GLOSOLAN PT 2022: global outcomes and perspectives

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GLOSOLAN steering committee
IRD – France
The mandate of the GSP is to improve governance of the limited soil resources of the planet.

What you cannot (correctly) measure, you cannot (correctly) manage.
Soil data can be obtained in different ways

Many data come from soil laboratory analysis

=> data provided by soil laboratories are essential for soil governance

6th Meeting of the Global Soil Laboratory Network (GLOSOLAN) | 22-24 November 2022
Soils are essential for food production:
Soils are essential for food production: Laboratories are essential for soil data production

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The good news: soil labs already exist all around the planet

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The good news: soil labs already exist all around the planet

The bad news: soil labs are working without coordination among them...

An option for improvement:
Purpose: to improve the quality of soil laboratory data to support decision making at field and policy levels

Objectives:
1. To strengthen the performance of laboratories through use of standardized methods and protocols.
2. To harmonize soil analysis methods so that soil information would be comparable and interpretable across laboratories, countries and regions.
3. To provide a certification for technical competencies in laboratory analysis.
For 5 years now GLOSOLAN helped these labs producing reliable and comparable soil data by providing SOPs, video explaining SOPs, trainings, webinars, technical publications, etc...
Now GLOSOLAN questions are:

1. How reliable and comparable are the data produced by soil laboratories?
2. How can GLOSOLAN help all labs to reach a minimum data quality?

For 5 years, GLOSOLAN has been helping soil labs producing reliable and comparable soil data by providing SOPs, video explaining SOPs, trainings, webinars, technical publications, etc…
Part 1 = assessment:

how reliable and comparable are the data produced by soil laboratories?
⇒ Launching a global (planet) proficiency testing (PT) or inter-laboratory comparison.

The PT design was decided according to:

our QUESTIONS (reliability / comparability)

& FEASABILITY (number of soil types, cost of preparation including irradiation, cost of sending worldwide, etc)
QUESTIONS: 2 + 1 more

1. **RELIABILITY**: for each lab, what is its precision?
   (i.e. when analysing several times the same sample, how close are the results?)

2. **COMPARABILITY**: among all labs, dispersion of their results?
   (i.e. when the same sample is analysed by several labs, how close are the results?)

3. 
QUESTIONS: 2 + 1 more

1. RELIABILITY: for each lab, what is its precision?
   (i.e. when analysing several times the same sample,
   how close are the results?)

2. COMPARABILITY: among all labs, dispersion of their results?
   (i.e. when the same sample is analysed by several labs,
   how close are the results?)

3. REFERENCE VALUE: at global scale, consensus value = reference value?
   (i.e. on a statistical and practical viewpoint,
   can we provide samples with reference values acceptable worldwide?)
FEASABILITY:

1. Which soil characteristics?

2. How many replicates?

3. Which range?
FEASABILITY:

1. Which soil characteristics?

   pH: top priority but difficult because too much soil weight is needed
FEASABILITY:

1. Which soil characteristics?

   pH: top priority but difficult because too much soil weight is needed

   C: top priority because
   - soil is a main compartment in C cycle... global warming...
   - and...
Protocol for the assessment of Sustainable Soil Management

List of contributors:
### Protocol for the assessment of Sustainable Soil Management

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Parameter/ metric</th>
<th>Measurement methods</th>
<th>Sample characteristics</th>
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<tbody>
<tr>
<td>Soil productivity</td>
<td>Agricultural productivity or biomass in dry matter (t ha⁻¹ year⁻¹)</td>
<td>Dry weight of vegetation quadrats, or yield measurements</td>
<td>Quadrat method or yield measurement</td>
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<td>Soil physical properties</td>
<td>Bulk density (kg dm⁻³)</td>
<td>The Core Method</td>
<td>Undisturbed representative sample with known volume</td>
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<td>In some cases, bulk density can be complemented by available water capacity, or other relevant soil physical properties (See additional indicators)</td>
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<td>Soil biological activity</td>
<td>Soil respiration rate (gCO₂ m⁻² d⁻¹)</td>
<td>Laboratory based soil respiration measurement (static or dynamic)</td>
<td>Representative soil sample to be analyzed within hours or refrigerated</td>
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<td>Ideally combined with at least one other biological indicator (See soil biological activity p. 4 and 5)</td>
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FEASABILITY:

1. Which soil characteristics?

pH: top priority but difficult because too much soil is needed...

C: top priority because
- soil is a main compartment in C cycle
- and « Protocole of assessment of sustainable management »
- low soil amount is needed

N & P: main factors of productivity / negative impact on environment
low soil amount is needed
FEASABILITY:

1. Which soil characteristics?

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N & P: main factors of productivity / negative impact on environment
      low soil amount is needed

Which methods?
Carbon

**METHODS**

- **Walckley & Black**
  - Wet chemistry

- **Dumas**
  - Combustion (controlled atmosphere)

**TOOLS**

- **Loss of ignition**
  - Combustion (450-550°C)
Carbon

Loss of ignition
Combustion (controlled atmosphere)

Dumas
Combustion (450-550°C)

Walckley & Black
Wet chemistry

METHODS

TOOLS

For some methods, ≠ procedures are possible

Temperature

NA
duration
METHODS

Soil characteristic

Nitrogen

Kjeldahl
Wet chemistry

Dumas
Combustion (controlled atmosphere)

TOOLS

For some methods, unequal procedures are possible
Phosphorus

Olsen

0.5 M NaHCO₃ solution, adjusted at a pH of 8.5.

Bray 1

0.03 M NH₄F and 0.025 M HCl

Bray 2

0.03 M NH₄F + 0.1 M HCl

For some methods, ≠ procedures are possible

METHODS ➔ EXTRACTANTS

shaking times
FEASABILITY:

1. Which soil characteristics? C N P

2. How many replicates?
2. How many replicates?

Enough rep. to be able to make a statistical analysis,
Not to much to avoid reduced efficiency

Comparability

Compare all labs

6 rep:

A  B  C  D  E  F

Reliability

of each individual lab
2. How many replicates?

Enough rep. to be able to make a statistical analysis,
Not to much to avoid reduced efficiency

Comparability

Compare all labs

6 rep:

A   B   C   D   E   F

Reliability

of each individual lab

Estimated through PRECISION

⇒ Is the analytical process under control?
⇒ or is random

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WHY PRECISION IS IMPORTANT:

If you go up and down your balance, you expect the same result everytime
WHY PRECISION IS IMPORTANT:

If you make several times the test (within short time)
    You expect the same result

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5 REPLICATES

5 times the same result?

(comment: relevant, whatever the method and procedures used by the labs)
FEASABILITY:

1. Which soil characteristics? C N P

2. How many replicates? 6 soil types & 5 rep for one soil
FEASIBILITY:

1. Which soil characteristics? C N P

2. How many replicates? 6 soil types & 5 rep

3. Which range?
FEASABILITY:

1. Which soil characteristics? C N P

2. How many replicates? 6 soil types & 5 rep

3. Which range?

   LOW to HIGH carbon content
FEASABILITY:

1. Which soil characteristics? C N P

2. How many replicates? 6 soil types & 5 rep

3. Which range?

   LOW to HIGH carbon content

   0.2 to 6 % carbon
FEASABILITY:

1. Which soil characteristics? C N P

2. How many replicates? 6 soil types & 5 rep

3. Which range? 0.2 to 6 % carbon

10 SOIL SAMPLES
After you sent the analysis, still a lot of work was done

Processes with customs for ‘difficult’ countries

Contact the labs that were late

Contact the labs that did not follow the recommendations (no C data...)

Make the statistical analyse and check

Individual lab performances

Regional performances

etc...

6th Meeting of the Global Soil Laboratory Network (GLOSLON) | 22-24 November 2022
GLOBAL RESULTS
Statistical procedure
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Consensus values
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Precision
**Precision**: interpretation of Z-score standard deviation (sd)

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Carbon
OK

the analytical process is under control
OK

Half have problems
Half have problems

Some have very serious problems

6th Meeting of the Global Soil Laboratory Network (GLOSOLAN) | 22-24 November 2022
Half have problems

Analytical problems or transcription problems?

Anyway clients gets low quality and unreliable data

OK
Using high tech. instruments but still problems => human factor?
Lab precision (or repeatability) for: C_Ig

Majority is OK but unreliable method
Many have very serious problems

> half have problems
Lab precision (or repeatability) for: N_Dum
Using high tech. instruments but still problems => human factor?
Phosphorus
Lab precision (or repeatability) for: P_Ols
A majority is OK! 😊

Few labs still had serious problems.
Lab precision (or repeatability) for: P_B1
A large majority is OK! 😊😊

Marginal problems

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Nearly all labs are OK! 😊 😊
Comparability & accuracy

How distant/different are the results from each lab
Compared to the consensus value.
Carbon
Average of the 10 Z score for the 10 analyses made

⇒ Possible to calculate a standard deviation:
  + short error bar: similar performances for all 10 samples (even the 2 extreme values)
  + long error bar: different performances
By chance some labs have an good average performance but indeed the performances different (very different) between samples => It was useful to have a large range of content

Whatever the difficulty of the method, some labs made it very well for a large range of C content.
Technology cannot solve all problems! The human factor is important too.
Z score 'average for C-lg

average Z score of each lab

Z_av

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Nitrogen
The human factor?
Phosphorus
Z score 'average for P_B2
Part 1 = assessment:

how reliable and comparable are the data produced by soil laboratories?
QUESTIONS: 2 + 1 more

1. RELIABILITY: for each lab, what is its precision?
   many labs have insufficient precision: need to develop IQC
QUESTIONS: 2 + 1 more

1. RELIABILITY: for each lab, what is its precision?
   many labs have insufficient precision: need to develop IQC

2. COMPARABILITY: among all labs, dispersion of their results?
   Depends on method but even with high tech
   Analytical problems &/or transcription mistakes?
QUESTIONS: 2 + 1 more

1. RELIABILITY: for each lab, what is its precision?
   many labs have insufficient precision: need to develop IQC

2. COMPARABILITY: among all labs, dispersion of their results?
   Depends on method but even with high tech
   Analytical problems &/or transcription mistakes?

3. REFERENCE VALUE: at global scale,
   consensus value = reference value: YES!
**Purpose:** to improve the quality of soil laboratory data to support decision making at field and policy levels

**Objectives:**

1. To strengthen the performance of laboratories through use of standardized methods and protocols.
2. To harmonize soil analysis methods so that soil information would be comparable and interpretable across laboratories, countries and regions.
3. To provide a certification for technical competencies in laboratory analysis.

*Done but need to go forward*
Purpose: to improve the quality of soil laboratory data to support decision making at field and policy levels

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Done but need to go forward

Record of performances but not yet certificates
Part 2 = future perspectives:
(suggestions to be discussed)

Which actions/activities to improve all labs performances?
let’s consider the laboratories as ‘factories producing data’

global situation of labs was a black box
GLOSOLAN has opened the door and brought some light...

Soil lab
= black box

Keep the duration as short as possible

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This is how it looks inside the ‘factory’:

client → SOIL → registration → storage → preparation → pH → Carbon → Nitrogen → Phosphorus → CEC → Texture → Etc… → Report (results, data) → client

client

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This is how it looks inside the ‘factory’:

What did we discover & what can be proposed?

This is what we have tested with GLOSOLAN PT

Report (results, data)

Carbon
Nitrogen
Phosphorus
This is how it looks inside the ‘factory’:

LACK OF INTERNAL QUALITY CONTROL

- Carbon
- Nitrogen
- Phosphorus

For the analytical processes?

For the transcription/secretary processes?

Report (results, data)
This is how it looks inside the ‘factory’:

**LACK OF INTERNAL QUALITY CONTROL**

- Carbon
- Nitrogen
- Phosphorus

For the analytical processes?

For the transcription/secretary processes?

Report (results, data)

Labs with poor ‘precision’ performances need to take action

Request GLOSOLAN members support or GSP/GLOSOLAN secretary

(confidentiality guaranteed!)
EXTERNAL QUALITY CONTROL?

ABSOLUTELY NECESSARY BUT...
Cannot be organised by GLOSOLAN for all labs

REGIONAL PTs are necessary
EXTERNAL QUALITY CONTROL?
EXTERNAL QUALITY CONTROL?

ABSOLUTELY NECESSARY BUT...
Cannot be organised by GLOSOLAN for all labs
EXTERNAL QUALITY CONTROL?

ABSOLUTELY NECESSARY BUT...
Cannot be organised by GLOSOLAN for all labs

REGIONAL PTs are necessary... how to do?
REGIONAL PTs are necessary... how to do?

- Each region or sub-region must organise PTs
- Glosolan will organise GLOBAL PTs involving only high performing labs to assure accuracy and comparability
Human factor?
GLOSOLAN has done many activities to help labs

Now GLOSOLAN needs the help of high performing labs to train the less successful labs, on a regular basis...
Human factor?

GLOSOLAN has done many activities to help labs.

Now GLOSOLAN needs the help of high performing labs to train the less successful labs, on a regular basis...

Performances

All participants know where they are..
Human factor?

GLOSOLAN has done many activities to help labs

Now GLOSOLAN needs the help of high performing labs to train the less successful labs, on a regular basis...

Performances

All participants know where they are..
It is important to reach the highest step.

It is also important to help each other to reach the highest step!
Human factor?

GLOSOLAN has done many activities to help labs. Now GLOSOLAN needs the help of high performing labs to train the less successful labs, on a regular basis...

Performances

All participants know where they are..

FOR THE FUTURE
Data are important

Precision  Accuracy

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Data are important

Precision  Accuracy

Health & Safety too!

On going, should develop...

People & environment

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3. To provide a certification for technical competencies in laboratory analysis.

Record of performances but not yet certificates
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Thanks for your attention
Thank you to PT participants