Beneficial use of river sediments as topsoil for passive carbon capture and storage during land restoration and energy crop production – A Net Zero management option?

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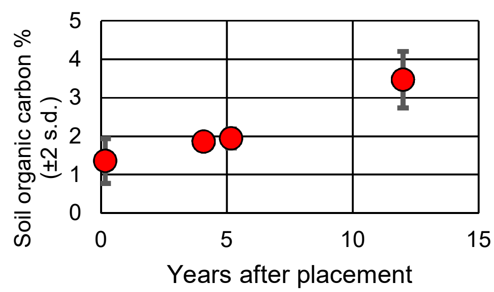
Introduction: Spreading dredged river sediments on adjacent derelict land or brownfield sites as replacement soils provides a convenient closed-loop solution to sediment management in keeping with the restorative and regenerative principles of the Circular Economy. A number of additional economic, social and environmental benefits can be realized from this approach, including low intensity dewatering of the sediment, ripening and conditioning as a technosol. Using the bioenergy crop Reed Canarygrass (*Phalaris arundinacea*) for phytostabilisation or phyto-conditioning offers the potential for delivery of a number of additional ecosystem services, including renewable energy provision [1] and the potential for soil carbon storage [2]. In this paper we report on the long-term patterns of soil carbon accumulation in placed sediments over a 13 year period, compared to those required to meet the 4 per mille initiative launched at COP21 in Paris in 2015 or help to meet the Net Zero targets subsequently set.

Fig. 1: Pilot site condition in February 2020.

Methods: In early 2008 a field trial was established at the Tees Barrage , Stockton-on-Tees, UK as part of the EU Life BioReGen Project (LIFE05 ENV/UK/000128). Here c.500 m^3 of excavated sandy river sediments arising from bridge pier construction were spread over a restored brownfield site for beneficial reuse, prior to natural drying, broadcast seeding and soil characterization [3]. This included sowing and sampling within 2 months of placement for baseline analysis for a comprehensive suite of soil contaminants, physio-chemical parameters, total and available nutrients. This soil monitoring was repeated in 2012 and 2013. Detailed soil characterization was completed in early 2020 as part of the SURICATES Interreg NWE 462 project [4] to predict long-term effects of similar bioengineering pilots using sediments and grass seeding.

Results:.
The sediments were derived from a former heavy industrial area, containing Cd, Cr^T, Cu, Pb, Hg, Ni and Zn levels above CEFAS action level 1 [5]. However, the placed soils met textural requirements, pH range, target conductivity, prescribed limits for Cu, Ni and Zn and available P, K, Mg levels for topsoil products [6] within two months. After four years the increasing organic matter and total N contents also met these product requirements in full, while harvested biomass at yields of 6-8 $odt.ha^{-1}$ for the 2011 and 2012 growth seasons met elemental requirements for domestic fuel pellets [7]. Organic carbon stored in the soils over 12 years averages c.2 t $C.ha^{-1}a^{-1}$ in the upper 0.1 m, a growth of c. 8% per annum (cf. 0.4% for 4 per mille).



Discussion: Although fugitive emissions and organic matter content during dredging were not determined our data suggest that the total organic carbon in sandy sediments placed as top soils increases steadily during growth of perennial grasses and natural succession, providing carbon capture and storage opportunities in net-zero sediment management.

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References: [1] Lord RA (2015) *Biomass Bioenergy* **78**:110–25; [2] Lord R, & Sakrabani R. (2019) *Sci Total Environ* **686**:1057-1068; [3] CEDA Beneficial Use of Sediments Case Study R1A_2008_UK; [4] https://www.nweurope.eu/projects/project-search/suricates-sediment-uses-as-resources-in-circular-and-territorial-economies/; [5] https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans###Suitability%20of%20material; [6] British Standards Institution (2015) BS3882; [7] British Standards Institution (2014) BS EN ISO 17225-6.