Soil Lead Contamination in Kansas State University Campus and Suggested Remediation Strategies

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Abstract

This study examines soil lead (Pb) contamination across Kansas State University's (KSU) campus, focusing on spatial patterns related to land use and remediation strategies. Portable X-Ray Fluorescence (XRF) spectroscopy revealed significant variability in lead concentrations across natural areas, buildings, and agricultural sites. Natural areas generally exhibited baseline levels averaging 33.32 ± 2.82 ppm, with exceptions like Campus Creek, where lead increased with depth from 35.15 ppm to 72.07 ppm. Older buildings, such as Anderson Hall, had the highest contamination, averaging 367.30 ± 339.47 ppm, requiring immediate remediation, while newer buildings showed low levels, averaging 20.55 ± 4.47 ppm. Agricultural areas displayed slightly elevated lead concentrations with an average reading of 25.5 ± 3.88 ppm, likely influenced by machinery and past land use practices. *In-situ* remediation strategies include encapsulation of lead-based paint, soil stabilization with biochar and apatite, and revegetation, alongside long-term monitoring to ensure environmental safety.

Introduction

Lead Contamination

- Lead is a heavy metal with persistent environmental and public health impacts due to its low solubility and tendency to accumulate in soils.
- For this study area, a background lead concentration of about 20 ppm is expected.

Anthropogenic Sources

- Human activities such as the use of lead-based paints, leaded gasoline, or industrial processes have significantly contributed to soil lead contamination.

Remediation

- Remediation strategies aim to reduce lead exposure and its mobility in soils. *In-situ* methods, like stabilization with biochar or phosphates, immobilize lead within the soil.

Materials and Methods

Soil Sampling Methodology

- Soil samples were collected across the study area, focusing on areas supposed to be impacted by legacy contamination or areas considered to be newer or natural. GPS coordinates were recorded at each sampling site.

Sampling Site Selection

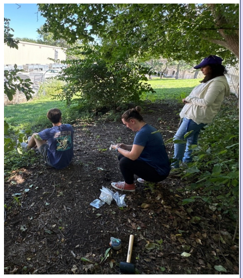
- Samples were taken where possible runoff accumulates (off gutters, low-elevation areas).

XRF Analysis

- The Thermo Scientific Niton XL3t XRF Analyzer was used to measure lead levels on site for 0-5 cm depths. Samples taken of lower depths were dried and measured later in a closed lab environment.

Geospatial Techniques for Data Analysis

- Transferring lead surface level data from each sites and pairing them with our recorded GPS data allowed for the integration of ArcGIS Pro. Visual tools such as heat maps and choropleths can be created from our simple XY data set. Techniques such as spatial interpolation and autocorrelation creates the opportunity to model lead distribution patterns as a more advanced geostatistical method.



Results

- Natural Areas had higher levels than expected at Anderson Lawn and Campus Creek, but were consistent and uncontaminated overall. For surface readings, natural areas had a mean lead concentration of 33.32 ± 2.82 ppm.
- Old Buildings had significantly high values compared to NA's, showing legacy contamination likely due to lead paint on windowpanes. For surface readings, old buildings had a mean lead concentration of 183.70 ± 248.14 ppm.
- New Buildings had lower lead levels than even the NA's, likely due to the addition of clean soils during construction. For surface readings, new buildings had a mean lead concentration of 20.55±4.27 ppm.
- Agronomy Farm levels were at or slightly above baseline. Any variability is likely due to machinery and gasoline use. For surface readings, the Agronomy Farm had a mean lead concentration of 25.5±11.65 ppm.

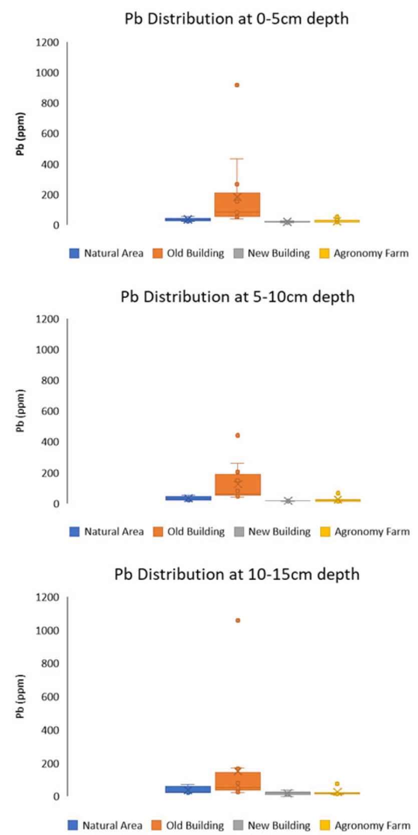


Fig. 1: Distribution of Pb levels at different depths.

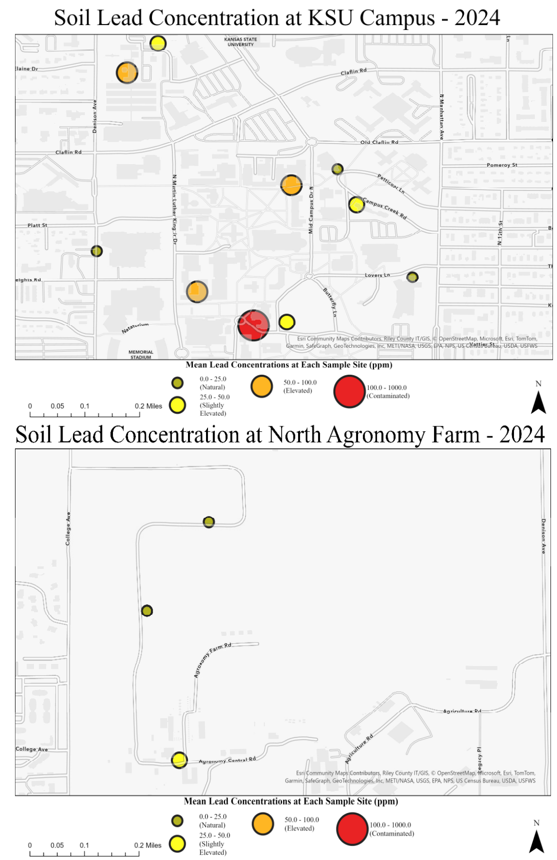


Fig. 2: Geospatial Analysis

Recommendations

There are some sampled areas on campus which have a need for action to address the elevated lead levels measured.

Anderson Hall

Peeling lead paint should be encapsulated, more vegetation should be planted and an amendment such as biochar or apatite added to the soil.

Waters Hall

Peeling lead paint should be encapsulated, sod should be replaced, and an amendment such as biochar or apatite added to the soil.

Campus Creek

Amendments such as biochar or apatite should be added to the soil. Stabilizing the creek bank with vegetation will prevent soil washing downstream.

Other Slightly Elevated Old Buildings

These areas are not as hazardous and can utilize a layer of topsoil to dilute the overall lead concentrations. Then, a layer of mulch can stabilize the soil.

We also suggest that regular lead monitoring be implemented to ensure the soil around these aging buildings remains below harmful thresholds.