Aerial Archaeology Research Group (AARG) September 12th-14th, 2018 University of Venice, Italy

Going the Spectra: Tackling Hyperspectral Data for Archaeological Purposes

Agnes Schneider[1, 2*], Simon Seyfried[1], Fabian Herche[2], Dr. Paul Magdon[4], Dr. Lukas Lehnert[3], Dr. Hanna Meyer[2]

[1] Vorgeschichtliches Seminar, Philipps-Universität Marburg, [2]Environmental Informatics & [3]Laboratory for Climatology and Remote Sensing, Department of Geography, Philipps-Universität Marburg
[4] Forest Inventory and Remote Sensing, Georg-August-Universität Göttingen; *contact: Schnei7v@students.uni-marburg.de

Objectives

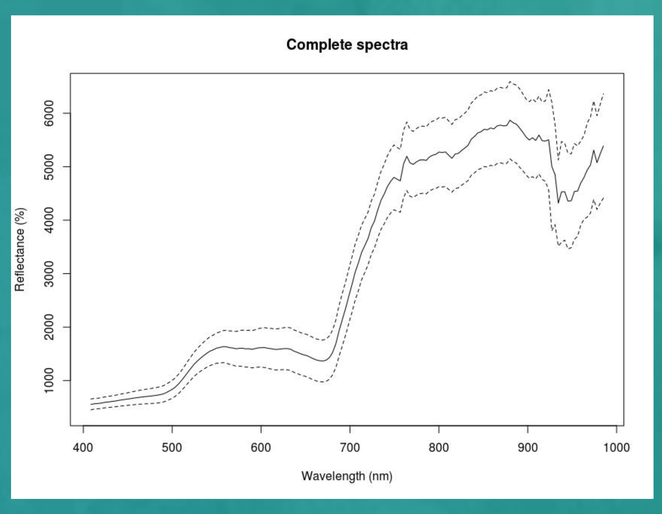
Hyperspectral data aquisition is quite a cost-intensive undertaking and the technical processing needs specialized methods. We would like to present and open-source toolset, the ***hsdar R-Package*** (primarily developed for climatological and remote sensing purposes) applied on an archaeological remote sensing question.
The **hsdar-Package** was applied to a test area in Baden-Württemberg, yielding cropmarks which suggest the presence of burial mounds or circular earth-works. The following illustrates a basic workflow.

The Functionalities of the hsdar Package

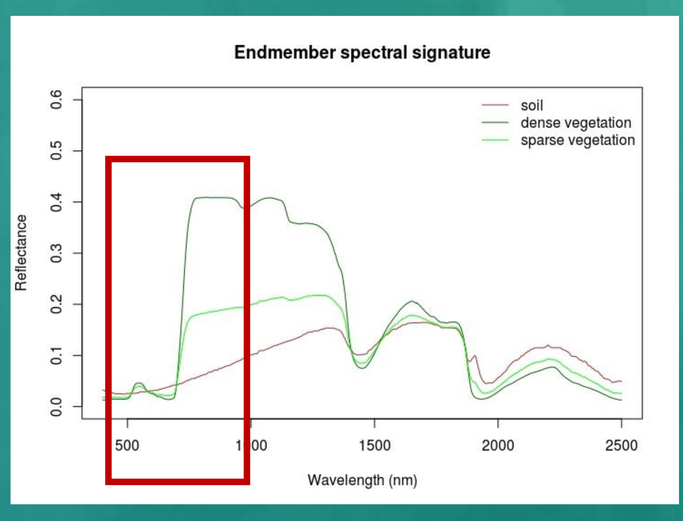
Data Handling

Data: 160 bands; 408.5 – 985.1 nm; mean width of 3.63 nm

Speclibs: consist of the wavelength and the reflectance for each band

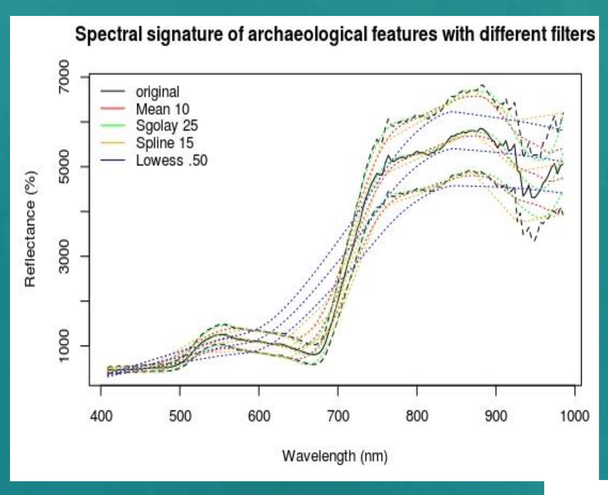


vs.



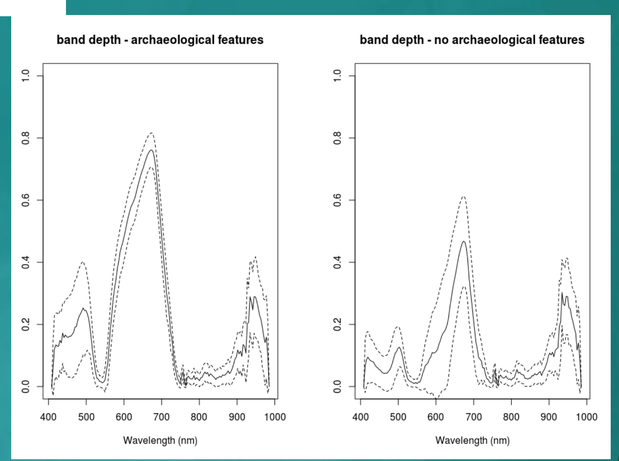
Data Manipulation

- **extraction of Spectra (subsets); calculation of derivatives**



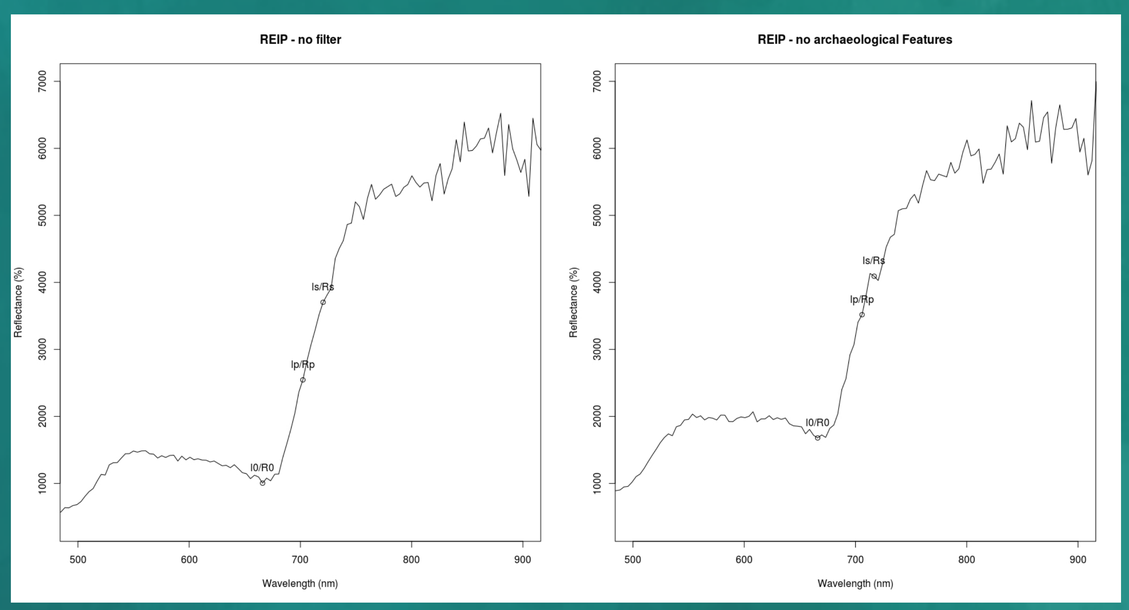
- **noise reduction** by using different filter methods

- calculation of **band-depth,** and the **spectral depth** what for e.g. underlines the increased reflection at the Red-Edge region



Data Analysis

- calulation of vegetation and soil indices **(vegindex, soilindex)**
- calculation of **derivatives** (for eg. to characterize the shape of the Red-Edge)
- extraction of the RedEdge parameter **(rededge)** and the RedEdge InflectionPoint **(REIP)**



I0/R0 – wavelength of the minimum reflectance in the red spectrum
Ip/Rp – wavelength at the inflection point
Is/Rs – wavelength at the reflectance shoulder

The hsdar R-Package is an open-source and open-access R-library, published on CRAN and well-suited for hyperspectral data analysis for archaeological remote sensing purposes.

Acknowledgements: We thank the core project 3 of the Biodiversity Exploratories for providing the hyperspectral data, the Landesamt für Denkmalpflege, Baden-Württemberg for the archaeological data. The R-Package was developed by Environmental Informatics & the Laboratory for Climatology and Remote Sensing of the Philipps-University Marburg. For the R-Package see https://github.com/cran/hsdar .

Bibliography Atzberger, C., – Wess, M., – Doneus, M., – Verhoeven, G., ARCTIS — A MATLAB® Toolbox for Archaeological Imaging Spectroscopy. *Remote Sensing* 6/9, 2014, 8617–8638. https://doi.org/10.3390/rs6098617; Cerra, D., – Agapiou, A., – Cavalli, R – Sarris, A., An Objective Assessment of Hyperspectral Indicators for the Detection of Buried Archaeological Relics. *Remote Sensing* 10/4, 2018, 500. https://doi.org/10.3390/rs10040500; Christlein, R., – Braasch, O. Das unterirdische Bayern. 7000 Jahre Geschichte und Archäologie im Luftbild. Stuttgart, 1982; Deppe, U., Klimadaten für Münsingen-Rietheim – 2015 (2015). <http://www.wetterstation-rietheim-lichse.de/html/download/Klimajahr2015.pdf> [last accessed: 21.05. 2108]; Dombert, A., – Schaich, M., Prospektion unterirdischer archäologischer Fundstätten mittels Fernerkundung. In: Buhmann, E., – Ervin, S. M., – Pietsch, m., (Eds.) Peer Reviewed Proceedings of Digital Landscape Architecture 2015 at Anhalt University of applied Sciences. Offenbach, 2015, 385-398; Doneus, M., – Verhoeven, G., – Atzberger, C., – Wess, M., – Ruš, M., New ways to extract archaeological information from hyperspectral pixels. *Journal of Archaeological Science* 52, 2014, 84–96. https://doi.org/10.1016/j.jas.2014.08.023; Lehnert, L., – Meyer, H., Introduction to "hsdar". https://cran.r-project.org/web/packages/hsdar/vignettes/Hsdar-intro.pdf [last accessed: 27.08. 2108]; Lehnert, L., – Meyer, H., – Bendix, J., Package 'hsdar' . ftp://cran.r-project.org/pub/R/web/packages/hsdar/hsdar.pdf [last accessed: 28.08. 2108]; Schwarz, R., – Meller, H., Pilotstudien. Zwölf Jahre Luftbildarchäologie in Sachsen-Anhalt. Halle, Saale, 2003; Scollar, I., Archäologie aus der Luft. In: *Schriften des Rheinischen Landesmuseums Bonn* 1. Düsseldorf , 1965.; Traviglia, A., Archaeological usability of Hyperspectral images: successes and failures of image processing techniques. In: *From space to place: 2nd International Conference on Remote Sensing in Archaeology : proceedings of the 2nd international workshop, CNR, Rome, Italy, December 4-7, 2006.* BAR IS 1568, 123-130; Traviglia, A., The combinatorial explosion: defining procedures to reduce data redundancy and to validate the results of prosessed hyperspectral images. In: *Proceeding of the Ist international EARSeL workshop. Advances in remote sensing for archaeology and cultural herigate managememnt, CNR, Rome, 30 Sept – 4 Oct. 2008, Aracne, Rome,* 23-26; Verhoeven, G. – Doneus, M., Balancing on the Borderline - a Low-cost Approach to Visualize the Red-edge Shift for the Benefit of Aerial Archaeology. *Archaeological Prospection* 18/4, 267–278. https://doi.org/10.1002/arp.420; Verhoeven, G., Rethinking the Spectrum – The Digital (R)Evolution in Archaeological Aerial Reconnaissance. In: P. Johnson, M. Millett (Eds.), *Archaeological survey and the city. University of Cambridge Museum of Classical Archaeology Monographs 2.* Cambridge, 45–67.; Verhoeven, G., – Sevara, Chr., Trying to break new Ground in Aerial Archaeology. *Remote Sensing* 8/11(2016). https://doi.org/10.3390/rs8110918; Verhoeven, G., The reflection of two fields – Electromagnetic radiation and its role in (aerial) imaging. *AARGnews 55* (October 2017) 13-18.