HARMONIOUS

UAS Techniques for Environmental Monitoring

EYAL BEN DOR

EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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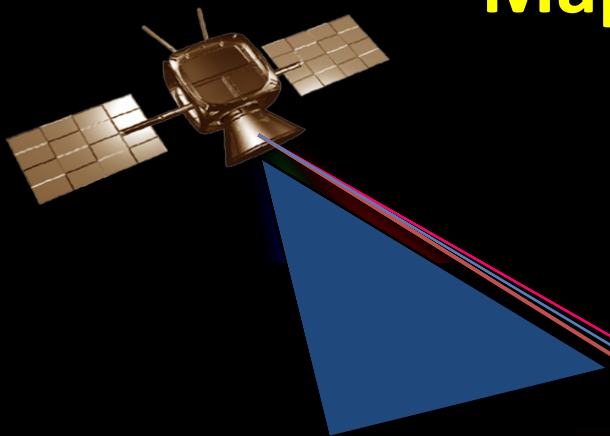
Soil Spectral Library for Quantitative Mapping of the Soil Surface



Eyal Ben-Dor

Department of Geography
School of Earth Sceince
Faculty of Exact Sceince
Tel Aviv University
ISRAEL

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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uas for environmental monitoring

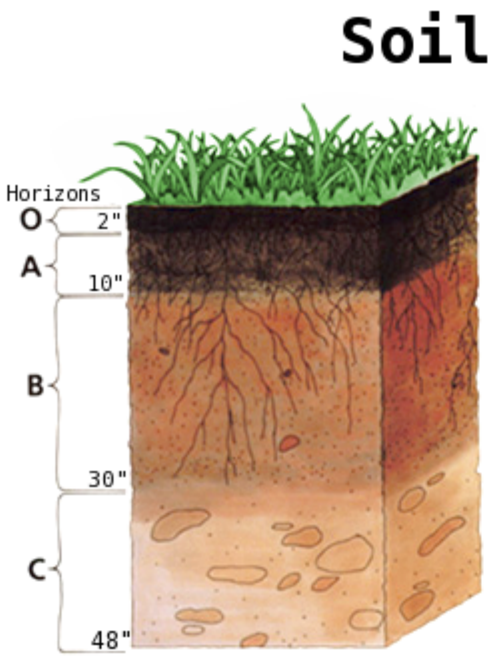
THE REMOTE SENSING LABORATORIES

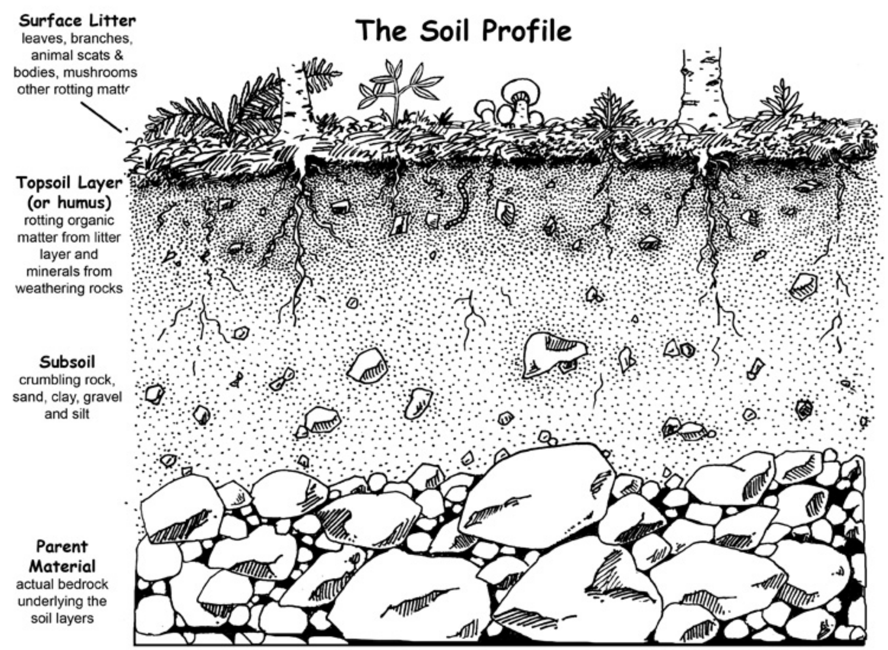
TEL AVIV UNIVERSITY אוניברסיטת תל אביב

Definition 1

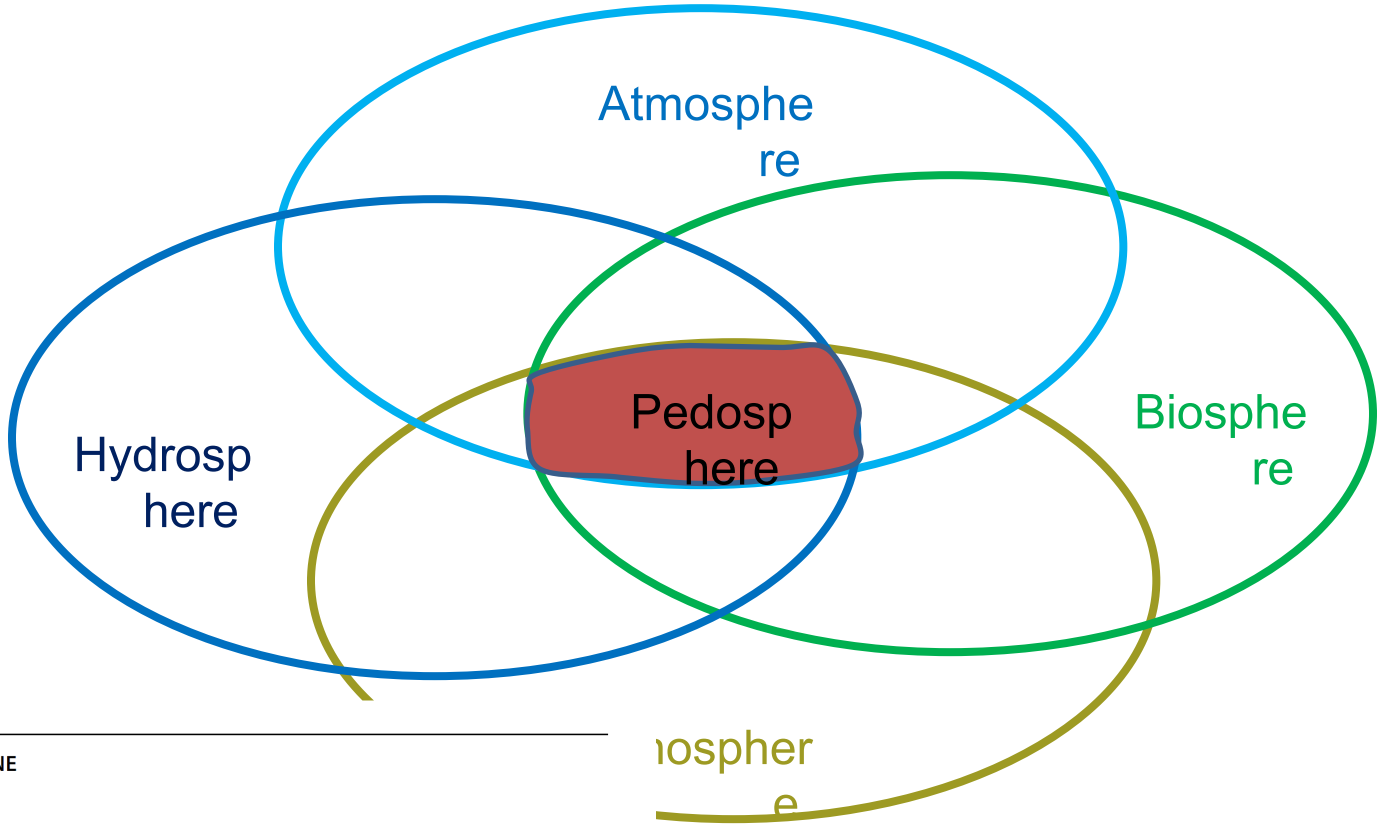
Soil

***The upper layer of the earth (≈0-2m) represent its loose surface material which is dug, plowed and being a medium for plants to grow*. (Thompson 1957)**





THE REMOTE SENSING LABORATORIES



CHAPTER ONE

Soil: The Forgotten Piece of the Water, Food, Energy Nexus

Jerry L. Hatfield*,[1], Thomas J. Sauer*, Richard M. Cruse[†]
*USDA-ARS, National Laboratory for Agriculture and the Environment, Ames, IA, United States
[†]Iowa State University, Ames, IA, United States
[1]Corresponding author: e-mail address: jerry.hatfield@ars.usda.gov

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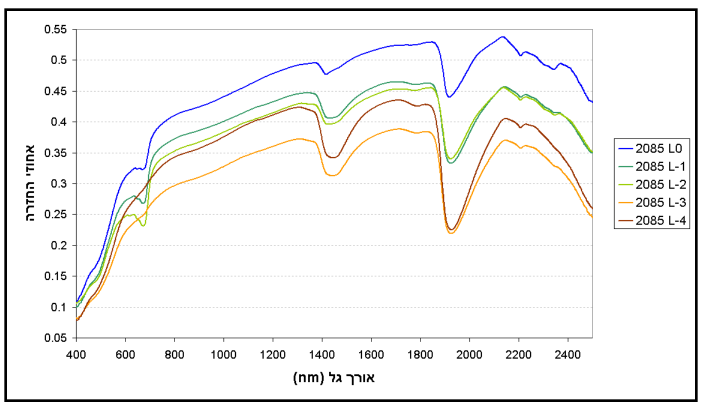
Definition 2

- Soil Spectroscopy refers to the reflectance/emittance part of the electromagnetic radiation that interacts with the soil matter across the VIS-NIR-SWIR-TIR spectral region range (0.35-14μm).



Point – one pixel

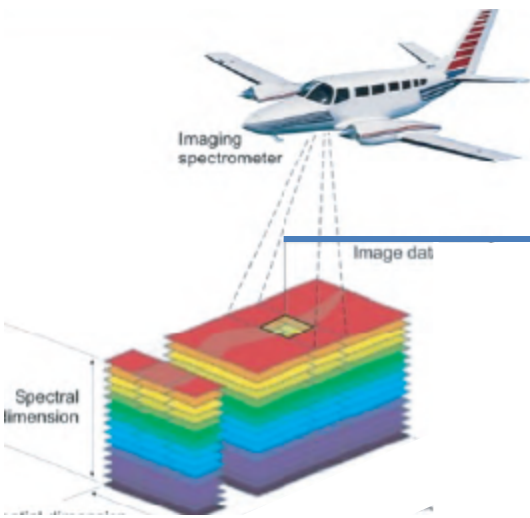
Strong Link between Point and Image Spectroscopy

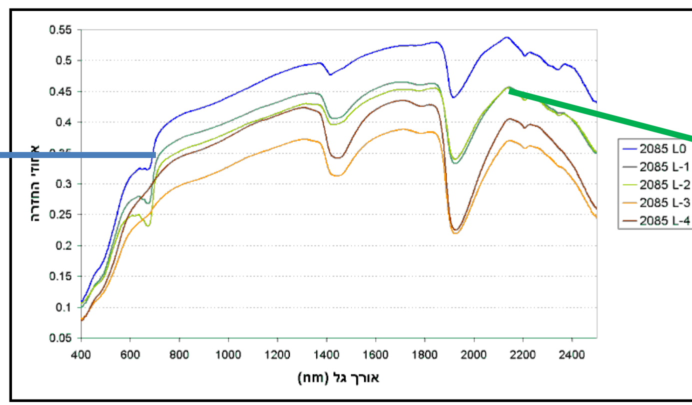
Image Spectroscopy

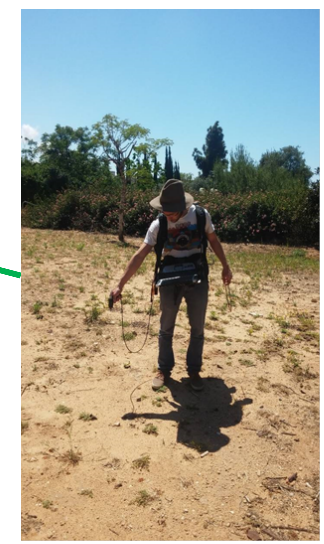
Geology
Vegetation
Water

Point Spectroscopy

Soil

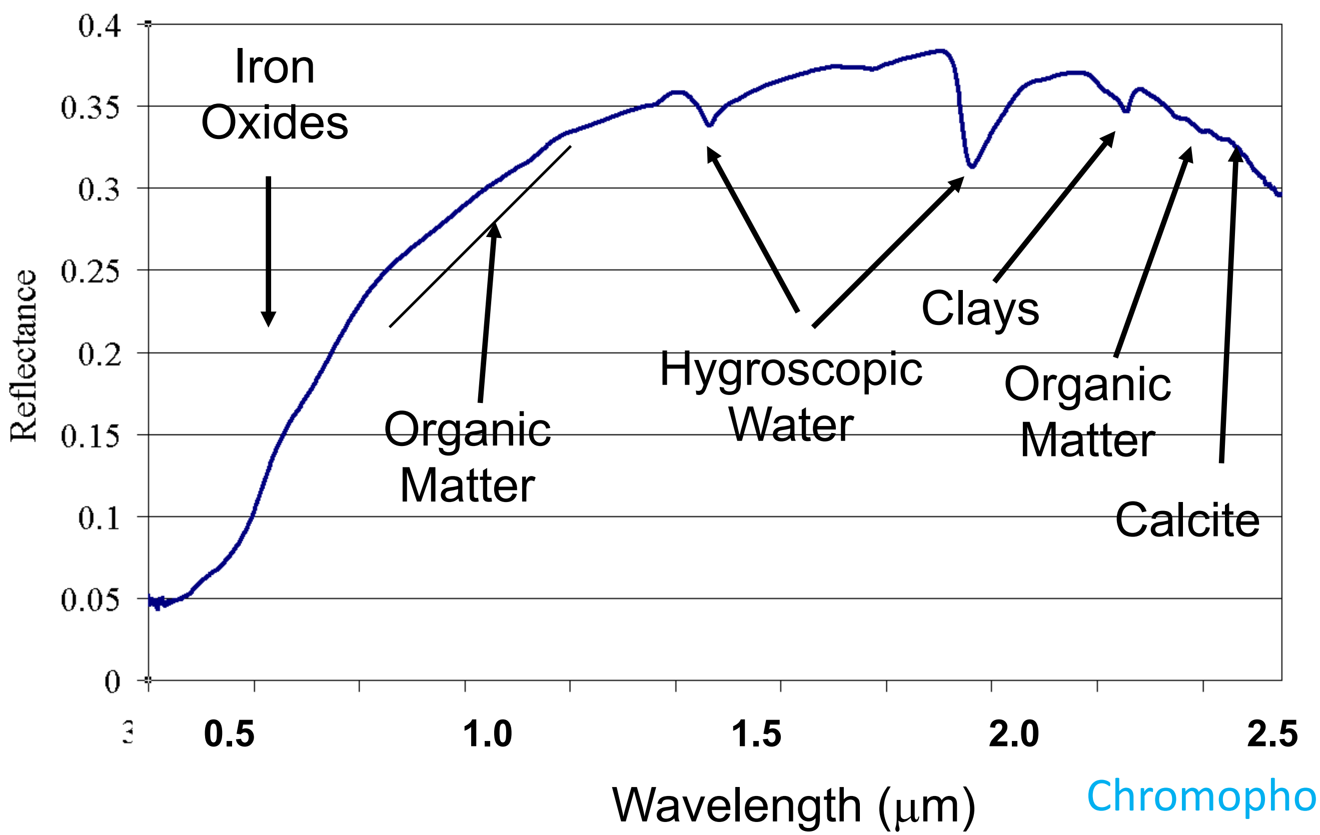






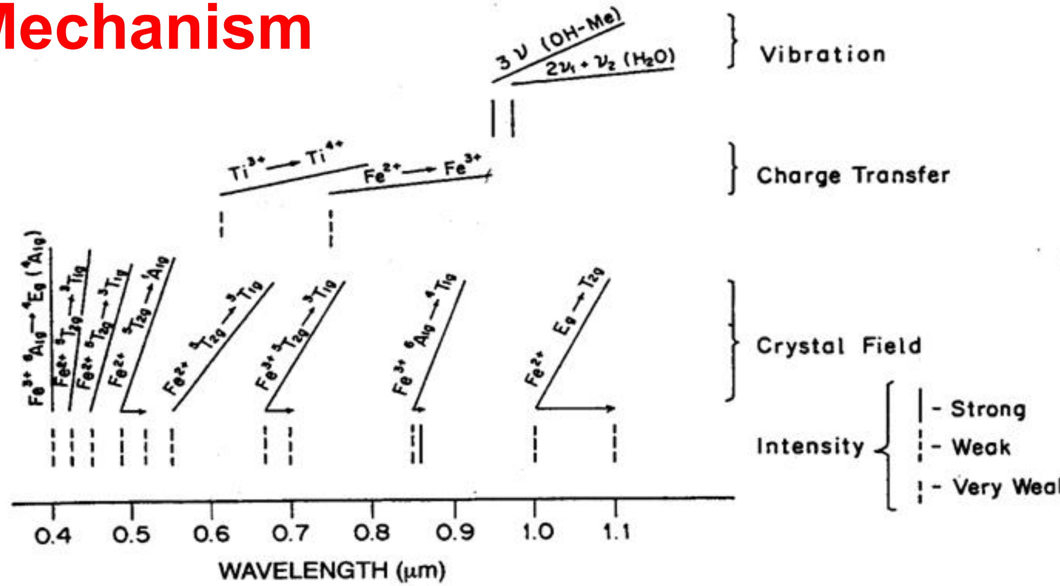
A typical Soil Spectrum

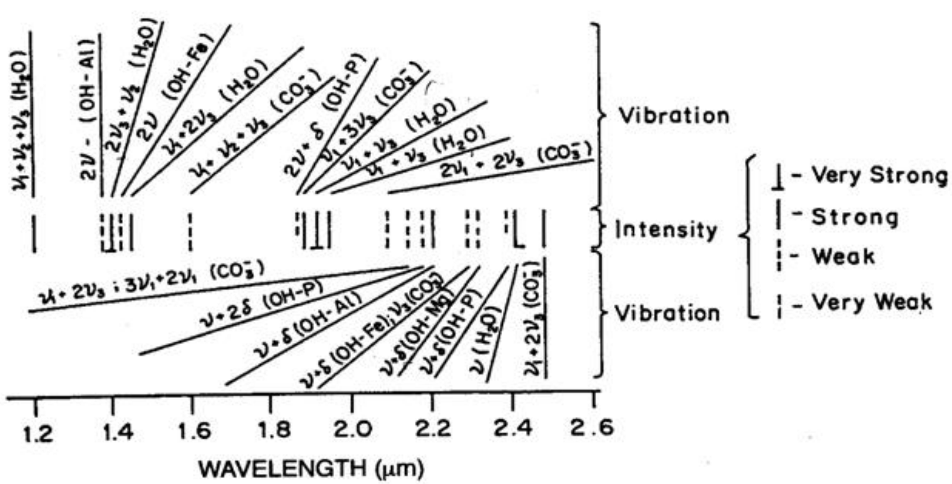
An effective way to simplest the complexity of the soil system



Chromophore = An attribute that interact with the electromagnetic radiation

Absorption Mechanism

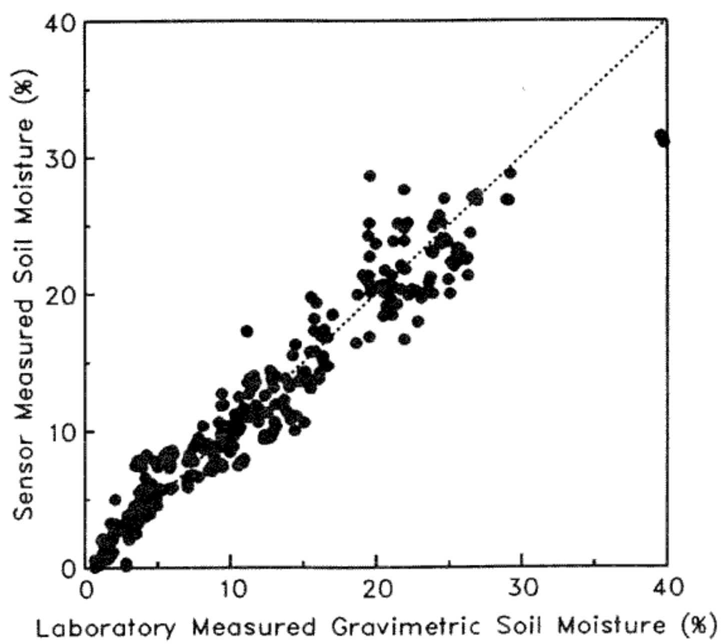




Soil Spectroscopy

Quantitative Information on soil attributes can be Extracted from soil spectral information

Dalal, R.C., and R.J. Henry. 1986. Simultaneous determination of moisture, organic carbon and total nitrogen by near infrared reflectance spectroscopy. Soil Science Society of America Journal 50:120-12



Simple, rapid, inexpensive and
can be applied from large domains (laboratory, field, air and space)

Growing ideas through networks

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Soil Spectroscopy

Examples of some of the soil attributes that can be extracted from spectral library (1)

Soil attribute	Spectral region	Spectral range (nm)	Multivariate method[a]	n_{calib} | n_{valid} [b]	RMSE	R^2	Authors
Mg; g/kg	VIS–NIR	400–2500	modified PLSR	315		0.90	Cozzolino and Moron (2003)
Mg (exch.); cmol(+)/kg	VIS–NIR	350–2500	MARS	493|246	11	0.81	Shepherd and Walsh (2002)
Mg (exch.); mg/kg	VIS–NIR	400–2498	PCR (9)	30|119	12.8	0.68	Chang et al. (2001)
Mg; mmol(+)/kg	UV–VIS–NIR	250–2500	PCR	121|40		0.63	Islam et al. (2003)
Mn (DTPA); mg/kg	MIR	2500–25,000	PLSR	183		0.57	Janik et al. (1998)
Mn (exch.); cmol/kg	MIR	2500–25,000	PLSR	183		0.66	Janik et al. (1998)
Mn (Mehlich III); mg/kg	VIS–NIR	400–2498	PCR (12)	30|119	56.4	0.70	Chang et al. (2001)
OC; %	MIR	2500–20,000	PLSR			0.92	Janik and Skjemstad (1995)
OC; %	MIR	2500–25,000	PLSR	188		0.93	Janik et al. (1998)
OC; g/kg	MIR	2500–25,000	PLSR (17)	177|60		0.94	McCarty et al. (2002)
OC; (acidified soil) g/kg	MIR	2500–25,000	PLSR (19)	177|60		0.97	McCarty et al. (2002)
OC; %	NIR	1100–2500	MLR (1744, 1870, 2052)	72|48		0.93	Dalal and Henry (1986)
OC; %	NIR	1100–2500	RBFN	140|60	0.32	0.96	Fidêncio et al. (2002)
OC; %	NIR	700–2500	PCR	121|40		0.68	Islam et al. (2003)
OC; g/kg	NIR	1100–2498	PLSR (18)	177|60		0.82	McCarty et al. (2002)
OC; mg/kg	NIR	1100–2300	PLSR (8)	180 x-val		0.94	Reeves and McCarty (2001)
OC (acidified soil); g/kg	NIR	1100–2498	PLSR (17)	177|60		0.80	McCarty et al. (2002)
OC; g/kg	VIS–NIR	400–2498	PLSR (6)	76|32	0.62	0.89	Chang and Laird (2002)
OC; g/kg	VIS–NIR	350–2500	MARS	449|225	0.31	0.80	Shepherd and Walsh (2002)
OC; dag/kg	VIS–NIR	350–1050	PLSR (5)	43|25	0.36		Viscarra Rossel et al. (2003)
OC; %	UV–VIS–NIR	250–2500	PCR	121|40		0.76	Islam et al. (2003)
OM; %	MIR	2500–25,000	PLSR (4)	31 x-val	0.72	0.98	Masserschmidt et al. (1999)
OM; %	NIR	1000–2500	MRA (30 bands)	39|52		0.55	Ben–Dor and Banin (1995)
OM; %	VIS–NIR	400–1100	NN	41		0.86	Daniel et al. (2003)
OM; %	VIS–NIR	400–2400	SMLR (606, 1311, 1238)	15|10		0.65	Shibusawa et al. (2001)
P (avail.); mg/kg	MIR	2500–25,000	PLSR	186		0.07	Janik et al. (1998)
P (avail.); mg/kg	VIS–NIR	400–1100	NN	41		0.81	Daniel et al. (2003)
pH	MIR	2500–20,000	PLSR			0.72	Janik and Skjemstad (1995)
pH	NIR	1100–2300	PLSR (8)	180 x-val		0.74	Reeves and McCarty (2001)
pH	NIR	1100–2498	PLSR (11)	120|59		0.73	Reeves et al. (1999)
pH	VIS–NIR	350–2500	MARS	505|253	0.43	0.70	Shepherd and Walsh (2002)
pH_{Ca}	MIR	2500–25,000	PLSR	183		0.67	Janik et al. (1998)

R.A. Viscarra Rossel et al. / Geoderma 131 (2006) 59–75

THE REMOTE SENSING LABORATORIES

Examples of some of the soil attributes that can be extracted from spectral library (2)

Soil attribute	Spectral region	Spectral range (nm)	Multivariate method[a]	n_{calib} | n_{valid} [b]	RMSE	R^2	Authors
OC; %	MIR	2500–20,000	PLSR			0.92	Janik and Skjemstad (1995)
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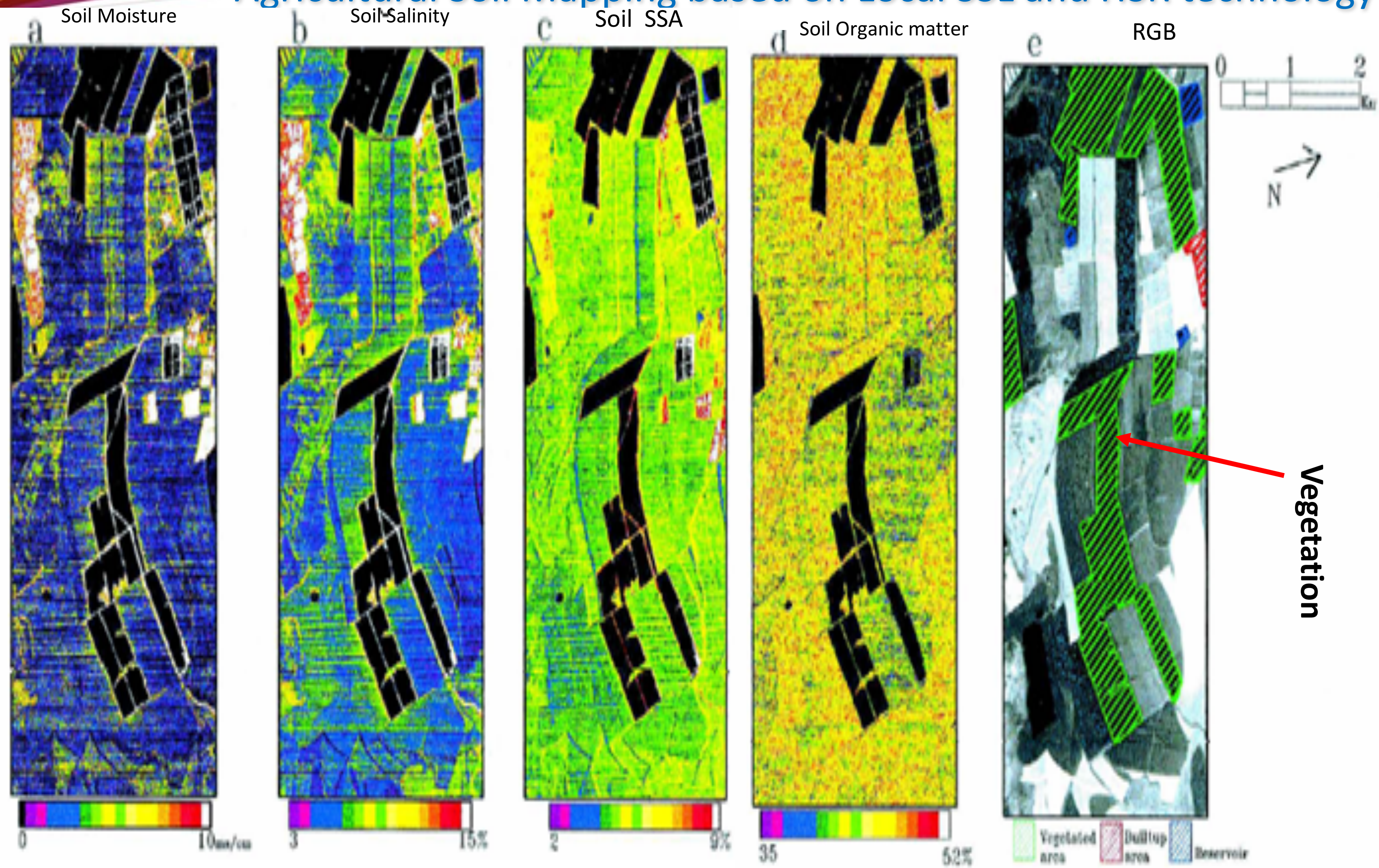
Field Spectral Library : The Practical Value (4)

Agricultural Soil Mapping based on Local SSL and HSR technology



Ben-Dor et al., 2004

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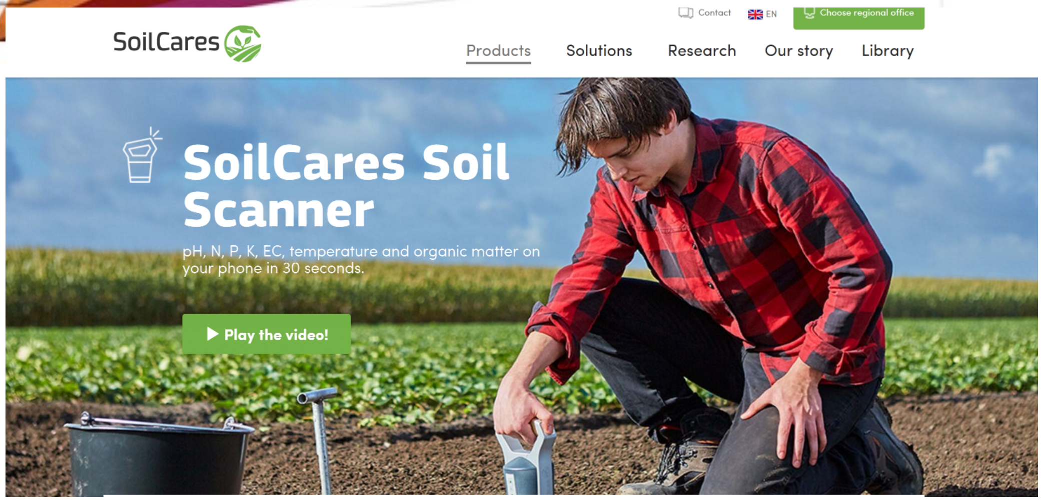
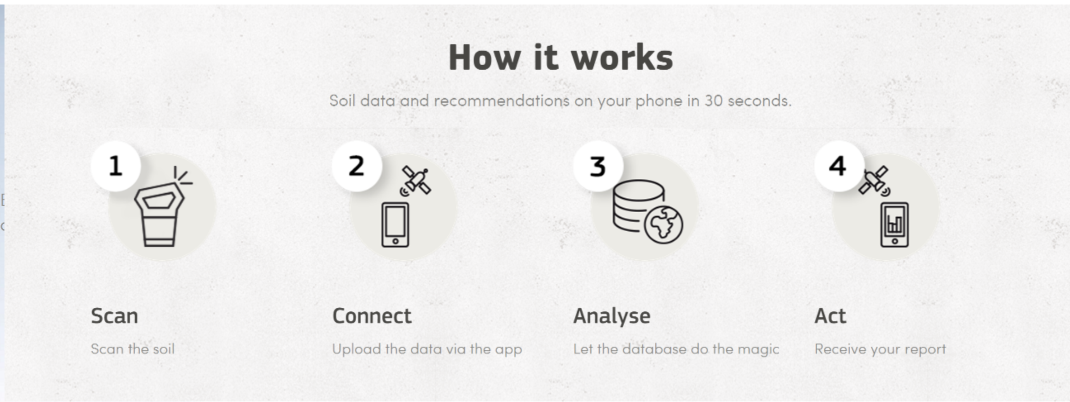
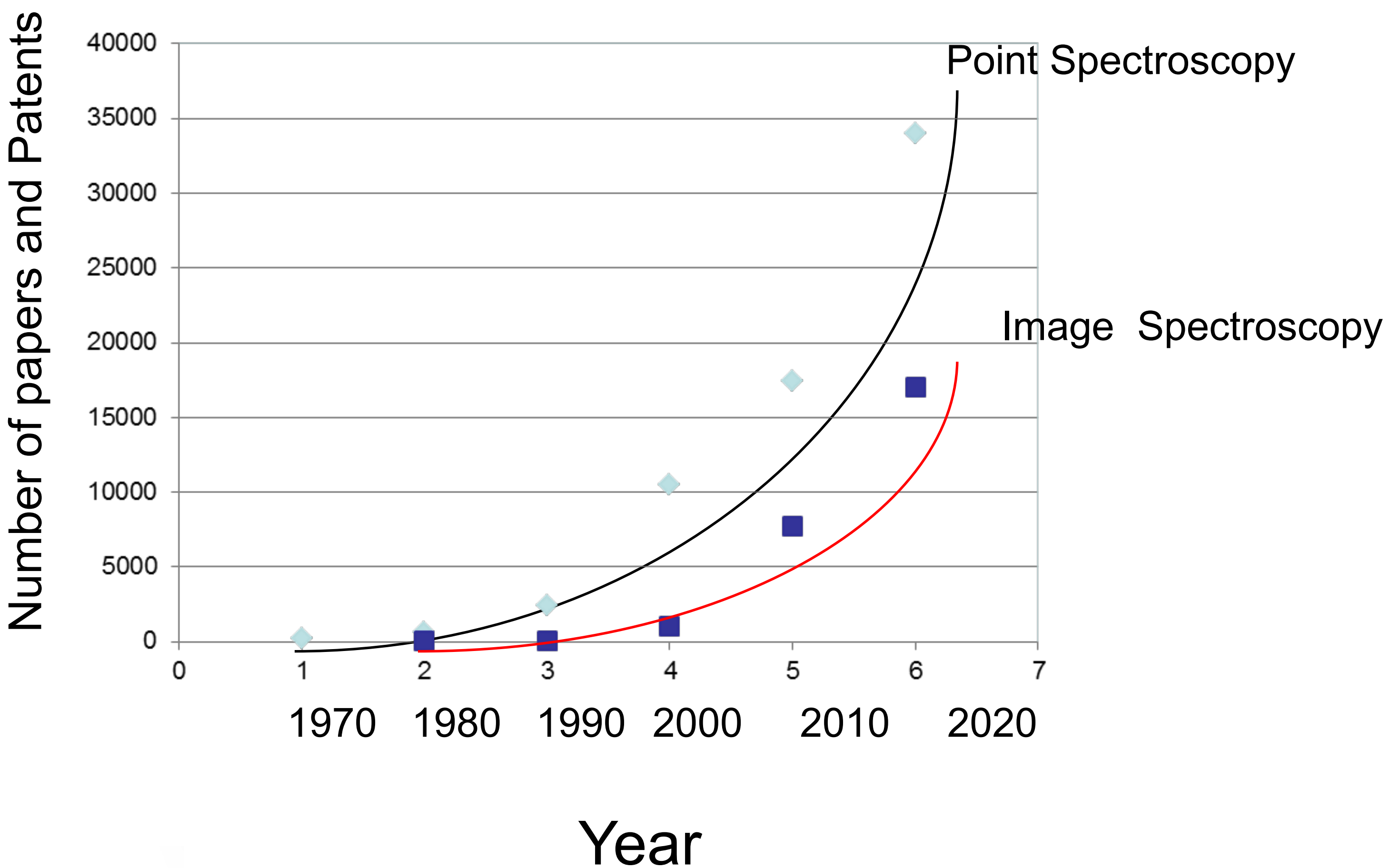
Soil Spectral Library : The Commercial Value (1)





http://www.soilcares.com/en/products/scanner/

Number of papers published in soil spectroscopy over the years : Point and Image domains



The need of Soil Spectral Library

- For quantitative (LAB) applications: many soil samples are needed (**Soil data mining of a "model" requires hundreds of spectra samples in order to provide reliable results**
- Users are gathering many soil samples mostly under local scale. Global scale is important for practical usage.
- Selecting and checking spectral bands of RS sensors for soil applications
- Applying quantitative models directly to any airborne/spaceborne sensors

Growing ideas through networks

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USGS science for a changing world

Spectral Libraries of Mineral and man made material

USGS Digital Spectral Library

http://speclab.cr.usgs.gov/spectral-lib.html

Title	Description	UV-NIR Plot
Acmite NMNH133746 Pyroxene	Description	0.2-3.0 µm plot
Actinolite HS22	Description	0.2-3.0 µm plot
Actinolite HS116	Description	0.2-3.0 µm plot
Actinolite HS315	Description	0.2-3.0 µm plot
Actinolite NMNHR16485	Description	0.2-3.0 µm plot
Actinolite NMNH80714	Description	0.2-3.0 µm plot
Adularia GDS57 (Orthoclase)	Description	0.2-3.0 µm plot
Albite GDS30 Plagioclase	Description	0.2-3.0 µm plot
Albite HS66 Plagioclase	Description	0.2-3.0 µm plot
Albite HS324 Plagioclase		
Allanite HS293		
Almandine HS114 Garnet		
Almandine WS475 Garnet		
Almandine WS476 Garnet		
Almandine WS477 Garnet		
Almandine WS478 Garnet		
Almandine WS479 Garnet		

TITLE: Acmite NMNH133746 Pyroxene DESCRIPT

DOCUMENTATION_FORMAT: MINERAL

SAMPLE_ID: NMNH133746

MINERAL_TYPE: Inosilicate

MINERAL: Acmite (Aegirine)(Pyroxene group)

FORMULA: NaFeSi2O6

FORMULA_HTML: $NaFeSi_2O_6$

COLLECTION_LOCALITY: Kangerdluarssuk, Narssaq (near), Greenland

ORIGINAL_DONOR: Smithsonian

CURRENT_SAMPLE_LOCATION: USGS Reston, VA

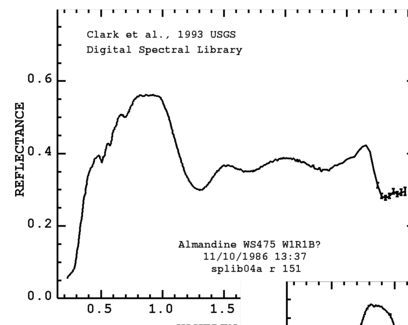
ULTIMATE_SAMPLE_LOCATION: USGS Reston, VA

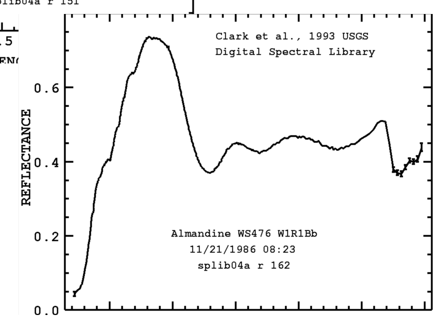
SAMPLE_DESCRIPTION:

This sample was obtained by John W. Salisbury, and the original sample analysis and mid-infrared spectra were published in:

Salisbury, J. W., Walter, L. W., and Vergo, N., 1987, Mid-Infrared (2.1-25µm) Spectra of Minerals: First Edition, U.S. Geological Survey Open File Report 87-263.

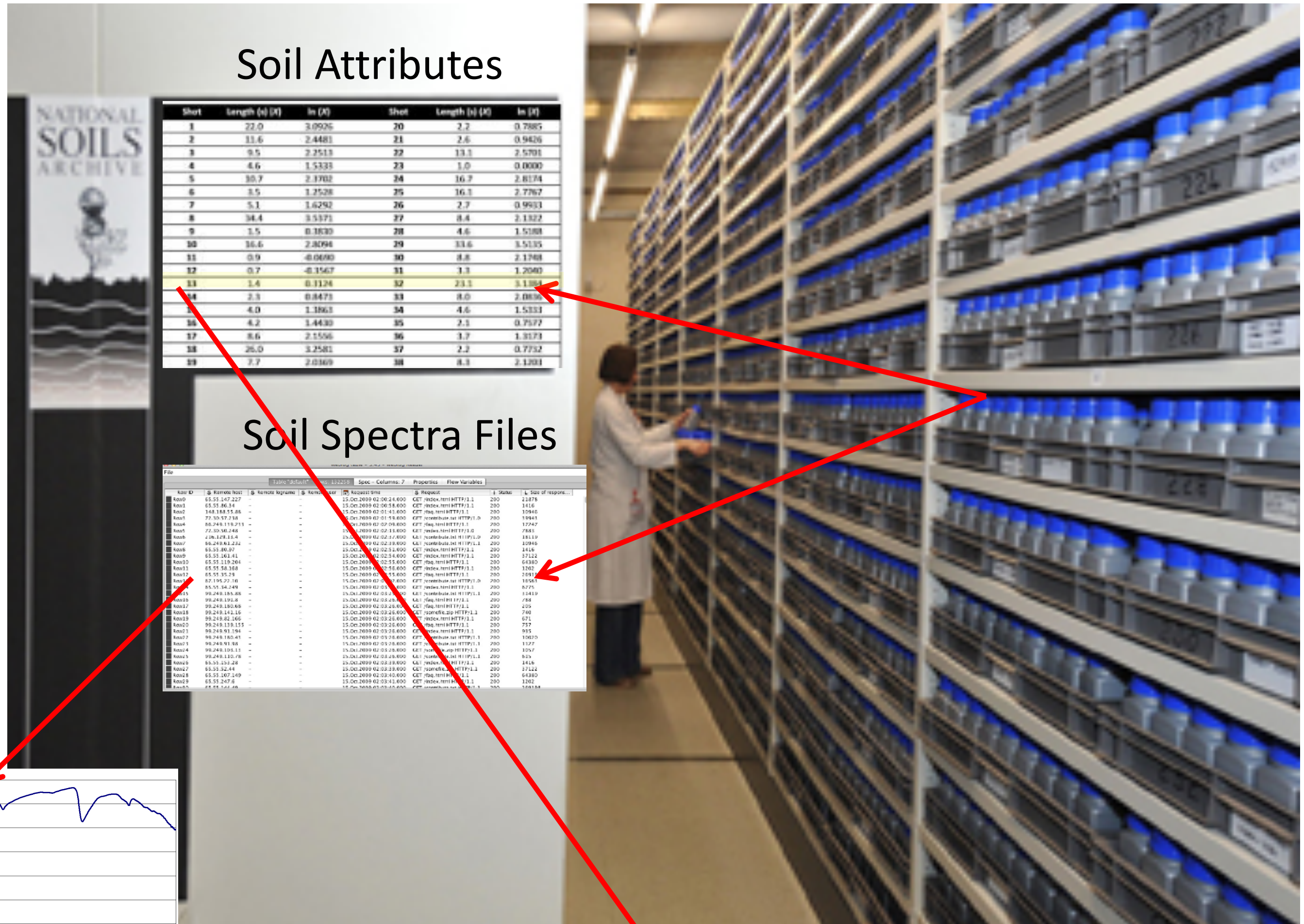
"Original sample was large (up to 2cm), very dark green prismatic crystals of acmite intergrown with albite(?). Material was crushed and hand picked by J. Salisbury for grinding."



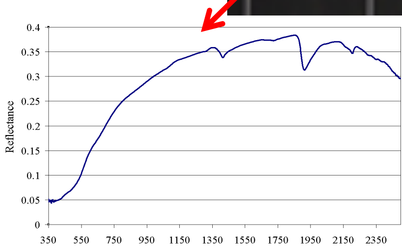


Soil Spectral Library : The Practical Structure

Soil samples at storage, with wet chemistry data plus reflectance spectra measured under a well accepted protocol process



Shot	Length (s) (X)	ln (X)	Shot	Length (s) (X)	ln (X)
1	22.0	3.0926	20	2.2	0.7885
2	11.6	2.4481	21	2.6	0.9426
3	9.5	2.2513	22	13.1	2.5701
4	4.6	1.5333	23	1.0	0.0000
5	10.7	2.3702	24	16.7	2.8174
6	3.5	1.2528	25	16.1	2.7767
7	5.1	1.6292	26	2.7	0.9933
8	34.4	3.5371	27	8.4	2.1322
9	1.5	0.1830	28	4.6	1.5188
10	16.6	2.8094	29	33.6	3.5135
11	0.9	-0.0690	30	8.8	2.1748
12	0.7	-0.3567	31	3.3	1.2040
13	1.4	0.3124	32	23.1	3.1384
14	2.3	0.8473	33	8.0	2.0806
15	4.0	1.3863	34	4.6	1.5333
16	4.2	1.4430	35	2.1	0.7577
17	8.6	2.1556	36	3.7	1.3173
18	26.0	3.2581	37	2.2	0.7732
19	7.7	2.0369	38	8.3	2.1203



Sample	Location	OM	Clay	Lime….
A1	34,5467.67	2.4 %	34%	23.4%
				36,654,32

Growing ideas through networks

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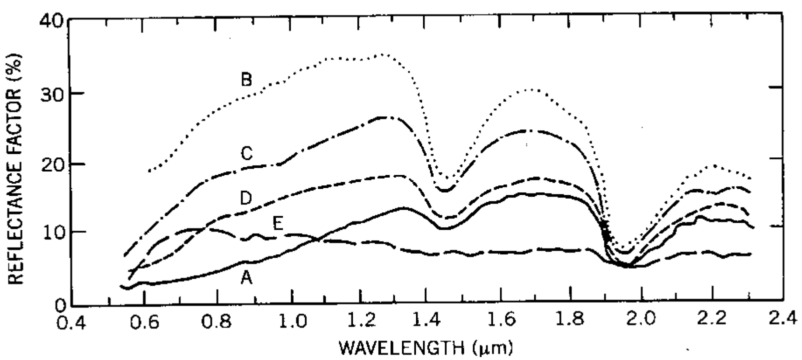
First Soil Spectral Library

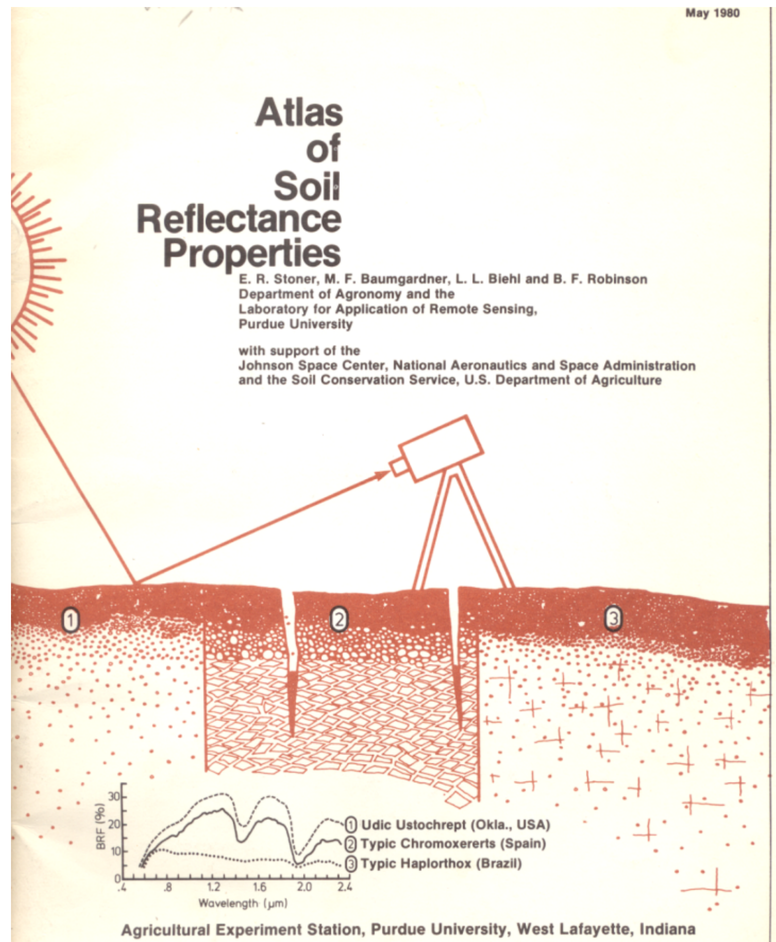
1980

Around 4000 spectra

5 spectral types in USA



Stoner, E.R. and M.F., Baumgardner, 1981. Characteristic variations in reflectance of surface soils. Soil Science Society of American Journal 45: 1161-1165



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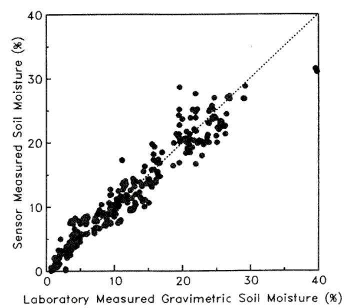
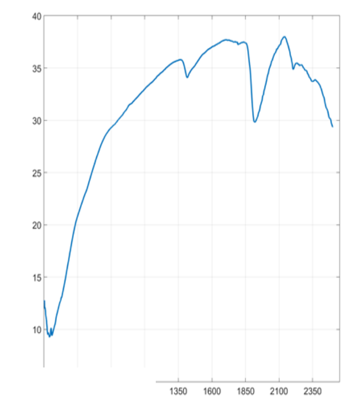
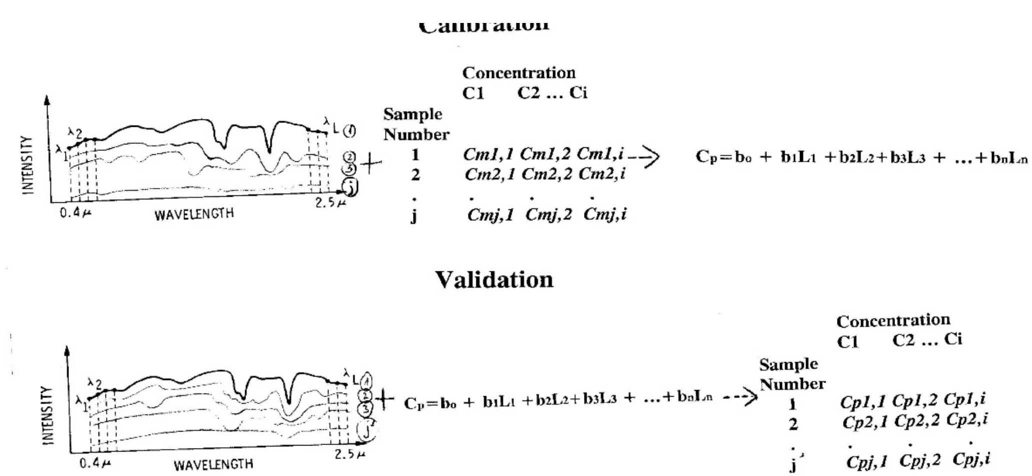


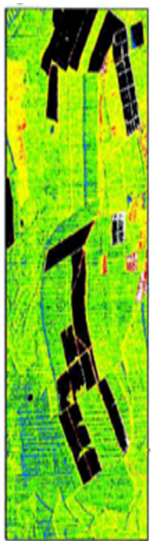
Soil Spectral Library
PK Unique ID
Chemical properties
Physical properties
Spectral signature



The following figures demonstrate the NIRA approach:



PARACUDA©



THE REMOTE SENSING LABORATORIES

Soil Spectral Mapping (SSM) using local soil spectral library

Organic Matter Image

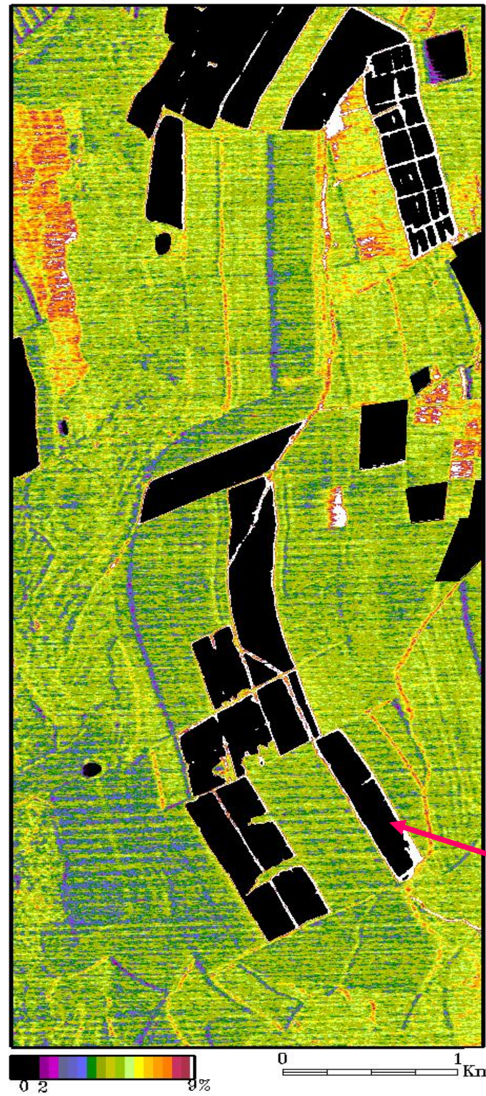


Table 2.

Property	SEC, SEP, SEL
Soil Field Moisture (SFM)	0.045, 0.14, 0.016 0.027@
Organic Matter (OM)	0.003, 0.015, 0.00 0.0012@
Soil-Saturated Moisture SPM	0.019, 0.021, 0.00 0.0006@
Electrical Conductivity (EC)	4.36, 4.58, 0.1 2.57@
PH	0.146, 0.26, 0.1 0.073@

wl stands for the wavelength (μm) predicted ($x=p$) domains. @ stands f multiple regression coefficient. SEP = [samples were not involved in the cali laboratory of sample i and AVE_i is the

more details).

Assignments
1.65 μm-reflectance slope
0.688 μm-reflectance slope
0.739 μm-reflectance slope/chlorophyll
0.722 μm-chlorophyll remaining
1.678 μm-C-H in cellulose
2.328 μm-Humic acid, Pectin, Lignin
2.085 μm–adsorbed water OH
2.183 μm-OH combination of $\upsilon' + \delta$ in clay mineral lattice
1.538, 1.563 μm-OH combination of 2☐☐ in clay mineral lattice
0.739 μm-organic-matter assignments
1.65 μm-adsorbed water OH
2.166 μm-adsorbed water OH
Not determined

ıstituent values in the measured ($x=m$) and ‚tory data (spectral and chemistry). R^2_m is a ıred ($x=m$) and predicted ($x=p$) domains in s to a single analytical measurement in the

Soil Salinity, Water and Organic matter

Vegetation mask

Growing ideas through networks

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ELSEVIER

Remote Sensing of Environment

Volume 48, Issue 3, June 1994, Pages 261-274

Visible and near-infrared (0.4–1.1 μm) analysis of arid and semiarid soils

E. Ben-Dor *, A. Banin †

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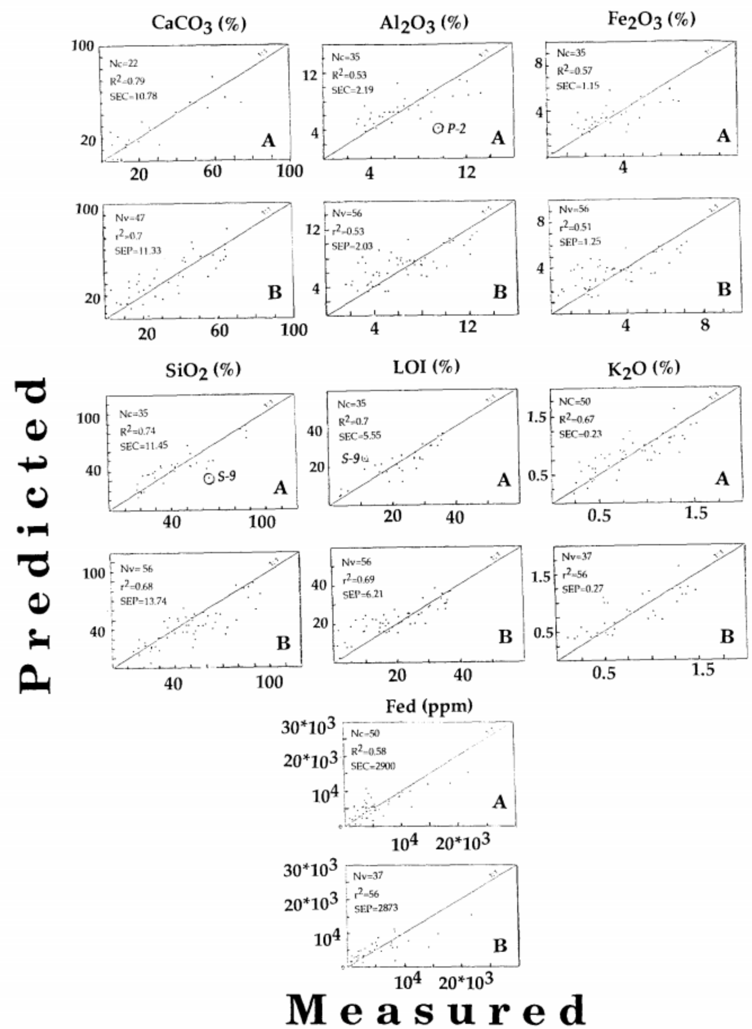


Table 6. The Regression Line Parameters (r^2 = coefficient of correlation, a = slope, and b = the intercept) of Seven Soil Constituents in the Validation Stage[a]

Property	*SEP*	r^2	*a*	*b*
$CaCO_3$	11.3	0.70[b]	0.76[b]	8.81[b]
Al_2O_3	2.02	0.53	0.54	3.52
Fe_2O_3	1.25	0.51[b]	0.49	2.20
SiO_2	13.74	0.68[b]	0.72[b]	7.29[b]
LOI	6.21	0.69[b]	0.64	9.40
K_2O	0.27	0.56[b]	0.68[b]	0.29[b]
Fed	2873	0.61[b]	0.56	2120

[a] Also are presented the parameters significance (at 0.05) that r^2 is not different from unity, a is not different from 1, and b is not different from 0 (see text).
[b] Significance at 0.05.

146 citations

THE REMOTE SENSING LABORATORIES

VIS NIR 6 TM channels

Evaluation of Several Soil Properties Using Convolved TM Spectra

E. BEN-DOR[1], A. BANIN[2]

1. Department of Geography, Tel-Aviv University, Ramat-Aviv, P.O. Box 39040, Tel-Aviv, Israel, 69978 bendor@ccsg.tau.ac.il

2. Department of Soil and Water Sciences, Faculty of Agriculture, Hebrew University of Jerusalem, Rehovot, Israel.

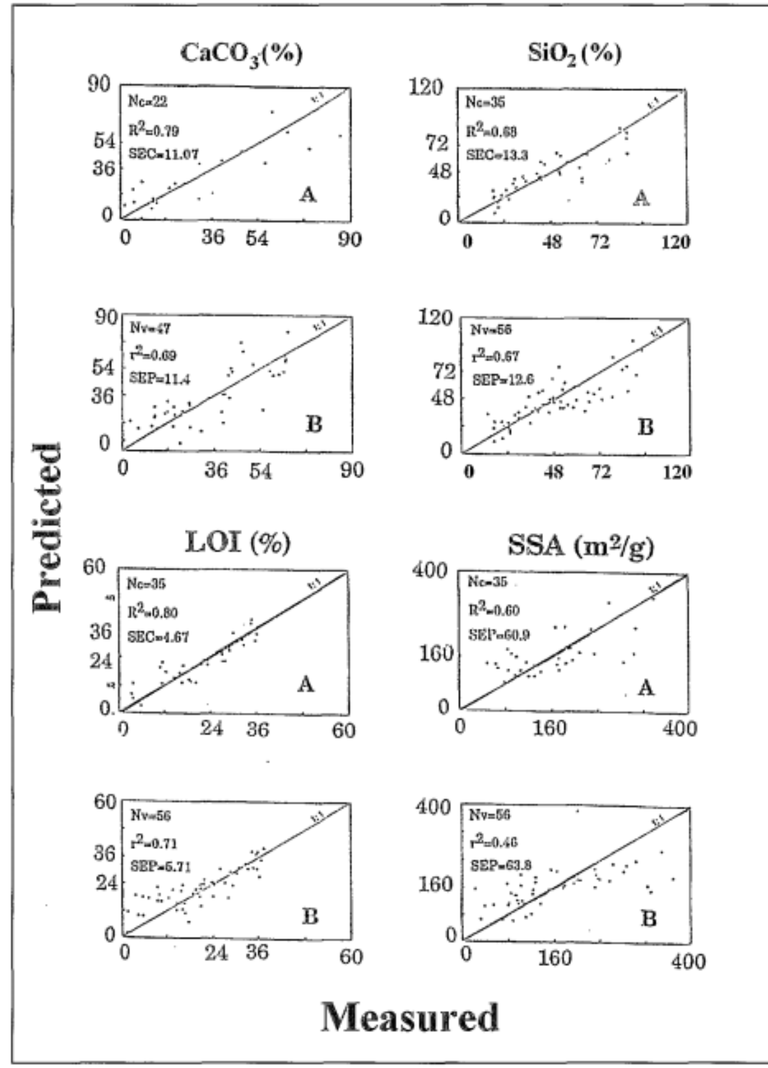


Figure 4. Plots of the predicted (C_p) vs. measured (C_m) values at the calibration (A) and validation (B) stages for the optimal TMA prediction of the significant soil properties.

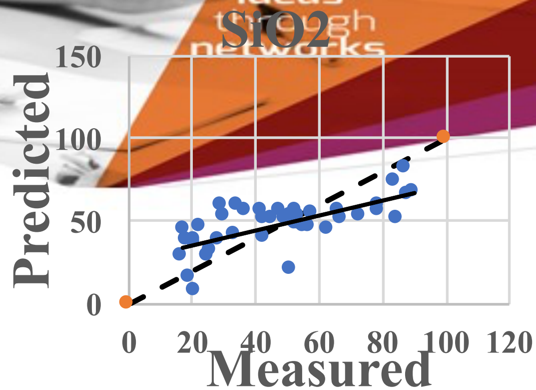
Journal
International Journal of Remote Sensing ›
Volume 18, 1997 - Issue 13

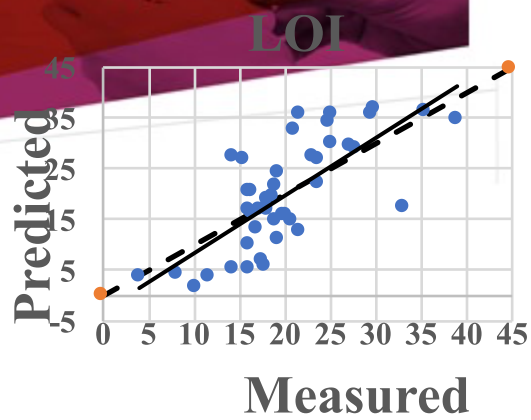
Original Articles

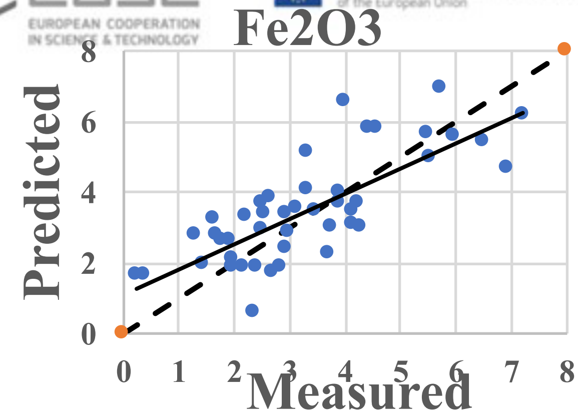
Visible spectrometric indices of hematite (Hm) and goethite (Gt) content in lateritic soils: The application of a Thematic Mapper (TM) image for soil-mapping in Brasilia, Brazil

J. Madeira, A. Bedidi, B. Cervelle, M. Pouget & N. Flay

Pages 2835-2852 | Published online: 25 Nov 2010
Download citation https://doi.org/10.1080/014311697217369







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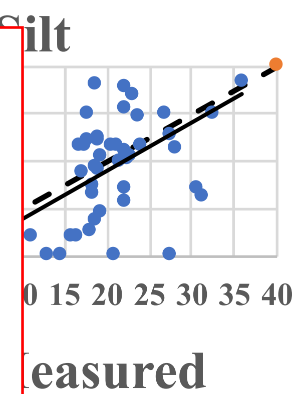
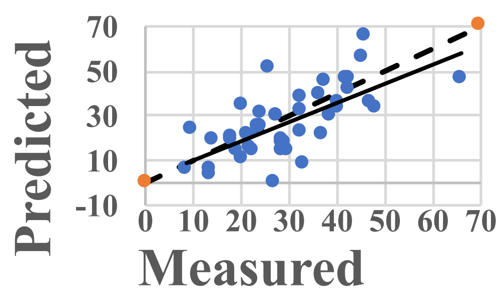
CaCO3



Using the Mediterranean Soil Spectral library
LANDSAT8

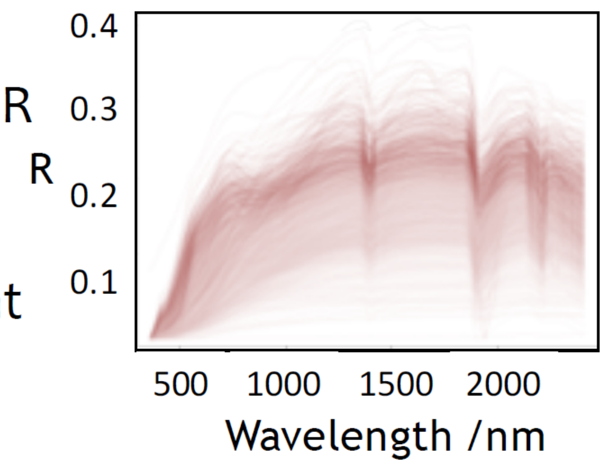


The Global Soil Spectral Library (GSSL)

In 2006 *Raphael Viscorra Rossel* understood the GSSL importance and initiated an activity toward establishing the first GSSL

Global spectral library project

- Started in 2008 as voluntary collaboration in response to growing interest in soil vis–NIR spectroscopy



- Scientists from each continent coordinated and developed guidelines and protocols
- Aim to bring together a community of scientists, encourage research, development of new applications and adoption of spectroscopy in the soil, earth and environmental sciences.

provided by Viscorra Rossel

cost
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GSSL

There is a publication on the global library

Authors: Those who contribute to GSSL established by Viscorra Rossel

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Earth-Science Reviews

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

A global spectral library to characterize the world's soil

CrossMark

R.A. Viscarra Rossel [a,*], T. Behrens [b], E. Ben-Dor [c], D.J. Brown [d], J.A.M. Demattê [e], K.D. Shepherd [f], Z. Shi [g], B. Stenberg [h], A. Stevens [i], V. Adamchuk [j], H. Aïchi [k], B.G. Barthès [l], H.M. Bartholomeus [m], A.D. Bayer [n], M. Bernoux [l], K. Böttcher [o,p], L. Brodský [q], C.W. Du [r], A. Chappell [a], Y. Fouad [s], V. Genot [t], C. Gomez [u], S. Grunwald [v], A. Gubler [w], C. Guerrero [x], C.B. Hedley [y], M. Knadel [z], H.J.M. Morrás [aa], M. Nocita [ab], L. Ramirez-Lopez [ac], P. Roudier [y], E.M. Rufasto Campos [ad], P. Sanborn [ae], V.M. Sellitto [af], K.A. Sudduth [ag], B.G. Rawlins [ah], C. Walter [s], L.A. Winowiecki [f], S.Y. Hong [ai], W. Ji [a,g,j]

THE REMOTE SENSING LABORATORIES

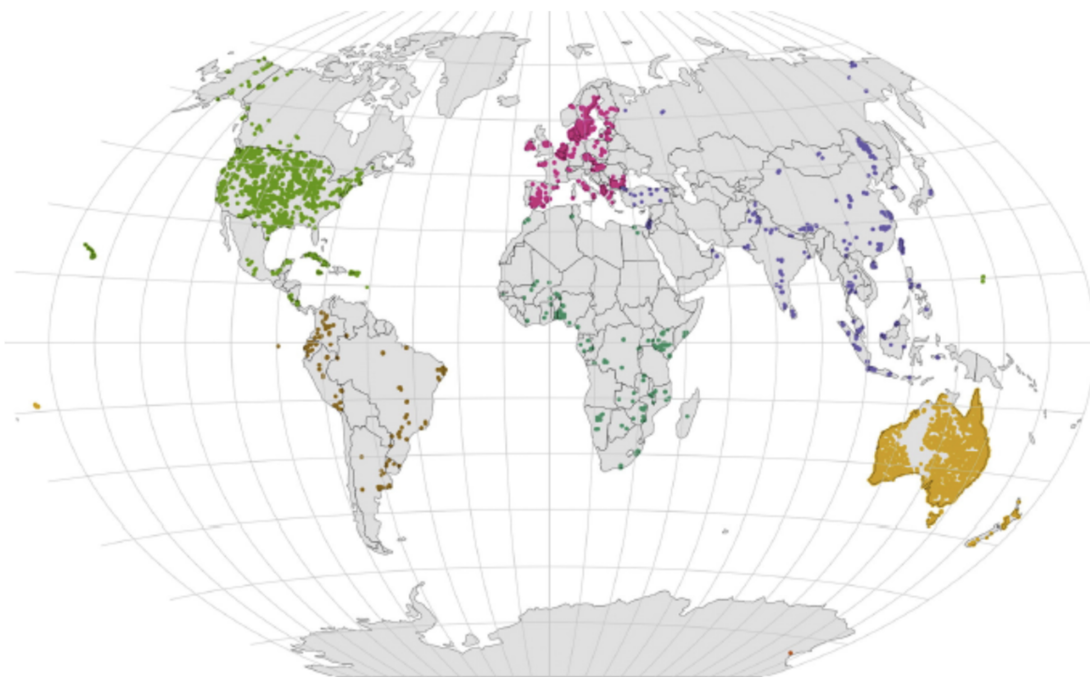
In 2015 Raphael effort yield the first GSSL

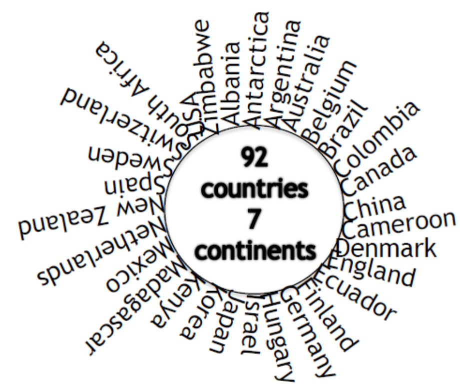
VNIR-SWIR

Global Soil VNIR-SWIR Spectra

Some 20,000+ vis-NIR (350-2500 nm) spectra from 12,509 sites

45 collaborators from 35 institutions

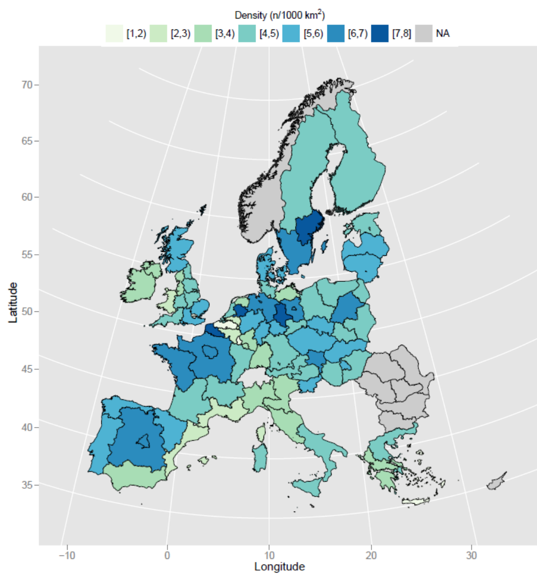


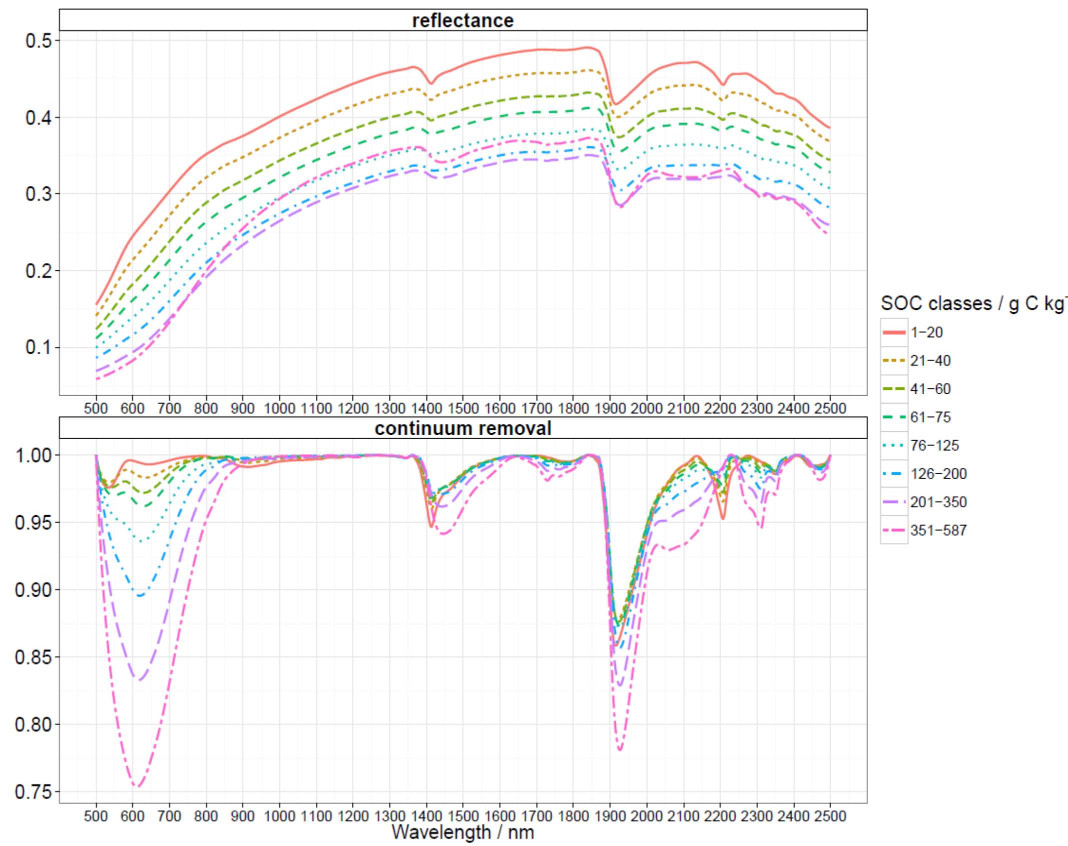


provided by Viscorra Rossel

The LUCAS spectral library

2011





- Current status:
- 23 European countries
- ~20,000 high quality spectral readings
- Metadata: Clay, silt, sand, OC, pH, CEC, $CaCO_3$, Geographical coordinates, land use, etc

Creation of four subsets: Cropland, Grassland, Woodland, and Organic soils

The European Soil Spectral Library

Growing ideas through networks

HARMONIOUS

cost
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First paper showing utilization of a global SSL – avoiding local work load

remote sensing

MDPI

January 2018

Article

Soil Organic Carbon Estimation in Croplands by Hyperspectral Remote APEX Data Using the LUCAS Topsoil Database

Fabio Castaldi [1,*], Sabine Chabrillat [2], Arwyn Jones [3], Kristin Vreys [4], Bart Bomans [4] and Bas van Wesemael [1]

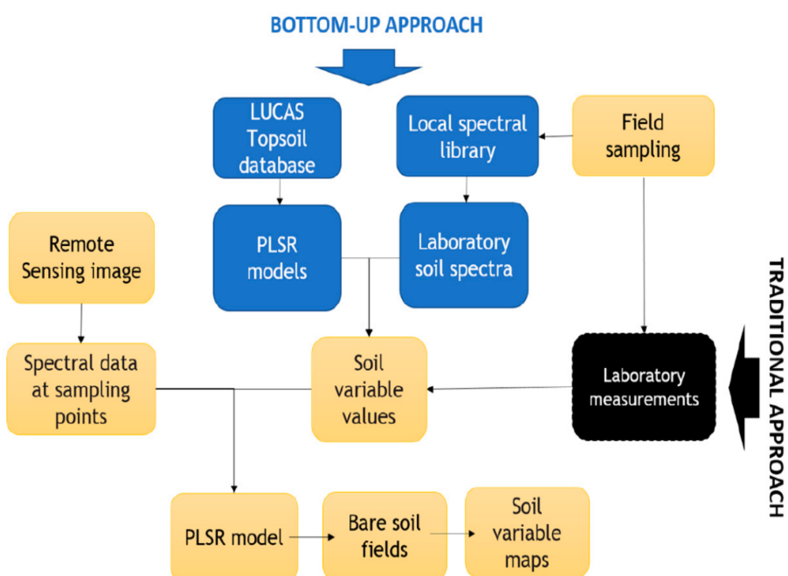


Figure 2. Flow chart concerning the two soil organic carbon (SOC) estimation approaches work: traditional and bottom-up.

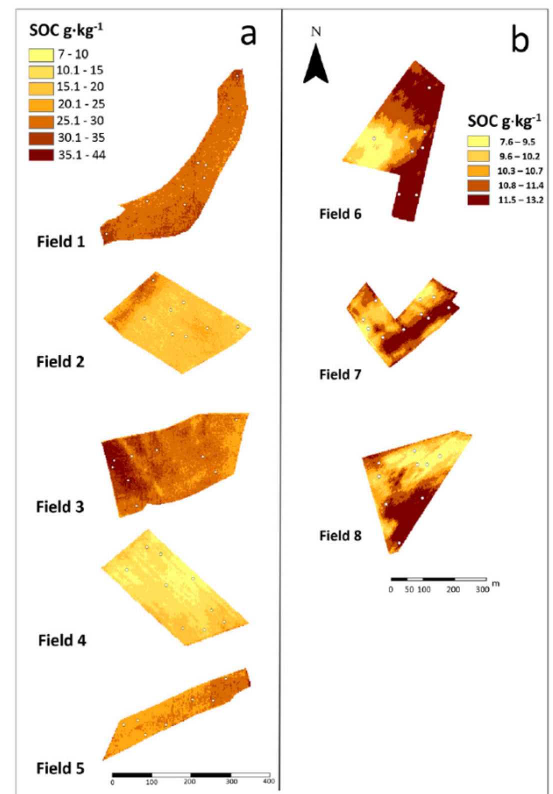


Figure 4. SOC maps of the validation fields in Luxembourg (**a**), and Belgium (**b**), using approach. The white points in the fields correspond to the validation dataset.

THE REMOTE SENSING LABORATORIES

The Problem

- Users are focused on their own protocols (*measurement methods and instrumentation*)
- Protocol may affects the final spectrum……

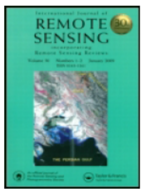
(Spectral information is not reliable)

- Quantitative models are sensitive to these effects (small spectral changes) …..
- The *Chmometric* models from one protocol can not be used by other protocol

Standardization

Lucky Bay

Wiely Bay



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Normalizing reflectance from different spectrometers and protocols with an internal soil standard

Veronika Kopačková & Eyal Ben-Dor

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Soil Mineralogy

Performance of Three Identical Spectrometers in Retrieving Soil Reflectance under Laboratory Conditions

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Gila Notesco
Eyal Ben-Dor
Dep. of Geography and Human Environment,
Tel-Aviv Univ.,
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Ramat Aviv 69978, Israel.

A wide range of electronic and mechanical noise factors can affect soil spectra when using different instruments or even when repeating a specific sample's measurements with the same spectrometer. In soil samples where very weak spectral features are monitored for chemometric purposes, alterations in wavelength location, peak absorption shape, or albedo intensity can limit the use of previously developed spectral models. To quantify this alteration and propose a standardization method, 12 soil samples and three different materials for internal standards (sand, glass and polyethylene) were analyzed. This population was concurrently measured with three identical spectrometers using a strict measurement protocol, and then by different operators with different protocols. Significant changes in the soil spectra were found when different operators performed the measurements, being reduced >50% when the strict protocol was applied. Sand was found to be the ideal internal standard for correcting the spectra to a reference spectrometer, even when different measuring protocols were used. This standardization also showed an improvement in the prediction of soil properties when applying chemometric spectral models even with different instruments, concluding that the use of an internal standard and a strict protocol must be applied for soil spectral measurements. As the measuring factors described in this research also affect any infrared diffuse reflectance spectroscopy measurements, the proposed method should be applicable to any instrumentation and configuration being used. This is crucial to enabling spectral comparisons between different spectrometers or, more importantly, to establishing robust chemometric models and to exchange soil spectral information.

Abbreviations: ASD, Analytical Spectral Devices, Inc.; CR, continuum removal; NIRS, near infrared analysis; PLS, partial least squares; RGB, red-greeen-blue color model; RMSEP, root mean square error of prediction; SAM, spectral angle mapper; TAU, Tel Aviv University.

Many reflectance spectroscopy applications have been developed for soils in the last 20 yr (Malley et al., 2004). Today, reflectance in the VIS-NIR-SWIR region is considered to be a solid and mature technique for qualitative and quantitative analyses of soil material (Ben-Dor et al., 2008b). Soil spectroscopy has advanced the discipline of soil science by providing a rapid and accurate methodology for quantitative analyses that bypasses the traditional "wet" laboratory analyses. Whereas most of the work in evaluating soil information from reflectance spectroscopy has been performed under controlled laboratory conditions, field applications are now rapidly gaining an important place in soil spectroscopy (Ben-Dor et al., 2009; Cecillon et al., 2009). Accordingly, portable spectrometers are being developed and utilized worldwide for many natural resource applications, such as soil, rock, vegetation, and water studies. In addition, a wide range of soil spectral measurements are being gathered around the globe with the intention of building a universal soil spectral library (Viscarra Rossel, 2009). However, this kind of initiative, or even the routine analyses of spectral data collected in one specific laboratory, are limited by the differences that are usually obtained when different spectrometers and protocols are used (Milton et al., 2009; Price, 1994). Spectral performance may vary among different types of spectrometers, or even among models from the same manufacturer, being therefore important to characterize

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Growing ideas through networks

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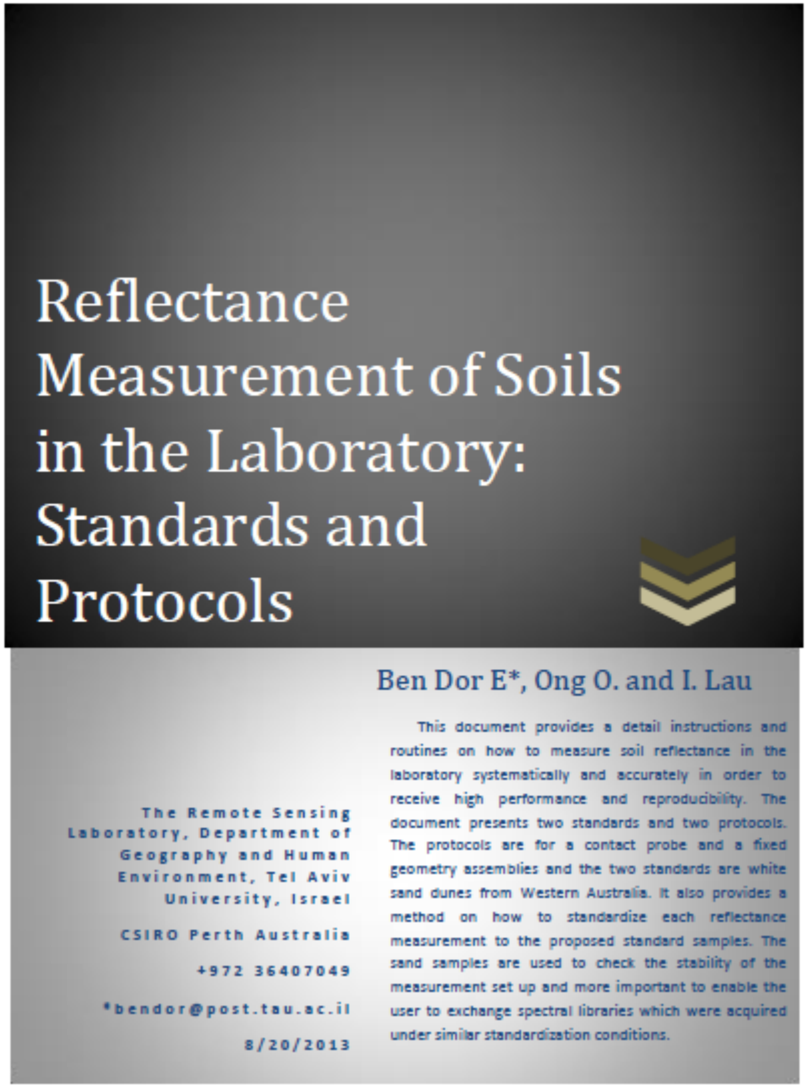
Protocol

A simple protocol has established for new users Since 2014



Reflectance Measurement of Soils in the Laboratory: Standards and Protocols

Ben Dor E*, Ong O. and I. Lau

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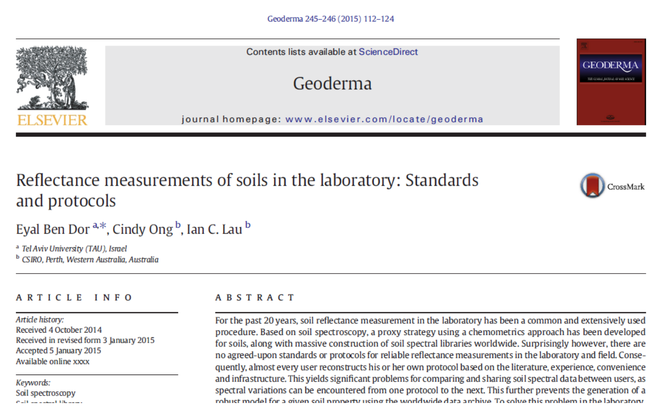
8/20/2013

This document provides a detail instructions and routines on how to measure soil reflectance in the laboratory systematically and accurately in order to receive high performance and reproducibility. The document presents two standards and two protocols. The protocols are for a contact probe and a fixed geometry assemblies and the two standards are white sand dunes from Western Australia. It also provides a method on how to standardize each reflectance measurement to the proposed standard samples. The sand samples are used to check the stability of the measurement set up and more important to enable the user to exchange spectral libraries which were acquired under similar standardization conditions.



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Reflectance measurements of soils in the laboratory: Standards and protocols

Eyal Ben Dor [a,*], Cindy Ong [b], Ian C. Lau [b]

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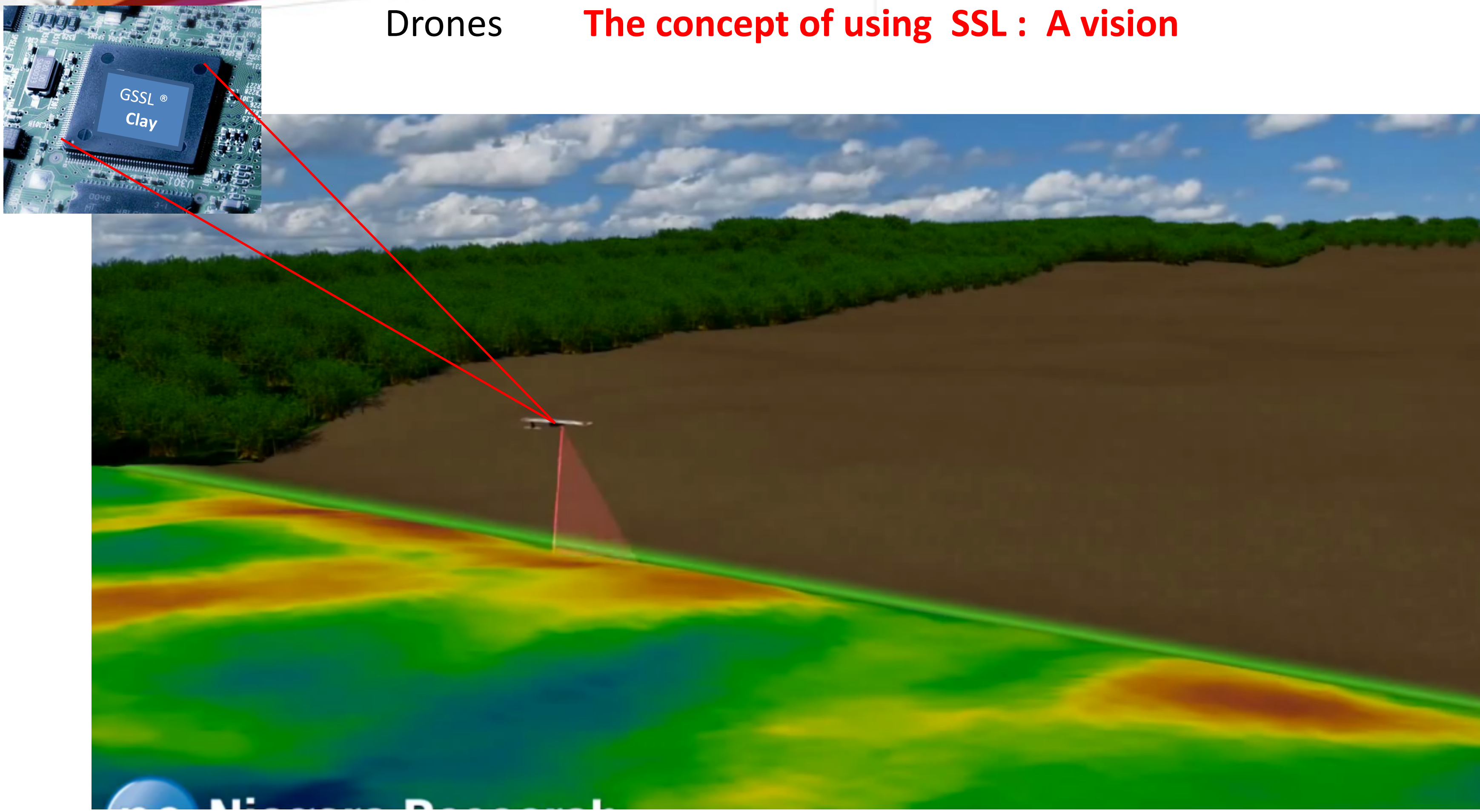
ABSTRACT

For the past 20 years, soil reflectance measurement in the laboratory has been a common and extensively used procedure. Based on soil spectroscopy, a proxy strategy using a chemometrics approach has been developed for soils, along with massive construction of soil spectral libraries worldwide. Surprisingly however, there are no agreed-upon standards or protocols for reliable reflectance measurements in the laboratory and field. Consequently, almost every user reconstructs his or her own protocol based on the literature, experience, convenience and infrastructure. This yields significant problems for comparing and sharing soil spectral data between users, as spectral variations can be encountered from one protocol to the next. This further prevents the generation of a

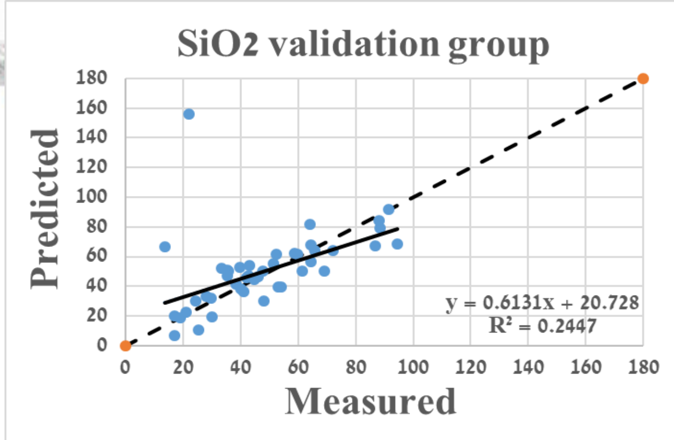
New *Standard for* world wide Soil Spectral Library – Adopted Countries

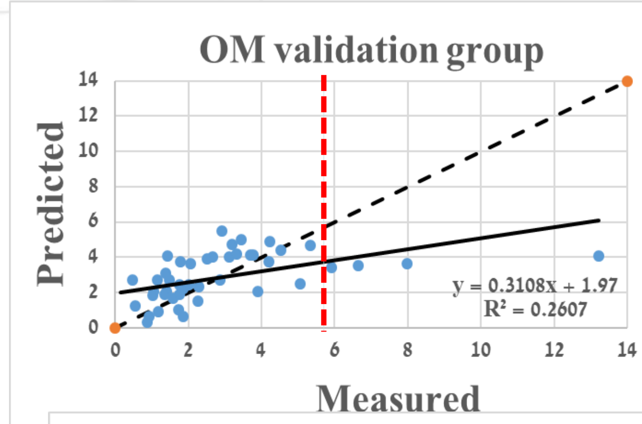
World Soil Spectral Library under ISS protocell

Drones **The concept of using SSL : A vision**



From local SSL – MAP-IR sensor





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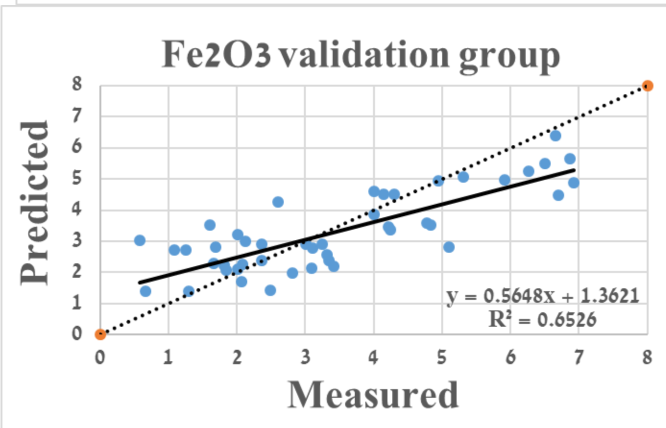
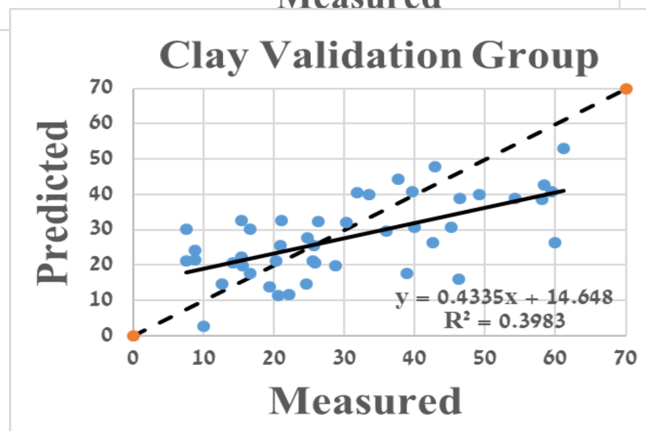
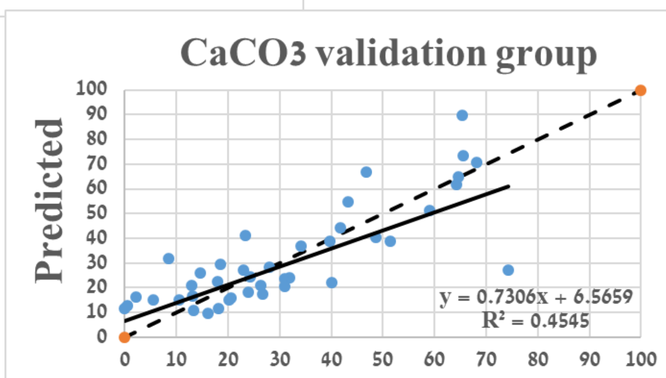
Nv = 45







Spectral Configuration
MAPIR

Band number	Wavelength (nm)	Use
1	405	Blue
2	450	Blue
3	490	Green
4	518	Green
5	550	Green
6	590	Yellow
7	615	Orange
8	632	Red
9	650	Red
10	685	Red
11	725	Red Edge
12	780	NIR
13	808	NIR
14	850	NIR
15	880	NIR
16		NIR (water

EUFAR2 - EUropean Facility for Airborne Research

EUFAR AISBL – H2020 CALL (2018-2022)

A New Interest of EUFAR

Fusion of Airborne imaging and point spectrometry with UAV platofms

Looking forward for collaboration with HARMONIOUS

EUFAR2 - EUropean Facility for Airborne Research

The Soil Spectroscopy Library ad UAV : Summary

- Spectral libraries are generated under regional, national, continental and global scales.
- Standard and protocols are important to hold
- SSL can be used n to check performances of sensor for a mission
- SSL can be used to map soil properties (and not only soil moisture) and important for future utilization of UAV sensors.

COST
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Dr Anna Zmarz	University of Warsaw, Poland

Important Dates	
Registration opening	February 1, 2018
Abstract submission deadline	April 30, 2018
Notification of authors	June 15, 2018
Registration deadline for authors of accepted contributions	July 30, 2018
Preliminary programme	July 1, 2018
Deadline of early bird registration	July 30, 2018

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Thank You !!