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EXCELSIOR

ERATOSTHENES:
Excellence Research Centre for Earth Surveillance & Space-Based Monitoring of the Environment

1st virtual EXCELSIOR International Technical Workshop
15 July 2020

"The SoilPRO® as a new assembly to measure soil spectral information in the field over the Mediterranean region"

@excelsior2020eu

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Tel Aviv University (TAU)

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CONSORTIUM

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Common methods for field reflectance measurements

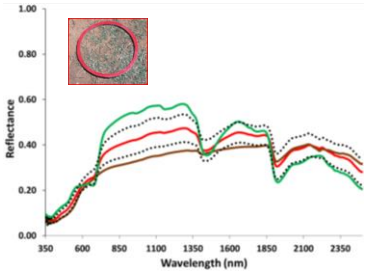
Contact Probe Measurements

Without dependence on environmental conditions

Measuring small surface area by contact

Surface Deformation

Contact probe field spectra

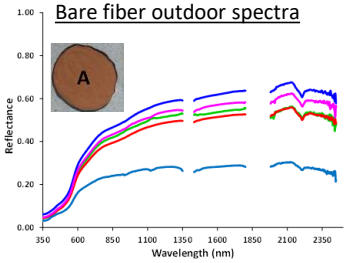


Bare Fiber Measurements

Depending on environmental conditions and influenced by the operator

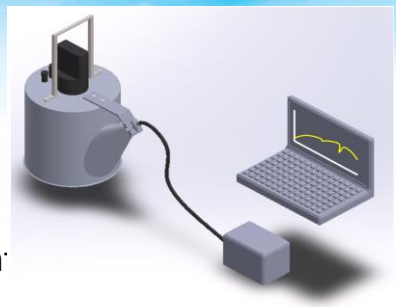
Measuring large surface area without interrupting the texture

Bare fiber outdoor spectra



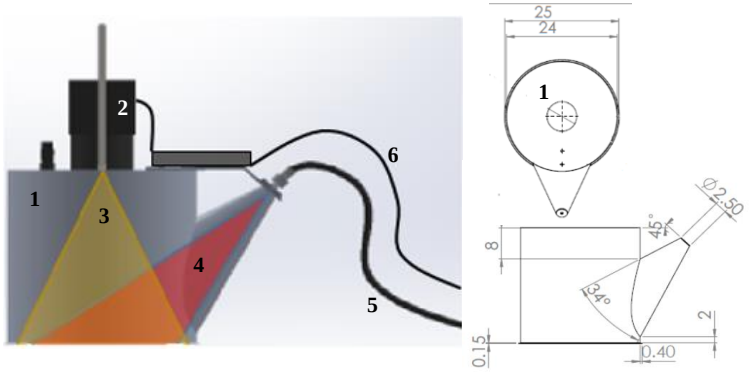
The SOIL field PRObe assembly – SoilPRO

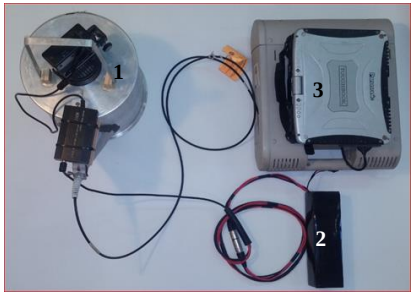
Soil field Probe (SoilPRO®)



- 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 constan

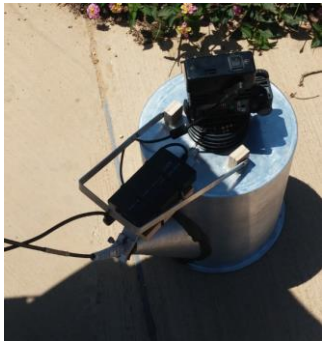
The **SoilPro** - design and operation





1) SoilPro, 2) portable battery,
3) ASD® fieldSpec

The **SoilPro** in the field



The SoilPRO assembly is under patent pending process, Patent application no. Patent Application: No. 62/278,471, Filed: 14/01/2016.

THE REMOTE SENSING LABORATORIES

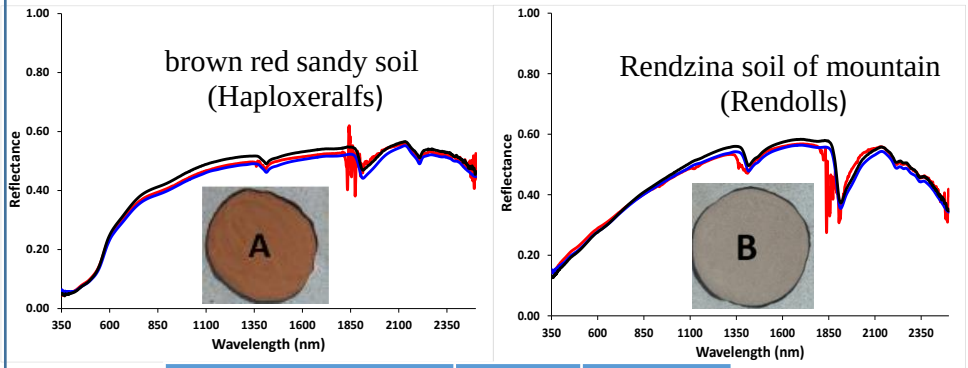
Fig. 3. Measurement procedure. (1) Bare fiber in the laboratory in dark box configuration, the lamp points downward toward the targets at nadir while the fiber tip points at 45° from the calculated distance according to the fiber FOV, to view most of the target. (2) Contact probe in the laboratory. (3) Bare fiber outdoors. (4) SoilPRO outdoors.

Testing the SoilPro

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

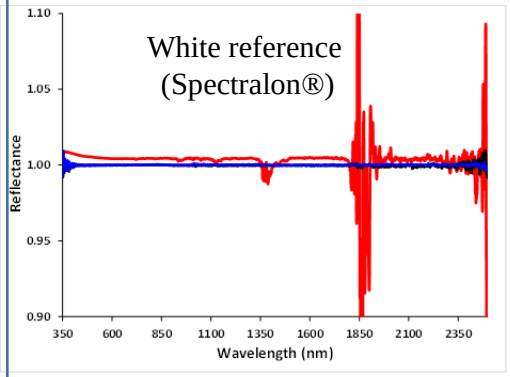


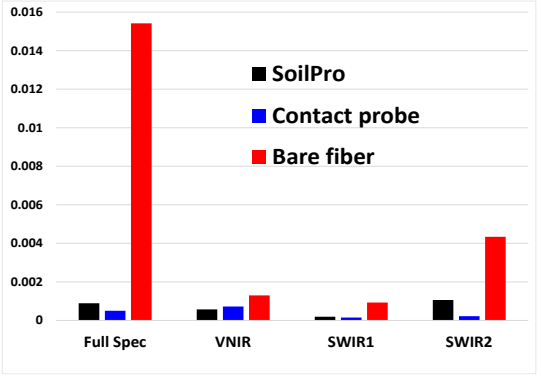
Spectra similarity



Reference spectrum	SAM Test	ASDS Test
A - Contact probe	0.012	0.021
B - Contact probe	0.010	0.012

Noise ratio





$$\mathrm{RMSD} = \sqrt{\frac{\sum_{t=1}^{n} (\hat{y}_t - y_t)^2}{n}}.$$

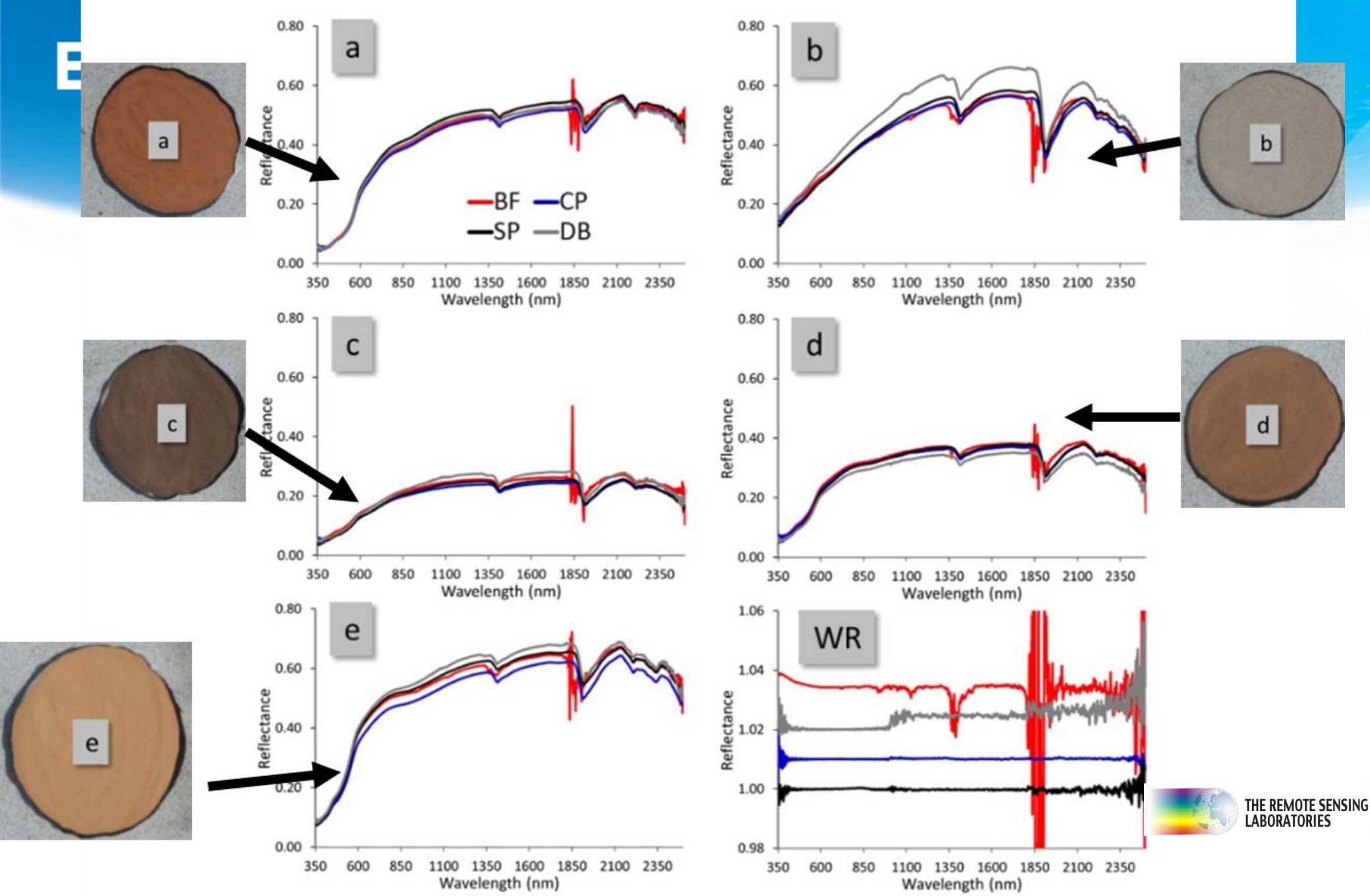


Fig. 4. Full FieldSpec spectra (350–2500 nm) of test soil samples (a–e) and white reference (WR; Spectralon). Comparison of the four methods' products obtained under optimal measuring conditions. BF, bare fiber; CP, contact probe; SP, SoilPRO; DB, dark box. The WR spectra are presented stacked with 0.02 increment offset for better definition between spectra.

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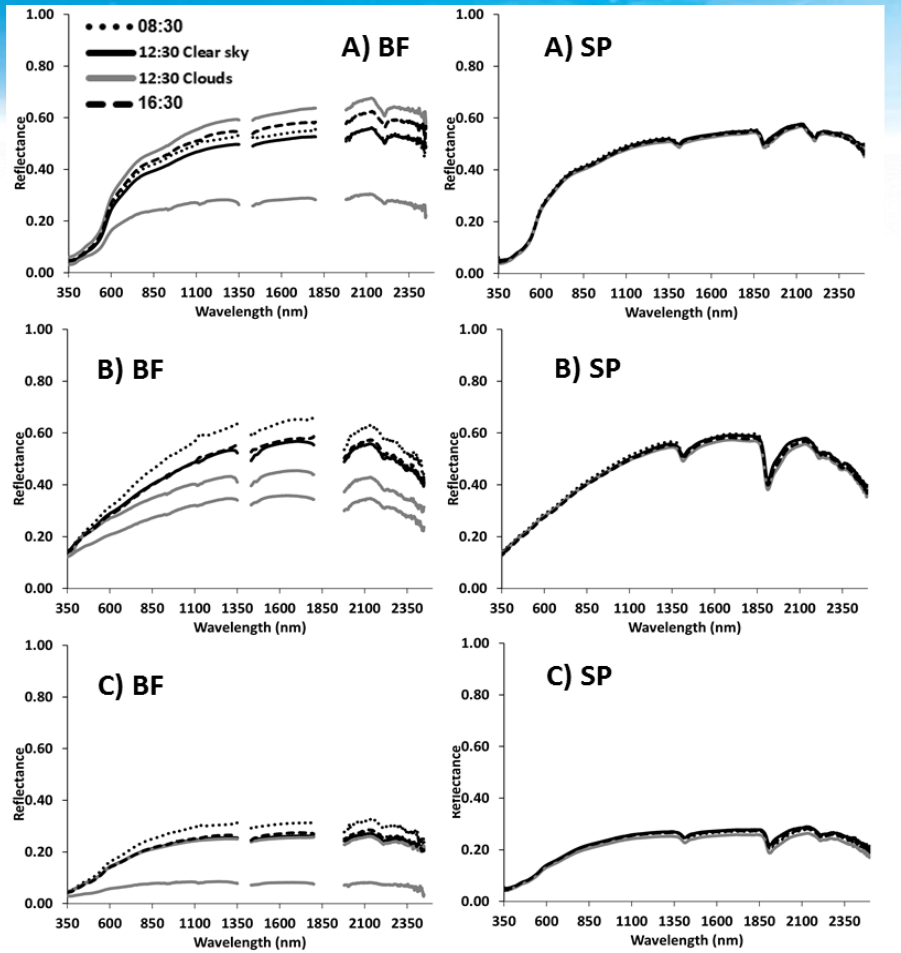
SoilPRO versus BareFiber at different times, same day

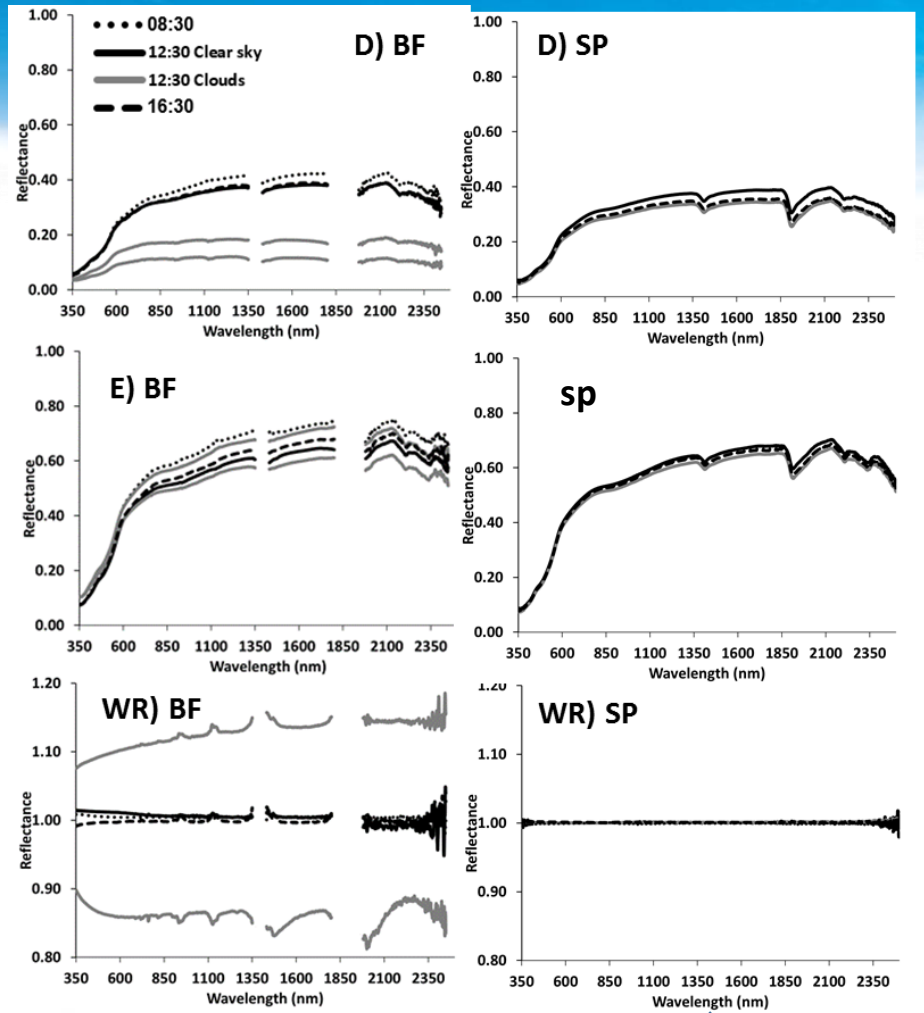


Soil c

Soil D

Soil F

FILED



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File (noisy) Quality

Laboratory Quality

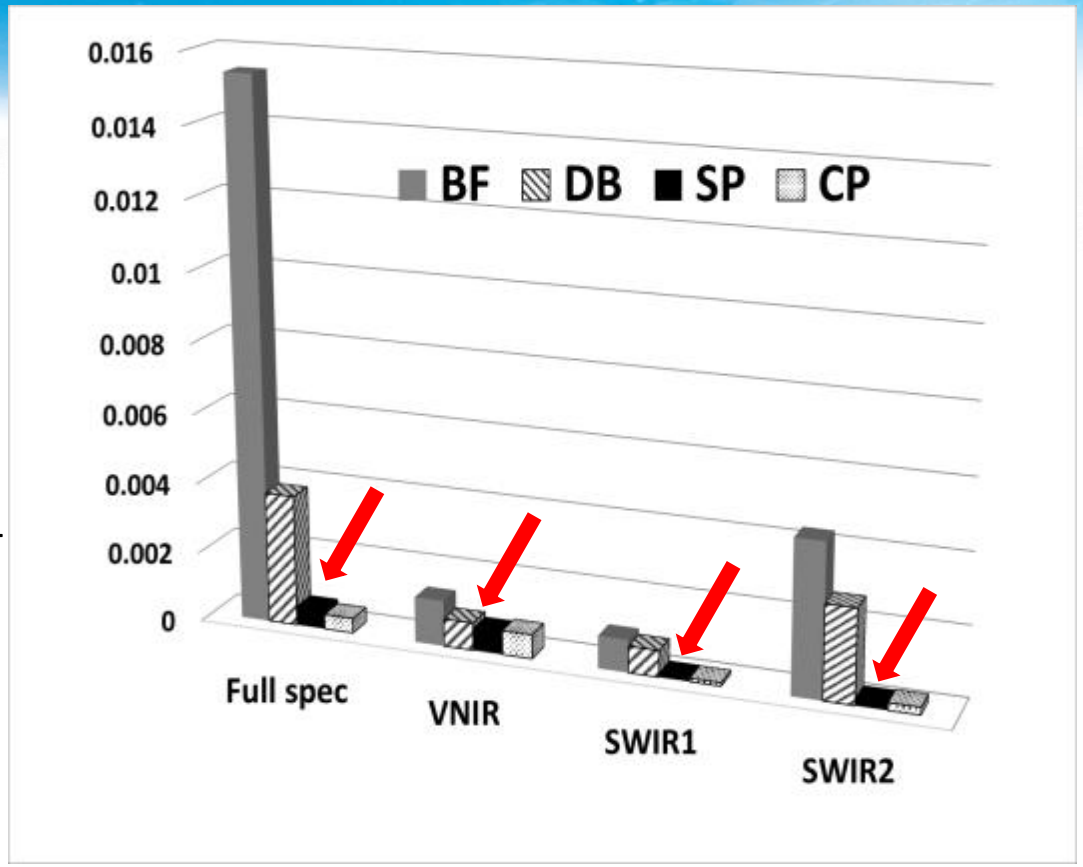
ASDS = Average Sum of Deviation Square
(Ben-Dor et al., 2004)

$$ASDS = \frac{\sum_{\lambda=350}^{2500} \sigma\left(1 - \rho_\lambda / \rho^*_\lambda\right)^2}{2151}$$

ρ : sample reflectance
ρ * : reference reflectance

ASDS → 0 = good match

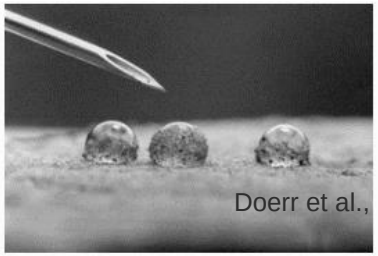
Spectral Variation across the Spectrum for the different methods for a given soil



Soil hydrophobicity

- Soil hydrophobicity (water repellency) reduces the affinity of soils to water such that they resist wetting for periods ranging from a few seconds to hours.

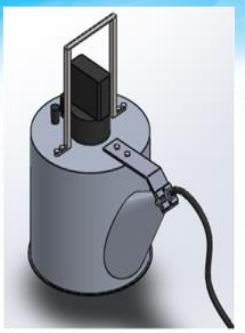
- Factors controlling the occurrence of soil Water repellency:
  - Chemical characteristics
  - Soil texture
  - Soil moisture
  - Microbial activity
  - Soil temperature
  - Soil organic Matter



Doerr et al., (1998)

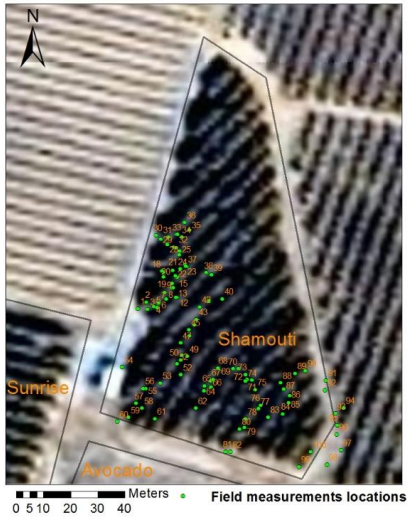
Doerr et al., (1998) Soil water repellency: its causes, characteristics and hydro-geomorphological significance, Earth Science Reviews: 51, 1-4

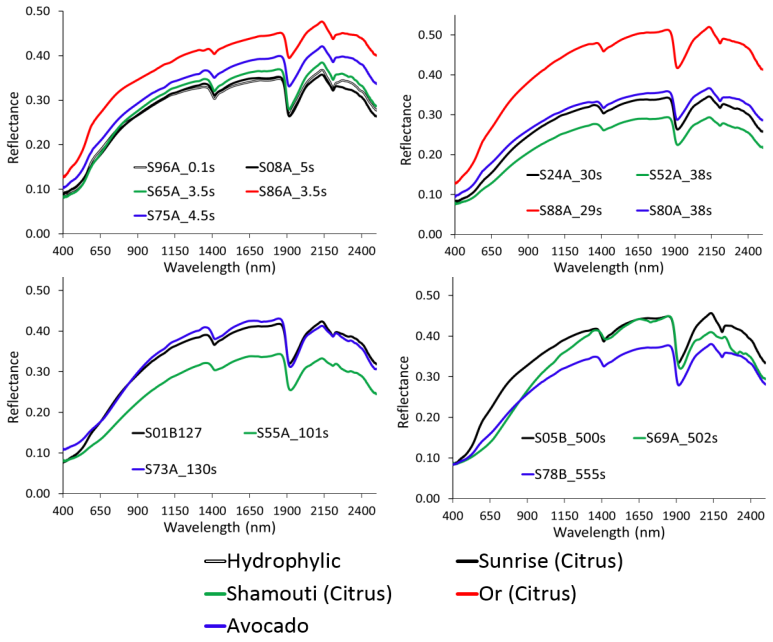
Field campaign



- The campaign was carried out in one plot
- Reflectance spectra obtain by utilizing the SoilPRO assembly
- Each location was marked and registered.
- During the campaign three testers were performing WDPT tests in the exact locations

100 SAMPLES 4 HOURS ONE USER





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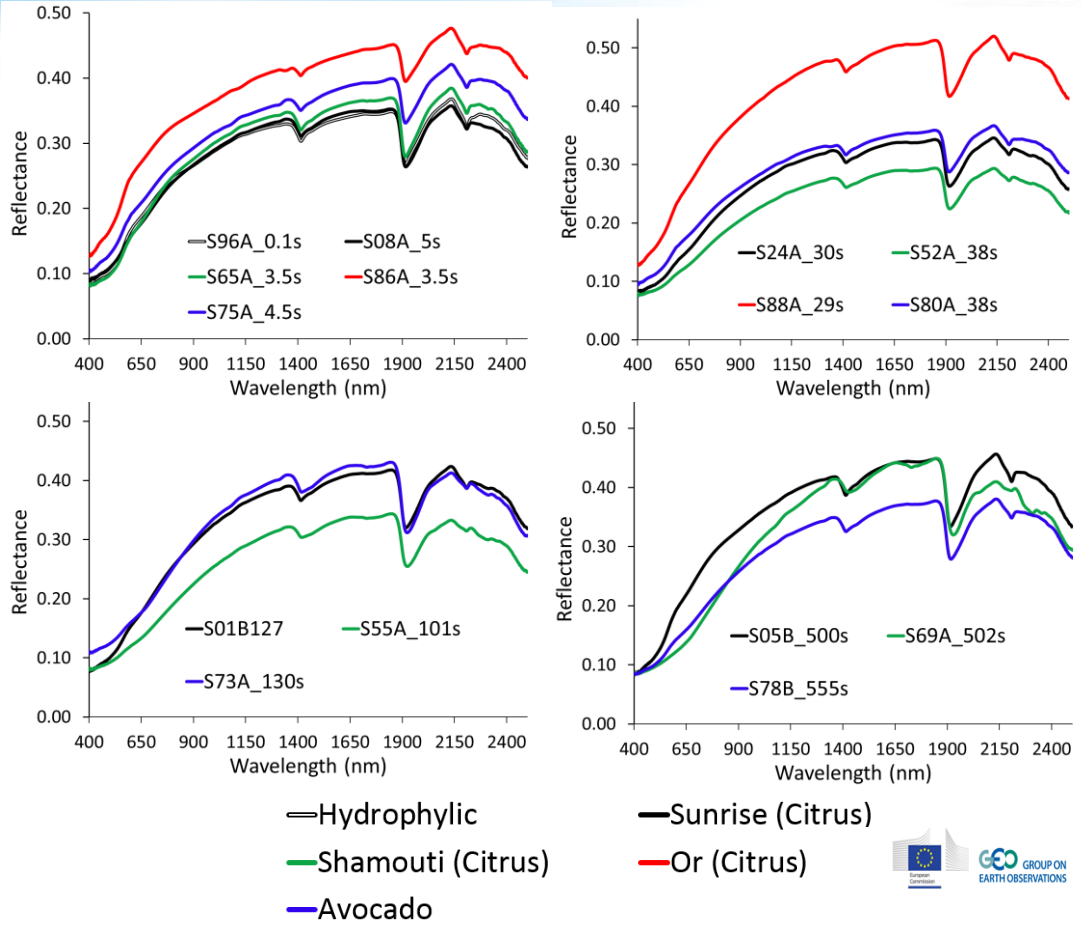
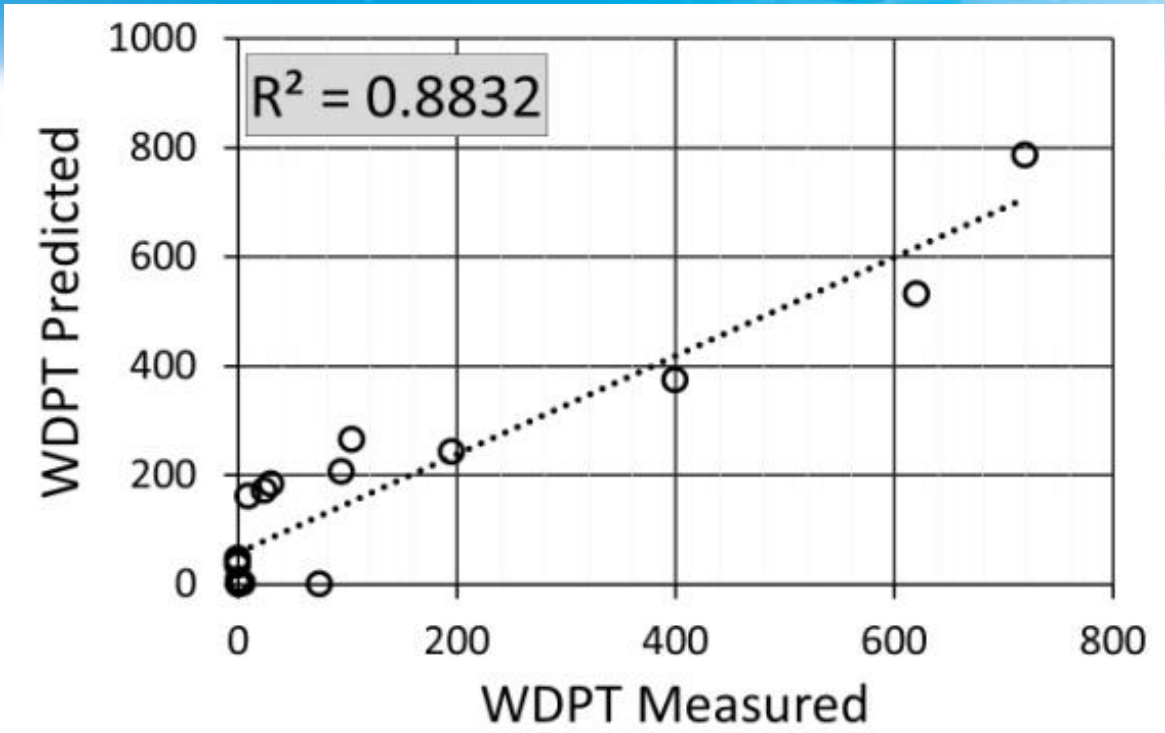
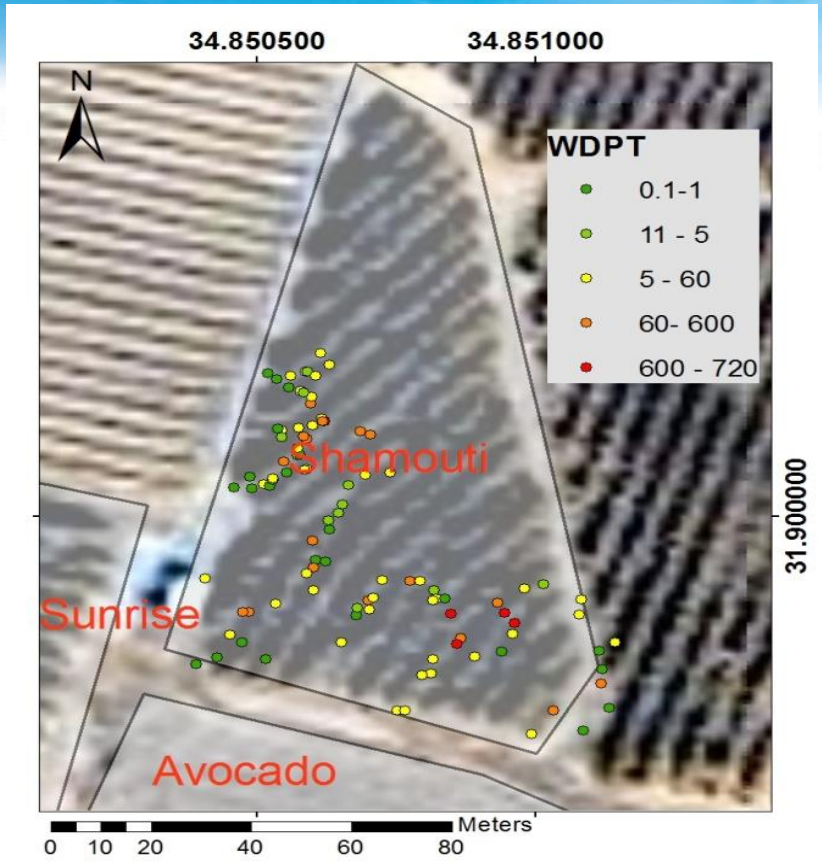
Spectra of varying hydrophobicity levels by different plots




R² = 0.8832
WDPT Predicted
WDPT Measured
0
200
400
600
800
1000

Hydrophobicity quantity map of soil uner shaded orchards trees



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journal homepage: www.elsevier.com/locate/geoderma

A simple apparatus to measure soil spectral information in the field under stable conditions☆

Eyal Ben-Dor, Amihai Granot*, Gila Notesco

Tel Aviv University, Israel

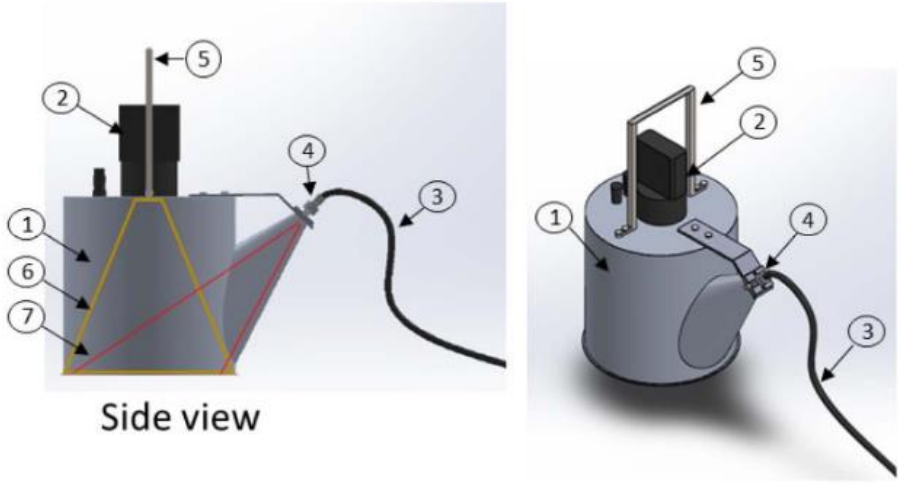


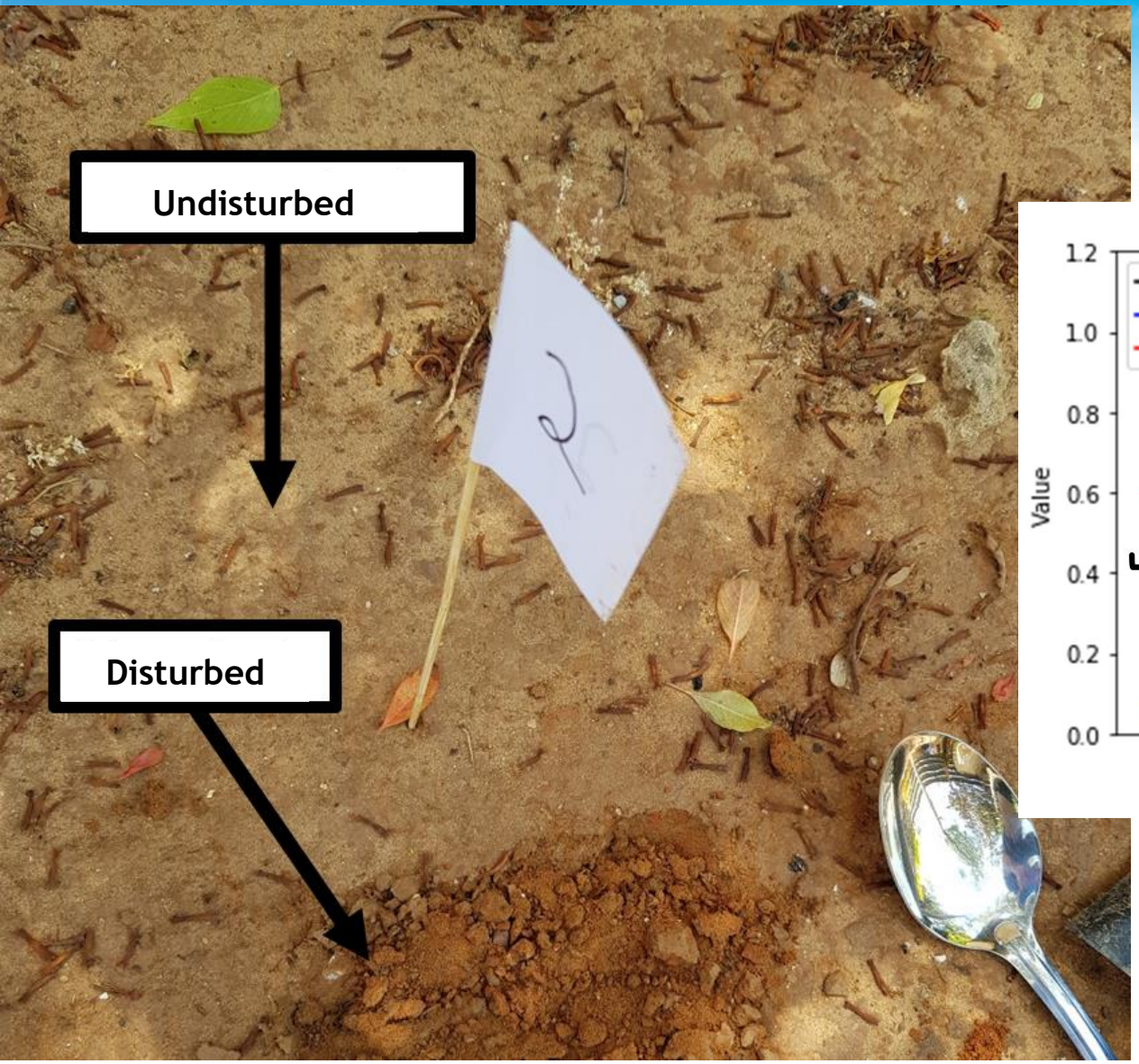
Fig. 1. Sketch of the SoilPRO device and operation principle. (1) Main body, (2) illumination source, (3) optic fiber, (4) fiber mount (5) handle, (6) illumination beam (7) fiber FOV.

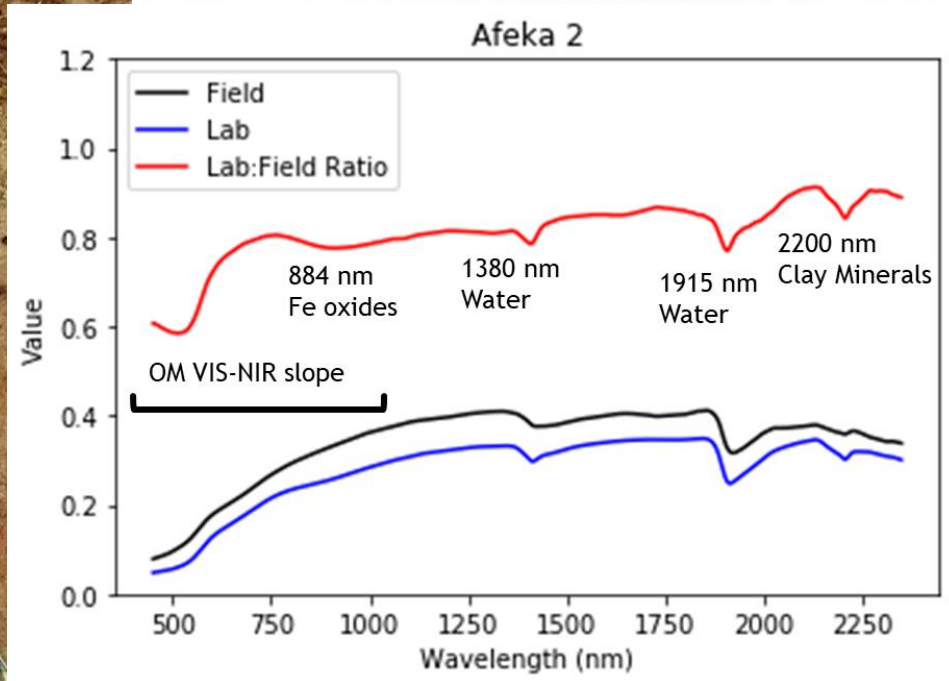
Why Use Water Infiltration Rate (WIR)

- ***WIR may be defined as "the meters (length units) per unit time of water entering into the soil regardless of the types or values of forces or gradients"*** **(Kirkham, 2014)**

- WIR is a very important hydrological parameter, which is strongly dependent on soil surface conditions.
- Thus, WIR is an excellent soil property to investigate the gap between lab and field spectral observations

Water Infiltration rate





The Gap between the Field and the Lab

- In different areas of the Mediterranean Basin we will measure WIR using a Mini Disk infiltrometer.
- Next, we measured the spectral signature in field and in the lab.
- The field spectra was measured using a ASD connected to SoilPro (Ben Dor et al., 2017) in order to get optimal spectral signatures in field.

Field Spectral Measurements using ASD connected to SoilPRO.

The Mini-disk Infiltrometer

Data Acquisition

- This dataset contain samples of 6 different fields alo the Mediterranean Basin:

i) Kibbutz Sde Yoav, Israel (30 Samples)

ii) Afeka, Tel Aviv, Israel (18 Samples)

iii) Alento, Italy (21 Samples)

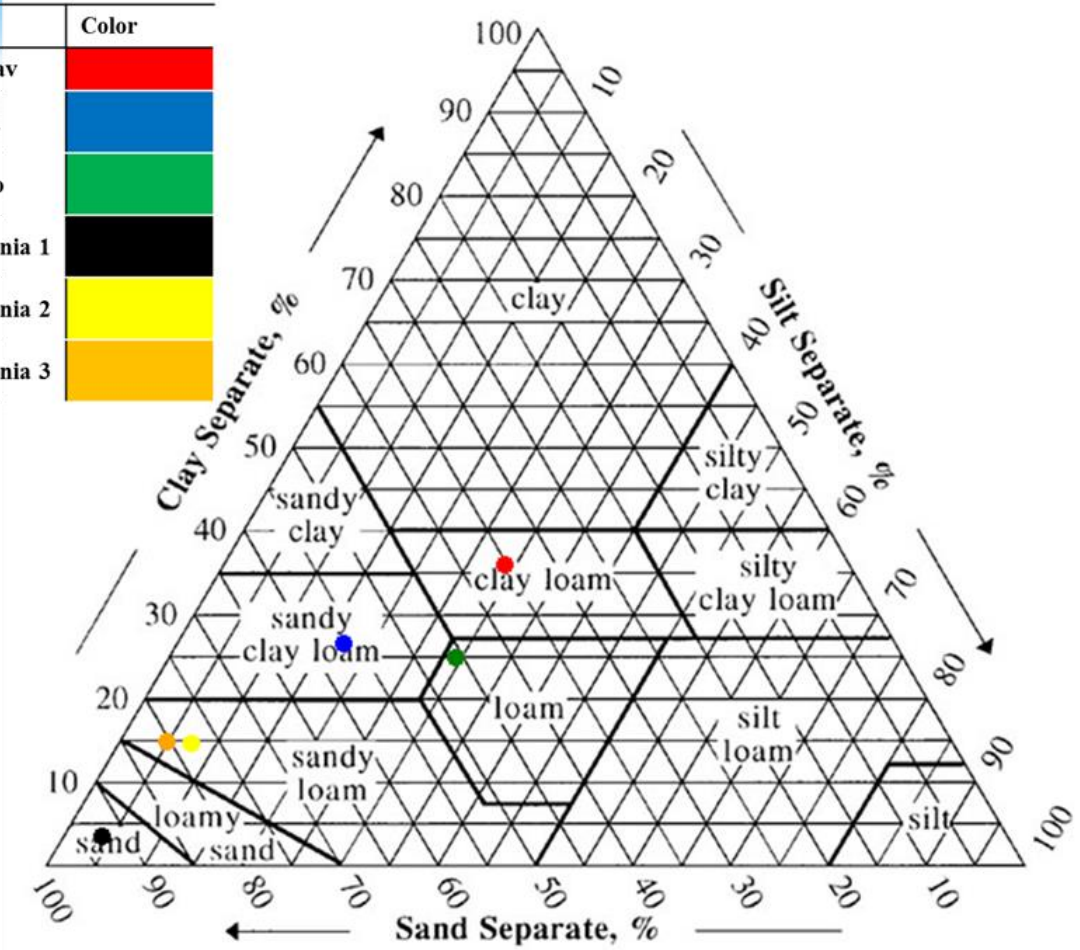
iv) Aminteo, Greece (45 Samples of 3 different fields)

Data Acquisition

The texture prediction is necessary to estimate WIR, and was performed using spectral-based-models using the:

- Israeli SSL (Ogen et al., 2019) for the samples of Sde Yoav and Afeka
- GEOCRADLE (Mediterranean) SSL (Tsakiridis et al., 2018) for the samples of Italy and Greece.

Field	Color
Sde Yoav	
Afeka	
Alento	
C. Macedonia 1	
C. Macedonia 2	
C. Macedonia 3	



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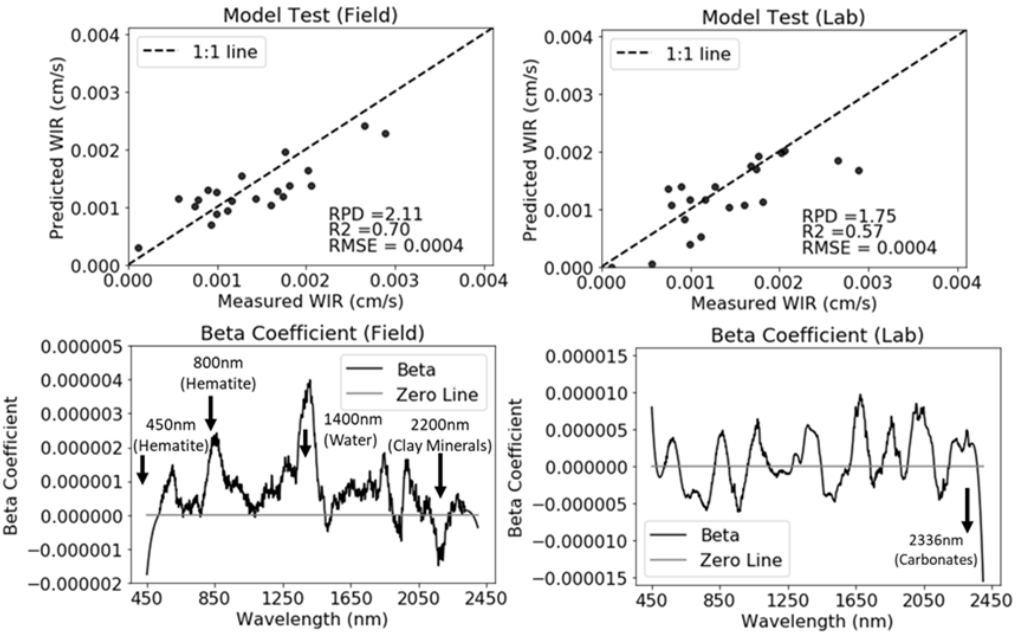
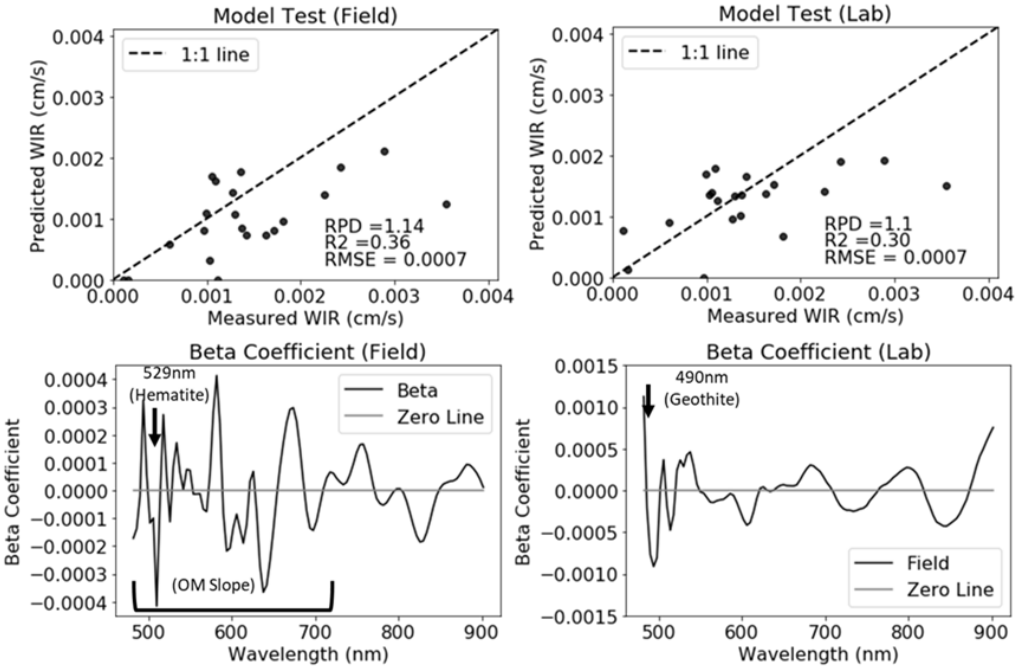
The Whole Dataset

ASD SPECTRAL RESOLUTION (VIS-NIR-SWIR)

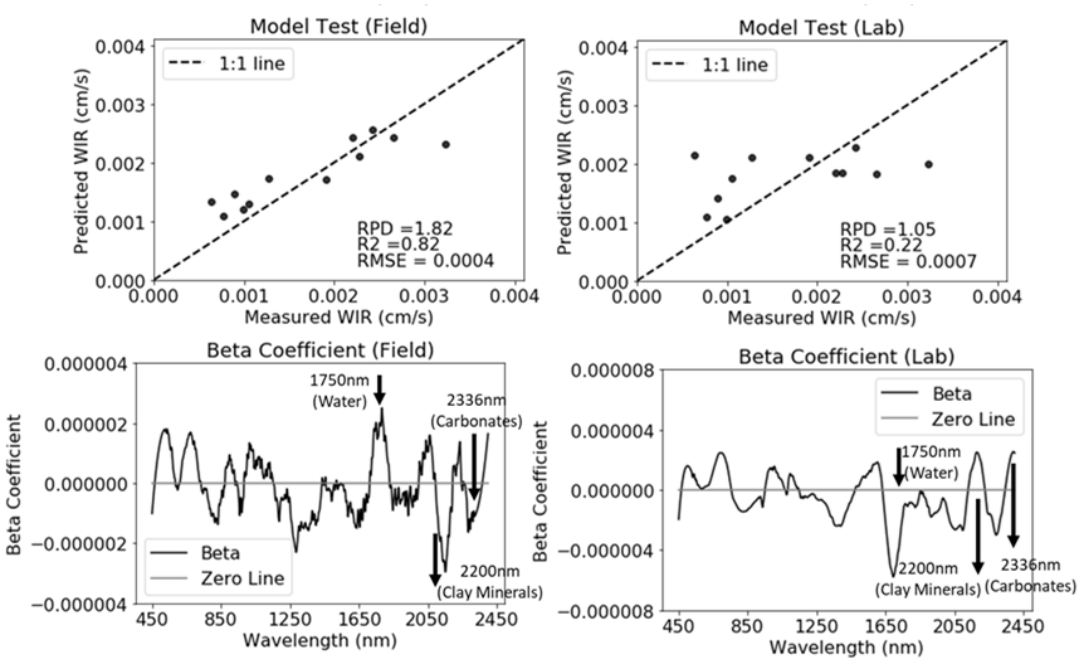


CUBERT UHD-185 SPECTRAL RESOLUTION (VIS-NIR)

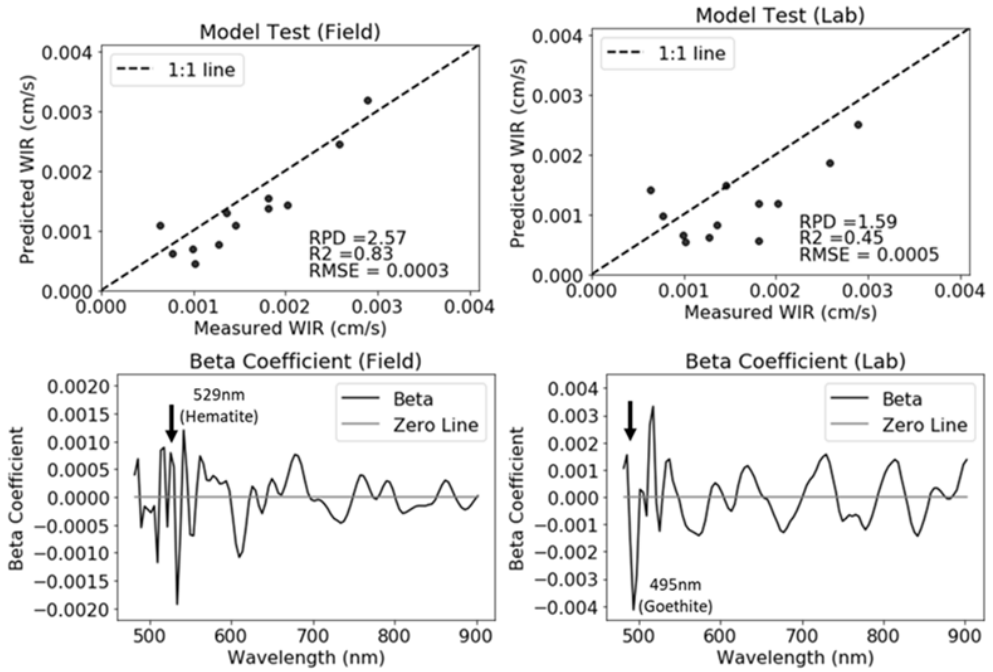


The Sandy Soils

ASD SPECTRAL RESOLUTION (VIS-NIR-SWIR)

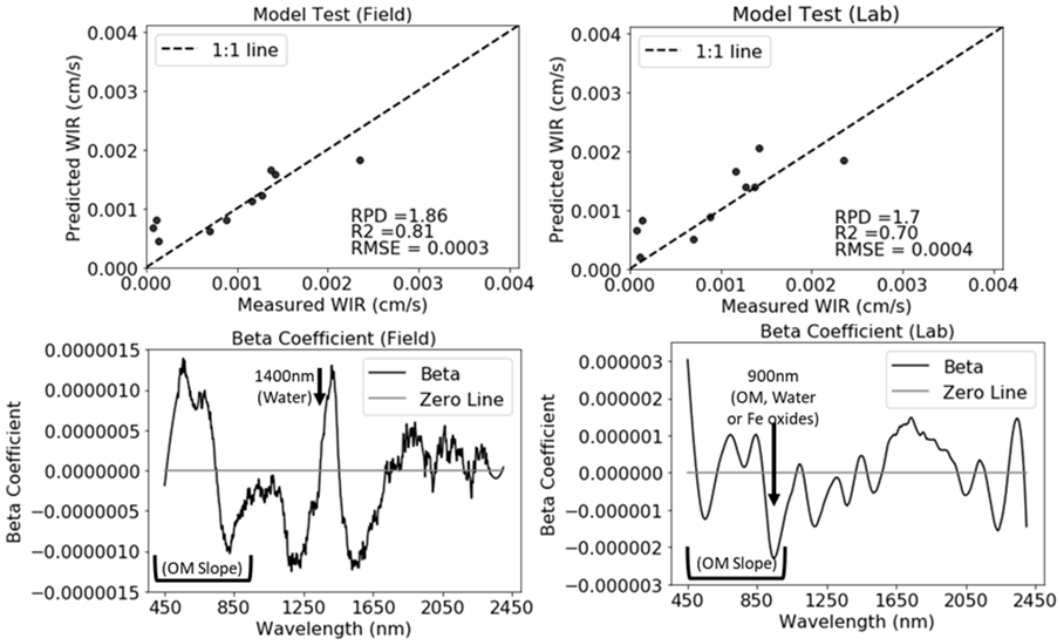


CUBERT UHD-185 SPECTRAL RESOLUTION (VIS-NIR)

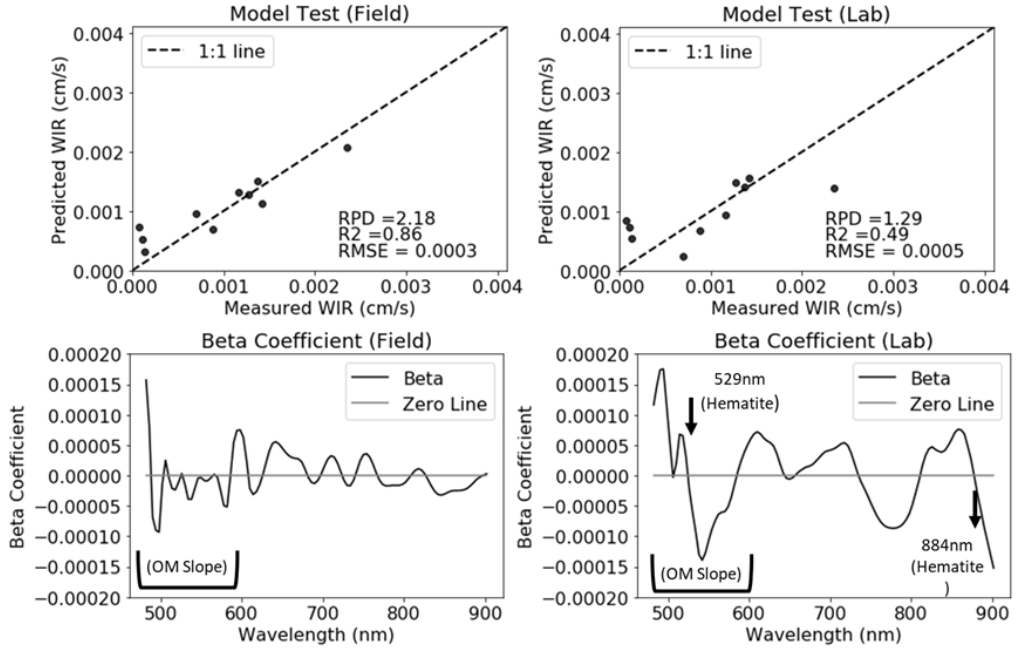


The Clayey Soils

ASD SPECTRAL RESOLUTION (VIS-NIR-SWIR)



CUBERT UHD-185 SPECTRAL RESOLUTION (VIS-NIR)



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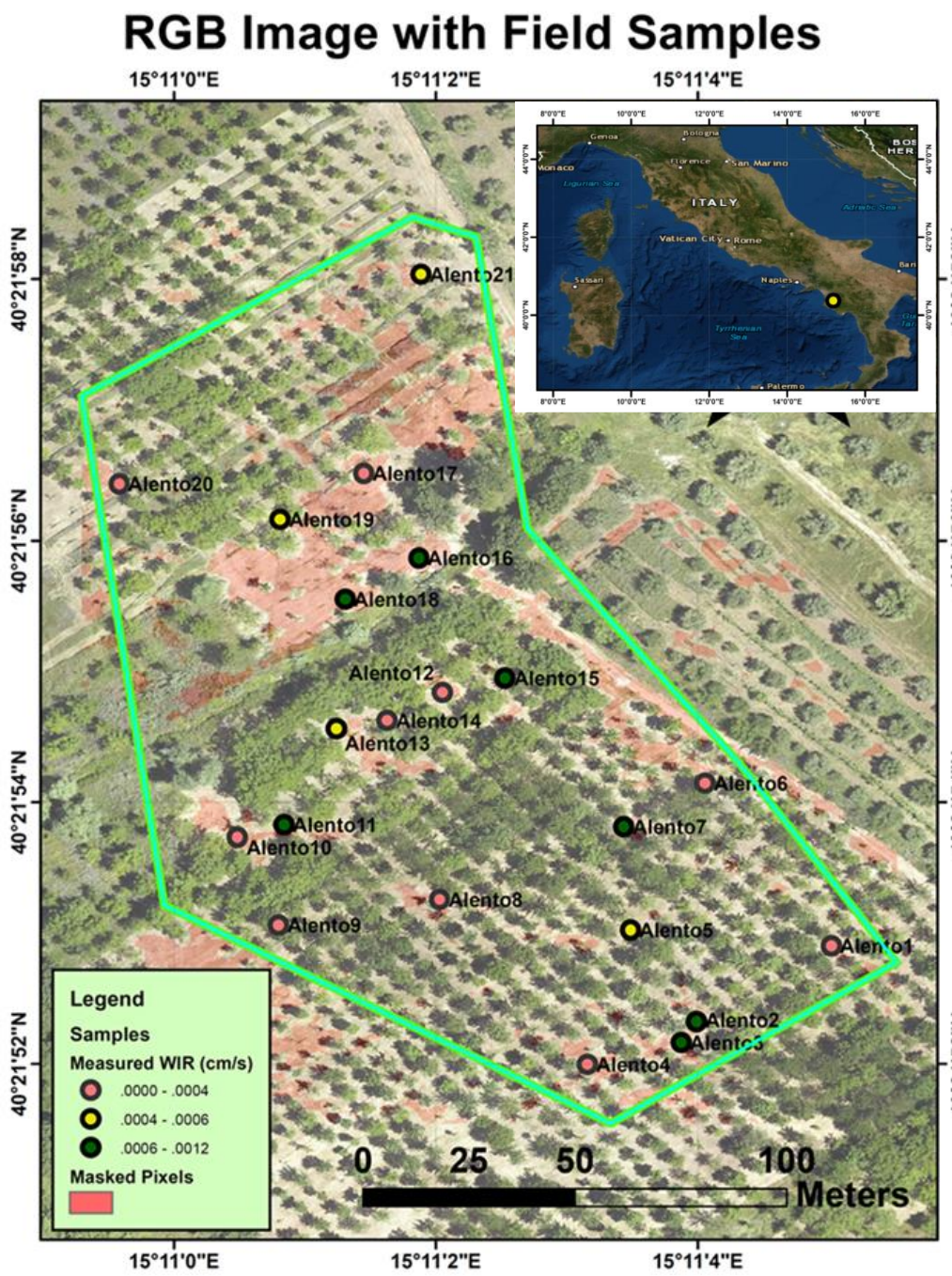
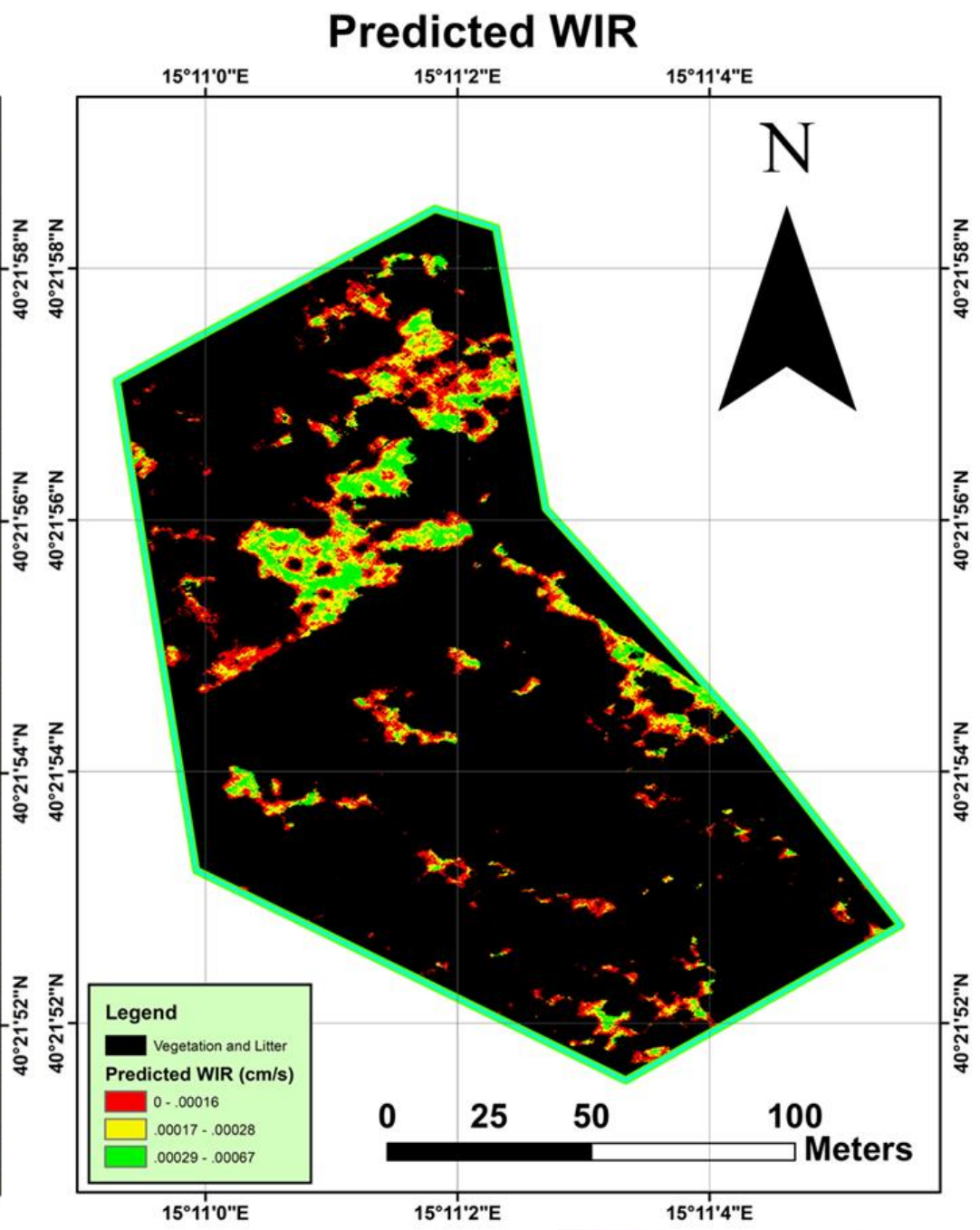
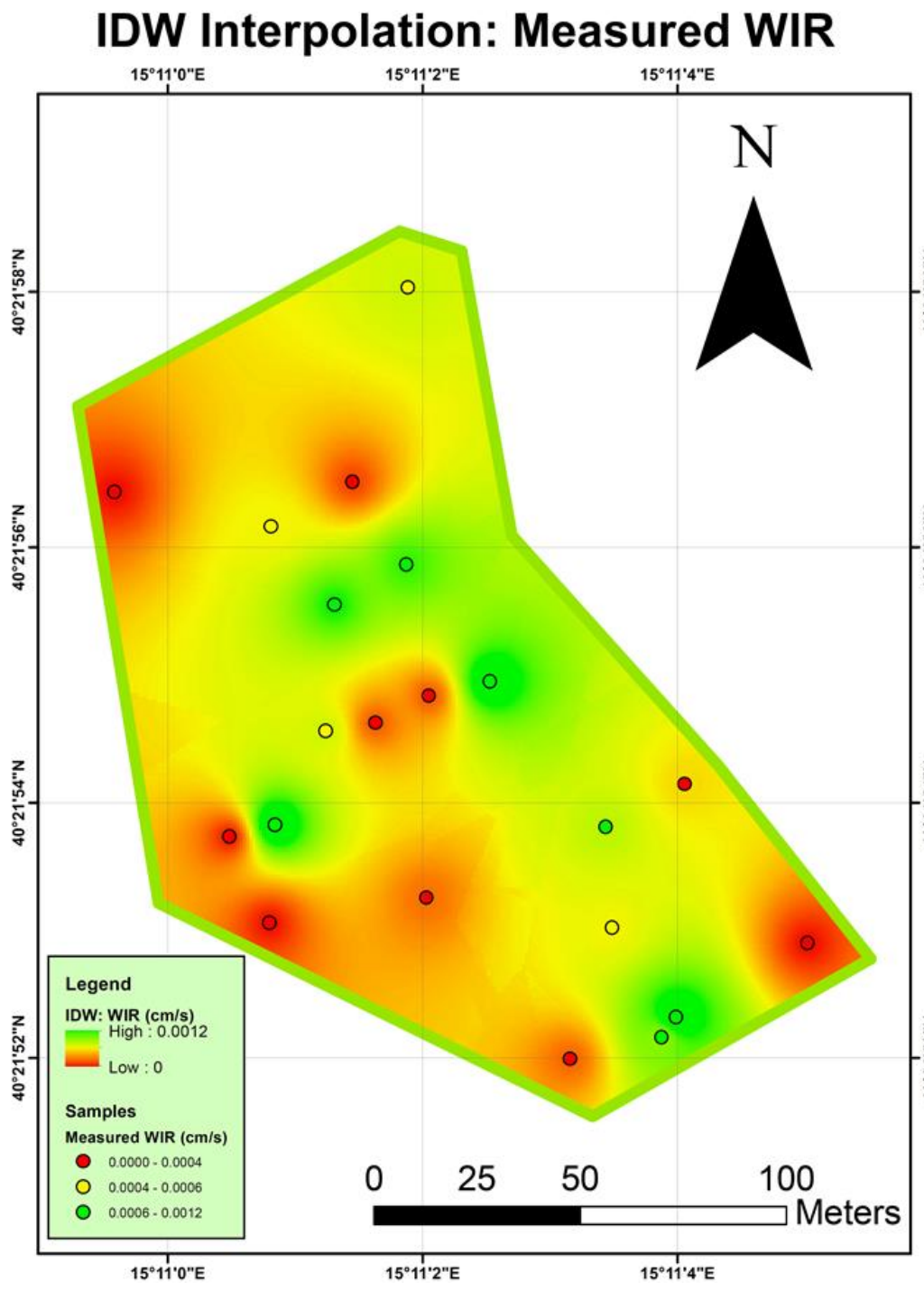
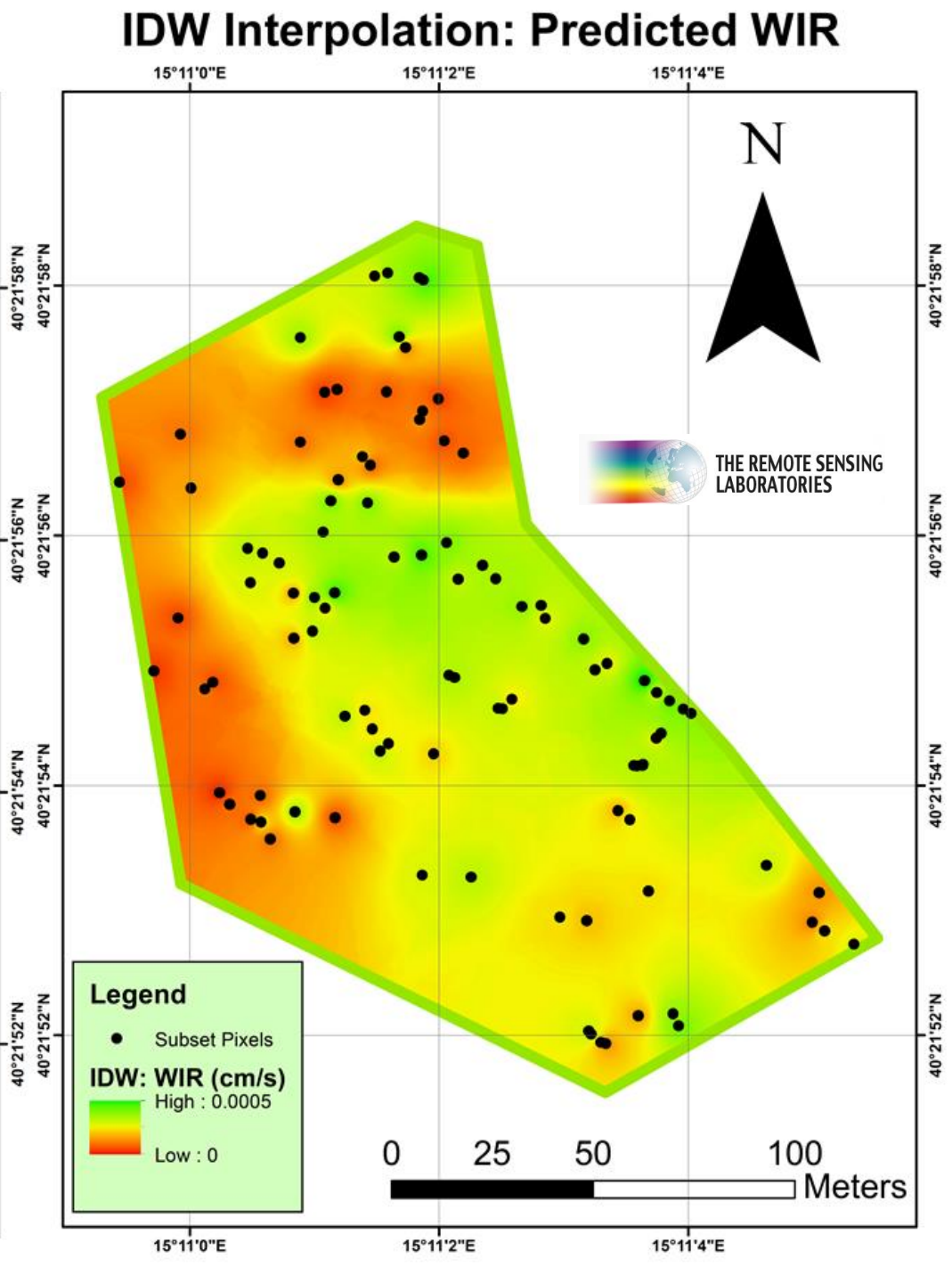


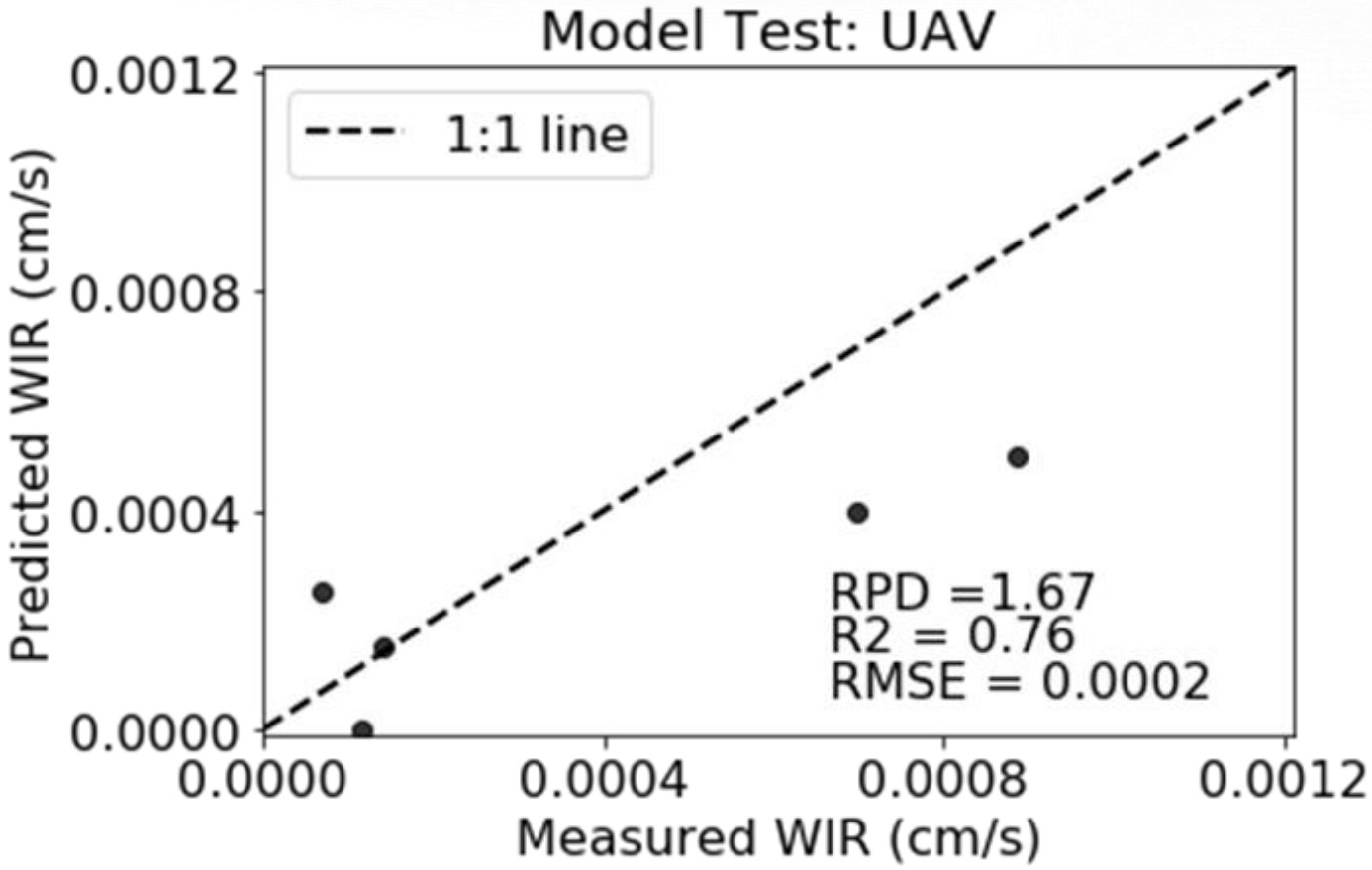


THE REMOTE SENSING LABORATORIES


IDW Interpolation: Measured WIR
15°11'0"E
15°11'2"E
15°11'4"E
40°21'58"N
40°21'56"N
40°21'54"N
40°21'52"N
N
Legend
IDW: WIR (cm/s)
High : 0.0012
Low : 0
Samples
Measured WIR (cm/s)
0.0000 - 0.0004
0.0004 - 0.0006
0.0006 - 0.0012
0
25
50
100
Meters


IDW Interpolation: Predicted WIR
15°11'0"E
15°11'2"E
15°11'4"E
40°21'58"N
40°21'56"N
40°21'54"N
40°21'52"N
N
THE REMOTE SENSING LABORATORIES
Legend
Subset Pixels
IDW: WIR (cm/s)
High : 0.0005
Low : 0
0
25
50
100
Meters

Validation


Model Test: UAV
1:1 line
RPD =1.67
R2 = 0.76
RMSE = 0.0002
Predicted WIR (cm/s)
Measured WIR (cm/s)
0.0000
0.0004
0.0008
0.0012

Conclusions

- The soil surface reflectance using the SOILPRO assembly showed a very good generic model to account for the soil surface area preserving a laboratory quality
- No dependency on the operator skills and on the natural conditions (illumination atmospheric attenuation ect.)
- A surface based models such as hydrophobicity and WIR has been proved to work better with the SoilPRO measurements
- The SoilPRO can be used also for ground truth measurements for satellite and drones data .
- The SoilPRO® is patented apparatuses and is commercially available!

THANK YOU FOR YOUR ATTENTION

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Coordination and support action
Grant agreement No. 857510
Proposal acronym: EXCELSIOR

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