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Get the lead out November 2019

TITLE: The concurrent decline of soil lead and children's blood lead in New Orleans

Author: Mielke, H.W., C.R. Gonzales, E.T. Powell, M.A.S. Laidlaw, K. J. Berry, P.W. Mielke Jr. and S.P. Egenforf

Source: PNAS. 2019 www.pnas.org/cgi/doi/10.1073/pnas.1906092116

Abstract: Lead (Pb) is extremely toxic and a major cause of chronic diseases worldwide. Pb is associated with health disparities, particularly within low-income populations. In biological systems, Pb mimics calcium and, among other effects, interrupts cell signaling. Further- more, Pb exposure results in epigenetic changes that affect multi- generational gene expression. Exposure to Pb has decreased through primary prevention, including removal of Pb solder from canned food, regulating lead-based paint, and especially eliminating Pb additives in gasoline. While researchers observe a continuous decline in children's blood lead (BPb), reservoirs of exposure persist in topsoil, which stores the legacy dust from leaded gasoline and other sources. Our surveys of metropolitan New Orleans reveal that median topsoil Pb in communities (n = 274) decreased 44% from 99 mg/kg to 54 mg/kg (P value of 2.09×10^{-08}), with a median depletion rate of ~2.4 $mg \cdot kg \cdot y^{-1}$ over 15 y. From 2000 through 2005 to 2011 through 2016, children's BPb declined from 3.6 µg/dL to 1.2 µg/dL or 64% (P value of 2.02×10^{-85}), a decrease of ~0.2 $\mu g \cdot dL \cdot y^{-1}$ during a median of 12 y. Here, we explore the decline of children's BPb by examining a metabolism of cities framework of inputs, transformations, storages, and outputs. Our findings indicate that decreasing Pb in topsoil is an important factor in the continuous decline of children's BPb. Similar reductions are expected in other major US cities. The most contaminated urban communities, usually inhabited by vulnerable populations, require further reductions of topsoil Pb to fulfill primary prevention for the nation's children..

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TITLE: Constructed soils for mitigating lead (Pb) exposure and promoting urban T community gardening: The New York City Clean Soil Bank pilot study

Author: Egenforf, S.P., Z. Cheng, M. Deeb, V. Flores, A. Paltseva, D. Walsh, P. Groffman, and H.W. Mielke

Source: Landscape and Urban Planning 2018 175:184-194

Abstract: Gardening provides a wide range of benefits to urban residents but may also increase risks of exposure to contaminants in soils. Here we evaluate the use of clean excavated glacial sediments and locally produced compost, to create soils for urban gardens in New York City, NY, USA. The objectives of this study are to examine contaminants in compost and manufactured soil, assess safety of produce, and evaluate the agronomic value of soil mixes with different ratios of sediment and compost. Methods of analysis include quantifying metal/metalloid concentrations in sediments, composts, and plant tissues, soil agronomic parameters (pH, salinity, organic matter, total nitrogen, total carbon), and crop yield. Contaminant levels in sediments from the New York City Clean Soil Bank (CSB) (< 10 mg Pb kg^{-1}) were far below background levels of soils in two selected gardens (66 and 1025 mg Pb kg^{-1}), while available composts had highly variable levels of contamination (10–232 mg Pb kg^{-1}). A relatively clean compost was used for this study (19 mg Pb kg^{-1}). Metal/metalloid levels did not increase in constructed soils during the 1-year pilot study period, and crops were well below EU safety standards of 0.1 and 0.3 mg Pb kg^{-1} for fruits and leafy greens, even when surrounded by contaminated soils. Sediment/compost mixtures produced yields comparable to control plots. Results suggest that CSB sediments have high potential to serve as manufactured topsoil. Creating these soil mixtures diverts materials from expensive waste disposal, reduces contamination risks for urban residents, and promotes the myriad benefits of urban agriculture and community gardening.

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TITLE: Effect of biosolids processing on lead bioavailability in an urban soil

Author: Brown, S., R.L. Chaney, J.G. Hallfrisch, and Q. Xue

Source: J. Environ. Qual. 2003. 32:100-108

Abstract The potential for biosolids products to reduce Pb availability in soil was tested on a high Pb urban soil with biosolids from a treatment plant that used different processing technologies. High Fe biosolids compost and high Fe + lime biosolids compost from other treatment plants were also tested. Amendments were added to a Pb-contaminated soil (2000 mg kg^{-1} Pb) at 100 g kg^{-1} soil and incubated for 30 d. Reductions in Pb bioavailability were evaluated with both in vivo and in vitro procedures. The in vivo study entailed feeding a mixture of the Pb-contaminated soil and AIN93G Basal Mix to weanling rats. Three variations of an in vitro procedure were performed as well as conventional soil extracts [diethylenetriaminepentaacetic acid (DTPA) and $Ca(NO_3)^2$] and sequential extraction. Addition of the high Fe compost reduced the bioavailability of soil Pb (in both in vivo and in vitro studies) by 37 and 43%, respectively. Three of the four compost materials tested reduced Pb bioavailability more than 20%. The rapid in vitro (pH 2.3) data had the best correlation with the in vivo bone results (R = 0.9). In the sequential extract, changes in partitioning of Pb to Fe and Mn oxide fractions appeared to reflect the changes in in vivo Pb bioavailability. Conventional extracts showed no changes in metal availability. These results indicate that addition of 100 g kg^{-1} of high Fe and Mn biosolids composts effectively reduced Pb availability in a high Pb urban soil.

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To request information or documents, please contact Sally Brown via e-mail: slb@u.washington.edu

TITLE: Case studies and evidence-based approaches to addressing urban soil lead contamination

Author: Silvaa, Laidlaw, M.A.S., G.M. Filippeli, S. Brown, J. Paz-Ferreiro, S.M. Reichman, P. Netherway, A. Truskewycz, A.S. Ball, and H.W. Mielke

Source: Applied Geochemistry 2017 83:14-30

Abstract: Urban soils in many communities in the United States and internationally have been contaminated by lead (Pb) from past use of lead additives in gasoline, deterioration of exterior paint, emissions from Pb smelters and battery recycling and other industries. Exposure to Pb in soil and related dust is widespread in many inner city areas. Up to 20-40% of urban children in some neighborhoods have blood lead levels (BLLs) equal to or above 5 mg per decilitre, the reference level of health concern by the U.S. Centers for Disease Control. Given the widespread nature of Pb contamination in urban soils it has proven a challenge to reduce exposure. In order to prevent this exposure, an evidence-based approach is required to isolate or remediate the soils and prevent children and adult's ongoing exposure. To date, the majority of community soil Pb remediation efforts have been focused in mining towns or in discrete neighborhoods where Pb smelters have impacted communities. These efforts have usually entailed very expensive dig and dump soil Pb remediation techniques, funded by the point source polluters. Remediating widespread non-point source urban soil contamination using this approach is neither economical nor feasible from a practical standpoint. Despite the need to remediate/isolate urban soils in inner city areas, no deliberate, large scale, cost effective Pb remediation schemes have been implemented to isolate inner city soils impacted from sources other than mines and smelters. However, a city-wide natural experiment of flooding in New Orleans by Hurricane Katrina demonstrated that declines in soil Pb resulted in major BLL reductions. Also a growing body of literature of smaller scale pilot studies and programs does exist regarding low cost efforts to isolate Pb contaminated urban soils. This paper reviews the literature regarding the effectiveness of soil Pb remediation for reducing Pb exposure and BLL in children, and suggests best practices for addressing the epidemics of low-level Pb poisoning occurring in many inner city areas.

Document#: BIC.TR.AV.5.8

TITLE: Long-Term in situ reduction in soil lead bioavailability measured in a mouse model

Author: Bradham, K.D., G.L. Diamond, C.M. Nelson, M. Noerpel, K.G. Scheckel, B.Elek, R.L. Chaney, Q.Ma and D.J. Thomas

Source: Environ. Sci. Tech. 2018 52:13908-13913

Abstract: Effects of different treatments on the bioavailability of lead (Pb) in soil from a smelter emission contaminated site in Joplin, Missouri, were evaluated in a mouse model. Similar estimates of relative bioavailability for Pb in untreated or treated soil were obtained in mice and in the well-established juvenile swine model. In the mouse model, treatments that used phosphate (phosphoric acid or triple superphosphate) combined with iron oxide or biosolids compost significantly reduced soil Pb bioavailability. Notably, effects of these remediation procedures were persistent, given that up to 16 years had elapsed between soil treatment and sample collection. Remediation of soils was associated with changes in Pb species present in soil. Differences in Pb species in ingested soil and in feces from treated mice indicated that changes in Pb speciation occurred during transit through the gastrointestinal tract. Use of the mouse model facilitates evaluation of remediation procedures and allows monitoring of the performance of procedures under laboratory and field conditions have implications for long-term SOC storage, because sorption has more persistent effects than substrate switching or dilution.

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