Using Field Spectroscopy in the VNIR-SWIR Spectral Region for Predicting the Hydrophobicity Level of Undisturbed Soils

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Hyperspectral Remote Sensing of Soils

- Reflectance spectroscopy in the VNIR-SWIR (350-2,500nm) region enables to <u>characterize soil properties</u>
- Main chemical chromophores¹:
 - Iron Oxides
 - Organic Matter (OM)
 - Hygroscopic water content
 - Clay minerals
 - Carbonates

(1) Thenkabail, A., Lyon, P. S., Huete, J. G., & **Ben-Dor, E.** (2011). Characterization of soil properties using reflectance spectroscopy. In Hyperspectral Remote Sensing of Vegetation (pp. 513-558). CRC Press.





Soil Hydrophobicity

- Soil hydrophobicity (water repellency) reduces the <u>affinity</u> of soils to water such that they <u>resist wetting</u> for periods ranging from a few seconds to hours.
- Factors controlling the occurrence of soil water repellence:
 - Chemical characteristics
 - Soil texture
 - Soil moisture
 - Microbial activity
 - Soil temperature







Objectives

- Developing a device for <u>field reflectance measurements</u> to be used under varying <u>environmental conditions</u> without disturbing the surface
 - ✓ Development
 - \checkmark Testing and performance evaluation
 - \checkmark Setting a working protocol
- Using reflectance spectra in the VNIR-SWIR region for <u>predicting soils'</u> <u>hydrophobicity values</u>
 - ✓ developing a robust spectral-hydrophobicity prediction model



Device Development

Contact Probe Measurements

Without dependence on environmental conditions

Measuring small surface area by contact







Bare Fiber Measurements

Depending on environmental conditions and influenced by the operator

Measuring large surface area without interrupting the texture







The SOIL Field PRObe Assembly – SoilPro

- The **SoilPro** is lightweight assembly and easy to operate, suitable to be connected to optic fiber of any field spectrometer.
- The **SoilPro** combines the advantages of the two common methods: acquiring a representative reflectance of large surface area, while keeping all factors constant.







Reference spectrum	SAM Test	ASDS Test	
A - Contact probe	0.012	0.021	$ ext{RMSD} = \sqrt{rac{\sum_{t=1}^n (\hat{y}_t - y_t)^2}{n}}.$
B - Contact probe	0.010	0.012	

The SoilPro products were evaluated in the laboratory and outdoor under different conditions, compared to the bare fiber and contact probe (ASDi[®]).







Soil Hydrophobicity Measurements





undisturbed sample



Field Campaign

- Research area: orchard plot in the central district in Israel which is highly effected by soil hydrophobicity (Haploxeralf USDA).
- Materials and methods:
 - Soil reflectance was acquired by the SoilPro connecting to ASDi[®] Fieldspec spectrometer
 - WDPT Hydrophobicity values for each point
 - Overall 100 samples, data process used 68 samples



Reflectance measurements



WDPT measurements



Data Process and Results

• PARACUDA II [®] system: TAU-RSL's development, combines several types of pre-processed spectra and generates spectral models (Carmon & Ben Dor 2016, in press)



CONCLUSIONS

- The SoilPro enables to acquire full and stable surface reflectance of any kind, under varying environmental condition, eliminating the dependence on the operator, atmosphere attenuation, and surface disturbances
- Using PARACUDA system enables to generate a predicting spectral model for WDPT.
- Further studies are required in order to generate spectral-hydrophobicity indices from airborne image spectrometer .

