



Food and Agriculture  
Organization of the  
United Nations

# 6<sup>th</sup> Meeting of the **Regional Soil Laboratory Network for Africa** (AFRILAB)

23 October 2024

# Standard Operating Procedures (SOPs)

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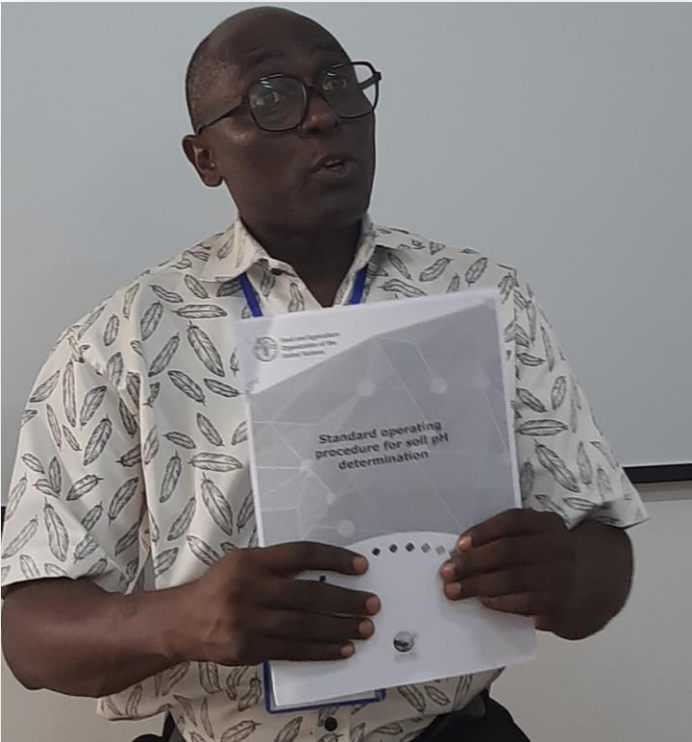


Soil data **comparability** is possible only if the same procedures are adopted or via **transfer functions**

Using the same SOPs  
=  
Speaking the same language

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

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
Global Soil Laboratory Network GLOSOLAN		GLOSOLAN-SOP-16	
SOIL ORGANIC CARBON Tyurin spectrophotometric method		Version number : 01	Page 16 of 18
		Effective date : 13 January 2021	



# Harmonization of Standard Operating Procedures (SOPs)

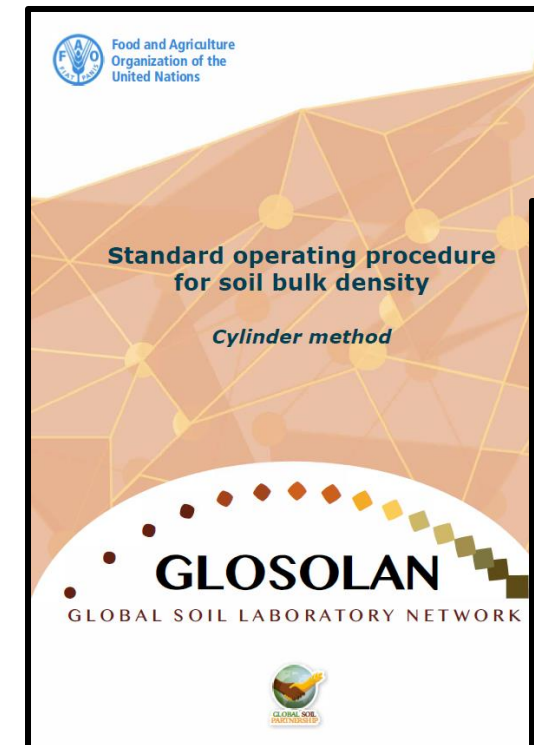


*Globally harmonized protocols, with a bottom-up, collaborative and inclusive approach.*

- Include step-by-step instructions, sections on health and safety, quality assurance and control (QA/QC),
- Contribute to the replicability of an analysis and to the quality and reliability of the data,
- **Accessible** online, for free and in several languages.

*In 2024, GLOSOLAN focused on:*

- **Translation** of SOPs
- **Finalization** of the pending SOPs from previous years
- **Review** the SOPs already published



Global Soil Laboratory Network GLOSOLAN		GLOSOLAN-SOP-22	
Version number : 1		Page 2 of 17	
Effective date : 15 May 2023			

**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

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# 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



# 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.  
Examples: enzymes, nematodes, DNA extraction
  - INSAS: review the SOPs related to soil salinity and sodicity  
Examples: pH, electrical conductivity, Sodium Adsorption Ratio (SAR), Exchangeable Sodium Percentage (ESP), SOC in saline soils
  - INSOP: review the SOPs related to pollutants and toxic elements  
Examples: microplastics, explosive residues, disposal of reagents



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# 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
	Effective date : 15 January 2019		

### Contents

1. Brief introduction to the topic
2. Scope and field of application
3. Principle
4. Apparatus
5. Materials
6. Health and safety
7. Sample preparation
8. Procedure
9. Calculation
10. Quality assurance / quality control
11. Reference documents (if any)
12. Appendix I - Results of inter-laboratory comparison
13. Appendix II – Acknowledgments
14. Appendix III - List of authors
15. Appendix IV - Contributing laboratories

# 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

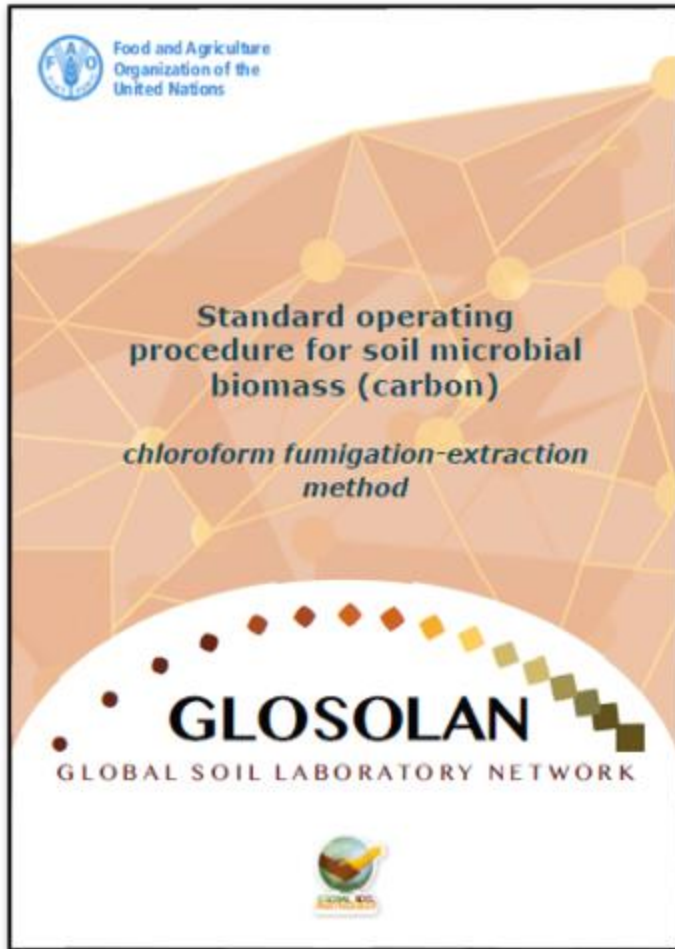




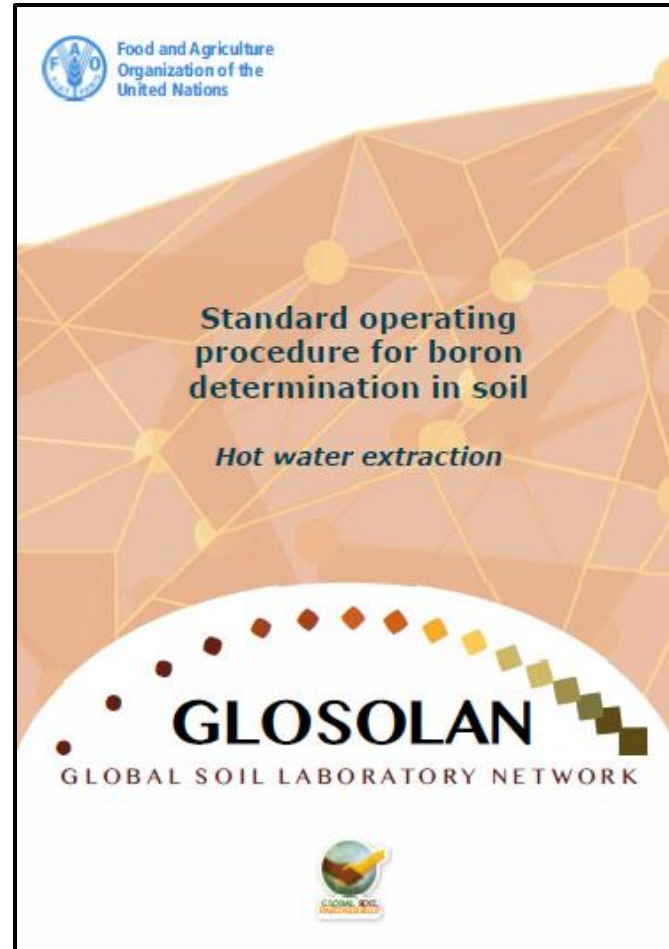
Over 15 000 views in three years!



# Recently released SOPs



*Microbial biomass*



*Boron by hot water extraction*



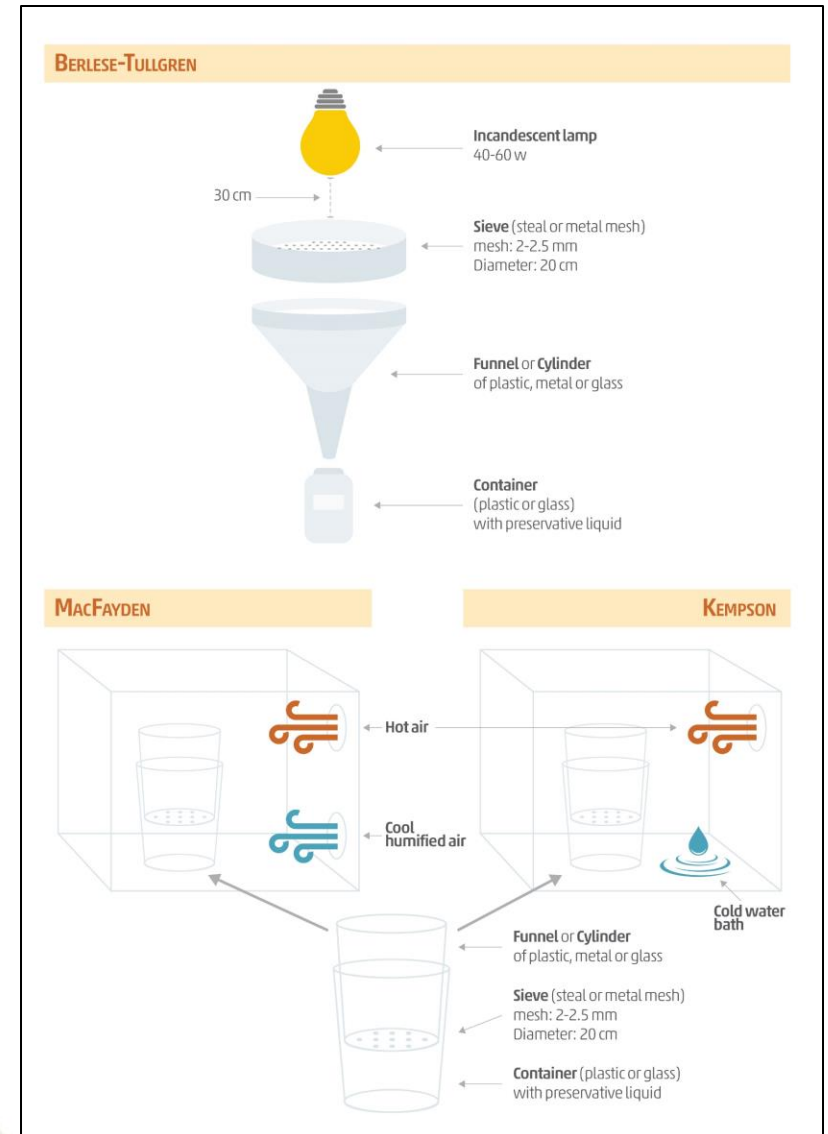
Scan to access all GLOSOLAN SOPs!

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# Status of the other SOPs

- Under publication (available soon):
  - Mesofauna by QBS-ar
  - Particulate organic carbon
  - Soil enzyme activity
    - $\beta$ -Glucosidases
    - Arylsulfatase
    - N-acetyl- $\beta$ -Glucosaminidase
    - Dehydrogenase
    - Phosphomonoesterases
- Under technical review:
  - Particle size distribution (*pipette and hydrometer*)
- Ongoing:
  - Water retention curve (pF)
  - Soil organic matter by loss of ignition
  - Nematodes
  - Explosive residues in soils



# GLOSOLAN SOPs developed so far

## Already published:

- 1 on sample pre-treatment
- 21 on soil chemical parameters (1 more ongoing)
- 2 on soil physical parameters (2 more ongoing)
- 4 on soil biological parameters

	2020	2021	2022	2023	2024
<b>Chemical</b>	Handling and preparation of soil samples for chemical and physical analyses, soil organic carbon (Walkley and Black), Calcium carbonate eq. (titrimetric and volumetric calcimeter methods)	Soil organic carbon (Tyurin), pH (H <sub>2</sub> O, KCl, CaCl <sub>2</sub> ), nitrogen (Dumas, Kjeldahl), electrical conductivity (in water and in saturated paste), Phosphorus (Bray I, Bray II, Olsen, Mehlich I), TC Dumas,	Available micronutrients (extraction using DTPA), Exchangeable bases and CEC (ammonium acetate)	Quasi-total elements-including heavy metals (digestion using aqua regia and EPA)	Boron by hot water extraction, particulate organic carbon (physical fractionation), <i>Organic matter (loss of ignition)</i>
<b>Physical</b>				bulk density (cylinder method), moisture content (gravimetric method)	<i>Water retention (pF) curve, Particle density (pycnometer), particle size-distribution (hydrometer, pipette)</i>
<b>Biological</b>				Soil respiration rate	Microbial biomass C and N by chloroform fumigation-extraction, soil enzyme activities (beta-glucosidase, arylsulfatase, beta-glucosaminidase, phosphatases and dehydrogenase), QBSar (mesofauna)



# Translations: where we are

## **French** – already done, just final review missing

- Guidelines on sample preparation
- Guidelines on how to prepare samples for internal reference material
- Guidelines on how to prepare samples for PT
- SOP for calcium carbonate
- SOP for carbon by Dumas
- SOP for soil organic carbon by Walkley and Black
- SOP on soil pH

## **Portuguese** – already done, just final review missing

- Guidelines on sample preparation
- Guidelines on how to prepare samples for internal reference material
- Guidelines on how to prepare samples for PT
- SOP for soil organic carbon by Walkley and Black
- SOP carbon by Dumas
- SOP on soil pH
- SOP on soil bulk density
- SOP for respiration rate
- SOP for electrical conductivity
- SOP for phosphorous by Bray I and II
- SOP for phosphorous by Olsen
- SOP for phosphorous by Mehlich I
- SOP for CEC and exchangeable bases
- SOP for available micronutrient and heavy metals by DTPA
- OP for heavy metals by acidic digestion
- SOP for moisture content

# Already in the pipeline

## CHEMICAL

- Organic matter by loss of ignition
- Available phosphorus by KCl
- Exchangeable acidity by KCl + Exchangeable Al by KCl
- Soil buffer capacity using KOH
- Exchangeable acidity by BaCl<sub>2</sub>
- Fe and Al oxides by ammonium oxalate and by sodium citrate plus sodium dithionite

## PHYSICAL

- Water retention (pF) curve
- Particle density by pycnometer
- Aggregate stability by Le Bissonais

## BIOLOGICAL

- N Mineralization by incubation method
- Nematodes trophic groups by wet extraction
- Greenhouse gases (GHS) emissions in soil
- DNA extractions

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# Any additional SOP?

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# Thank you

