Effects of heavy metal contamination in Saltmarsh and Reed bed on Carbon Sequestration

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ABSTRACT

Assessing stabilization of soil organic matter (SOM) with heavy metal contamination is one factor that will invariably provide an answer to whether heavy metal contamination affects the storage of soil organic matter/carbon. The transformations of SOM will bring about changes in functional group chemistry during decomposition/mineralization. The effects of heavy metal contamination level under different land use type on carbon sequestration were investigated. Results indicated that, the concentration of heavy metal under different land use affects the transformation of soil organic matter. This will have implication on carbon storage/Sequestration.

INTRODUCTION

A study of heavy metals in surface sediments of the Mersey, monitored over a period of 25 years (Harland, Taylor, & Wither, 2000), has shown that heavy metal concentrations are strongly correlated with organic matter and soil particle size, resulting in distribution patterns which reflect sediment characteristics and dynamics rather than the position of input sources.

Hsu and Lo (1999), reported that transformations of SOM through decomposition and mineralization brings about changes in functional group chemistry, such as the relative increase in aromatic to aliphatic groups during decomposition. By quantifying relative changes in functional groups, Fourier Transform Infrared (FTIR) spectrometer can be used to help explain SOM transformations and stabilization.

Research linking the effect of heavy metal contamination under different land use type and carbon sequestration is scare. The content of this study relate to one of my PhD research objectives.

OBJECTIVE

- To assess the effects of heavy metal contamination under different land use type on the transformation of soil organic matter.

METHODS

- The study was conducted in the Upper Mersey Estuary, northwest England (Photo 1).
- Thirty (30) representative soil samples were collected within 30 cm depth from experimentally designed plots (Fig 1)
- Soil samples were air dried, crush and passed through 63µm and 2mm sieve for analysis of heavy metal concentration by ICP-OES, and soil organic carbon content/characterization using FT-IR Spectrometer, Nuclear Magnetic Resonance (NMR) Spectrometer and loss on ignition method. Statistical analysis was by IBM SPSS 20 version.

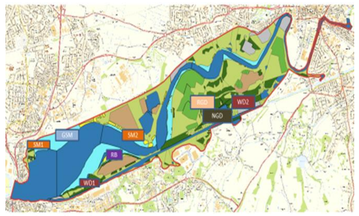

Fig 1 Sampling design

Photograph 1 showing aerial photograph of the upper Mersey estuary

SM= Salt Marsh, GSM= Grazing Salt Marsh, GSM-N= Non-Grazing Salt Marsh, RB= Reedbed, WD= Woodland, NGD= Natural Grassland, RGD = Rough Grassland

RESULTS

- Results indicated that the concentration of heavy metal affects the transformation of soil organic matter/carbon.
- Inorganic phosphate, aliphatic primary amines and aliphatic hydrocarbons functional groups were observed in grazing saltmarsh while inorganic phosphate and aliphatic primary amines functional groups were found in un-grazing location (Figs 2&3).
- Soil organic carbon content was statistically significantly higher at 0.05 level of confidence in the grazing saltmarsh as compared to un-grazed location (Fig 4). This may be due to the grazing activities.
- The proton spectra indicated that aliphatic hydrocarbon and aromatic protons are present in different humic substances (Fig 5).
- The soil that were less contaminated with heavy metal contains more functional groups (Fig 6).

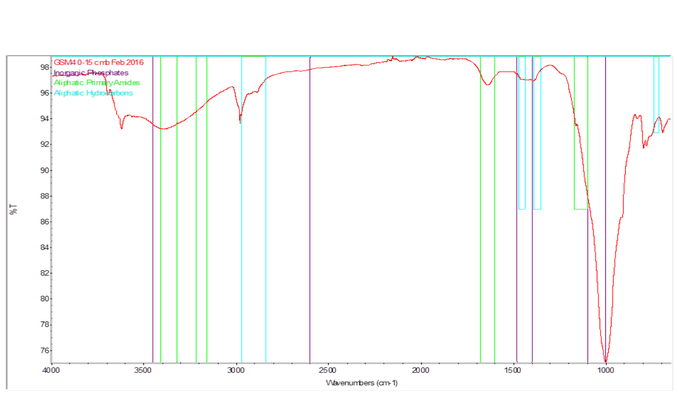

Fig 2 FT-IR Spectra showing different functional groups within GSM

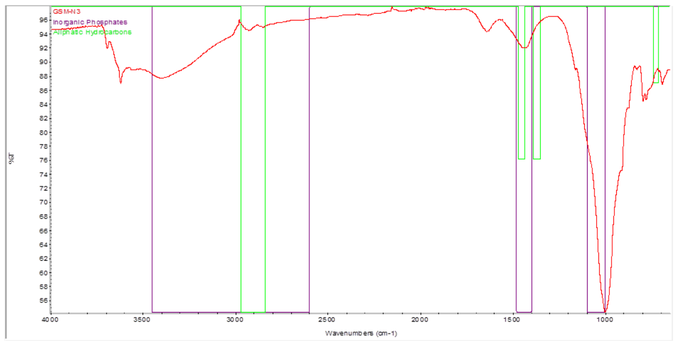

Fig 3 FT-IR Spectra showing different functional groups within GSM-N

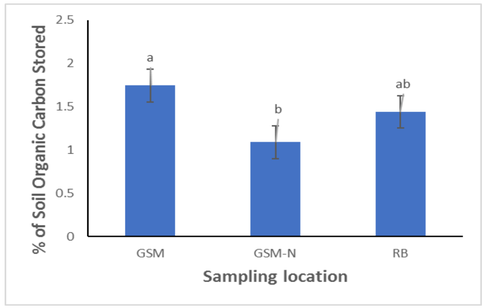

Fig 4 Showing the storage of soil organic carbon under different land use type

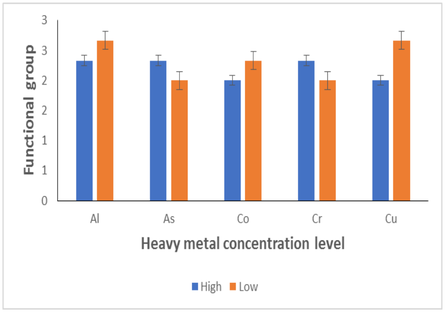

Fig 6 Showing effect of concentration on functional group

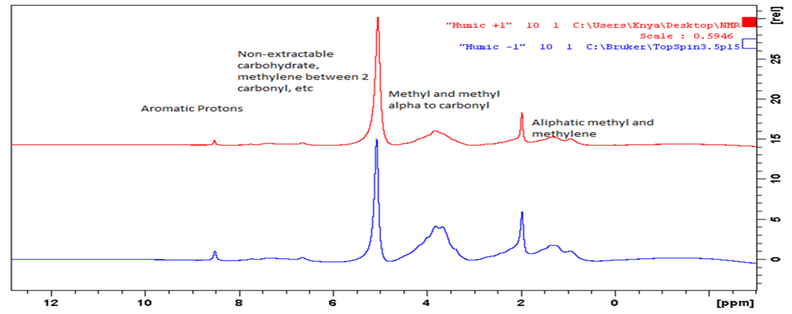

Fig 5 ^{1}H-NMR spectra of humic substances with different carbon species (Humic +1 = acid hydrolysis before extraction Humic -1 is without acid hydrolysis before extraction)

CONCLUSIONS

- Concentration levels of heavy metal in saltmarsh and reed bed have an effect on the transformation of soil organic matter.
- Less contaminated sites show more functional groups indicating higher rates of decomposition or transformation of soil organic matter.
- Significantly more soil organic carbon was stored within the cattle grazing area than un-grazing.

Further Research

Laboratory incubation experiment is ongoing using three levels of heavy metal contamination (high, medium and low) with six treatments (control, As, Cr, Cu, Pb and Zn) to assess their effects on soil organic matter content/functional group.

References

Harland, B. J., Taylor, D., & Wither, A. (2000). doi: http://dx.doi.org/10.1016/S0048-9697(00)00374-0
Hsu, J. H., & Lo, S. L. (1999). Chemical and spectroscopic analysis of organic matter transformations during composting of pig manure. *Environmental Pollution*, *104*(2), 189-1969326/2/4/045024

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