New approaches to identifying and reducing persistent lead exposure pathways to urban populations

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A new paradigm has emerged to explain the continued exposure of urban children to lead (Pb). Although acute Pb poisoning is caused by exposure to discrete Pb sources like Pb-based paints, large proportions of urban children exhibit chronic lower-level Pb poisoning, resulting in well-known and permanent neuro-cognitive defects. A source for chronic Pb poisoning is exposure to Pb-contaminated urban soils, which have retained a century of Pb deposited from leaded gasoline, Pb-based paints, and industries. Given a soil-based exposure pathway, the mitigation strategy to reduce Pb is straightforward but daunting--separate the urban population from the high-Pb surface horizon of soils. Wholesale removal is not a viable economic option. Instead, we are developing a surgical approach to targeting and remediating community-level 'hotspots' by analyzing the coupled spatial relationship of soil Pb contamination and human exposure.

Our earlier analyses of soil Pb:Pb poisoning in Indianapolis revealed a key community in Indianapolis with high soil Pb and high rates of blood Pb poisoning. We have collected and analyzed over 250 soil samples from this community, have targeted homes in these areas for interior dust Pb sampling, and have identified several discrete areas with soil Pb levels significantly above urban background level. We also received full-spectrum blood Pb level data, to the address scale, for ~16, 000 children from 0-5 year olds. With the spatial analysis of blood Pb levels of children, we can develop risk models to analyze the costs of soil remediation and to add address 'triggers' for clinicians to order Pb tests.

Factors controlling the stabilization of above and belowground plant biopolymers in soil

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The relative contribution and stabilization of above ground litter and roots is an important consideration when determining the response of ecosystems to drivers that influence soil carbon accrual and loss. We investigated soil carbon dynamics of a sweet gum plantation exposed to free air CO_2 enrichment (FACE) for ten years. We applied a combined biomarker, stable isotope, and soil physical fractionation approach to assess the proportion of root and leaf derived material within particulate (microaggregated and non-microaggegated) and clay/silt-associated carbon. Additionally, to assess decay dynamics of roots grown under high and low CO_2 conditions, we also conducted a root decay study. Factors such as plant productivity and chemistry, edaphic properties, and invertebrate activity, all have a control on the proportion, depth, and chemistry of soil carbon stabilized in this system. Indications of root vs. leaf input to soil physical fractions and earthworm casts were derived from differences in the chemical and isotope composition of alkaline CuO-derived lignin and substituted fatty acids (SFA) from cutin and suberin. Decay pathways alter the composition of specific released monomers from root and leaf but even after extensive decay root and leaf SFA remain distinguishable. Over time we found that non-microaggregated particulate carbon shifted to greater suberin-like SFA. Endogeic species were proportionately more responsible for fine root cycling while some epigeic species were responsible for microaggregation of foliar cutin. As earthworm species abundance and activity are not is steady state in many forests, the important role of these invertebrates should be considered when assessing the changing soil state.