BIOCHAR FOR REMEDIATING CONTAMINATED SOILS: OUTDOOR EXPERIMENTS IN WALES, UK

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Most soil-related applications of biochar have involved agriculture or horticulture. Our current research focusses on remediation of contaminated soils using biochar or biochar compost. We will present the results of outdoor pot and plot trials on three contrasting site types: 1) colliery waste; 2) cleared invasive rhododendron; and 3) metal-mine tailings. All experiments utilized sustainable, lignocellulosic biochar (EarthChar®; UK Biochar Quality Mandate: High Grade), produced using a modified BigChar-1000 fast-pyrolysis/gasification unit equipped with a thermal oxidiser.

Cwm Dulais, Swansea, is the site of the former Graig Merthyr Colliery (51.72N, 4.00W, 158m a.s.l.). Excavation of spoil to construct a flood-relief barrage for Natural Resources Wales has left several ha of steeply sloping, bare colliery waste in urgent need of erosion control. Annual rainfall is ~1200mm and mean monthly air temperature 3-19°C. The colliery spoil is a very compact, rubbly diamict including bricks, slag and ash, with a pH of 4.5–7.7. The most problematic contaminants are Cu (since ~14mg/kg dietary Cu is fatal to sheep), As and PAHs. In an initial pot trial, an acid-grassland seed mix was grown for 90 days in screened (<20mm) colliery waste. Later, a 90-day plot trial was conducted on-site. Varying application rates of rhododendron biochar (pot trial: 0-20%v/v; plot trial: 0-10%v/v) and PAS100-certified *Pteridium aquilinum* (bracken) compost (pot trial: 0 or 25%v/v; plot trial: 0-25%v/v) were used, with 6-fold replication in both cases. Overall, the most successful treatment with respect to grass growth and above-ground phytomass was 25%v/v bracken compost with 5%v/v added biochar.

The hillside facing Graig Merthyr has been invaded by a ~46ha stand of *Rhododendron ponticum*, now partially cleared. In Cwm Dulais, tall rhododendron causes substantial habitat damage by acidifying topsoil to pH 3.6–4.5, killing the native seedbank and eliminating earthworms. Its thick litter/humus layer, rich in allelopathic compounds, is dominated by specialist ericoid mycorrhizae. In Wales, it acts as a host plant for the oomycete pathogen *Phytophthora ramorum*, which is currently devastating *Larix kaempferi* (larch) plantations. Rhododendron clearance alone achieves very little habitat regeneration. In Cwm Dulais, which is situated very close to the historic concentration of non-ferrous metal-smelting in the Lower Swansea Valley, burning of piles of cleared rhododendron also causes severe localized contamination with Pb and As. Two, side-by-side, 90-day outdoor pot trials (with/without addition of acid-grassland seed mix) were conducted on topsoil collected from four site types: cleared, burnt and dense rhododendron, with adjacent permanent grassland as control. Both mineral nutrient- and mycorrhizae-amended, as well as unamended, rhododendron biochars were tested at an application rate of 5%v/v. Seedling germination was very poor in unseeded pots, though improved by mycorrhizal inoculant. In contrast, application of grass seed along with 5%v/v mineral nutrient-amended biochar produced significant improvements in grass growth on all substrate types. Promising results from a recent biochar hydroseeding trial will be presented.

The abandoned Frongoch Zn/Pb mine, Ceredigion (52.35N, 3.52W, 245m a.s.l.,11ha) is a major source of toxic dissolved metals and particulates entering Cardigan Bay. Its acidic tailings heaps (pH 3.9–6.2) contain ~1–130g/kg Pb, ~1–110g/kg Zn and ~0.02–0.4g/kg Cd. A 98-day outdoor pot trial with 6-fold replication was conducted to assist the design of a low-cost, artificial-soil product for remediation of abandoned metal-mine tailings. A 1500ml (~7.5cm deep) layer of PAS100-certified greenwaste/foodwaste compost, mixed with a metal-tolerant grass-seed mix and 5%v/v un-amended or mineral nutrient-enhanced coniferous biochar, was added to 500ml of tailings in 2L pots. Superior grass growth and biomass were obtained in treatments involving amended biochar.

Proposed future applications of biochar for coupled land remediation and carbon sequestration will be discussed.

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