European Commission

Science for Environment Policy

Land use affects potential health risks of cadmium and lead soil contaminants

Exposure to polluted soil can affect human health, but the risk may vary depending on the soil type. A recent study has shown that the differing amounts of cadmium and lead that can be dissolved in the human digestive system can be predicted for contaminated agricultural, urban and woody habitat soils using a model. Its authors suggest this is a useful method for assessing the risks of contaminated land.

Human activities, such as mining and smelting, release high concentrations of dust containing trace elements, which are deposited in surrounding soils. Soil contaminated with toxic metals, such as cadmium and lead, may pose a threat to people if it is eaten accidentally, by children, for example, or if people eat food grown in the soil. Cadmium consumption can cause kidney and liver damage, and lead can cause neurological damage, among other health problems.

However, the amount of metal contamination in soil that is 'bioaccessible' varies. Bioaccessibility is the proportion of a contaminant that can be dissolved in the digestive system and which may go on to enter the bloodstream.

In previous studies, the researchers developed a model to determine the human bioaccessibility of toxic metals in agricultural soils that had been contaminated by past cadmium and lead smelting activities in an area of Northern France. They extended this work in this study to test the model on the bioaccessibility of both metals found in urban soils and woody patches in the same area.

The main properties of soil that affect the bioaccessibility of cadmium and lead were measured in 505 topsoil samples: 390 from agricultural land, 50 from urban sites (kitchen gardens and lawns) and 65 from woody areas (hedges, groves and forests). In addition, for all soil samples, the researchers used laboratory tests to measure the bioaccessibility of cadmium and lead in the human stomach and intestines. (Bioaccessibility was expressed as a percentage of the pseudototal metal concentration, which reflects the extraction methods used in the laboratory to measure metal availability).

The properties of the different soil samples varied significantly. Compared with agricultural soils, urban and woody patch soils had higher concentrations of cadmium and lead. However, the pH (acidity) of urban and agricultural soils was, on average, similar and less acidic than woody patch soils, probably as a result of liming practices in agriculture and the presence of building rubble in urban soils and liming in kitchen gardens.

Different land use practices affected the bioaccessibility of cadmium and lead. On average, 68% of total cadmium from urban soils was bioaccessible in the stomach. For soils from woody habitats and agriculture samples, this figure was higher at 75% and 77.3%, respectively. In the intestines, the bioaccessible fraction of cadmium was the highest in agricultural soils (46.2%), 32% was bioaccessible in urban soils and 31% in woody soils.

In the stomach, the bioaccessible fraction of lead in urban soils was 59.8% and 65.3% in woody soils and 57.6% in agricultural soils. In the intestines, these fractions were 20.8%, 24.6% and 24.4%, respectively, for agricultural, woody habitat and urban soils.

The bioaccessibility of metals depends on the physical and chemical properties of the soil, as well as the level of contamination. For example, cadmium bound to carbonates or iron/manganese complexes in agricultural soils may be more available for uptake in the gastrointestinal tract than cadmium held tightly in urban and woody habitat soils, which contain high organic matter. Lead was found to be more bioaccessible from urban and woody habitat soils with high carbonate levels and organic matter compared with agricultural soils.

12 September 2013
Issue 341

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Source: Pelfrêne, A., Waterlot, C., Douay, F. (2013) Influence of land use on human bioaccessibility of metals in smelter-impacted soils. *Environmental Pollution*. 178: 80-88. Doi.org/10.1016/j.envpol.2013.03.008

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To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.