Item 2: Outcomes of the First Plenary Meeting on Soil Spectroscopy

GLOSOLAN

GLOBAL SOIL LABORATORY NETWORK

Fenny van Egmond (ISRIC – World Soil Information),
Rich Ferguson (USDA-NRCS-KSSL),
Keith Shepherd (ICRAF-iSDA)

GLOBAL SOIL PARTNERSHIP

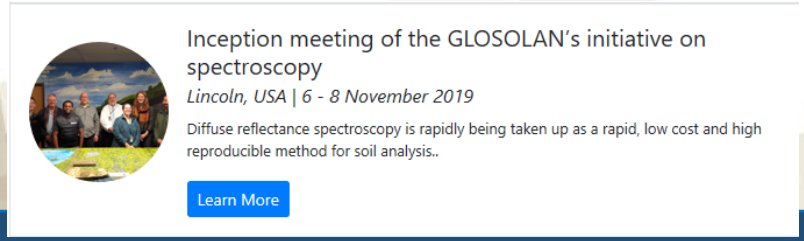
GLOSOLAN WG

2019: Establishment of a **working group on lab soil spectroscopy** and set up of a work plan including:

- **Inventory** on the information and capacity GLOSOLAN members need/ have on spectroscopy
- Development of **guidelines** on lab spectroscopy measurements
- Identification of **metadata** shortlist

Future aim: include lab spectral data in GLOSIS as Global Soil Spectral Library using agreed upon guidelines and calibration transfer algorithms for spectra. ---- > Lincoln meeting to elaborate more

Leaders: ICRAF, ISRIC, USDA



April 2020 : Launch of the GLOSOLAN initiative on spectroscopy

In order to open the discussion and start building collaboration with institutes and experts on spectroscopy, two concept notes were prepared.
One focuses on the establishment of a **global soil spectral calibration library and estimation service**, the other on the accompanying **capacity building**: http://www.fao.org/global-soil-partnership/glosolan/soil-analysis/dry-chemistry-spectroscopy/en/

Food and Agriculture Organization of the United Nations

GLOBAL SOIL PARTNERSHIP

A Global Soil Spectral Calibration Library and Estimation Service

A Concept Note of the Global Soil Partnership

Prepared by the Steering Committee on Soil Spectroscopy in the framework of the Global Soil Laboratory Network (GLOSOLAN)

Background

Many studies have demonstrated the potential of soil diffuse reflectance spectroscopy as a rapid and low-cost method for soil characterization (Janik et al., 1998; McBratney et al. 2006; Shepherd et al., 2007; Nocita et al. 2015). Numerous soil properties can be calibrated to near- and mid-infrared spectra owing to the fact that soil spectra respond to soils mineral and organic composition (Soriano-Disla et al. 2014; Wijewardane et al. 2018). However, a major constraint for wider uptake of soil spectroscopy is the lack of spectral calibration libraries for different soil types. Building spectral calibrations requires reference soil property data with matching spectral data for the diversity of soils in a region of interest.

Objectives of GLOSOLAN initiative on spectroscopy

1. Build a **globally representative calibrated soil spectral library (database)** based on MIR spectra with accompanying soil property reference data recorded in one gold-standard reference laboratory;

2. Provide a freely available and easy-to-use **soil property estimation service** based on the evolving GLOSOLAN global MIR spectral library;

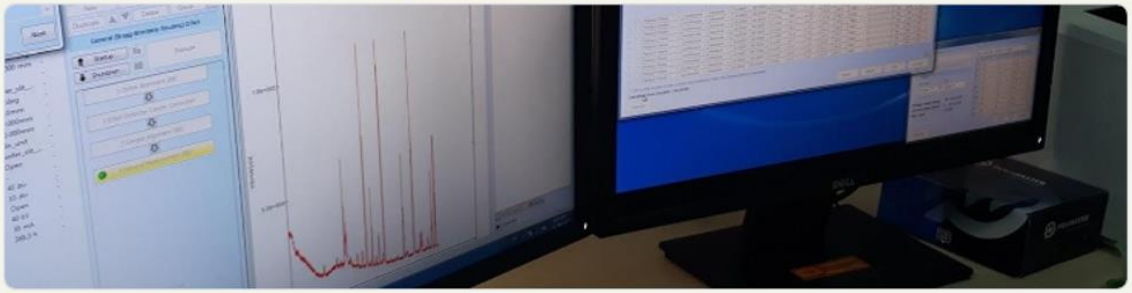
3. **Support countries** to contribute to the GLOSOLAN global spectral calibration library and use the soil property estimation service;

4. **Harmonize soil spectroscopy methods** (including soil sample preparation, spectral measurement and quality assurance of data analysis) by developing standard and protocols;

5. **Develop the capacity of countries and labs** in the performance of lab-based soil spectroscopy measurements. Soil spectroscopy measurements.

April – September 2020 | Questionnaire

Questions Responses 75



Section 1 of 9

Spectral Soil Data: Needs and Capacities Questionnaire

Thank you for your willingness to fill in this questionnaire. It is intended to gather insight into the needs and capacities of GLOSOLAN and the wider soil-sensing community.

With your contribution, we hope to:
1. Acquire an overview of the capacities, needs, and goals of soil laboratories worldwide with respect to spectral soil data; and
2. Determine if serving spectral data in a more structured, cooperative, and coordinated way would be useful for laboratories and other users. If so, we hope to understand how to address the needs of potential users and suppliers of data.

The questionnaire consists of four parts:
Part 1. The Global Soil Information System (GLOSIS) and Soil Spectral Data
Part 2. Laboratories and Procedures
Part 3. Spectral Data Provisioning
Part 4. Spectral Data Analysis

Questions Responses 8

Section 1 of 9

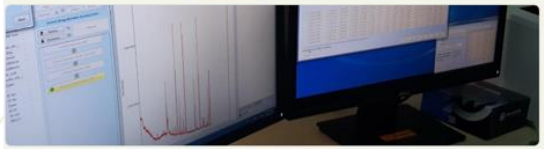
Datos espectrales del suelo: cuestionario de necesidades y capacidades

Agradecemos su disposición a completar este cuestionario. El objetivo es recopilar información sobre las necesidades y capacidades de GLOSOLAN y la comunidad más amplia de detección de suelos.

Con su contribución, esperamos:
1. Adquirir una visión general de las capacidades, necesidades y objetivos de los laboratorios de suelos en todo el mundo con respecto a los datos espectrales del suelo; y
2. Determine si servir datos espectrales de una manera más estructurada, cooperativa y coordinada sería útil para laboratorios y otros usuarios. Si es así, esperamos comprender cómo abordar las necesidades de los usuarios potenciales y proveedores de datos.

El cuestionario consta de cuatro partes:
Parte 1. El Sistema Mundial de Información del Suelo (GLOSIS) y los datos espectrales del suelo
Parte 2. Laboratorios y procedimientos
Parte 3. Aprovisionamiento de datos espectrales
Parte 4. Análisis de datos espectrales

Questions Responses 13



Section 1 of 9

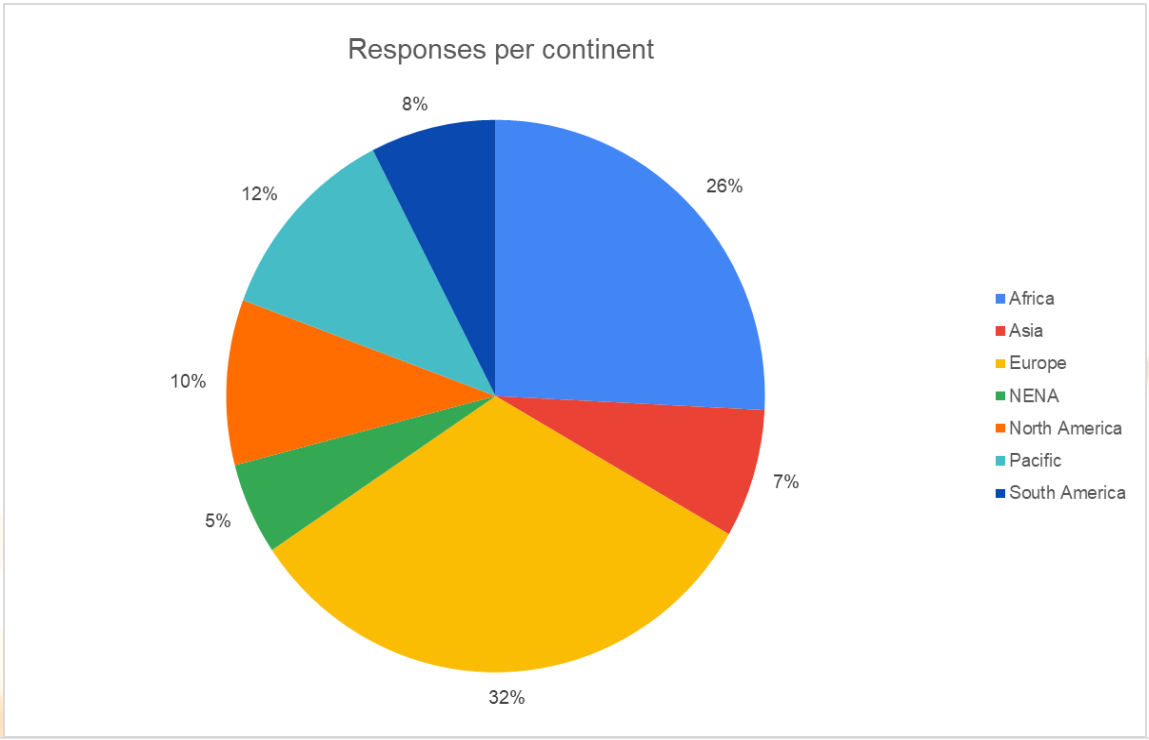
Données spectrales sur les sols: Questionnaire sur les besoins et les capacités

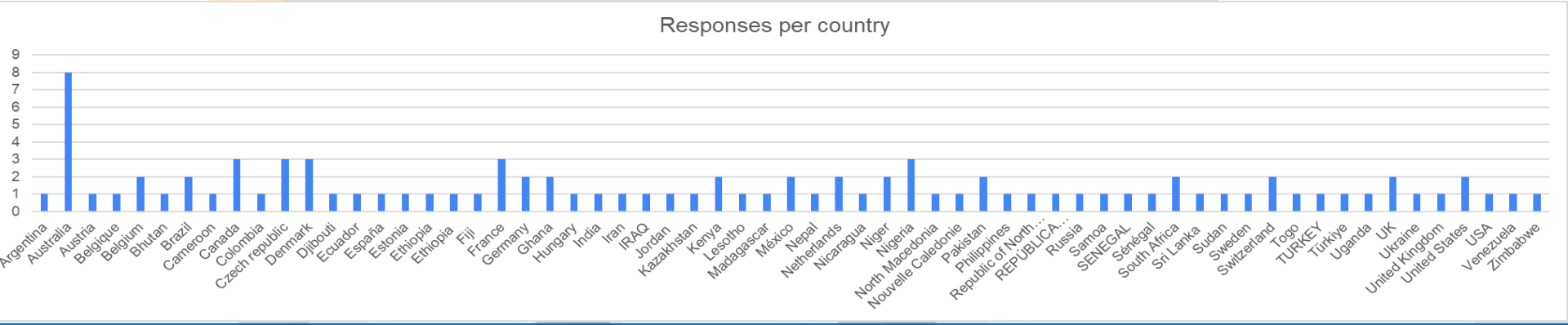
Merci de votre disponibilité à remplir ce questionnaire. Il est destiné à recueillir des informations sur les besoins et les capacités de GLOSOLAN et de la communauté de détection des sols au sens large.

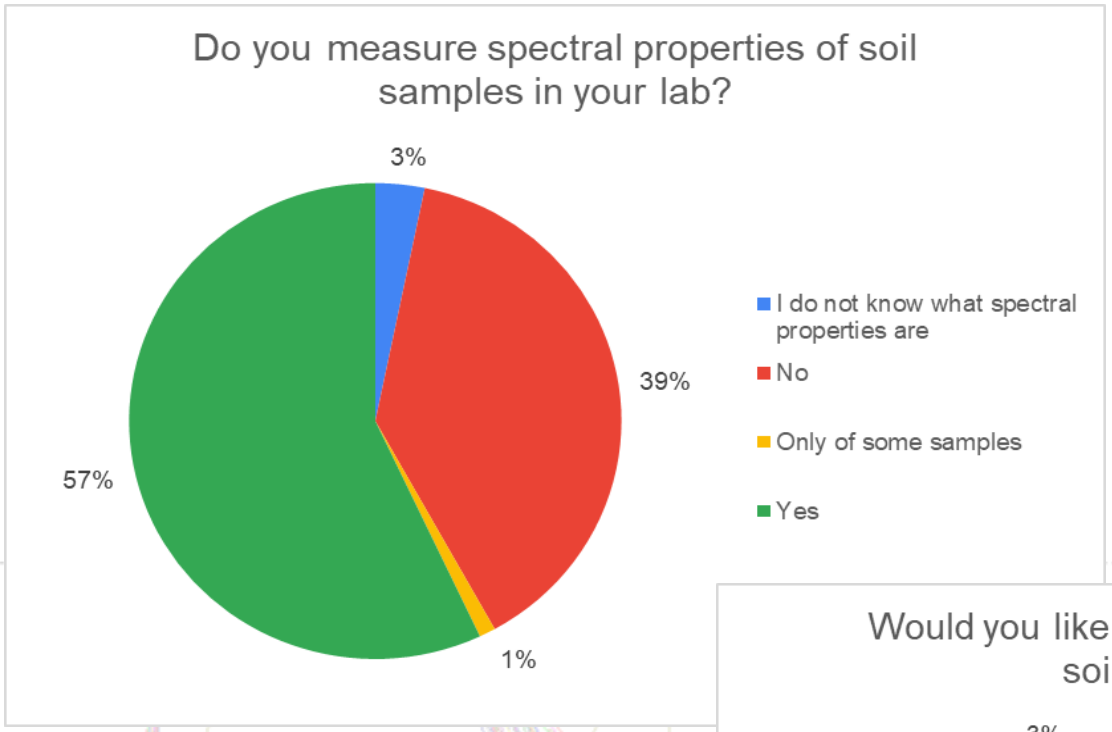
Avec votre contribution, nous espérons:
1. Obtenir une vue d'ensemble des compétences, des besoins et des objectifs des laboratoires d'analyse de sol dans le monde en ce qui concerne les données spectrales sur le sol; et
2. Déterminer si la fourniture de données spectrales de manière plus structurée, coopérative et coordonnée serait utile pour les laboratoires et les autres utilisateurs. Si tel est le cas, nous espérons trouver comment répondre aux besoins des utilisateurs potentiels et des fournisseurs de données.

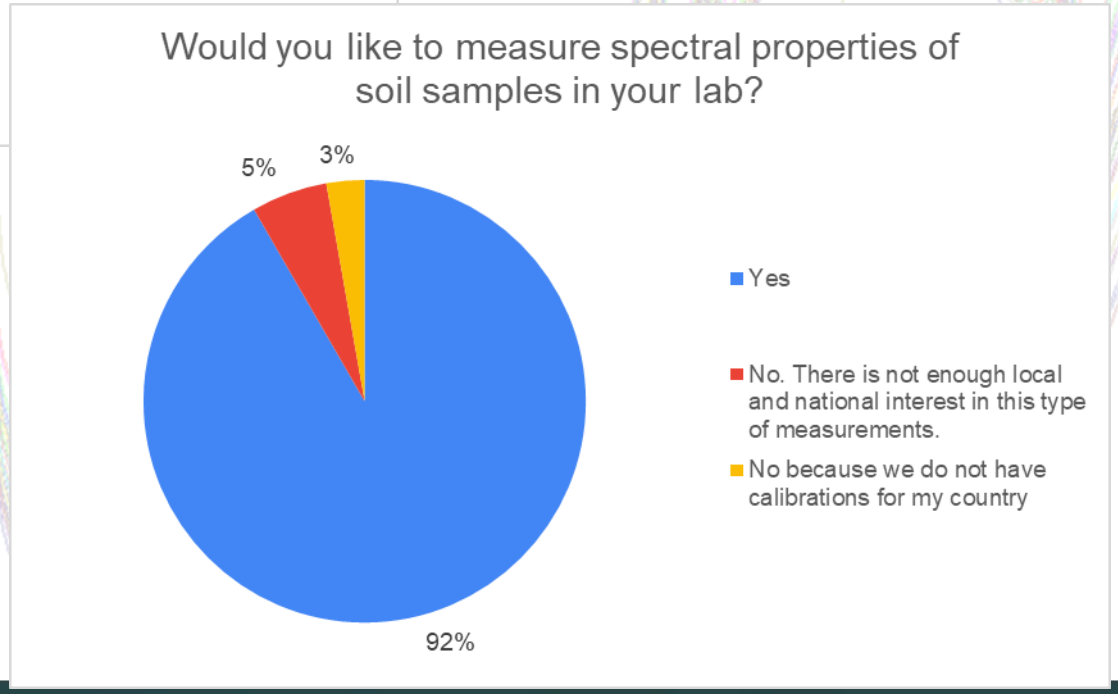
Le questionnaire comprend quatre parties:
Partie 1. Le système mondial d'information sur les sols (GLOSIS) et les données spectrales des sols
Partie 2. Laboratoires et procédures
Partie 3. Fourniture de données spectrales
Partie 4. Analyse spectrale des données

Responses: 96 respondents

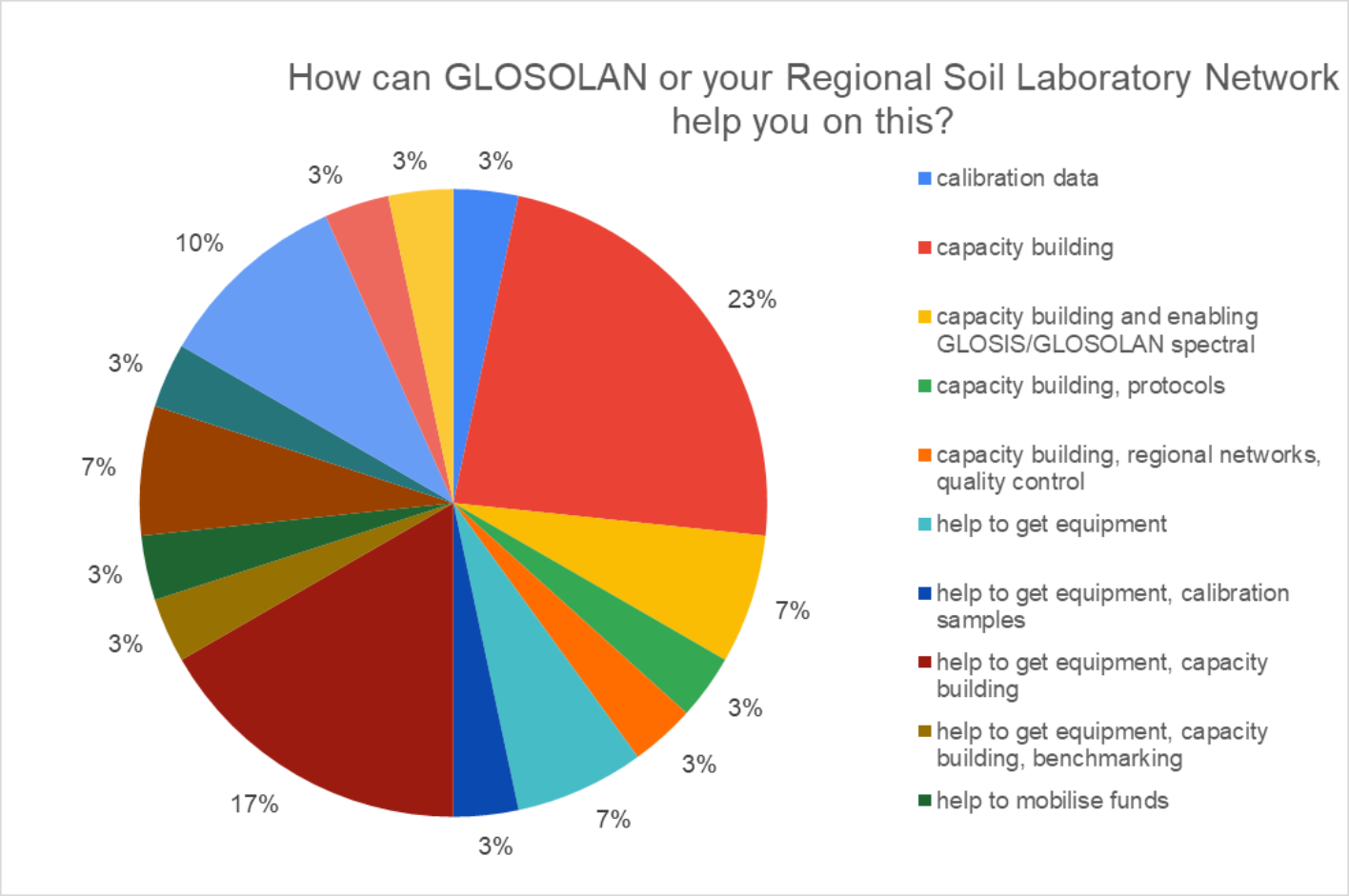




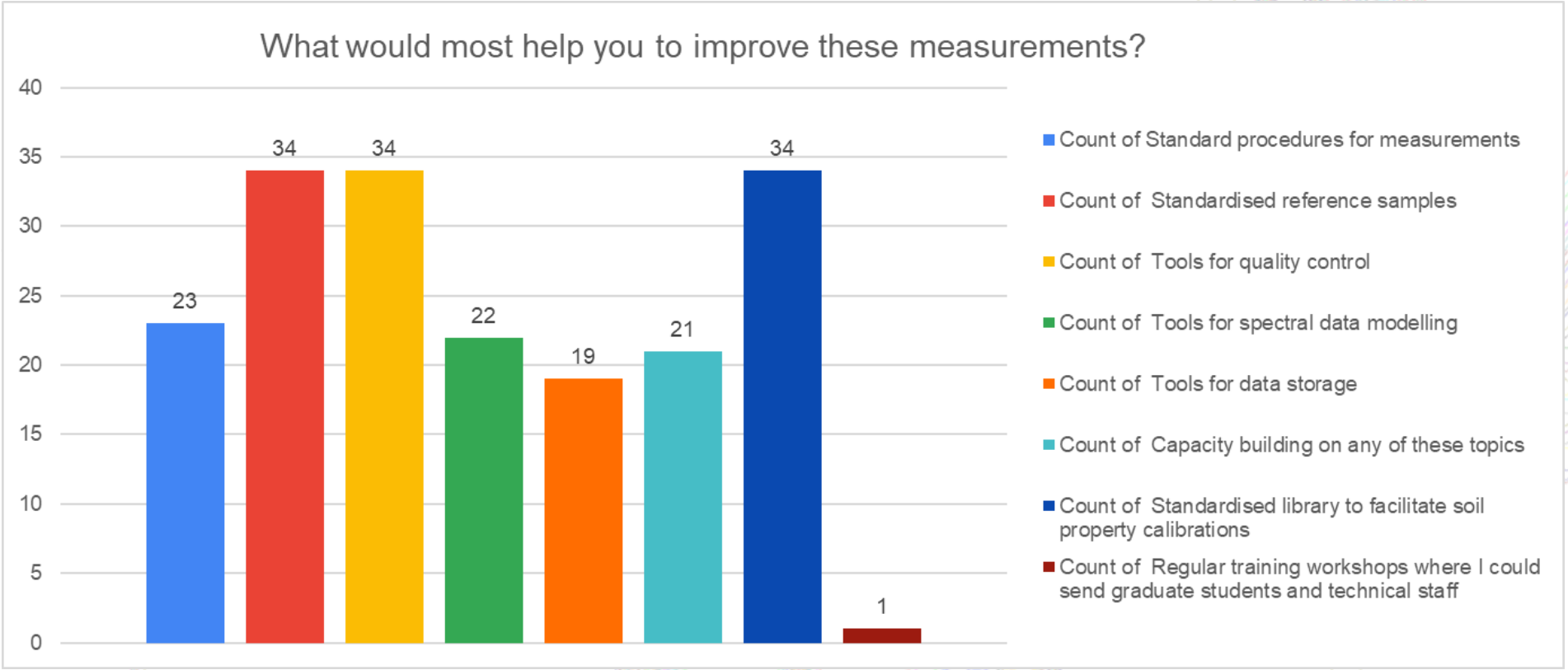

Do you measure spectral properties of soil samples in your lab?
3%
39%
57%
1%
I do not know what spectral properties are
No
Only of some samples
Yes


Would you like to measure spectral properties of soil samples in your lab?
5%
3%
92%
Yes
No. There is not enough local and national interest in this type of measurements.
No because we do not have calibrations for my country

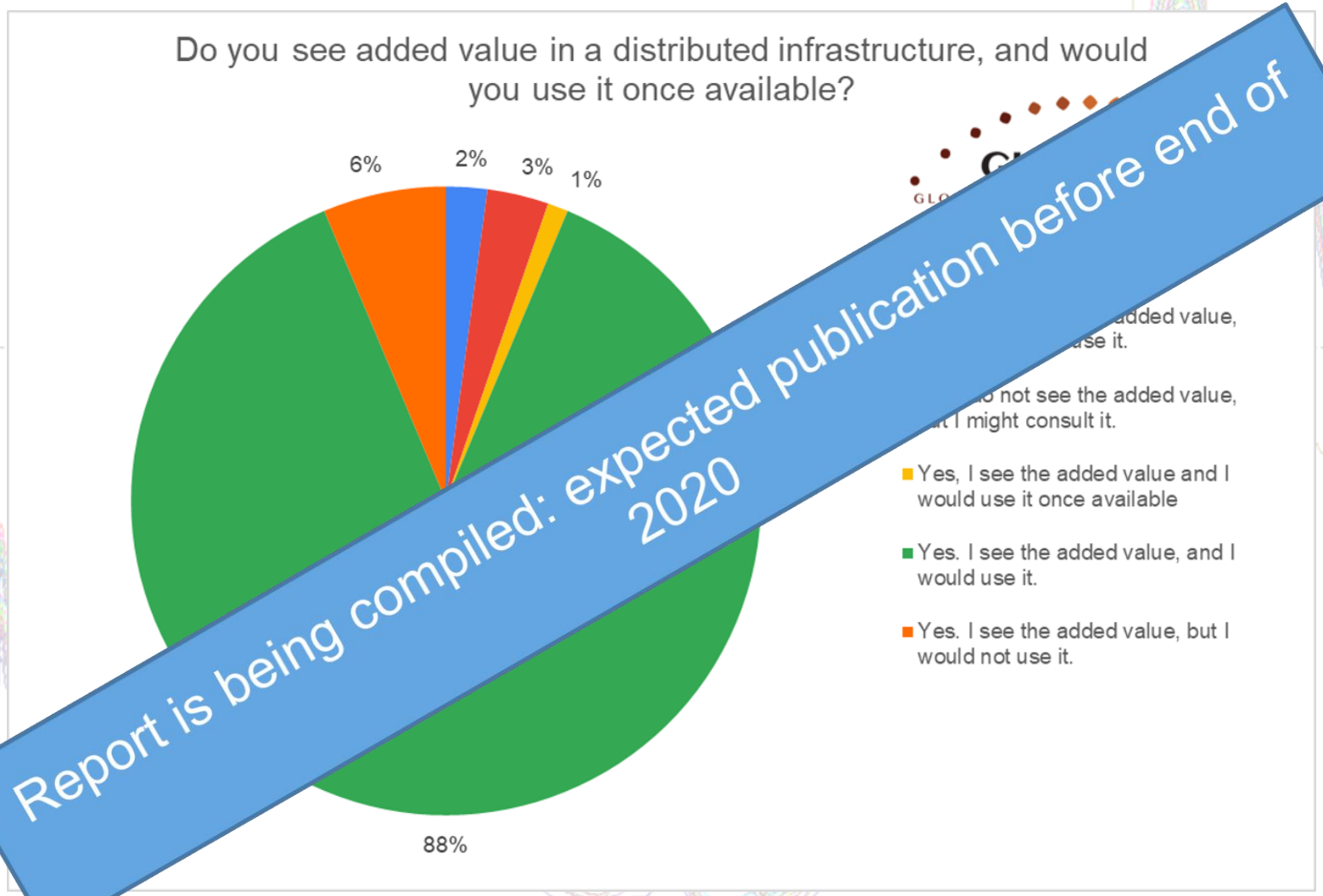
How can GLOSOLAN or your Regional Soil Laboratory Network help you to start these measurements?



When performing measurements



Infrastructure to serve spectral data



Report is being compiled: expected publication before end of 2020

September 2020 : First plenary meeting on soil spectroscopy

Objectives:

1. **Define the work plan** of GLOSOLAN on soil spectroscopy (main activities, timeline, and implementing partners) and especially on the establishment of a global soil spectral calibration library and the writing of guidelines, protocols, and manuals on soil spectroscopy;

2. **Define how GLOSOLAN will interact with other initiatives and** how **projects** can contribute to GLOSOLAN;

3. **Define how GLOSOLAN will interact with countries and laboratories, institutions, and organizations**; and

4. **Define the governance of the initiative**: working group, working group chairs, and regional champion laboratories/institutes on spectroscopy.

About 340 participants from 63 countries

GLOSOLAN 1st Plenary meeting on spectroscopy

Revised Proposal

Global spectral calibration library ***established as a federated system***

Main characteristics:

- *Data consultable at a central portal at FAO*
- *Partners will work together on the development of the initiative and its architecture*
- *The ownership of the data remains with the data provider*
- *Possibility to include spectra other than MIR*

Areas of concern:

- *Calibration of data and instruments*

The two systems will be linked

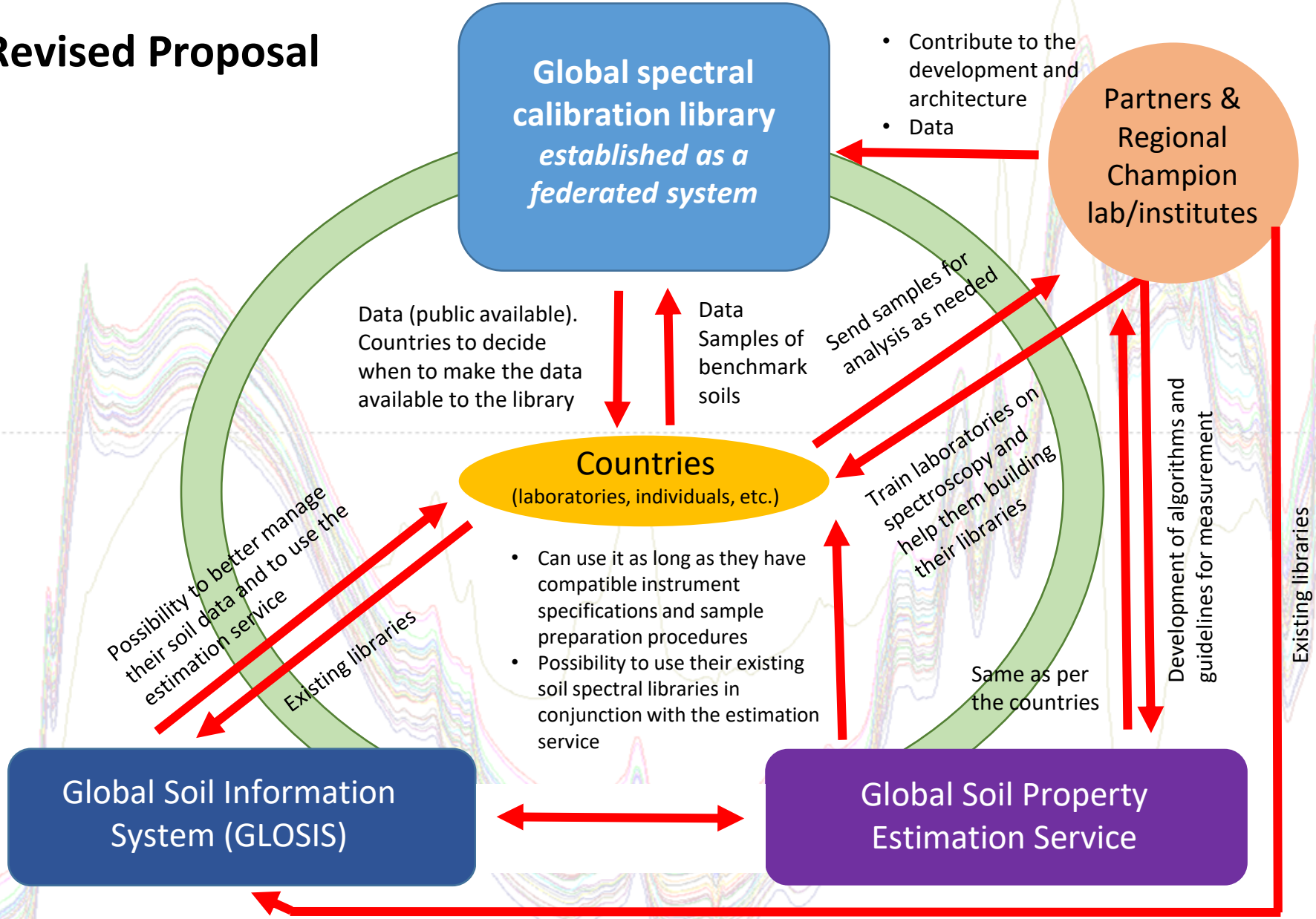
Global Soil Property Estimation Service

Main characteristics:

- *Based on the global spectral calibration library*
- *Uses in country measured spectra of new samples according to standard protocol*
- *Partners to work together on the development of the best calibration algorithms and serve them up through use friendly web-based interfaces*
- *The service would provide alternative models including downloadable desktop versions, for countries with limited internet connectivity*
- *All code will be open source and FAIR (findable, accessible, interoperable and re-usable)*

Global Soil Information System (GLOSIS)

Revised Proposal



Revised Proposal

STAGE 1

Establishment of the MIR library and calibration service based on KSSL instruments (Estimated duration: 2 years)

STAGE 2

Including other spectrometers and spectral data in the library and establishment of the necessary calibration

Revised Proposal

STAGE 1

- We focus on MIR
- No need to have the federated system in place

Main activities:

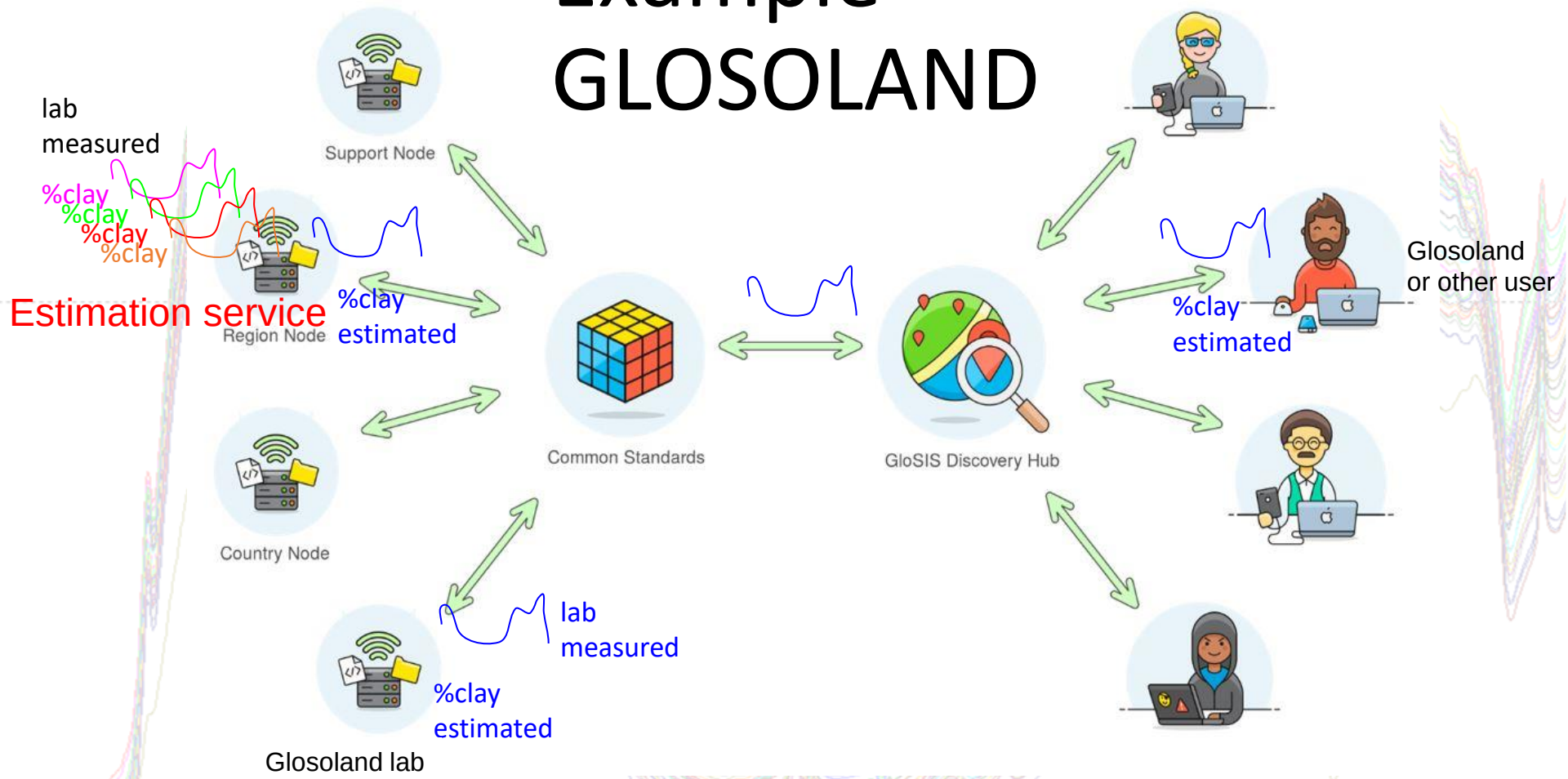
- Labs that accept USDA open data policy can send subsets of their samples to the US for wet and dry chem analysis: representative sets from each country. This will increase applicability of the library (spatially and spectrally)

- Labs that do not accept USDA open data policy can work on their own or with their regional champion laboratory/institute and contribute to GLOSOLAN guidelines, protocols, etc.

- GLOSOLAN (GSP/FAO and partners) will start building the federated system

- GLOSOLAN (GSP/FAO and partners) will start working on calibration and calibration transfer

Example GLOSOLAND



How can laboratories that are not using spectroscopy or with little experience in the subject collaborate in this initiative?

Type of lab	How they can contribute	What they get back (added value)	Notes
Laboratories using spectroscopy eq. already that also do wet chemistry	• They can contribute with their own spectral library and a subset of their samples • They can scan samples for others in the region • Contribute to the development of standards and models	• They can get more spectra for improving their calibration • They can get models for building or strengthening their calibration • Common publications • Free alignment of instruments on spectroscopy and wet chemistry (PT costs to be covered by the initi	Attention: the equipment and range of spectrum should b atible with the guidelines o be prepared)
Laboratories that are using spectroscopy eq. but DO NOT DO wet chemistry	• They can contribute with their own spectral library • They can scan samples for others in the region • Contribute to the development of standards and models	• Use the calibrati • Common pu • Free ali sp	e equipment and range of m should be compatible with guidelines (guidelines to be prepared)
Laboratories that just got to use spectroscopy eq.	• Send soil samples t KSSL • They can s other i b	n service of the results obtained with their own pacity building Common publications • Free alignment of instruments on spectroscopy and wet chemistry (PT costs to be covered by the initiative)	Attention: the equipment and range of spectrum should be compatible with the guidelines (guidelines to be prepared)
Laborator not have sp eq.	soil samples to the SSL Contribute to the development of standards and models	• Get their samples scanned by the KSSL or another laboratory (see above) • Use of the calibration service • Common publications • Guidance on how to implement the spectroscopy analysis (they can start approaching the technology)	

Governance

Structure
Tasks
Terms of Reference

GLOSOLAN meeting (annual)

Attended by GLOSOLAN members

Working group leaders to report at

Plenary meeting on spectroscopy (annual)

Attended by GLOSOLAN members interested in spectroscopy and partners

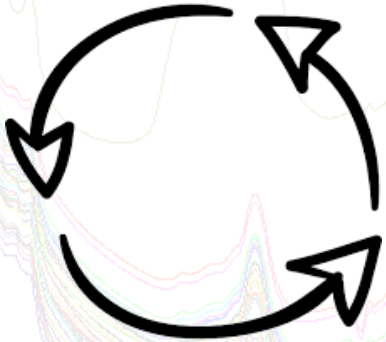
This is where the work plan on spectroscopy is revised and agreed upon, and tasks are assigned

To present on progresses and proposals on spectroscopy

Working group including partners

(international organizations, projects, etc.)

To write the draft of documents and finalize them before presenting them at the plenary. To develop tools for countries to use



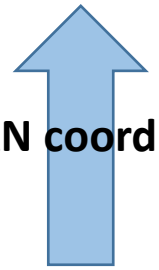
To provide inputs for the writing of documents and the development of tools, and to review documents as needed

Countries and laboratories

Terms of Reference WG leaders:

- Support and ensure implementation of activities
- Report on the work of the working group at GLOSOLAN meetings
- Represent the working group at meetings as needed
- Support capacity building and financial resource mobilization activities
- Ensure compliance of the working group work with the GLOSOLAN principles

GLOSOLAN Chair
GLOSOLAN vice-Chair



GLOSOLAN coordinator (FAO)

Working group leader(s)
Mandate as per the ToR: 2 years

Working group on spectroscopy

- Experts on the topic with time to contribute to the work, showing commitment to the work GLOSOLAN is doing)
- Representatives from the Regional Champion Laboratories/Institutes on spectroscopy

Regional Champion Laboratories/Institutes

Countries

Terms of Reference:

- Support laboratories using spectroscopy to improve
- Support laboratories new to spectroscopy to get started
- Assist GLOSOLAN in capacity building
- Assist GLOSOLAN with downscaling activities

Terms of Reference working group:

- Preparation of documents
- Advice laboratories in need
- Support capacity building activities
- Coordinate the establishment of the global spectral library and calibration service
- Publications
- Support the organization of meetings
- Development work plan
- Promote GLOSOLAN
- Mobilization of financial resources

Endorsement of the Terms of Reference (ToR)

The ToRs for the working group on spectroscopy and its leaders were revised and endorsed. The final document will be published on the GLOSOLAN website, spectroscopy webpage at http://www.fao.org/global-soil-partnership/glosolan/soil-analysis/dry-chemistry-spectroscopy/en/

7. GLOSOLAN work plan on soil spectroscopy for the years 2020-2021

The GLOSOLAN work plan for 2020 is reported in Table 4.

Table 4. GLOSOLAN work plan for the years 2020-2021

Activity	Responsible party	Deadline
General assignments		
Contact the ITPS Chair to ask for clearance on their role	GLOSOLAN Coordinator	25 September 2020
Collect inputs on the possibility to have an amendment to the GSP Soil Data Policy	GLOSOLAN Coordinator	15 October 2020
Contact all the regional champion laboratories/institutes identified during the meeting: - confirmation on their availability to take up this role - get the name of a contact person - ask them to complete a form (based on the ToR) to let laboratories and regions know about what they can offer and help with - publication of this information on the GLOSOLAN website	GLOSOLAN Coordinator	December 2020 It depends on how fast regional champion laboratories / institutes are in getting back to the GLOSOLAN Coordinator
Inform GLOSOLAN members on the outcomes of the first plenary meeting on spectroscopy and move forward establishing the working groups:	GLOSOLAN Coordinator	30 October 2020

Green: done
Yellow: ongoing

Activity	Responsible party	Deadline
General assignments		
Contact the ITPS Chair to ask for clearance on their role	GLOSOLAN Coordinator	25 Sept 2020
Collect inputs on the possibility to have an amendment to the GSP Soil Data Policy	GLOSOLAN Coordinator	15 Oct 2020
Contact all the regional champion laboratories/institutes identified during the meeting: - confirmation on their availability to take up this role - get the name of a contact person - ask them to complete a form (based on the ToR) to let laboratories and regions know about what they can offer and help with - publication of this information on the GLOSOLAN website	GLOSOLAN Coordinator	Dec 2020
Inform GLOSOLAN members on the outcomes of the first plenary meeting on spectroscopy and move forward establishing the working groups: - general WG on spectroscopy - WG on the development of the spectral calibration library - WG on the development of the global soil property estimation service The email should inform GLOSOLAN members on INSII in case they would like to help with developing GLOSIS and connecting it to the global spectral calibration library and the global soil property estimation service.	GLOSOLAN Coordinator	30 Oct 2020

Activity	Responsible party	Deadline
Global Spectral Calibration Library		
Report the suggestions of GLOSOLAN on the data review period to the USDA and report back to GLOSOLAN members	GLOSOLAN Coordinator	30 October 2020
Ask all GLOSOLAN members and participants at the first plenary meeting on spectroscopy if: - they would like to send samples to the USDA - they would like to send samples to their regional champion laboratories and work with them - they will analyse the samples themselves and work with their regional champion laboratories / institutes - what type of spectra they analyse and with what instruments - if they have a spectral library already (please provide details) All information will be organized in a database to be used by the WGs. Follow up actions will be taken with those willing to work with the USDA and other regional champion laboratories / institutes.	GLOSOLAN Coordinator	December 2020
Ask regional champion laboratories / institutes to provide the following information: - wet chemistry and spectroscopy methods used - instruments used - soil sample preparation protocols in use	GLOSOLAN Coordinator	December 2020
Process the information provided by the regional champion laboratories / institutes and plan the next steps on harmonization	WG on the library	February 2021
Organization of the second meeting of the working group on the library aiming to: - review work - work on the information provided by the regional champion laboratories / institutes	GLOSOLAN Coordinator, WG leaders and WG on the library	End of January 2021

Activity	Responsible party	Deadline
Global Spectral Calibration Library		
Organization of a first inter-laboratory comparison among regional champion laboratories	GLOSOLAN Coordinator, WG leaders, regional champion laboratories / institutes	May – September 2021 Together with the GLOSOLAN PT for wet chemistry
Identification of the soils missing in the KSSL library and compilation of a list of what regional champion laboratories / institutes can provide data for what soil type - Identify gaps (need to work on the criteria for the identification of gaps) - regional champion laboratories/ institutes help filling in the gaps	- KSSL and regional champion laboratories / institutes, WG on the library	
Regional champion laboratories / institutes contact laboratories in their region: - identification of laboratories that are using spectroscopy instruments - identification of laboratories that have spectral calibration libraries - assessment of needs in terms of capacity building - shipment of soil samples to KSSL first, to all other regional champion laboratories / institutes once quality is checked through the PT	- Regional champion laboratories / institutes and local laboratories	April 2021
Compilation of the software pieces to develop	Ms. Fenny van Egmond, ISRIC	30 Oct/Nov 2020
Organization of the first meeting of the working group on the global spectral calibration library aiming to: - review the software pieces to develop - agree on a work plan (including a timeline) - assign tasks - reflect on how the library, estimation service, and GLOSIS can be connected	- GLOSOLAN Coordinator, WG Leaders, WG on the library	- 30 November 2020
Calibration transfer research	WG on the library, IEEE	September 2021 Reporting on progresses every 6 months

Activity	Responsible party	Deadline
Global Soil Property Estimation Service		
Organization of the first meeting of the working group on the global soil property estimation service aiming to: - discuss the algorithms and models to develop/use - agree on a work plan (including a timeline) - assign tasks - reflect on how the library, estimation service, and GLOSIS can be connected	- GLOSOLAN Coordinator, WG Leaders, WG on the estimation service	15 December 2020
Writing of protocols and guidelines		
Start writing the document as per the work plan in Table 3.	GLOSOLAN Coordinator, WG, GLOSOLAN members	September 2021
Finalize the discussion on the collaboration between GLOSOLAN and the IEEE SA	GLOSOLAN Coordinator and Eyal Ben Dor	October 2020
Ask GLOSOLAN members if they would like to join any IEEE working group	GLOSOLAN Coordinator	October 2020
Training and webinars		
Organization of a series of webinars on the installation, use, and maintenance of spectroscopy equipment Combined with the use of protocols	GLOSOLAN Coordinator, WGs, manufacturers, regional champion laboratories / institutes	September 2021
Webinar on the standard operating procedures produced in 2020-2021	GLOSOLAN Coordinator, WGs	September 2021
Organization of training courses on the use of different software packages for soil spectral data	Working group on spectroscopy	September 2021

Activity	Responsible party	Deadline
Projects		
Writing of project proposals for covering the following costs: - shipment and analysis of soil samples to the USA and the regional champion laboratories - organization of a inter-laboratory comparison among regional champion laboratories/institutes - training and remote support (if needed) - development of the global spectral calibration library and the global soil property estimation service	- GLOSOLAN Coordinator, WG leaders and WGs (general, library and estimation service)	December 2020
Identification of projects (outside GLOSOLAN) that can contribute and are willing to contribute to the implementation of the GLOSOLAN work plan on spectroscopy.	GLOSOLAN Coordinator, WG leaders, WGs, partners, GLOSOLAN members	September 2021 [continuous activity]

Invitation to contribute/support

- Joint effort
- Seeing is believing
- Attractive alternative to conventional analysis
- Soil sample archives, computational and research developments provide a unique opportunity
- **Unique opportunity:**
  - For underrepresented areas on the map,
  - for developing countries to get to cutting edge methods overnight,
  - to overcome differences between groups, to enable new applications,
  - to increase cooperation between pillars

Thanks for your attention!