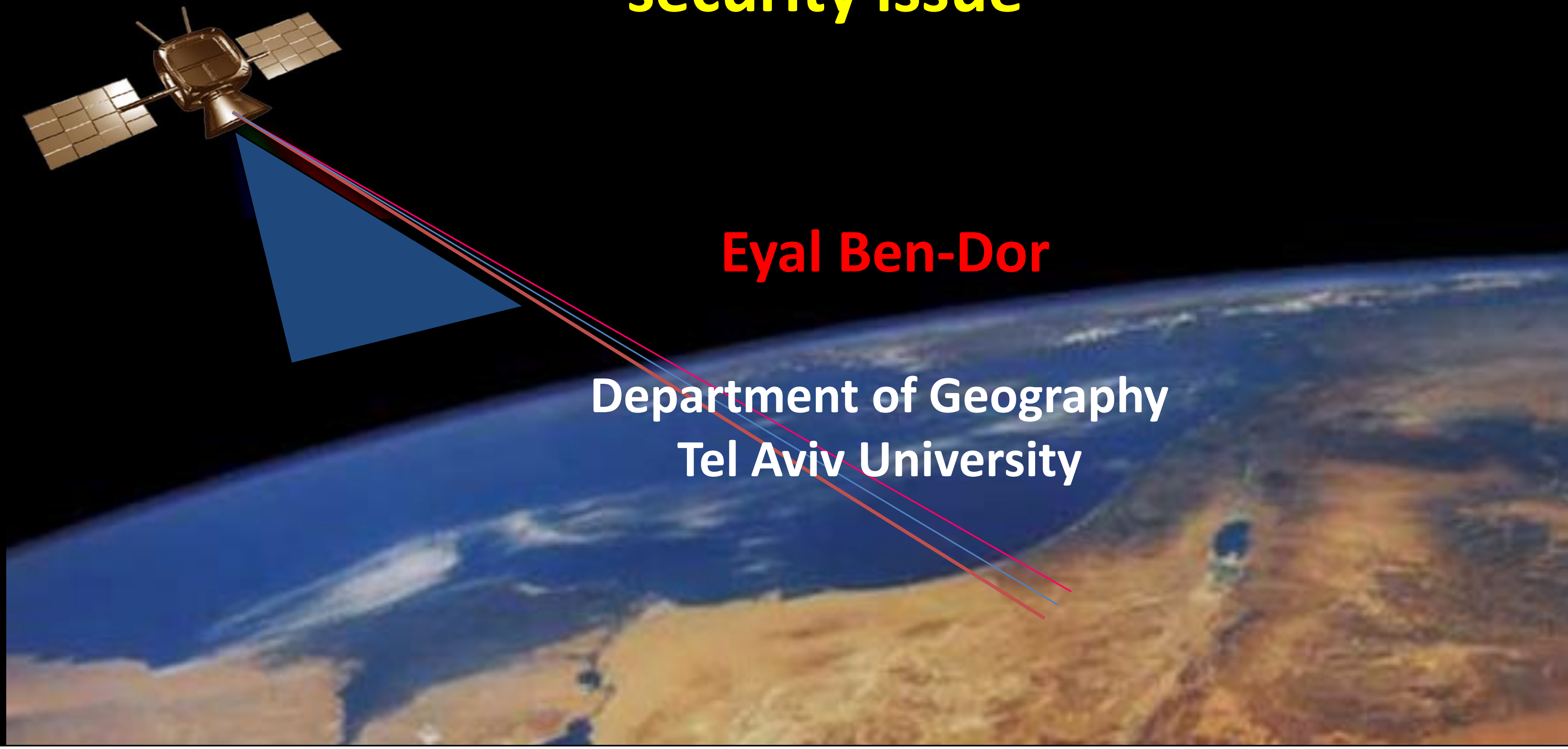
The role of soil spectral library for the food security issue



Eyal Ben-Dor

Department of Geography
Tel Aviv University

GROUP ON EARTH OBSERVATIONS

CRADLE

THE REMOTE SENSING LABORATORIES

Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East and Balkans and Developing Links with GEO related intiatives toward GEOSS

THE REMOTE SENSING LABORATORIES

The GEO-CRADLE project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 690133.

Why Soils Are Important

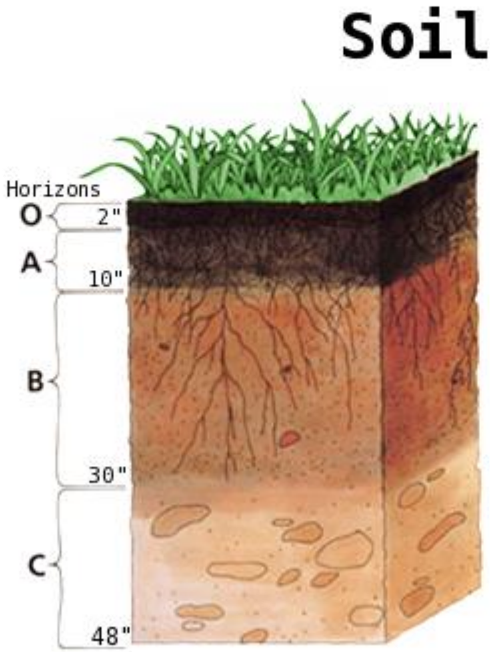
- Plants grow on soils .
- Plants support animal life.
- Plants and animals support human life.
- World population is rapidly increasing, with food demand.
- A large part of the world's population has inadequate nutrition.
- Soil affects all the above

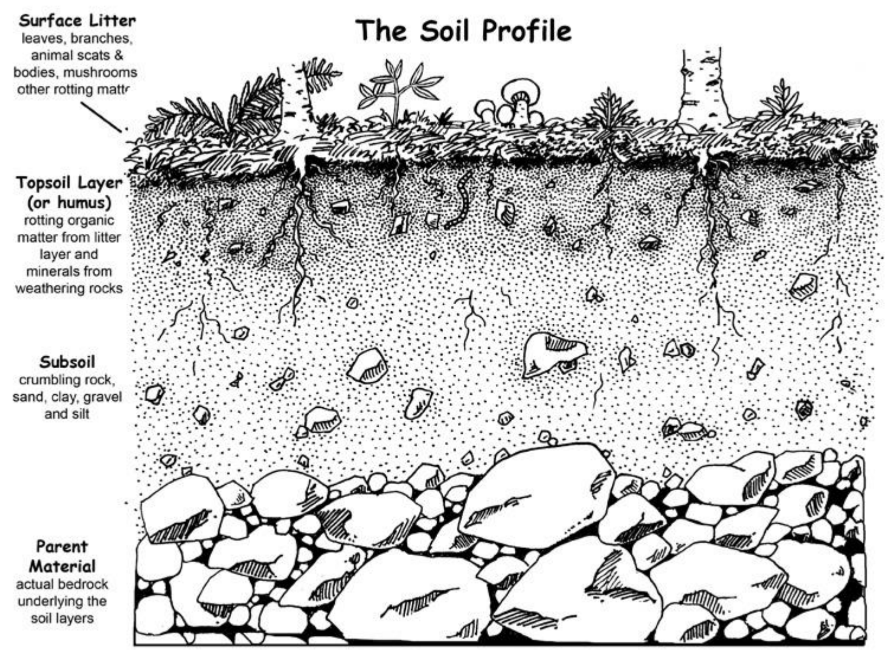
And is a critical factor in **Food Security**

Definition 1

Soil

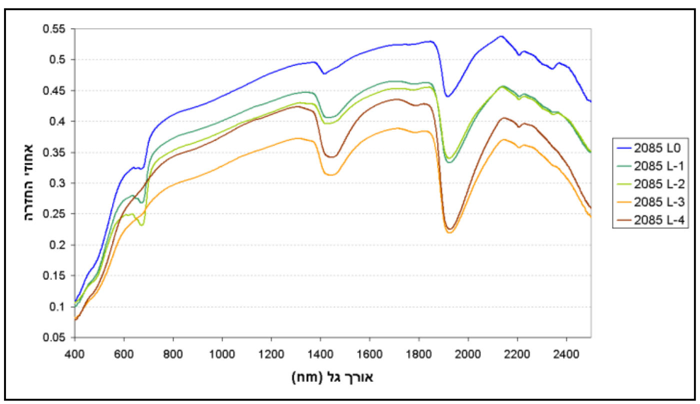
The upper layer of the earth (≈0-2m) represent its loose surface material which is dug, plowed and being a medium for plants to grow. **(Thompson 1957)**





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

THE REMOTE SENSING LABORATORIES

Definition 4

Imaging spectroscopy

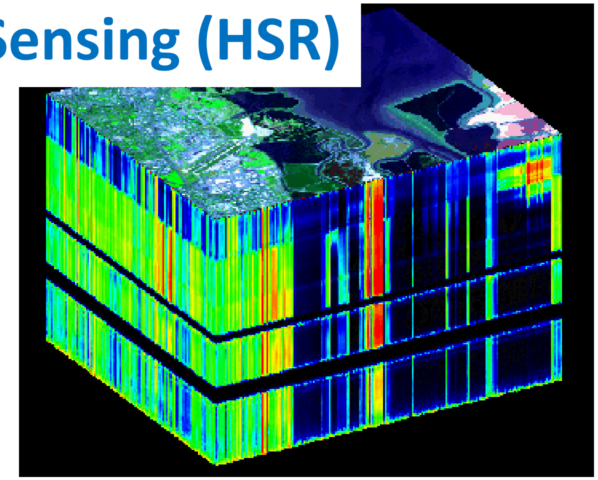
From Wikipedia, the free encyclopedia

Hyperspectral Remote Sensing (HSR)

Imaging spectroscopy is the simultaneous acquisition of spatially coregistered images in many spectrally contiguous bands. To be scientifically useful, such measurement should be done using an internationally recognized system of units. The image produced by imaging spectroscopy is similar to an image produced by a digital camera, except each pixel has many bands of light intensity data instead of just three bands: red, green and blue.

Imaging spectrometer data acquisition allows the quantitative and qualitative characterization of both, the surface and the atmosphere, using geometrically coherent spectrodirectional radiometric measurements. These measurements can then be used for the unambiguous direct and indirect identification of surface materials and atmospheric trace gases, the measurement of their relative concentrations, subsequently the assignment of the proportional contribution of mixed pixel signals (e.g., the spectral unmixing problem), the derivation of their spatial distribution (mapping problem), and finally their study over time (multi-
te

Ash plumes on Kamchatka Peninsula, eastern Russia. A MODIS image.



adjusted From A. Goetz 1994

Simultaneous acquisition of images in many registered spectrally- high resolution continuous bands at selected (or all) spectral domains across the UV-VIS-NIR-SWIR–MWIR-LWIR spectral region (0.3-12μm)

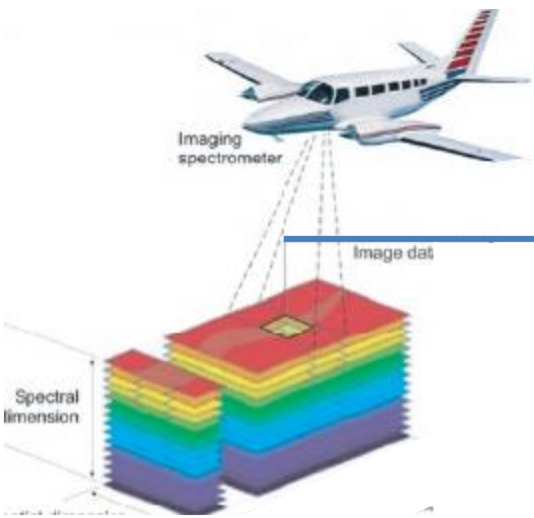
Strong Link between Point and Image Spectroscopy

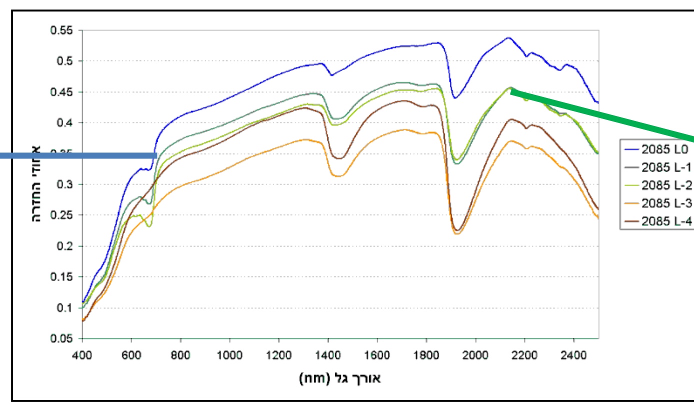
Image Spectroscopy

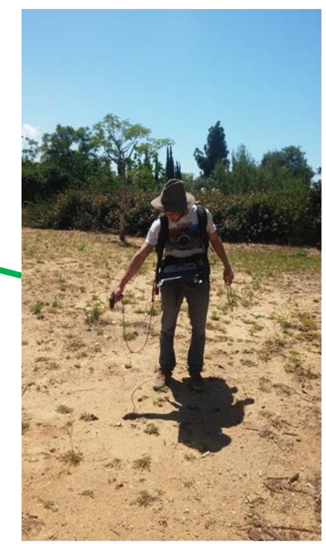
Geology
Vegetation
Water

Point Spectroscopy

Soil

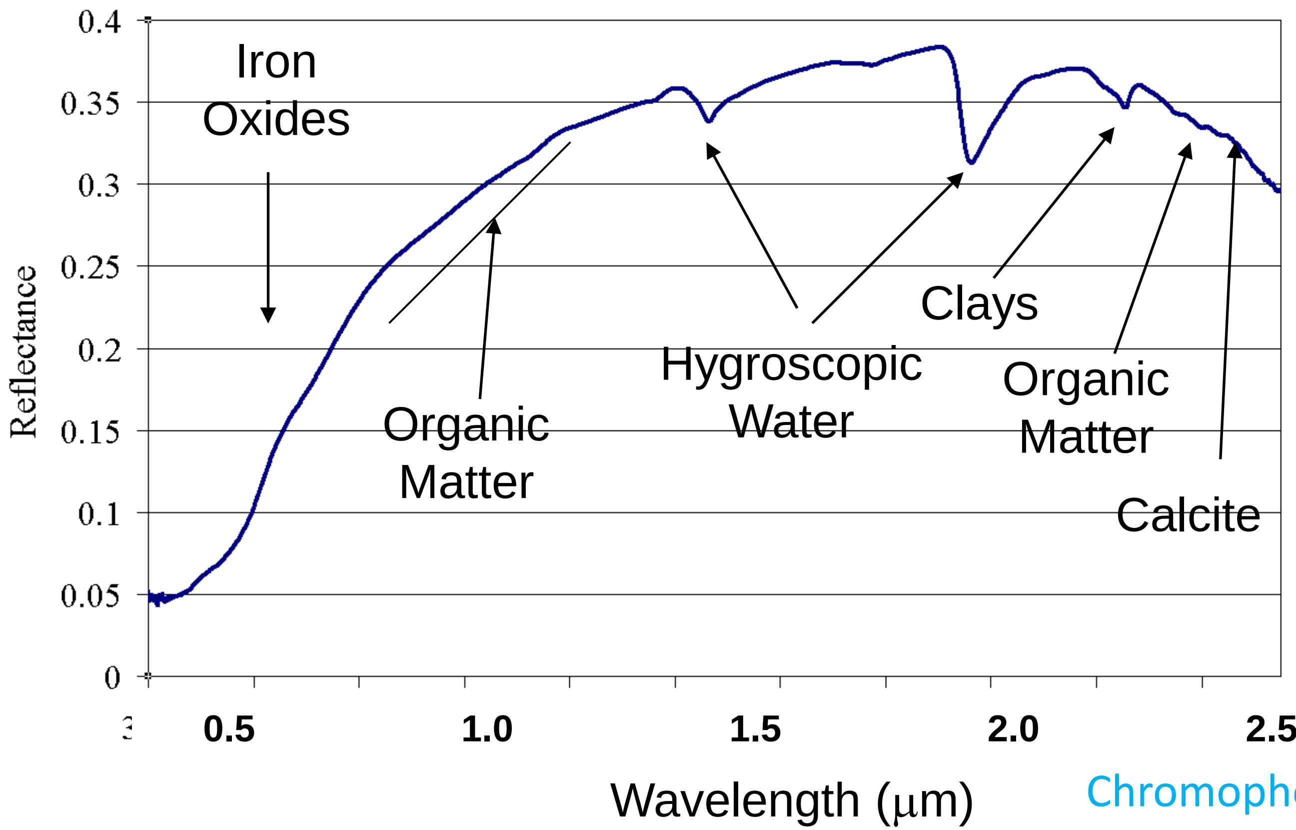






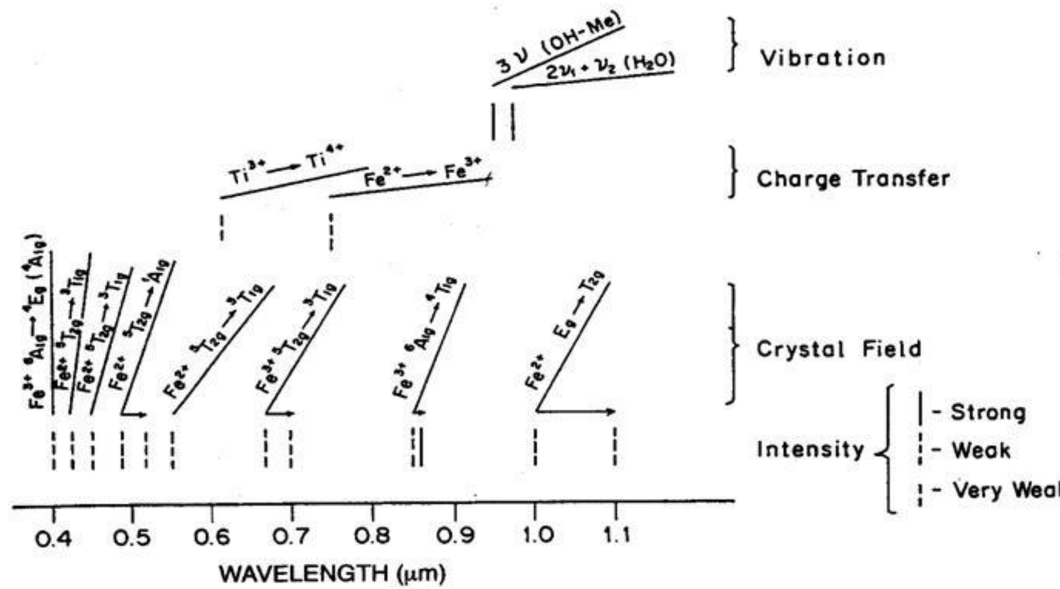
A typical Soil Spectrum

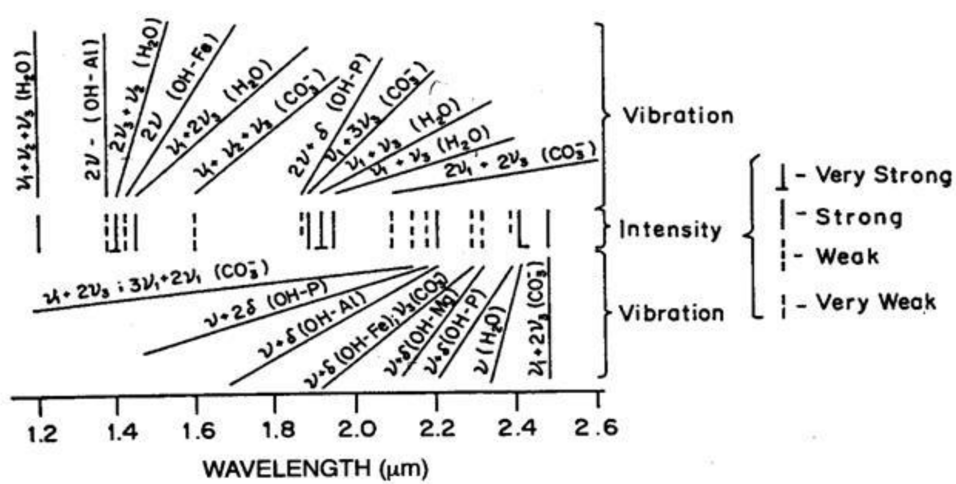
An effective way to simplest the complexity of the soil system



Chromophore = An attribute that interact
with the electromagnetic radiation

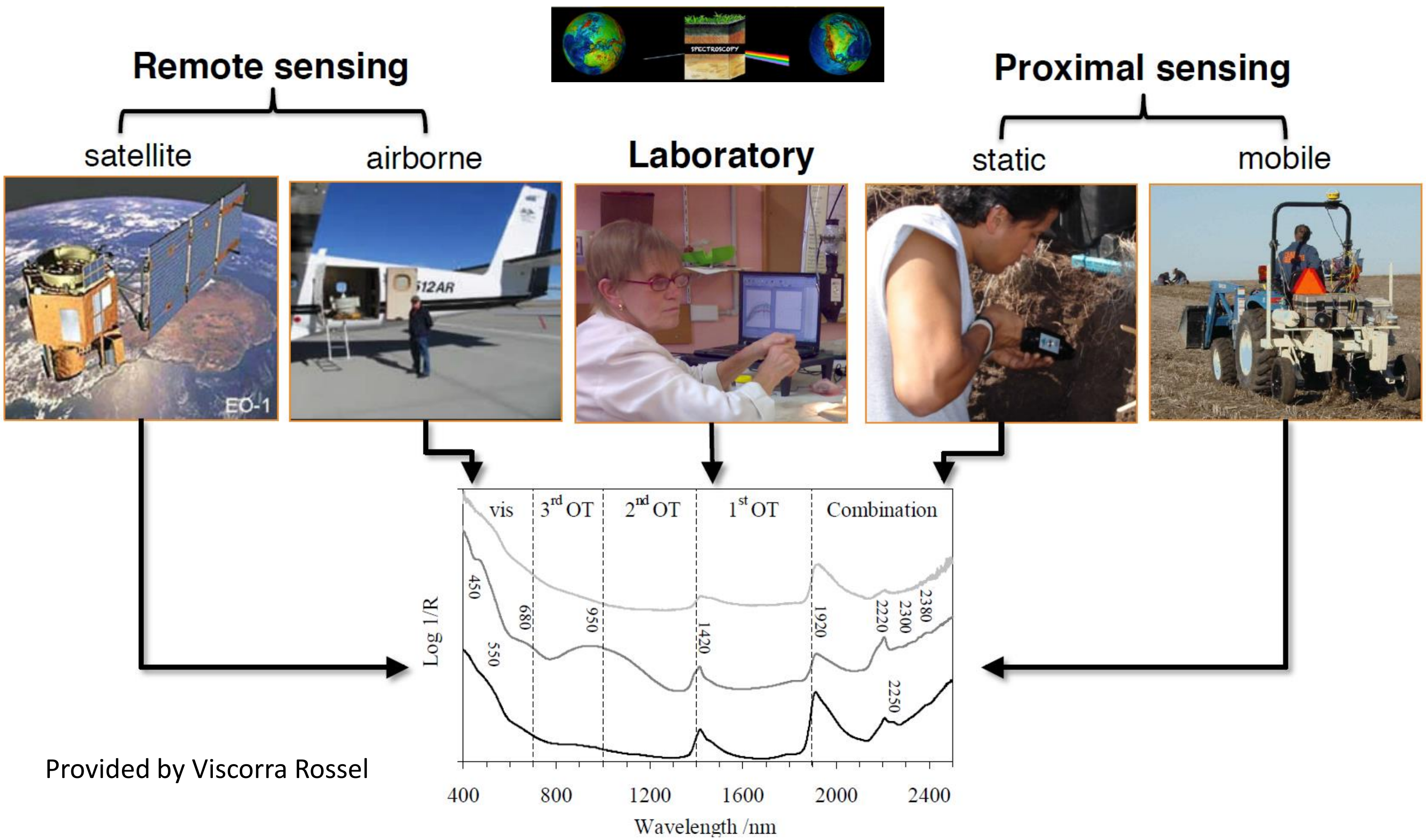
Absorption Mechanism





Soil Spectroscopy

Why so much interest in soil spectroscopy?



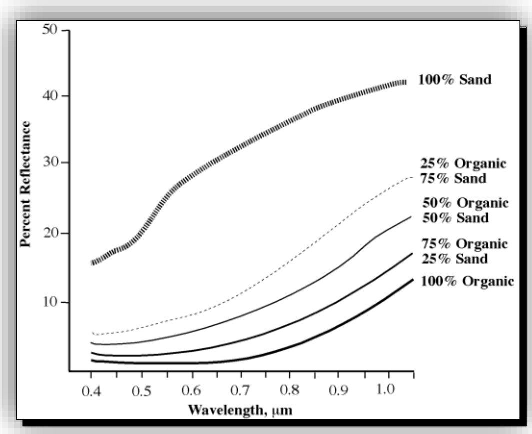
Provided by Viscorra Rossel

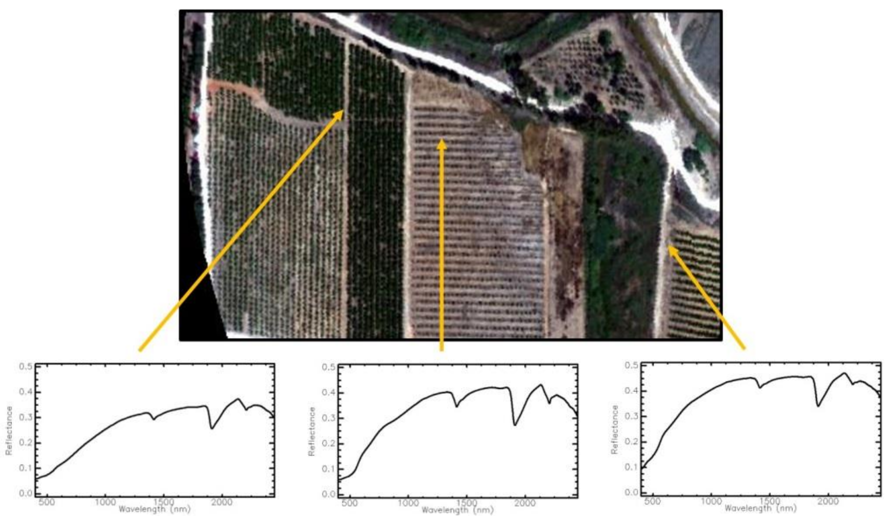
THE REMOTE SENSING LABORATORIES

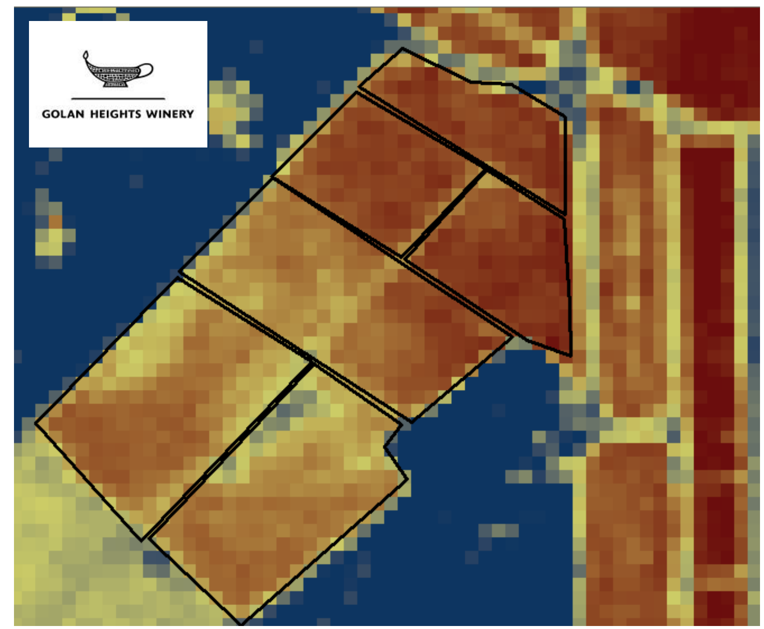
Variance of exposed soil – very important for the quality of wine

A very good example for “Food Security”

THE REMOTE SENSING LABORATORIES



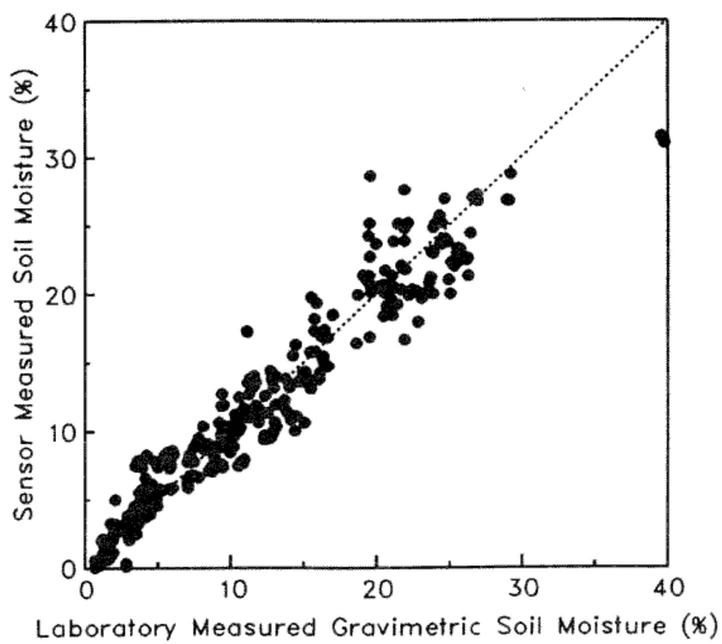




Soil Spectroscopy

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)

Soil Spectroscopy

THE REMOTE SENSING LABORATORIES

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

Soil Spectroscopy

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

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

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

The need of Soil Spectral Library

- For quantitative applications: many soil samples are needed (**Soil data mining of a “model” requires hundreds of spectra samples in order to provide reliable results**

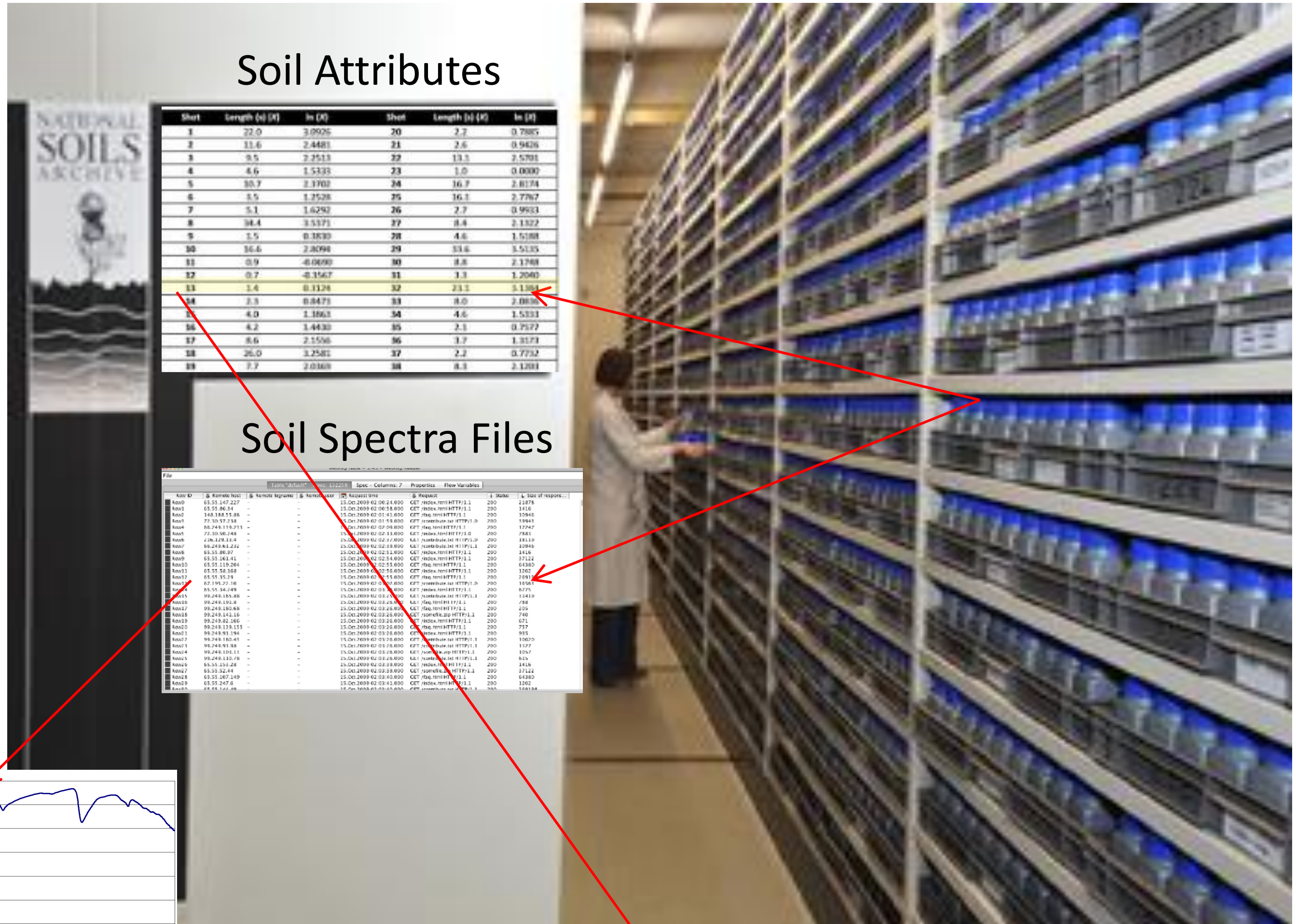
- Users are gathering many soil samples mostly under local scale

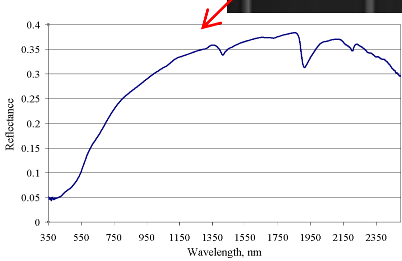
- A need for regional and global scales’ library is essential

- Gathering local and regional spectral data (soil spectral library) needs agreed “standard and protocols”

Soil Spectral Library : The Practical Structure

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





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

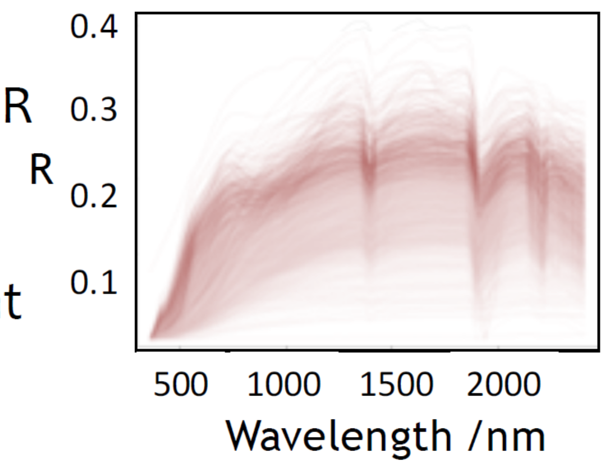
The Global Soil Spectral Library (GSSL)

THE REMOTE SENSING LABORATORIES

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

GSSL

THE REMOTE SENSING LABORATORIES

There is a publication on the global library

Authors: Those who contribute to GSSL established by Viscorra Rossel

Contents lists available at ScienceDirect

Earth-Science Reviews

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

ELSEVIER

EARTH-SCIENCE REVIEWS

A global spectral library to characterize the world's soil

CrossMark

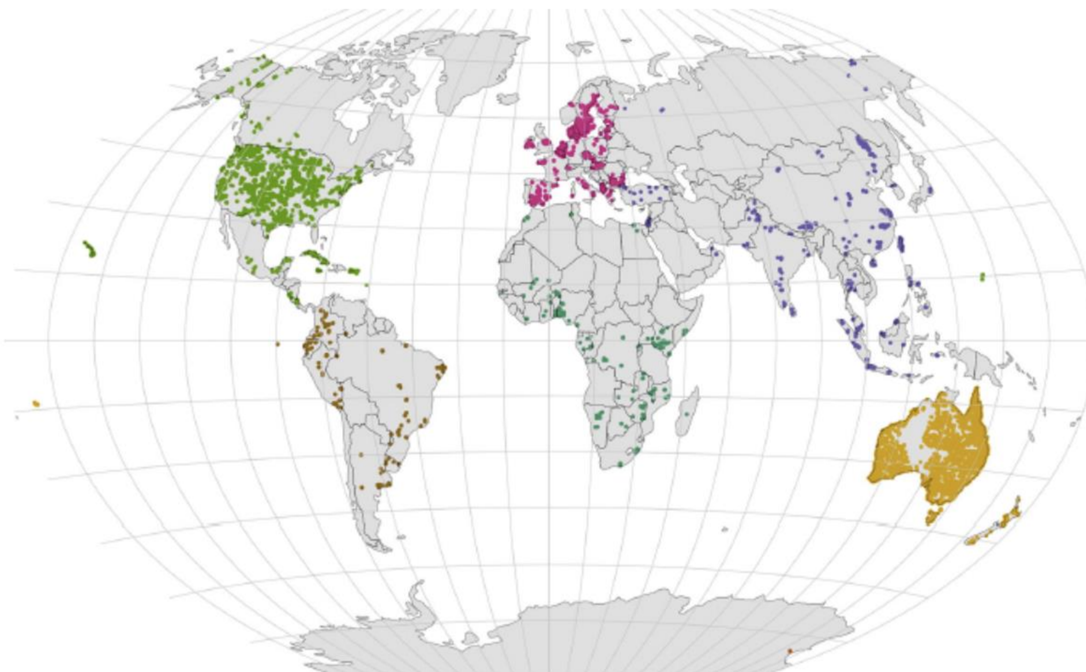
R.A. Viscarra Rossel [a,*], T. Behrens [b], E. Ben-Dor [c], D.J. Brown [d], J.A.M. Demattê [e], K.D. Shepherd [f], Z. Shi [g], B. Stenberg [h], A. Stevens [i], V. Adamchuk [j], H. Aïchi [k], B.G. Barthès [l], H.M. Bartholomeus [m], A.D. Bayer [n], M. Bernoux [l], K. Böttcher [o,p], L. Brodský [q], C.W. 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]

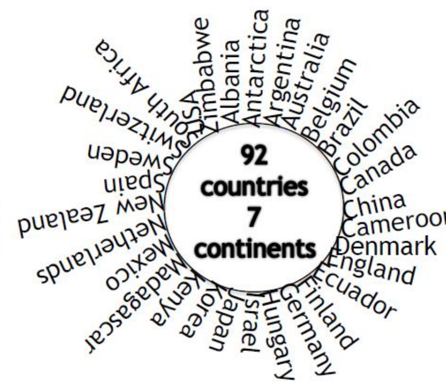
In 2015 Raphael effort yield the first GSSL

Global soil Soil VNIR-SWIR Spectra

Some 20,000 VNIR-SWIR (350-2500 nm) spectra from 12,509 sites

45 collaborators from 35 institutions





provided by Viscorra Rossel

GSSL

THE REMOTE SENSING LABORATORIES

Global soil vis–NIR spectra in numbers

Continent

- 8646 **Oceania**
- 5198 **North, Central America**
- 3518 **Europe**
- 3097 **Asia**
- 1621 **Africa**
- 1407 **South America**
- 144 **Antarctica**

Position

- 84% with **coordinates**
- 60% from the **0–30 cm**
- 30% from the **30–100 cm**
- 10% from **> 1m**

Attributes

- **pH** 20,515 (20,515)
- **Organic C** 17,931 (9757)
- **Clay** 17,463 (10,064)
- **Sand** 12,058 (3395)
- **CEC** 9588 (5014)
- **Silt** 9542 (1280)
- **Fe** 4151 (3311)
- **$CaCO_3$** 2960 (1388)

Description

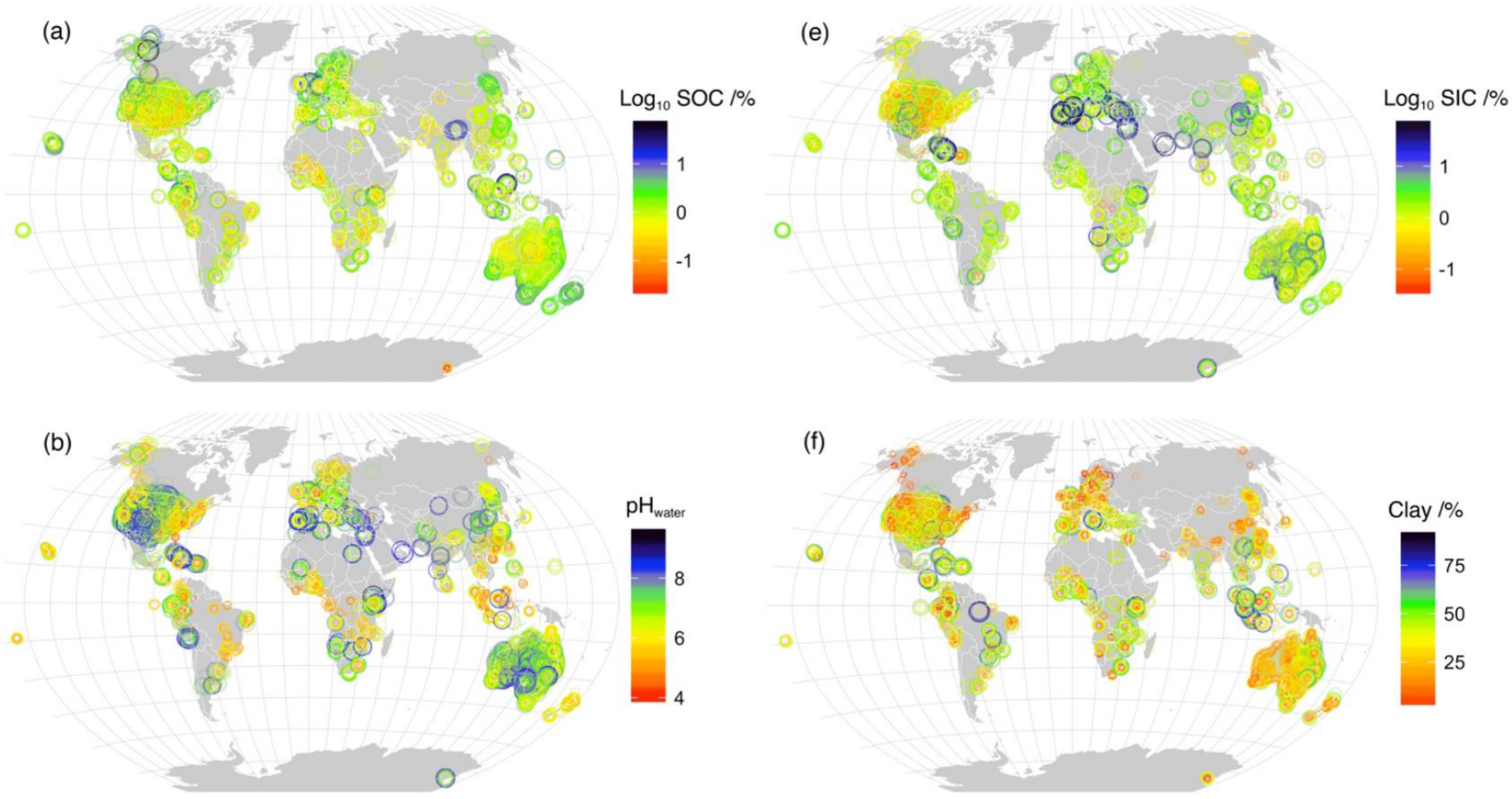
- 15% have **soil horizon**
- 95% with **FAO WRB**
- 80% with **land cover**

provided by Viscorra Rossel

GSSL – Example

Chemomtric (non linear spectral data mining) from the GSSL

Spatial distribution of predictions

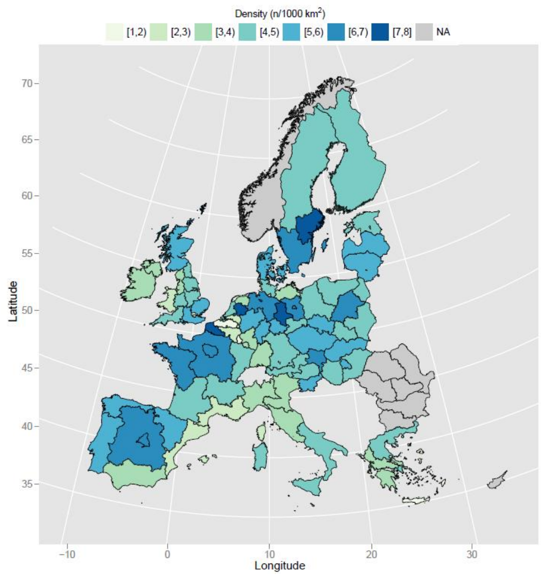


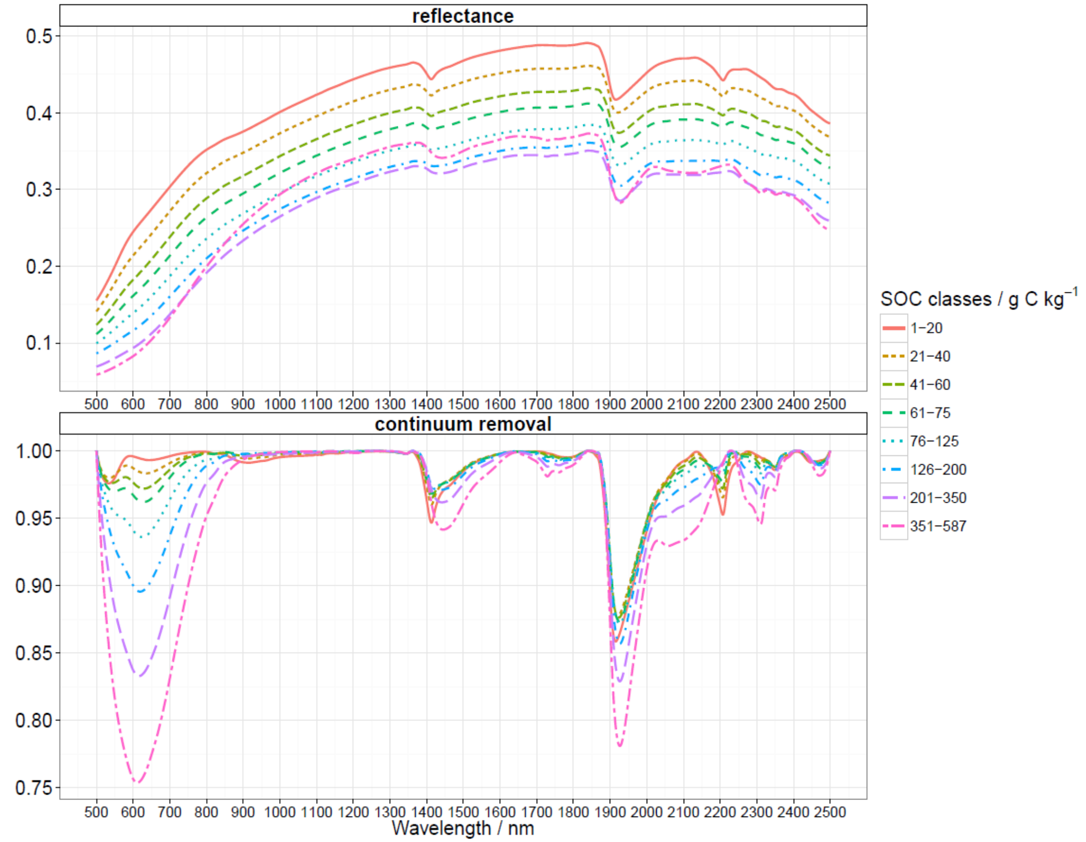
Viscorra Rossel 2015

The European Soil Spectral Library

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 Problem

- Users are focused on their own protocols (*measurement methods and instrumentation*)

- Protocol may affects the final spectrum…… (Spectral information is not reliable)

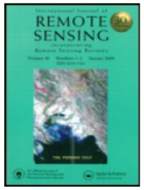
- Quantitative models are sensitive to these effects (small spectral changes) …..

- The *Chmometric* models from one protocol can not be used by other protocol

Standardization

Lucky Bay

Wiely Bay



Taylor & Francis

International Journal of Remote Sensing

ISSN: 0143-1161 (Print) 1366-5901 (Online) Journal homepage: http://www.tandfonline.com/loi/tres20

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

Veronika Kopačková & Eyal Ben-Dor

To cite this article: Veronika Kopačková & Eyal Ben-Dor (2016) Normalizing reflectance from different spectrometers and protocols with an internal soil standard, International Journal of Remote Sensing, 37:6, 1276-1290

To link to this article: http://dx.doi.org/10.1080/01431161.2016.1148291

Soil Mineralogy

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

Agustin Pimstein*
Facultad de Agronomía e Ingeniería Forestal of the Pontificia Universidad Catolica de Chile.

Gila Notesco
Eyal Ben-Dor
Dep. of Geography and Human Environment, Tel-Aviv Univ., P.O.B. 39040, 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-green-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

This article has supplemental material available online.
Soil Sci. Soc. Am. J. 75:2011
Posted online 18 Feb. 2011
doi:10.2136/sssaj2010.0174
Received 20 Apr. 2010.
*Corresponding author (pimstein@uc.cl).

Protocol

THE REMOTE SENSING LABORATORIES

Reflectance Measurement of Soils in the Laboratory: Standards and Protocols

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

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.

The Remote Sensing Laboratory, Department of Geography and Human Environment, Tel Aviv University, Israel

CSIRO Perth Australia

+972 36407049

*bendor@post.tau.ac.il

8/20/2013

A simple protocol has established for new users Since 2014

Geoderma 245–246 (2015) 112–124

Contents lists available at ScienceDirect

Geoderma

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

ELSEVIER

Reflectance measurements of soils in the laboratory: Standards and protocols

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

[a] Tel Aviv University (TAU), Israel

[b] CSIRO, Perth, Western Australia, Australia

ARTICLE INFO

Article history:
Received 4 October 2014
Received in revised form 3 January 2015
Accepted 5 January 2015
Available online xxxx

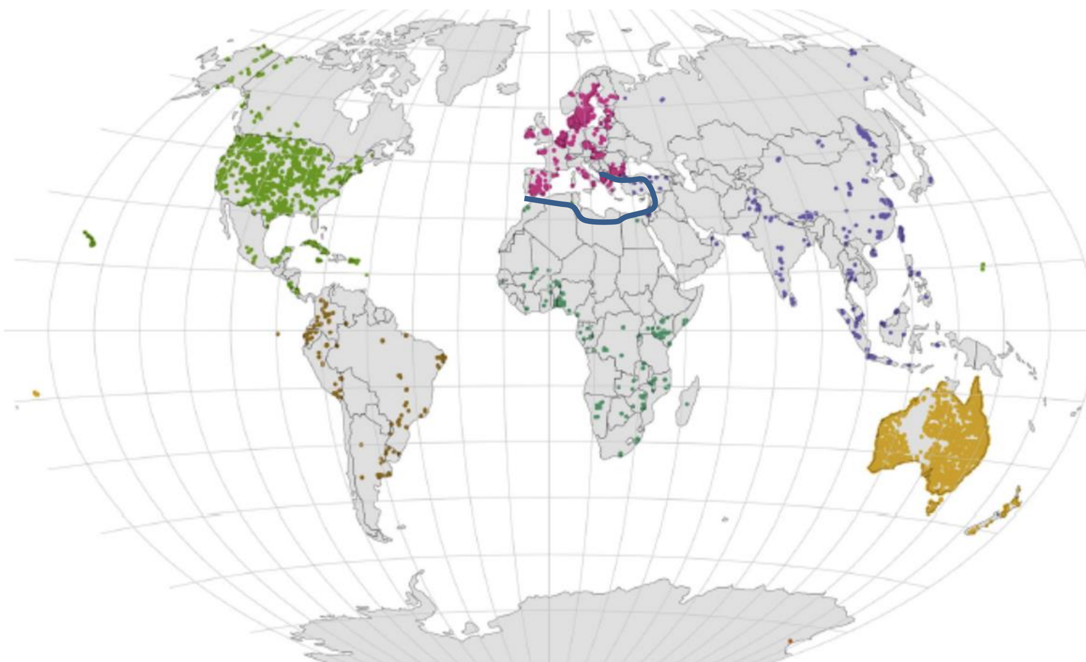
Keywords:
Soil spectroscopy

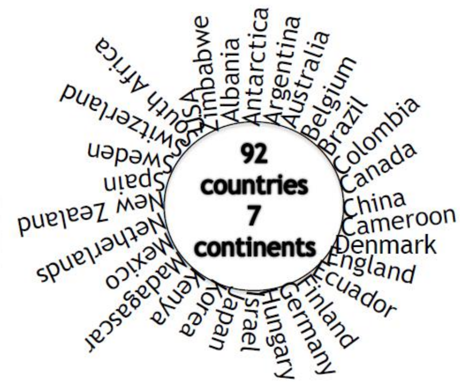
ABSTRACT

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

Enlarged the GSSL by Establishing the Foundation (knowhow, standard and protocol) to Build a Regional SSL

A Regional North Africa, Mediterranean, Balkan Soil Spectral Library





provided by Viscorra Rossel

New Standard for world wide Soil Spectral Library – Adopted Countries

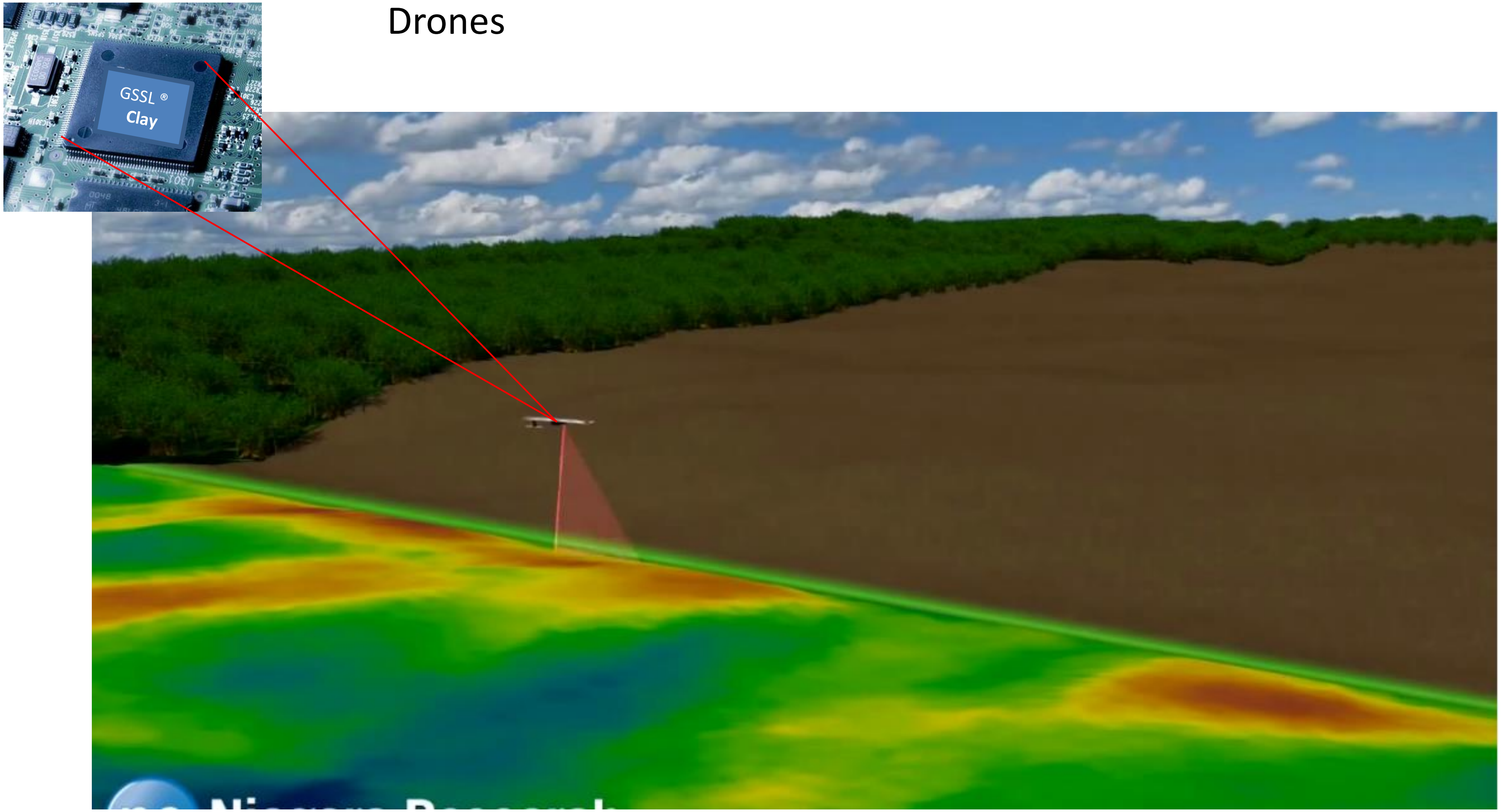
World Soil Spectral Library under ISS protocell

GROUP ON EARTH OBSERVATIONS

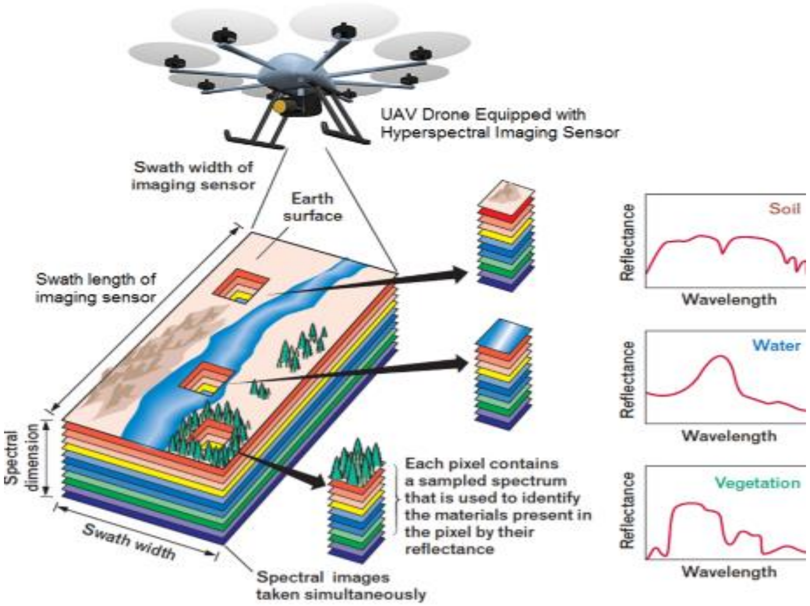
THE REMOTE SENSING LABORATORIES

The concept of using SSL : A vision

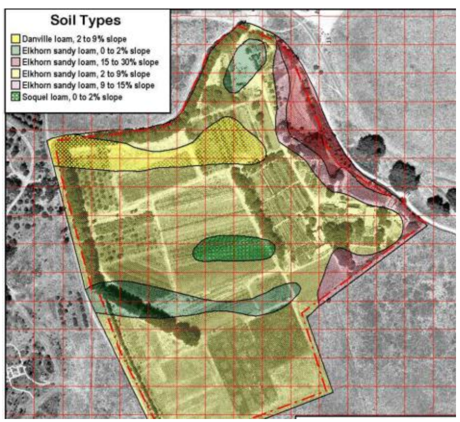
Drones



The Concept of Soil Mapping using LSSL and Drones in real time mode



Model from SSL



The Soil Spectroscopy Library Summary

THE REMOTE SENSING LABORATORIES

- Reflectance spectroscopy (RS) of soils is an important property for Food Security issues world wide.
- Spectral libraries are generated under regional, national, continental and global scales.
- The GSSL initiative paves the road to accumulate libraries from all scales and resources global wide
- SSLs from North Africa, Mediterranean and Balkan countries should be extend in order to be a data base for modern precision agriculture activities
- Standard and protocols are existing and should be used for the GEO SSL on behalf of GODAN and other initiative.

Thank You !!

THE REMOTE SENSING LABORATORIES