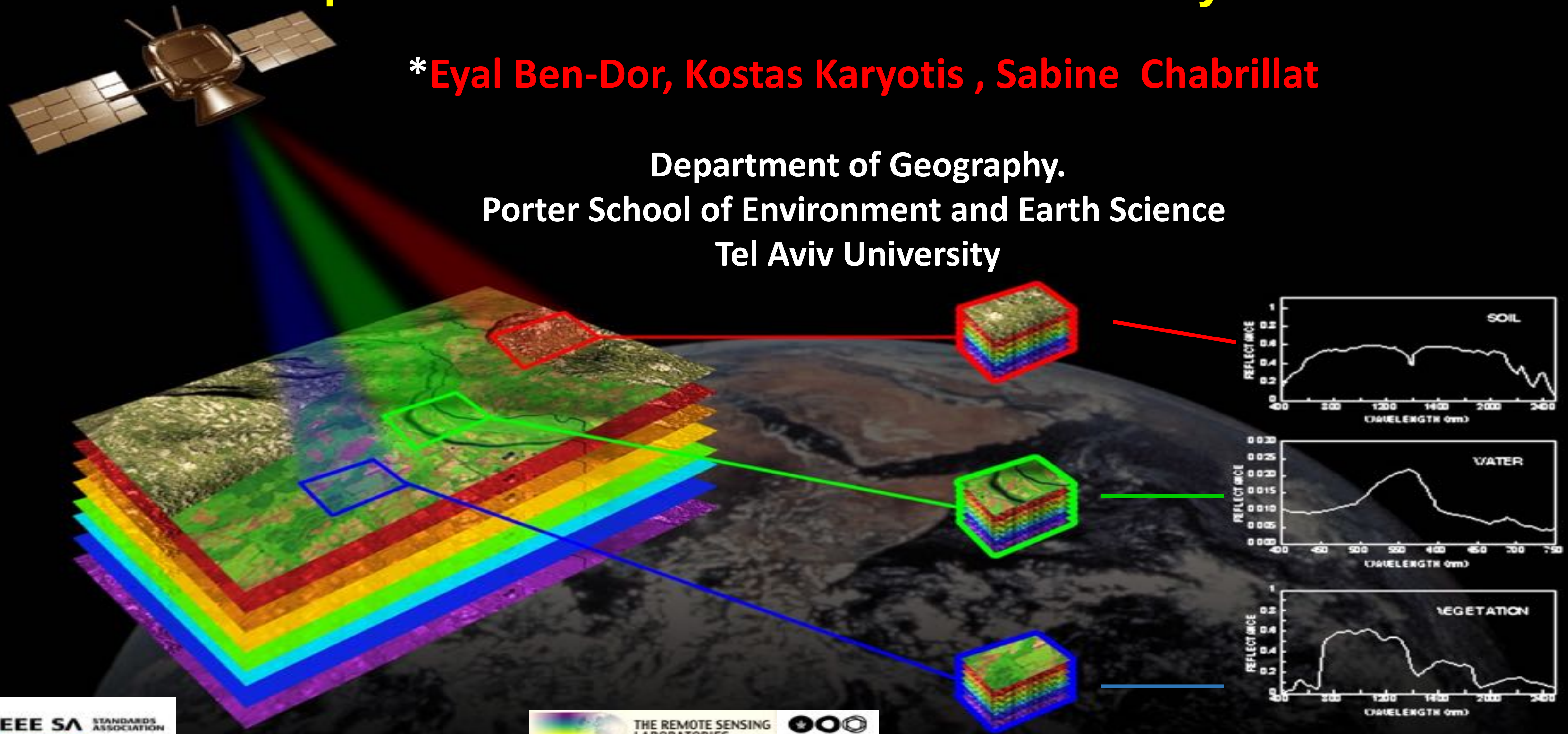
The IEEE SA Standard and Protocol Scheme for soil Spectral Measurement in both laboratory and field

*Eyal Ben-Dor, Kostas Karyotis , Sabine Chabrillat

Department of Geography.
Porter School of Environment and Earth Science
Tel Aviv University



IEEE SA STANDARDS ASSOCIATION

THE REMOTE SENSING LABORATORIES

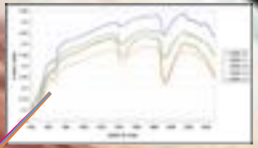
Why Soils ?

Soil, like air and water, is **critical to life on earth**. Soils are incredibly resilient, but they are also fragile and can easily be damaged or lost. Improved management of our planet's limited soil resource is essential to ensure a sustainable future and guarantee healthy and productive soils for **food security**, as well as to support many essential ecosystem services that **enable life on earth**


theguardian
Third of Earth's soil is acutely degraded due to agriculture

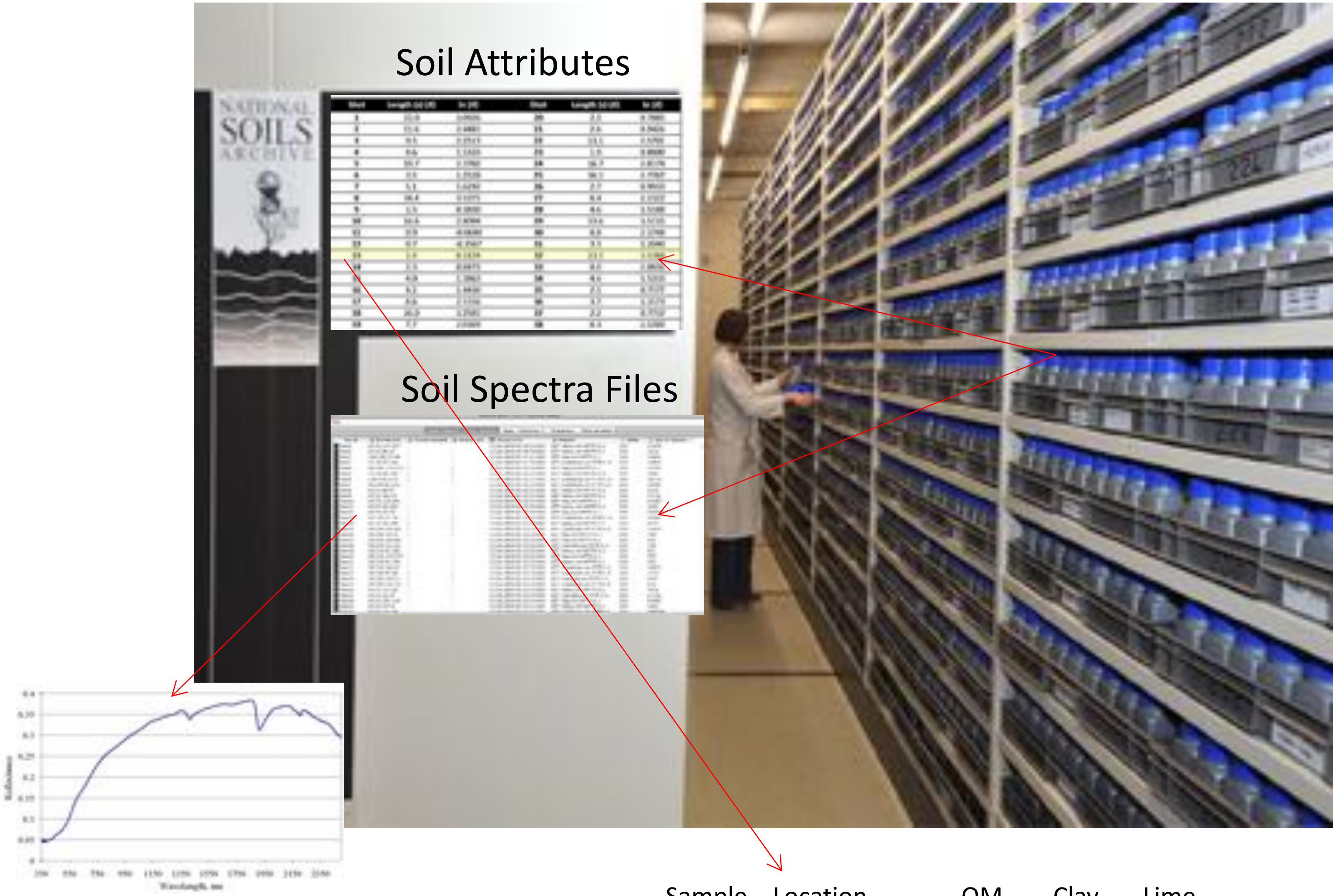
Soil Spectral library

An important archieve of soil samples for Food Security



Definition

Soil Spectral Library : A collection of soils samples with their spectra and wet chemistry data

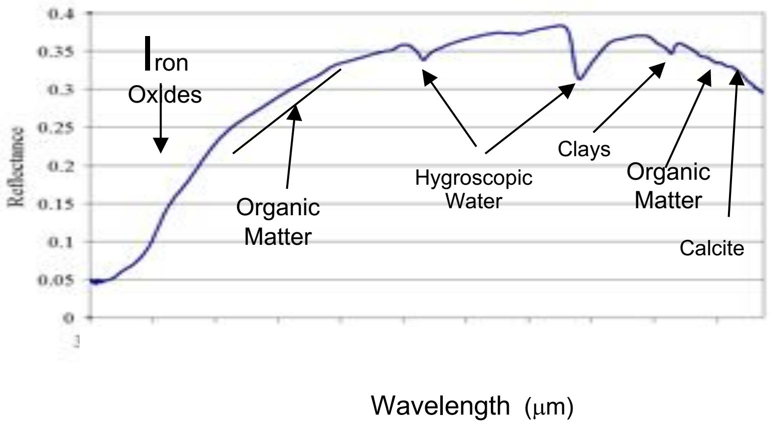


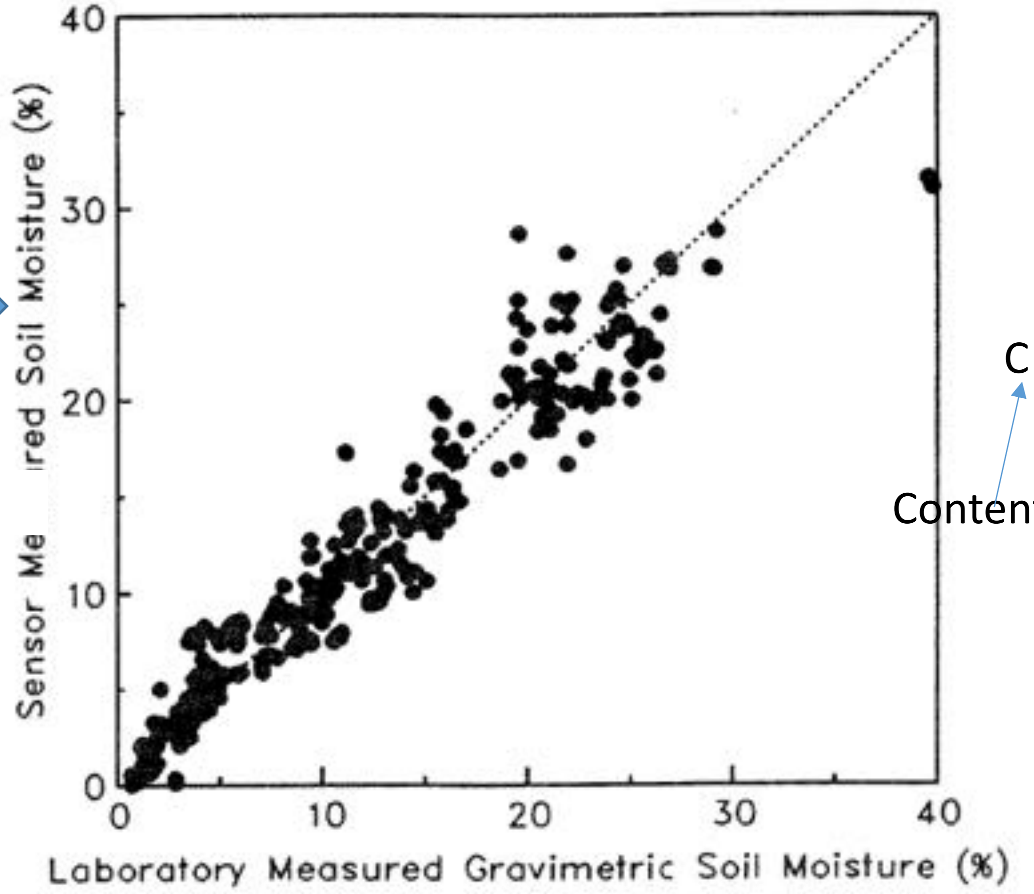
Sample	Location	OM	Clay	Lime....
A1	34,5467.67 36,654,32	2.4 %	34%	23.4%

First Paper on Soil Spectral Analysis (NIRS) 1986

Quantitative Method for spectral based SOIL properties

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





constants

$$C = B0 + B1.R1 + B2.R2 \ldots.Bn.Rn$$

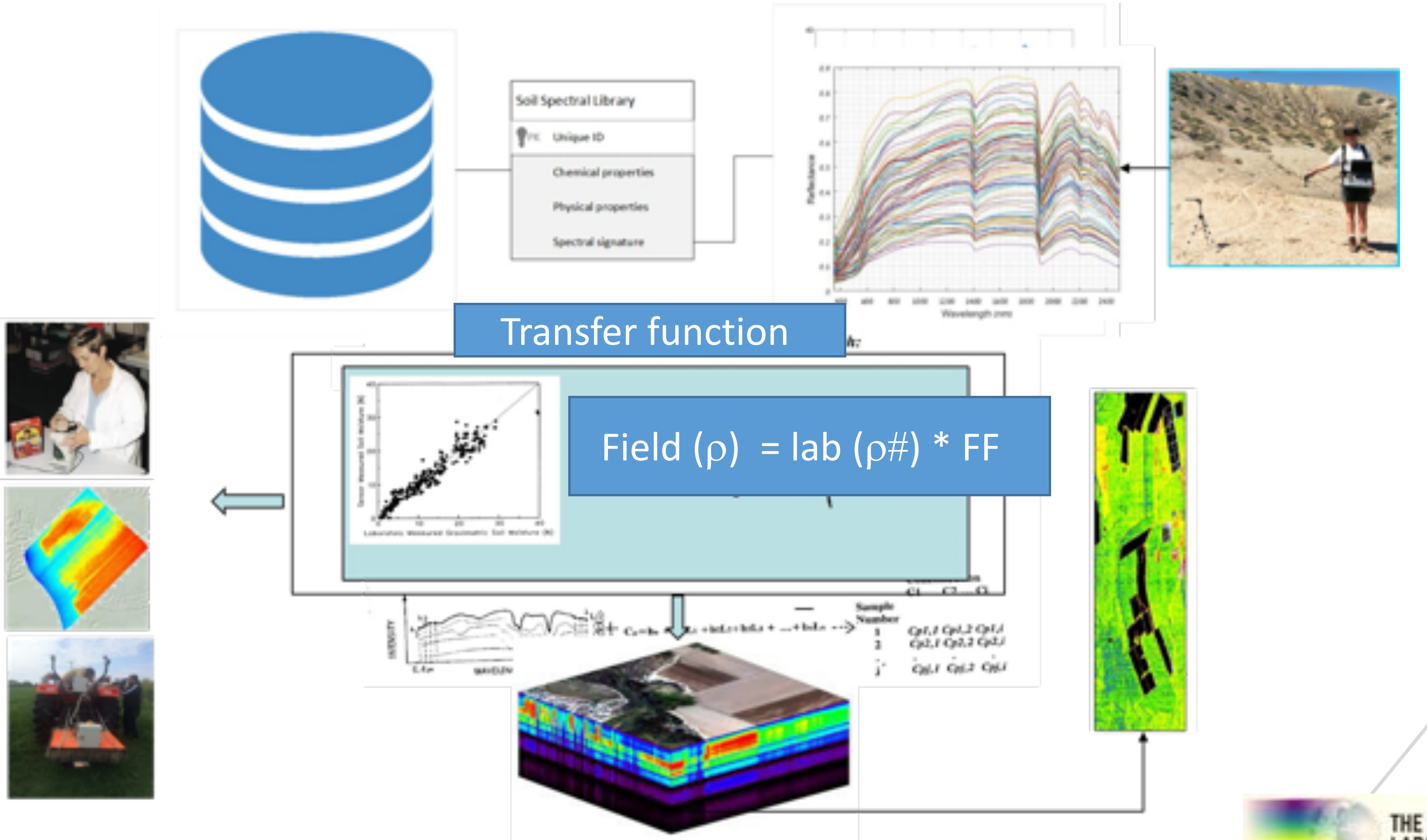
Content

Reflectance at wavelength n

Soil attribute	Spectral region	Spectral range (nm)	Multivariate method[a]	n_{calib} | n_{valid} [b]	RMSE	R^2	Authors
Acid (exch.); cmol/kg	VIS–NIR	400–2498	PCR (11)	30|119	24.4	0.65	Chang et al. (2001)
Al (exch.); cmol/kg	MIR	2500–25,000	PLSR	183		0.64	Janik et al. (1998)
Biomass (N); mg/kg	NIR	1100–2300	PLSR (8)	180 x-val		0.71	Reeves and McCarty (2001)
Biomass (N); mg/kg	NIR	1100–2498	PLSR (6)	120|59		0.79	Reeves et al. (1999)
Biomass; g/kg	MIR	2500–25,000	PLSR	23		0.69	Janik et al. (1998)
Biomass; mg/kg	VIS–NIR	400–2498	PCR (9)	30|119	389.71	0.60	Chang et al. (2001)
C (inorg.); g/kg	MIR	2500–25,000	PLSR (16)	177|60		0.98	McCarty et al. (2002)
C (inorg.) g/kg	NIR	1100–2498	PLSR (19)	177|60		0.87	McCarty et al. (2002)
C (inorg.); g/kg	VIS–NIR	400–2498	PLSR (6)	76|32	0.15	0.96	Chang and Laird (2002)
C (total); g/kg	MIR	2500–25,000	PLSR (17)	177|60		0.95	McCarty et al. (2002)
C (total); g/kg	NIR	1100–2498	PLSR (16)	177|60		0.86	McCarty et al. (2002)
C (total); g/kg	NIR	1100–2498	PLSR (7)	120|59		0.96	Reeves et al. (1999)
C (total); g/kg	VIS–NIR	400–2498	PLSR (5)	76|32	0.65	0.91	Chang and Laird (2002)
C (total); g/kg	VIS–NIR	400–2498	PCR (7)	30|119	0.79	0.87	Chang et al. (2001)
C; %	UV–VIS–NIR	250–2450	PLSR (6)	59 x-val	0.06		Walvoort and McBratney (2001)
C:N ratio	VIS–NIR	400–2498	PLSR (6)	76|32	0.21	0.88	Chang and Laird (2002)
CEC; cmol(+)/kg	MIR	2500–25,000	PLSR	183		0.88	Janik et al. (1998)
CEC; cmol(+)/kg	NIR	1000–2500	MRA (63 bands)	35|56		0.64	Ben-Dor and Banin (1995)
CEC; mmol(+)/kg	NIR	700–2500	PCR	121|40		0.67	Islam et al. (2003)
CEC; cmol(+)/kg	VIS–NIR	400–2498	PCR (8)	30|119	38.2	0.81	Chang et al. (2001)
CEC; cmol(+)/kg	VIS–NIR	350–2500	MARS	493|247	38	0.88	Shepherd and Walsh (2002)
CEC; mmol(+)/kg	UV–VIS–NIR	250–2500	PCR	121|40		0.64	Islam et al. (2003)
Σ exch. cations; cmol(+)/kg	MIR	2500–20,000	PLSR			0.84	Janik and Skjemstad (1995)
Ca; cmol/kg	MIR	2500–25,000	PLSR	183		0.89	Janik et al. (1998)
Ca; mmol(+)/kg	NIR	700–2500	PCR	121|40		0.72	Islam et al. (2003)
Ca; g/kg	VIS–NIR	400–2500	modified PLSR	309		0.90	Cozzolino and Moron (2003)
Ca (exch.); cmol(+)/kg	VIS–NIR	350–2500	MARS	493|247	28	0.88	Shepherd and Walsh (2002)
Ca (exch.); cmol(+)/kg	VIS–NIR	400–2498	PCR (12)	30|119	40	0.75	Chang et al. (2001)
Ca; mmol(+)/kg	UV–VIS–NIR	250–2500	PCR	121|40		0.67	Islam et al. (2003)
Carbonate; %	MIR	2500–20,000	PLSR			0.95	Janik and Skjemstad (1995)
EC; mS/cm	UV–VIS–NIR	250–2500	PCR	121|40		0.10	Islam et al. (2003)
Fe (DTPA); mg/kg	MIR	2500–25,000	PLSR	183		0.55	Janik et al. (1998)
Fe (free); %	NIR	700–2500	PCR	121|40		0.49	Islam et al. (2003)
Fe; mg/kg	VIS–NIR	400–2500	modified PLSR	311		0.90	Cozzolino and Moron (2003)
Fe (Mehlich III); mg/kg	VIS–NIR	400–2498	PCR (9)	30|119	61.4	0.64	Chang et al. (2001)
Fe (free); %	UV–VIS–NIR	250–2500	PCR	121|40		0.52	Islam et al. (2003)
K; g/kg	VIS–NIR	400–2500	modified PLSR	317		0.72	Cozzolino and Moron (2003)
K; mmol(+)/kg	UV–VIS–NIR	250–2500	PCR	121|40		0.00	Islam et al. (2003)
K (exch.); mg/kg	MIR	2500–25,000	PLSR	183		0.33	Janik et al. (1998)
K (avail.); mg/kg	VIS–NIR	400–1100	NN	41		0.80	Daniel et al. (2003)
K (exch.); cmol/kg	VIS–NIR	400–2498	PCR (13)	30|119	4.2	0.55	Chang et al. (2001)
LR; t/ha	MIR	2500–25,000	PLSR	188		0.86	Janik et al. (1998)
LR; t/ha	NIR	700–2500	PLSR	188		0.73	Janik et al. (1998)
Mg (exch.); cmol/kg	MIR	2500–25,000	PLSR	183		0.76	Janik et al. (1998)
Mg; mmol(+)/kg	NIR	700–2500	PCR	121|40		0.59	Islam et al. (2003)

Soil Spectral Analysis : The flood!

Laboratory soil spectral library proximate the field spectral response for hyperspectral remote sensing



Food and Agriculture Organization of the United Nations

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Global Soil Partnership

Overview | Partners | Regional partnerships | ITPS | Technical networks | Areas of work | Pillars of action | Resources

Global Soil Laboratory Network

Soils: if you cannot measure it, you cannot manage it

The Global Soil Laboratory Network (GLOSOLAN) was established in 2017 **to build and strengthen the capaci of laboratories in soil analysis and to respond to the need for harmonizing soil analytical dat** Harmonization of methods, units, data and information is critical to (1) provide reliable and comparab information between countries and projects; (2) allow the generation of new harmonized soil data sets; and (support evidence-based decision making for sustainable soil management.

The work of GLOSOLAN supports the implementation of the Sustainable Development Goals, the Agenda 20 for Sustainable Development and the mandate of FAO on food security and nutrition. For more informatic contact Lucrezia.Caon@fao.org

Giant leaps on Soil Spectroscopy

After the launch of the initiative on soil spectroscopy by the Global Soil Laboratory Network (GLOSOLAN) of the Global Soil Partnership in April 2020, GLOSOLAN organized its first plenary meeting on soil spectroscopy from 23 to 25 September 2020. The meeting was attended by 350 participants from 63 countries, including leading institutions and organizations in the field of soil spectroscopy.

28/09/2020 The meeting was successful in presenting the initiative, addressing concerns, defining the governance and decision-making procedures within the initiative and endorsing the GLOSOLAN work plan on soil spectroscopy for the period 2020-2021.

Special attention was given to the establishment of the global spectral calibration library, the soil property estimation service, capacity building on spectroscopy, and the writing of standard operating procedures on soil spectroscopy for which collaboration opportunities with the IEEE Standard Associations were explored. In order to overcome any data ownership issue, the global spectral calibration library will be established as a federated system connected to the Global Soil Information System (GLOSIS). Regional champion laboratories or institutes on soil spectroscopy will be identified to support capacity building activities and safeguard the fair participation of all regions to all the proposed activities.

The initiative will be regulated by the GSP Soil Data Policy. Participants were kindly invited to revise this document and to inform the GLOSOLAN coordinator whether an amendment to it is needed. In case of need, the request for an amendment will be presented at the 9th GSP Plenary Assembly in June 2021.

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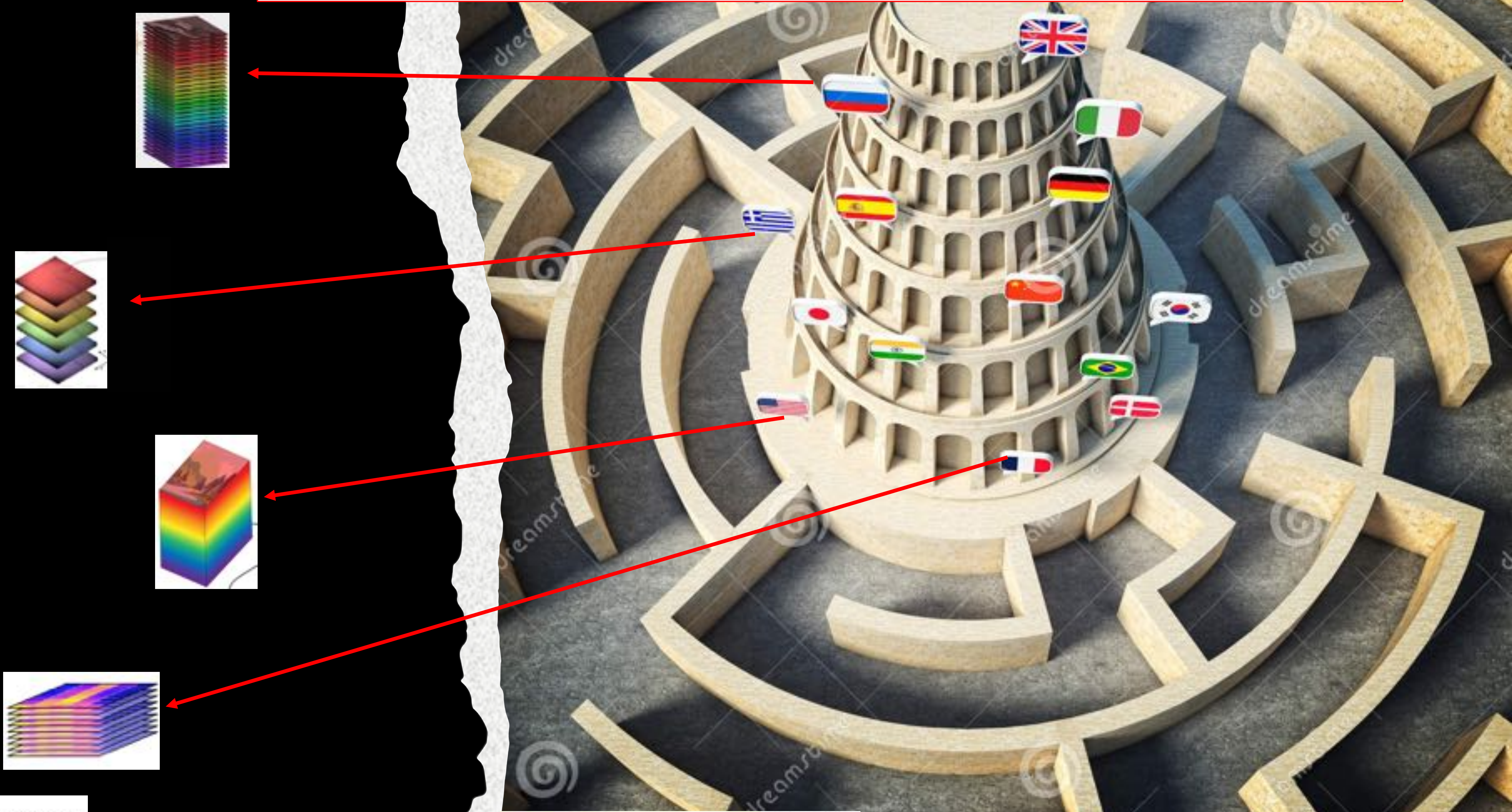
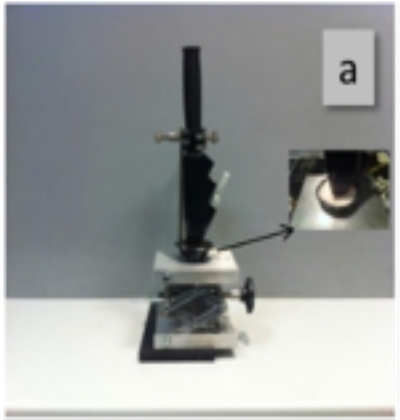
TEL AVIV UNIVERSITY אוניברסיטת תל אביב

SSL from different sources – Not speaking the same language- A Babylon Tower Situation

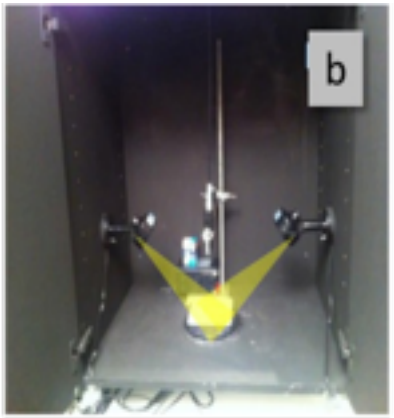


Different laboratory protocols and configurations:

CSIRO: CP

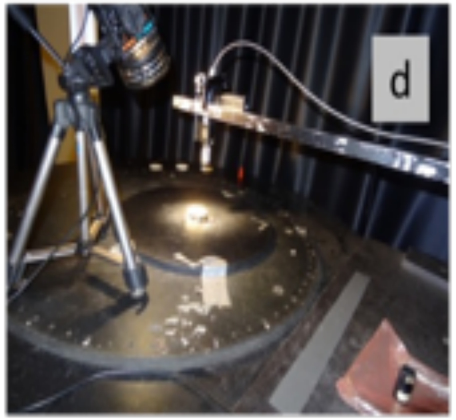


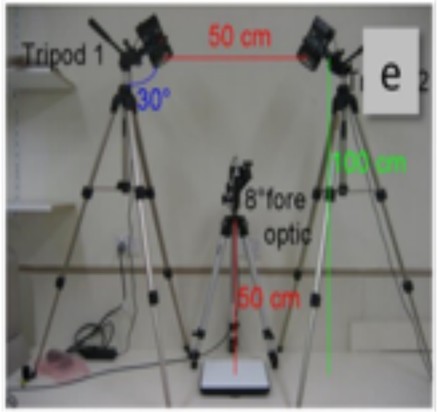
CSIRO: Dark box



TAU RSL: CP

GFZ Potsdam:
8° for optic fiber

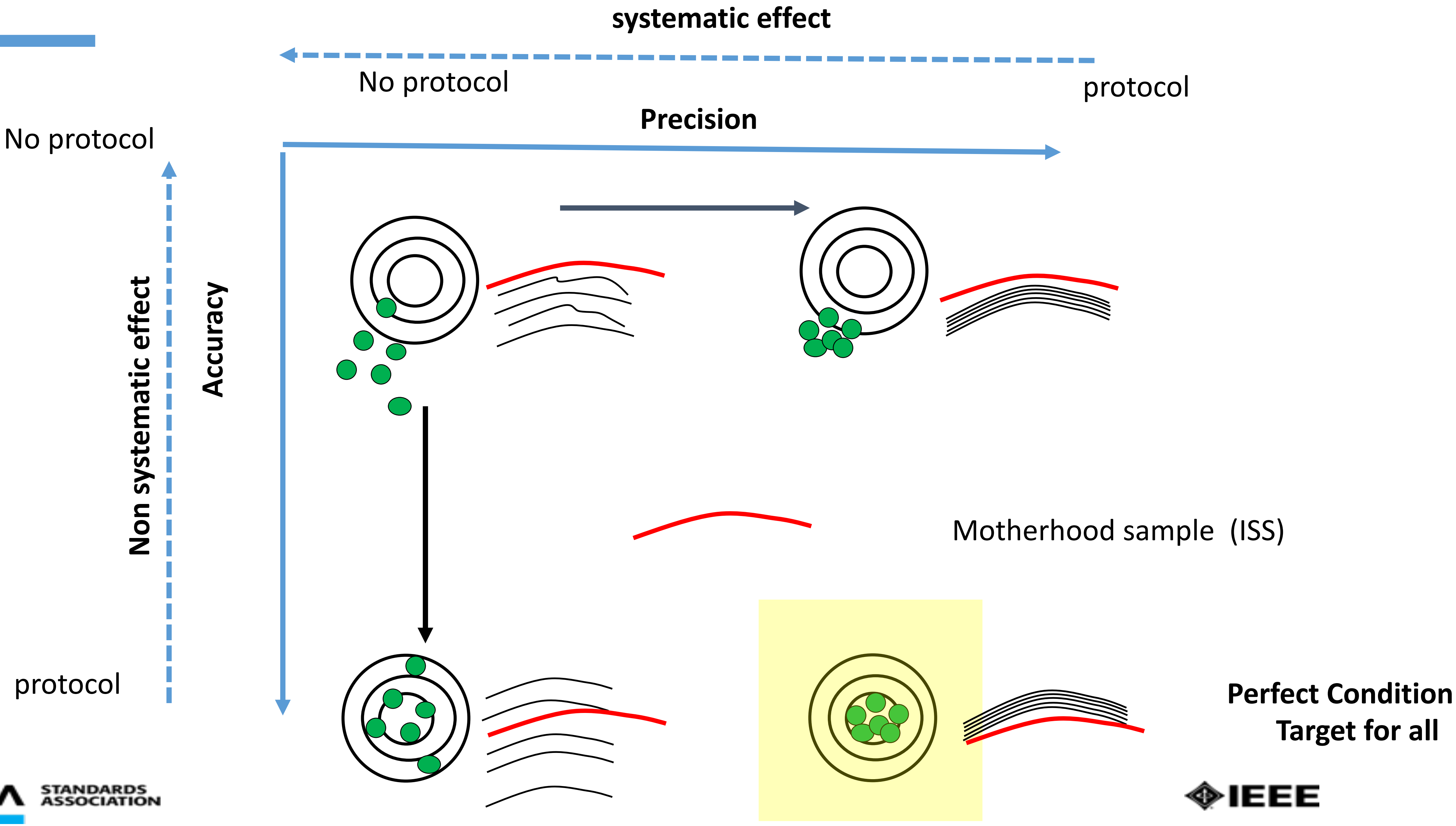




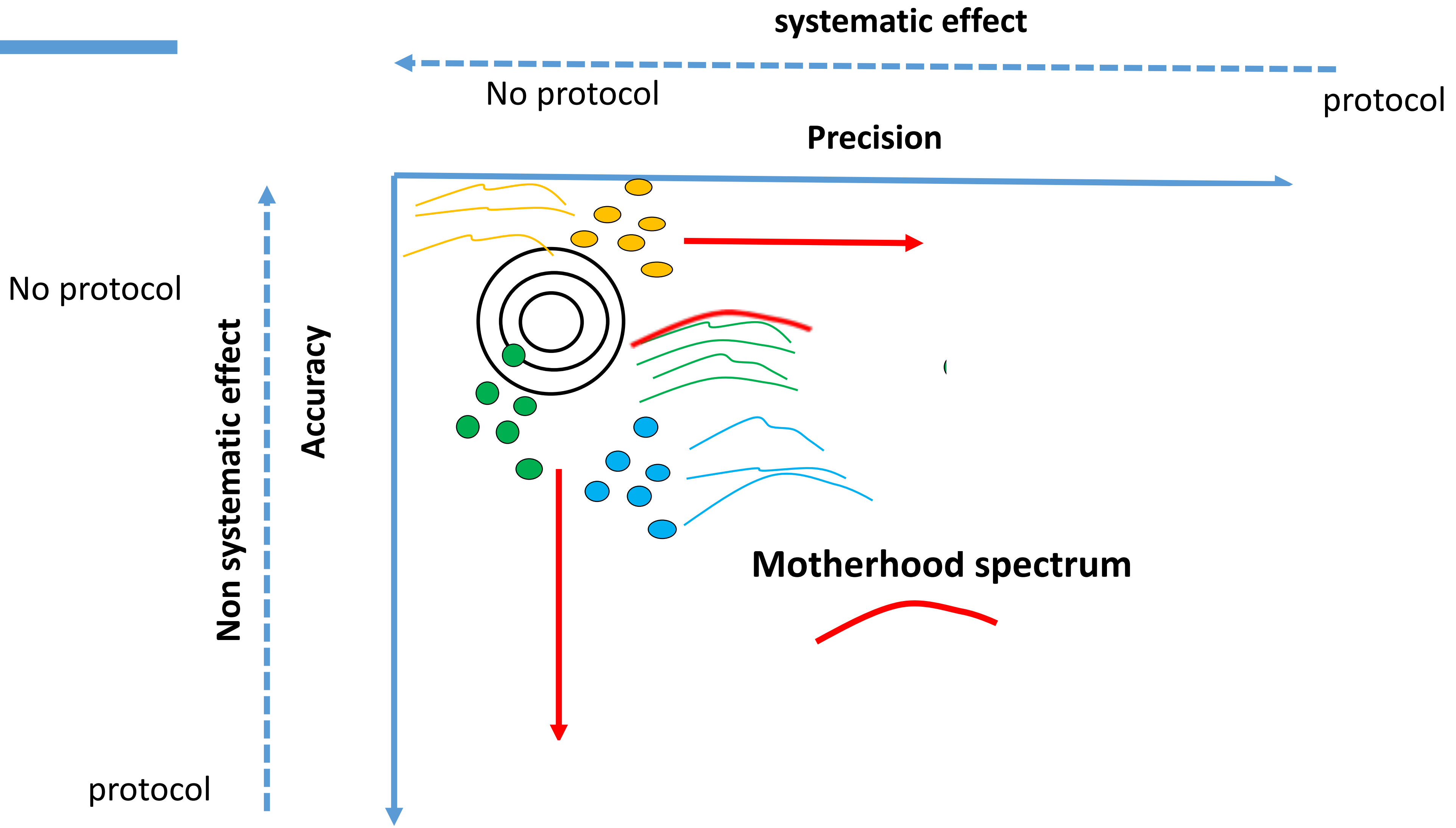
Spectral — not ISO

Chemical — ISO

One sample one spectrometer

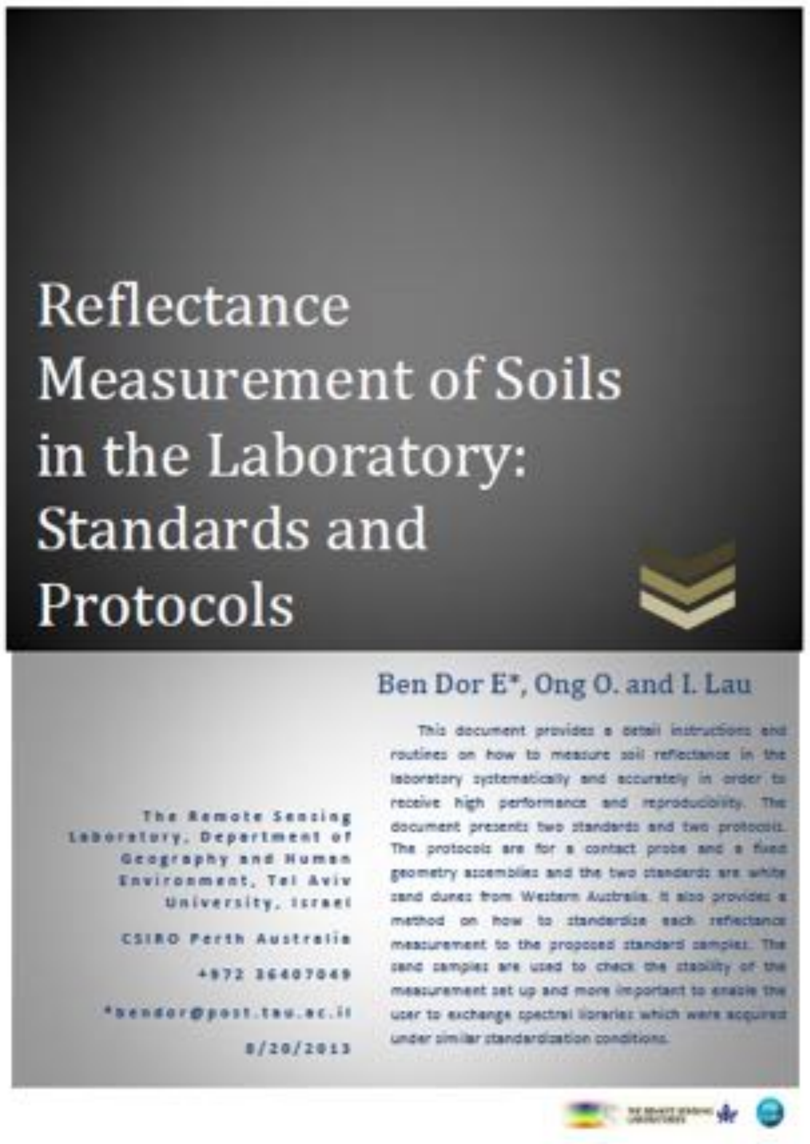


3 identical samples, 3 spectrometers all corrected to motherhood spectrometer



Perfect Condition
Target for all

The first solution to harmonize SSLs from different origions


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

Reflectance measurements of soils in the laboratory: Standards and protocols

Eyal Ben Dor, Cindy Ong, Ian C. Lau

STANDARDS DEVELOPMENT PROCESS IEEE P4005

LEADERS:
EYAL BEN-DOR, SABINE CHABRILLAT, KOSTAS KYROTIK

STANDARD PROTOCOL AND SCHEME FOR MEASURING SOIL SPECTROSCOPY

IEEE GEOSCIENCE AND REMOTE SENSING SOCIETY STANDARDS COMMITTEE (GRSS-SC)

JUNE 4, 2020

SCOPE

To develop a standard and protocol scheme that will be well agreed upon by the whole soil spectral and remote sensing community. The interested groups are: pedometrics, HSR, soil spectroscopy, and precision agriculture

NEED FOR THE PROJECT

As many SSLs are being generated today worldwide and others are in preparation, merging them is highly important for their implementation into worldwide HSR data. Another important need for this project is to join the SSL databases into a large homogeneous database that will cover all soil types worldwide and can be used by anyone at any time.

KOM – LIST OF ATTENDEES (KOM)

IEEE SA STANDARDS ASSOCIATION

13. List of attendees

Agnelo Rocha da Silva, METER Group, Inc. USA,
Andreas Christofe, University of Cyprus in Limassol
Andrew Vincent Bradley, University of Nottingham
Anna Brook, Geography Department, Haifa University
Anne Gobin, VITO
Antonella Tornato, ISPRA-Institute for Environmental Protection and Research (Rome)
Arwyn Jones, European Commission Joint Research Centre
Asa Gholizadeh, Czech University of Life Sciences Prague
Bas van Wesemael, Universite catholique de Louvain
Brendan Malone, Soil Processes & Function CSIRO
Charles M. Bachmann, Rochester Institute of Technology, Rochester, N.Y
Christian Omuto, FAO
Diofantos Hadjimitsis, Cyprus University of Technology
Dorian Gorgan, Technical University of Cluj-Napoca
Emmanuelle Vaudour, AgroParisTech
Euclides Lourenco Chuma, Photonics Innovation Institute
Eyal Ben Dor, Tel Aviv University | TAU
Fenny van Egmond, Wageningen Environmental Research
Gifty E. Acquah, Rothamsted Research, Harpenden, UK,
Gil Eshel, Soil and Water Conservation Center Israel
Ian Lau, CSIRO Perth
Jean Robertson, The James Hutton Institute, Scotland UK,
José Alexandre Melo Demattê, University of Sao Paulo
Konstantinos Karyotis, Interbalkan Environment Center
Kyriacos Themistocleous, Cyprus University of Technology
Lubos Boruka, Life Science University Prague
Luigi Verzola, STE
Macoumba Loum, National Institute of Pedology
Maria Augusta Knadel, Aarhus University, Dept. of Agroecology
Mariana Hoelent, Unidad de Desarrollo de Applicioned Especificas Buenos Aires
Martin Schodlok, Federal Institute for Geosciences and Natural Resources (BGR)

standards.ieee.org

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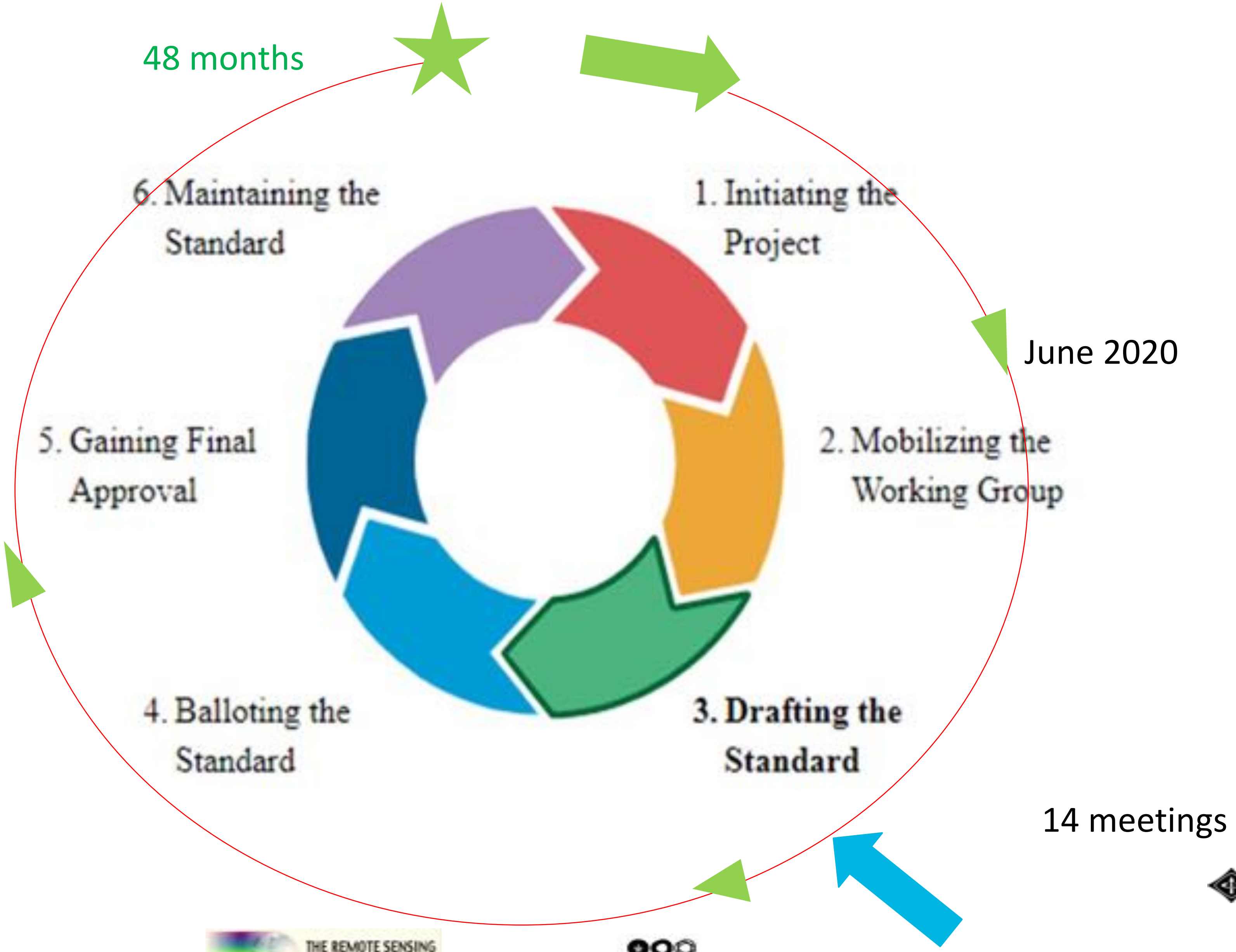
Michael Berger, ESA/ESRIN
Milo Lulevo, Agrocares BV
Nicolas Francos, The Remote Sensing Laboratory, Tel Aviv University
Nikos Tsakiridis, Interbalkan Environment Center
Nunzio Romano, University of Napoli
Raffaele Casa, University of Tuscia
Robert Milewski, Helmholtz Center Potsdam GFZ German Research Center for Geosciences
Sabine Chabrillat, Helmholtz Center Potsdam GFZ German Research Center for Geosciences
Sadeq Dwenee, Ministry of science and technology/ Directorate of agricultural research, Iraq
Simone Pascucci, CNR IMAA
Siri Jodha Khalsa, National Snow & Ice Data Center
Stefano Pignatti, CNR IMAA
Theodora Angelopoulou, Laboratory of Remote Sensing, Aristotle University of Thessaloniki
Thomas Schmid, Soil Conservation and Remediation Unit, Department of Environment
Veronika Strnadová, Czech Geological Survey
Viktor Bacu, Technical University of Cluj-Napoca
Yoran Ogen, Martin-Luther University Halle-Wittenberg Institute of Geosciences and Geography Department of Remote Sensing and Cartography, Halle (Saale), Germany

48 members

Quorum 24<

STANDARDS DEVELOPMENT STAGES



S-WG suggested leaders

- **SWG1 - Optical operational scheme (0.4-2.5 um): Eyal Ben Dor + Sabine Chabrillat (RSL-TAU, GFZ)**
- **SWG2- Thermal operational scheme (3-15 um): Martin Schodlok (BGR)**
- **SWG3- Data saving and archiving (optical + thermal): Jose Dematte (USP)**
- **SWG4 - Cross calibration for spectral exchange (optical + thermal): Milla Luleva, Jonatan Senderman (AgroCares)**
- **SWG5- Spectral performance assessment for Optical and Thermal spectral ranges: Bas van Wesemael (UCL)**
- **SWG6- Field operational scheme (Optical): Thomas Schmid + Nicolas Francos (CIEMAT, RSL-TAU)**

In all SWG - Consideration to Mineral and Organic soils Should be given

IEEE – SA P4005
WG Protocol for Soil for measurements in the laboratory Point and image spectrometer VIS-NIR-SWIR region

DRAFT

SWP 1
(SWP 4, 5)

v-6

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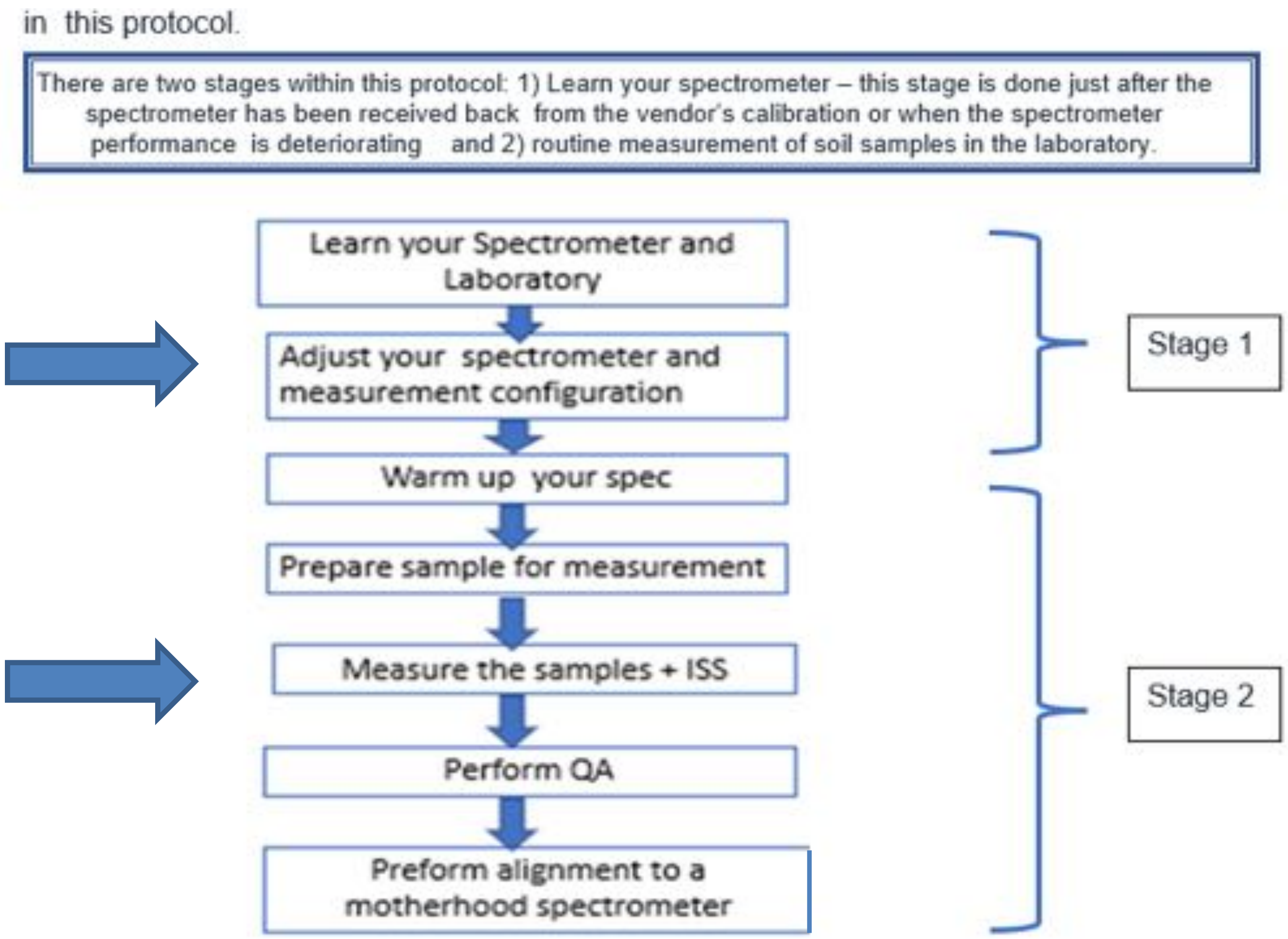
Reflectance Measurement stages in the Laboratory

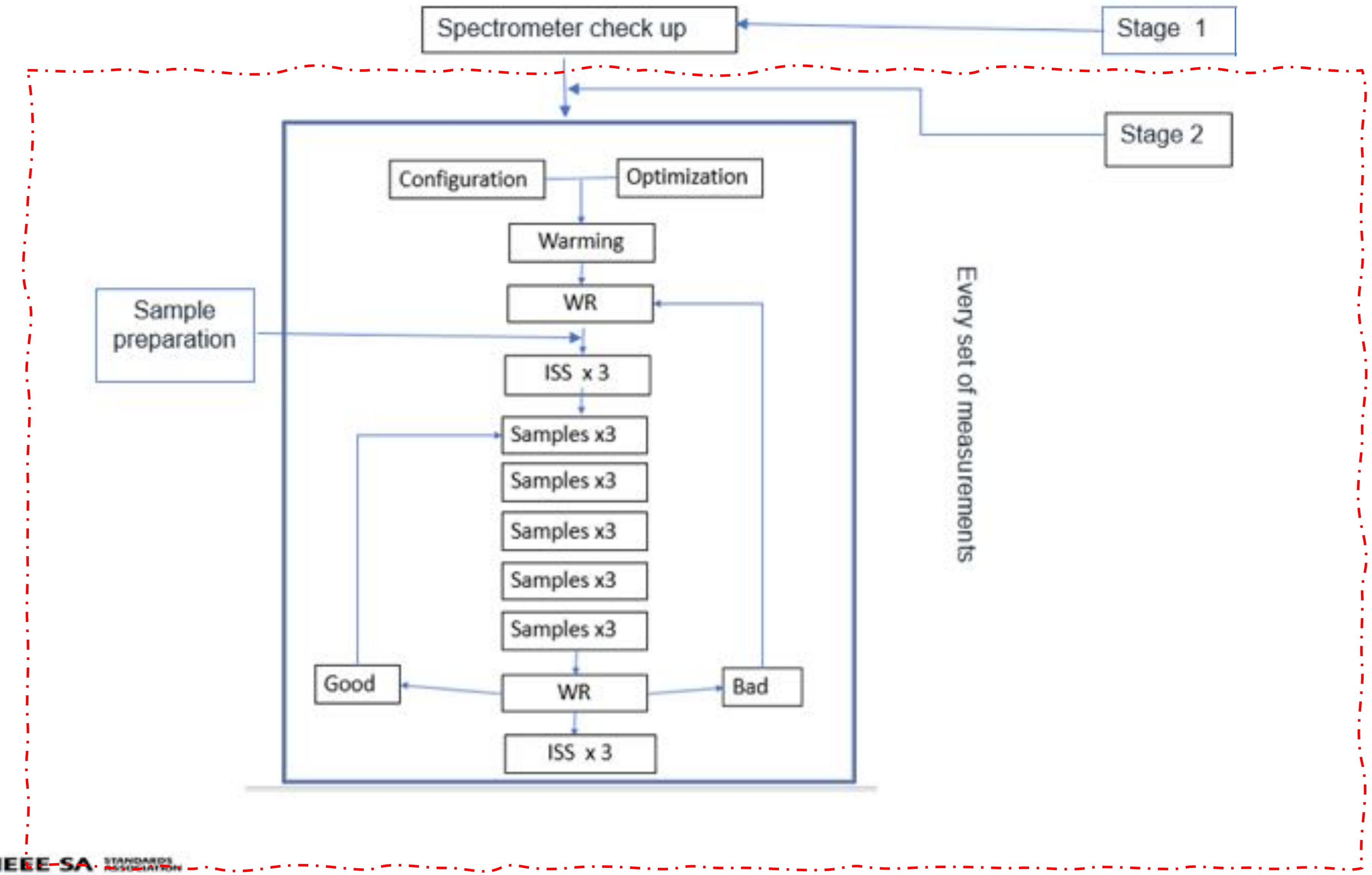
A simple card



Learn you spectrometer (every 6 months)

Routine spectral measurements

Synopsis of Measurement



FAST CHECKLIST FOR SPECTROMETER ASSESSMENT (STAGE 1)

1) Check the warming time with HALON
2) Check SNR with LB and BS
3) Measure Polymer and compare it with the benchmark
4) Documenting all information

Every 6 months or after getting the spectrometer back from vendor's calibration

Short Document

FAST CHECKLIST FOR SOIL SPECTRAL MEASUREMENTS (STAGE 2)

1) Prepare the measurement environment
2) Config the system
3) Set up the measurement geometry
4) Warm up the system
5) Measure WR
6) Prepare and measure Polymer, LB (or and WB) – three replicates
7) Prepare and measure soil - three replicates X 5
8) Check WR back to 100%
9) If not – prepare and measure LB (X3)
10) Proceed to 5
11) If stage 8 is yes – proceed to stage 7
12) save and check that all measurements have been documented and archive
13) Proceed to calculation and QA checks
14) Correct for the ISS
15) Fill up the "measurement document"

For routine soil spectral measurements

Conclusions

- Soil is an important component in the food security world
- Soil Spectral Libraries (SSL) are important (big) data information to foster precise agriculture and better food production
- Different protocols to measure SSL result in a "Babylon tower effects "
- An agreed standard and protocol for soil reflectance measurement is the main product of the IEEE P4005 WG.
- The IEEE P4005 standard will be a game changer in exploiting SSLs globally

Thank You !!

TAU-RSL

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TEL AVIV UNIVERSITY אוניברסיטת תל אביב

bendor@post.tau.ac.il

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