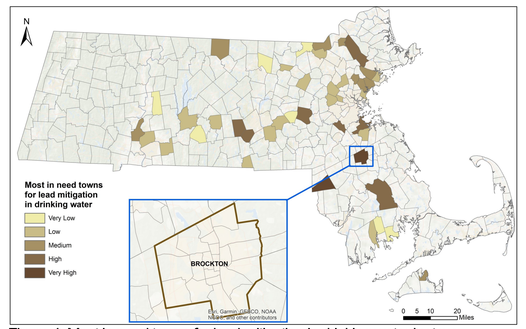


Figure 4. Most in need towns for lead mitigation in drinking water by town

School-Level Analysis

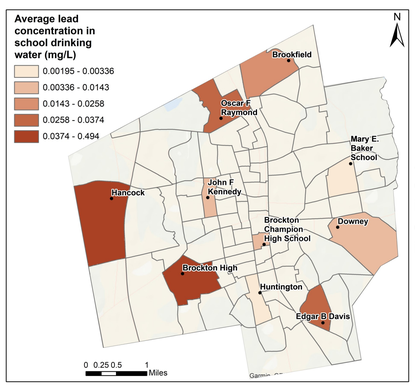


Figure 5. Average lead concentration in school drinking water in Brockton

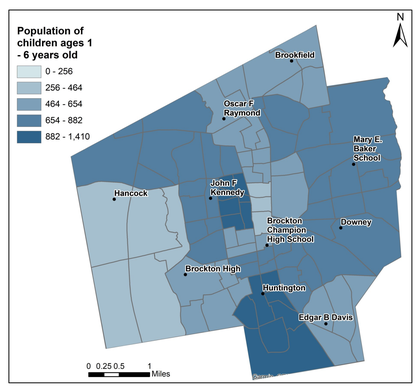


Figure 6. Population of children ages 1-6 in Brockton

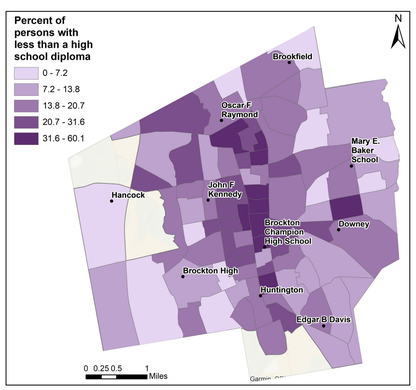


Figure 7. Percent of persons with less than a high school diploma in Brockton

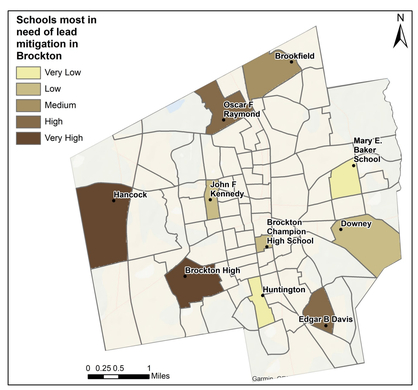


Figure 8. Schools most in need of lead mitigation in Brockton

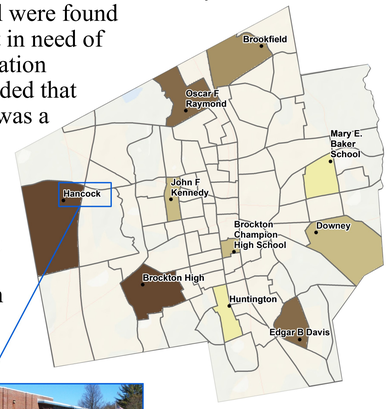
DISCUSSION

After the town-level Weighted Overlay was produced, two towns fell into the Very High need category (Figure 4). These two towns were Brockton and Attleboro.

Of the two towns, Attleboro was not further analyzed because the schools with increased lead levels were middle or high schools. Based on the criteria outlined in this study, it was determined that a town with more elementary schools and child care facilities would be a better candidate for the school-level analysis.

The Block Groups from the 2010 U.S. Census were used to identify which schools fell within areas with high lead concentrations, low graduation rates, and high density of children under six years old.

The school-level Weighted Overlay combined all three Brockton rasters using the previously defined influences. Because the lead data was weighted the most, it had the greatest influence on the result. Hancock Elementary School and Brockton High School were found to be the schools most in need of funding for lead mitigation (Figure 8). It was decided that Hancock Elementary was a better candidate for lead mitigation because there are most likely fewer children under the age of six at Brockton High.



Lead samples from Hancock Elementary School revealed concentrations that were the highest in the town and among the highest in the state. Hancock Elementary recorded an average lead concentration of approximately 0.5 mg/L which is over three times the EPA limit. Hancock Elementary falls in a minority region with 17,801 children under the age of six.

Figure 9. Hancock Elementary School, Brockton, Massachusetts

In this study, Hancock Elementary School in Brockton was determined to be the school most in need of government funding for lead mitigation in the state of Massachusetts. However, there are several limitations to this study. First, while the EEA lead data was extensive, it excluded several towns in the state. The EJ data also excluded information about graduation rates in several towns. In addition, the lead data gathered from the EEA data portal was from the last four years, while the population and graduation rate data was collected from the 2010 U.S. Census.

This study shows that far too many schools and child care facilities have contaminated drinking water. The potential harmful effects from this exposure are too great to be ignored. For communities that cannot afford mitigation, assistance should be provided to them by the state. An example of one such community is that of Hancock Elementary School, but many others exist in Massachusetts and elsewhere.

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