Food and Agriculture Organization of the United Nations

5th Meeting of the
European and Eurasian Soil Laboratory Network
(EUROSOLAN)

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Standard Operating Procedures (SOPs)

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EUROSOLAN
EUROPEAN AND EURASIAN SOIL LABORATORY NETWORK

GLOBAL SOIL PARTNERSHIP

Globally harmonized standard operating procedures (SOPs)

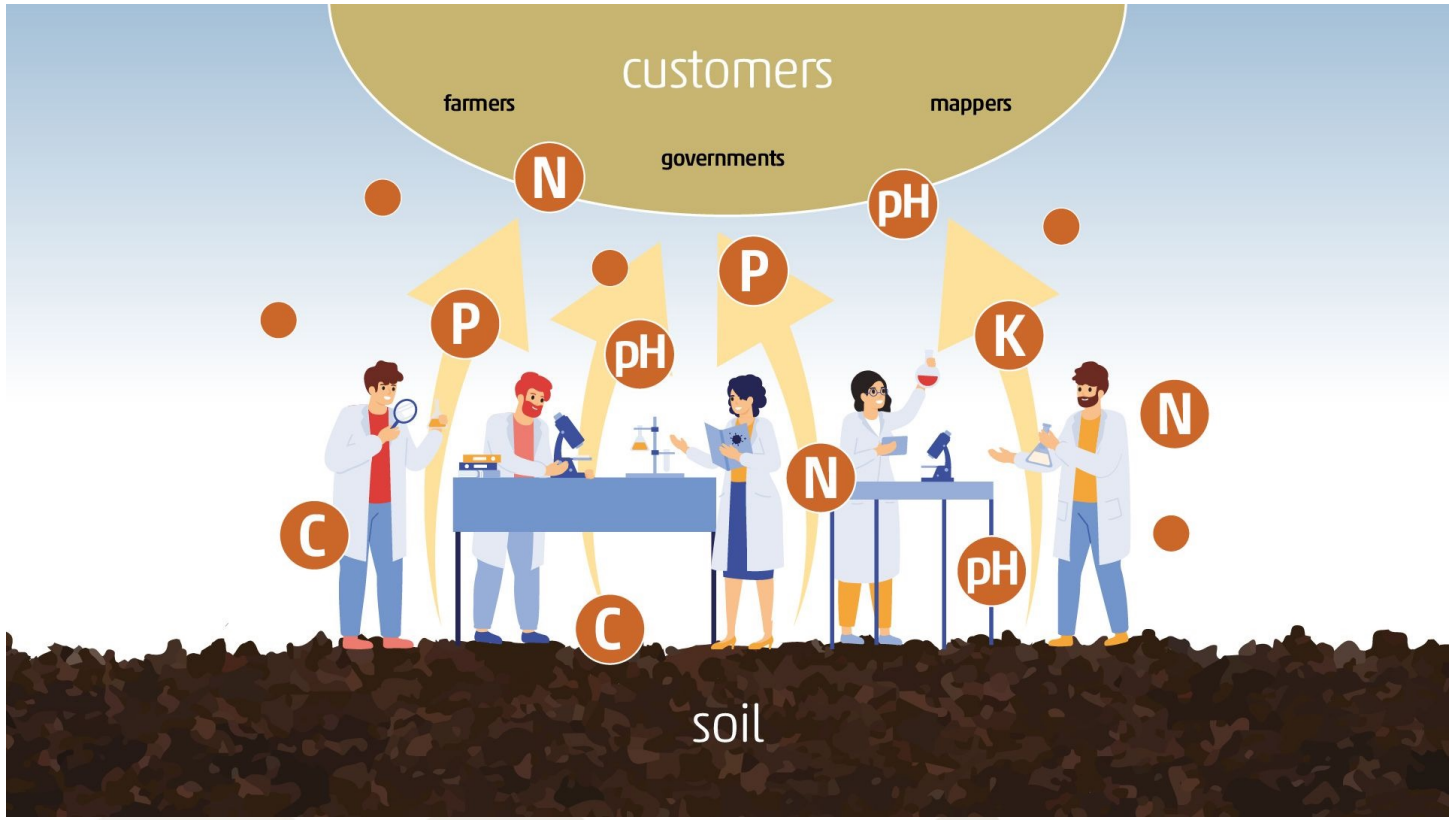
Harmonized soil data - critical for addressing a wide range of environmental, agricultural, and societal challenges

Soil data:

- Accuracy and precision
- Reliability
- Comparability
- Interpretability

Main issues for laboratories:

- Cost of the protocols
- Language barrier
- More confident with local/national/regional procedures



Global harmonized SOP is needed

- Starting points:

  Global Soil Laboratory Assessment (Hartmann & Suvannang, 2019) reported

  - *Only a small number of methods are currently used to measure the most common soil parameters (pH, C, N, P, particle size distribution; etc.)*
  - *The issue of high variability of methods and procedures among laboratories*

- The need for the global decision to support the decision making need comparable data
  - *Many different level of SOPs already existed. But still common for laboratories to use their own locally developed standard operation procedures,*
  - *International SOPs issued by authoritative bodies are not always available for free, and can be very expensive*

Different methods and procedures used by different laboratories can lead to inconsistent and unreliable results, which can make it difficult to compare and interpret data

SOP = Standard Operating Procedure

- **Globally harmonized - bottom-up, inclusive approach**

e.g. GLOSOLAN SOP for OC by Walkley and Black involved 67 laboratories from 52 countries located on the different continents.

- Ensures the replicability of a measurement and the credibility and traceability of data

- Step-by-step instructions

- Includes sections on health and safety, quality assurance and quality control (QA/QC) – and in some cases sampling guidelines

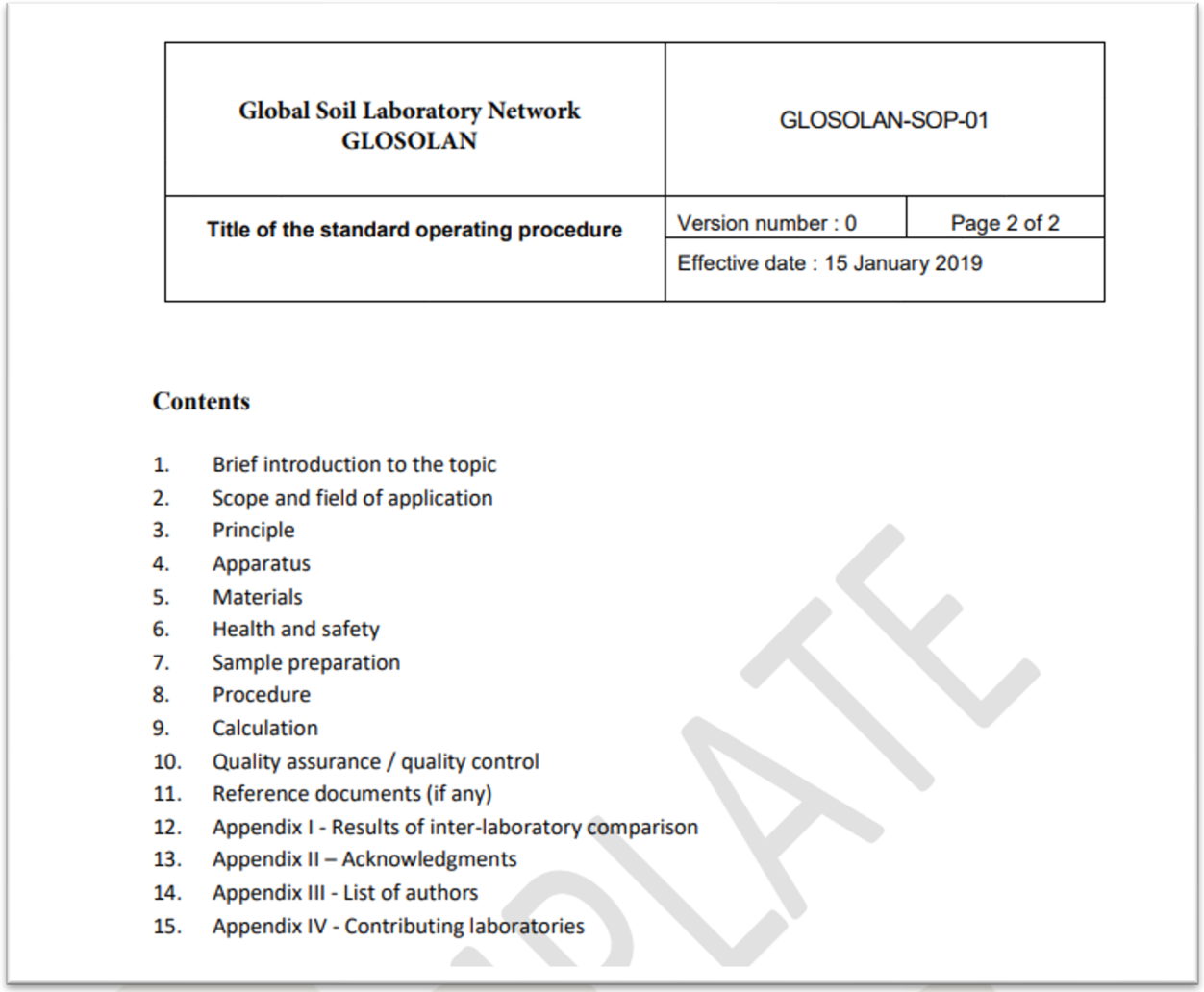
- Available online, <u>for free</u> and in multiple languages

Harmonization- bottom-up, inclusive procedure

1. Discussion and decision on the methods to harmonize (done within the Regional Soil Laboratory Network first, and then at a global level)
2. Establishment of the working groups, assignment of roles:
   - Global leader
   - Regional leaders (supporting authors)
   - Review panel
3. Prepare the matrix (=survey) and send it to all GLOSOLAN members who are familiar with the method to collect information on the procedures adopted worldwide
4. Compile the information on a regional basis → regional matrices are harmonized
5. Merge the regional matrices into a global matrix
6. Convert the matrix into a text
7. Review of the procedure's text
8. Publication and translation

Structure of the procedure - standard template

In come cases (e.g. physical or biological parameter tests): sections on **sample collection, storage and disposal**



Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-01	
Title of the standard operating procedure	Version number : 0	Page 2 of 2
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Contents

Not only procedural details

- **Consistency and Quality**
  - QC/QA procedures

- **Recommendations on health and safety**
  - Personal protective equipment, chemical and biological safety, emergency procedures

- **Sustainability of methods**
  - reliable, accurate, and cost-effective, while minimizing the use of resources, energy, and hazardous substances.

Soil Nitrogen methods : Sustainability of methods

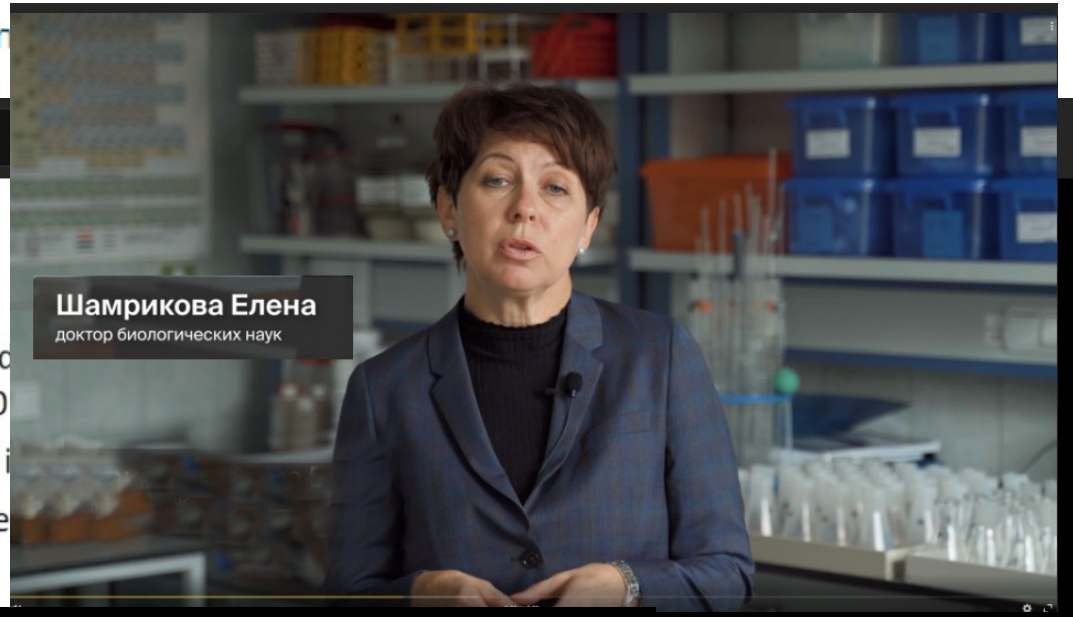
Method	Risk for human health related to the use of chemicals and the overall implementation of procedure by staff	Environmental risk (waste disposal)	Level of technology required	Average duration of the analysis	Global median price of the analysis (for the customers)
Kjeldahl	High	High	Medium	> 1 working day	7.5 USD
Dumas	Low	Low	High	Up to half working day	11.6 USD
Distillation method	Medium	Medium	Medium	Up to one working day	8.3 USD

Facilitate the adoption of the SOPs

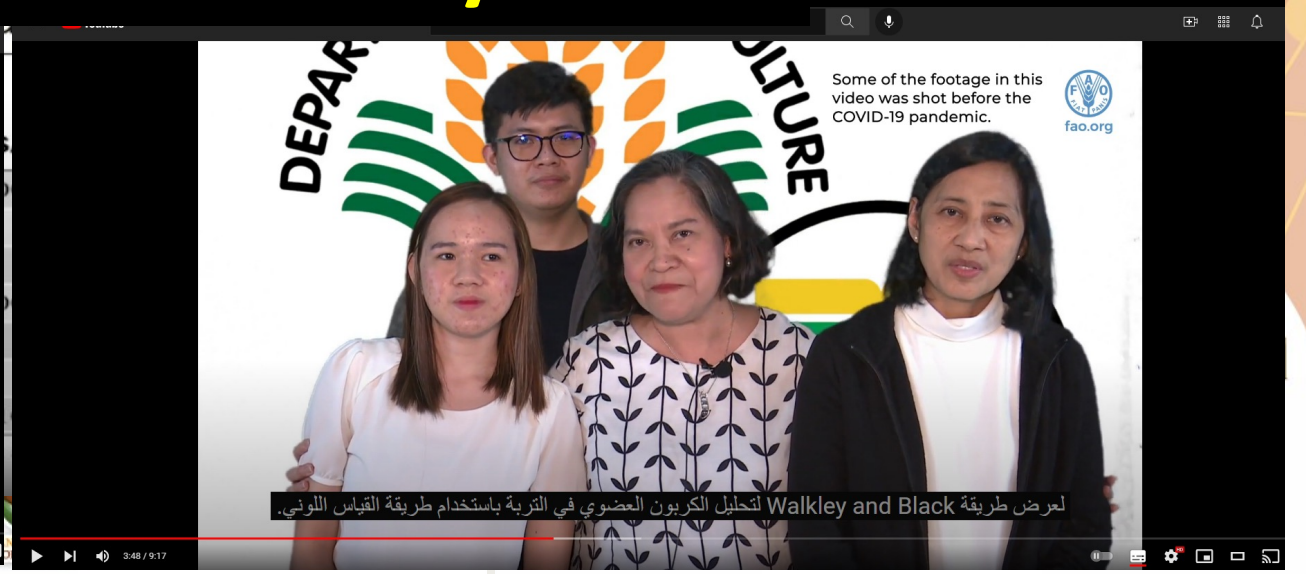
- Accessibility
  - SOPs are available for free on the GLOSOLAN website
  - Translation in the UN Official languages and other national/local languages as needed (according to the translator availability)

- Capacity building
  - Webinars are regularly organized (in multiple languages) to present the methodologies
  - Training videos are created

Examples from Thailand



Almost 9000 views in one year!



Joint products

- GLOSOLAN SOPs are living documents and are revised regularly and/or as needed

- Experts from other GSP Technical Networks support the harmonization process according to the parameter:
  - NETSOB: active members of the working groups for all SOPs dealing with soil biological parameters
  - INSAS: review the SOPs related to soil salinity and sodicity
  - INSOP: review the SOPs related to pollutants and toxic elements

How should GLOSOLAN SOPs be validated?

- Validation in a group of GLOSOLAN member laboratories
  - Collaborative studies
  - Inter-laboratory comparisons

Collaborative studies and inter-laboratory comparisons can be used to validate methods and procedures, ensuring that they are **accurate**, **precise**, and **reliable** across different laboratories and settings

What action of validation is done: in our case

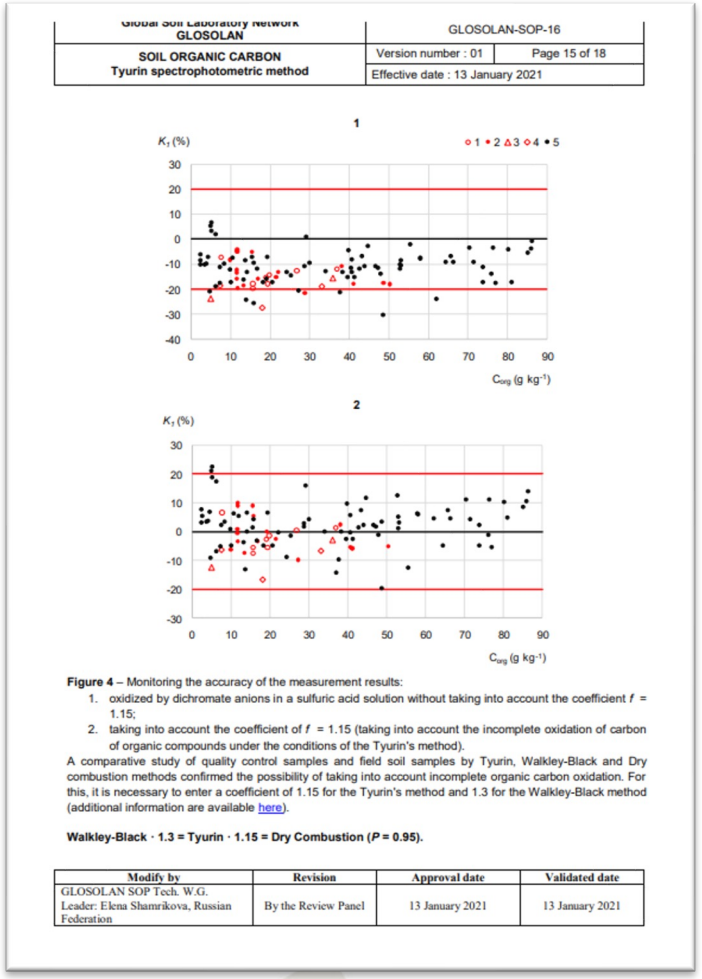
Category of the method	Action
Inter-laboratory tested	Precision **(how close results are to another)** Accuracy **(the closeness of a result to a true value)**

What is next action to make comparable data visibility in reality

- Transfer functions

  Shamrikova et al., 2022. Transferability between soil organic matter measurement methods for database harmonization. Geoderma 412 , 115547

- Connect with global specific networks:
  - Awareness
  - Encorage the use of GLOSOLAN SOPs
  - Develop transfer functions



Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-16	
SOIL ORGANIC CARBON Tyurin spectrophotometric method	Version number : 01	Page 15 of 18
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1

2

Figure 4 – Monitoring the accuracy of the measurement results:

1. oxidized by dichromate anions in a sulfuric acid solution without taking into account the coefficient f = 1.15;
2. taking into account the coefficient of f = 1.15 (taking into account the incomplete oxidation of carbon of organic compounds under the conditions of the Tyurin's method).

A comparative study of quality control samples and field soil samples by Tyurin, Walkley-Black and Dry combustion methods confirmed the possibility of taking into account incomplete organic carbon oxidation. For this, it is necessary to enter a coefficient of 1.15 for the Tyurin's method and 1.3 for the Walkley-Black method (additional information are available here).

Walkley-Black · 1.3 = Tyurin · 1.15 = Dry Combustion (P = 0.95).

Modify by	Revision	Approval date	Validated date
GLOSOLAN SOP Tech. W.G. Leader: Elena Shamrikova, Russian Federation	By the Review Panel	13 January 2021	13 January 2021

SOPs harmonized so far

Already published:

- 1 on sample pre-treatment
- 17 on soil chemical parameters (7 more ongoing)
- 2 on soil physical parameter (4 more ongoing)
- 1 on soil biological parameter (6 more ongoing)

	2019	2020	2021	2022
Chemical	OC Walkley and Black, TC Dumas, Calcium carbonate eq. (titrimetric and volumetric calcimeter methods)	Phosphorus (Bray I, Bray II, Olsen, Mehlich I), pH, electrical conductivity (in water and in saturated paste), nitrogen (Dumas, Kjeldah), carbon (Tyurin)	Particulate organic carbon (physical fractionation), Quasi-total elements (digestion using aqua regia and EPA), Exchangeable bases and CEC (ammonium acetate), available micronutrients (extraction using DTPA), Boron (hot water extraction), Mehlich III for macro and micronutrients (including S and B)	Organic matter (loss of ignition), Available phosphorus (KCl), Exchangeable acidity + Exchangeable Al (KCl), Soil buffer capacity (KOH), Fe and Al oxides (ammonium oxalate)
Physical			Particle size-distribution (hydrometer, pipette), bulk density, moisture content (gravimetric method)	Water retention (pF) curve, Particle density (pycnometer)
Biological			Microbial biomass C and N by chloroform fumigation-extraction, soil respiration	Microbial Enzyme Activities (B-Glucosidase, Arylsulfatase, Dehydrogenase), N Mineralization (incubation method), Nematodes trophic groups (wet extraction), QBSar (mesofauna), ISO-TSBF (megafauna)

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Standard operating procedure for soil bulk density

Cylinder method

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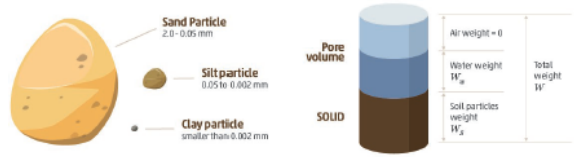
1. A brief introduction to soil bulk density

Soil is the result of rock fractioning and weathering over periods ranging from thousands to millions of years. Fractioning and weathering produce mineral fractions and particles of an extremely large range of sizes, from several metres to less than one micrometre. By definition, soil is made by the packing and assemblage of particles <2 mm, with larger particles being called "coarse material". The way the soil is packed and the particle size determine the size and number of spaces between particles, which are called pores or voids. The fraction that the volume of these voids over the total soil is called the pore volume or porosity (Figure 1). The amount of pore volume depends on the size of the particles, as well as by their shape and packing.

Figure 1. Representation of soil particles (left); major components of soil (right)



Source: Elaborated by FAO

Approximately 10 000 years ago, agricultural practices had started using tools to loosen the topsoil layer, resulting in decreased bulk density (increasing its porosity) and facilitating water infiltration and storage, as well as soil aeration and root penetration. With the eventual development of machinery and extension of soil mechanical tillage, it was then possible to increase the ploughing depth. However, the ever-increasing weight of machinery and tractors has resulted in the intensification of mechanical pressure, thus increasing bulk density (reduced porosity) and consequently lower water infiltration and root growth. Additionally, bulk density can also vary with the differing soil structural conditions of terrain, cultivation, trampling by animals, and weather. Soil compaction is a critical component of soil degradation, and the Protocol for the Assessment of Sustainable Soil Management (FAO-ITPS, 2020) recognized bulk density as a key indicator that is recommended to monitor to assess the impact of sustainable soil management practices.

Soil bulk density is an indicator of soil compaction and soil health and is an important factor to consider when assessing the physical behaviour of soils, as it affects infiltration, root depth and restrictions, available water capacity, and soil porosity. Soil porosity controls many soil properties and ecosystem services and is consequently one of the most important soil characteristics. The pore volume can

Modify by	Revision	Approval date	Validated date
GLOSOLAN SOP Tech. W.G. Global leaders: Gina Nilo, Marjorie Jean Tao, Philippines	By review panel and GLOSOLAN Technical Committee	15 May 2023	31 August 2023

Decisions made at the last (2022) GLOSOLAN meeting

- Harmonize the following SOPs at global level:

  Chemical
  - Exchangeable acidity by BaCl2
  - A general multi-element suite of potentially toxic elements (PTEs) - elements to include to be discussed with INSOP. Shall we review the SOP on Quasi-total elements (digestion using aqua regia and EPA) to include As in it? Need to organize a meeting with INSOP to assess the work on this SOP and discuss the eventual harmonization of a SOP on pesticides.

  Physical
  - Aggregate stability by Le Bissonais
  - Textural determination by laser diffraction

  Biological
  - Greenhouse gases (GHGs) emissions in soil
  - DNA extraction
  - Soil Health Lipidic Index

- **RESOLANs to decide which SOPs to harmonize at regional level, starting from the proposals they made**

- Establish a joint working group with other GSP Technical Networks to work on guidelines/SOP on samples collection, transportation and storage

- Focus more on transfer functions and activities on QA/QC

Proposals from EUROSOLAN?

- Translation?
- Review?
- New SOPs?

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