Brownfield Remediation using Short-Rotation Coppice

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Regeneration and urban greening of former industrial landscapes in lowland England have been achieved through substantial tree planting. Less onerous risk assessment criteria for this type of soft end-use remediation, compared to land for food crops, may be somewhat contradictory because increased usage of the land may increase human exposure. We aim to understand what happens to residual contamination and whether tree planting provides an effective long-term management of risk. The potential for using trees to extract or immobilise heavy metals in soil has been well discussed previously.

Results presented here are one part of 7 years of experimental fieldwork at more than 50 trial plots at 18 sites in NW England. Trace element mobility has been quantified and in this paper we focus on contaminant hotspots and the potential for site clean-up by tree harvest. Mass balance models are used (i) to quantify the dispersion and mobility of potentially-toxic elements at typical brownfield sites and (ii) to assess the feasibility of influencing contaminant hotspots through uptake and harvest of short-rotation coppice.

Twelve trial plots (each 30m x 30m, with 2-3 plots per site) were located at 7 sites with differing former land uses (landfill, industrial waste, sewage sludge) and a range of trace element contamination. Dispersion patterns of trace elements were measured and mapped at sites variously contaminated with As, Cd, Cu, Ni, Pb, Zn and B, with sampling designed to identify 1% hotspots (72 sampling points per plot) at 0-30 cm depth. Plots were planted with 5 taxa of *Salix*, 2 *Populus* hybrids, *Alnus*, *Betula* and *Larix* in a fully randomised block design (10 blocks per taxa, 12 plants per block, double rows 1.5m x 0.5m spacing). *Salix* and *Populus* were cut back after 1 year and then all plants were harvested after a further 2 years.

Overall mortality was low (mean 11%) and was not related to contamination, except at one site with over 4,000 mg As kg^{-1}. At brownfield sites, uniform contamination of the land surface is unusual; hotspots in both vertical and horizontal profiles are more typical

Predictive models based on stem and foliage harvest data (Fig. 2) show that significant amounts of Cd and Zn could be removed from soil by repeated harvest. Over a typical 20 year life cycle of the crop this would amount to removal of 5.6 kg Cd ha^{-1} and 96 kg Zn ha^{-1} by the most efficient taxa (*Salix* x *calodendron*) from the land.

Phytoextraction of Cd using short-rotation coppice may provide an efficient and cost-effective method of clean-up for low-level contamination of brownfield land where this metal frequently cause concern; other elements have little risk associated with human exposure (e.g. Zn, Ni, Cu) or are insufficiently mobile in soil-plant systems (e.g. Pb, Cr). Tree planting provides aesthetic improvement and economic benefits. Time scales are long but we argue this could be improved by careful targeting of hotspots, clone selection, and final harvest of the root bole.