Soil Metal Concentrations in Urban Gardens

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Abstract

Several areas of Youngstown, Ohio have had dilapidated homes removed due to risk of harm to curious neighbors and the unsightliness of the structures resulting in lower property values. Some of the now vacant lots have been acquired by groups for planting with trees, shrubs or other vegetation with the goal of beautifying the area. Other vacated lots have been converted into community gardens. Two Youngstown sites were obtained by the group Grow Youngstown and small gardens were planted last year on a portion of the lots. There is concern that there is a potential of heavy metal contamination on the site from the structures and previous land use. A few home sources of heavy metals include lead based paints; batteries with lead, nickel and cadmium; mercury and arsenic from insecticides, fungicides and adhesives. The areas obtained by Grow Youngstown include 6-vacated lots at St. Patrick's Church near Oakhill Ave and Cleveland St. and 11-vacated lots in the Fairgreen neighborhood on the corner of Ohio Ave. and Fairgreen Ave. Each site was sampled in a grid pattern (15 foot squares). Composite samples from each grid were separated into soil 2 layers: from the surface to 6 inches deep (15.2 cm) and 6-12 inches (15.2-30.4 cm) deep. The soil was analyzed for total metals using EPA Method 3050B.

Introduction

The Rust Belt comprises of an area in northeast United States from Minnesota to the east coast of Pennsylvania. This area including the once booming city of Youngstown, Ohio. After the collapse of the steel industry in the late 1970's, Youngstown lost not only the main industry in the city but the population left to find work elsewhere. Homes and neighborhoods were left vacant becoming unkempt and dilapidated. Not only are these areas unsightly, but are dangerous to the remaining residents. As a result of this changing environment, the city of Youngstown has taken an unusual step. Abandoned and dilapidated homes have been removed and converted to green-spaces (Finnerty 2003). These spaces have been planted with grass, bushes, flowers and some have been used for community gardens. Grow Youngstown, a local non-profit organization, supports Urban Agricultural Land Development. These urban gardens provide an opportunity for added income for families , increases in health potential, increased access to fresh produce and, with sustainable farm practices, rejuvenation of urban soil. In addition the gardens act as a social area where neighbors familiarizing themselves with one another. The gardens also lead to a sense of pride and accomplishment.

There are definite benefits to the urban gardens, but there are concerns as well. These gardens are developed on previously abandoned or dilapidated homes built at the turn of the century during the steel mill boom. At that time, air quality was very poor, with plumbs of smoke coming off the mills covering the city in a fog and leaving dark residue on buildings and roads (High 2005). The atmospheric movement of particulates laded with metals along with lead-based gasoline and paints, arsenic laden pesticides, cadmium batteries and other products are sources of metals in urban soils. These metals could persist in the soil for an extended amount of time potentially posing a risk to the garden workers and to the vegetation being grown (Ritter and Rinefierd 1983). Therefore efforts are underway to sample the gardens to test for the presence of metals in the soil.

Methodology

Two neighborhood gardens were select comprising of approximately 6-10 home lots. A grid of 15 foot (4.57 m) squares was use to sample soils (Figure 1 and 2). Each squares was a composite sample from a 5-spot sampling design. A 13 inch soil probe was used to take the samples and separated into top 6 inches (15.2 cm) and bottom 6 inches (15.2 cm) (where available). The soils were dried sieved through a 2 mm sieve and analyzed total metals (EPA 3050B) using AES-ICP. Only the top 6" inch sample are addressed here.

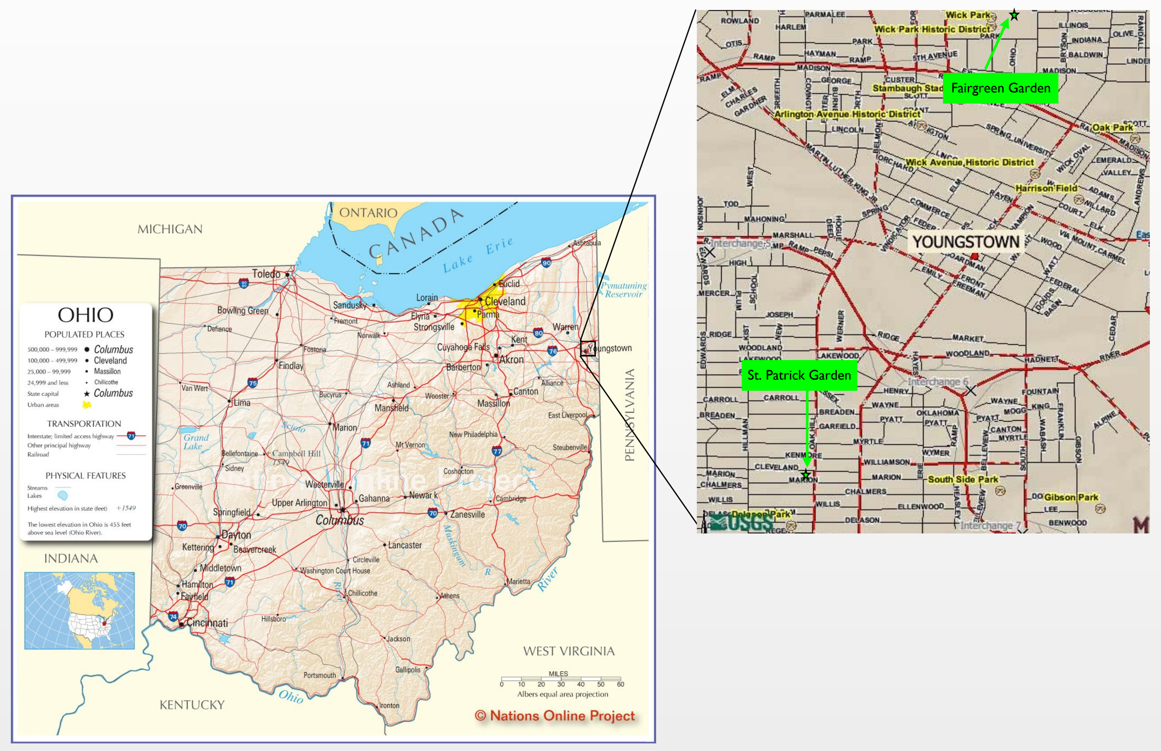

Figure 1 Fairgreen Neighborhood Garden, Youngstown, Ohio (on left and St. Patrick Community Garden, Youngstown, Ohio (on right)

Figure 1 Sampling grid for Fairgreen neighborhood garden.

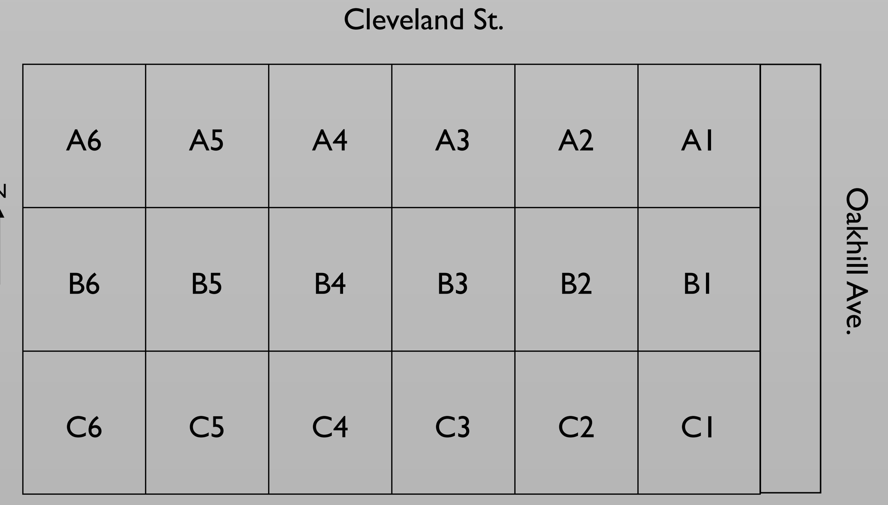

Figure 2 Sampling grid for St. Patrick's garden.

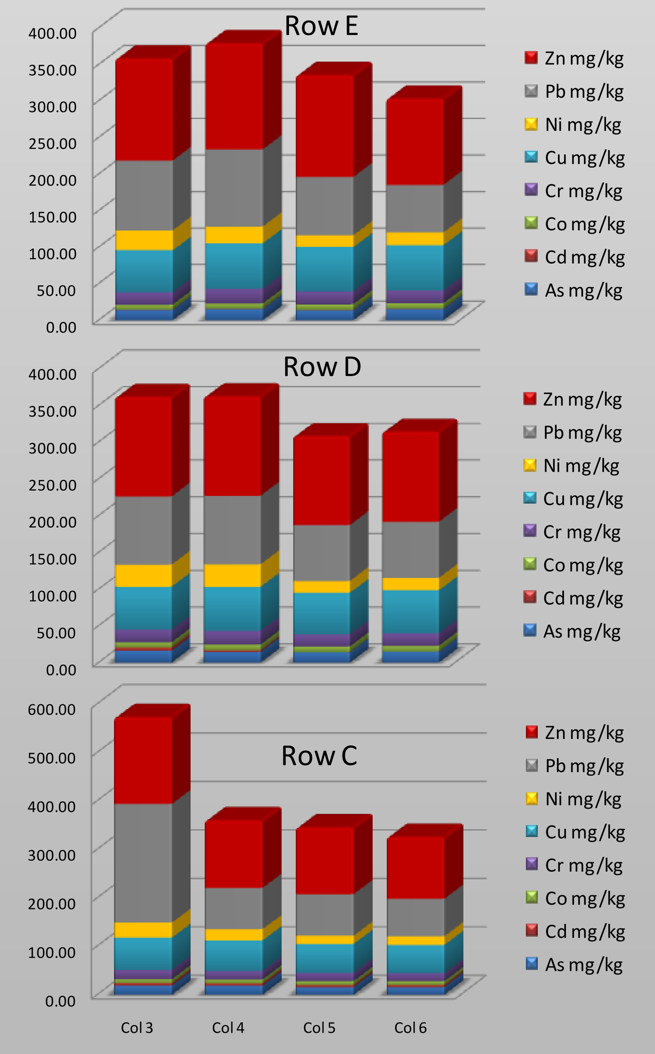

Figure 3 Total metal concentrations in Fairgreen neighborhood garden soils.

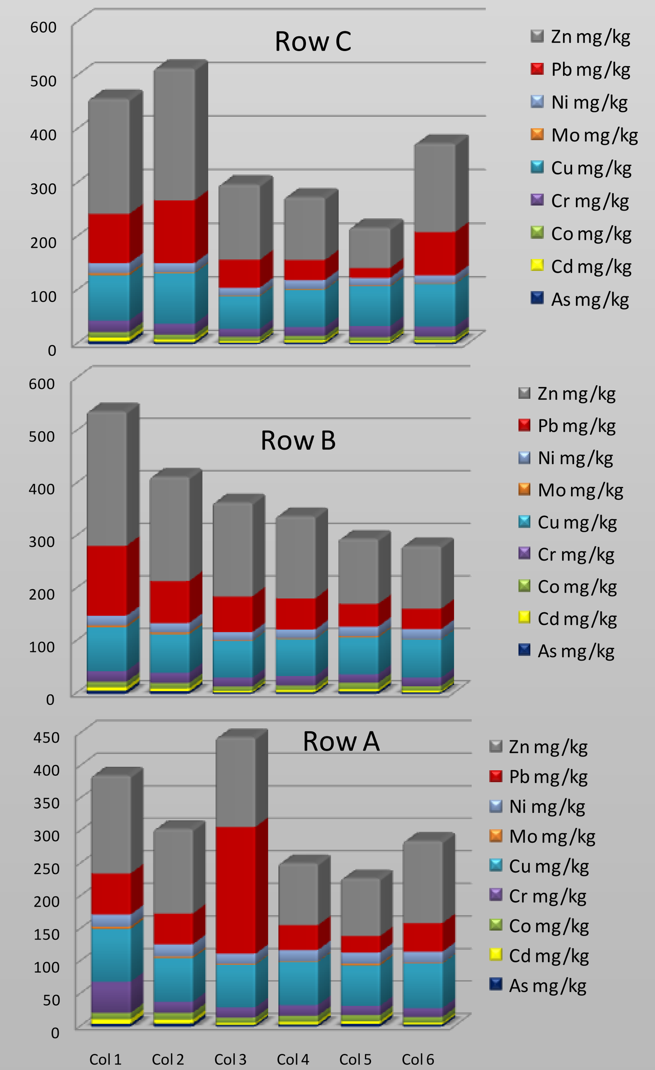

Figure 4 Total metal concentrations in St. Patrick's Garden soils.

In general, the Fairgreen garden has higher levels of arsenic (13.7-8.6 mg kg^{-1}) than St. Patrick's garden (2.6-3.4 mg kg^{-1}). The St. Patrick's garden has more variability in lead and zinc concentrations ranging from 18.4-195 mg kg^{-1} and 74.9-256 mg kg^{-1} respectively. All other metals analyzed for were within the same range of concentrations.

Results and Discussions

Zinc has the highest average concentrations (152 mg kg^{-1}) of the whole fractions (< 2mm) of the St. Patrick's garden soil followed by copper with 73.1 mg kg^{-1}, then lead with 69.5 mg kg^{-1} (Figure 4). All other average metals concentrations were found at levels below 20 mg kg^{-1}. These values are all below the Ohio and Pennsylvania guidance for residential soils (Table 1). The results from Fairgreen neighborhood garden were similar (Figure 3). Zinc was the highest overall average concentration (136.4 mg kg^{-1}) followed by lead (98.1 mg kg^{-1}), then copper (60.2 mg kg^{-1}). Arsenic levels in the Fairgreen soils ranged from 13.7-18.6 mg kg^{-1} placing them slightly above the Pennsylvania guidance values. There were no detected "hot spots" in either of the gardens. Any variability that was seen was still well below the Ohio State Guidance levels for each metal respectively.

The finer fractions of soil (<110 μm) typically are identified as the fraction of soils that poses the greatest risk due to the adherence to skin and surfaces and ability to be inhaled (Siciliano 2009). Therefore the next step will be to analyze the fine fractions of soil for total metal content and the plant available metal levels. Although the total metal levels from whole soils do not indicate any potential hazard, analyzing the finer fraction will better determine if there is a human health risk for garden workers. Since plants are being grown on the property, extractants to simulate plant available metals (Mechlich III) will be conducted to deter-

Table 1 Generic Direct-Contact State Soil Guidance values for some heavy metals in residential soils

	As mg/kg	Cd mg/kg	Co mg/kg	Cr III mg/kg	Cr VI mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg
Ohio	22	35	1,400	120,000	230	—	1,500	400	23,000
Pennsylvania	12	47	1,300	190,000	94	8,200	4,400	500	66,000

References

Finnerty Jr., Thomas A. 2003. Youngstown Embraces Its Future. *Planning*, 69(8):14-19.

High, Steven. 2005. Steeltown U.S.A.: Work and Memory in Youngstown. *Labour / Le Travail*, 55:187-196.

Jennings, A., A Cox, S Hise and E. Petersen. 2002. Heavy Metal Contamination in the Brownfield Soils of Cleveland, Soil and Sediment Contamination, 11(5):719-750.

OEPA. 2002. Voluntary Action program rules; 3745-300-08 Generic Numerical Standards, http://www.epa.state.oh.us/derr/vap/rules/rules.aspx

Petersen, E, A. Jennings, J Ma. 2006. Screening Level Risk Assessment of Heavy Metal Contamination in Cleveland Area Commons, *J. of Environ Engineering*, March:392-404.

PDEP. 2001. Cleanup standards scientific advisory board agenda handout, Table 4a Soil MSC inorganic, DC. http:// www.dep.state.pa.us/dep/subject/advcoun/cleanup/cleanup2001.htm.

Siciliano, S., K. James, G. Zhang, A. Schafer, J. Peak. 2009. Adhesion and Enrichment of Metals on Human Hands from Contaminated Soil at Arctic Urban Brownfield. Environ. Sci. Technol., 43 (16):6385-6390.

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