Poster-EGU2020-9370

Innovative Drone-based Hyperspectral Detection of Heavy Metals (Ni, Zn, and Cu) in Plants cultivated for Phytomining

Friederike Klos[1], Magdalena Sut-Lohmann[2], Thomas Raab[2], Florian Hirsch[2]

[1]Helmholtz Centre Potsdam, German Research Center for Geosciences, Telegrafenberg, Potsdam 14473,Germany; Email: klos@gfz-potsdam.de

[2]Brandenburg University of Technology Cottbus-Senftenberg, Chair of Geopedology and Landscape Development, Siemens-Halske-Ring 8, 03046 Cottbus, Germany

Introduction

The aim of this project is to study heavy metal accumulation in plants with drone-based hyperspectral sensors (Fig. 1). The development of such monitoring systems contributes to the recycling of environmentally critical heavy metals and supports the development of environmentally friendly processes for metal recovery, known as **Phytomining**. We took soil samples from former sewage farms, which contain various heavy metals and organic pollutants from industrial and domestic wastewater.

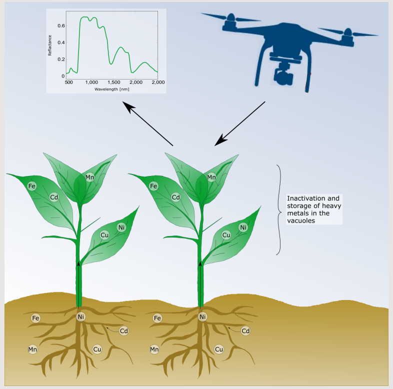

Fig. 1: Scheme of the HyPhy project.

Study area and field work

The study field is a sedimentation basin of the former sewage farm 'Deutsch Wusterhausen', located south of Berlin, Germany. In a 5x5m grid, disturbed soil samples were collected in 15 - 20cm depth (Fig. 2).

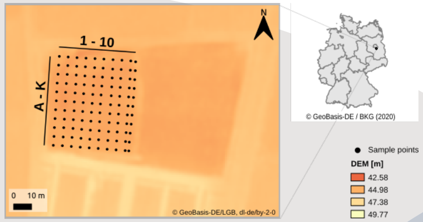

Fig. 2: DEM and sample point overview of the study site.

Lab Measurement

All disturbed soil samples were oven dried (40°C), sieved (≤ 2mm) and ground. **Soil heavy metals** were determined using microwave plasma atomic emission spectrometry (Agilent Technologies 4210 MP-AES).

Spectral measurements were acquired with the hyperspectral sensor HySpex, covering a spectral range from 450 to 2500nm in 408 distinct bands under laboratory conditions (Fig. 3). The reflectance data were used to build a spectral library.

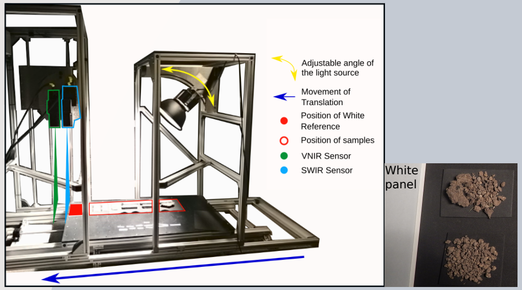

Fig. 3: Left: HySpex System under Lab conditions, (after Körting, 2019). Right: Soil sample arrangement during measurement.

First test analysis

...to study the correlation between heavy metals and contaminated soil from the study area to find the best statistical approach.

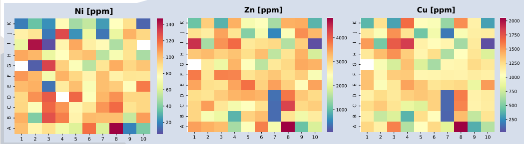

Fig. 4: Spatial heatmaps of Ni, Zn and Cu concentration.

First tests with the PLSR method with defined wavelength ranges (window) may enable a better prediction (after Pelliccia, D., NIRPY Research © 2020).

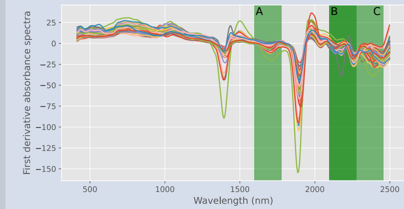

Fig. 5: First derivative spectra with 3 wavelength ranges used for PLSR (A: 1580-1755nm; B: 2083-2264nm; C: 2083- 2444nm).

	2083 - 2263 nm		2083 - 2444 nm		1580 - 1754 nm	
Heavy metal	R^2_{cv}	RMSE	R^2_{cv}	RMSE	R^2_{cv}	RMSE
Zn	0.34	763.99	0.36	752.26	0.42	718.38
Cu	0.28	332.19	0.34	318.11	0.37	309.36
Ni	-0.06	31.71	0.10	29.19	0.28	26.16

Table 1: Results of the PLRS analysis for three different wavelength windows.

Summary

The element analysis show higher accumulation in sinks (Fig. 4). First results with the PSRL method for different wavelength windows (Fig. 5) show no adequate values to point a link between the concentration of Ni, Cu and Zn and the associated hyperspectral data (Table 1).

Outlook

- Testing further methods with different pre-processing of the hyperspectral data.
- Starting hyperspectral and chemichal measuremtns of the greenhouse experiment (Fig. 6).

Fig. 6: First greenhouse experiment with Brassica juncea by adding a Cu/Zn solution, © Sut-Lohmann (2020).

Acknowledgements

This work is part of the HyPhy project (Hyperspectral Phythomining), funded by the ZIM Network of the Federal Ministry for Economic Affairs and Energy (BMWi).

References

Sut, M., Fischer, T., Repmann, F,Raab, T., Dimitrova, T. (2012): Feasibility of field portable near infrared (NIR) spectroscopy to determine cyanide concentrations in soil. Water, Air, and Soil Pollution, 223(8), 5495–5504. https://doi.org/10.1007/s11270-012-1298-y.

Körting, F. (2019). Development of a 360 ° hyperspectral drill core scanner Test of technical conditions and validation of high-resolution near- field analysis of crystalline basement rocks using COSC-1 core samples. 123. https://doi.org/http://doi.org/10.2312/GFZ.b103-19071.

Pelliccia, D., NIRPY Research © 2020 (URL: https://nirpyresearch.com/moving-window-pls-regression/).