Lead and Organic Carbon in Soil: A Study on Potential Gardens in Redlined Areas of Springfield, Ohio

TIFFANY LANGE

ENVIRONMENTAL RESEARCH METHODS

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Introduction

The disparities between high- and low-income housing has become a more prominent and pressing problem than ever before. After the American Great Depression, the housing market set up new policies to limit risky investments—a well-intended idea that turned into oppressive legislation. Low-income communities, poor urban areas frequently dominated by minorities, were affected the most. Even a century later, those impacted by redlining continue to be disregarded and overlooked (Aaronson et al., 2017).

Comparatively, these same neighborhoods often have more contaminants in their soil and at higher levels than others. In one study, average lead concentrations were found to be up to 440% higher in areas with below $50,000 income than areas with incomes greater than $100,000 (Shahir et al., 2020). Lead is a dangerous toxin as it can cause anemia, convulsions, comas, and even death. Children, in particular, are at a higher risk for lead severely damaging their mental development that will have long-lasting effects (WHO, 2019).

On the other hand, soil organic carbon is an element that communities should be striving to have more of in their soils. It helps to enrich the soil with plenty of nutrients while also aiding in water drainage and overall stability. It can even improve oxygen amounts in the soil to give agriculture a better chance of thriving (Corning et al., 2016).

Goals

Conscious Connect is an organization dedicated to bettering low-income neighborhoods and stopping the cycle of oppressive socioeconomic statuses despair. One of the ways in which they are helping with this is by creating a list of specific places in several different cities for others to discover and find joy in. Among these include "Houses of Knowledge," which are locations, mainly grade schools, that seek to provide free literature for any children in the community who may not have access to them normally. The Houses of Knowledge in Springfield, Ohio are the places we were interested in analyzing the soil from so that they could potentially be recommended for community gardens to help promote a better future by investing in these areas that have historically been disinvested in.

Methodology

Using trowels, we took 5, 10cm-deep soil samples from 12 different Houses of Knowledge locations in the Springfield area. Of the 60 total samples, 48 were tested for lead and 36 were tested for soil organic carbon. To test for carbon, soil samples were placed into small tins, weighed, burned, and weighed again (also called the "loss on ignition" method). The difference between the mass after burning and the mass of the empty tins gives the burned soil weight. Then the burned mass is subtracted from the mass of the dry soil before burned, divided by the dry mass, multiplied by 100 (for the percent of carbon present), and finally multiplied by 0.45 (the amount of soil organic carbon present).

The amount of lead in the soil samples was found using an XRF lead testing gun. The soil was put into small plastic bags and packed down tightly into the machine before being analyzed. A few samples were tested more than once for accuracy, and the average was calculated from those tests. To create a boxplot and histogram from the results, we used Minitab—a desktop application designed for analyzing data through statistics and graphs. In addition, GIS was utilized in order to make a concentration map of the results.

Results

After analyzing the amount of soil organic carbon (SOC), shown in Figure 1, we discovered the median of our locations to be around 4.5% with a minimum of 2.1% and a maximum of 15.6%. Depending on what specific food the community would choose to garden, this information could be helpful to guide them in the right direction of what plants would succeed with this amount of SOC.

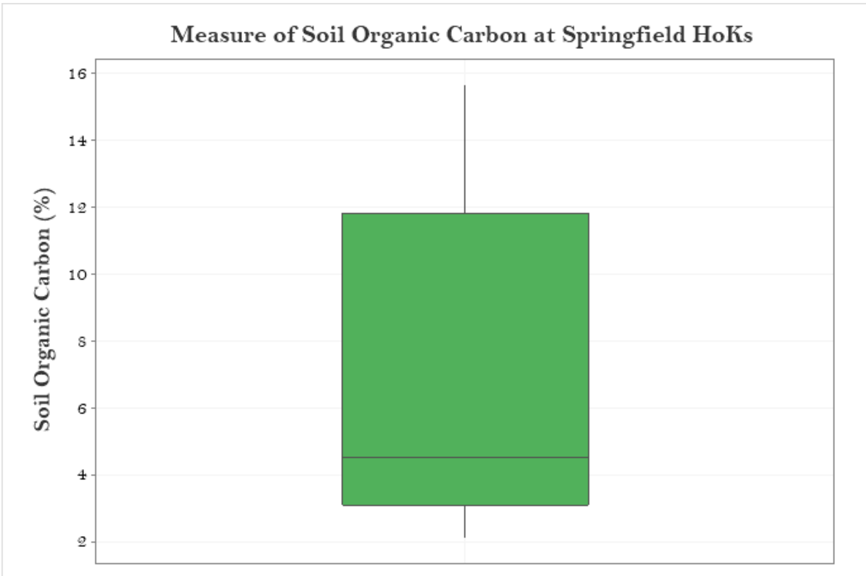

Figure 1. A boxplot of soil organic carbon levels. Median=4.5%, Minimum=2.1%, Maximum=15.6%.

Our main focus of these results was the lead levels. Not only is a high amount of lead not helpful for gardening, but it could be detrimental to the community's health as well if the soil were to contaminate the food they choose to grow. There was a relatively large range of lead we observed: the minimum was 21.1ppm found at Kenwood Elementary, and the maximum was 897.6ppm found at AJT Peace Garden. Figure 2 shows the general outline of lead level frequencies, with a mean of 130.2ppm. The majority of the samples tested in the 0-200ppm range, which is safe for human health as well as gardening. Very few were above 400ppm, the EPA standard for safe play-area levels, and none of our samples were over 1,200ppm, the EPA standard for non-play areas.

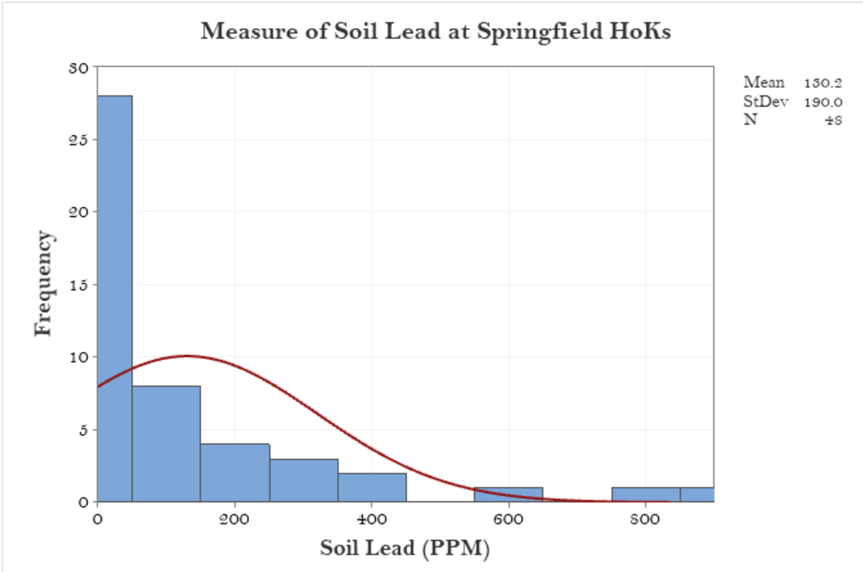

Figure 2. A histogram of the soil lead levels. Most were in the safe range for gardening, under 400ppm. A select few were above that range.

To help visualize where these different amounts of lead were found, Figure 3 is a concentration map showing each location and the corresponding lead level, symbolized by graduated black triangles. We also chose to project the map onto the Springfield redlining map to get a sense of any disproportionate levels of lead in each of the four Home Owners' Loan Corporation (HOLC) zones. Rather than include every sample on the map when several were from the same HoK, we calculated the average lead level of each location to represent it. The lowest average lead concentration, 14.96ppm, was found at Perrin Woods Elementary (located in the southwest portion of the map, not in a HOLC zone). The highest average lead concentration, 406.86ppm, was found at Miami Valley Child Development Center (MVCDC—in the C zone).

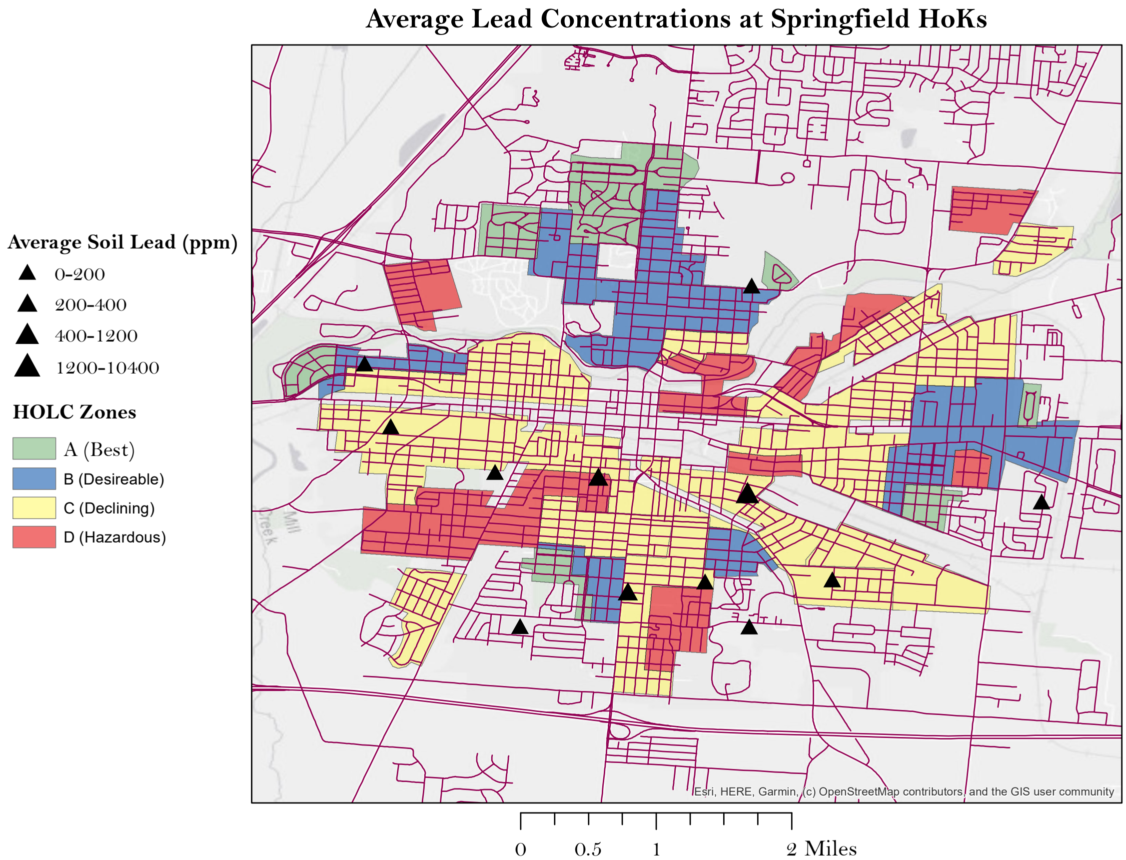

Figure 3. GIS map of soil lead concentrations at the Springfield, Ohio HoKs projected onto the Springfield redlining map. Lowest concentration found at Perrin Wood Elementary. Highest concentration found at MVCDC.

The following table includes the 12 HoK site names, the HOLC zone they are located in, their average lead concentrations, and their average SOC levels. Figure 4 summarizes this data.

Site	HOLC Zone	AVG Lead (ppm)	AVG SOC (%)
AJT Peace Garden	Yellow	329	4.4
Clark Preschool	Yellow	34	3.8
Fulton Elementary	N/A	29	3.7
Horace Mann Elementary	N/A	18	12.8
Kenwood Elementary	Yellow	25	12.1
Lagonda Elementary	Blue	32	3.4
Lincoln Elementary	Yellow	108	14.2
MVCDC	Yellow	407	4.1
MVCDC E. John	N/A	104	13.7
Perrin Woods Elementary	N/A	15	3.9
Robert C. Henry Funeral Home	Red	204	4.2
Snyder Park Elementary	Blue	33	2.6

Figure 4. Summary of the average SOC and average lead concentrations from each HoK site. It was also noted what HOLC zone the HoK is located in, if any.

Discussion

The premise of our study and results was to find a useful area for a potential community garden. Though there are many factors to consider, we felt it was important to focus on the concentrations of lead as that seems to be the source of harm for many low-income neighborhoods. And especially for the purpose of a garden, it is extremely important to choose a location that will not harm citizens even more from lead-contaminated food. From our results, we suggest almost any of the HoK locations except for the AJT Peace Garden, MVCDC and Robert C. Henry Funeral Home. These three locations had the highest average lead concentrations overall in almost all of the samples that were taken from them; interestingly, only Robert C. Henry Funeral Home was definitively in a red/hazardous HOLC zone. Most of the levels were also over 200ppm, the suggested limit for gardening, with a few over 800ppm, reaching the hazardous level. In relation to carbon, Perrin Woods Elementary would be the safest choice as it was very low in lead but contained some of the highest levels of SOC.

There were, of course, a few limitations to this study. Our agreed-upon sample size was fairly small, so our soil samples from each location were taken from various spots, some several meters away from each other. This gave us general insight for each location, which is useful but not enough to plan a garden with just yet. Also, not every soil sample was tested for its lead concentration—these locations include Horace Mann Elementary, Kenwood Elementary, MVCDC E. John, and Lincoln Elementary. This resulted in only two lead-tested samples from each, instead of the five tested samples all of the other locations had.

In future studies, it would be helpful to thoroughly examine the HoK locations with adequate ranges of lead to get a better sense of where exactly on that property a garden would benefit the community the most. Also, it would aid the leader of this project if there were studies/experiments done to determine what food would be the best options to plant at these locations, factoring in both lead and carbon concentrations.

References

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