

Investigating the Potential of Hyperspectral Imaging (HSI) for the Quantitative Estimation of Lead Contamination in Soil (LCS)

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I. INTRODUCTION

Hyperspectral Imaging (HSI) in combination with different geostatistical methods, have been used during the last decade for identifying, estimating and mapping heavy-metal contaminated soils and also for quantifying soil lead content [2-3-4]. This work aims to investigate the potential of field spectroradiometry in quantifying lead (Pb) contaminated soil (LCS) at a floodplain site with known elevated metals levels [1]. The specific objectives were to (i) acquire field-based spectral measurements of soil samples, and (ii) perform a spectral discrimination analysis of the reflectance spectra to identify the specific wavelengths/spectral regions associated with LCS detection.

II. STUDY AREA & METHODOLOGY

The site comprises a triangular plot of land divided into a series of experimental test plots, managed by Aberystwyth University's Biological Sciences Institute (IBERS) (Fig.1). Details about the site characteristics can be found in [1].

The data were collected in August 2014. Field spectra using an ASD FieldSpec®3 portable spectroradiometer in a hand-held mode were collected from a LCS area and from a control area, where no previous heavy metal contamination had been registered.

The spectral signatures were recorded *in-situ* from 97 locations in total, at each site of soil and vegetation samples were also

collected for subsequent laboratory geochemical analysis.

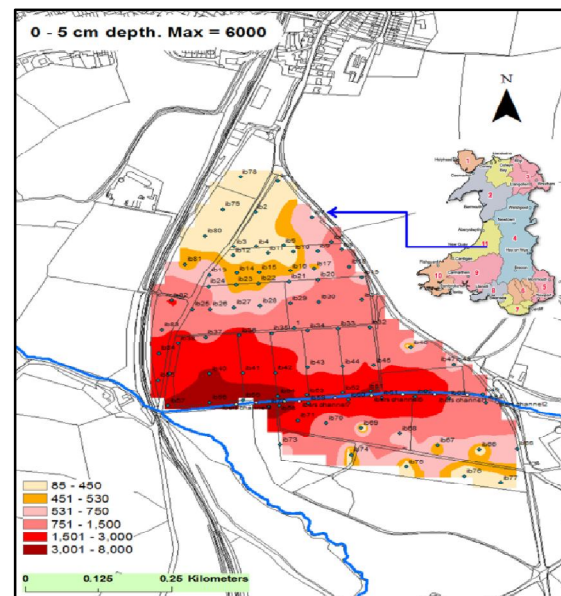


Fig.1. Map of the study area with Pb sediment concentration (mg/kg) [1]

RESULTS & ANALYSIS

The collected field spectra from the contaminated and non-contaminated area were pre-processed in terms of outlier and noise exclusion, and were averaged (5 spectra per location) in order to obtain representative spectra. The spectra from the two sites received the same spectral and statistical analysis (Fig.2).

A statistical discrimination analysis was implemented on the two spectral libraries. The results of the analysis of variance (ANOVA) tests on the reflectance at each spectral band from 350-2400 nm are plotted in Fig.3.

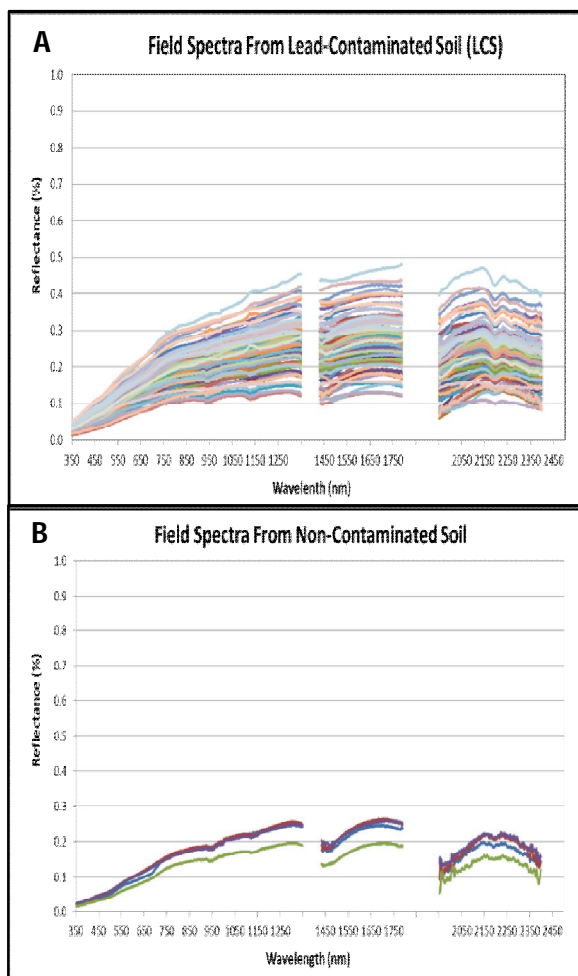


Fig.2. Pre-processed field spectral libraries of A) contaminated and B) no-contaminated soils.

There were significant differences between the reflectance spectra from the two sites along the entire visible (VIS, 350-800 nm) and the beginning of the near-infrared (NIR, 800-950 nm), including the red edge at about 850 nm. Also the SWIR spectrum (1400-2400 nm) was important in the discrimination between the Pb-polluted and control soil spectra, with exception of 1630-1780 nm wavelengths.

Statistically significant regions were isolated and the results identified potentially important spectral regions for discrimination between the soils. These findings will be correlated in future soil geochemistry analyses, with particular focus on the VIS, NIR and SWIR portion of the spectrum.

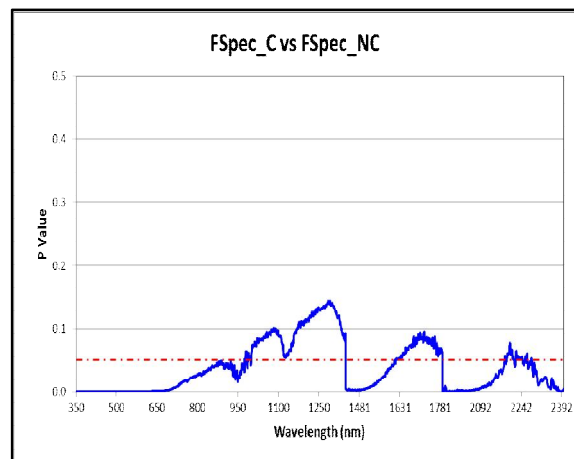


Fig.3. Discrimination analysis of the collected field spectra from both Pb-contaminated and non-contaminated area. NB: Red dashed line denotes the limit for statistical differences at $P=0.05$ (95% confidence level).

CONCLUSIONS

A spectral library was created and preliminary analysis of the field spectra collected for the different targets has shown some interesting features related to soil contamination. Contaminated and non-contaminated soils was possible to be statistically differentiated on the basis of their spectral signature.

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