

Division 4. The Role of Soils in Sustaining Society and the Environment

Commission 4.2 - Soils, Food Security and Human Health

Description of Commission 4.2

Soils are the essential for food production in most countries. Considering that one third of the land area is presently used for agriculture, and the world population is increasing, creating additional pressure on agricultural land, providing enough safe and nutritious food will be an ongoing challenge. Among the concerns of this commission, there is the maintenance and conservation of agriculture lands, the role of soils in a changing world in relationship to human health.

During the 2015 International Year of Soils, the IUSS Division 4 will illustrate its main topics through articles written by Division 4 officers or their colleagues. These will each be highlighted every week from October to December 2015.

For this third week, we are displaying an article from the Commission 4.2 chair – Ganga Hettiarachchi.

Growing food crops on urban brownfields. Best management practices to reduce potential human health risk

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Growing of local crops, especially in urban areas is on the increase and many gardens are or will be located on land that may be impacted by previous use. These kinds of properties, i.e. vacant or abandoned properties with real or perceived contamination issues are called “brownfields”. Not all brownfields sites will, of course, be suitable for growing food crops as the environmental conditions may not allow for this use. Growing food crops safely on mildly contaminated sites is possible for both the grower and consumer, if precautions are taken and best management practices are adhered to. Common urban soil contaminants include lead (Pb), arsenic (As), cadmium (Cd), zinc (Zn), and polycyclic aromatic hydrocarbons (PAH). Of these, lead is by far the most dominant and wide-spread contaminant in urban environments. Soil remediation or managing risk posed by contaminants can be challenging

as a result of poor soil quality and the presence of co-contaminants. Options such as raised-bed gardening or soil replacement can be physically and financially restrictive and there is a great need for sharing science-based knowledge on risk management associated with common urban soil contaminants.

Researchers at Kansas State University have been evaluating the uptake of heavy metals, metalloids and other contaminants by food crops grown on urban brownfields sites. The research is made possible by a grant from the U.S. Environmental Protection Agency (USEPA). Nationwide, seven test sites were established on brownfields sites slated for community gardens were evaluated by planting food crops over two consecutive growing seasons. Prior to adding a site to the project, historic site use of all sites was researched to narrow down potential contaminants. Soils were then tested for potential contaminants as well as for general soil properties. Soils at the various test sites exhibited lead concentrations from 100 mg/kg to 2,000 mg/kg, arsenic concentrations from 50 mg/kg to 130 mg/kg, and total PAH concentrations ranging up to 50 mg/kg. Three vegetable crop types with three very different growth and contaminant uptake patterns were planted over two growing seasons and soil and plant tissue samples were tested. Effectiveness of selected site-specific soil amendments to reduce bioavailability of lead, arsenic and/or PAH was evaluated.

Root crops were the only crops accumulated soil lead above the Joint WHO/FAO CODEX maximum levels (MLs) with carrots taking up more lead than beets, radishes and sweet potatoes. In sandy soils with lead concentrations around 200 mg/kg to 250 mg/kg, lead concentrations in root crops exceeded the MLs of 1-1.5mg/kg (dry weight basis). Arsenic uptake by all crop types was low indicating that food-chain transfer of arsenic may not be a problem for urban brownfields. PAH uptake by all crop types tested at our test site contaminated with PAHs was non-detect.

Overall findings indicate the potential exposure pathway of concern is direct exposure of humans to contaminated soils. The pathway from contaminated soil to plant to human is insignificant. When deciding to grow food crops on a mildly contaminated brownfields site, two options exist: growing in-situ (directly in the soil) or growing in raised beds filled with imported (tested) soils. If raised beds are selected as a best management practice, care should be taken that the garden paths, sideways and in between the beds are covered to prevent exposure to dust. If in-situ growing is selected, the soil very likely needs to be amended using compost and fertilizer because brownfields soils tend to be of poor quality. Generally, actions are taken to improve soil quality may also help to reduce the bioavailability of soil contaminants.

Examples are:

- 1) Compost addition will dilute overall contaminant concentrations, and mature/stable organic matter in the compost and the iron oxides present in some products such as composted Class A-biosolids will bind metals and organic contaminants in soils and thereby reduce their bioavailability.
- 2) Compost addition also helps maintain good soil nutrient status in soils. Maintaining good soil fertility and thereby increasing biomass production diluted contaminant concentrations in the vegetables.
- 3) The nutrient phosphorus, will transform lead into lead phosphate and reduce bio-availability.

- 4) Adjusting pH to around neutral (i.e. 6.5 to 7) will reduce the mobility of cationic metals such as lead and cadmium. For arsenic containing soils, the pH should not be adjusted to values over 6.5 to avoid enhanced arsenic mobility.
- 5) Soils may be impacted by more than one contaminant and a mixture of amendments (compost, phosphorus, and biosolids) would be beneficial.
- 6) Root crops such as carrots, turnips, etc. (i.e., extended hypocotyls) may be grown in raised beds or container with clean soil when soils have elevated levels of soil contaminants.