Mapping mining heaps using multi- and hyperspectral remote sensing: A case study in the Mansfelder Land region in Central Germany

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Motivation & Objectives

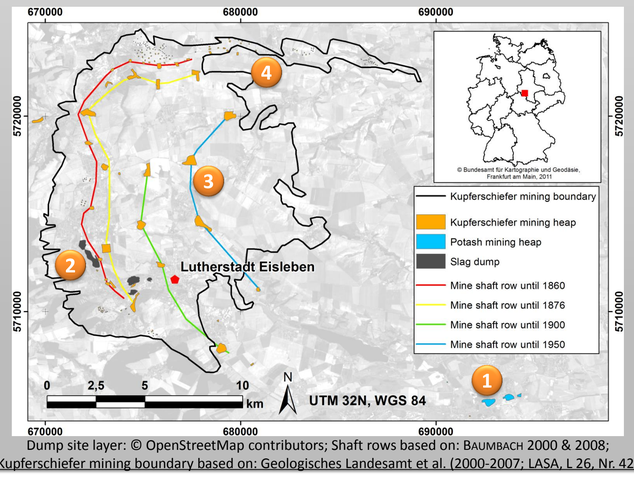
Old mining heaps can be considered as anthropogenic deposits. As such, they are of increasing importance in the context of urban mining, meaning the detection and reuse of materials of potential economic interest. In this study, we focus on the well documented Mansfelder Land region in Central Germany, which is a suitable test site for the application of multi- and hyperspectral remote sensing approaches for the identification and analysis of potential deposits in less documented and less explored regions in a global context.

Aims & Multi Scale Approach

This study is considered as a multi sensor and multi scale approach, encompassing free data and imagery associated with costs. The aim of this study is to spectrally characterise and map dominant materials found at the various heaps and dumps in the test region. ASTER satellite imagery is used for a region wide screening, while WorldView-2 data in combination with a high resolution DTM are utilised for more detailed analysis. AisaDUAL data aided by in situ spectroscopy allow the differentiation of most dump site materials.

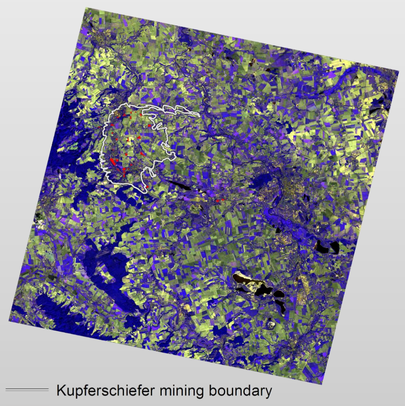
Test Site

The Mansfelder Land region is well known for its copper and salt mining history. Kupferschiefer has been mined and processed for more than 800 years while potash salt mining has taken place since the end of the 19th century. Relics of these mining activities are multitudes of heaps and dump sites of different ages and dimensions based on the corresponding mining and deposition technologies. The dominant dump materials are low-grade Kupferschiefer, limestone, slag from Kupferschiefer processing and materials from potash mining.

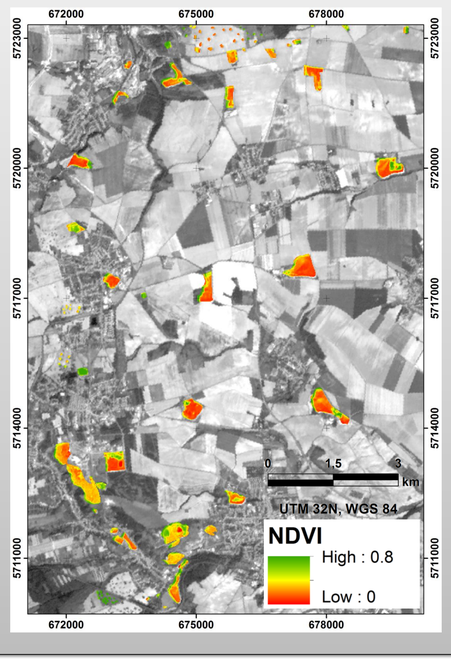


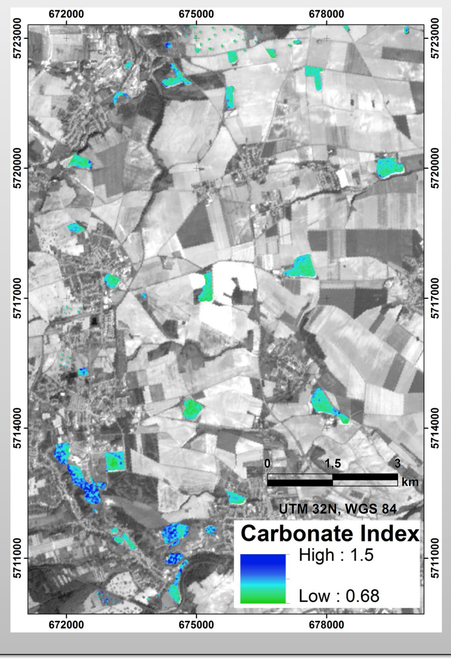
Dump site layer: © OpenStreetMap contributors; Shaft rows based on: Baumbach 2000 & 2008; Kupferschiefer mining boundary based on: Geologisches Landesamt et al. (2000-2007; LASA, L 26, Nr. 42)

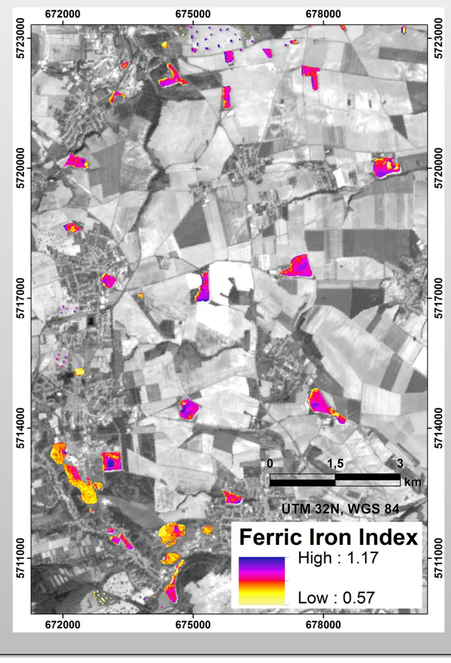
ASTER Image Analysis

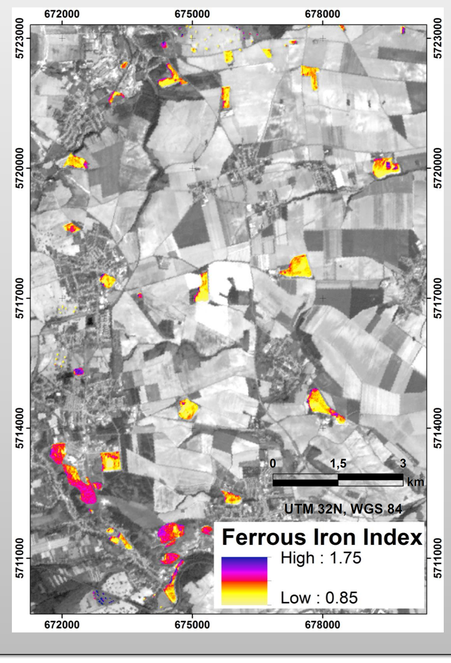


- 15/30 m spatial resolution
- 9 spectral bands (VNIR & SWIR)
- 60 x 60 km tile size



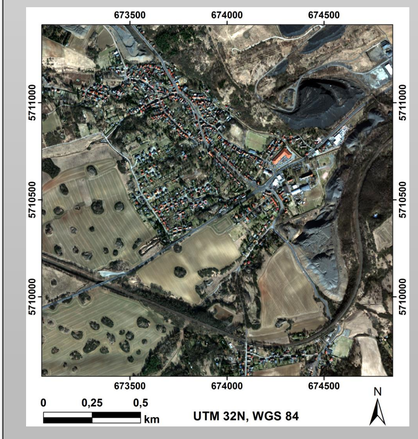




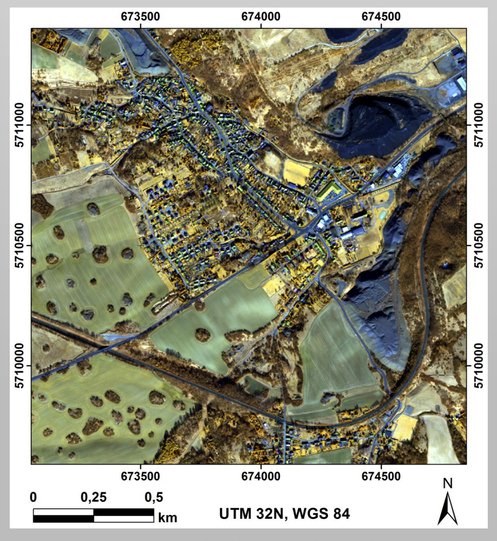


ASTER image: © NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

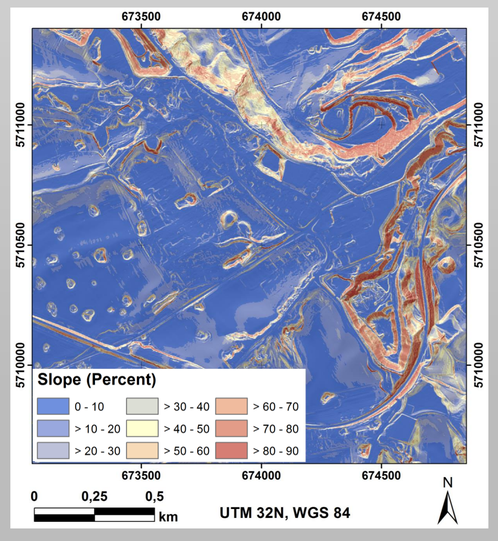
WorldView-2 Image Analysis



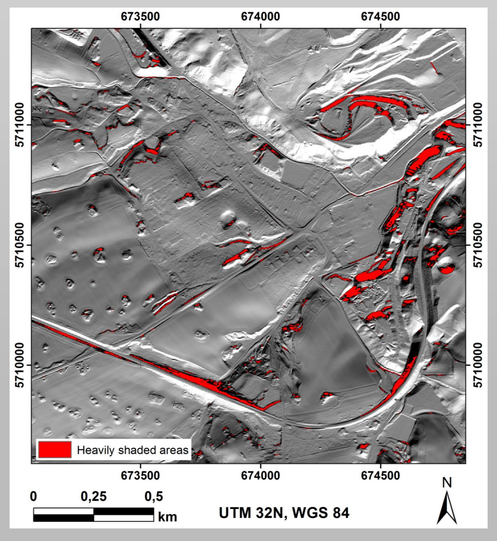
- 2 m spatial resolution (ms)
- 0.5 m spatial resoluton PAN
- 8 spectral bands (VNIR)



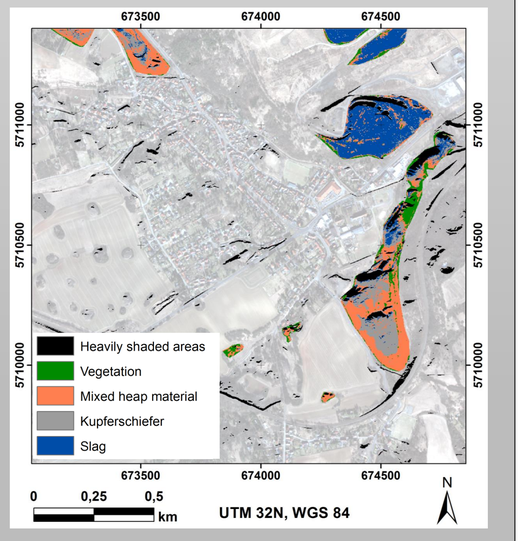
WV-2 bands 8/6/2 (949/724/478 nm) as R/G/B



Slope derived from DTM 1



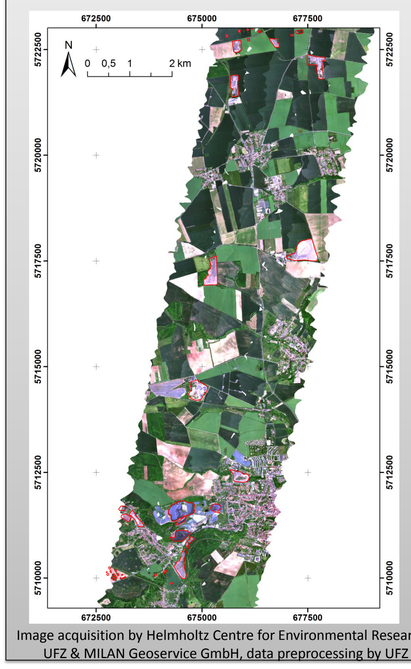
Shadow mask derived from DTM 1



SAM classification

WV-2 imagery: © DigitalGlobe, Inc. All Rights Reserved. Derivatives: Include copyrighted material of DigitalGlobe, Inc., All Rights Reserved.; DTM 1: © LVermGeo Sachsen-Anhalt 2012

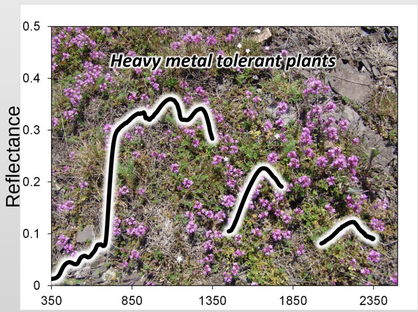
AISA Dual Campaign

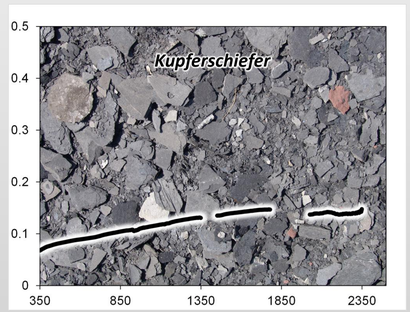


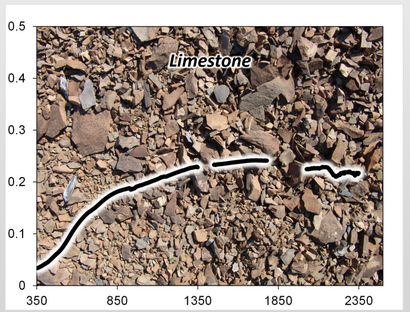
- Image acquisition 06-07/2014
- 9 flight stripes, 3 m GSD
- 368 spectral bands
- BRDF correction with DTM 1
- In situ spectroscopy

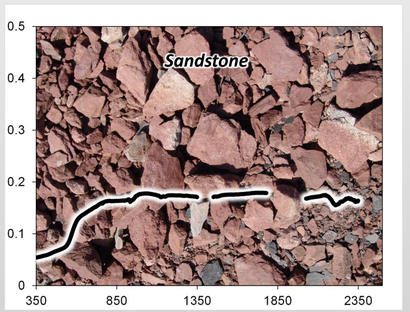
Image acquisition by Helmholtz Centre for Environmental Research - UFZ & MILAN Geoservice GmbH, data preprocessing by UFZ

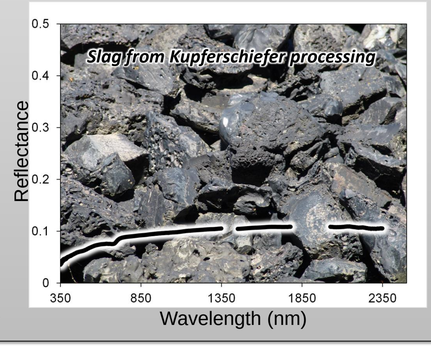
Field Spectroscopy

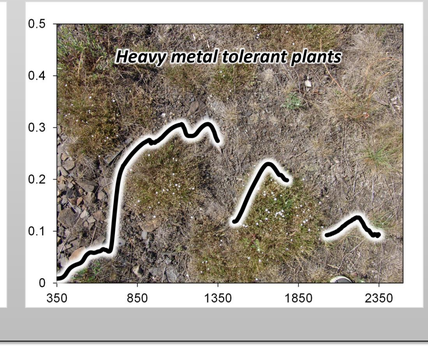


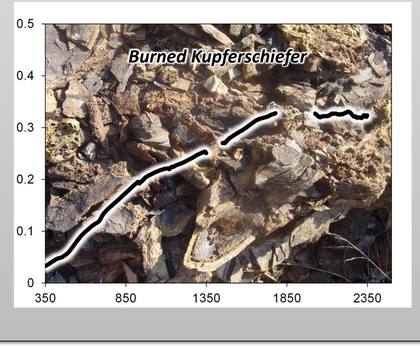


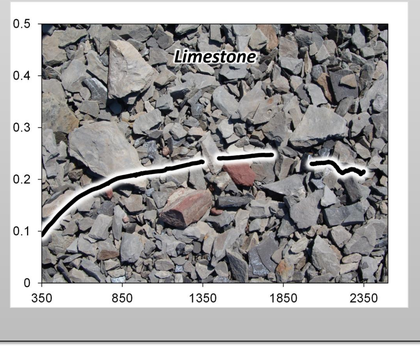


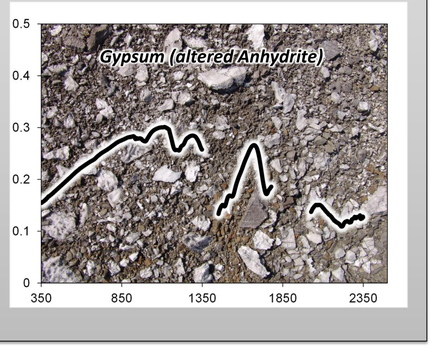












Conclusion

- ✓ Satellite remote sensing is beneficial for screenings of large heap landscapes
- ✓ Identification of dominant heap materials
- ✓ Coarse quantitative analysis using band ratios and indices
- ✓ Only few reference data needed

Outlook

- ✓ Detailed analysis of field and lab spectra
- ✓ Mapping dominant heap materials using field measurements as endmembers
- ✓ Detection of heavy metal tolerant plants and use of corresponding abundances as indicator for geochemical properties

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FONA Ressourceneffizienz BMBF