Phytoremediation
Using native vegetation to stabilise heavy metal contaminants at polluted sites

Elevated concentrations of heavy metals at polluted sites represent serious human health hazards and environmental threats. Persistent metal pollution is hard to remedy but one possible and effective method is phytoremediation, using plants to stabilise the metal pollution and ameliorate the contaminated soil properties. Across 20 years of research, Drs Madeleine Günthardt-Goerg and Pierre Vollenweider of the Swiss Federal Institute for Forest, Snow and Landscape Research WSL – together with Professor Dr Rainer Schulin of the Swiss Federal Institute of Technology Zürich – have improved current mechanistic understanding of phytoremediation potential using native trees and mixed afforestation. Their insights can help decision-makers find solutions that are economically beneficial as well as environmentally and socially sustainable.

...more Zn accumulation in the leaves than in the wood and roots of tested deciduous trees (yewloses, poplars, and birches), whereas in conifers (spruce) the root compartment showed the highest Zn concentrations. Generally, considering the soil-to-shoot transfer of contaminants, deciduous trees were found to be more efficient than conifers or understorey plants.

...trees growing on calcareous versus acidic subsoil, the surface-based metal extraction could be superior. This was especially the case for Zn and Cu contaminants, primarily because of the higher biomass production on nutrient-rich calcareous soils.

Trees and other plants can stabilise heavy metal pollutants in moderately contaminated sites, while providing biomaterials and valuable ecosystem services.

In metal polluted sites, the pollution depth depends on the site characteristics and land use. Topsoil pollution is very frequent, especially in the case of atmospheric deposition or abovement underground activities. Remediation sites with persistent metal contaminants can require expensive and technically demanding in- or off-site treatment. Still, it is estimated that up to 20% of European polluted sites could be cured using phytoremediation. This method uses green plants, including trees, and is a cost-effective, socially, and environmentally friendly solution.

The performed research has demonstrated that conifers and deciduous trees accumulate heavy metals in different ways. For example, there was little indicative yellowing in older needles (A), the symptoms in broadleaved material were more specific. Typical were discolourations and dark dots along veins (B).

Polar symptoms of metal accumulation and stress. Whereas conifer foliage only showed little indicative yellowing in older needles (A), the symptoms in broadleaved material were more specific. Typical were discolourations and dark dots along veins (B).
Behind the Research

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Research Objectives

Madeleine Günthardt-Goerg and Pierre Vollenweider are researching how the properties of trees can be used to develop sustainable management strategies to phyto-stabilise contamination at metal-polluted sites.

Detail

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Bio
Dr Madeleine Günthardt-Goerg and Dr Pierre Vollenweider are both senior researchers at the Swiss Federal Institute for Forest, Snow and Landscape Research WSL (Forest Dynamics Research Unit). Günthardt-Goerg received her PhD in biology (botany, zoology, chemistry, and mathematics) from the University of Zürich.

What are the next steps for your future research on environmental contamination? Will you be looking at other stress factors?

"Our research on heavy metal contamination is part of a larger research effort on abiotic stress and its effects in native tree and herbaceous plant species. Other soil-borne (e.g., de-icing salt, drought) and air-borne (ozone, low or high air temperature) stressors have also been under investigation and the plant responses compared. A forthcoming publication will deal with root cells and the interactions with adhering soil particles under metal contamination. Further mechanistic work on tolerance conferred by safer contamination allocation is in preparation. Major research topics include natural or urban ecosystem stress and acclimation responses to ongoing climate change."

Personal Response

References


It’s not just the concentration of absorbed metal pollutants within plant organs that matters but also the amounts extracted in the different plant parts.

remediation would take up to 350 years for Zn, 30 years for Cu, and just one year for Cd, whereas Pb concentrations for Zn, 30 years for Cu, and just one year for Cd, whereas Pb concentrations...